No. ________________

**UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT**

IN RE ECOLOGY CENTER, INC.,
CENTER FOR ENVIRONMENTAL HEALTH,
UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and
SIERRA CLUB,

Petitioners.

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, and MICHAEL REGAN, in his official capacity as ADMINISTRATOR of the U.S. ENVIRONMENTAL PROTECTION AGENCY,

Respondents.

PETITION FOR WRIT OF MANDAMUS

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FRAP 26.1 CORPORATE DISCLOSURE STATEMENT

Petitioners Ecology Center, Inc., Center for Environmental Health, United Parents Against Lead & Other Environmental Hazards, and Sierra Club, state that they are nonprofit organizations, have no parent corporations, and no publicly held corporation owns 10 percent or more of their stock.

Respectfully submitted this 22nd day of August, 2023.

s/Lakendra S. Barajas
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INTRODUCTION

Petitioners Ecology Center, Inc. (the "Ecology Center"), Center for Environmental Health, United Parents Against Lead & Other Environmental Hazards f/k/a United Parents Against Lead National, Inc. ("UPAL"), and Sierra Club respectfully petition this Court for a writ of mandamus directing Respondents, the U.S. Environmental Protection Agency ("EPA") and its Administrator Michael Regan, to conclude a rulemaking under the Toxic Substances Control Act ("TSCA") regulating lead wheel weights within six months.

In August 2009, EPA granted a TSCA petition filed by Petitioners and allied individuals and organizations requesting EPA establish regulations prohibiting the manufacture, processing, and distribution in commerce of lead wheel balancing weights. Ecology Ctr. et al., Citizen Petition Under TSCA to Prohibit the Production and Use of Lead Wheel Weights in the United States (May 28, 2009) ("2009 Petition") [A001].[1] In its grant of the 2009 Petition, EPA committed to prompt action and highlighted its ongoing effort to reduce lead exposures. Letter from Stephen A. Owens, EPA, to Jeff Gearhart, Ecology Ctr., & Tom Neltner, Sierra Club (Aug. 26, 2009) (the "2009 Response") [A005]. Yet nearly fourteen years later, EPA has failed

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[1] Select documents and the declarations cited in this petition are provided in the accompanying Appendix of Select Cited Documents and Declarations. The Bates numbers in the Appendix corresponding to the first page of the cited document are included in brackets at the end of the full citation in this petition, *e.g.,* [A001].

to conclude a rulemaking on lead wheel weights, and all action toward that end appears to have completely stalled a decade ago.

This egregious delay has left Petitioners' members and supporters, and their children, unnecessarily exposed to a highly toxic chemical for which exposure at any level can cause irreversible harm. Interstate transit of vehicles with easily dislodged lead wheel weights makes this harm widespread and curbs the effectiveness of the limited number of state laws regulating lead wheel weights. Further, communities of color and low-wealth communities are disproportionately harmed by lead, and the exposure to lead from lead wheel weights adds to their cumulative lead burdens. EPA must act now to eliminate this source of lead exposure. Because EPA appears unwilling to fulfill its legal obligation without court intervention, Petitioners ask this Court to compel EPA to expeditiously conclude a rulemaking on lead wheel weights.

RELIEF SOUGHT

Petitioners seek a writ of mandamus directing EPA to conclude a TSCA rulemaking for lead wheel weights within six months of the Court's issuance of a writ.

STATEMENT OF JURISDICTION

This Court has jurisdiction to compel EPA to complete the rulemaking it pledged to undertake. 28 U.S.C. § 1651(a); 5 U.S.C. § 706(1). The Administrative Procedure Act ("APA") provides that a federal agency must "conclude a matter presented to it" "within a reasonable time," 5 U.S.C. § 555(b), and that a "reviewing court shall . . . compel agency action unlawfully withheld or unreasonably delayed," *id.* § 706; *see also id.* § 702.

"Any court that would have jurisdiction to review a final rule has jurisdiction to determine if an agency's delay is unreasonable," *In re A Cmty. Voice*, 878 F.3d 779, 783–84 (9th Cir. 2017) (citing *Telecommc'ns. Rsch. & Action Ctr. v. FCC* ("*TRAC*"), 750 F.2d 70, 75 (D.C. Cir. 1984)), and this Court has jurisdiction to review a final rule issued by EPA under section 6 of TSCA, *see* 15 U.S.C. § 2618(a). This Court thus has jurisdiction to determine if EPA's delay is unreasonable. And because the All Writs Act empowers federal courts to "issue all writs necessary or appropriate in aid of their respective jurisdictions," 28 U.S.C. § 1651(a), this Court has the authority to issue a writ of mandamus directing EPA to act. *See In re Pesticide Action Network N. Am.* ("*In re PANNA*"), 798 F.3d 809, 813 (9th Cir. 2015). Venue is proper here because Petitioners Center for Environmental Health and Sierra Club have their principal places of business in California. *See* 15 U.S.C. § 2618(a)(1)(A).

STANDING

Petitioners have standing to pursue this writ of mandamus. Ecology Center, Center for Environmental Health, UPAL, and Sierra Club were among the organizations that filed the 2009 Petition. Petitioners are organizations dedicated to reducing exposure to lead and other toxic chemicals and safeguarding the health of their communities. *See* Decl. of Jeff Gearhart [A430]; Decl. of Kaya Allan Sugerman [A451]; Decl. of Zakia Rafiqa Shabazz [A478]; Decl. of Sonya Lunder [A493]. Petitioners have members and/or supporters who have been and continue to be harmed by lead exposure and who would benefit from restrictions on lead wheel weights. *See* Decl. of Melissa Cooper Sargent [A442]; Decl. of Gabriel Cardenas [A461]; Decl. of Andrea Braswell [A470]; Decl. of Charlotte Scott [A485]; Decl. of Doris Cellarius [A501]; Decl. of Christy McGillivray [A509].

EPA's delay in regulating the manufacture, processing, and distribution in commerce of lead wheel weights harms Petitioners and their members and supporters. For almost fourteen years, Petitioners' members and supporters have been exposed to lead from wheel weights while waiting in vain for EPA to conclude the rulemaking it pledged to undertake and regulate this source of lead exposure. These injuries could be redressed by an order from this Court compelling EPA to conclude the rulemaking. *See Salmon Spawning & Recovery All. v. Gutierrez*, 545 F.3d 1220, 1226–29 (9th Cir. 2008) (discussing standing requirements for parties alleging procedural-rights violations). If EPA prohibits the manufacture, processing, and distribution in commerce of lead wheel weights, as the granted 2009 Petition requested, Petitioners' members and supporters would not face ongoing lead exposures from the use of lead wheel weights. And if EPA ignores its obligations under TSCA to eliminate the unreasonable risks posed by lead wheel weights and takes final agency action that does not address this exposure source, Petitioners could challenge that action in court.

ISSUE PRESENTED

Whether EPA's nearly fourteen-year delay in regulating lead wheel weights under TSCA—a rulemaking that EPA agreed to initiate in response to a 2009 citizens' petition—is unreasonable, warranting the issuance of a writ of mandamus from this Court requiring EPA to conclude the rulemaking expeditiously.

BACKGROUND

I. THE DANGER POSED BY LEAD AND LEAD WHEEL WEIGHTS

A. Lead Is a Dangerous Toxic Chemical That Can Cause Irreversible Health Harms at Low Levels of Exposure

Lead is a toxic heavy metal for which there is no safe level of exposure. *See* EPA, *Integrated Science Assessment for Lead*, at lxxxviii (2013) ("Lead ISA") [A106]; Reconsideration of the Dust-Lead Hazard Standards and Dust-Lead Post-Abatement Clearance Levels, 88 Fed. Reg. 50,444, 50,455 (proposed Aug. 1, 2023) [A135] ("[T]here is no evidence of a threshold below which there are no harmful health effects from lead exposure."). Lead affects virtually every organ system. Lead ISA at lxxxiii—lxxxvii; Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Lead* 4 (2020) ("ATSDR Tox. Profile") [A175]. Lead exposure is associated with serious health effects, including an increased risk of cancer; higher blood pressure; lower cognitive function; harm to the nervous, cardiovascular, immune, and reproductive systems; adverse kidney and blood effects; and adverse neurobehavioral effects, including anxiety and depression. *See* Lead ISA at lxxxiii—lxxxvii; *see also* 88 Fed. Reg. at 50,448. Lead is also a probable human carcinogen. *See* ATSDR Tox. Profile at 8–9, 248; 88 Fed. Reg. at 50,448.

Lead harms human health even at very low levels: At extremely low blood-lead levels, adults face increased risks of cardiovascular disease, and children can suffer neurodevelopmental harm with irreversible effects. Lead ISA at xciii, 1-68, 1-76. And lead is a bioaccumulative toxicant, meaning that it accumulates in the body, where it can be retained for decades. ATSDR Tox. Profile at 4, 12. "As lead exposure increases, the range and severity of symptoms and effects also increase." *Lead Poisoning*, Page in *Health Topics*, WHO (last visited Aug. 22, 2023) [A187].

Children are at particularly high risk of harm from exposure to lead. Due to their age-appropriate behaviors, such as increased hand-to-mouth contact and poor handwashing, children typically ingest more lead than adults, including lead deposited on the ground, floor, and in soil. Lead ISA at 1-11, 1-78, 5-6. Children's bodies absorb ingested lead more easily than those of adults, *id.* at 3-37, and more of the lead that enters the body gains access to the brains of children than of adults, *see id.* at 3-80, 4-237. Indeed, as EPA recognizes, "[l]ead exposure has the potential to impact individuals of all ages, but it is especially harmful to young children because the developing brain can be particularly sensitive to environmental contaminants." 88 Fed. Reg. at 50,446. Lead exposure can start at the earliest life stages: Lead stored in a pregnant person's bones can release into their blood during pregnancy and expose the fetus, ATSDR Tox. Profile at 292–93, 296–97, and breastfed infants can be exposed to lead through breast milk during crucial development windows, *id.* at 297–98; *see also* Lead ISA at 3-29, 4-589 to -590, 5-9.

Black children and children living in low-wealth households are especially at risk of harm from additional lead exposure because of existing racial and socioeconomic disparities in exposure and because they "have persistently been found to have higher blood lead levels" than children from other backgrounds. EPA, *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities* 5 (2022) ("Lead Strategy") [A189]; *see also id.* at 3, 5. Since lead accumulates in the body and higher lead levels are associated with a broader range and increased severity of symptoms, additional sources of lead exposure can exacerbate the harms experienced by children of color and children living in low-wealth households. *See* ATSDR Tox. Profile at 12; *Lead Poisoning*, WHO.

Lead also harms fish and wildlife. *See* Lead ISA at 1-39 ("Commonly observed effects of [lead] on terrestrial organisms include decreased survival, reproduction, and growth, as well as effects on development [and] behavior . . . ."); *id.* at 1-44 to -47 (reviewing the harmful effects of lead on freshwater organisms and explaining that evidence supports "that waterborne [lead] is highly toxic to freshwater plants, invertebrates and vertebrates"). Terrestrial organisms can be exposed to lead through soil, *id.* at 1-42, and aquatic organisms can be exposed from contaminated water or by ingesting lead-contaminated food or sediment, *id.* at 1-43.

B. Lead Wheel Weights Are a Widespread and Ongoing Source of Exposure to Lead

One way lead enters the environment—and ultimately people's bodies—is through the use and detachment of lead wheel weights. Wheel weights are pieces of metal that attach to automobile wheel rims to balance tires while driving. Despite the dangers associated with lead exposure, lead wheel weights are still in use across the United States. *See* Lead ISA at 2-17. During normal driving conditions, wheel weights often "fail"—they become loose and fall off of rims—allowing lead to enter the environment. *See id.*; *see also* EPA, Peer Draft Report of *Approach for Estimating Changes in Blood Lead Levels from Lead Wheel Weights* 13 (2011) ("Estimating Changes") [A330] ("Lead wheel weights can be dislodged and then lost from vehicles, thus releasing lead into the environment."); Jack Caravanos et al., *An Exterior and Interior Leaded Dust Deposition Survey in New York City: Results of a 2-Year Study*, 100 Env't Rsch. 159, 163 (2006) [A251] (explaining that lead from wheel weight failure is "continuous, significant, and widespread"). Millions of pounds of lead per year are estimated to be released into the environment from lead wheel weights. *See* Estimating Changes at 13 (reviewing estimates between three and four million pounds each year); *cf. National Lead Free Wheel Weight Initiative*, EPA (last updated Feb. 22, 2016)[2] [A257] (estimating that over 12.5 million pounds of lead from wheel weights are "uncontrolled or unmanaged in the environment" each year and 1.6 million pounds are "lost" each year when wheel weights fall off).

When lead wheel weights fall off, they land on road surfaces, where they can be ground into dust by passing traffic. *See* Estimating Changes at 13. This lead dust can then contaminate surrounding streets, soil, and waterways. *See* 2009 Petition at 3; Env't Council of the States, Resolution 08-9, *Phasing Out the Sale and Installation of Lead Wheel Weights* 2 (last updated Mar. 30, 2023) ("ECOS Resolution") [A259]; Lead ISA at 2-17; Robert A. Root, *Lead Loading of Urban Streets by Motor Vehicle Wheel Weights*, 108 Env't Health Persps. 937 (2000) [A262]. This dust can also migrate into indoor environments, *see* Caravanos et al. at 5; Estimating Changes at 10. People can be exposed to lead from wheel weights by inhaling or ingesting lead dust or by drinking contaminated water. *See* Estimating Changes at 10. In addition to facing exposures to lead dust, children can also be exposed to lead from wheel weights by picking up and playing with lead wheel weights that are not fully abraded. *See* 2009 Petition at 3. This is particularly concerning given the potential for children to ingest lead and lead-contaminated soil

[2] Available at:
https://archive.epa.gov/epawaste/hazard/wastemin/web/html/nlfwwi.html.

during age-appropriate hand-to-mouth behaviors. Lead wheel weights can also contaminate waste streams when they are collected during street cleaning and sent to a landfill for disposal or if they end up in auto-shredder residue (end-of-life vehicle waste). *See Lead and Mercury-Added Wheel Weights*, N.Y. Dep't of Env't Conservation (last visited Aug. 21, 2023) [A266]. And lead wheel weights along roads can pollute soil, waterbodies, and groundwater, poisoning fish and wildlife. *See Maine's Lead & Mercury Wheel Weight Ban*, Me. Dep't of Env't Protection (last visited Aug. 21, 2023) [A269].

Lead wheel weights are still sold and distributed in the United States, and forty-one states still have no prohibition on their use, manufacture, or installation. *See* ECOS Resolution at 2; *Balancing Weights,* Perfect Equip., (last visited Aug. 22, 2023)[3] ("High-quality zinc and steel, as well as lead, are the basic materials for our adhesive weights and adhesive weight rolls for rims."); Product Page for Perfect Equip. Wheel Weights, Grainger (last visited Aug. 22, 2023)[4] (showing lead wheel weights available for sale domestically in most states). Lead is not a required component of wheel weights, even though it is still widely used—in 2015, the Ecology Center estimated "that approximately 50% of the market continues to use

[3] Available at: https://www.perfectequipment.com/us/products/balancing-weights.
[4] Available at: https://www.grainger.com/category/fleet-vehicle-maintenance/tire-maintenance/tire-wheel-performance/wheel-balancing?brandName=PERFECT+EQUIPMENT&filters=brandName.

the lead product, despite viable, lead-free alternatives being extensively used." Letter from Jeff Gearhart, Ecology Ctr., to Wendy Cleland-Hamnett et al., EPA (May 27, 2015) ("May 2015 Letter") [A328]; *cf.* ECOS Resolution at 2 ("[L]ead-free wheel weights with cost and performance superior or equal to that of lead wheel weights are readily available in the U.S. and world markets.").

II. TSCA'S LEGAL FRAMEWORK

Section 21 of TSCA permits "[a]ny person" to "petition [EPA] to initiate a proceeding for the issuance . . . of a rule" under certain sections—including section 6—of TSCA. 15 U.S.C. § 2620(a). Within ninety days of a petition's filing, EPA must either grant or deny the petition, and if EPA grants it, it "shall promptly commence an appropriate proceeding in accordance with" the relevant TSCA provision. *Id.* § 2620(b)(3).

Section 6 of TSCA requires EPA to regulate a chemical that poses an unreasonable risk of injury to health or the environment. *See* 15 U.S.C. § 2605. When EPA granted the 2009 Petition, section 6(a) provided that if EPA found a reasonable basis to conclude that a chemical's manufacture, processing, distribution, use, or disposal presents or will present an unreasonable risk of injury to health or the environment, EPA must use "the least burdensome requirements" to protect against such risk. *See* 15 U.S.C. § 2605(a) (2009) (amended 2016). When TSCA was amended in 2016, the mandate to choose the "least burdensome requirements" to regulate risk was removed. Frank R. Lautenberg Chemical Safety for the 21st Century Act, Pub. L. No. 114-182, § 6, 130 Stat. 448, 460 (2016). Now, EPA must eliminate unreasonable risks presented by a chemical, and while it must consider "the reasonably ascertainably economic consequences" of a rule in doing so, it is not obligated to choose the least burdensome regulatory option. 15 U.S.C. § 2605(c)(2)(A)(iv); *see also id.* § 2605(a), (c). One regulatory option available to EPA under section 6 is to "prohibit[] . . . the manufacture, processing, or distribution in commerce of [a] substance" for "a particular use." *Id.* § 2605(a)(2)(A).

III. EPA'S DELAY

Almost two decades ago, in May 2005, the Ecology Center first petitioned EPA under section 21 of TSCA "to establish regulations prohibiting the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights." Ecology Ctr., Citizen Petition Under TSCA to Prohibit the Production and Use of Lead Wheel Weights in the United States 1 (May 13, 2005) ("2005 Petition") [A006]. The 2005 Petition explained that lead wheel weights play a significant role in the release of lead into the environment and provided EPA with evidence of these releases. *Id.* at 2, 5. It estimated that, each year, lead wheel weight failure causes as much as 1,631 metric tons—over three million pounds—of lead to be deposited on roads in the United States. *Id.* at 2–6. The 2005 Petition requested regulation pursuant to section 6 of TSCA. *Id.* at 9.

EPA denied the 2005 Petition, asserting that it did not have enough information about human or environmental exposures to adequately assess the risks posed by lead wheel weights. *See* TSCA Section 21 Petition; Response to Citizen's Petition, 70 Fed. Reg. 51,061, 51,063 (Aug. 29, 2005) [A102]. It noted, however, that it was "concerned about the potential contribution of lead wheel weights and other products that contain lead to elevated blood lead levels in children" and that it would continue to study the issue, explaining that it was "developing an approach to prioritize for further analysis and action the variety of products containing lead, that would be subject to TSCA and/or voluntary initiatives, including lead wheel weights." *Id.* Despite its stated concern, EPA did not use its TSCA authority to regulate lead wheel weights.

In May 2009, Petitioners and others submitted another petition under section 21 of TSCA, again requesting that EPA "establish regulations prohibiting the manufacture, processing, and distribution in commerce of lead wheel balancing weights." 2009 Petition at 1. The 2009 Petition incorporated the 2005 Petition by reference and provided additional evidence that lead wheel weights falling into roadways is a significant source of lead exposure. *See id.* at 1, 3. It also pointed to EPA's own acknowledgements that, each year, over one million pounds of lead is "lost when wheel weights fall off during normal driving conditions such as hitting a pot hole." *Id*. at 3.

On August 26, 2009, after opening a docket and receiving public comment, EPA granted the petition. In so doing, EPA explained that it "will promptly commence an appropriate proceeding under TSCA" and "anticipates commencing this proceeding through either an Advance Notice of Proposed Rulemaking or a Proposed Rule." 2009 Response. However, despite granting the petition, EPA has never issued an Advance Notice of Proposed Rulemaking or proposed a rule to address the concerns raised in the petitions, much less concluded a rulemaking concerning lead wheel weights.

EPA has failed to do so despite its own recognition that any level of lead in a person's bloodstream can cause serious health harms and that lead wheel weights expose individuals to lead and can increase the level of lead in their blood. In 2011, EPA prepared a peer review draft report in which EPA investigated human exposures to lead wheel weights in two scenarios. *See* Estimating Changes. There, EPA explained that lead wheel weights "can be lost from cars and can enter the environment, leading to potential exposures to children and adults who inhale or ingest roadway particles containing wheel weight lead or who drink contaminated water." *Id.* at 10. It estimated that lead wheel weights would result in an increase in blood lead levels for children and adults, with greater increases in children and people living in urban environments. *See id.* at 63–66. Despite this finding, EPA did not take action to ban lead wheel weights.

Over the past decade, all fifty states' environmental agencies through the Environmental Council of the States ("ECOS"), and environmental and health organizations, have continued to urge EPA to finalize action on lead wheel weights, to no avail. *See* ECOS Resolution at 3 (requesting EPA to "move forward in an expedited manner on its 2009 granted petition and notice under TSCA to initiate regulatory action to address lead hazards associated with the manufacture, processing, and distribution in commerce of lead wheel balancing weights in the United States"); *id.* at 1 (showing resolution was initially approved in 2008 and revised five times thereafter). In 2015, the Ecology Center wrote to EPA to inquire about the status of EPA's proceeding in response to the granted 2009 Petition. *See* May 2015 Letter. The letter pointed out that "[p]rogress to address this significant ongoing release of lead to the environment has been effectively halted by EPA's lack of action on this rulemaking." *Id.* A month later, the Ecology Center and its counsel Earthjustice submitted a Freedom of Information Act request, seeking information about EPA's decision to grant the 2009 Petition and subsequent actions taken in response to that grant. *See* Decl. of Eve C. Gartner [A324] ¶ 4.

In 2016, the Ecology Center, several of its partners, several U.S.-based wheel weight manufacturers, and other stakeholders met with EPA to discuss EPA's delay in regulating lead wheel weights. In a letter sent after that meeting, Petitioner Ecology Center reiterated its concerns about the delay. *See* Letter from Jeff Gearhart, Ecology Ctr., to Jeffrey Morris et al., EPA (June 15, 2016) [A423]. It explained that a ban on lead wheel weights would fit within an amended TSCA and once again outlined why a ban would protect human health and the environment from toxic exposures to lead. *See id.* After TSCA was amended, EPA responded to the letter by stating that it "is reviewing the new law to determine next steps," including how to evaluate and address potential risks from ongoing lead uses like lead wheel weights. *See* Letter from Jeffery T. Morris, EPA, to Eve C. Gartner, Earthjustice (July 11, 2016) [A428]. Since then, EPA has not publicly identified any "next steps" that it plans to take in response to its grant of the 2009 Petition, much less acted to regulate lead wheel weights.

Indeed, any progress that may have been made on EPA's "appropriate proceeding under TSCA," 2009 Response, appears to have stopped entirely more than a decade ago. In Regulatory Agenda entries in 2010 and 2011, EPA identified moving timetables for issuing a Notice of Proposed Rulemaking in response to the 2009 Petition—first May of 2011, then March of 2012, then June of 2012, then October of 2012—before the lead wheel weights matter disappeared completely from the Regulatory Agenda. In each of those entries, EPA acknowledged that "[l]ead is highly toxic, especially to young children," cite

d a U.S. Geological Survey study that approximately 2,000 tons—four million pounds—of lead wheel weights were lost to the environment in a single year, and stated that, despite voluntary actions by domestic automobile manufacturers, lead wheel weights "continue to be [a] predominant product in the tire replacement market." OMB, RIN 2070-AJ64, Spring Unified Agenda Notice for Lead Wheel Weights (2010) [A272]; OMB, RIN 2070-AJ64, Fall Unified Agenda Notice for Lead Wheel Weights (2010) [A273]; OMB, RIN 2070-AJ64, Spring Unified Agenda Notice for Lead Wheel Weights (2011) [A274]; OMB, RIN 2070-AJ64, Fall Unified Agenda Notice for Lead Wheel Weights (2011) [A275].

For nearly fourteen years, despite repeated pleas from stakeholders, EPA has failed to conclude the rulemaking it committed to initiate. As a result of EPA's inaction, individuals across the country continue to be exposed to lead from lead wheel weights, putting them at risk of irreversible health harms.

ARGUMENT

Mandamus relief is "warranted in those rare instances when the agency's delay is 'egregious.'" *In re PANNA*,798 F.3d at 813 (citation omitted). In deciding whether an agency's delay is "sufficiently egregious" to warrant mandamus relief, this Court considers the six factors set forth in *TRAC*, 750 F.2d at 79–80. *In re Nat. Res. Def. Council, Inc* ("*In re NRDC*"), 956 F.3d 1134, 1138 (9th Cir. 2020). However, "an agency cannot unreasonably delay that which it is not required to do," so before applying the *TRAC* factors, the Court considers whether the agency is under a duty to act. *In re A Cmty. Voice*, 878 F.3d at 784.

EPA has an obligation under the APA to conclude the rulemaking requested in the 2009 Petition "within a reasonable time," and it has failed to do so. 5 U.S.C. § 555(b). EPA's nearly fourteen-year delay in fully responding to the request for regulation of lead wheel weights is well outside the bounds of reason, particularly given the significant danger to human health and welfare posed by lead exposure. Once again, "EPA ha[s] unreasonably delayed its response to serious dangers to human health," and this Court should grant the Petition for Writ of Mandamus. *In re NRDC*, 956 F.3d at 1138 (reviewing the "three occasions over the [prior] five years" that the Court granted petitions for writ of mandamus in the face of EPA's unreasonable delays).

I. EPA HAS A DUTY TO CONCLUDE A RULEMAKING ON LEAD WHEEL WEIGHTS

The APA provides that an agency "shall" "conclude a matter presented to it" "within a reasonable time." 5 U.S.C. § 555(b). As this Court has explained, this directive "has been interpreted to mean that an agency has a duty to fully respond to matters that are presented to it under its internal processes." *In re A Cmty. Voice*, 878 F.3d at 784. That is, "[t]o 'conclude [the] matter,' EPA must enter a final decision subject to judicial review, and they must do so 'within a reasonable time.'" *Id.* at 785 (alteration in original) (quoting 5 U.S.C. § 555(b)); *see also Pub. Citizen Health Rsch. Grp. v. Comm'r, FDA*, 740 F.2d 21, 32 (D.C. Cir. 1984).

EPA has not concluded the requested rulemaking "within a reasonable time," 5 U.S.C. § 555(b), and has thus abdicated its duty under the APA. In the nearly fourteen years since EPA granted the 2009 Petition, EPA has entered no final decision, nor has it even proposed a rule. As this Court has explained in the context of another petition seeking EPA action on lead exposure, "[h]aving chosen to grant the petition for rulemaking, EPA came under a duty to conclude a rulemaking proceeding within a reasonable time." *In re A Cmty. Voice*, 878 F.3d at 785.

II. A WRIT OF MANDAMUS IS WARRANTED TO COMPEL EPA TO PROCEED WITH AND CONCLUDE THE RULEMAKING IT PLEDGED TO UNDERTAKE

This Court evaluates whether an agency delay is unreasonable and mandamus is warranted by considering the six *TRAC* factors. *See In re A Cmty. Voice*, 878 F.3d at 786. Those factors are:

> (1) the time agencies take to make decisions must be governed by a "rule of reason"; (2) where Congress has provided a timetable or other indication of the speed with which it expects the agency to proceed in the enabling statute, that statutory scheme may supply content for this rule of reason; (3) delays that might be reasonable in the sphere of economic regulation are less tolerable when human health and welfare are at stake; (4) the court should consider the effect of expediting delayed action on agency activities of a higher or competing priority; (5) the court should also take into account the nature and extent of the interests prejudiced by delay; and (6) the court need not "find any impropriety lurking behind agency lassitude in order to hold that agency action is 'unreasonably delayed.'"

TRAC, 750 F.2d at 80 (citations omitted). Because EPA's nearly fourteen-year delay is well outside the bounds of what is reasonable, puts human health at risk, prejudices individuals who continue to be exposed to this source of lead in the face of EPA's inaction, and cannot be justified by competing priorities, the Petition for Writ of Mandamus should be granted.

A. EPA's Nearly Fourteen-Year Delay in Concluding the Rulemaking It Agreed to Undertake Is Excessive and Violates the Rule of Reason

The first factor—the "most important" of the *TRAC* factors—weighs strongly in favor of Petitioners because EPA's nearly fourteen-year delay violates the rule of reason. *In re A Cmty. Voice*, 878 F.3d at 786; *see also In re Core Commc'ns, Inc.*, 531 F.3d 849, 855 (D.C. Cir. 2008). Under this factor, a court considers "whether the time for agency action has been reasonable." *In re NRDC*, 956 F.3d at 1139. "Repeatedly, courts in this and other circuits have concluded that 'a reasonable time for agency action is typically counted in weeks or months, not years.'" *Id.* (quoting *In re A Cmty. Voice*, 878 F.3d at 787). Indeed, delays much shorter than the nearly fourteen-year delay here have been found to be unreasonable. *See, e.g.*, *In re Am. Rivers & Idaho Rivers United*, 372 F.3d 413, 419 (D.C. Cir. 2004) (holding that "six-year-plus delay is nothing less than egregious"); *In re Int'l Chem. Workers Union*, 958 F.2d 1144, 1150 (D.C. Cir. 1992) (considering a rulemaking that "will have taken over six years," and stating that "we do not see how any further delay . . . —resulting in continued exposure of workers to dangerous levels of cadmium—could be excusable"); *cf. In re A Cmty. Voice*, 878 F.3d at 787 ("Critically, EPA fails to identify a single case where a court has upheld an eight year delay as reasonable, let alone a fourteen year delay . . . .").

On multiple occasions over the past decade, this Court has held that EPA's years-long delays in addressing public-health threats warrant mandamus relief. In *In re PANNA*, this Court held that EPA's delay of eight years and lack of a "concrete timeline" to resolve an administrative petition to revoke the approval of a dangerous pesticide "stretched the 'rule of reason' beyond its limits." 798 F.3d at 814. Two years later, in *In re A Community Voice*, the Court again found that a delay that was "into its eighth year" with no "'concrete timetable' for final action" favored issuance of a writ. 878 F.3d at 787. And most recently, in *In re NRDC*, the Court once again concluded that EPA's years-long delay—whether the Court calculated it as three years or ten years—in resolving a petition to cancel a pesticide registration "'stretched the "rule of reason" beyond its limits'" and "'tip[ped] sharply in favor' of mandamus relief." 956 F.3d at 1140 (quoting *In re PANNA*, 798 F.3d at 814).

In 2009, faced with a petition that set forth the dangers of lead wheel weights, EPA committed to commencing an appropriate proceeding to regulate that source of lead. Nearly fourteen years later, EPA has still not even proposed a rule, much less concluded the proceeding. This delay—like the delays in *In re PANNA*, *In re A*

Community Voice, and *In re NRDC*—patently violates the rule of reason, and this factor weighs in favor of mandamus relief.

B. Congress Intended for EPA to Proceed Expeditiously Under TSCA to Address Toxic Chemical Exposures

Congress made clear that it expected EPA to act expeditiously under TSCA to address unreasonable risks posed by chemical substances. The second *TRAC* factor, which considers any congressional "indication of the speed with which it expects the agency to proceed" in determining whether the rule of reason is violated, *TRAC*, 750 F.2d at 80, thus favors a finding of unreasonable delay. This factor does not ask whether Congress established a firm deadline for the challenged inaction. *See Biodiversity Legal Found. v. Badgley*, 309 F.3d 1166, 1177 n.11 (9th Cir. 2002). Rather, it involves consideration of whether the statutory scheme evinces a congressional intent that the agency act expeditiously. *See Sierra Club v. Thomas*, 828 F.2d 783, 797 (D.C. Cir. 1987).

TSCA expressly states that "[i]t is the intent of Congress that the Administrator [of the EPA] shall carry out this chapter in a reasonable and prudent manner." 15 U.S.C. § 2601(c). The rest of TSCA provides context for this directive—EPA must evaluate chemicals and manage unreasonable risks expeditiously. For example, Congress provided EPA, at most, four years from the time EPA determines a chemical poses an unreasonable risk to adopt section 6 rules that eliminate such risk.[5]

Section 21 itself contemplates swift action in response to a citizens' petition. Within ninety days of a petition's filing, EPA must either grant or deny the petition. *Id.* § 2620(b)(3). If EPA grants the petition, it must "promptly commence an appropriate proceeding." *Id.* The requirement to "promptly" begin a proceeding indicates that Congress anticipated that EPA would act expeditiously to address the concerns raised in a petition that it granted.

Indeed, TSCA's legislative history indicates that section 21 was conceived as a tool to ensure EPA is responsive to the risks posed by toxic chemicals. As the D.C. Circuit has explained, citing a floor statement from TSCA's initial passage in 1976, "[c]itizen participation," including by section 21 petitions, "is broadly permitted to 'ensure that bureaucratic lethargy does not prevent the appropriate administration of this vital authority.'" *Env't Def. Fund v. Reilly*, 909 F.2d 1497, 1499 (D.C. Cir. 1990) (quoting 122 Cong. Rec. 32,857 (1976) (statement of Sen. Tunney)). A Senate Committee Report from 1976 reinforced the view that prompt action in response to

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[5] Once EPA starts the process of evaluating whether an existing chemical poses an unreasonable risk, it must complete that process "as soon as practicable," but at most within three years. 15 U.S.C. § 2605(b)(4)(G). The statute allows this process to be extended but only by a maximum of six months. *Id.* If EPA evaluates a chemical and determines that it poses an unreasonable risk, section 6 provides that within one year of that risk evaluation being published, EPA must propose a risk management rule, and within two years, EPA must finalize the risk management rule. *Id.* § 2605(c)(1)(A)–(B). In certain circumstances, EPA can extend these deadlines but only by a combined maximum of two years. *Id.* § 2605(c)(1)(C).

section 21 petitions was expected, stating that "[t]he responsiveness of government is a critical concern and the citizens' petition provision will help to protect against lax administration of [TSCA]." S. Rep. 94-698, at 13 (1976). Congress' intent would be thwarted if EPA were allowed to delay acting pursuant to granted section 21 petitions for years on end.

C. The Health and Welfare of Individuals Exposed to Lead from Lead Wheel Weights Support a Finding of Unreasonable Delay

Both the third and fifth *TRAC* factors support a determination that EPA's delay in regulating a significant source of exposure to lead is so egregious that mandamus relief is necessary. The third factor counsels that "delays that might be reasonable in the sphere of economic regulation are less tolerable when human health and welfare are at stake." *TRAC*, 750 F.2d at 80. In many contexts, including this one, this factor overlaps with the fifth factor, which requires consideration of "the nature and extent of the interests prejudiced by delay." *Id.*; *see also In re United Mine Workers of Am. Int'l. Union*, 190 F.3d 545, 552 n.6 (D.C. Cir. 1999); *In re NRDC*, 956 F.3d at 1141–42 (analyzing the third and fifth factors together and finding both favored the issuance of a writ where children exposed to a toxic pesticide were "'severely prejudiced by EPA's delay'" (citation omitted)).

These factors underscore the unreasonableness of EPA's delay. Lead has devastating health effects for adults and children. Lead harms adults across body systems, and each year, an estimated 400,000 deaths—including hundreds of thousands of cardiovascular disease-related deaths—in the U.S. are attributable to lead exposure. *See* Bruce P. Lanphear et al., *Low-Level Lead Exposure and Mortality in US Adults: A Population-Based Cohort Study*, 3 Lancet Pub. Health E177, E178 (2018) [A276]. Children can suffer from irreversible cognitive harm from lead exposure. *See* Lead ISA at lxxxvii. EPA's own scientific assessment on lead concluded that "it is clear that [lead] exposure in childhood presents a risk [and] there is no evidence of a threshold below which there are no harmful effects on cognition from [lead] exposure." *Id*. at lxxxviii. As this Court pointed out, "EPA itself has acknowledged that '[l]ead poisoning is the number one environmental health threat in the U.S. for children ages 6 and younger.'" *In re A Cmty. Voice*, 878 F.3d at 787 (alteration in original); *see also* EPA, *Protecting Children from Lead Exposures* 3 (2018) [A284] ("Despite the overall decline of blood lead levels over time, lead exposure remains a significant public health concern for some children because of persistent lead hazards in their environment."); 88 Fed. Reg. at 50,446 ("Lead exposure . . . is especially harmful to young children . . . ."). And here, as in another case where this Court found EPA's delay to be unreasonable, "millions of young children potentially face significant risks to their neurodevelopment from further exposure." *In re NRDC*, 956 F.3d at 1142.

EPA has acknowledged that there is no safe level of lead. 88 Fed. Reg. at 50,455. And, according to EPA's own estimate, each year, over a million pounds of this no-threshold toxicant enter the environment because of lead wheel weight failure. *National Lead Free Wheel Weight Initiative*, EPA. In this case, "there is a clear threat to human welfare," *In re A Cmty. Voice*, 878 F.3d at 787, and a writ of mandamus is warranted. *See In re PANNA*, 798 F.3d at 814 ("In view of EPA's own assessment of the dangers to human health posed by this pesticide, we have little difficulty concluding it should be compelled to act quickly to resolve the administrative petition.").

Moreover, individuals who face harm from lead exposure from unregulated lead wheel weights "are severely prejudiced by EPA's delay." *In re A Cmty. Voice*, 878 F.3d at 787 ("The children exposed to lead poisoning due to the failure of EPA to act are severely prejudiced by EPA's delay, and the fifth factor thus favors issuance of the writ."); *see also In re NRDC*, 956 F.3d at 1142. Communities of color and individuals living in low-wealth communities already face disproportionately high levels of lead exposure, putting them at an especially high risk of harm from the toxic effects of lead. Lead Strategy at 11. And research suggests that people of color and lower-wealth groups are more likely to live in areas with high road and traffic densities than white and affluent populations. Nancy Tian et al., *Evaluating Socioeconomic and Racial Differences in Traffic-Related Metrics in the United States Using a GIS Approach*, 23 J. Exposure Sci. & Env't Epidemiology 215, 218 (2013) [A316]. This unregulated source of lead—a source that is especially prevalent in urban environments—adds to the lead exposures faced by overburdened communities.

EPA's delay in concluding the rulemaking also prejudices Petitioners by leaving them "stuck in administrative limbo" and unable to seek judicial review of any final action. *In re People's Mojahedin Org. of Iran*, 680 F.3d 832, 837 (D.C. Cir. 2012). As this Court explained only three years ago in remarkably similar circumstances: "For more than a decade, the EPA has frustrated [petitioners'] ability to seek judicial review by withholding final agency action, all the while endangering the wellbeing of millions of children and ignoring its 'core mission' of 'protecting human health and the environment.'" *In re NRDC*, 956 F.3d at 1142–43 (citation omitted).

Each day that passes without regulation permits more lead to enter the environment and people's bodies, contributing to this disparity and to the multiple health harms that individuals experience as a result of exposure to this cumulative, no-threshold toxicant. "The stakes to human health and the interests prejudiced by delay are indisputable," *In re NRDC*, 956 F.3d at 1142, and the third and fifth *TRAC* factors support the issuance of a writ.

D. EPA's Delay Is Not Justified by Higher, Competing Priorities

The fourth *TRAC* factor directs courts to "consider the effect of expediting delayed action on agency activities of a higher or competing priority." *TRAC*, 750

F.2d at 80. Because the Agency itself has said that addressing sources of lead exposure is a priority, *see infra*, it cannot point to its general workload as justification for delay. *Cf. In re NRDC*, 956 F.3d at 1141 (rejecting EPA argument that it should get a "free pass" on several *TRAC* factors because "all of its activities to some extent touch on human health, such that prioritization of one goal will necessarily detract from competing priorities," where EPA had acknowledged that the chemical at issue in that case "poses a serious risk to human health and welfare—specifically, to the neurodevelopment of children"). This factor thus supports a grant of mandamus relief.

Over the past few years, and over multiple presidential administrations, EPA has repeatedly explained that it views reducing lead exposure as a priority and is committed to doing so. *See, e.g.*, *Protecting Children from Lead Exposures* at 3 ("EPA is committed to reducing lead exposures from multiple sources . . . , especially among children who are the most vulnerable to the effects of lead."); *id.* at 4 ("EPA continues to make children's health a top priority and is committed to protecting children from lead exposures in their environments."); *A Public Health Approach to Addressing Lead*, EPA (last updated July 15, 2021)[6] ("[I]t remains a public health priority to continue reducing lead exposure, especially in highly-exposed communities."). It reiterated this commitment earlier this month, when it stated that

[6] Available at: https://www.epa.gov/lead/public-health-approach-addressing-lead.

"reducing childhood lead exposure is a priority for both EPA and the Federal Government." 88 Fed. Reg. at 50,446.

Just last year, in its *EPA Strategy to Reduce Lead Exposures and Disparities in U.S. Communities*, EPA recognized that "[l]ead exposure can have devastating impacts to human health and can be especially harmful to developing children," Lead Strategy at 3, and that reducing lead exposure is an environmental justice imperative, given the "significant disparities" in lead exposure that remain along racial, ethnic, and socioeconomic lines, *id.* at 5. To that end, EPA is "determined to take ambitious actions that follow the science and advance justice and equity to rid communities of harmful lead exposure and the resulting toxic effects." *Id.* at 6.

EPA itself has thus made clear that reducing lead exposure is a priority. And yet it is ignoring a source of lead exposure that it committed to addressing almost fourteen years ago. EPA cannot excuse its failure to regulate lead wheel weights by pointing to other obligations. *See In re NRDC*, 956 F.3d at 1141–42 (rejecting EPA's contention that its review of other pesticides prevented prioritizing action on pesticide known to be dangerous to children as "not an 'acceptable justification for the considerable human health interests prejudiced by the delay'" (quoting *In re PANNA*, 798 F.3d at 814)). This factor favors granting the petition.

CONCLUSION

Nearly fourteen years ago, EPA granted Petitioners' request to regulate lead wheel weights. And for nearly fourteen years, Petitioners' members and supporters have waited in vain for EPA to finally conclude that rulemaking and to eliminate an ongoing source of lead—a toxic substance for which there is no safe level—in their neighborhoods and homes. "There is a point when the court must 'let the agency know, in no uncertain terms, that enough is enough . . . .'" *In re Int'l Chem. Workers Union*, 958 F.2d at 1150 (citation omitted). That point has come; EPA must be directed to conclude the rulemaking it promised to initiate in 2009.

Petitioners respectfully request that this Court (1) find that EPA's delay in concluding the rulemaking it promised to initiate in response to the 2009 Petition is unreasonable and a violation of the APA; (2) order that EPA proceed with and conclude the rulemaking process within six months of the Court's order, by taking final agency action subject to judicial review in that time, with such deadline subject to modification only upon a showing of good cause by EPA; (3) retain jurisdiction of this matter for the purposes of enforcing the Court's order; (4) award Petitioners their reasonable fees, costs, and expenses, including attorneys' fees associated with this litigation; and (5) grant Petitioners such further and additional relief as the Court deems just and proper.

Respectfully submitted this 22nd day of August, 2023.

s/Kelly E. Lester
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CERTIFICATE OF COMPLIANCE

This Petition for Writ of Mandamus complies with the type-volume limitation of Ninth Circuit Rule 21-2(c) because it does not exceed 30 pages, excluding the parts exempted by Federal Rule of Appellate Procedure and 32(f) and required by Federal Rule of Appellate Procedure 21(a)(2)(C).

This Petition for Writ of Mandamus complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6) because it has been prepared in a proportionally spaced typeface using Microsoft Word Times New Roman 14-point font.

Respectfully submitted this 22nd day of August, 2023.

s/Lakendra S. Barajas
Lakendra S. Barajas

Counsel for Petitioners

CERTIFICATE OF SERVICE

I hereby certify that I have this day electronically filed the foregoing documents and accompanying Appendix of Select Cited Documents and Declarations with the Clerk of the Court for the United States Court of Appeals for the Ninth Circuit by using the appellate CM/ECF system.

I further certify that I have served the foregoing document and accompanying appendix by dispatching them to a third-party commercial carrier for delivery within three calendar days to the following parties:

Environmental Protection Agency
Office of General Counsel,
Mail Code 2310A
1200 Pennsylvania Avenue, N.W.
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Administrator Michael Regan
Environmental Protection Agency
Office of the Administrator
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Merrick B. Garland, Attorney General
U.S. Department of Justice
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Civil Process Clerk
U.S. Attorney's Office for the Northern
District of California
450 Golden Gate Avenue, 11th Floor
San Francisco, CA 94102

Respectfully submitted this 22nd day of August, 2023.

s/Isabel An
Isabel An

No. _______________

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC.,
CENTER FOR ENVIRONMENTAL HEALTH,
UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and
SIERRA CLUB,

Petitioners.

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, and MICHAEL REGAN, in his official capacity as ADMINISTRATOR of the U.S. ENVIRONMENTAL PROTECTION AGENCY,

Respondents.

APPENDIX OF SELECT CITED MATERIALS AND DECLARATIONS

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CITED MATERIALS

SUPPORTING DECLARATIONS

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May 28, 2009

Lisa Jackson, Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Citizen Petition under TSCA to Prohibit the Production and Use of *Lead Wheel Weights* in the United States

Dear Administrator Jackson**:**

The time has come for the U.S. Environmental Protection Agency ("EPA") to recognize that lead is an element that does not go away. It simply accumulates in our environment, year after year. EPA must use pollution prevention to regulate major sources of lead releases into our environment, our communities, our neighborhoods, and our homes.

Therefore, pursuant to Section 21 of the Toxic Substances Control Act ("TSCA"), 15 U.S.C. § 2620, the Ecology Center, Sierra Club and the other signatories below ("Petitioners") petition EPA to establish regulations prohibiting the manufacture, processing, and distribution in commerce of lead wheel balancing weights ("wheel weights"). These actions are necessary to address the significant threat that lead from wheel weights poses to human health.

This petition incorporates by reference the previous petition submitted by Ecology Center on May 13, 2005 (OPPT–2005–0032; FRL–7720–5) on the same matter. In that petition, Ecology Center asked EPA to prohibit the manufacturing, processing, distribution in commerce, use and improper disposal of lead wheel balancing weights. EPA denied that petition on August 8, 2005. Almost four years have passed since EPA denied children the opportunity to dramatically reduce their exposure to a major source of new lead on their streets and in their neighborhoods.

Ecology Center has previously highlighted that automobiles are a significant contributor of ongoing lead releases to the environment.[1] It previously identified lead wheel weight failure (weights falling off rims into roadways) as one of the largest ongoing releases of lead to the environment.[2] Lead is consistently found to be in high concentrations on roadways and in end-of-life, vehicle waste (commonly called Auto Shredder Residue – "ASR"). Wheel weights are the second largest ongoing

[1] Gearhart, Jeff et al; Getting the Lead Out; Impacts of and Alternatives for Automotive Lead Uses. July, 2003. www.cleancarcampaign.org

[2] Gearhart, Jeff et al; Citizen Petition under TSCA to Prohibit the Production and Use of *Lead Wheel Weights* in the United States, Ecology Center, May 13, 2009.

use of lead in vehicles and play a significant role in the release of lead to the environment.[3] High concentrations of environmental lead are directly correlated with traffic volume. In 2009, the New Jersey Department of Environmental Protection ("NJDEP") completed work on an EPA Region 2 Pollution Prevention Grant entitled *"Investigation of release, fate and transport of lead from automotive wheel weights, and development and evaluation of best management approaches."* The NJDEP research found wheel weight failure rates similar to previous studies.

To compensate for its failure to regulate lead wheel weights, EPA announced its voluntary National Lead-Free Wheel Weight Initiative (NLFWWI). The Initiative – launched on August 29, 2008 – had 40 charter members and four subsequent members including every new car manufacturer, four domestic wheel weight producers (3M, Hennessy, Perfect, and Plombco), two leading tire manufacturers (Bridgestone Firestone and Goodyear) and major retailers (Bridgestone Firestone, Goodyear, Costco, Wal-Mart, and Sam's Club). These organizations committed in writing to:

- Identify the volume of lead to be eliminated;
- Reduce the use of lead for wheel weights by December 31, 2011;
- Take responsibility for providing information, education, and outreach to the public, regarding the benefits of using lead-free wheel weights;
- Properly collect and recycle used lead wheel weights in their current inventory or acquired through normal business operation; and
- Publicly endorse the NLFWWI and encourage the use of lead-free wheel weights by others.

While the Petitioners appreciate the leadership demonstrated by these companies, the NLFWWI falls short of what is needed to protect children, the public and the environment. Eliminating lead wheel weights from new cars is a step forward, but new tires last only so long. While commitment of major retailers has an impact, the tire repair and replacement market is diversified with hundreds of thousands of service stations across the country. Petitioners estimate that no more than one-third of the lead wheel weight market would potentially be changed to lead-free due to the NLFWWI.

California is a perfect case study in why EPA action is needed. In 2008, three lead wheel weight producers, Henessy-Bada, Perfect Equipment and Plombco, agreed to stop retailing lead weight in the California market by the end of 2009. This agreement was a settlement of a Proposition 65 case filed against the companies in California. The withdrawal from the lead wheel weight market by these three manufacturers leaves the one remaining major manufacturer – Halko Manufacturing (a.k.a. New Products, Inc.), making products in Clayton, Delaware and Woodbury, Tennessee – still able to sell lead weights in California. In addition, without further restrictions, foreign producers will quickly fill the gap in the wheel weight marketplace as retailers stick with the familiar leaded wheel weights. This situation will be repeated across the country as cheap imports of lead weights undermine the efforts of manufacturers and retailers who are trying to phase out lead usage. Instead, Petitioners believe that the restrictions should benefit the national economy by encouraging technological innovation and preserve the jobs in the wheel weight industry, which would otherwise shift overseas if foreign producers filled the gap created by domestic producers' commitment to children's health and lead poisoning prevention.

States have attempted to take action in spite of EPA's failures. On April 28, 2009, the State of Washington instituted a ban on leaded wheel weights effective January 1, 2011. California, Iowa and Maine have similar proposals under consideration. In 2008, Vermont banned lead wheel weights on state-owned vehicles by January 1, 2010 and in new motor vehicles as of January 1, 2011. While state action is important, states have limited ability to regulate imports. Congress gave EPA that authority in Section 13 of TSCA. Congress also gave EPA the responsibility, under Section 6 of

[3] Gearhart, Jeff et al; Getting the Lead Out; Impacts of and Alternatives for Automotive Lead Uses. July 2003. www.cleancarcampaign.org

TSCA, to protect the public from unreasonable risks, such as those currently posed by the installation of leaded wheel weights.

In its National Lead-Free Wheel Weight Initiative, EPA acknowledged that:

- 12.5 million pounds of lead from wheel weight is uncontrolled or unmanaged in the environment;
- 1.6 million pounds of lead is lost when wheel weights fall off during normal driving conditions such as hitting a pot hole; and
- 10.9 million pounds is sold or given to hobbyists for recreational purposes (See www.epa.gov/waste/hazard/wastemin/nlfwwi.htmm, accessed May 14, 2009).

In 2005, EPA seemed unable to understand that 1.6 million pounds of lead falling off on the city streets each year would do nothing but harm. Since then, kids have picked up the lead wheel weights and played with them, and cars and trucks have ground the wheel weights into a powder that has spread into the neighborhoods along busy streets, especially those city streets where traffic is heaviest and stops, starts, and bumps are more common.

Lead wheel weights result in a pervasive exposure to children. EPA has acknowledged that there is no safe level of exposure. And because of the nature of the threat, there is no simple way to identify the source. While lead-based paint is the primary source of lead poisoning in children, it is not the only source. EPA's has a responsibility to protect children from all threatening sources.

The NLFWWI makes clear that the change from leaded wheel weights to lead-free wheel weights is both possible and practical. It is entirely reasonable. But it is impossible to achieve by market forces alone. Just as with seat belts, rules are needed to protect the public. The information gathered in the past four years has only reinforced the need for action.

Therefore, Petitioners once again demand, pursuant to Section 21 of TSCA (15 U.S.C. § 2620), that EPA fulfill its responsibilities to protect the public health and the environment from the ongoing installation of lead wheel weights. EPA must ban the manufacturing, distribution and sale of lead wheel weights, effective January 1, 2011. Petitioners look forward to EPA's response to this petition within 90 days, as required by TSCA, 15 U.S.C. § 2620(b)(3).

Respectfully Submitted,

Jeff Gearhart
Ecology Center
Ann Arbor, Michigan

Tom Neltner, Co-Chair,
Sierra Club, National Toxics Committee
San Francisco, California

Ralph Scott
Alliance for Healthy Homes
Washington, DC

Caroline Cox
Center for Environmental Health
Oakland, California

Stu Greenberg
Environmental Health Watch
Cleveland, Ohio

Ruth Ann Norton
Coalition to End Childhood Lead Poisoning
Baltimore, Maryland

Zakia Shabazz
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Lelia M. Coyne, PhD
Lincoln, Nebraska

Cc: Wendy Cleland-Hamnett, Acting Director, Office of Pollution Prevention and Toxics

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 26 2009

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Jeff Gearhart
Ecology Center
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Tom Neltner
Sierra Club, National Toxics Committee
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San Francisco, CA 94105

Dear Sirs:

On May 29, 2009 EPA received your petition under Section 21 of the Toxic Substances Control Act (TSCA) requesting the Agency initiate a proceeding for the issuance of a rule to prohibit the manufacture, processing and distribution in commerce of lead wheel balancing weights. Your petition is granted.

The Agency will promptly commence an appropriate proceeding under TSCA. EPA anticipates commencing this proceeding through either an Advance Notice of Proposed Rulemaking or a Proposed Rule. Please note that the Agency cannot commit to a specific rulemaking outcome or to a date certain for a final rule, nor does TSCA section 21 provide the ability to petition for such commitments. Thus your final request that a ban take effect by a certain date is beyond the scope of TSCA section 21, and beyond the scope of the commitment arising from the Agency's decision to grant your petition.

Thank you for your continued interest in the Agency's efforts to reduce lead exposures.

Sincerely,

Stephen A. Owens
Assistant Administrator

ECOLOGY CENTER

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May 13, 2005

Charles M. Auer
Director, Office of Pollution Prevention and Toxics
Environmental Protection Agency - East
Room 3166
1201 Constitution Ave., NW
Washington, D.C. 20460
(202-260-3810)

Re: Citizen Petition under TSCA to Prohibit the Production and Use of *Lead Wheel Weights* in the United States

Dear Mr. Auer**:**

Pursuant to Section 21 of the Toxic Substances Control Act ("TSCA"), 15 U.S.C. § 2620, the Ecology Center hereby petitions the Environmental Protection Agency ("EPA") to establish regulations prohibiting the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights "wheel weights". These actions are necessary to address the significant threat that lead from wheel weights pose to human health. As EPA suggested in its guidance governing TSCA petitions (50 Fed. Reg. 46825 (1985)), the bases for this petition are set forth below in detail and extensive supporting documentation is included in an attached appendix.

A. Lead is a Chemical Substance that is Subject to Regulation Under TSCA

The bio-toxic properties of lead are widely recognized. More recent attention has been given to the effects of lead on the learning abilities of children. "Lead[1] is neurotoxic, and young children are at particular risk of exposure. Numerous studies indicate that blood lead concentrations above 10 µg per deciliter (0.483 µmol per liter) are associated with adverse outcomes on measures of intellectual functioning and social–behavioral conduct. Such studies influenced the identification of a blood lead concentration of 10 µg per deciliter or higher as a "level of concern" by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO).

Continued efforts both in the United States and Europe have been undertaken to identify sources of lead in order to minimize release into the environment. The automotive industry is recognized as the largest user of lead in a number of applications,

[1] Richard L. Canfield et al; Intellectual Impairment in Children with Blood Lead Concentrations below 10 micrograms per deciliter. NEJM, April 17, 2003.

including the use of lead wheel weights.[2] A number of governments have already begun to recognize the threat that lead pollution from wheel weight degradation poses to human health and the environment. Perhaps most significantly, the European Union has amended its directive on end-of-life vehicles to phase-out the use of leaded wheel weights for new vehicles by July 2003 and all vehicles by July 2005.[3] The European phase-out promises to eliminate the threat that leaded wheel weights pose within 2-3 years as existing lead weights are replaced (when tires are naturally replaced due to wear) with non-lead alternatives. New make vehicles will automatically receive lead-free weights. The Ecology Center has conducted research and on the ground demonstrations, which document that the phase out of lead wheel weights is desirable and feasible in the U.S.

B. The Presence of Lead in Highly-Trafficked Areas & End of Life Vehicle Waste

Lead is consistently found to be in high concentrations on roadways and in end of life vehicle waste (commonly called Auto Shredder Residue – ASR). Wheel weights are the second largest ongoing use of lead in vehicles and play a significant role in the lead release to the environment.[4]

High concentrations of environmental lead are directly correlated with traffic volume. Despite the shift towards unleaded gasoline and the largely successful effort to recycle car batteries, lead concentrations remain disproportionately higher around areas of high traffic volume[5,6]. A University of Wisconsin study estimates that 70% of total lead concentrations in residential and institutional urban runoff can be linked back to street traffic. In addition, 94% of total lead concentrations in commercial urban runoff and 89% of concentrations in industrial urban runoff have been traced back to either parking lots or streets[7]. An Australian Environmental Protection Authority study also finds that soils in the inner city and along major traffic routes can have lead concentrations well above recommended levels[8]. And, a University of Alabama study likewise finds that urban lead concentrations are at their highest in vehicle service areas and in street runoff[9].

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[2] Gearhart, Jeff et al; Getting the Lead Out; Impacts of and Alternatives for Automotive Lead Uses. July, 2003. http://www.cleancarcampaign.org

[3] Directive 2000/53/EC of the European Parliament and of the Council on End of Life Vehicles. September 18, 2000.

[4] Gearhart, Jeff et al; Getting the Lead Out; Impacts of and Alternatives for Automotive Lead Uses. July, 2003. http://www.cleancarcampaign.org

[5] Johnson, C.D. and Juengst, D. (1997). Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, Madison, WI.

[6] NSW EPA (2003) Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices. A Guide for Councils. NSW Environmental Protection Authority, Sydney.

[7] Johnson, C.D. and Juengst, D. (1997). Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, Madison, WI.

[8] NSW EPA (2003) *Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices.* A Guide for Councils. NSW Environmental Protection Authority, Sydney.

[9] Pitt, R. and Lalor, M. (2001). The Role of Pollution Prevention in Stormwater Management. *Models and Applications to Urban Water Systems, Monograph 9.1.*

Streets and parking lots that drain into a storm sewer system have been found to be leading sources of lead[10,11], especially in urban areas[12]. A study done for the National Cooperative Highway Research Program in 2001 cites lead as a major constituent of highway runoff, signaling that lead concentrations from urban runoff (0.40 mg/l) are much higher than those from rural runoff (0.080 mg/l)[13]. These results are corroborated by a Michigan Department of Transportation study that compares lead concentrations in the stormwater of three comparably-sized Michigan cities, Flint, Grand Rapids, and Ann Arbor. Concentrations of lead are shown to be significantly higher for cities that received heavier rainfall (69 ug/l) compared to those that received less rainfall (10 ug/l). The concentrations of lead in rainfall are significantly less than concentrations of lead in runoff[14]. A report issued by the Watershed Professionals Network cites vehicle wear as a major contributor to the persistence of lead in urban runoff[15].

Concentrations in these areas have been found to exceed standards for human and environmental health. A study published in the Journal of Soil and Water Conservation cites the automobile as a leading source of lead contamination in urban runoff. Individual lead samples of stormwater runoff in Lubbock, TX were found to exceed the EPA's Maximum Contaminant Levels (MCLs), reaching values as high as 0.089mg/L. The EPA Office of Water Regulations and Standards (OWRS) ambient water quality criteria for the protection of human health is 0.050mg/L.[16] Furthermore, of the nineteen metals studied, lead was the only one found to exceed MCLs in a dissolved form, reaching a maximum value of 0.022 mg/L[17]. The EPA OWRS sets its chronic MCLs at .0032 mg/L and .0056 mg/L for Freshwater and Marine aquatic organisms respectively.[18] The University of Wisconsin studied sited above finds that 40% of discharges in the storm sewer drainage of a residential area and 70% of discharges from a commercial area have lead levels high enough to kill aquatic life[19]. Additionally, a study done on runoff contamination of Toronto Harbor found lead concentrations to be above its Provincial Water Quality Standards of 5 ug/L. In various parts of the harbor, concentrations were

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[10] Johnson, C.D. and Juengst, D. (1997). Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, Madison, WI.
[11] Zartman, R.E., Ramsey, R.H. III, Huang, A. (2001) Variability of Total and Dissolved Elements in Stormwater Runoff. Journal of Soil and Water Conservation. 56 (3): 263-267.
[12] "Management of Runoff from Surface Transportation Facilities – Synthesis and Research Plan" Prepared for: National Cooperative Highway Research Program. Submitted by: GKY and Associates, Inc: Springfield, Virginia; and Louis Berger and Associates, Inc.: East Orange, New Jersey. March 2001
[13] Ibid
[14] "Highway Stormwater Runoff Study" Prepared for: The Michigan Department of Transportation. Submitted by: CH2MHILL with McNamee, Porter, and Seeley, Inc. April 1998..
[15] Richter, Joanne E. Undated. "Urban Runoff Water Quality: A Salmonid's Perpective." Watershed Professionals Network. www.4sos.org/wssupport/ws_rest/Urban-Runoff.doc. Last accessed: May 2005.
[16] EPA. 1980d. U.S. Environmental Protection Agency. 45 FR 79318, Toxicological Profile.
[17] Zartman, R.E., Ramsey, R.H. III, Huang, A. (2001) Variability of Total and Dissolved Elements in Stormwater Runoff. Journal of Soil and Water Conservation. 56 (3): 263-267.
[18] EPA. 1985f. U.S. Environmental Protection Agency. . 50 FR 30784. Toxicological Profile.
[19] Johnson, C.D. and Juengst, D. (1997). Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, Madison, WI.

found as high as 200 ug/g, far in excess of the Canadian Lowest Effects Level (LEL) guideline of 32 ug/g[20] for aquatic life.

These studies clearly show that lead concentrations remain disproportionately high around heavily-trafficked areas such as urban roads and parking lots. While few studies have analyzed the contribution of lead wheel weights to such concentrations, it is reasonable to assume that wheel weights play a role in lead's persistence in highly-trafficked areas. Given the readily available alternatives, it is clear the best method of prevention is to remove lead weights from sale entirely.

Lead weights also contribute to lead contamination of end of life vehicle recyclable and waste streams. A European Union report explains the shortcomings of alternative lead removal methods. First, the method of dismantling and recycling wheel weights at the end of their life has proven itself unworkable for two reasons. The value of recycled lead is critically low and there is not enough time in the recycling process to remove such an economically impotent part of the automobile.

Secondly, the method of coating weights before they are affixed to the wheel seems inadequate because coating is not environmentally impermeable. Numerous weights fall off during use and coating could not prevent the lead of fallen weights from eventually leaking into the environment[21]. Further, a second report issued by the EU highlights the dangerously high levels of lead that remain in shredder waste: between 4,000 and 25,000 mg/kg. These levels are significantly higher than the EU's orientation for a target describing the maximum tolerable level of lead in shredder wastes: between 100 and 200 mg/kg[22].

Table 1: Lead Content of Auto Shredder Residue (ASR)

	Lead Concentration (mg/kg)	Lead in ASR, Average, metric tons/year [(a)]	
		U.S.	Canada
Umweltbundesamt, Germany [(b)]	3,500-7,050	15,825	1,583
EPA, U.S. [(c)]	570-12,000	18,855	1,886
Department of Health Service, California [(d)]	2,330-4,616	10,419	1,042
Average		15,033	1,504

Notes:

[a] Based on 3 million metric tons of ASR potentially landfilled each year in the U.S. and 300,000 metric tons in Canada.

[b] Weiss, et. Al. Emittlung und Verminderung der Emissionen von Dioxinen and Furan en aus Themischen Prozessen, For chungsbericht 104 03 365/17, Umweltbundesamt (UBA). 1996.

[c] U.S. EPA. PCB, Lead and Cadmium Levels in Shredder Waste Materials: A Pilot Study, EPA 560/5-90-00 BA. April 1991

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[20] The Influence of Urban Runoff on Sediment Quality and Benthos in Toronto Harbour" Duncan Boyd. Aaron Todd. Rein Jaagumagi. Environmental Monitoring and Reporting Branch. Ministry of the Environment. June 2001.

[21] "Heavy Metals in Vehicles – Final Report" Compiled for the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. Knut Sander, Dr. Joachim Lohse, and Ulrike Pirntke. March, 27, 2000.

[22] "Heavy Metals in Vehicles II" Compiled for the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. Dr. Joachim Lohse, Knut Sander, and Dr. Martin Wirts. July 2001.

[d] Nieta, Eduardo. Treatment Levels for Auto Shredder Waste, State of California Department of Health Services, June 1989.

Table 1 above summarizes the lead concentration found in auto shredder residue(ASR) from three additional sources. ASR is commonly used as daily cover for landfills in the U.S. To prevent lead from entering the environment both during and after vehicle use the most effective action is end the sale of lead wheel weights.

C. The Use of Lead Wheel Weights

Lead wheel weights are used worldwide to balance vehicle tires. An estimated 64 million kg/year (70,000 ton/year) of lead is used worldwide in the manufacture of wheel weights. Automobile and light truck wheel weights vary in size and weight, ranging between 5-150 mm (0.2-6 in) in length and 7-113 grams (0.25-4oz) in weight. A typical vehicle contains between 200 and 250 grams of lead in wheel weights. Excluding the vehicle's lead-acid battery, wheel weights are the number one ongoing automotive use of lead. Recent studies have shown that lead deposition from wheel weights is responsible for a significant, and previously unquantified, volume of lead in the environment.[23] The majority of wheel weights currently in use are clip-on types that are attached at the edge (horn) of a wheel's rim; however some new aluminum rims require adhesive weights due to their shape.

An average vehicle contains ten wheel weights (two on each of the four wheels and two more on the spare). Although some effort is made to collect and recycle these weights at the end of a vehicle's life, most of them are overlooked and often end up in the environment or as contaminants in auto shredders. A disturbingly large number fall off onto the road during vehicle use. In October of 2000, Robert A. Root published a study documenting the rates at which these weights fall off their host vehicles and are gradually abraded into lead dust.[24] His study was the first to examine this phenomenon, and it established that lead wheel weights are, in his words, "a major source of lead exposure that heretofore has not been recognized." The Ecology Center surveyed a one-mile stretch of urban roadway in Ann Arbor in 2002 and recorded very similar lead deposition rates.[25]

Michigan's 8.5 million registered vehicles are serviced with nearly 500 metric tons of lead each year for new tires and repairs, and all registered vehicles combined in Michigan contain nearly 1,700 metric tons of lead in wheel weights. Nationally, using lead wheel weight failure rates from existing research, we can estimate that as much as 1,631 metric tons of lead are deposited on streets in U.S. (see Table 2 & Appendix 1). Approximately 13% of wheel weights fail during the lifetime of typical tires.

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[23] Root, Robert A. Lead Loading of Urban Streets by Motor Vehicle Wheel Weights. Environmental Health Perspectives, Volume 108, Number 10. October 2000.
[24] Ibid.
[25] Lead Use in Ammunition and Automotive Wheel Weights, Ryan Bodanyi, April 2003, University Of Michigan, unpublished thesis.

Table 2: U.S. Lead Wheel Weight Loss Estimates, metric tons

Yearly Weight Loss (urban only)	Mass loss per year	Lead Lost During Tires Life, average 3.5 years	Lead Used (based on average tire life of 3.5 years)	Percent Mass Lost
77,647,528	1,631	6,038	46,086	13%

Sources: Vehicles Miles Traveled and State Motor Vehicle Registrations data from USDOT, Federal Highway Administration, Highway Statistics 2001, Tables VM-2 & MV-1. Lead wheel weight deposition rate derived from Root, Environmental Health Perspectives, Volume 108, Number 10. October 2000 & *Lead Use in Ammunition and Automotive Wheel Weights*, Bodanyi, April 2003, University Of Michigan, unpublished thesis. Lead deposition rate, in weight deposited per vehicle mile traveled, was applied only to urban vehicle miles traveled. Existing studies have only examined urban vehicle travel.

Root estimates that an average of 11.8 kg/km (40 lb/mi) of lead is deposited each year along the 2.4-km (1.5-mi) length of street in Albuquerque. Urban lead deposition, which he estimates at 1.5 million kg/year (3.3 million lb/year), poses a significant lead poisoning threat to poor and minority populations that are already overexposed to lead burdens. Root estimates that wheel weights fall off on major Albuquerque thoroughfares at a rate of 3,730 kg/year (8,200 lb/year).

Root's findings also indicate that lead from fallen weights is rapidly abraded into fine dust particles, which are susceptible to atmospheric corrosion, and normally turn into lead oxides, hydroxides, and bicarbonates under ambient environmental conditions. These conversions make lead more soluble, and increase the risk that lead will contaminate surface, groundwater, and drinking water supplies.

Studies conducted by the Wisconsin Department of Natural Resources in Madison, Wisconsin, have shown that approximately 40% of the runoff from residential areas and 70% of the runoff from commercial areas had lead levels "high enough to kill aquatic life."[26] Concentrations of lead in Madison's runoff ranged from 3-160 µg/L. "The primary source of many metals in urban runoff is vehicle traffic," the authors write. "Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic on streets that drain into a storm sewer system. Streets and parking lots are the primary sources of lead in urban (runoff)."

D. Alternatives to Lead Wheel Weights

A number of materials are being introduced as alternatives to the use of lead in wheel weights. External balancing technologies include tin, steel, plastic (various polymers and systems), and a zinc based alloy called ZAMA (an alloy of zinc, aluminum, and copper). Internal balancing systems including injecting various materials into the tire are also being considered as alternatives to wheel weights.

The major commercial suppliers known to be producing lead-free weights include:

Canada
Plombco
http://www.plombco.com/

[26] Johnson, C.D. and Juengst, D. (1997). Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, Madison, WI.

United States
Perfect Equipment – Zinc Weights
http://www.perfectequipment.com/

Europe
Dionys-Hofman – Zinc Weights
http://www.dionys-hofmann.de/25+B6Jkw9MQ__.0.html

Trax – Zinc Weights
http://www.traxjh.com/

Banner Battery – Steel and Zinc Weights
http://www.bannerbatterien.com/eng/bb5/bb53/bb531/bb5311/00936/index.asp

Thailand
PCP Products – Zinc Weights
http://www.pcproductsinter.com/product_z1.html

Japan
Azuma – Iron Weights
http://home1.catvmics.ne.jp/~azuma/

Commercial production of steel adhesive and ram-on weights has been occurring for several years by the Japanese company, Azuma. Several manufacturers in Italy are beginning to produce ZAMA weights, including one of larger wheel weight producers in Europe, Dionys Hofmann. Two of the largest wheel weight manufacturers in North America, Perfect Equipment Inc. in Tennessee and Plombco in Canada, are currently producing coated zinc wheel weights for the U.S. vehicle market. All of these weights have passed Original Equipment Manufacturer (OEM) specifications and many are currently being installed on OEM new vehicles. These same companies also provide zinc wheel weights to the Ecology Center for its lead-free wheel demonstration program in the US (see www.leadfreewheels.org). Based on discussion with the manufacturers we expect the prices of alternative weights to be very similar to the price of comparable lead weights.

E. Commercial Use of Lead-free Alternatives

The major wheel weight manufacturers in Europe (Dionys Hofmann - Germany and TRAX-UK), Japan (Azuma) and North America (Plombco - Canada and Perfect Equipment-USA). Dionys Hoffman is the largest producer of wheel weights in Europe and Perfect Equipment controls 99% of the original equipment market and approximately 50% of the aftermarket in North America. Recently the parent company of Hoffman purchased Perfect Equipment. Most major lead wheel weight producer has commercialized at least one lead-free alternative. All of these manufacturers have invested significant amounts of resources to develop non-lead wheel weights using either zinc, or steel as an alternative to lead weights. However these investments in commercializing lead-free weights are potentially risky if low cost imported lead weights are allowed to continue to be used in the aftermarket.

All of the non-lead weights have been tested in accordance with the standards and specifications already established by the automotive industry for lead wheel weights. Currently, new vehicles exported to Europe are being equipped with zinc weights produced by a US-based wheel weight manufacturer. Honda plants in Marysville and East Liberty, Ohio have converted to lead-free balancing for all new vehicles.[27] Vehicle production at these 2 plants is approximately 600,000 vehicles per year.

The European market has already made significant shift towards lead-free wheel balancing. Dionys-Hofman has produced and sold over 1 million weight in 2004 and is looking to completely convert its operations to lead-free production.[28]

In Asia, the phase-out of lead-free has progressed even more aggressively. A recent survey of import auto dealers in the Ann Arbor, Michigan area identified which new vehicles are currently being equipped with lead-free wheel weights as original equipment. Steel weights were identified using a magnet. Zinc weights were identified only if they were labeled. The survey results showed (see Table 3) that many of the Asian manufacturers have already converted to lead-free (primarily steel) wheel balancing for many vehicles.

Table 3: Vehicles for sale in the U.S. with lead-free wheel weights

Weight types: FE=Steel Clip; FE/ADH=Steel Tape-a-Weight; PB=Lead; ZN=Zinc

Subaru
Forrester (FE)
Legacy (FE/ADH)
Impreza WRX (FE)
Outback (FE)
Impreza RS (FE)

Hyundai
Elantra GT (FE)
Tiburon (FE)
Sonata (FE)
Accent (FE)
Santa Fe (FE)

Nissan
Murano SL (FE/PB)

Toyota
Rav4L (FE/ADH)
Rav4L (FE/ADH)
Highlander (FE/ADH)
4Runner (FE/ADH)
Matrix (FE/ADH)

Honda
CRV (FE)

Mazda
Mazda 3 (FE/ADH)
RX8 (FE/ADH)
Mazda 6 (FE/ADH)
MPV LX (FE/ADH)

Suzuki
XL7 (FE)
Grand Vitara (FE)
Vitara V6 (FE)
Verona (FE)
Aerio SX (FE)
Aerio Sedan (FE)
Forenza (FE)

2004 U.S. sales of new car models identified as having lead-free wheel balancing were over 1.4 million. Total production of these models, both in Asia and the U.S. was over 4.8 million. The Ecology Center estimates that as many as 38 million lead-free weights were installed on these vehicles in 2004 (see Table 4). No European new car imports were identified with lead-free wheel weights. However, European lead-free weights are zinc, which is very difficult to distinguish from lead weights.

Table 4: 2004 US sales & total production for new import cars with lead-free balancing weights

	Sales/Production	Weights	Pounds	Tons
US Sales	1,422,743	11,381,944	551,548	276
Total Production	4,831,481	38,651,848	1,872,997	936

[27] Personal communication, John Mejia, Plombco, November 2004.
[28] Personal communication, Helmut Ringwald, Dionys-Hofmann, December 2004.

The Ecology Center (http://www.ecocenter.org) is currently conducting a pilot program to replace lead in wheel weights with non-toxic alternatives in government fleets and tire retailers in the select locations in the U.S. More information on the project can be found at http://www.leadfreewheels.org. One of the primary objectives of our program is to evaluate the technical and economic feasibility of alternative weights in comparison with lead weights. To this end, we have established cooperative agreements with tire dealers, vehicle service shops, trade organizations representing the automotive service industry, and state and local government fleets. To date, we have provided retailers, dealers and government fleet service centers with nearly 30,000 non-lead weights (over 2,500 pounds) for use on vehicles. The weights have received positive feedback from fleet managers and the public. These lead-free weights were zinc weights purchased from Perfect Equipment and Plombco.

F: EPA Action is Necessary to Eliminate This Risk

Without EPA action U.S. vehicle manufacturers and tire dealers will continue to use lead wheel weights. Automotive wheel weights are installed as original equipment on new vehicles and in the aftermarket as tires are replaced or repaired. The new vehicle market accounts for approximately 20% of lead wheel weight use. Auto manufacturers in Europe and Asia are already nearing a complete phase-out of leaded weights. Ford, DaimlerChrysler and General Motors have not made any commitments to phase out lead wheel weight use in North America. Of even more concern is the aftermarket, were 80% of lead wheel weights are used by a diverse groups of small, medium and large size businesses. It is very likely that cheap, commodity uncoated lead weights will continue to be used by these businesses. The failure to establish a prohibition on the sale of lead weights will assure that lead wheel weights will continue to be a significant source of lead releases to the environment.

F. Conclusion

Based on the foregoing discussion and the attached references, the Ecology Center respectfully requests EPA to establish regulations pursuant to TSCA - 15 U.S.C. § 2605 (a)(1)(A) - that prohibit the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights. The Ecology Center looks forward to EPA's response to this petition within 90 days, as required by TSCA, 15 U.S.C. § 2620(b)(3).

Respectfully Submitted,

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Appendices:
A) Lead Wheel Weight Loss Estimates By State, Metric tons

B) Getting the Lead Out; Impacts of and Alternatives for Automotive Lead Uses. July, 2003

C) Root, Robert A. Lead Loading of Urban Streets by Motor Vehicle Wheel Weights Environmental Health Perspectives, Volume 108, Number 10. October 2000

D) Lead Use in Ammunition and Automotive Wheel Weights: An Examination of Lead's Impact on Environmental and Human Health, the Alternatives to Lead Use, and the Case for a Voluntary Phase-Out, Ryan Bodanyi

Appendix 1: Lead Wheel Weight Loss Estimates By State, metric tons

State	Yearly Weight Loss (urban only)	Mass loss per year	Lead Lost During Tires Life, average 3.5 years	Lead Used (based on average tire life of 3.5 years)	Percent Mass Lost
Alabama	1,275,058	27	89	847	11%
Alaska	105,097	2	12	120	10%
Arizona	1,508,412	32	110	793	14%
Arkansas	484,724	10	29	373	8%
California	11,483,029	241	998	5,756	17%
Colorado	1,213,316	25	123	930	13%
Connecticut	1,072,692	23	95	583	16%
Delaware	235,067	5	17	131	13%
Dist. of Columbia	173,695	4	11	50	22%
Florida	5,408,484	114	468	2,868	16%
Georgia	2,696,067	57	171	1,461	12%
Hawaii	287,268	6	27	174	16%
Idaho	241,227	5	21	265	8%
Illinois	3,347,677	70	301	1,972	15%
Indiana	1,626,107	34	120	1,125	11%
Iowa	504,132	11	52	664	8%
Kansas	620,160	13	48	466	10%
Kentucky	908,725	19	67	725	9%
Louisiana	877,135	18	72	722	10%
Maine	175,547	4	12	204	6%
Maryland	1,629,952	34	116	788	15%
Massachusetts	2,034,591	43	187	1,040	18%
Michigan	2,844,472	60	228	1,691	13%
Minnesota	1,273,576	27	102	911	11%
Mississippi	518,305	11	26	391	7%
Missouri	1,669,508	35	98	842	12%
Montana	105,328	2	10	207	5%
Nebraska	321,451	7	27	327	8%
Nevada	570,506	12	37	256	15%
New Hampshire	234,372	5	20	220	9%
New Jersey	2,532,933	53	228	1,316	17%
New Mexico	386,714	8	22	286	8%
New York	4,320,090	91	316	2,039	16%
North Carolina	2,142,976	45	136	1,236	11%
North Dakota	86,153	2	8	142	6%
Ohio	2,991,440	63	278	2,111	13%
Oklahoma	1,012,386	21	72	656	11%
Oregon	781,395	16	65	608	11%
Pennsylvania	2,643,680	56	232	1,926	12%
Rhode Island	322,053	7	29	153	19%

South Carolina	778,755	16	49	629	8%
South Dakota	90,090	2	8	161	5%
Tennessee	1,662,884	35	119	1,028	12%
Texas	6,498,963	136	405	2,872	14%
Utah	674,723	14	47	350	14%
Vermont	109,590	2	6	107	5%
Virginia	1,913,885	40	150	1,234	12%
Washington	1,687,340	35	153	1,036	15%
West Virginia	247,017	5	17	290	6%
Wisconsin	1,215,771	26	89	895	10%
Wyoming	103,013	2	6	115	6%
U.S. Total	77,647,528	1,631	6,038	46,086	13%

Sources: Vehicles Miles Traveled and State Motor Vehicle Registrations data from USDOT, Federal Highway Administration, Highway Statistics 2001, Tables VM-2 & MV-1. Lead wheel weight deposition rate derived from Root, Environmental Health Perspectives, Volume 108, Number 10. October 2000 & *Lead Use in Ammunition and Automotive Wheel Weights*, Bodanyi, April 2003, University Of Michigan, unpublished thesis. Lead deposition rate, in weight deposited per vehicle mile traveled, was applied only to urban vehicle miles traveled. Existing studies have only examined urban vehicle travel.

Appendix B

Getting the Lead Out

IMPACTS OF AND ALTERNATIVES FOR AUTOMOTIVE LEAD USES

July 2003

A report by: Environmental Defense, Ecology Center, Clean Car Campaign

Getting the Lead Out

IMPACTS OF AND ALTERNATIVES FOR AUTOMOTIVE LEAD USES

July 2003

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finding the ways that work

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Contents

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Executive summary

Over 19 million cars and trucks are sold each year in North America. Thousands of pounds of iron, steel, aluminum, plastic, rubber and glass go into making these vehicles. Each car that rolls off the assembly line also contains toxic chemicals–chemicals that impact our health and the environment from the time the car is built until it hits the junk heap.

Lead is one such chemical. Each car manufactured today contains approximately 27 pounds of lead used in many vehicle components. In fact, one car component, the lead acid battery, accounts for the majority of lead use in the world today.

Lead is extremely toxic. Scientific studies show that long-term exposure to even tiny amounts of lead can cause brain damage, kidney damage, hearing impairment and learning and behavioral problems in children. Children are most vulnerable because growing bodies absorb more lead. In adults, exposure to lead can increase blood pressure, cause digestive problems, kidney damage, nerve disorders, sleep problems, muscle and joint pain and mood changes.

Because of the dangers, lead was phased out of consumer products like gasoline and paint decades ago. But the largest remaining source of lead pollution–auto batteries–has been largely overlooked. Most auto batteries are recycled, giving the impression that the industry is "clean." However, a closer inspection reveals that lead is released to the environment at many points during vehicle manufacture, use and disposal. This lead pollution could be avoided if the auto industry used less toxic materials.

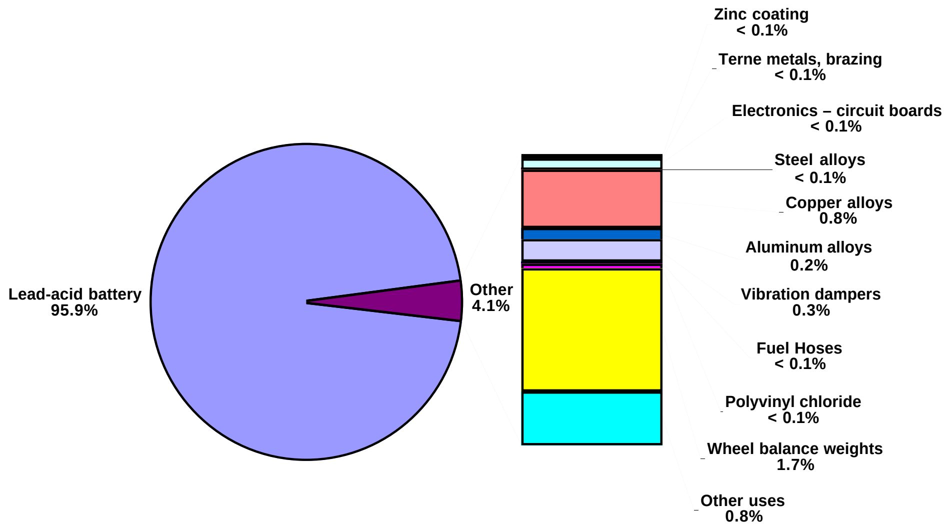
This report documents the historic and continuing uses of lead by automakers despite the availability of cleaner alternatives. It also examines the technology and policy options for eliminating lead and minimizing its impacts on human health and the environment. Among its recommendations are the phase-out of lead-acid batteries and a range of other unnecessary lead-containing components, such as lead wheel weights. Phasing out these two uses alone would go a long way toward eliminating lead's continuing environmental health threat.

Lead in Automotive Applications

In 2000, more than 2 million metric tons of lead were consumed in North America.[1] The auto industry was responsible for more than half of this total (at least 1.15 million metric tons). More than 90% of the lead in vehicles is used in lead-acid, starting-lighting-ignition (SLI) batteries found in most vehicles. An estimated 2.6 million metric tons of lead can be found in the batteries of vehicles on the road today.

Other automotive applications of lead include wheel balance weights, alloys and protective coatings, vibration dampers, solders in electronics and stabilizers in polyvinyl chloride (PVC) and other plastics. See Chart 1. Although the quantity of lead in these applications is significantly less than that in batteries, findings in this report suggest their contribution to lead contamination of the environment is still significant.

CHART 1
Automotive Lead Applications



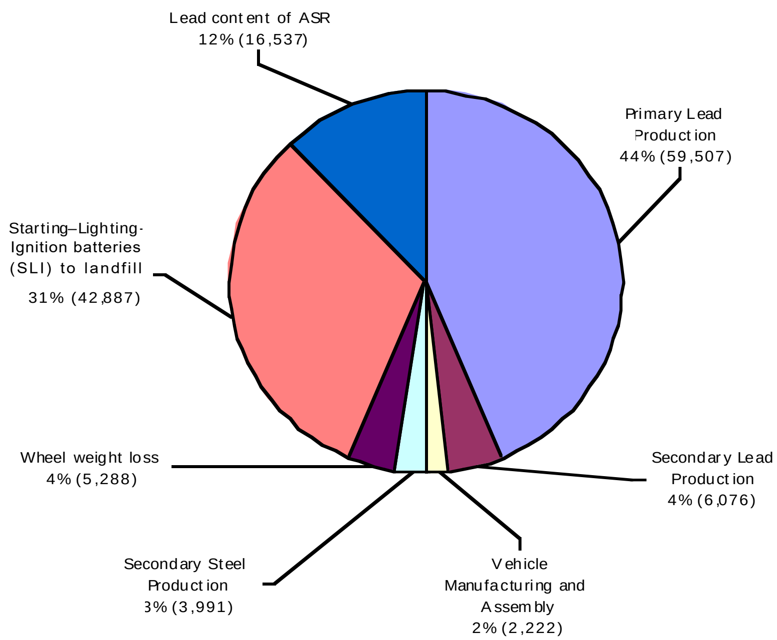
Source: Table 1, Estimated Lead Content of Vehicles in North America. The non-battery uses on the chart represent an average of minimum and maximum values of lead use per vehicle as presented in Table 1.

Environmental Releases from Automotive Lead Use

As the principle consumer of lead in North America, the automobile industry is responsible for the majority of lead pollution. The largest source of lead pollution is lead production–i.e., the mining and processing of lead ores and the recycling of lead scrap. Releases and transfers of lead from lead production and automotive-related manufacturing processes were 71,000 metric tons in 2000, according to federal Toxic Release Inventory data (See Chart 2).

Other lead releases occur during vehicle use and disposal. Although these releases are not officially reported, estimates made in this study suggest they may be significant sources of lead to the environment. Most of these releases occur because of inadequate vehicle dismantling and recycling processes, since many automotive components containing lead are not separated and collected. Even in the case of lead-acid batteries, the most recycled product known, more than 42,000 metric tons of lead are still lost to landfills each year. In addition, as many as 10% of lead wheel weights fall off during use, with more than 5,000 metric tons accumulating on our roadsides and washing into waterways. Lead in steel alloys and automotive coatings is released to the environment when the metals are recycled. Other lead-containing components, such as plastics and ceramics, enter landfills as a contaminant in auto-shredder residue or "fluff."

CHART 2
Automotive Related Lead Releases and Transfers (in metric tons)



Source: Table 7. The Automobile Industry's Contribution to Lead Releases Throughout the Vehicle Life Cycle

Alternatives to Automotive Lead Applications

Cost-effective alternatives exist for almost all uses of lead in automobiles, including the largest use, SLI lead-acid batteries. While some of the alternatives may cost more in the short-run, others may in fact be cheaper, especially if regulatory and liability costs for the continued use of lead are factored in.

LEAD-ACID BATTERIES

While the lead-acid SLI battery industry has been well entrenched in the automotive market for the last 75 years, lead-free alternatives exist. For example, nickel-metal hydride (NiMH) batteries already dominate the market in high-voltage battery systems used by electric and hybrid-electric vehicles, and lithium batteries common in electronics applications are emerging in automotive uses as well. These alternatives provide superior performance and significant potential for reduced environmental impact, although they cost somewhat more than their lead-acid equivalents. The automobile industry is expected to significantly increase its production of hybrid vehicles with these alternative battery systems over the next decade.

Despite these proven and available alternatives being used in high-voltage systems, however, some auto manufacturers are moving towards larger lead-acid batteries in other automotive applications. Some "mild" or low-voltage hybrids, and luxury vehicles that need additional onboard power for DVD players and other electronic equipment, are beginning to use 42-volt systems that nearly double per vehicle lead use. The expected rapid growth of 42-volt battery systems presents a key new opportunity to reduce the use of lead in automotive applications over the coming decade, rather than increase it. Strategic investments in lead-free 42-volt systems would help to bring down costs to ease the transition for standard 12-volt batteries as well.

OTHER LEAD APPLICATIONS

A number of lead-free alternatives exist for other applications as well, many with little or no cost disadvantage. Tin or steel, for example, can be used as a cost-effective alternative to lead for wheel balance weights. PVC plastics that use lead as a stabilizer can be replaced with more stable plastics, or by choosing alternative stabilizers. Lead-free or at least low-lead alloying agents can be used for the production of steel and aluminum alloys. These and other alternatives are currently available and can be implemented in a relatively short time.

Lead Component	**Alternative**
• SLI batteries	Nickel-metal hydride, Lithium- ion
• Wheel balancing weights	Tin, Steel
• Alloying agents	Limit as percentage of weight
• Coatings	Lead-free formulations
• Electronic applications	Lead-free solder
• Vibration dampers	Cast iron; more research needed
• Fuel hoses	Steel tubes; lead-free rubbers
• PVC Stabilizers	Polypropylene, other plastics

Recommendations

In light of the significant environmental releases resulting from the use of lead in automobiles, and the potential for increased lead use with the rise of 42-volt battery systems, new policies are needed to discourage lead use and support alternatives in this key industry. While a majority of states have enacted legislation requiring the recycling of lead-acid batteries, these laws do little to encourage the use of less hazardous materials in batteries or any other automotive components. The European Union, by contrast, has begun to phase out lead in automobiles through the 2000 End-of-Life Vehicles (ELV) Directive. The United States and Canada should develop their own policies for replacing lead in automobiles with safer alternatives.

Specific policy recommendations include the following:

° *Phase out the use of lead in SLI batteries:* The United States and Canada should develop a transition plan for the automotive industry to phase out the use of lead-acid batteries within 10 years (by model year 2014). This plan should include a near-term phase-out of lead-acid batteries in new 42-volt systems (by model year 2007), in order to prevent the growth of lead use in the meantime. A transition to non-lead battery systems could also help spur advanced vehicle technologies–such as hybrid gasoline-electric and fuel cell vehicles--making costs competitive for both high and low-voltage battery systems.

° *Phase out all other uses of lead in vehicles:* Governments should also develop policies for the near-term phase-out of all other uses of lead in vehicles (such as wheel balance weights, and lead used in electronic circuit boards). At a minimum, such policies should meet the phase-out requirements of the European Union's End-of-Life Vehicle (ELV) Directive. Governments can use both regulatory and purchasing restrictions in bringing about this phase-out.

- *Require producer responsibility for the recovery of lead automotive components:* During the transition to lead-free automobiles, automakers, battery manufacturers and other auto component manufacturers should take responsibility for ensuring the recovery and safe management of lead-containing automotive components. Despite impressive recycling rates, thousands of tons of automotive batteries still wind up in landfills every year, and up to half of wheel balance weights never make it to a vehicle's end-of-life. Governments should enact producer responsibility policies to significantly increase the recovery of lead in vehicles currently on the road.

- *Establish a lead retirement program and ban on lead mining:* As the transition is made away from lead in automobiles, lead that is recovered will need to be retired so that it does not re-enter commerce and become a contaminant in new products. Governments should also establish a ban on lead mining, so as not to add new sources of lead to the environment.

- *Improve the environmental standards for industries that handle end-of-life vehicles:* Governments should also more aggressively monitor and implement storm water plans and air pollution permit requirements to ensure best management practices for industries that routinely handle end-of-life vehicles.

CHAPTER 1

Introduction

Automobiles play an important role in North American life, offering personal mobility to millions, but they also cause significant environmental impacts. Included in the range of environmental impacts caused by automobiles are the human health and environmental effects caused by the release of toxic chemicals, including lead. Often present in small quantities in an individual vehicle, these toxic materials have large impacts when aggregated across the entire fleet of 246 million cars and light trucks on the roads of North America.[2]

Materials Composition of the Automobile

The average family sedan weighs about 1,500 kg (3,309 pounds), and is comprised largely of steel and iron (over 64% of the total weight), as well as plastics, aluminum, rubber and other materials.[3] Unfortunately, this crude breakdown does not sufficiently identify some of the materials that can have a significant impact on human health and the environment. Lead is one such toxic material.

Lead is used in a variety of automotive applications. The lead-acid battery in every automobile weighs approximately 15 kg (contributing to about 1% of the weight of the vehicle), 11 kg of which is lead and lead compounds.[4] The mass of lead in other automotive applications is considerably smaller–approximately 2 kg per vehicle in total–but still significant. It is estimated that the current North American vehicle fleet contains more than 2.8 million metric tons of lead. Most lead-acid batteries are recycled; however, even with the existing battery recycling infrastructure, significant quantities of lead are released into the environment. Furthermore, the lead contained in other automotive applications often remains unrecovered at the end of the vehicle's useful life, and the lead enters the environment, where it can cause adverse human health and environmental impacts.

Health Effects of Lead

Because lead targets the nervous system, children and fetuses are especially vulnerable to lead's toxic effects. Lead is easily absorbed into growing bodies, interfering with the developing brain and other organs and systems.[5] The developing bodies of fetuses, infants and children more easily absorb lead than adult bodies; in children, about 50% of ingested lead is absorbed, compared to 8–10% for adults.[6] Once absorbed into the bloodstream, lead spreads to practically all of the body's systems. Lead moves quickly to the soft tissues, such as the liver, lungs, spleen and kidneys, and eventually settles in the bones. Once in the bones, lead tends to stay there but can be mobilized during pregnancy, menopause, trauma or other times of high bone turnover. A person's nutritional status and eating behavior affects lead absorption and toxicity. Iron and calcium deficiencies result in increased lead absorption. Some absorbed lead can be eliminated from the body in urine and feces.

Acute symptoms of high-level lead exposure in children include abdominal pain, vomiting, headaches, loss of appetite and mental changes. Coma and death can result from excessive exposure. Long-term lead exposures in children can cause brain damage, affect a child's growth, damage kidneys, impair hearing, and cause learning and behavioral problems. In adults, exposure to lead can increase blood pressure, cause digestive problems, kidney damage, nerve disorders, sleep problems, muscle and joint pain and mood changes.[7] Increased blood levels of lead have resulted in increased mortality rates from a variety of causes.[8] The International Agency for Research on Cancer (IARC) lists lead and inorganic lead compounds in Group 2B, or as possible human carcinogens, based on sufficient evidence of carcinogenicity in animal studies.[9]

People are exposed to lead by eating food contaminated with lead or lead-containing soils or dusts, by drinking contaminated water, by inhaling lead particles and by using consumer products that contain lead.[10] Adult exposures typically result from occupational (e.g., lead-acid battery recycling) or recreational sources (e.g., indoor firing ranges), whereas childhood exposures commonly result from ingestion of deteriorating lead-based paint, which contaminates residential dust and soil.

Historically, consumer products such as gasoline, paint, food cans and plumbing contained lead. As government controls have eliminated or drastically curtailed these uses, lead exposures from these sources have declined dramatically. Prior to its phase-out in the late 1970s and early 1980s, leaded gasoline was by far the leading cause of lead exposure.

As with other toxic chemicals, a little bit of lead goes a long way. According to the Residential Lead Hazard Standards set by the U.S. Environmental Protection Agency, lead contamination is considered a hazard if there are 40 micrograms of lead in dust per square foot on floors; 250 micrograms of lead in dust per square foot on interior window sills; and 400 parts per million (ppm) of lead in bare soil in children's play areas (1,200 ppm average for the entire yard). Using the EPA standard for floors, a single kilogram of lead released into the air has the potential to contaminate 2 million square meters of floorspace.

The workplace is also a significant site of lead exposure. According to the U.S. Occupational Safety and Health Administration (OSHA), overexposure to lead is a leading cause of workplace illness. The current OSHA limit for the blood lead level (BLL) of lead is 50 µg/dL, a level that is far higher than allowable levels of exposure for children, and that has been associated with chronic damage to the adult nervous system.[11] Workplace exposures can also lead to exposures in the cohabitants of the worker through contaminated work clothes. Many industries directly associated with vehicle manufacturing use and emit lead, such as lead mining and processing, lead recycling, battery manufacturing, vehicle component assembly and auto and steel recycling. As other sources of lead exposure have decreased over the years, the more than 1 million metric tons used in automotive applications has become proportionately more significant.

Through its National Health and Nutrition Examination Surveys, the Centers for Disease Control (CDC) has been tracking blood lead levels (BLLs) in the United States since the 1970s and in 1991 set the "level of concern" (the level at which further investigation into the child's exposure is indicated) at 10 µg/dL. Over the years, the surveys have documented a decrease in BLLs, from a geometric mean of 15 µg/dL among children aged one through five in the late 1970s to a geometric mean of 2.2 µg/dL in the most recent survey (1999–2000). However, according to this most recent survey, about half a million U.S. children younger than six years of age have blood lead levels high enough to adversely affect their intelligence, behavior and development.[12] Recent studies suggest that loss of intelligence in children occurs with BLLs below 10 μg/dL and raises the question of whether exposure to lead at any level causes measurable harm to children's brains.[13]

A Life-Cycle Approach

To assess the full environmental impacts associated with the use of lead by the automotive industry, this report takes a life-cycle approach. This report estimates that automotive applications of lead comprise 56% of annual North American lead consumption. Total lead use by the entire transportation sector accounts for 76% of U.S. lead consumption.[14]

The life-cycle emissions from lead are inextricably linked to the automotive life cycle. Environmental releases of lead take place at every life-cycle stage. Lead and other toxic chemicals are released from the extraction and processing of lead ores, and the subsequent refining of these ores to produce lead. As lead is incorporated into automotive parts and components, the manufacturing processes and automobile assembly facilities release lead into the environment. During vehicle use, the wear, replacement and disposal of lead-containing parts contribute to the environmental load attributable to the automobile life cycle. Finally, lead contaminates the materials that are later recycled, releasing the lead into the environment, or contaminating materials destined for landfills.

While environmental regulations have been effective in reducing lead emissions to date, a more preventive approach must now be fostered in order to eliminate the root cause of lead emissions. A more preventive approach for this industry is to design lead out of automobiles and the manufacturing processes that produce them. While progress has been made in reducing or eliminating lead from some applications, other, more pervasive, applications remain; and the most significant use–lead-acid batteries–persists. By documenting the relationships between the automotive uses of lead and lead emissions, this report identifies policy recommendations for the phase-out and management of lead in automobiles.

CHAPTER 2

Lead in automotive applications

While it is commonly known that an automotive battery contains lead, considerable amounts of this heavy metal are designed into a variety of other automotive components as well. The most prominent applications of lead, including lead-acid batteries, are discussed below, drawing on research completed for the European Commission, and published in the report, "Heavy Metals in Vehicles."[15]

Lead-acid Batteries

The single largest use of lead worldwide is for lead-acid batteries, which represents 75% of total western world lead use.[16] The most common form of lead-acid battery is the starting-lighting-ignition (SLI) battery for automobiles; 80% of the western world lead battery market is represented by SLI batteries.[17] As the name implies, this battery is used to start the vehicle's engine, and to supply a stable source of power for its electrical system. The SLI battery is a mature technology that has changed little in 75 years.[18] The low cost of a lead-acid battery system is its main advantage over new technologies, and the industry seems unwilling to adopt lead-free alternatives despite their advantages.

The average automotive SLI battery weighs approximately 15 kg. It consists of a plastic container (typically polypropylene), positive and negative internal lead plates immersed in a liquid electrolyte, and plate separators made of either polyethylene, PVC, or fiberglass. The positive lead plate is lead dioxide supported on a metallic lead grid; the negative lead plate is sponge lead; and the liquid electrolyte is a 35% sulfuric acid solution in water.[19] The average composition of a lead-acid battery varies around the world, but lead and lead compounds typically make up about 75% of the mass of each battery (or about 11 kg), acid approximately 15% and plastics about 5%. The remaining 5% is made up of residual materials, including silica used for bulking up the separators.[20]

Automotive battery shipments for North America in 2001 totaled 106.6 million batteries (86.2 million replacement batteries and 20.4 million original equipment batteries),[21] or approximately 1.12 million metric tons of lead. In the batteries of North American vehicles on the road today, there are approximately 2.6 million metric tons of lead and lead compounds.

Surface Treatments and Coatings

E-COAT—VEHICLE BODY

A number of different steps are required to give cars and trucks their brightly colored, shiny finish. The electro-deposition primer coat (or e-coat) is an early step in the process that provides a layer of corrosion resistance and ensures good adhesion of subsequent coatings. To apply the electro-deposition primer coating, the vehicle body is immersed in a liquid bath and an electrical current is applied to the system. Because of the electrical charge, the primer is attracted to the metallic vehicle body, thus coating it with the protective layer. After the vehicle body is coated, it is rinsed with water to remove excess primer and then oven-cured. Wastes are generated by the process in the periodic maintenance of the bath (e.g., filtration to remove sludge, or complete bath change-out), chemical carry-over to the rinse tank and accidental spills.

By 2002, most automakers had eliminated the use of lead in this surface treatment and coatings process. When used, however, leaded e-coat contained an estimated 20-180 grams of lead per vehicle.[22] For the North American fleet of vehicles already on the road, the quantity of e-coat lead is estimated to be 4,400–39,800 metric tons (estimate considers recent lead phase-out by industry).

ZINC COATINGS—VEHICLE BODY

Galvanizing is another process for improving the corrosion resistance of steel through the application of a zinc coating. In the galvanizing process, the steel reacts with the zinc to form a zinc/steel alloy coating. The zinc is deposited onto the vehicle body when the steel is dipped into the hot-dip galvanizing bath. Lead is added to this galvanizing bath to improve viscosity and assist in the drainage of excess solution when the steel is removed from the hot-dip bath. In addition to improving the quality of the zinc coating, lead also protects the kettle against corrosion. Lead is deposited on the steel, along with zinc, as a contaminant of the galvanized coating. Other than helping in the galvanizing process, lead contributes little to the final properties of the galvanized steel product. The overall amount of lead contained in the zinc layer is approximately 1 gram per vehicle,[23] or 246 tons in the existing fleet of 246 million North American vehicles.

TERNE METALS—FUEL TANKS

Some automobile fuel tanks are made using terne metal–a steel sheet that has been coated with a lead/tin alloy in a hot-dip process. In 1998, 70% of all fuel tanks produced in North America were made of terne metal.[24] Several automakers, however, have moved away from the use of terne metals for fuel tanks, choosing instead from a number of available options. No data is available on the amount of lead used in this application; however the amount of lead used may be substantial. This is particularly significant since fuel tanks are not dismantled and will become part of the ferrous scrap stream generated by the vehicle recycling infrastructure. Like other metals coatings, this lead is a contaminant that must be managed when the steel is recycled.

Once formed, many steel tanks are also brazed with an additional coating containing 70% lead. For this coating, the amount of lead falls in the range of 30–60 grams per vehicle.[25] Assuming that 70% of the North American vehicles on the road are equipped with brazed steel tanks, the amount of lead from this application is estimated to be between 5,170–10,330 metric tons. This estimate does not include the contribution from terne metal coatings.

Electronics

Automotive electronics continue to increase as manufacturer options and consumer demands for safety, security and gadgetry increase. Radios, navigation systems, engine control systems, air bags and so on all must contain electronic devices to operate properly. These electronic devices have printed circuit boards that contain lead as a soldering element.

Although the quantity of lead contained in the printed circuit boards of each of these devices is not large, the increasing electronics content in today's vehicles makes the quantity of lead in automotive electronics likely to continue to increase. The total amount of lead contained in automotive electronics is 53–100 grams per vehicle.[26] For the fleet of North American vehicles on the road today, that is approximately 13,000–24,600 tons of lead contained in automotive electronic circuit boards.

Lead Alloys

STEEL ALLOYS

Low concentrations of lead (between 0.15% and 0.35%, by weight)[27] are added to some types of steel to improve machinability. Automotive applications of steel-lead alloys include transmission, power steering and air conditioning parts, crankshafts, connection rods, fitting turn-offs and high-pressure fuel injector parts.[28] Automakers believe that a maximum lead content of 0.3% is usually sufficient.[29] Therefore, the amount of lead used in machining steel per vehicle is estimated to be 10–50 grams, though it may be as high as 100 grams for some cars produced in Japan.[30] For the fleet of vehicles now on the road, there is an estimated 2,460–12,300 tons of lead contained in steel alloys.

COPPER ALLOYS

Copper alloys containing up to 4% lead are used in bearing shells and bushes. In addition, numerous other parts are made of brass and other alloys of copper, which also contain lead, e.g., nozzles, connection parts, fixtures or locks. The amount of lead in these applications is estimated to be in the range of 50–1,000 grams per vehicle.[31] For the North American fleet, an estimated 12,300–246,000 metric tons are currently on the road.

ALUMINUM ALLOYS AND LEAD IMPURITIES IN ALUMINUM

Aluminum is increasingly used in automobile production because of its weight-reduction potential (which leads to better fuel economy) over steel. A very small percentage of lead is typically present, as an impurity, in the aluminum alloys that are used for a majority of automotive applications. Because it is cost prohibitive to completely remove lead from recycled aluminum, secondary aluminum always contains lead impurities. The lead content in standardized casting aluminum alloys is typically around 0.1% by weight, though up to 0.35% is allowable in the case of certain alloys. Based on an average aluminum content of 116 kg and an average lead concentration of 0.1%, the total quantity of lead contained as an impurity in aluminum alloys is around 116 grams.[32] For a few minor applications, however, aluminum alloys are formulated with a lead content of up to 1%, for improved machinability. Machined aluminum contributes an additional 1–5 grams of lead per vehicle,[33] taking the total lead content of aluminum alloys to approximately 119 grams per vehicle, or 10,580 metric tons for the vehicle fleet currently on the road in North America.

Lead in Brake Linings

Lead and lead compounds have historically been used as performance enhancers for brake linings. The friction materials of brakes have contained an average of 2% lead, but up to 10% lead was possible. Friction material suppliers in the United States have stated, however, that original equipment brake manufacturers phased out lead in the early to mid 1990s.[34] Despite this U.S. phase-out, auto manufacturers around the world have requested an extension of the European Union's directive that phases out this use of lead. Under a revised schedule, auto manufacturers have until July 2004 to comply with the phase-out. Even after this date, brake linings will still be allowed to contain up to 0.5 % lead by weight. In Europe, estimates for the 1990s suggest that 100,000 metric tons of brake linings, containing 800 metric tons of lead, were produced each year for passenger cars (vehicle class M1) and light commercial vehicles (vehicle class N1).[35] Friction producers in Europe estimated that a typical brake lining had 1.38 grams of lead.[36] For the purposes of this analysis no estimates of lead use were made due to the uncertain status of lead use in brake linings.

Vibration Dampers

Vibration dampers made of lead are often used to alleviate noise and vibration problems that may occur during the use of the automobile. They usually consist of a lead weight connected to the vibrating part via a spring that absorbs the vibration energy. They may be used on the axle from gearbox to wheel, the steering column, or in various places on the chassis. Though automakers avoid using vibration dampers in new vehicles (as they increase vehicle weight and connote poor design), they are sometimes necessary to eliminate noise problems that become apparent later, especially in lighter weight vehicles that make use of more plastics in their construction, or sports cars or convertibles, where increased rigidity is sought. Vibration dampers, whether installed by original equipment manufacturers or in the aftermarket, typically contribute an additional 100–300 grams of lead to the automobile, though much heavier ones weighing several kilograms can be used.[37] Assuming an average of 100–300 grams per vehicle, an estimated 1,767–5,300 metric tons of lead are used per year as vibration dampers.

Fuel Hoses

Lead compounds are often employed as vulcanizing agents in the production of high pressure hoses and fuel lines, such as those used in fuel tubes, power steering and hydraulic applications. The presence of lead in the vulcanizing system provides resistance against heat aging and swelling in water. The quantity of lead in fuel lines alone–up to 4.7% by weight–is estimated to be in the range of 4–40 grams per vehicle,[38] or 980–9,840 metric tons of lead in the North American fleet of vehicles now on the road. Other high-pressure hoses contain additional quantities of lead.

Polyvinyl Chloride Plastic (PVC)

Lead is also used as a stabilizer in polyvinyl chloride (PVC) and other plastics. The main reason for this application of lead is to make plastics resistant to heat during production and against visible light and UV radiation during use. Lead use came into being when the more problematic use of cadmium was phased out. The major applications of PVC in the automotive industry are underseal coatings (for protection from abrasion to prevent rust and corrosion), electrical cables, upholstery and skin-material (faux-leather) of instrument panels and interior trims. Lead concentrations in PVC range between 0.5–3%, by weight, with interior and exterior trim representing the lower end of this range and cabling and wire harnesses representing the higher end.[39] Considering these applications, the average vehicle contains between 6–7 kg of PVC with a lead content of 50–60 grams per vehicle. The total fleet of North American vehicles therefore contains 13,000–15,250 metric tons of lead in PVC applications.

Wheel Balancing Weights

Lead weights are used worldwide to balance the wheels (tires and rims) of vehicles. While new vehicle wheels come pre-balanced from the assembly plant, there is a significant demand for wheel weights in the aftermarket for re-balancing, usually after tire replacement. The majority of wheel weights currently in use are the clip-on types that are fixed at the edge (horn) of the wheel rim. Some new shapes of aluminum rims, however, require adhesive weights. Though efforts are made to collect and recycle these wheel weights from end-of-life vehicles, a large number of them are overlooked and often end up entering the environment or contaminating the recycled metals from shredder facilities. A surprisingly high number drop off onto the road during vehicle use.

The amount of lead in weights used per vehicle varies between 200 and 250 grams,[40] based on an average of 20–25 grams per weight and 10 weights per vehicle (two on each of the four wheels and two more on the spare). The entire North American fleet contains 49,200–61,500 tons of lead as wheel weights. Each year, lead wheel weight use is roughly 20% original equipment manufacturer installation and 80% tire replacement for the vehicles on the road; or approximately 17,590–21,990 metric tons per year.

Other Automotive Uses of Lead

Small amounts of lead are also used in the ceramic glazes of spark plugs and piston coatings. The lead-silicate glass found in spark plugs contains 50% lead, amounting to an overall quantity of about 0.15 grams per plug.[41] The amount of lead in spark plugs is, therefore, estimated to be in the range of 0.6–1.2 grams per vehicle for vehicles with four to eight cylinders. Other applications in which either small or unknown amounts of lead are used include piston coatings, valve seats (up to 24 grams per vehicle), carbon brushes for electric motors and starters (10 grams for starters, 0.1 grams for smaller motors) and pyrotechnic initiators for air bags (up to 310 mg per vehicle).[42] The exact amounts and extent of use by automakers are not known for many of these applications. However, lead consumption data indicates that lead is used in amounts beyond those identified above.[43] As a result, it is estimated that other uses of lead total approximately 500 grams per vehicle.

Total Lead Content of New Automobiles and the North American Vehicle Fleet

This assessment of automotive lead applications shows its use pervades many, if not all, automotive systems. New vehicle designs continue to include lead in many applications, while the fleet of vehicles now on the road represents a rolling reservoir of lead capable of contaminating our environment and impacting human health.

The total quantity of lead currently contained in the fleet of 246 million vehicles now on the roads of North America is estimated to be 2,860,630–3,228,940 metric tons. The industry also consumes more than 1.15 million metric tons of lead per year (see Table 1) in the production of new cars and trucks, as well as replacement batteries and wheel weights. Based on these figures, the automotive industry accounted for approximately 56% of North American lead consumption in 2000.

TABLE 1
Estimated Lead Content of Vehicles in North America

Application	Use per Vehicle (min–max) (g/vehicle)	New Fleet, MY2000 (metric tons)	Existing Fleet on Road (metric tons)
Lead-acid battery	10,500	1,120,000[a]	2,583,000
Electro-coat	20–180	NA	4,400–39,800[b]
Zinc coating	1	18	246
Terne metals, brazing	30–60	370–740	5,170–10,330
Electronics—circuit boards	53–100	937–1,767	13,000–24,600
Steel alloys	10–50	177–884	2,460–12,300
Copper alloys	50–1,000	884–17,673	12,300–246,000
Aluminum alloys	119	2106	29,274
Vibration dampers	100–300	1,767–5,300	24,600–73,800
Fuel Hoses	4–40	70–707	980–9,840
Polyvinyl chloride	50–60	884–1,060	13,000–15,250
Wheel balance weights	200–250	17,591–21,988[a]	49,200–61,500
Other uses[c]	500	8,836	123,000
Total	11,637–13,160	1,153,640–1,181,079	2,860,630–3,228,940

Please see Chart 1 in the Executive Summary for a graphical representation of this data.

Notes:
Figures assume 17.7 million vehicles in New Fleet, Model Year 2000 and 246 million vehicles in the *Existing Fleet on the Road in 2000*.
a. New vehicle fleet estimates for batteries and wheel balance weights include original equipment installation as well as in-use replacement demands.
b. North American fleet estimate considers recent phase-out of e-coat from new vehicle fleet.
c. Other uses of lead include applications such as piston coatings, valve seats, starters, electric motors , rubber goods and pyrotechnic initiators for air bags.

Sources :

Estimates are largely based on vehicle lead content estimates contained in :

Sander, et al. *Heavy Metals in Vehicles*. Report compiled for the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. Hamburg, Germany. March 27,2000

Lohse, et al. *Heavy Metals in Vehicles II*. Report compiled for the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. Hamburg, Germany. July 2001

In addition, a variety of North American references were used to modify the European Union estimates where appropriate.

CHAPTER 3

Environmental releases of lead from the automotive life cycle

The use of lead in automobiles contributes to toxic releases to the environment throughout the products' life cycles—from the production of lead for use in automobiles through the disposal of these vehicles. To assess the potential impacts of automotive lead applications on human health and the environment, a life-cycle approach is taken. The following life-cycle stages are considered in this approach: lead production (including the extraction and processing of ore and lead recycling); component manufacturing and vehicle assembly; vehicle use; and end-of-life vehicle (ELV) disposal. Because lead-acid batteries represent the single largest use of automotive lead, the battery life cycle has also been pulled from the aggregate and presented separately on pages 11 and 12.

This assessment focuses on lead releases to the environment (i.e., releases directly into the air, into surface waters, or disposal on land) and the transfer of lead wastes to treatment and disposal facilities. Actual releases and transfers of lead are quantified when possible, and these releases and transfers are placed in context with an assessment of total toxic chemical releases and transfers, when data are available. Data for North America has been obtained from the U.S. Toxic Release Inventory (TRI) and the Canadian National Pollutant Release Inventory (NPRI). Similar data for Mexico are not available.

Limitations to these inventories do exist. In 2000, the most recent year for which data are available, U.S. facilities were not required to report releases or transfers unless they manufactured or processed more than 25,000 pounds (11.34 metric tons) of toxic chemicals, or otherwise used more than 10,000 pounds (4.54 metric tons), annually.[a] Similar thresholds apply in Canada—only facilities that employ more than 10 full time employees and use or manufacture more than 10 metric tons of a Schedule 1, Part 1 NPRI-listed substance (which includes lead and its compounds) are required to report to Environment Canada.[44] These high thresholds cause lead releases from smaller facilities to go undocumented; therefore, the lead emissions documented in this report from the vehicle life cycle, particularly component manufacturing, will be underestimated, and the potential for adverse human health effects conservative.

[a] In January 2001, the U.S. EPA issued a final rule under section 313 of the Emergency Planning and Community Right to Know Act (EPCRA), under which the TRI reporting thresholds for lead and lead compounds were lowered. The new rule lowers the annual reporting threshold to 100 pounds (0.045 metric tons) for facilities that manufacture, process, or otherwise use lead or lead compounds, with the exception of lead contained in stainless steel, brass, and bronze alloys. This new rule went into effect on February 16, 2001, and will apply to TRI reports covering 2001 (released in 2003) and subsequent years.

As this report went into final production, U.S. EPA released its 2001 TRI data. Preliminary review of the new data for the six SIC codes most closely associated with the automotive industry indicates consistent patterns in releases and transfers that confirm the findings of this report. It also shows a spike in the number of facilities reporting lead releases and transfers to 247 from 92, indicating that lead is more commonly present in automotive production than had previously been documented.

Life-Cycle of Lead-Acid Automotive Batteries

The lead-acid batteries found in most automobiles account for the majority of lead use in North America. The activities associated with these batteries–producing the lead required, manufacturing the batteries, and disposing of them–all release lead to the environment. These toxic emissions, and the associated human health impacts, could be avoided if the automotive industry chose to eliminate lead from its battery systems by adopting one of the several lead-free alternatives now available.

LEAD PRODUCTION

The automobile industry consumes 56% of all lead production. Lead-acid batteries in automobiles accounted for over 95% of this use. Automakers, therefore, are responsible for most of the pollution from lead production, about 58,500 metric tons of lead released directly to the environment. This figure refers only to lead releases from the primary production of lead. Total toxic releases (all pollutants) attributable to the automotive industry were more than three times larger than this figure (See Table 3).

BATTERY MANUFACTURING

The vast majority of storage batteries produced for the North American market are manufactured in the United States. Automotive starting-lighting-ignition (SLI) batteries represent more than 80% of the storage battery market. This means that more than 80% of lead releases and transfers from battery manufacturing are attributable directly to the automotive industry, or 478 metric tons of lead released and transferred to disposal facilities.

BATTERY RECYCLING AND DISPOSAL

To prevent lead-acid batteries from going to landfills, most states have banned their disposal. These laws are usually supported by a deposit-refund system that encourages consumers to return spent batteries to retail outlets or collection centers when they purchase new ones. At the end of a vehicle's life, its battery is removed by the dismantlers and also recycled. Each year in the United States alone, an estimated 114 million lead-acid batteries are disposed of through replacing lead-acid batteries in vehicles on the road and end-of-life vehicles salvage.

RECYCLED BATTERIES

In the recycling process, each battery is separated into constituent materials. The batteries are cracked by dropping them from a considerable height onto a hard, inclined surface. The acid is allowed to drain away, and is later neutralized and discharged into the public sewer system or converted to sodium sulfate, which is used in laundry detergents, glass and textile manufacturing.

The cracked batteries are crushed into small pieces using a hammermill. These pieces are then sprayed with water to remove soluble lead (lead oxide, lead dioxide and lead sulfate), followed by a hydrodynamic separation process to remove metallic lead from the plastic casing pieces. The soluble lead water slurry is treated with either sodium hydroxide or sodium carbonate, causing the lead to precipitate out of solution in the form of lead oxide or lead carbonate. These solids are removed and recycled, along with the separated metallic lead in the secondary lead smelting process. The plastic from the battery casing is also recycled.

Automotive batteries provide the single largest source of lead scrap for the production of secondary lead. In the United States, automotive lead-acid batter ies alone accounted for 90% of the scrap lead recycled in 2000. Therefore, the automobile industry is responsible for 90% of the emissions generated by secondary lead production: 156 metric tons of lead released directly into the environment, and 5,920 metric tons transferred to treatment and disposal facilities.

NON-RECYCLED BATTERIES

Unfortunately, not all spent lead-acid batteries enter this battery recycling infrastructure. Figures from the Battery Council International indicate that as many as 7% of spent automotive batteries are not recycled. The fate of these batteries is not known; for this analysis, it is assumed that these batteries enter landfills or are discarded in the broader environment illegally. Considering the best estimates for the number of lead-acid batteries recycled each year, the quantity of lead entering the environment illegally in North America is 52,668 metric tons.

In landfills, lead has the potential to leach into surrounding soils and groundwater. While landfills may reduce atmospheric exposure by burying batteries under other materials, recent studies by landfill experts have seriously questioned the long-term integrity of landfills. Lead concentrations found in municipal landfill leachates can be as high as 1.6 mg/l in pre-1980 landfills and 0.15 mg/l in post-1980 landfills. A more detailed study and literature review of hundreds of landfills around the world showed that the average lead concentration in landfill leachate is consistently elevated.

Lead Releases and Transfers Attributable to the Automotive Industry from Lead-Acid Batteries

	Automaker Responsibility	**Lead Releases** (metric tons)	**Lead Transfers** (metric tons)
Primary Lead Production (SIC 1031 and 3339)	56%	58,500	707
Battery Manufacturing (SIC 3691)	80%	115	267
Secondary Lead Production (SIC 3341)	90%	156	5,920
Illegal Disposal	100%	--	52,668
Total		58,771	59,562

Emissions data sources: U.S. Environmental Protection Agency's Toxics Release Inventory, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory, http://www.ec.gc.ca/pdb/npri/index.html.

[i]A detailed list of existing state laws related to used lead-acid batteries is provided in Appendix E.
[ii]Rubber Manufacturer's Association web site. http://www.rma.org/scraptires/facts_figures.html Accessed July 3, 2001.
[iii]USGS. *2000 Minerals Yearbook: Lead. U.S. Geological Survey.* 2000.
[iv]Reasbeck. P and J.G. Smith. *Batteries for Automotive Use.* Research Studies Press Ltd., Somerset, England. 1997.
[v]Battery Council International Web site. http://batterycouncil.org/recycling.html Accessed March 27, 2001.
[vi]Lee, G.F. and Jones-Lee, A. *Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches.* Proc. Air and Waste Management Assoc. 91st Annual Meeting, San Diego, CA, available on CD ROM as paper 98-WA71.04(A46), 40pp, June (1998).
[vii]Lee, G. F. and Jones-Lee, A. *Geosynthetic Liner Systems for Municipal Solid Waste Landfills: An Inadequate Technology for Protection of Groundwater Quality.* Waste Management & Research, 11:354-360 (1993).
[viii]EPA Lead Battery Risk Assessment. SCSP-00144.D. September, 1991
[ix]Rooker, Alexandria Pettway. A Critical Evaluation of Factors Required to Terminate the Post-Closure Monitoring Period at Solid Waste Landfills. M.S. Thesis by Alexandria Pettway Rooker, N.C. State University; Department of Civil Engineering; 2000

Lead Production

Lead is produced from lead ore mined from the ground (primary lead production) or from the recycle of scrap lead (secondary lead production). Combined primary and secondary lead production in North America produced 1,907,075 metric tons in 2000, approximately 29% of the world's total lead production that year.[45] The most significant force behind the flow of lead is the automobile industry's demand for the production of SLI lead-acid batteries. As previously mentioned, at least 1,120,000 metric tons of lead were consumed by automotive batteries alone in the year 2000. The aggregate of all automobile applications represented more than 56% of total North American lead consumption. Because of this automotive demand for lead, a significant portion of the emissions resulting from the production of lead is inextricably linked to automotive life-cycle emissions.

PRIMARY LEAD PRODUCTION

After lead ore is extracted from the ground and concentrated, the primary lead production process consists of four basic steps: sintering, smelting, drossing and pyrometallurgical refining. The sintering process uses hot air to burn off sulfur impurities from the lead ore; other raw materials such as iron, silica, limestone fluxes, coke, soda ash, pyrite, zinc, caustics or pollution control particulates are added to the ore to aid in processing. The resulting lead "sinter" is then sent to a blast furnace for smelting. In the blast furnace, sinter is mixed with coke, limestone, recycled scrap and other fluxing agents, and then melted.

As melting occurs, several layers form in the furnace. The molten lead layer sinks to the bottom of the furnace; other layers include the lightest elements, such as arsenic and antimony, at the top of the furnace (the "speiss"), a layer of copper and metal sulfides (the "matte") and slag consisting mostly of silicates. The lead from the blast furnace, called lead bullion, then undergoes the drossing process, which further purifies the lead. The bullion is agitated in kettles, then cooled to 700–800 degrees Celsius. This process results in molten lead and dross. Dross refers to the lead oxides, copper, antimony and other elements that float to the top of the lead. Dross is usually skimmed off and sent to a dross furnace to recover the non-lead components, which are sold to other metal processors. Finally, the molten lead is refined. Pyrometallurgical methods are usually used to remove the remaining non-lead components of the mixture. The refined lead may be made into alloys or directly cast.

A variety of toxic wastes are generated from each step in the primary lead production process. These either are released directly into the environment or transferred off-site for treatment or disposal. These releases and transfers from primary lead production, summarized in Table 2, include lead, arsenic, antimony and cadmium. Lead producers in the United States are subject to Maximum Achievable Control Technology (MACT) standards. The MACT standards for allowable emissions are based on the best-performing facilities (top 12%) in each industry sector. While both primary and secondary lead smelters (including lead-acid battery manufacturers) are governed by MACT standards, the mining industry is not.[46] Emissions from these facilities, therefore, are significantly larger than those from lead smelting and refining.

In 2000, primary lead production in North America was 629,863 metric tons. Lead ores were mined from 18 mines in the United States and five mines in Canada; data for Mexico were not available.[47] Direct releases to the environment–emissions directly to air, water or disposed of on land–dominate the environmental profile of these facilities. According to TRI and NPRI data (Table 2), 101,679 metric tons of lead were released to the environment from lead and zinc ore mining in the United States and Canada in 2000, and 3,321 metric tons from primary non-ferrous smelting and refining (primarily lead processing). Total lead releases per metric ton of primary lead produced in 2000 were 215.8 kg/ton for the United States and Canada combined.

TABLE 2
Primary Lead Production Toxic Chemical Releases and Transfers

	U.S.	Canada	Total
Lead/Zinc Ore Mining (SIC 1031)			
Lead Releases (metric tons)	101,666	13	101,679
Total Releases (metric tons)	340,956	185	341,141
Lead Transfers (metric tons)	0	0	0
Total Transfers (metric tons)	0	4	4
Lead/Zinc Ore Mining (SIC 1031)			
Lead Releases (metric tons)	2,965	356	3,321
Total Releases (metric tons)	29,334	9,025	38,359
Lead Transfers (metric tons)	958	306	1,264
Total Transfers (metric tons)	2,437	11,685	14,122
Primary Lead Production	341,000	145,640	486,640
Lead Releases, Normalized (kg/metric ton produced)	306. 8	2.5	215.8
Total Releases, Normalized (kg/metric ton produced)	1,085.9	63.2	779.8
Lead Transfers, Normalized (kg/metric ton produced)	2.8	2.1	2.6
Total Transfers, Normalized (kg/metric ton produced)	7.1	80.3	29.0

Sources :

U.S. Environmental Protection Agency's Toxics Release Inventory 2000, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory, http://www.ec.gc.ca/pdb/npri/index.html.

Primary Lead Production: USGS, Minerals Yearbook–Lead, 2000.

SECONDARY LEAD PRODUCTION

The United States is the world's largest recycler of lead scrap. Scrap recycling alone represents 77% of the country's total lead production, or 1,130,000 metric tons.[48] In North America, secondary lead smelters and refiners produced 1,267,212 metric tons of lead in 2000.[49] There are 23 secondary lead smelters in the United States; eight companies operating 16 of these smelters produced nearly all (about 98%) of the secondary lead here in 2000.[50] There are six lead metallurgical plants in Canada, producing 231,000 metric tons per year. (See Appendix A for a complete list).

In North America, secondary lead smelters use two types of scrap: old and new. Sources of new scrap are production wastes and smelter-refinery drosses, residues and slags. Old scrap comes chiefly from automotive lead-acid batteries, which account for about 90% of the raw material feed stock for secondary smelters.[51] An estimated 114 million lead-acid batteries were recycled in the United States in 2000, based on EPA's reported recovery of 1,710,000 metric tons of lead-acid batteries in that year,[52] and the average battery weight of 15 kg.

The majority of lead battery scrap is processed in blast furnaces or rotary reverberatory furnaces. In a reverberatory furnace, about 47% of the charge is recovered as lead product, 46% is removed as slag to be processed later in blast furnaces, and the remaining 7% escapes as dust or fumes. In a blast furnace, 82.5% of the charge is made up of lead oxides, refining dross and reverberatory slag from metal processing facilities; the remaining charge consists of siliceous slag from previous runs (4.5%), scrap iron (4.5%), limestone (about 3%) and coke (about 5.5%). Approximately 70% of a blast furnace's charge is recovered as lead product, while 18% is recovered as slag, 5% is retained for reuse, and the remaining 7% escapes as dust or fumes.[53]

Secondary lead smelter facilities emit a number of toxic air pollutants, including lead and lead compounds; a summary of releases and transfers is presented in Table 3. In 2000, secondary lead smelting and refining facilities in the United States released 171.9 metric tons of lead; total toxic chemical releases were 224 metric tons. Canadian facilities released 1.5 metric tons of lead and lead compounds and transferred 155 metric tons. Based on a United States-Canada com-

TABLE 3
Secondary Lead Production Toxic Chemical Releases and Transfers

	U.S.	Canada	Total
Secondary Lead Smelting (SIC 3341)			
Lead Releases (metric tons)	171.9	1.5	173.4
Total Releases (metric tons)	224.0	155	379.0
Lead Transfers (metric tons)	6,461.0	117	6,578.0
Total Transfers (metric tons)	7,679.6	272	7,951.6
Secondary Lead Production	1,130,000	137,212	1,267,212
Lead Releases, Normalized (kg/metric ton produced)	0.15	0.01	0.14
Total Releases, Normalized (kg/metric ton produced)	0.2	1.1	0.3
Lead Transfers, Normalized (kg/metric ton produced)	5.7	0.9	5.2
Total Transfers, Normalized (kg/metric ton produced)	6.8	2.0	6.3

Sources :

U.S. Environmental Protection Agency's Toxics Release Inventory 2000, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory, http://www.ec.gc.ca/pdb/npri/index.html.

Secondary Lead Production: USGS, Minerals Yearbook–Lead, 2000.

bined secondary lead production of 1,267,212 metric tons,[54] the total lead releases to the environment in 2000 were 0.14 kilograms per metric ton produced.

Emissions from lead production facilities directly attributable to the automotive industry include 58,956 metric tons of lead and lead compounds released directly into the environment (or 212,861 metric tons of total toxic chemical releases) and 6,628 metric tons of lead-containing wastes. These figures represent 56% (fraction of automotive lead consumption relative to North American total) of releases and transfers from primary lead production, and 90% (automotive batteries' contribution to raw material feed stock of secondary lead production) of releases and transfers from secondary lead production.

Automobile Component Manufacturing and Vehicle Assembly

Automobile manufacturing involves a complex web of suppliers of the materials and components for final assembly at the original equipment manufacturer (OEM, i.e., the automaker) facilities. Individual parts that go into the vehicle could be manufactured at any one or more of hundreds of supplier facilities. The first-level (or Tier 1) suppliers provide parts and components directly to the automaker and depend, in turn, on the second-level (or Tier 2) suppliers for their own needs, and so on. The extent of manufacturing that takes place at an automaker's own facility (termed "vertical integration") varies from manufacturer to manufacturer, and some facilities are more vertically integrated than others.

Emissions reported by the OEM facilities (automobile assembly plants) themselves are directly attributable to auto applications. OEM facilities report toxic emissions under SIC code 3711–Motor Vehicles and Passenger Car Bodies. However, the vast majority of automotive parts are manufactured by suppliers that are not captured by SIC 3711 and are scattered over a number of other industrial classifications. Assessing emissions to the environment from these facilities, therefore, is difficult. Emissions data are either not reported (small facilities are not subject to regulatory reporting requirements), or it is not possible to separate emissions attributable to the automotive industry from other industry sectors (e.g., emissions from a printed circuit board manufacturer cannot be readily attributed to auto applications since it supplies other industries as well).

In addition to examining emissions reported under SIC 3711, this report assesses emissions from the following industrial sectors that capture many of the Tier 1 suppliers for the automotive industry: SIC 3714–Motor Vehicle Parts and Accessories; SIC 3465–Automotive Stampings; SIC 3592–Carburetors, Pistons, Piston Rings and Valves; SIC 3694–Electrical Equipment for Internal Combustion Engines; and SIC 3691–Battery Manufacturing.

In 2000, these manufacturing facilities sent a total of 2,071 metric tons of lead waste to treatment and disposal facilities and released a total of 151.2 metric tons directly to the environment. See Table 4. Even though lead-containing wastes represented less than 1% of all reported toxic releases and transfers for these industry sectors and the lead releases and transfers for these sectors are small compared to emissions from lead production, these lead emissions and transfers are significant because of the potential exposure to populations located nearby.

TABLE 4

Automotive Manufacturing and Vehicle Assembly Toxic Chemical Releases and Transfers

	U.S.	Canada	Total
Automotive Manufacturing and Vehicle Assembly (SIC 3711, 3714, 3465, 3592, 3694, 3691)			
Lead Releases (metric tons)	151	0.2	151.2
Total Releases (metric tons)	24,249	5916	30,165
Lead Transfers (metric tons)	2,060	6	2,071
Total Transfers (metric tons)	144,093	370	144,463
Car and Truck Production[a]	12,814,190	2,921,601	15,735,791
Lead Releases, Normalized (kg/metric ton produced)	0.00001	NA	0.00001
Total Releases, Normalized (kg/metric ton produced)	0.002	0.002	0.002
Lead Transfers, Normalized (kg/metric ton produced)	0.0002	NA	0.0002
Total Transfers, Normalized (kg/metric ton produced)	0.01	0.0001	0.01

Sources :
U.S. Environmental Protection Agency's Toxics Release Inventory 2000, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory, http://www.ec.gc.ca/pdb/npri/index.html.

Note:
Not all reported chemical releases and transfers can be attributed to the automotive industry. Some facilities reporting under these industrial codes supply the automotive OEMs as well as other industry sectors. Considering the size of the automotive industry and its supply chain, however, a significant fraction of these emissions can be attributed to the industry.

a. An additional 1,937,631 vehicles were produced by facilities in Mexico *(Automotive News, 2001 Market Data Book)*. Emissions data was not available for these facilities.

Vehicle Use

The use stage of the vehicle life cycle also contributes to the release of lead to the environment; leaded gasoline, not yet eliminated worldwide, still constitutes a significant health threat in many countries, and the wear and replacement of lead-bearing automotive parts in the United States and Canada contribute to the total environmental load of lead from the vehicle life cycle.

LEADED GASOLINE

From 1930 to the mid-1990s almost 10 million metric tons of lead were used as gasoline additives worldwide.[55] In the United States and Canada, the gasoline additive tetraethyl lead (TEL) was the major source of lead emissions and poisonings before it was gradually phased out between 1976 and 1986. Worldwide, lead use in gasoline peaked in 1974 at nearly 400,000 metric tons per year. This use declined to 50,000 metric tons per year globally by 1995. In the late 1990s, however, the rate of leaded gasoline phase-out has slowed, and 44,755 metric tons of lead were still being used as fuel additives worldwide in 2000.[56] (See Appendix B for the current status of the global phase-out of leaded gasoline).

Approximately 50 countries have verifiably completed phase-out, while more than 100 countries still use leaded gasoline. To address this problem, the Alliance to End Childhood Lead Poisoning has created a Global Lead Initiative (GLI). The goal of GLI is to "catalyze expedited completion of leaded gasoline phase-out and to identify and eliminate other exposure sources."[57] The continued use of leaded gasoline remains the major source of lead exposure in many parts of the world, and a tremendous human health threat.

WEAR AND REPLACEMENT OF LEAD-CONTAINING AUTOMOTIVE PARTS

During the useful life of the automobile (spanning an average of 120,000 miles or 10 years), numerous parts need to be replaced. The lead-containing parts of significance that are usually replaced during use are lead-acid batteries, wheel balancing weights, brake pads, starter motors and vibration dampers (both original equipment and aftermarket add-ons). In the absence of maintenance and replacement data, this study does not attempt to estimate total lead emissions from the use of the automobile. The study does quantify lead pollution due to the loss of wheel weights. (See Lead Pollution from Wheel Weights section) Efforts have also been made to document the quantities of lead in high lead-containing parts, wherever possible. Battery recycling is dealt with in more detail in a later section.

LEAD POLLUTION FROM WHEEL WEIGHTS

One noteworthy quantity of lead released during the use stage of the automobile is from the loss of wheel weights and their subsequent abrasion on roads across North America. A recent study by Robert Root, formerly of Battelle Memorial Institute, documents this previously unaccounted for load of lead to our environment.[58] Based on his findings, it is estimated that 5,288 metric tons of lead is released into the environment each year. This is based on the amount of lead believed to be contained in wheel weights (Section 2.11) and the assumption that 10% of it is likely to get deposited in the streets each year. Based on the vehicle fleet strength in the United States vs. Canada, approximately 92% (4,865 metric tons) are estimated to be lost in the United States and 8% (423 metric tons) in Canada. The Root study documented that within eight days of deposition on the road nearly 50% of the lead was no longer visible. The remaining weights were abraded, some severely, or broken into smaller pieces.

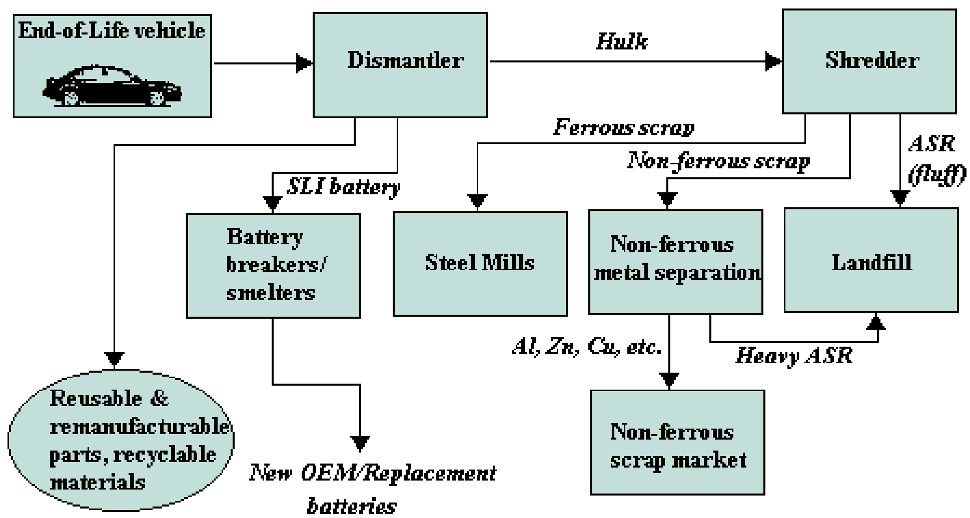
Lead wheel weights frequently drop off and are gradually abraded and reduced in size. The resulting lead dust is dispersed into the air, contaminating soils and potentially inhaled. In residential areas, this wheel weight abrasion can contribute to the lead contamination of dust on floors, on window sills and in soils. Lead dust can also migrate into nearby homes as it adheres to pedestrians' shoes or pets' feet.

A study on lead loading of urban streets by vehicle wheel weights estimates the "pool of lead rolling over U.S. highways" to be on the order of 25 million kg (25,000 metric tons or 27,558 short tons).[59] This is based on the assumption that there are 200 million automobiles and light trucks in the U.S., and 130 grams of lead are contained in the wheel weights for each vehicle. Performing a similar calculation given the current North American fleet strength of 235 million automobiles and assuming 225 grams per vehicle instead of 130 grams (average obtained from the European Commission report on heavy metals in vehicles, cited earlier), it is estimated that 52,875 metric tons of lead are currently "rolling over" North American highways.

End-of-Life Vehicle Recycling

In 2000, more than 13 million vehicles (passenger cars and light trucks) were retired from the roads in the United States and Canada.[60] Approximately 94% of these end-of-life vehicles (ELVs) enter the well-established vehicle recycling infrastructure depicted in Figure 1. This infrastructure removes parts and components of value through the dismantling process and then separates the remaining materials into recyclable materials (mostly ferrous and non-ferrous metals) and wastes (e.g., plastics, fabric, carpeting and foams) through the auto shredding process. Most sources currently estimate materials recovery at 75% of vehicle weight, most of which is represented by the recovery of iron, steel and other metals. The remaining 25% of vehicle weight, known as automotive shredder residue (ASR), or fluff, is landfilled, as in many parts of the United States,[61] or treated as hazardous waste and landfilled, as in California.[62] In Europe these wastes are labeled as hazardous waste and incinerated.[63]

FIGURE 1
Existing Vehicle Recycling Infrastructure



The fate of automotive lead in this process varies and depends, in part, on its use in each automotive component. Larger pieces of lead, such as wheel weights and vibration dampers, may be segregated and recovered by vehicle dismantlers or in the metals recovery process of auto shredders. Lead contained in alloys, hoses, plastics, electronics, cables, or in coatings adhering to metals, on the other hand, cannot be segregated and are not easily recovered. This lead will either remain with the metals fraction and contaminate the metals recycling process, or end up in ASR fractions that are disposed of in landfills, with the potential of leaching into groundwater.

DISMANTLERS

North America has more than 10,000 dismantlers, 20% of which use advanced technologies and target late model vehicles for high-value parts.[64] The remaining 8,000 dismantlers conduct more traditional auto salvage operations and are referred to generically as auto salvage yards or scrap yards. High-value parts dismantlers tend to be high-volume operations that quickly process late-model ELVs and either send them on to a scrap yard for further processing or directly to a shredder facility for materials recovery. In comparison, salvage yards tend to be low-volume, low technology operations that store ELVs while parts are gradually removed and sold.

Eventually, the remaining vehicle hulks are crushed (optional) and sent to a shredder facility for materials recovery. Both facilities typically remove tires, wheel rims, engines, transmissions, batteries, fuel tanks, radiators, air bags, motors and catalytic converters for reuse, remanufacturing or recycling. Many parts, such as instrument panels, seats and carpeting, are not designed to be reused or recycled and, therefore, remain with the vehicle hulks where efforts are made to separate them from materials of value in the auto shredding process.

Chemical releases to the environment from these facilities are not reported under federal law; most dismantling facilities are small enough to fall outside existing regulatory requirements. However, the historical record of salvage yards does show the potential environmental impacts that can occur if proper management of these facilities is not followed. Poorly managed dismantling operations can release to the environment gases such as freon, gasoline vapors and liquids such as motor oil, antifreeze (glycols), sulfuric acid or dissolved lead from lead-acid batteries, methanol, brake fluid and gasoline.

Management Practices in the Industry

EPA storm water regulations require auto recyclers to obtain a federal National Pollutant Discharge Elimination System (NPDES) storm water permit. The NPDES permit requires a detailed storm water pollution prevention plan that incorporates Best Management Practices (BMPs) to reduce water quality impacts. However, a recent study identified a number of barriers to implementing such plans at auto salvage yards.[70] These range from a lack of knowledge of best practices and a lack of environmental stewardship to more technical barriers, such as difficulty in separating components.[71] Despite known problems of contamination at auto scrap yards, many of these sites continue to operate with only limited regulatory oversight. Stricter regulatory controls for the auto recycling industry would not only make recyclers more mindful of implementing best management practices, but also encourage automakers first to eliminate the use of toxic substances in their vehicles and, second, to design them with fewer, easily separable, and more recyclable materials.

SHREDDERS

Following the dismantling process, the gutted vehicle hulks (crushed, or not) are sent to auto shredder facilities for materials recovery. About 200 auto shredders process ELVs, as well as discarded appliances (e.g., washing machines), in North America.[72] Vehicles typically are sold to shredder facilities at a price of about 3 cents per pound.[73] As the name implies, these facilities first shred the vehicle hulks into fist-sized pieces. These pieces are then separated into three fractions: ferrous metals, non-ferrous metals and auto shredder residue (ASR). The ferrous metals are magnetically separated and sent to metal recyclers, typically electric arc furnaces; the ASR fraction, consisting of foam, textiles, plastics, glass, metal fines and dirt, is removed by air cyclone and landfilled; the remaining material, rich in

Lead Pollution from Auto Dismantling

Historically, scrap yards were used to store not only ELVs but other metal scrap and wastes as well. Scrap yards first came into existence in the 1940s and '50s when cars were disposed of in open fields. At that time, the shredding technology was not available and ELVs were stored for their parts. Scrap yards were usually located on the fringes of towns and cities, often on farmland. Over the years, some of these facilities started accepting other wastes, such as transformers containing polychlorinated biphenyls (PCBs), spent chemicals and other industrial wastes. Little attention was paid to environmental management practices until recently, when environmental contamination issues began to emerge at a number of poorly managed sites.

An ELV may be stored for two to five years in a scrap yard before being processed.[65] During this time, wrecked and corroding vehicles may slowly release contaminants into the soil, air (through volatilization) or water (through storm water runoff). Many scrap yards are contaminated with used oil and heavy metals, as well as PCBs—a testament to the types of activities that occurred there. As a result, a number of scrap yards have been listed as Superfund sites in the United States because of heavy metal contamination. This is mainly a result of bad storage practices and lack of regulatory oversight of scrap yards, many of which are small facilities that have historically fallen below the regulatory radar screen. Hebelka Auto Salvage Yard and Steven's Scrap Yard are two facilities that exemplify the possible environmental impacts from this life-cycle stage.

HEBELKA AUTO SALVAGE YARD, LEHIGH COUNTY, PENNSYLVANIA

The Hebelka Auto Salvage Yard is located in rural Lehigh County, Pennsylvania. The 20-acre site is bordered primarily by agricultural fields, but three residences are located on or adjacent to the site. From 1958 to 1979 and again from 1989 to at least 1991 the property was used as an automo bile scrap yard and for salvage activities.[66] The Hebelka Auto Salvage yard was placed on the National Priorities List (NPL) after a 1985 inspection by U.S. EPA and the Pennsylvania Department of Environmental Resources revealed large piles of uncovered battery casings on the site. On-site soils, sediments in a drainage way and sediments in an off-site stream contained elevated levels of lead and mercury.[67] The site was remediated at a cost of $2,244,680 in federal cleanup funds and was deleted from the NPL in September 1999.[68]

STEVEN'S SCRAP YARD, LITTLETON, MAINE

Steven's scrap yard and metal reclamation, located in Littleton, Maine, on Road Number 1 in Aroostock County, has operated since 1976. The scrap yard and metal reclamation facility is located on the eastern portion of 62 acres of former farmland. The rest of the property now comprises overgrown vegetation and woods; about 100 feet from the metal reclamation operations, a small stream flows.

During a U.S. EPA investigation, inspectors found 55-gallon drums partially or wholly filled with waste oil contaminated with PCBs (between 50 to 210 parts per million) on the property. An order was placed to remove the PCB-contaminated oil from the site and to clean up the immediate area. The waste oil and contaminated soils were removed and disposed of in Braintree, Massachusetts.

In 1995, Maine's Department of Environmental Protection (ME EPA) conducted a sampling and investigation of the same site. This time officials looked for inorganic toxic contaminants in surrounding neighborhood properties. They found high levels of inorganic substances in nearby residential wells, including lead, cadmium, mercury and chromium levels above the reference concentration. The ME EPA concluded the elevated levels of toxic heavy metals were attributable to the nearby automobile salvage operations.[69]

non-ferrous metals, is further processed (on-site or at another facility) to recover aluminum, copper and zinc. The waste from this non-ferrous metals separation process, called heavy ASR, is also landfilled by facilities in North America. In one year, the 12 million vehicles processed by auto shredders in North America generate 12 metric tons of steel, 960,000 metric tons of non-ferrous metals and 3.3 million metric tons of ASR.[74] Lead contaminates each of these material fractions, and contributes to lead emissions to the environment.

FERROUS METALS RECYCLING IN ELECTRIC ARC FURNACES

Electric arc furnaces (EAFs) use electric energy to melt and refine ferrous scrap in a batch process to make a variety of steel products. EAFs are unique in the fact that they use only scrap metals as primary raw materials, and ferrous scrap from auto shredders is a significant source of raw materials for these facilities.[75] As the scrap melts in the EAF, impurities in the raw materials are removed as slag or released as dust and gaseous by-products to the environment. It is this process of melting that releases lead, which contaminates the ferrous fraction from auto shredders.

Particulates and gases that evolve during this steel-making process are conveyed into either a wet or dry gas cleaning system. EAF sludge and EAF dust generated by the wet and dry gas cleaning systems, respectively, are listed as hazardous waste. The composition of EAF dust or sludge varies greatly, depending on the scrap composition and furnace additives. The U.S. EPA reports, however, that the primary hazardous constituents of EAF wastes are lead and cadmium.[76] Recovery of lead from EAF dust is practiced only when zinc concentrations are above 16% by weight, as the sole recovery of lead is not profitable in itself; otherwise the dust is disposed of in industrial waste landfills. Depending on production practices, 10–20 kg of EAF dust (or 20–40 lbs/short ton) may be generated per metric ton of steel produced, and 500,000 metric tons (550,000 short tons) of EAF dust are generated annually in the United States alone.[77] Despite these cleaning steps, the secondary steel industry releases lead and other toxic chemicals to the environment.

In 1999, there were 120 EAF minimills operating in the United States, 20 in Canada and 19 in Mexico.[78] Approximately 37% of all domestic ferrous scrap processed by the steel industry is supplied by the automotive recycling sector, which also processes discarded appliances and other industrial scrap steel.[79] As presented in Table 5, EAFs released 407 metric tons of lead to the environment, and transferred 10,379 metric tons to treatment and disposal facilities in 2000. The quantity of steel scrap coming from the automotive industry in the United States is about 12,700,590 metric tons[80], or about 28.2% of EAF steel production in 1999. Therefore, by applying this percentage to the industry's emissions, the automotive industry is responsible for about 115 metric tons of lead released directly into the environment and 2,927 metric tons of lead waste transferred to treatment and disposal facilities.

Landfilling of ASR

The quantity of lead contained in ASR has been estimated from levels reported in three studies. One of these, a study conducted by the German Umweltsbundesamt (Federal Environmental Agency), which presents the most complete data, found high concentrations of toxic contaminants in ASR, including lead.[81] The U.S. EPA conducted a pilot study of ASR, which also found high concentrations of lead, as well as PCBs and cadmium.[82] And based on its 1989 evaluation, the California Department of Health Services concluded that lead is one of the metals of concern in ASR–research that supported the state's designation of ASR as hazardous.[83]

TABLE 5

Secondary Steel Production Toxic Chemical Releases and Transfers

	U.S.	Canada	Total
Secondary Steel Production (EAFs)			
Lead Releases (metric tons)	261	146	407
Total Releases (metric tons)	25,299	3,150	28,449
Lead Transfers (metric tons)	10,379	0	10,379
Total Transfers (metric tons)	194,282	11,989	206,271
EAF Steel Production Capacity	55,865,340	11,787,050	67,652,390
EAF Steel Actual Production	45,062,590	NA	NA
Lead Releases, Normalized (kg/metric ton produced)	5.7E-06	1.5E-05	7.45E-06
Total Releases, Normalized (kg/metric ton produced)	0.00056	0.0003	0.00052
Lead Transfers, Normalized (kg/metric ton produced)	0.00023	0	0.0002
Total Transfers, Normalized (kg/metric ton produced)	0.0043	0.0013	0.0038

Sources :

U.S. Environmental Protection Agency's Toxics Release Inventory 2000, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory, http://www.ec.gc.ca/pdb/npri/index.html.

EAF Steel Production Capacity: Iron and Steel Society, Iron and Steel Maker, EAF Roundup Issue, May 2000.

EAF Steel Actual Production: American Iron and Steel Institute, http://www.steel.org/stats/1999.htm.

TABLE 6

Lead Content of Auto Shredder Residue (ASR)

Data Source	**Lead Concentration** (mg/kg)	**Lead in ASR, Average** (metric tons per year)[a]	
		U.S.	**Canada**
Umweltsbundesamt, Germany[b]	3,500–7,050	15,825	1,583
Environmental Protection Agency, USA[c]	570–12,000	18,855	1,886
Dept. of Health Services, California[d]	2,330–4,616	10,419	1,042
Average	--	15,033	1,504

a. Based on 3 million metric tons of ASR potentially landfilled each year in the U.S. and 300,000 metric tons in Canada.

b. Weiss et al. Ermittlung und Verminderung der Emissionen von Dioxinen und Furanen aus Thermischen Prozessen, Forschungsbericht 104 03 365/17, Umweltsbundesamt (UBA). 1996.

c. U.S. EPA. PCB, Lead and Cadmium Levels in Shredder Waste Materials: A Pilot Study; EPA 560/5-90-00BA. April 1991.

d. Nieto, Eduardo. Treatment Levels for Auto Shredder Waste, State of California Department of Health Services, June 1989.

Contribution of Auto Applications to Total Anthropogenic Lead Releases

The automobile industry's demand for lead in SLI batteries, as well as many other automotive applications, contributes to toxic chemical releases and transfers throughout the automobile life cycle. The automobile industry is responsible for lead emission in each stage of the life cycle, from the extraction and processing of lead to the ultimate disposal of vehicles. Table 7 summarizes these life-cycle lead releases and transfers reported by industries in the United States and Canada.

In comparison, the total reported lead emissions (releases and transfers) for North America in 2000 were 175,531 metric tons.[84] Therefore, from the data presented in Table 7, it is estimated that the automobile industry is responsible for at least 41% of the known lead releases and transfers in North America. The other major industry sectors responsible for lead emissions in the U.S. are mining of copper, silver and gold ores.

TABLE 7

The Automobile Industry's Contribution to Lead Releases Throughout the Vehicle Life Cycle

	Lead Releases (metric tons)	**Lead Transfers** (metric tons)
Reported Emissions		
Primary Lead Production[a]	58,800	707
Secondary Lead Production[b]	156	5,920
Vehicle Manufacturing and Assembly[c]	151. 2	2,071
Secondary Steel Production[d]	151	3,840
Total Reported Emissions	59,258	12,538
Unreported Emissions		
Wheel weight loss	5,288	--
SLI batteries to landfill	--	42,887
Lead content of ASR	--	16,537
Total Releases and Transfers	64,546	71,962

Notes:

a. The automobile industry consumes 56% of total lead production.

b. SLI batteries represent over 90% of the raw material feed stock for Secondary Lead Production.

c. Assumes 100% attributable to the automobile industry. The contributions to this total from every facility captured by these industries, however, may not be fully attributable to the automotive industry; some automotive suppliers manufacture similar products for different industry sectors.

d. Automotive ferrous scrap represents 37% of the raw material feed stock for Electric Arc Furnaces and the Secondary Steel Production industry.

Sources:

Reported emissions : U.S. Environmental Protection Agency's Toxics Release Inventory 2000, as presented by the Right-to-Know Network, http://www.rtk.net/rtkdata.html; and Environment Canada's National Pollutant Release Inventory

Unreported emissions : Wheel weights : Wheel weight deposition rate derived from Root, Robert A. Lead Loading of Urban Streets by Motor Vehicle Wheel Weights. Environmental Health Perspectives, Volume 108, Number 10. October 2000.

SLI batteries to landfills : Deposition rate derived from EPA estimates of percentage battery content in waste and Battery Council International 5 year average weight of batteries available for recycling. EPA. Municipal Solid Waste in the United States : 2000 Final Report (2000 data). April 2000. http://www.epa.gov/epaoswer/non-hw/muncpl/report-00/report-00.pdf. Accessed December 1, 2002 ; and Battery Council International website. http://batterycouncil.org/recycling.html Accessed March 27, 2001.

Lead Content of ASR : Content estimate is average of data referenced in Endnotes 81, 82 and 83 multiplied times ASR generation.

CHAPTER 4

Alternatives to automotive uses of lead

The hazardous nature of lead and its potential health impacts call for switching to more benign alternatives, wherever possible. Several alternatives do exist for a large number of automotive lead applications, including the single largest use, SLI lead-acid batteries. In some cases, procurement of lead-free alternatives might be more expensive; the human health benefits and life-cycle savings from the elimination of lead in automobiles, however, can justify increased cost. Designing lead out of automobile parts by replacing them with non-toxic alternatives would, in the long run, result in lower environmental, health and safety costs for personal protective equipment, emissions control devices, accidents (both human health- and environment-related), hazardous waste disposal, recording keeping, reporting and labeling. This chapter discusses some available alternatives.

Lead-Acid Batteries

The electronic content of the average automobile has been growing steadily, threatening to exceed the capacity of the current 12-volt, SLI lead-acid battery. This evolution has been spurred by changing needs, including a growing emphasis on safety, increased demand for additional features that provide enhanced levels of comfort and entertainment, and consumers' increasing information-access needs. To meet these increased electrical demands, automakers are working with battery manufacturers to develop new battery technologies to replace the 12-volt lead-acid battery. Industry research and development into battery options for electric and hybrid gasoline-electric vehicles have also contributed to the advancement of lead-free battery options. Research advances in nickel-metal hydride (NiMH), lithium-ion (LiIon) and other lead-free alternative battery technologies have vastly improved upon these systems' power density, weight, longevity and expected cost competitiveness. Two available battery alternatives for the existing 12-volt battery are the dual-battery system and high voltage (24-, 36-, 42-volt) battery system.[85]

A dual-battery system employs two batteries to meet the growing demands on the existing 12-volt lead-acid battery. One battery would be used exclusively to start the vehicle; the other battery would serve as the continuous source of power to run the electronics of the vehicle (e.g., lights, radio, power windows, etc.). One possible battery combination is a small-sized lead-acid battery as the starter battery, and a NiMH or LiIon battery to supply continuous power.

A high-voltage system could also employ NiMH or LiIon battery technologies to eliminate completely the use of lead in automotive battery systems. Such a high-voltage system could satisfy the growing electrical demands of today's automobiles while offering opportunities to improve other environmental aspects of the automobile. If integrated into new vehicle designs, a high-voltage system could be coupled with existing advanced technologies (sometimes termed "soft hybrid" technologies) to improve fuel economy and vehicle emissions. For example, an integrated starter-generator, in combination with a lead-free, 42-volt, NiMH battery system, could eliminate vehicle idle, thereby increasing fuel economy and decreasing vehicle emissions. The integrated starter-generator allows a vehicle's engine to turn off at stop lights, in stop-and-go traffic and other idling situations and start again automatically when the accelerator is pressed.

Yet another option for the elimination of lead from automotive batteries is to use the NiMH or LiIon technology in 12-volt batteries. Extensive research has been underway to develop these technologies for use in electric and hybrid gasoline-electric vehicles.[86] Using a design and costing model developed from this national research effort, Tim Lipman of the University of California at Davis developed a sophisticated electric vehicle battery production cost model in 1999.[87] Cost estimates for lead-free, NiMH 12-volt batteries are analyzed in Table 8. The model, developed for large battery packs, was reduced proportionally to produce single module, 12-volt batteries; additional cost reductions were calculated based on a higher volume production and the fact the battery itself is smaller. All other cost factors are identical to those used in the original model.[88]

TABLE 8

Selling Price Estimates for 12-Volt NiMH Batteries Generation 3 and Generation 4 Batteries

Generation and cell size	Low cost price		High cost price	
	$/kWh	$/battery	$/kWh	$/battery
Gen 3: 520,000 batteries/yr				
50 Ah; 12Volt (600Wh)	359.95	215.97	409.24	245 54
Salvage Value	20.58	12.35	20.58	12.35
Price minus Salvage Value	339.37	203.62	388.66	233.19
Gen 3: 2.6 million batteries/yr				
50 Ah; 12Volt (600 Wh)	306.84	184.1	358.18	214.91
Salvage Value	20.58	12.35	20.58	12.35
Price minus Salvage Value	286.26	171.75	337.6	202.56
Gen 4: 520,000 batteries/yr				
60 Ah; 12Volt (720 Wh)	238.69	171.86	269.02	193.69
Salvage Value	20.58	14.82	20.58	14.82
Price minus Salvage Value	218.11	157.04	248.44	178.87
Gen 4: 2.6 million batteries/yr				
60 Ah; 12Volt (720 Wh)	199.23	143 45	225.66	162.48
Salvage Value	20.58	14.82	20.58	14.82
Price minus Salvage Value	178.65	128.63	205.08	147.66

Source:

Based on cost estimates contained in Lipman, Timothy A., "The Cost of Manufacturing Electric Vehicle Batteries," Institute of Transportation Studies, UCLA at Davis, May 1999. Tables 17 and 21.

Notes:
Production numbers in source tables (Lipman, 1999) are for battery packs containing 26 modules of 10 cells each. Production numbers in table are extrapolated accordingly. Lipman reviewed four generations of NiMH battery technology. These generations are partly based on projections of the advanced NiMH battery technology for Electric Vehicle applications (Gifford, 1997), and partly based on additional assumptions made by Lipman, 1999. Gen 3 is the most likely scenario and Gen 4 is possible based on specifications for materials which are in an active research and development phase.

As shown in Table 8, at a production level of 2.6 million using advance generation 4 technology (6 Ah, 12 Volt/720 Wh), a selling price for 12-volt NiMH batteries of between $143 to $162 per battery is possible in the future. Achieving large production volume is vital to achieving this selling price and would require major commitments from automakers to assure these volumes could be met. The cost to the user could be cut in half because NiMH batteries are likely to have at least double the life of lead acid batteries. A further cost reduction of $25 is realized from the higher salvage value of NiMH batteries at end of life.

Despite the availability of these alternatives, and the clear environmental and human health benefits they offer, automakers are still looking to the lead-acid battery for answers. Automakers and battery manufacturers seek to increase the specific energy of lead-acid batteries, and even increase their size for high-voltage applications. These efforts, unfortunately, will significantly increase the use of lead in batteries—already the single largest use of lead in the world.

Surface Treatments and Coatings

LEAD-FREE E-COAT

Coating manufacturers have developed lead-free primer alternatives that offer a quality coating, as good as or better than the lead-containing counterpart.[89] These lead-free formulas do not require special or unique application equipment, and they provide advantages such as 1) the elimination of lead-containing hazardous waste; 2) improved performance of the filtration system (which removes contaminants from the electro-deposition bath); and 3) simplified rinse water treatment and disposal. There are many different lead-free e-coat formulations available, depending on the manufacturer. PPG Industries, Inc., for example, has developed Environ-Prime 2000, a lead-free primer alternative that also contains less than 0.5% volatile organic compounds (over 99% VOC-free). In addition to eliminating lead, this primer coating reduces VOC emissions, is compliant with hazardous air pollutant regulations, covers more efficiently, and cures at lower temperatures to reduce energy consumption and carbon dioxide emissions.

By model year 2002, all North American automakers had switched to lead-free e-coatings. DaimlerChrysler was the first to commit to a lead-free e-coat system. Working with PPG Industries, Inc., DaimlerChrysler began phasing out leaded e-coat in the mid-1990s in the United States, and completed the change in 2001 with two final facilities in Mexico.

The change to lead-free e-coat by General Motors was more abrupt. In 2000, GM's experience with lead-free e-coats had been negative. From their perspective, not only was the lead-free formulation and process more expensive than the traditional leaded e-coat, but GM was also having difficulties achieving the desired quality with the alternative. In less than two years, these limitations were overcome, and the automaker was able to implement lead-free e-coat in all its manufacturing facilities.

All of Ford's North American plants were converted to lead-free e-coat in July 2001.[90]

Lead-Free Electronics

A number of efforts are underway to develop lead-free solder technologies for the electronics industry. Recently, the industry announced a global alliance–the Global Environmental Coordination Initiative (GECI)–to help plan for an early transition to lead-free solders by the end of 2003.[91] This voluntary deadline is far ahead of the proposed European Union deadline that would have banned leaded solders by 2008.

There are two different types of electronic applications specific to the automobile. Low-temperature applications are one type; these electronics are those typically found within the passenger compartment of the vehicle and are not exposed to heat, moisture and dirt. High-temperature electronics are the second type of application; these electronics are typically found in areas of the vehicle exposed to the elements, as well as to the extreme heat of the engine compartment (e.g., transmission, engine mount applications).

While lead-free alternatives exist for the low-temperature applications, the high-temperature applications appear to be the remaining hurdle for the automobile. Recent research by the electronics industry, however, has resulted in positive results with newly developed alloys. Specific selenium-silver-copper (Sn/Ag/Cu) alloys have passed all thermal cycling tests including temperature ranges from −40 to 125 degrees Celsius, and the National Electronics Manufacturers Initiative has chosen Sn/Ag/Cu alloys as the new target standard. Other options include alloys of copper/silver (Cu/Ag) and bismoth/senineum (Bi/Sn) for substitute candidates for lead solder applications.[92]

In addition to research and development efforts by the electronics industry, the National Institute of Standards and Technology is helping electronics manufacturers convert to these lead-free alloys and implement the accompanying manufacturing processes.

Lead-free Alloys

To maintain the machinability of some steels, lead can be replaced by a number of other metals. Such alternatives to lead in steel alloys are calcium, bismuth or tin. Recently published research at the University of Pittsburgh School of Engineering[93] reported the development of a "green steel" in which 0.05% tin (12T14 steel) replaces the usual 0.3% lead (12T14) in steel alloys. Steelmakers claim that 12T14 poses fewer manufacturing and environmental problems than the commonly used lead-based alloys, while maintaining machinability. In Europe, where there is an increasing interest and mandate for vehicle recycling, steel-lead alloys are being eliminated. According to Milton Harris, CEO of Harris Steel Group, "Recycling is a serious issue in Europe, where there has been a strong attempt to ban lead from shredded auto scrap. Both Mercedes-Benz and Volkswagen have said that they will not accept leaded steel beginning with the 2001 model."[94] Calcium is another alternative to lead to maintain the machinability of some steels. The cost of this lead-free steel alloy, however, is prohibitive; a cost premium of 20–30% is possible with steel-calcium alloys.

In the majority of aluminum alloys, lead is an undesirable impurity that must be tolerated, given the current recycling infrastructure. However, in some applications in which lead is deliberately introduced to aid machining, there are two possibilities: Do away with the use of lead altogether in those applications that are less machining-intensive; or use alternatives such as tin and bismuth. Another reason for keeping lead contamination in aluminum as low as possible is that secondary aluminum smelters will either not accept scrap containing high concentrations of lead or will accept it at a reduced price because it requires additional quantities of clean scrap.

Vibration Dampers

While the use of lead in vibration dampers easily solves vibration problems in automobiles, the imposition of this additional heavy burden goes against worldwide efforts currently underway to reduce vehicle weight and maximize fuel efficiency. Some alternatives being tested use cast iron or filled polyacrylates in place of lead. However, these materials are not as effective as lead in absorbing vibrations. More research needs to be done to either eliminate vibration problems altogether, or to find application-specific solutions.

Fuel Hoses

Lead compounds are used to aid vulcanization in high-temperature resistant rubbers suitable for fuel hoses. One alternative is the use of steel tubes to carry fuel, thereby reducing the length of the rubber hose to a few centimeters only (with the sole purpose of dampening engine vibrations). Alternative rubbers are also being developed that are free of lead. Lead-free rubbers, however, involve costly modifications to existing production processes.

Alternatives to PVC Stabilizers and PVC Plastic

While there are alternatives to lead as a stabilizer for automotive PVC applications, replacing PVC plastic with other, lead-free plastics could be the best environmental choice for the industry. Lead-free alternatives are already being used for the underseal application, while the use of PVC upholstery is on the decline. Polypropylene, polyurethanes and other polymers are being increasingly used in place of PVC skins for instrument panels and interior trims. Substitutes being developed for lead-free cables include those that use cadmium/barium, barium/zinc or calcium/zinc as a stabilizer for PVC. Calcium/zinc systems are preferable because of their relative non-toxicity. Even if the lead is taken out of PVC, reproductive toxins like pthalates and other chemicals used in PVC plastics still make it a dangerous material to use in cars.

Alternatives to Lead Wheel Weights

A number of materials are being considered as potential alternatives to the use of lead in wheel weights. They include tin, steel, tungsten, plastic (thermoplastic polypropylene) and ZAMA (an alloy of zinc, aluminum and copper). Injecting plastic beads into the tire is also being considered as an alternative to wheel weights. Though tin appears to be a favorable alternative and is considered a "drop-in" replacement for lead, it is lighter; for the same cross-section, a tin weight will have to be about 50% longer than a lead weight. Plastic-coated tin wheel weights are recommended for alloy wheels (to minimize corrosion).[95] These alternatives are not yet used in any appreciable quantity by the industry.

Other Automotive uses

Several car manufacturers have switched to lead-free alternatives for fuel tanks, ranging from alternate coating materials on steel, such as tin-zinc, aluminum, or nickel, to plated-zinc or plastic tanks. In the case of valve seats, in which lead is used as a lubricant, other lubricants such as MnS, MoS_2, CaF_2 or graphite can be used. Developing and testing of these alternatives is underway.

CHAPTER 5

Strategies and policies for lead-free vehicles

Two basic strategies exist for reducing the releases of lead and other toxic substances from the production, use and end-of-life processing of vehicles: 1) prevent releases by eliminating uses of lead in vehicles and 2) reduce releases by removing, collecting and recovering lead from lead-containing vehicle components. Both of these strategies have been used, although for the dominant use of lead in vehicles–batteries–the second strategy has been the primary choice. In general, however, eliminating uses of lead will result in greater benefits than those achieved by adopting more effective recycling processes for a product at its end of life.

Eliminating lead use will also help to curtail impacts from both "upstream" and "downstream" lead releases associated with mining, production and processing, including worker exposures. Close to 90% of automotive lead use, and as much as 75% of all lead use, is due to the production of lead-acid batteries. Even with high rates of recycling and recovery, lead production and recycling processes associated with automotive batteries are still responsible for a majority of lead releases to the environment. With the emerging introduction of higher power 42-volt electrical systems in new vehicles, automotive-related releases of lead may grow, rather than decline. Therefore, any strategy or policy for reducing lead releases must address this dominant use.

Other automotive uses of lead should not be ignored, however. Non-battery automotive applications still account for over 5% of total non- battery lead use (and release). Many of these applications are not recovered and recycled as batteries are, making the lead a contaminant in other recycling and disposal processes. Again, the best solution is to find alternatives to lead in these applications. Where that is not possible, the auto recycling system should be improved to better remove and recover lead-containing components.

Currently, automakers in the United States and Canada have little incentive to eliminate lead from automobiles or to take responsibility for the collection and recycling of lead-containing components. European countries, however, have mandated comprehensive Extended Producer Responsibility (EPR) legislation that requires producers to eliminate uses of lead and to take responsibility for the financial impacts of vehicle end-of-life management. Many U.S. states now require the recycling of lead-acid batteries, with the primary responsibility falling on battery producers, but there is little incentive to find alternatives to lead in batteries or other automotive components here in North America.

This chapter discusses measures that can help reduce the environmental and health impacts of automotive lead use. It will focus on existing policies and practices for end-of-life vehicle management in Europe and North America, including those specifically addressing lead use and disposal. Because current policies and practices in North America are not adequately addressing this issue, the report concludes with specific recommendations for change.

Extended Producer Responsibility Policies

Extended Producer Responsibility (EPR), sometimes called Product Stewardship, is an emerging principle for a new generation of pollution-prevention policies that focuses on product systems instead of production facilities. Implementation of EPR relies on the life-cycle concept of identifying opportunities to prevent pollution and reduce resource and energy use in each stage of a product's life cycle (or product chain) through changes in product design and process technology.

EPR as a broad principle states that producers of products bear a significant degree of responsibility for the environmental impacts of their products throughout the products' life cycles, including upstream impacts inherent in the selection of materials for the products, impacts from the manufacturer's production process, and downstream impacts from the use and disposal of the products.[96] Responsible producers design their products to minimize life-cycle environmental impacts, and they accept legal, physical, economic or informational responsibility for mitigating the environmental impacts that cannot be eliminated by design.

Governments can encourage producers to accept responsibility through a variety of policy measures that differ significantly from past pollution prevention policies focusing on production facilities. Although the roots of EPR can be traced back to the deposit-refund system for beverage packagingæwhere bottlers take back packaging for refilling the use of one-way packaging in states without deposit-refund laws has effectively transferred the responsibility for managing empty beverage containers to local taxpayers.

EPR legislation has now also been developed for other end-of-life products in Europe, including automobiles and consumer electronics.[97] Sweden, the Netherlands and Germany developed take-back and recycling requirements for automobiles in the mid-1990s. This was followed in 2000 by passage of a European Union Directive for End-of-Life Vehicles (ELVs) (see following section). All EU member states are required to adopt ELV legislation meeting the Directive's criteria. The European Union has also recently passed legislation for waste electronics and electrical equipment (WEEE).[98]

European Union End-of-Life Vehicle Directive

The European Union (EU) End-of-Life Vehicle (ELV) Directive, adopted in September 2000, establishes producer responsibility for the management of ELVs, sets increased recycling requirements and begins a phase-out of certain heavy metals, including lead, used in automotive components (see Appendix C).[99] The ELV Directive required member nations to adopt appropriate legislation and regulations by April 2002, but as of April 2003, only Germany, the Netherlands and Sweden had completed the process.[100] Legislative development is underway in most EU member countries. There are four main aspects of the Directive that must be applied.

TAKE BACK

EPR is the cornerstone of the directive. In fact, the directive requires manufacturers and importers of cars to pay for the costs of end-of-life management, so that the last owner of the car does not have to bear the costs of proper management. The last owner will be induced to turn the car over for proper management because registration fees must be paid until the owner provides a certificate from the dismantler that says the car has been recycled. The member countries decide how best to set up the system of producer responsibility. In some countries, producer responsibility organizationsæoperated jointly by manufacturers and importers of carsæalready collect fees on the sale of new cars to fund the end-of-life management of scrap cars.

Under the EU plan, producers will be responsible for the costs of recycling cars put on the market after July 1, 2002. They will not be responsible for the costs of recycling cars put on the market before July 1, 2002, until January 1, 2007. At that time, they will be responsible for the costs of recycling all cars, without regard to age.

PHASE-OUT OF HEAVY METALS

The EU directive recognizes the environmental and health consequences associated with the disposal of heavy metals in vehicles, and thereby establishes a program that phases out most uses of four heavy metalsælead, mercury, cadmium and hexavalent chromium æin automotive components. EU member states must adopt legislation to ensure that vehicles put on the market after July 1, 2003, do not contain these heavy metals, except in certain components excluded from the phase-outs.

The purpose of the phase-outs is primarily to prevent the release of these heavy metals into the environment from the end-of-life management of vehicles, but the directive also recognizes other pollution prevention benefits in eliminating these toxic metals from the automobile's life cycle. In fact, the preamble to the EU Directive states that "it is important that preventative measures be applied from the conception phase of the vehicle onwards and take the form, in particular, of reduction and control of hazardous substances in vehicles, in order to prevent their release into the environment, to facilitate recycling and to avoid the disposal of hazardous waste; in particular the use of lead, mercury, cadmium and hexavalent chromium should be prohibited."

Significant exclusions from the phase-outs are contained in an Annex to the Directive, which was recently updated. (See the section in this report titled "Exemptions from the EU Directive.") These include well-known uses, such as lead in lead-acid batteries and hexavalent chromium as a corrosion-preventative coating (up to 2 grams per vehicle). The exclusions also contain some less-acknowledged uses of these heavy metals, including lead-containing alloys of steel, aluminum and copper; lead as a coating inside fuel tanks; and mercury in headlamps. The directive requires labeling of some components that are exempt from the phase-outs, including bulbs and instrument panel displays containing mercury, so that they can be stripped before shredding.

INCREASED RECYCLING REQUIREMENTS

The directive also requires producers to increase levels of reuse and recycling for ELVs, and to improve recyclability of vehicles, with the means of determining recyclability to be established by regulations. By January 1, 2006, reuse and recovery of ELVs must be increased to a minimum of 85% by weight on average, and recycling and reuse must be increased to 80% by weight. "Reuse" means that the components are used for the same purpose for which they were conceived. "Recycling" means reprocessing ELV materials for their original or other use but excludes energy recovery. "Recovery" includes material recycling, but also includes combustion of waste materials with energy recovery. By January 1, 2015, reuse and recovery must be increased to a minimum of 95% by weight. Recycling and reuse must be increased to a minimum of 85% by that date.

To aid the achievement of the increased levels of recycling, cars put on the market after the end of 2004 must be reusable or recyclable to a minimum of 85% of vehicle weight and reusable or recoverable to a minimum of 95% per vehicle. The European Commission has intended to draft amendments to the EU Directive to include the means of determining recyclability.

OTHER PROVISIONS

The EU Directive is a comprehensive approach to reducing the environmental impacts of ELV management. The directive says that

- Member states must encourage Design for Environment, including reductions in the use of hazardous substances and design for dismantling, reuse and recycling.

- Vehicle manufacturers and their suppliers must increase the quantity of recycled materials in their products.

- Vehicle manufacturers and suppliers must code components and materials to facilitate product identification for material reuse and recovery.

- Producers must provide dismantling information for every vehicle they build.

- Producers and member states must report periodically on ELV management and product design measures that enhance reuse and recycling.

- ELV management systems must be upgraded in accordance with more stringent environmental standards that call for registration of collection and treatment facilities; improvements in treatment facility design; and removal of fluids, hazardous materials and recyclable materials from ELVs before shredding.

EXEMPTIONS FROM THE EU DIRECTIVE

As noted above, the Directive provided exemptions for the phase-outs of heavy metals. These exemptions are contained in Annex II and are to be updated regularly by the European Commission (EC). In July 2002, a number of amendments were made based in part on recommendations made in the Heavy Metals in Vehicles II report published by Okopol (July 2001).[101] These amendments included labeling requirements, changes to existing exemption limits and changes to several lead requirements. (See Appendix D.)

Some of the key provisions of the amended Annex include:

• Lead as an alloying agent	limited as a percentage of weight
• Lead in wheel balancing weights	phase out by 2003–2005
• Lead in coatings	phase out by July 2005
• Lead in batteries	exempted, with labeling
• Lead in vibration dampers	exempted, with labeling
• Lead in electronic applications	limited to 60g/vehicle
• Lead in valve seats	phase out by 2003–2006
• Lead in glass and spark plugs glaze	phase out by 2005

The above EU requirements will clearly be a driver globally for future lead-free automotive component designs. However, there is no guarantee that automakers will put in place identical practices for vehicles intended solely for the North American market. Past experience with the use of mercury in automotive lighting and anti-lock brake (ABS) switches gives reason for concern here.[102] North American policies should be developed that match or provide additional guidance to that of its trans-Atlantic partners.

North American Policies on Automotive Batteries

EPR laws relating to batteries, including SLI lead-acid batteries, have been adopted in the United States. While no federal "take back" requirements exist, legislation at the state level has led to the creation of a voluntary system nationwide. Laws in 42 states for lead-acid batteries generally require a consumer deposit on batteries to encourage recovery, which must be refunded by battery retailers. Retailers must accept any batteries returned by consumers, and are required to send them to licensed battery recyclers. Disposal in landfills is also prohibited. (See Appendix E for a summary of U.S. State Lead-Acid Battery Laws.) Despite the relative success of these battery recycling requirements, with recovery rates of 93% reported by the battery industry, more than 42,000 metric tons of lead may still be improperly managed and released to the environment.

Conclusions and Recommendations

This report has documented that the continuing use of lead in automobiles contributes to significant environmental releases of this hazardous material, posing risks to public health and the environment. Government policies in North America have so far failed to discourage lead use in automobiles. While a majority of states have enacted legislation requiring the recycling of lead-acid batteries to help ensure high levels of lead recovery from ELVs, these laws do little to encourage the substitution of less hazardous materials in batteries or other automotive components.

The European Union (EU), by contrast, has begun to phase out lead use in automobiles through the 2000 End-of-Life Vehicles Directive. In a global automotive economy, the EU requirements may help to drive similar efforts here in North America, but there are no assurances. It is time for the United States and

Canada to develop their own policies to replace lead and other hazardous materials in automobiles with safer alternatives.

Based on the findings of this report, and a review of policy options available, the following actions are recommended:

PHASE OUT THE USE OF LEAD IN SLI BATTERIES

The dominant use of lead globally is for automotive batteries. Batteries in turn are responsible for the majority of lead releases, despite high levels of recycling. Automotive lead use could grow even more, given the expected increase in 42-volt battery systems that use up to twice the amount of lead per battery. While the lead-acid SLI battery industry has been well entrenched in the automotive market for the last 75 years, alternatives are now available (e.g., nickel-metal hydride, lithium-ion) that offer improved performance and reduced environmental impact. With key investments in manufacturing capacity, and associated purchase commitments, these alternative battery systems could also become economically competitive.

Federal governments in the United States and Canada should develop a transition plan for the automotive industry to phase out lead-acid batteries within 10 years (by 2014). This plan should include a near-term phase-out of lead-acid batteries from new 42-volt systems (or by the 2007 model year), in order to prevent the growth of lead use in the meantime. Investments in lead-acid alternatives will also help spur advanced vehicle technology, such as hybrid gasoline-electric, fuel cell and electric vehicles, since these technologies rely more heavily on lightweight, high-performance energy storage systems. With a plan for transition to non-lead batteries, costs could become competitive for both high and low-voltage systems.

PHASE OUT OTHER USES OF LEAD IN VEHICLES

Governments in North America should also phase out other uses of lead in vehicles no later than 2006, and should include the use of lead in wheel balance weights, protective paints, carbon brushes and valve seats, as well as limits for the amount of lead used as an alloying agent in steel, aluminum and copper, and in electronic components. Annex II of the EU's End-of-Life Vehicles Directive, which establishes phase-out requirements that have been determined to be technically and economically feasible, should serve as a starting point. Additional phase-out requirements should be established for other lead-containing products currently exempted in the Annex, including large auto parts like vibration dampers. More progress is also possible in reducing or eliminating the use of lead as an alloying agent. Governments should also use their purchasing power to seed early market introduction of alternatives prior to these phase-out dates.

REQUIRE PRODUCER RESPONSIBILITY FOR THE RECOVERY OF LEAD AUTOMOTIVE COMPONENTS

During the transition to lead-free automobiles, automakers, battery manufacturers and other auto component manufacturers should take responsibility for ensuring the recovery and safe management of both past and continuing uses of lead-containing automotive components. While a significant percentage of the larger lead components (including batteries) are currently separated and recovered for recycling, a substantial amount of automotive lead nonetheless remains an unmanaged contaminant in the vehicle end-of-life system and should be recovered. In addition, despite impressive recycling rates cited by battery manufacturers, as much as 40,000 tons of lead from automotive batteries still makes its way to landfills or other locations. Additional policy measures, such as higher battery deposits or stiffer penalties for improper disposal, should be put in place during the transition to lead-free batteries. Replacement programs for lead wheel weights should also be required. Automakers and auto component manufacturers should provide the public with regular reporting on its activities to increase the effectiveness of these recovery efforts.

ESTABLISH LEAD RETIREMENT PROGRAM AND BAN ON LEAD MINING

Federal governments in the United States and Canada should also establish programs for the retirement of lead. As the transition is made away from lead in automobiles, lead that is recovered will need to be retired so that it does not re-enter commerce and become a contaminant in new products. Governments should also establish a ban on lead mining, so as not to add new sources of lead to the environment.

IMPROVE THE ENVIRONMENTAL STANDARDS FOR END-OF-LIFE INDUSTRIES THAT HANDLE VEHICLES

The United States and Canada should aggressively monitor and implement storm water plans and air pollution permit requirements to ensure best management practices (BMPs) for industries that routinely handle end-of-life vehicles. Additional record keeping and enforcement will also be required to help assure compliance.

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APPENDIX A

Secondary lead smelters in the U.S.

1) Sanders Lead Co. - Troy, Alabama
2) GNB, Inc. - Vernon, California
3) RSR Corp. - City of Industry, California
4) Gulf Coast Recycling, Inc. - Tampa, Florida
5) GNB, Inc. - Columbus, Georgia
6) Exide Corp. - Muncie, Indiana
7) Refined Metals Corp. - Beech Grove, Indiana
8) RSR Corp. - Indianapolis, Indiana
9) Delatte Metals - Ponchatoula, Louisiana
10) Schuylkill Metals Corp. - Baton Rouge, Louisiana
11) Gopher Smelting & Refining, Inc. - Eagan, Minnesota
12) Doe Run Co. - Boss, Missouri
13) Schuylkill Metals Corp. - Forest City, Missouri
14) RSR Corp. - Middletown, New York
15) Master Metals, Inc. - Cleveland, Ohio
16) East Penn Manufacturing Co. - Lyon Station, Pennsylvania
17) Exide Corp. - Reading, Pennsylvania
18) General Smelting & Refining Co. - College Grove, Tennessee
19) Refined Metals Corp. - Memphis, Tennessee
20) GNB, Inc. - Frisco, Texas
21) Tejas Resources, Inc. - Terrell, Texas
22) PBX, Inc. - Norwalk, Ohio
23) Ross Metals - Rossville, Tennessee

Source:

http://www.epa.gov/ttn/oarpg/t3/fact_sheets/secldfa.pdf

APPENDIX B

Countries that have phased out leaded gasoline, 2001

Country Name	Country Name *(Continued from previous column)*
Albania	India
Antigua	Ireland
Argentina	Jamaica
Austria	Japan
Bangladesh	Luxembourg
Belgium	Mexico
Belize	Netherlands
Bolivia	New Zealand
Brazil	Nicaragua
Canada	Norway
Colombia	Philippines
Costa Rica	Saudi Arabia
Denmark	Singapore
Dominican Republic	Slovakia
Ecuador	South Korea
El Salvador	Sweden
Finland	Switzerland
Germany	Taiwan
Guatemala	Thailand
Haiti	United Kingdom
Honduras	United States
Hungary	Vietnam
Iceland	

Note:
This includes countries that have verifiably completed phase-out as of November 2001. It does not include countries that have laws and regulations on the books that have not been fully implemented.

Source:

Global Lead Network Website http://www.globalleadnet.org/advocacy/initiatives/countries.cfm

(Accessed April 17, 2002)

ANNEX II

Materials and components exempt from Article 4(2)(a)

Materials and components	To be labelled or made identifiable in accordance with Article 4(2)(b)(iv)
Lead as an alloying element	
1. Steel (including galvanised steel) containing up to 0,35 % lead by weight	
2. Aluminium containing up to 0,4 % lead by weight	
3. Aluminium (in wheel rims, engine parts and window levers) containing up to 4 % lead by weight	X
4. Copper alloy containing up to 4 % lead by weight	
5. Lead/bronze bearing-shells and bushes	
Lead and lead compounds in components	
6. Batteries	X
7. Coating inside petrol tanks	X
8. Vibration dampers	X
9. Vulcanising agent for high pressure or fuel hoses	
10. Stabiliser in protective paints	
11. Solder in electronic circuit boards and other applications	
Hexavalent chromium	
12. Corrosion preventative coating on numerous key vehicle components (maximum 2 g per vehicle)	
Mercury	
13. Bulbs and instrument panel displays	X

Within the procedure referred to in Article 4(2)(b), the Commission shall evaluate the following applications:

— lead as an alloy in aluminium in wheel rims, engine parts and window levers
— lead in batteries
— lead in balance weights
— electrical components which contain lead in a glass or ceramics matrix compound
— cadmium in batteries for electrical vehicles

as a matter of priority, in order to establish as soon as possible whether Annex II is to be amended accordingly.As regards cadmium in batteries for electrical vehicles, the Commission shall take into account, within the procedure referred to in Article 4(2)b and in the framework of an overall environmental assessment, the availability of substitutes as well as the need to maintain the availability of electrical vehicles.

COMMISSION DECISION

of 27 June 2002

amending Annex II of Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles

(notified under document number C(2002) 2238)

(Text with EEA relevance)

(2002/525/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles ([1]), and in particular Article 4(2)(b) thereof,

Whereas:

(1) Under Directive 2000/53/EC the Commission is required to evaluate certain hazardous substances prohibited pursuant to Article 4(2)(a) of that Directive.

(2) Having carried out the requisite technical and scientific assessments the Commission has reached a number of conclusions.

(3) Certain materials and components containing lead, mercury, cadmium or hexavalent chromium should be exempt or continue to be exempt from the prohibition, since the use of these hazardous substances in those specific materials and components is still unavoidable.

(4) Some exemptions from the prohibition for certain specific materials or components should be limited in their scope and temporal validity, in order to achieve a gradual phase-out of hazardous substances in vehicles, given that the use of those substances in such applications will become avoidable.

(5) Cadmium in batteries for electrical vehicles should be exempt until 31 December 2005 since, in view of present scientific and technical evidence and the overall environmental assessment undertaken, by that date, substitutes will be available and the availability of electrical vehicles will be ensured. The progressive replacement of cadmium should, however, continue to be analysed, taking into account the availability of electrical vehicles. The Commission will publish its findings and, if proven justified by the results of the analysis, may propose an extension of the expiry date for cadmium in batteries for electrical vehicles.

([1]) OJ L 269, 21.10.2000, p. 34.

(6) The exemption from the prohibition relating to lead for coating inside petrol tanks should be deleted, since the use of lead in these specific components is already avoidable.

(7) Since it is evident that a total avoidance of heavy metals is in some instances impossible to achieve, certain concentration values of lead, mercury, cadmium or hexavalent chromium in specific materials and components should be tolerated, provided that these hazardous substances are not intentionally introduced.

(8) Directive 2000/53/EC should therefore be amended accordingly.

(9) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 18 of Council Directive 75/442/EEC of 15 July 1975 on waste ([2]), as last amended by Commission Decision 96/350/EC ([3]),

HAS ADOPTED THIS DECISION:

Article 1

Annex II to Directive 2000/53/EC is replaced by the text set out in the Annex to this Decision.

Article 2

Member States shall ensure that cadmium in batteries for electrical vehicles is not put on the market after 31 December 2005.

In the framework of the overall environmental assessment already undertaken, the Commission shall continue to analyse the progressive substitution of cadmium, taking into account the need to maintain the availability of electrical vehicles. The Commission shall finalise and make public its findings by 31 December 2004 at the latest and may make, if proven justified by the results of the analysis, a proposal to extend the deadline in accordance with Article 4(2)(b) of Directive 2000/53/EC.

([2]) OJ L 194, 25.7.1975, p. 39.
([3]) OJ L 135, 6.6.1996, p. 32.

Article 3

This Decision shall apply from 1 January 2003.

Article 4

This Decision is addressed to the Member States.

Done at Brussels, 27 June 2002.

For the Commission
Margot WALLSTRÖM
Member of the Commission

ANNEX

'ANNEX II

Materials and components exempt from Article 4(2)(a)

Materials and components	Scope and expiry date of the exemption	To be labelled or made identifiable in accordance with Article 4(2)(b)(iv)
Lead as an alloying element		
1. Steel for machining purposes and galvanised steel containing up to 0,35 % lead by weight		
2. a) Aluminium for machining purposes with a lead content up to 2 % by weight	1 July 2005 (1)	
b) Aluminium for machining purposes with a lead content up to 1 % by weight	1 July 2008 (2)	
3. Copper alloy containing up to 4 % lead by weight		
4. Lead-bronze bearing shells and bushes		
Lead and lead compounds in components		
5. Batteries		X
6. Vibration dampers		X
7. Wheel balance weights	Vehicles type-approved before 1 July 2003 and wheel balance weights intended for servicing of these vehicles: 1 July 2005 (3)	X
8. Vulcanising agents and stabilisers for elastomers in fluid handling and powertrain applications	1 July 2005 (4)	
9. Stabiliser in protective paints	1 July 2005	
10. Carbon brushes for electric motors	Vehicles type-approved before 1 July 2003 and carbon brushes for electric motors intended for servicing of these vehicles: 1 January 2005	
11. Solder in electronic circuit boards and other electric applications		X (5)
12. Copper in brake linings containing more than 0,5 % lead by weight	Vehicles type-approved before 1 July 2003 and servicing on these vehicles: 1 July 2004	X
13. Valve seats	Engine types developed before 1 July 2003: 1 July 2006	

Materials and components	Scope and expiry date of the exemption	To be labelled or made identifiable in accordance with Article 4(2)(b)(iv)
14. Electrical components which contain lead in a glass or ceramic matrix compound except glass in bulbs and glaze of spark plugs		X (6) (for components other than piezo in engines)
15. Glass in bulbs and glaze of spark plugs	1 January 2005	
16. Pyrotechnic initiators	1 July 2007	
Hexavalent chromium		
17. Corrosion preventive coatings	1 July 2007	
18. Absorption refrigerators in motorcaravans		X
Mercury		
19. Discharge lamps and instrument panel displays		X
Cadmium		
20. Thick film pastes	1 July 2006	
21. Batteries for electrical vehicles	After 31 December 2005, the placing on the market of NiCd batteries shall only be allowed as replacement parts for vehicles put on the market before this date.	X

(1) By 1 January 2005 the Commission shall assess whether the phase-out time scheduled for this entry has to be reviewed in relation to the availability of substitutes for lead, taking into account the objectives of Article 4(2)(a).
(2) See footnote 1.
(3) By 1 January 2005, the Commission shall assess this exemption in relation to road safety aspects.
(4) See footnote 1.
(5) Dismantling if, in correlation with entry 14, an average threshold of 60 grams per vehicle is exceeded. For the application of this clause, electronic devices not installed by the manufacturer on the production line shall not be taken into account.
(6) Dismantling if, in correlation with entry 11, an average threshold of 60 grams per vehicle is exceeded. For the application of this clause, electronic devices not installed by the manufacturer on the production line shall not be taken into account.

Notes:

— a maximum concentration value up to 0,1 % by weight and per homogeneous material, for lead, hexavalent chromium and mercury and up to 0,01 % by weight per homogeneous material for cadmium shall be tolerated, provided these substances are not intentionally introduced (1),

— a maximum concentration value up to 0,4 % by weight of lead in aluminium shall also be tolerated provided it is not intentionally introduced (2),

— a maximum concentration value up to 0,4 % by weight of lead in copper intended for friction materials in brake linings shall be tolerated until 1 July 2007 provided it is not intentionally introduced (3),

— the reuse of parts of vehicles which were already on the market at the date of expiry of an exemption is allowed without limitation since it is not covered by Article 4(2)(a),

— until 1 July 2007, new replacement parts intended for repair (4) of parts of vehicles exempted from the provisions of Article 4(2)(a) shall also benefit from the same exemptions.'

(1) "Intentionally introduced" shall mean "deliberately utilised in the formulation of a material or component where its continued presence is desired in the final product to provide a specific characteristic, appearance or quality". The use of recycled materials as feedstock for the manufacture of new products, where some portion of the recycled materials may contain amounts of regulated metals, is not to be considered as intentionally introduced.
(2) See footnote 1.
(3) See footnote 1.
(4) This clause applies to replacement parts and not to components intended for normal servicing of vehicles. It does not apply to wheel balance weights, carbon brushes for electric motors and brake linings as these components are covered in specific entries.

APPENDIX E

Summary Of U.S. state lead-acid battery laws

Summary Of U.S. State Lead-Acid Battery Laws
October 2000

State/County	Effective Date	Battery Council International Model Legislation	Deposit[a] (Refundable)	Split Of Deposit	Deposit Refund Period	Point Of Sale Sign[b]	Fee (Nonrefundable)
Arizonac	09/27/90	Yes	$5 in-lieu of a trade-in (T)	100% Retailer	30 days	Retailer	
Arkansas	07/1/92	Yes	$10 (T)	100% Retailer	30 days	State	
California	01/1/89	Yes				None	
Connecticutd	10/1/90	Yes	$5 (T)	100% Retailer	30 days	Retailer	
Florida	01/1/89	Yes				None	$1.50°
Georgia	01/1/91	Yes				Retailer	
Hawaii	01/1/90	Yes				State	
Idaho1	07/1/91	Yes	$5 (T)	100% Retailer	30 days	Retailer	
Illinois	09/1/90	Yes				Retailer	
Indiana	01/1/91	Yes				Retailer	
Iowa	07/1/90	Yes				Retailer	
Kansas City,e	03/14/90	Yes				Retailer	
Missouri	03/14/90	Yes				Retailer	
Kentucky	07/13/90	Yes				Retailer	
Louisiana	09/1/89	Yes				Retailer	
Maine	10/30/89	Yes	$10 (T)	100% Retailer	7 days	State	$1.00p
Massachusetts	12/31/90	Nog				None	
Michigan	04/1/90	Yes				State	
Minnesota	10/4/89	Yesf	$5 (%)	100% Retailer		State	
Mississippi	07/1/91	Yes				State	
Missouri	01/1/91	Yes				State	
Nebraska	09/1/94	Noi					
Nevada	01/1/92	Nog				None	
New Hampshire	01/1/91	Nog				None	
New Jersey	10/9/91	Yes				Retailer	
New Mexico	12/31/91	Nog					
New York	01/1/91	Yes	$5 (T)	100% Retailer	30 days	Retailer	
North Carolina	01/1/91	Yes				Retailer	
North Dakota	01/1/92	Yes				None	
Oklahoma	09/1/93	Yest				Retailer	
Oregonh	01/1/90	Yes				Retailer	

State/County	Effective Date	Battery Council International Model Legislation	Deposit[a] (Refundable)	Split Of Deposit	Deposit Refund Period	Point Of Sale Sign[b]	Fee (Nonrefundable)
Pennsylvania	07/26/89	Yes				State	
Rhode Island	01/1/89	Yes	Seeu			State	
South Carolina	05/27/91	Yes	$5 (T)	100% Retailer	30 days	State	$2.00m
South Dakotar	07/1/92	Yes				None	
Tennessee	07/1/90	Yesq				None	
Texas	09/1/91	Yes				State	$2.00/$3.00n
Utahk	01/1/92	Yes				Retailer Wholesaler	
Vermont	06/17/94	Yes				Retailer	
Virginia	07/1/90	Yes				State	
Washington	07/23/89	Yes	$5 (T)	100% Retailer	30 days	State	
West Virginia	04/6/94	Yess				Retailer/ Wholesaler	
Wisconsin	01/1/91	Yes	Seej			State	See[j]
Wyoming	06/8/89	Yes				State	

Footnotes:

a This refers to a deposit in lieu of a trade-in (T).

b This refers to whose responsibility it is to make the educational signs, the state or the retailer. A "None" indicates that there is no sign requirement."

c AZ requires all lead batteries sold to be labeled with a universally accepted recycling symbol. AZ also requires that State agencies and political subdivisions comply with the battery recycling law.

d Retailers in CT must take back batteries one-for-one at the point of sale.

e Kansas City's ordinance requires that retailers take back up to 3 batteries not at the point of sale, and it requires that junk batteries be stored in "an adequately ventilated enclosure in good repair that protects its contents from any precipitation, etc." Any spilled acid must be immediately collected and neutralized.

f MN now requires that retailers take back up to 5 batteries not at the point of sale.

g NH, NM, NV and MA placed a ban on the landfilling and incineration of lead batteries only. NV will allow lead battery disposal at stat "permitted" facilities, however.

h OR requires that until 12/31/93 retailers must accept at least 1 battery from consumers, after which they must only accept batteries one-for-one at the point of sale.

i NE placed a prohibition on only the landfilling of lead batteries.

j WI law allows retailers to charge a $5 deposit in lieu of a trade-in, and to charge $3 for taking a battery.

k UT requires retailers to take back a maximum of two used lead batteries from customers. In addition to the BCI model law, a 1998 regulation prohibits solid waste disposal of lead acid batteries.

l ID requires all lead batteries sold to be labeled with a universally accepted recycling symbol. In addition, batteries used in motorcycles, off-road recreation vehicles or lawn and garden equipment are exempt from the deposit in lieu of a trade-in requirement.

m SC requires retailers to collect a $2.00 fee for lead batteries sold to the ultimate consumer. The retailer may retain three percent of the collected fees to cover administrative costs. Fees collected by the state treasurer are to be deposited into a Solid Waste Management Trust Fund. Small sealed lead-acid batteries are now exempt from the fee and BCI model provisions; however, a study on the recycling of these batteries is required. See S.C. Code Ann. x 44-96-40(23).

n TX requires the collection of a $2.00 and $3.00 fee for batteries less than 12volts, and, equal to or greater than 12 volts respectively. Exempted from the fee is any battery that is: 1) rated at less than 10 ampere hours; 2) sealed so that no access to the interior of the battery is possible without destroying the battery; and 3) with dimensions (sum of height, width and length) less than 15 inches. The fees are to be collected by any wholesaler or retailer who sells a battery not for resale. To cover administrative costs, the dealer may retain 2-1/2 cents per unit. All remaining money, less four percent to cover state administrative costs, goes to the state comptroller to be placed in a waste remediation fund.

o FL requires the collection of a $1.50 fee per battery at the retail level.

p ME requires the collection of a $1.00 fee per battery at the retail level.

q TN prohibits landfills or incinerators in the state from accepting lead-acid batteries for incineration or disposal. Further, lead-acid battery retailers must accept used lead-acid batteries as trade-in batteries.

r SD requires wholesalers and retailers to "accept, on a one for one exchange basis, used lead-acid batteries and . . . ensure the proper handling and disposal of the batteries." Further, after July 1, 1995, all lead-acid batteries shall be eliminated from landfilled wastes."

s WV requires retailers and wholesalers to collect used lead-acid batteries from customers and post point-of-sale signs.

t OK requires that retailers of lead-acid batteries post and maintain a sign at or near the point of display or sale to inform the public that lead-acid batteries are accepted for recycling.

u RI law specifies that retailers may voluntarily add a core charge (amount unspecified) to the price of a new vehicle battery. The core charge must be refunded if a used battery is returned within 7 days of the date of purchase.

Final Note: Several states have adopted separate household or dry cell battery recycling laws that include provisions strictly applicable to small sealed lead-acid batteries. These states are California, Florida, Illinois, Iowa, Maine, Maryland, Minnesota, New Hampshire, New Jersey, New York, Oregon, and Vermont.

Source:

Battery Council International http://www.batterycouncil.org/states.html

Appendix C

Environmental Health Perspectives 108:937-940
October 2000 (English units added)

Lead Loading of Urban Streets by Motor Vehicle Wheel Weights

by

Robert A. Root, Ph.D.

This study documents that lead weights, which are used to balance motor vehicle wheels, are lost and deposited in urban streets, that they accumulate along the outer curb, and that they are rapidly abraded and ground into tiny pieces by vehicle traffic. The lead is so soft that half the lead deposited in the street is no longer visible after little more than 1 week. This lead loading of urban streets by motor vehicle wheel weights is continuous, significant, and widespread, and is potentially a major source of human lead exposure because the lead is concentrated along the outer curb where pedestrians are likely to step. Lead deposition at one intersection in Albuquerque, NM, ranged from 50 to 70 kg/km/year [175 to 250 lb/mi/year](almost 11 g/ft^2/year along the outer curb [0.4 oz/ft^2/year]), a mass loading rate that, if accumulated for a year, would exceed federal lead hazard guidelines more than 10,000 times. Lead loading of major Albuquerque thoroughfares is estimated to be 3,730 kg/year [8,200 lb/year]. Wheel weight lead may be dispersed as fugitive dust, flushed periodically by storm water into nearby waterways and aquatic ecosystems, or may adhere to the shoes of pedestrians and the feet of pets, where it can be tracked into the home. I propose that lead from wheel weights contributes to the lead burden of urban populations.

In 1997, the U.S. Public Health Service reaffirmed its 1991 call for a society-wide effort to eliminate childhood lead poisoning, one of the most common and preventable pediatric health problems (*1*). Lead affects virtually every system in the body, especially the developing brain and nervous system of fetuses and young children (*2*). Some 890,000 children in the United States have blood lead levels high enough to cause adverse effects on their ability to learn, and 2.7 million children have increased dental cavities attributable to lead exposure (*1, 3*). A highly significant association has been found between lead exposure and children's IQ, and there is no evidence of a threshold down to blood lead concentrations as low as 1 µg/dL (*4*). Virtually all children are at risk for lead poisoning, and the risk for lead exposure is disproportionately high for children living in large metropolitan areas (*2, 5*). Lead-contaminated dusts and soils are one of the primary pathways of lead exposure for children, especially in urban populations (*2, 6, 7*).

Lead levels in roadside soil along some heavily traveled roads have been reported as high as 10,000 ppm (*2, 7, 8*). The U.S. Environmental Protection Agency (EPA) assumes that the large amount of lead near busy streets comes from the prior use of leaded gasoline (*9*). Motor vehicle wheel weights, which are 95% lead, are potentially a major source of lead exposure that heretofore has not been recognized.

Automobile and light truck wheel weights are lead castings 5−150 mm [0.2−6 in] long and weigh 7−113 g [0.25−4 oz]. They contain approximately 5% antimony to increase hardness. This alloy is known as antimonious lead. To ensure that a newly balanced wheel runs smoothly, wheel weights are affixed at appropriate locations by a steel clip to both the inner and outer wheel rims. A few wheels are balanced by gluing the weights to the inside of the rim with adhesive strips. Automobile and light truck wheels typically require one and usually two weights per wheel to achieve balance.

METHODS AND RESULTS

I conducted studies in Albuquerque, New Mexico, to ascertain the baseline or steady state amount of metallic lead found in urban streets, the rate of lead deposition, and the rate of lead abrasion.

Steady-State Surveys. To estimate the steady state amount of lead found in urban streets, I surveyed eight six-lane divided street segments, totaling 19.2 km [12 mi], by walking along the sidewalk adjacent to the outer lane and retrieving any lead found along the outer curb, in the street, and on the sidewalk. The sidewalk was adjacent to the outer curb along most segments. Along some segments the sidewalk was set back approximately 1m and the space between the sidewalk and curb occupied by gravel, cobbles, or low shrubs. These obstacles made searching for wheel weights more difficult. Curbside parking did not occur on any of the streets surveyed. I attempted only one survey along the median because of the potential danger; the posted speed limit on these streets is 65 km/hr [40 MPH] and the average weekday traffic volume is as high as 45,000 vehicles/day (*10*).

These initial surveys are referred to as steady-state surveys because the amount of lead deposited and worn away, if undisturbed, should not change substantially over time. The cleaning history of the eight streets is unknown; however, they appear, based on the interstreet consistency of the amount of lead found, to have achieved a steady-state condition. The pieces of lead found in the street averaged 21g [0.75 oz] each; the smallest found was approximately 3 g [0.1 oz]. Virtually all lead was found in either the 0.6-m-[2 ft-]wide outer curb area (i.e., the concrete gutter) or the 25-cm-[10-in-]wide median curb area. Approximately 1% of the lead was found outside the curb area—about half in the street and half on the sidewalk. Metallic lead is very soft and highly malleable (*11*). Once the wheel weights are deposited in the street they are easily abraded and broken into tiny pieces as vehicles run over them. Figure 1 shows street-abraded wheel weights.

I weighed lead found during these eight steady-state surveys to the nearest 0.1 g. The metallic lead ranged from 0.35 to 1.1 kg/km [1.2 to 3.9 lb/mi], with a geometric mean of 0.50 kg/km [1.75 lb/mi]. More than 97% of the lead found was recognizable as whole or pieces of wheel weights. I resurveyed two of the eight street segments to confirm that their steady states were consistent over time. Total lead for each resurveyed street varied by 25% from the mean, and right-side versus left-side deposition varied approximately 5% for each.

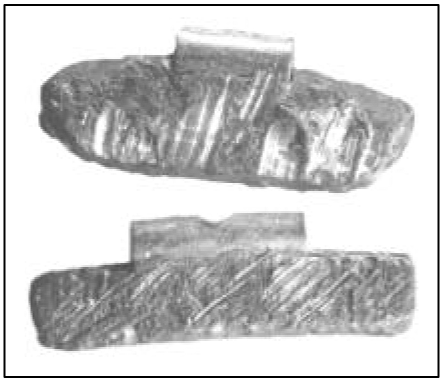

Figure 1. Abraded wheel weights. Note the scratches, scrapes, and gouges resulting from the weights being run over by motor vehicles.

The survey results are considered conservative (in the sense that the quantity of lead deposited is underestimated) because it is impossible to ensure complete recovery of all lead pieces by visual inspection. Many pieces of lead are the size, shape, and color of roadside debris. Indeed, on several occasions when the survey route was immediately retraced, approximately 10% more lead was found.

Biweekly Surveys. To determine the rate of wheel weight deposition, I conducted surveys in the same manner as the steady-state surveys every other week for 46 weeks along a 2.4-km [1.5 mi] six-lane divided street segment, designated JTML. JTML was selected because more wheel weights were found in the initial steady-state survey along this segment than along any of the other seven streets. JTML has an average daily traffic flow of 41,500 vehicles/day (*10*). These biweekly surveys were conducted at midday to ensure that the lead was not obscured by curb-side shadows. Figure 2 presents the JTML steady-state and biweekly survey results. The mean steady state level was 1.09 kg/km [3.8 lb/mi]. On average, 0.35 kg/km [1.2 lb/mi] was found during the biweekly surveys, an accumulation equivalent to 9.1 kg/km/year [32 lb/mi/year].

During the steady-state and biweekly surveys, approximately 60% of the lead was found on the west side of JTML and 40% on the east side (Figure 3). Knowledge of Albuquerque's terrain and the fact that the middle of streets usually has a crown to promote drainage are important in understanding this pattern of deposition. East of the Rio Grande, the terrain dips gently to the west from the base of the Sandia Mountains. JTML runs north-south perpendicular to the slope, such that the east side of JTML is somewhat uphill and the west side is somewhat downhill. Thus, the street slopes less on the east side and more on the west side. In general, the east side of the JTML street surface is flatter and at some intersections slopes toward the median. Conversely, the west side of the street is more steeply sloped, its surface is rarely level, and it has no surfaces that slope toward the median except for left turn lanes carved into the median. Street slope is significant because it affects the direction and time it takes for wheel weights to migrate to the side of the street. Longer migration time would result in greater wheel weight wear. Wheel weight deposition on relatively flat urban streets is therefore likely to be underestimated.

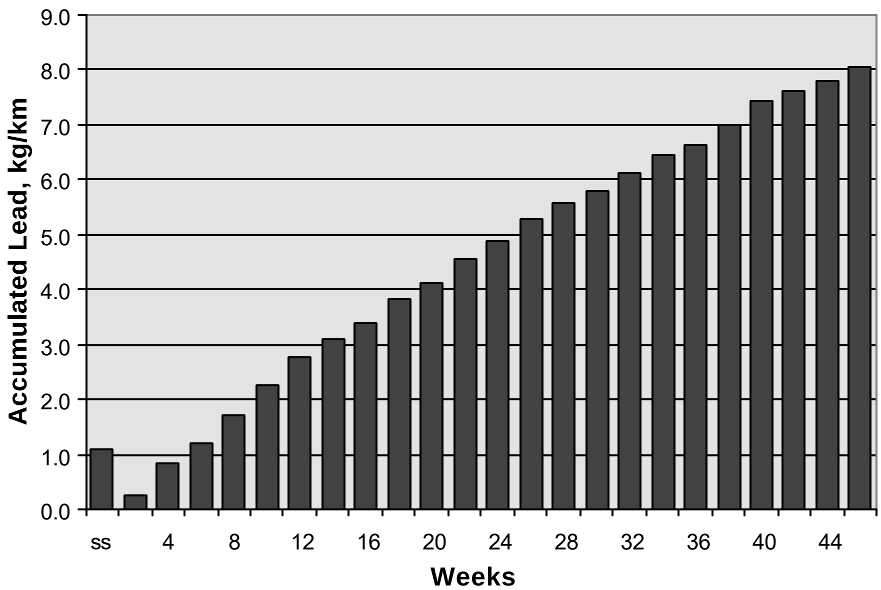

Figure 2. JTML steady-state (SS) and biweekly survey results. Bars indicate the accumulated total of lead found biweekly.

The effect of street slope is illustrated by the steady-state survey of the JTML median. On the east side of JTML, where the street slope is reduced by the dipping terrain and where 40% of the wheel weight lead was found, wheel weights along the median were 50% of the steady state. On the west side, with steeper slopes and 60% of the wheel weight lead, the wheel weights along the median were 10% of the steady state. Overall, wheel weights along the median were 25% of the steady state.

Wheel weight deposition was more frequent in the vicinity of businesses, side streets, and intersections where motorists slow down rapidly. For example, 90% of the lead found on the west side of JTML was concentrated along the southwestern quarter of the street segment (Figure 4). (Deposition along two blocks at the southern end of the west side of JTML, a distance of 600 m [0.3 mi], was significantly greater than for any other street segment. This two-block segment, which was one-quarter of the west side of JTML, is referred to as the southwestern quarter. The remainder of the west side of JTML is referred to as the northwestern three-quarters). The 1,800-m [1.2 mi] northwestern three-quarters has few businesses frequented by motorists, whereas the southwestern quarter has six such business (brake repair, two tire shops, donut shop, restaurant, supermarket), two frequently used side streets, and a traffic light intersection whose incoming lanes all slope toward the outer curb. Wheel weight deposition on the east side of JTML, where business and intersections are more evenly distributed, was more uniform.

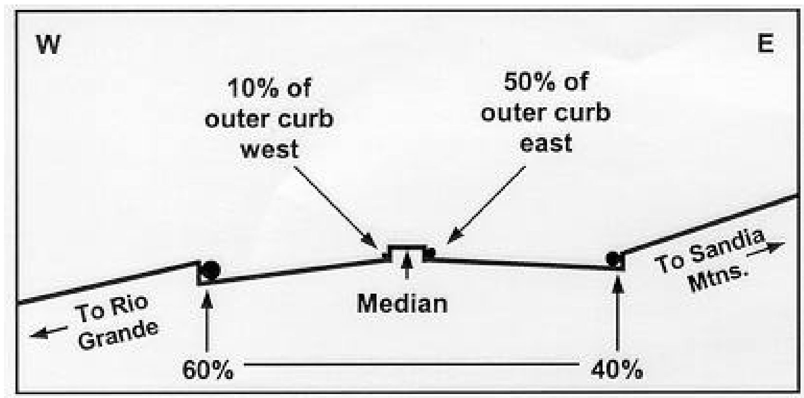

Figure 3. A schematic profile of JTML showing the effect of terrain on the deposition of wheel weights. Approximately 60% of lead was found on the steeper sloping west side of the street and 40% on the east. The inner (median) curb on the east side had 50% as much lead as the outer curb on that side, whereas the inner curb on the west side had only 10% as much as the outer curb.

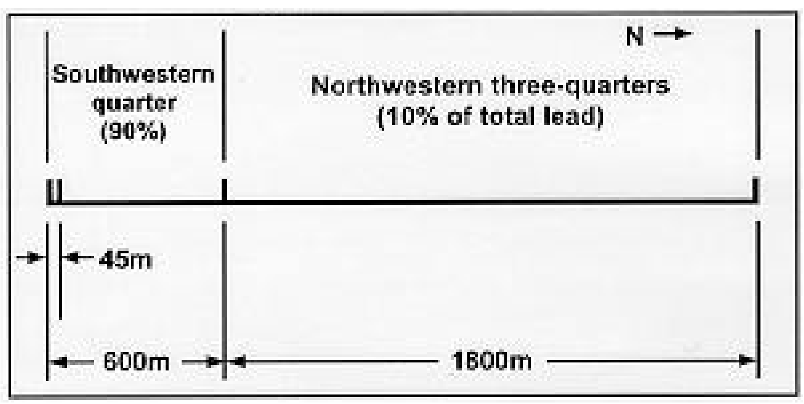

Figure 4. A schematic of the west side of JTML showing the uneven deposition of wheel weight lead. Of the lead found along the southwestern quarter, 15 to 22% was found within 45m of the intersection at the southern end of JTML

Degradation Study. To determine the rate at which wheel weights are abraded in the street, I conducted a degradation study on the same street but not within the JTML segment included in the surveys. The study was initiated by clearing all whole or pieces of wheel weights from the study area. Then, every day for 14 days, I scattered five or six previously used wheel weights ranging from 14 to 84 g near the center of each of three lanes on one side of the street; each day's weights totaled about 0.50

kg. A total of 7.0 kg was deposited in this way. On the 15th day, I searched the entire area and retrieved lead from along the outer curb, the sidewalk, the paved area beyond the sidewalk, the street, along the median curb area, and from the median itself.

Only 4.0 kg of the 7.0 kg [8.8 lb of the 15.4 lb] of wheel weights was found on the 15th day. Approximately 2.7 kg [6 lb], or 38% of the amount deposited, was found in the street, along the outer curb, and on the sidewalk—the areas searched during the biweekly surveys. No adjustment was made for wheel weights potentially lost from motor vehicles because the biweekly survey estimated that only 14 g [0.5 oz] would, on average, have been deposited. This bias is small and would increase slightly the lead found, and thereby reduce the estimate of lead apparently lost through abrasion. Most wheel weights were found along the outer curb "upstream" from their original locations. Apparently, as vehicles run over wheel weights, the torque from the vehicle drive wheels skids the weights against the traffic flow. Most wheel weights showed signs of abrasion, some severe, as shown in Figure 1. Many of the weights were broken into two or more pieces. About two-thirds migrated laterally to the outer curb and one-third to the median curb. In the degradation study, half of the wheel weight lead deposited in the street was not visible after eight days.

Rate of Lead Deposition. Comparison of the amount of steady-state lead with the lead accumulated biweekly (Figure 2), and the rapid rate of lead abrasion found during the degradation study, indicate that lead deposited in a busy street is rapidly worn away, to the extent that a significant fraction of the amount deposited would not be found in the biweekly surveys. I used two approaches to adjust for this lead loss. First, the daily fraction of lead that is worn away was obtained mathematically from the results of the steady-state and biweekly surveys, as shown below.

The relationship between the lead deposited in kilograms per kilometer per day (D) and the lead retrieved at the end of 2 weeks in kilograms per kilometer (R_{14}) can be expressed as follows:

$$R_{14} = Dp(1-p^{14})/(1-p), \qquad [1]$$

where D is the amount of lead deposited per kilograms per day, and p is the fraction remaining each day from the previous day's lead deposition.

The steady state amount of lead in kilograms per kilometer (S) is, therefore,

$$S = R_{\infty} = Dp/(1-p). \qquad [2]$$

To estimate p from the observed values of R_{14} and S, divide Equation 1 by Equation 2:

$$R_{14}/S = 1 - p^{14},$$

which is equivalent to

$$p = \sqrt[14]{1 - R_{14}/S}\ . \qquad [3]$$

Accumulation during the biweekly surveys, R_{14}, was 0.35 kg/km [1.2 lb/mi]. The steady-state surveys yielded a value for S of 1.094 kg/km [3.85 lb/mi]. Using Equation 3, the estimated value for p is 0.9728, implying that 2.72% of the lead deposited each day is worn away by the next day.

To estimate the actual rate of lead deposition, I adjusted the biweekly survey rate to account for the amount of lead worn away by the grinding action of traffic. The "wear adjustment factor" is estimated to be the ratio of lead deposited per km per 14 days to the lead retrieved in the biweekly surveys (0.35 kg/km [1.2 lb/mi]). From Equation 2, D is estimated to be the amount of lead deposited per km per day, as D = (1-p)S = (0.0272)(1.094) = 0.0297 kg/km/day. Thus:

Wear Adjustment Factor = (14 • 0.0297) / 0. 35 = 1.2.

Second, I conducted daily surveys of the southwestern quarter of JTML for four weeks, presented as Figure 5, and compared them with the biweekly surveys for this 600-m [0.3 mi] segment. From this study, a wear adjustment factor was estimated to be nearly 1.4 by dividing the daily survey rate of 26.0 kg/km/yr [90 lb/mi/yr] by the biweekly survey rate of 18.9 kg/km/yr [65 lb/mi/yr]. A combined wear adjustment factor of 1.3 was adopted.

To estimate the amount of lead deposited along the outer curb in JTML, I multiplied the annual rate of wheel weight deposition (9.1 kg/km) [32 lb/mi] by the wear adjustment factor of 1.3 and then by 0.95 as a lead adjustment factor to compensate for the 5% antimony content of the weights. The resultant deposition rate does not include lead abraded from the wheel weights between their deposition in the street their migration to the outer curb. No adjustment was made to include lead deposited along the median because that lead would probably not migrate to the outer curb. Accordingly, lead deposition along JTML is conservatively estimated to average 11.8 kg/km/year [40 lb/mi/year] along the outer curb of both sides of the street along the entire 2.4-km [1.5-mi] street segment and 24.5 kg/km/year [85 lb/mi/year] along the southwestern 600-m [0.3-mi] interval on one side of the street. During the weekly surveys of this southwestern quarter, 15% of the wheel weights found were along a 45-m [150 ft]curb interval at the southernmost intersection; during the steady-state surveys 22% was found along the same 45 m [150 ft]. Using these percentages, lead deposition is estimated to be 50 to 70 kg/km/year [175 to 250 lb/mi/year] for this 45-m interval.

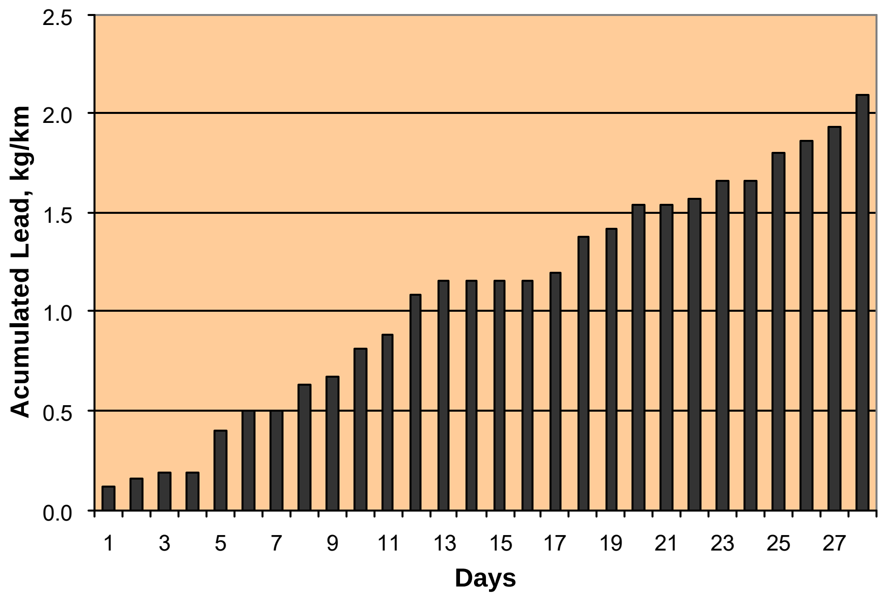

Figure 5. Daily Survey Results for Southwestern JTML. Accumulated metallic lead found along the outer curb on the west side of JTML.

DISCUSSION

Although lead weights may be found anywhere motor vehicles go, they most commonly fall off where vehicles rapidly change momentum—for example when slowing down for a traffic light or turning onto a side street or into a business. Thus one would expect to find higher deposition of lead weights in these areas.

The federal guideline for the amount of lead needed to create a lead hazard on an outdoor surface such as a sidewalk is 800 µg/ft^2 (*1, 12, 13*). If accumulated for a year, the lead deposited along the 45 m of outer curb at the southernmost JTML intersection would, using the deposition rates estimated by this study, meet the lead hazard guideline 10,200–13,400 times/ year (more frequently than once per hour), which is sufficient to create a continuous hazardous environment. Furthermore, this 45-m curb area at a traffic light intersection is one where pedestrians are likely to step.

The results of this study can be used to estimate the lead loading of Albuquerque's major thoroughfares by motor vehicle wheel weights. To arrive at this estimate, the geometric mean of lead found along the eight streets included in the steady-state surveys was multiplied by the number of steady states reached per year, and then multiplied by the number of kilometers of major streets. The geometric mean of lead for the eight streets is 0.50 kg/km [1.75 lb/mi]. JTML results indicate that wheel weight deposition is equivalent to ten steady states per year. The city of Albuquerque has 330 km [206 mi] of six-lane principal traffic arteries and 200 km [126 mi] of four-lane minor traffic arteries (*10*). At this time, the wheel weight steady state for minor arterials is not known. However, minor arteries were included by estimating their per-kilometer contribution to be two-thirds that of the principal arteries. The lead deposition rates included the wear adjustment factor of 1.3, the lead adjustment factor of 0.95, and the median adjustment factor of 1.25. Using these factors, lead loading of major Albuquerque thoroughfares by motor vehicle wheel weights is estimated at 3,730 kg/year [8,200 lb/year]: 2,650 kg/year [5,830 lb/year] for principal arteries and 1,080 kg/year [2,370 lb/year] for minor arteries. Similar results should be anticipated wherever lead weights are used to balance motor vehicle wheels.

An estimated 64 million kg/year [70,000 ton/year]of lead is consumed worldwide for wheel weights (*14*). The pool of lead rolling over U.S. highways is estimated to be on the order of 25 million kilograms [55 million lb], based on 200 million automobiles and light trucks (*15*) and assuming 130 g [4.5 oz] of wheel weights per vehicle. Approximately 15 million kg [33 million lb] of the total is urban because 60% of roadway vehicle-miles traveled are urban (*16*). Scaling the estimated Albuquerque deposition to the entire U.S. indicates that a significant amount of this rolling lead, perhaps 10% (1.5 million kg/year [3.3 million lb/year]), is deposited in urban streets.

The ramifications of this lead loading are numerous. Small lead particles from abraded wheel weights likely contribute to the lead found in urban runoff. Storm water can sweep this lead into nearby culverts and arroyos and ultimately washes it into nearby waterways where it can adversely affect water quality and aquatic ecosystems. In Albuquerque the storm-water runoff flows down concrete-lined drainage ditches into the Rio Grande. Such flushing accounts for a large part of the nonpoint urban pollution (*17*). Wheel weight lead can also be dispersed as fugitive dust. In semiarid environments such as that of Albuquerque, dust is common, and the air turbulence that vehicles create as they speed along urban streets can increase the suspension and dispersal of street dust. Finally, lead particles may adhere to pedestrian shoes or the feet of pets. Because contact with exterior leaded soil and dust is a potential hazard wherever it can be easily tracked into the home (*1, 12, 13*), I propose that wheel weight lead contributes to the lead burden of urban populations. In the absence of leaded gasoline, therefore, lead wheel weights are potentially a major source of lead exposure.

Consistent with U.S. policy to eliminate lead poisoning and protect the environment, the federal government should sponsor research to further document the deposition of wheel weights and evaluate the contribution to total lead exposure and effects on human health and ecosystems. In addition, the federal government should establish performance standards for the attachment of wheel weights to wheels, encourage the manufacture of wheel weights from benign materials, and ultimately phase out the lawful use of lead and other potentially hazardous materials in wheel weights. These findings also indicate that urban streets should be regularly swept and washed, and the street debris taken to a licensed hazardous waste disposal facility. Once motor vehicle wheel weights are no longer made of antimonious lead, the lead hazard in urban streets will subside.

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Appendix D

Lead Use in Ammunition and Automotive Wheel Weights

An Examination of Lead's Impact on Environmental and Human Health, the Alternatives to Lead Use, and the Case for a Voluntary Phase-Out

By

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An Honors Thesis
Submitted in April, 2003

Thesis Advisor: Professor Steve Brechin
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Section Eight

Lead Use in Wheel Weights

Lead wheel weights are used worldwide to balance vehicle tires.[1] Automobile and light truck wheel weights vary in size and weight, ranging between 5-150 mm [0.2-6 in] in length and 7-113g [0.25-4oz] in weight.[2] Lead weights contain approximately 5% antimony (an alloy known as antimonious lead) to increase their hardness. The majority of wheel weights currently in use are clip-on types that are attached at the edge (horn) of a wheel's rim; however some new aluminum rims require adhesive weights due to their shape.

All vehicles require wheel weights to ensure tire balance and prevent vibration at high speeds.[3] An estimated 64 million kg/year [70,000 ton/year] of lead is used worldwide in the manufacture of wheel weights.[4] Approximately 40 million kilograms [88 million lb] of this lead may be rolling over U.S. highways each year, as the U.S. vehicle fleet comprises more than 200 million vehicles and each one contains between 200 and 250 grams of lead in wheel weights.[5] This amounts to 1.5-2% of an average vehicle's total lead use by weight (13 kg), or 10-12.5% of lead use, excluding the vehicle's lead-acid battery.[6]

Figure 6: A selection of clip-on and adhesive wheel weights.

An average vehicle contains ten wheel weights (two on each of the four wheels and two more on the spare).[7] Although many of these weights are collected during tire replacement and recycled, they can also end up in the environment or as contaminants in the metals recycling process. A disturbingly large number fall off onto the road during vehicle use. In October of 2001, Dr. Robert A. Root published a study documenting the rates at which these weights fall off their host vehicles and are gradually abraded into lead dust. His study was the first to examine this phenomenon, and

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[1] Personal interview with Jeff Gearhart, Auto Policy Director at the Ecology Center of Ann Arbor, January 13, 2003.

[2] Root, Robert A. *Lead Loading of Urban Streets by Motor Vehicle Wheel Weights. Environmental Health Perspectives*, Volume 108, Number 10. October 2000.

[3] Personal interview with Jeff Gearhart, Auto Policy Director at the Ecology Center of Ann Arbor, January 13, 2003.

[4] International Tin Research Institute website, accessed January 17, 2003. See http://www.itri.co.uk/wweights.htm

[5] Personal interview with Jeff Gearhart, Auto Policy Director at the Ecology Center of Ann Arbor, January 13, 2003.

[6] Ibid.

[7] Lohse, et al. *Heavy Metals in Vehicles II*. Report compiled for the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. Hamburg, Germany. July, 2001.

it established that lead wheel weights are, in his words, "a major source of lead exposure that heretofore has not been recognized."[8]

The Root Study

Dr. Root conducted his survey by walking along several roads in Albuquerque, NM, visually surveying the sidewalk adjacent to the roads, and retrieving any lead found along the outer curb, in the street, or on the sidewalk. Surveys were conducted at midday to ensure that the lead pieces were not obscured by curb-side shadows. Eight six-lane divided street segments, totaling 19.2 km [12 mi], with an average weekday traffic volume of 45,000 vehicles/day were initially surveyed, establishing a steady state baseline of lead deposition. Collected lead ranged from 0.35 to 1.1 kg/km [1.2 to 3.9 kg/mi], while the geometric mean was 0.50 kg/km [1.75 lb/mi]. Individual lead pieces averaged 21g [0.75 oz] each; the smallest weighed approximately 3 g [0.1 oz]. Nearly all the lead that was collected in the survey was found in the 0.6-m-[2 ft-]wide curb area: only 1% of the lead was found elsewhere, in the street or the sidewalk.[9]

Figure 7: Buckets of lead weights collected by an auto mechanic.

Dr. Root also conducted a biweekly survey of a 2.4-km [1.5 mi] six-lane divided street segment, lasting 46 weeks. The segment, designated JTML, had an average daily traffic flow of 41,500 vehicles/day. Although JTML's steady state level was 1.09 kg/km [3.8 lb/mi], Dr. Root found an average accumulation of 0.35 kg/km [1.2 lb/mi] of lead biweekly, an annual accumulation equivalent to 9.1 kg/km [32 lb/mi].[10]

Finally, a degradation study was conducted, in which a total of 7.0 kg [15.4 lb] of wheel weights were spread over 14 days onto a heavily-trafficked street. On the 15th day, the entire area was searched and lead was retrieved from all areas of the street and sidewalk. Only 4.0 kg [8.8 lb] of the lead was found, or 57 percent of the lead originally deposited. This is unsurprising, as metallic lead is very soft and highly malleable. No adjustment was made

Figure 8: An example of wheel weight abrasion. Notice the deformity when compared to the weights in Figure 6.

[8] Root, Robert A. *Lead Loading of Urban Streets by Motor Vehicle Wheel Weights. Environmental Health Perspectives*, Volume 108, Number 10. October 2000.
[9] Ibid.
[10] Ibid.

for wheel weights potentially lost from motor vehicles because the biweekly survey indicated that this quantity would be small and it would, in any case, add to the lead collected and thus reduce the estimated lead lost due to abrasion. Most of the wheel weights found were abraded, some severely, and many of the weights had been broken into two or more pieces. Approximately half of the wheel weight lead deposited onto the street was not visible after eight days.[11]

These results indicate that when wheel weights fall off on busy streets and highways they are rapidly worn away, and that a significant fraction of the lead deposited would thus not be found in a roadside survey. Dr. Root calculated that 2.72% of the lead deposited in a given day will be worn away by the following day. This figure, together with the 5% antimony content found in wheel weights, was used to estimate an annual lead deposition rate for JTML. Dr. Root estimates that an average of 11.8 kg/km [40 lb/mi] of lead is deposited each year along the 2.4-km [1.5-mi] length of JTML. This estimate is considered conservative, as the highway median was not surveyed for lead deposition, and the retrieval rate in any visual survey is bound to be less than optimal. Many pieces of lead are the size, shape, and color of other roadside debris. On those occasions when Dr. Root immediately retraced the survey route, approximately 10% more lead was found.[12]

Wheel weight deposition occurred more frequently in places where vehicles rapidly change momentum, such as at intersections, near side streets, and in the vicinity of businesses. Dr. Root estimates that fully 24.5 kg/km [85 lb/mi] of lead is deposited annually along the southwestern 600-m [0.3-mi] quarter of JTML, which contains most of the segment's businesses and which precedes a stoplight. Lead deposition rates are estimated to be even higher for the 45 m [150 ft] immediately preceding the stoplight; between 50 and 70 kg/km [175 to 250 lb/mi] may be deposited there annually.[13]

Lead deposition at these levels can pose grave dangers, and it occurs in an area (the curb at a traffic light intersection) where pedestrians are most likely to step. Accumulated lead dust can easily find its way into homes on the soles of shoes and the paws of pets. According to the federal government, 800 mg/ft^2 of lead on an outdoor surface such as a sidewalk qualifies as a lead hazard. According to Dr. Root's estimates, the lead deposition rates at this traffic intersection would meet the lead hazard standard between 10,2000 and 13,400 times each year, more than once every hour.[14]

Adjusting for wear, highway medians, and antimony content, Dr. Root estimates that wheel weights fall off on major Albuquerque thoroughfares at a rate of 3,730 kg/year [8,200 lb/year]. The highest rate of lead deposition occurs in urban areas because 60% of vehicle-miles traveled are urban. Urban lead deposition, which he estimates at 1.5 million

[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.

kg/year [3.3 million lb/year], poses a significant lead poisoning threat to poor and minority populations that are already overexposed to lead burdens.[15]

Ann Arbor Street Survey Results

In the fall of 2001, I conducted a visual survey of two Ann Arbor thoroughfares in the hopes of confirming and extending Dr. Root's results. The methodology for this survey can be found in the introduction, on page 4. The study area, a one-mile stretch of Division and Huron streets, was surveyed initially to clear away accumulated lead and establish a baseline for comparison. Twenty-seven wheel weights were collected, weighing a total of 19.52 ounces [1.22 lbs]. Many showed signs of serious abrasion. Their average weight, 20.5 g, roughly equates with the weights that Dr. Root retrieved (weighing 21 g on average).

A total of twenty wheel weights were recovered during the course of the weekly surveys, weighing a total of 14.5 ounces [.906 lbs.]. Many of these weights also showed signs of abrasion. Their average weight, 20.6 g, again equates with the average weight of those that Dr. Root retrieved.

In the study conducted by Dr. Root, 15.7% of the lead found in the initial steady state survey was retrieved each week by weight (3.8 lbs of lead was found per mile in the steady state survey vs. 1.2 lbs per mile in the biweekly survey). In my own study, 18.6% of the lead found in the steady state survey was retrieved on a weekly basis. This higher weekly retrieval rate can only be explained by the smaller sample and shorter length of my study (four weeks vs. the 46-week length of Dr. Root's study).

Forty-seven wheel weights were retrieved in all over the course of my survey; fully 96% of these were found within 2 feet of the curb. These results accord with those of Dr. Root; 99% of the wheel weights he found were retrieved within 2 feet of the curb.

Dr. Root's study revealed that wheel weights fall off much more frequently in locations where vehicles are slowing down and changing momentum. My own study verified these results. Nearly 98% of the wheel weights I retrieved were found within 25 feet of an intersection (only one was not). This is an extremely high proportion that can partially be explained by the streets themselves: both Division and Huron are intersected every block by other streets in the area I surveyed.

Based on my results, I was able to calculate an estimate for the number of wheel weights that are lost per vehicle-mile/year. The adjusted daily traffic count for Huron and Division, 15,199.6 vehicles, can be multiplied by 365 to yield an annual traffic count of 5,547,854. The average number of wheel weights collected per week, five, can similarly be multiplied by 52 to yield an annual wheel weight deposition rate of 260. Considering that we surveyed a stretch of road one mile in length, our study found that .000046865 wheel weights are lost per vehicle-mile/year.

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[15] Ibid.

Dr. Root's results were a virtual match in this regard. Dr. Root doesn't reveal in his report the total number of wheel weights that he collected, but this data can be derived from other information contained in his study. He reports that he collected an average of 8.05 kg of lead per kilometer over the course of his 46 week survey. As his survey route was 2.4 km in length, Dr. Root therefore collected a total of 19.32 kg of lead. The lead wheel weights that he found weighed an average of 21 g, yielding a total of 920 wheel weights collected over the 46-week time period. Over a 52-week period, Dr. Root would have therefore found 1040 wheel weights.

The survey route that Dr. Root examined supported a daily traffic burden of 41,500 vehicles/day. Multiplying this number by 365, we find that the annual traffic burden of his survey area is 15,147,500. Given that his survey area was a full 1.5 miles in length, we find that .0000457721 wheel weights were lost per vehicle-mile/year in Dr. Root's study area. Dr. Root therefore found 97.67% as many wheel weights as I did, adjusted for survey distance and traffic counts.

Ann Arbor Street Survey Conclusions

This correlation is highly significant, and suggests that the number of wheel weights lost per vehicle-mile/year is consistent nationwide. Additional research will be necessary to determine if this is, in fact, the case, but given that contact with the curb or a change in momentum appears to make wheel weights fall off of their host vehicles, and that both conditions occur throughout the nation, it seems likely that a consistent nationwide figure can be determined. Both surveys of wheel weight deposition rates thus far have been conducted in urban areas (in Albuquerque and Ann Arbor) where curbs are present and where stop-and-go traffic is most frequent. It seems possible that wheel weights would fall off less frequently on interstates and freeways—where speeds are more consistent and curbs are lacking—but this has not been studied.

If the number of wheel weights lost per vehicle-mile/year is consistent, as suggested, it becomes possible to calculate the number of wheel weights lost annually in the United States, and the quantity of lead that is thus deposited upon roads and highways. The average number of wheel weights lost per vehicle-mile/year across both studies is 0.0000463186; given that there were 2.778 trillion vehicle-miles traveled in 2001,[16] it appears that 128,672,973 wheel weights may have been lost on American roads and highways in 2001. If these wheel weights weigh an average of 21 g, as both studies have suggested, 2,702,132 kg [5,957,082 lbs] of lead may have been deposited on the nation's highways in 2001.

These figures suggest a serious health threat, particularly in urban areas, where 60% of all vehicle-miles are traveled.[17] Testing of roadside soil has frequently revealed lead levels

[16] National Highway Traffic Safety Administration testimony before Congress, June 27, 2002. Available at http://www.nhtsa.dot.gov/nhtsa/announce/testimony/HWYSafetyUpdate.html
[17] U.S. DOT. Table 1-29. Roadway Vehicle-Miles Traveled (VMT) and VMT per Lane Mile by Functional Class. Available at http://www.bts.gov/ntda/nts/nts99/data/Chapter1/1-29

as high as 10,000 parts per million.[18] Although the EPA has attributed these lead levels to the prior use of leaded gasoline,[19] it seems likely, in light of this research, that lead wheel weight abrasion and the resultant lead dust contributes heavily to roadside lead contamination.

Ann Arbor Parking Survey Results

I also conducted a survey of parked vehicles in the fall of 2001, in the hopes of expanding upon Dr. Root's original study. Several area parking garages were surveyed with the intention of determining how many had retained their quota of lead wheel weights. The complete methodology for this survey can be found on page five of the in the introduction.

A total of 926 wheel weights were found missing, as shown in Table 1. On average, one

Table 4: Wheel Weights Lost

Company	**Total Cars**	**Total Wheel Weights Lost**	**Weights Lost per Vehicle**
Audi	4	4	1
DaimlerChrysler	160	154	0.963
Ford	268	290	1.082
GM	219	250	1.142
Saab	9	8	0.889
Honda	92	78	0.848
Nissan	21	22	1.048
Subaru	23	22	0.957
Toyota	61	70	1.148
Volkswagen	20	28	1.4
Total	877	926	1.056

wheel weight was found missing per vehicle. Assuming that missing wheel weights are replaced on an annual basis,[20] it becomes possible to compare the results of this survey to the street survey results obtained in Ann Arbor and Albuquerque. As there are 200 million vehicles in use in the United States today,[21] and as these vehicles traveled a total of 2.778 trillion miles in 2001,[22] the average vehicle travels 13,890 miles per year. If each vehicle travels 13,890 miles per year, than the surveyed vehicles travel a total of 12,181,530 miles each year. Given the total number of wheel weights lost, 926, it appears that 0.0000760167 wheel weights are lost per vehicle-mile/year.

[18] ATSDR. The Nature and Extent of Lead Poisoning in Children in the United States: A Report to Congress. Atlanta, GA: Agency for Toxic Substances and Disease Registry, 1988.
[19] U.S. EPA. "Soil Near Street." Available at http://www.epa.gov/grtlakes/seahome/leadenv/src/soilnr.htm
[20] Rebalancing is recommended every other time the tires are rotated; rotations are recommended every 6,000 miles. As the average vehicle travels some 14,000 miles per year, it should have its tires rebalanced once per year. See http://www.goodyeartires.com/faqs/Balancing.html and http://www.renosbrake.com/services/.
[21] Personal interview with Jeff Gearhart, Auto Policy Director at the Ecology Center of Ann Arbor, January 13, 2003.
[22] National Highway Traffic Safety Administration testimony before Congress, June 27, 2002. Available at http://www.nhtsa.dot.gov/nhtsa/announce/testimony/HWYSafetyUpdate.html

Ann Arbor Parking Survey Conclusions

This number is significantly different from that obtained by the Albuquerque and Ann Arbor surveys. The two street surveys combined recovered only 61% of the wheel weights that the parking structure survey indicated should be there. This lower recovery figure can be explained, at least in part, by the imperfect retrieval rate of street surveys: Dr. Root reported that when he immediately retraced his survey route, approximately 10% more lead was found.[23] The rest of the lead, it seems likely, cannot be found because it has already been abraded into fine lead dust. In his study, Dr. Root reported that wheel weights suffer from an impressive degradation rate of fully 2.72% per day. This rapid disintegration could easily account for the difference between the parking structure survey and the street surveys. The parking structure survey supports Dr. Root's degradation findings, and suggests that far more lead may be deposited each year on our nation's highways than his street survey indicated. If wheel weights are actually lost at a rate of 0.0000760167 per vehicle-mile/year, than as many as 211,174,458 weights may be lost each year, weighing in excess of 4,434,665 kg [9,776,595 lbs].

Effects of Wheel Weight Deposition

Wheel weight lead deposition is "continuous, significant, and widespread, and is potentially a major source of human lead exposure," according to Dr. Root. My own research closely coincides with Dr. Root's findings, and suggests that between 6 million

and 10 million pounds of lead may be deposited on our country's roads and highways each year. Dr. Root's findings indicate that this lead is rapidly abraded into fine dust particles, which are susceptible to atmospheric corrosion, and are expected to turn into lead oxides, hydroxides, and bicarbonates under ambient environmental conditions. These conversions make lead more soluble, and increase the risk that lead will contaminate surface, groundwater, and drinking water supplies. Soluble lead is also more easily absorbed by the human body, whether by ingestion or inhalation.

Lead dust created by wheel weight abrasion may contribute to the airborne lead concentrations of urban areas, as the turbulence that vehicles create sweeps street dust into the atmosphere. Lead dust may also adhere to the shoes of pedestrians or the feet of pets, from whence it would be tracked into and deposited in homes and workplaces. As this lead has been abraded into small particles, it poses a significant risk of exposure via inhalation, in addition that of ingestion.

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[23] Root, Robert A. *Lead Loading of Urban Streets by Motor Vehicle Wheel Weights. Environmental Health Perspectives*, Volume 108, Number 10. October 2000.

The lead dust created by the abrasion of fallen wheel weights is also likely contribute to the lead found in urban runoff. Rainwater can sweep accumulated lead dust into culverts, drains, and ultimately waterways, where it can adversely affect water quality, wildlife, and aquatic ecosystems. One study of urban runoff in Washington, D.C. estimated that over a 10-month period, fully 22,000 pounds of lead had been carried into area rivers and streams by runoff from impervious areas.[24] Studies conducted in Madison, Wisconsin, have shown that approximately 40% of the runoff from residential areas and 70% of the runoff from commercial areas had lead levels "high enough to kill aquatic life." Concentrations of lead in Madison's runoff ranged from 3-160 µg/L.[25] "The primary source of many metals in urban runoff is vehicle traffic," the authors write. "Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic on streets that drain into a storm sewer system. Streets and parking lots are the primary sources of lead in urban [runoff]."[26]

In the absence of leaded gasoline, lead wheel weight deposition and degradation may be one of the primary sources of urban lead contamination and exposure. The lead dust created by wheel weight abrasion is difficult to retrieve, and seems likely to contribute to the permanent lead burdens of urban areas. This contamination will continue to impact human and environmental health until lead wheel weights are exchanged for a safer alternative.

[24] http://eces.org/articles/static/97080840044714.shtml

[25] University of Wisconsin-Extension, Wisconsin Department of Natural Resources *Urban Runoff: How Polluted Is It?* 1995. Available at: www.env21.com/DocShareLight/Upload/Project12/URBAN%20RUNOFF(1).doc

[26] Carolyn D. Johnson and Dotty Juengst, University of Wisconsin-Extension, Wisconsin Department of Natural Resources *Polluted Urban Runoff : A Source of Concern* I-02-97-5M-20-S DNR: WT-483-97 Available at clean-water.uwex.edu/pubs/sheets/hiurban.pdf

Section Nine
Alternatives to Lead Use in Wheel Weights

A number of governments have already begun to recognize the threat that lead pollution from wheel weight degradation poses to human health and the environment. Japan has called for a drastic voluntary reduction in the use of lead in vehicles, and Nissan and Toyota have both responded. Nissan has stated that it will reduce most uses of lead in vehicles by fully two-thirds by 2005, and Toyota has called the reduction of lead use in its vehicles an "urgent objective."[27] The Japan Automobile Manufacturers Association (JAMA) aims to cut all uses of lead, excepting batteries, to one-third of 1996 levels by 2005. Perhaps most significantly, the European Union has amended its directive on end-of-life vehicles to ban the use of leaded wheel weights by 2005. This ban applies to all vehicles type-approved before July 1st, 2003, and the wheel weights intended for servicing those vehicles.[28] The ban will be reviewed for its impact on road safety prior to taking hold, but promises to eliminate the threat that leaded wheel weights pose and replace them with more responsible alternatives.

A variety of alternatives have been considered, including the use of tin, steel, tungsten, plastic (thermoplastic polypropylene), and ZAMA (an alloy of zinc, aluminum, and copper).[29] Plastic beads are in use today, although primarily in American trucks and commercial vehicles. The beads are injected into the tire and allowed to roll around inside it, balancing the vehicle while driving. However the beads are primarily effective only in larger vehicles, and their disadvantages have prevented wider use.[30]

Steel wheel weights have been in production since June of 1998, when Azuma, a Japanese company, began manufacturing adhesive steel weights. Clip-on steel weights have been available since April of 2001, but a number of disadvantages have prevented their wide acceptance. Firstly, steel clip-on weights, unlike lead or tin, cannot be manufactured with an integral clip, as the clip would melt in typical molding injection processes. A separate clip must be attached to the weight,

Figure 9: A selection of the steel clip-on weights produced by the Japanese company Azuma.

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[27] International Tin Research Institute website, accessed January 14, 2003. See http://www.tintechnology.com/materials/detail/materials_projects_/Wheel%20Weights.htm

[28] 2002/525/EC, Commission Decision of 27 June 2002 Amending Annex II of Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles. *Official Journal of the European Communities* June 29, 2002 L170/81.

[29] Personal interview with Jeff Gearhart, Auto Policy Director at the Ecology Center of Ann Arbor, January 13, 2003.

[30] International Tin Research Institute website, accessed January 14, 2003. See http://www.tintechnology.com/materials/detail/materials_projects_/Wheel%20Weights.htm

increasing the cost and time of manufacture. Additional corrosion-resistant coatings are also necessary for steel weights to prevent rusting and disintegration. Although steel is cheap and plentiful, the production of steel weights is a relatively high-cost process, one that involves expensive capital equipment, increased die wear, and a significant departure from existing production processes. Finally, steel's hardness is a drawback, as the installation of these weights is likely to cause damage to alloy wheel coatings, thereby marring the wheel's appearance and corrosion resistance. The use of non-malleable weights causes particularly severe problems in the aftermarket, as tires are rebalanced. Rebalancing weights account for fully two-thirds of all wheel weight sales; although lead and tin weights can be spot-adjusted to fit almost any type of rim, precise designs are required for non-malleable weights to fit a rim without causing undue damage. Fortunately, these problems are not as severe for adhesive steel weights, which are uniform in appearance and can fit any type of rim with the proper adhesive. The production costs of adhesive steel weights still exceed those for lead, but the cheap value of raw steel makes it an attractive and inexpensive alternative to adhesive lead weights.

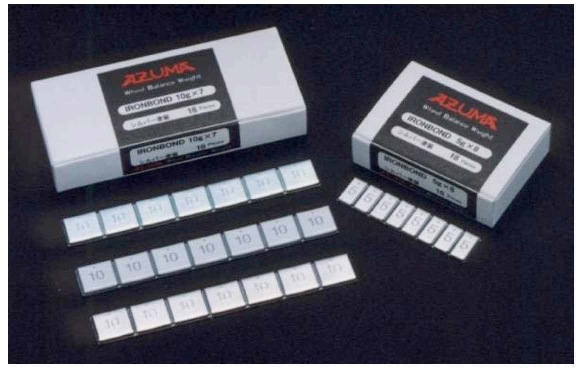


Figure 10: A selection of the steel adhesive weights produced by Azuma.

ZAMA weights have many of the same drawbacks as steel weights. They require the same corrosion-resistant coatings and clip-fixture processes that increase the costs of steel weights. Zinc, like steel, is a hard metal, and is likely to harm alloy wheel coatings during installation. Unlike steel, zinc has been rejected by the US Fish and Wildlife Service for use in non-toxic ammunition and shot; zinc is an eco-toxin itself, and while it might present a lesser threat than lead, the threat is not insignificant. All of these factors have made ZAMA weights an unattractive alternative to lead weights.

Polypropylene weights are also an unattractive alternative. Although made of plastic, polypropylene weights are non-malleable, presenting similar difficulties to those of steel and zinc in application. As a thermoplastic, polypropylene weights will deform under heating, and polypropylene is subject to degradation through the exposure to UV light. Finally, the raw material cost of polypropylene is roughly twice that of lead, explaining the reluctance of most weight manufacturers to launch a polypropylene line.

Today, tin appears to be the obvious alternative to lead use in wheel weights. Tin weights can be formed and cut in the same way as lead weights, using existing production processes without substantial modification. Although some changes are required to the equipment set-up and control mechanisms, these can be achieved at relatively low cost. This makes tin a "drop-in" replacement for lead from a production standpoint. Quality tin weights can be produced within six months of a trial initiation.

Tin weights have a suitable malleability and adhesion to the clip, and are resistant to corrosion. Production and performance trials are now complete, and have shown that these weights enjoy the same performance as traditional lead wheel weights. Tin weights are also bright and attractive, an improvement upon lead wheel weights, which often had to be coated or plated to prevent lead's dull color from ruining the appearance of shiny alloy wheels.[31]

Figure 11: Some of the tin clip-on weights produced by the British company TRAX.

Tin is non-toxic, and is expected to be a safe and environmentally-friendly replacement for lead use in wheel weights. Research has indicated that tin exposure is benign in wildlife populations,[32] and exposure to tin is considered harmless to humans. Tin-plated food cans have been in use over a hundred years, and have never demonstrated any ill effects. The International Tin Research Institute estimates that food from over 300 million tin cans is eaten on a daily basis.[33] Tin's lack of human and environmental health impacts is in marked contrast to those of lead.

Tin's only drawback is its density. For the same cross-section, a tin weight will have to be about 50% longer than a comparable lead weight in order to achieve the same balancing effect.[34] However these larger tin wheel weights can be easily accommodated by the majority of the vehicle market.[35]

One of Europe's major wheel weight manufacturers, TRAX, is now producing wheel weights made entirely from tin. A wide range of tin wheel weights are now commercially available, and it is expected that these tin weights will become dominant in the European market over the next few years.[36] Although tin weights are more expensive than lead weights, due to the increased raw material cost—tin weights cost approximately 16 cents more than lead wheel weights, a cost increase of $1.60 per vehicle—this cost is negligible when compared to the ongoing environmental and health costs of continued lead use.

[31] Ibid.
[32] Grandy J. et al, "Relative Toxicity of Lead and Five Proposed Substitute Shot Types to Pen-reared Mallards," *J.Wild. Man.*, 1968, 32, p.483.
[33] International Tin Research Institute website, accessed January 14, 2003. See http://www.tintechnology.com/materials/detail/materials_projects_/Tin%20Shot.htm
[34] TRAX website, accessed February 10, 2003. See http://www.traxadm.demon.co.uk/tin1.html
[35] International Tin Research Institute website, accessed January 14, 2003. See http://www.tintechnology.com/materials/detail/materials_projects_/Wheel%20Weights.htm
[36] Ibid.

U.S. Environmental Protection Agency, Region II, Office of Regional Counsel, New York/Caribbean Superfund Branch, 290 Broadway, 17th Floor, New York, NY 10007–1866.

DATES: Comments must be submitted on or before September 28, 2005.

ADDRESSES: The proposed PPA and additional background information relating to the settlement are available for public inspection at the U.S. Environmental Protection Agency, Region II, Office of Regional Counsel, New York/Caribbean Superfund Branch, 290 Broadway, 17th Floor, New York, NY 10007–1866. A copy of the proposed PPA may be obtained from the individual listed below. Comments should reference the Circuitron Corporation Superfund Site, East Farmingdale, Suffolk County, New York and EPA Index No. CERCLA–02–2005–2018, and should be addressed to the individual listed below.

FOR FURTHER INFORMATION CONTACT: Carl P. Garvey, Assistant Regional Counsel, New York/Caribbean Superfund Branch, Office of Regional Counsel, U.S. Environmental Protection Agency, 290 Broadway, 17th Floor, New York, NY 10007–1866, Telephone: (212) 637–3181.

Dated: August 19, 2005.

Dore LaPosta,

Acting Regional Administrator, Region II.

[FR Doc. 05–17188 Filed 8–26–05; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[FRL–7962–1]

Proposed CERCLA Administrative Cost Recovery Settlement; The Vega Alta Public Supply Wells Superfund Site, Vega Alta, PR

AGENCY: Environmental Protection Agency.

ACTION: Notice; request for public comment.

SUMMARY: In accordance with Section 122(h) of the Comprehensive Environmental Response, Compensation, and Liability Act as amended (''CERCLA''), 42 U.S.C. 9622(h), notice is hereby given of a proposed administrative settlement for recovery of past response costs concerning the Vega Alta Public Supply Wells Superfund Site located in Vega Alta, Puerto Rico with the settling parties, Caribe General Electric Products, Inc. and Unisys Corporation. The settlement requires the settling parties to pay $858,433.41, plus an additional sum for Interest on that amount calculated from January 28, 2004 through the date of payment to the Vega Alta Public Supply Wells Superfund Site Special Account within the EPA Hazardous Substance Superfund in reimbursement of EPA's past response costs incurred with respect to the Site. The settlement includes a covenant not to sue the settling party pursuant to Section 107(a) of CERCLA, 42 U.S.C. 9607(a) for past response costs. For thirty (30) days following the date of publication of this notice, the Agency will receive written comments relating to the settlement. The Agency will consider all comments received and may modify or withdraw its consent to the settlement if comments received disclose facts or considerations which indicate that the settlement is inappropriate, improper, or inadequate.

DATES: Comments must be submitted on or before September 28, 2005.

ADDRESSES: The proposed settlement is available for public inspection at USEPA, 290 Broadway, 17th Floor, New York, New York 10007–1866. A copy of the proposed settlement may be obtained from Marla E. Wieder, Assistant Regional Counsel, USEPA, 290 Broadway, 17th Floor, New York, New York 10007–1866, (212) 637–3184. Comments should reference the Vega Alta Public Supply Wells Superfund Site, CERCLA Docket No. 02–2005–2029. To request a copy of the proposed settlement agreement, please contact the individual identified below.

FOR FURTHER INFORMATION CONTACT: Marla E. Wieder, Assistant Regional Counsel, USEPA, 290 Broadway, New York, New York 10007–1866, (212) 637–3184.

Dated: August 18, 2005.

Kathleen Callahan,

Acting Regional Administrator, U.S. Environmental Protection Agency, Region II.

[FR Doc. 05–17189 Filed 8–26–05; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[OPPT–2005–0032; FRL–7730–7]

TSCA Section 21 Petition; Response to Citizen's Petition

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: On May 13, 2005, the Ecology Center of Ann Arbor, Michigan, petitioned EPA under section 21 of the Toxic Substances Control Act (TSCA) to establish regulations prohibiting the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights. For the reasons set forth in this notice, EPA has denied the petition to initiate rulemaking. In this notice, the Agency elaborates the reasons for its denial and the type of information it may need.

FOR FURTHER INFORMATION CONTACT: *For general information contact:* Colby Lintner, Regulatory Coordinator, Environmental Assistance Division (7408M), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460–0001; telephone number: (202) 554–1401; e-mail address: *TSCAHotline@epa.gov*.

For technical information contact: Dave Topping, National Program Chemicals Division (7404T), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460–0001; telephone number: (202) 566–1974; e-mail address:*topping.dave@epa.gov*.

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does this Action Apply to Me?

You may potentially be affected by this action if you manufacture, import, process, use, distribute, or dispose of lead wheel balancing weights or are an automobile tire retailer. Since other entities may also be interested, the Agency has not attempted to describe all the specific entities that may be affected by this action. If you have any questions regarding the applicability of this action to a particular entity, consult the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

B. How Can I Get Copies of this Document and Other Related Information?

1. *Docket*. EPA has established an official public docket for this action under docket identification (ID) number OPPT–2005–0032. The official public docket consists of the documents specifically referenced in this action, any public comments received, and other information related to this action. Although a part of the official docket, the public docket does not include Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. The official public docket is the collection of materials that is available for public viewing at the EPA Docket Center, Rm. B102–Reading Room, EPA West, 1301 Constitution Ave., NW., Washington, DC. The EPA Docket Center is open from 8:30 a.m. to

4:30 p.m., Monday through Friday, excluding legal holidays. The EPA Docket Center Reading Room telephone number is (202) 566–1744, and the telephone number for the OPPT Docket, which is located in the EPA Docket Center, is (202) 566–0280.

2. *Electronic access.* You may access this **Federal Register** document electronically through the EPA Internet under the''**Federal Register**'' listings at *http://www.epa.gov/fedrgstr/.*

An electronic version of the public docket is available through EPA's electronic public docket and comment system, EPA Dockets. You may use EPA Dockets at *http://www.epa.gov/edocket/* to submit or view public comments, to access the index listing of the contents of the official public docket, and to access those documents in the public docket that are available electronically. Although not all docket materials may be available electronically, you may still access any of the publicly available docket materials through the docket facility identified in Unit I.B.1. Once in the system, select ''search,'' then key in the appropriate docket ID number.

Certain types of information will not be placed in the EPA Dockets. Information claimed as CBI and other information whose disclosure is restricted by statute, which is not included in the official public docket, will not be available for public viewing in EPA's electronic public docket. EPA's policy is that copyrighted material will not be placed in EPA's electronic public docket but will be available only in printed, paper form in the official public docket. To the extent feasible, publicly available docket materials will be made available in EPA's electronic public docket. When a document is selected from the index list in EPA Dockets, the system will identify whether the document is available for viewing in EPA's electronic public docket. Although not all docket materials may be available electronically, you may still access any of the publicly available docket materials through the docket facility identified in Unit I.B.1. EPA intends to work toward providing electronic access to all of the publicly available docket materials through EPA's electronic public docket.

II. Background

A. What is a TSCA Section 21 Petition?

Section 21 of TSCA allows citizens to petition EPA to initiate a proceeding for the issuance, amendment, or repeal of a rule under TSCA section 4, 6, or 8 or an order under section 5(e) or 6(b)(2). A TSCA section 21 petition must set forth facts that the petitioner believes establish the need for the action requested. EPA is required to grant or deny the petition within 90 days of its filing. If EPA grants the petition, the Agency must promptly commence an appropriate proceeding. If EPA denies the petition, the Agency must publish its reasons for the denial in the **Federal Register**. Within 60 days of denial, or the expiration of the 90–day period, if no action is taken, the petitioners may commence a civil action in a U.S. District Court to compel initiation of the requested rulemaking proceeding.

B. What Action is Requested Under This TSCA Section 21 Petition?

On May 13, 2005, EPA received a petition under TSCA section 21 from the Ecology Center of Ann Arbor, Michigan. The petition requests that EPA initiate a rulemaking under TSCA section 6(a)(1)(A) to prohibit the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights.

To promulgate a rule under TSCA section 6(a), EPA must find that there is a ''reasonable basis to conclude'' that activities involving a chemical substance or mixture present or will present ''an unreasonable risk of injury to health or the environment.'' It is important to note that TSCA section 6 does not require a factual certainty, but only a ''reasonable basis to conclude'' that a risk is unreasonable. The legislative history of TSCA makes it clear that EPA may take regulatory action to prevent harm even though there are uncertainties as to the threshold levels of risk. Congress recognized that ''such action must be based not only on consideration of facts but also on consideration of scientific theories, projections of trends from currently available data, modeling using reasonable assumptions, and extrapolations from limited data.'' (H.R. Rep. No. 1341, 94th Cong., 2d Sess. 32 (1976).)

Although TSCA uses unreasonable risk as its basic standard for deciding on appropriate action regarding the manufacture, processing, distribution in commerce, use, or disposal of a chemical substance or mixture, TSCA does not define the term ''unreasonable risk.'' Guidance is provided by section 6(c), which requires certain considerations in promulgating a rule under section 6(a). EPA must consider the following: (1) The effects of the chemical on health and the magnitude of human exposure; (2) the effects of the chemical on the environment and the magnitude of environmental exposure; (3) the benefits of the chemical for various uses and the availability of substitutes for such uses; and (4) the reasonably ascertainable economic consequences of the rule, after consideration of the effect on the national economy, small business, technological innovation, the environment, and public health.

Section 6(c) offers no further guidance to decision-makers. In particular, it does not discuss how each of these factors is to be weighed in relationship to each other. However, the House Report on TSCA (H.R. Rep. No. 1341, 94th Cong., 2d Sess. 13-15 (1976)) provides a useful pertinent explanation. The House Report describes the finding of unreasonable risk as involving a balancing of the probability that harm will occur, and the magnitude and severity of that harm, against the adverse effects (social and economic) on society of the proposed Agency action to reduce the harm.

III. Disposition of Petition

EPA finds that there are insufficient data available for the Agency to initiate a TSCA section 6 rulemaking at this time. EPA has reviewed the supporting information included with the petition, as well as other available information on lead wheel balancing weights. The petition contains very limited, uncertain evidence on the potential environmental releases from lead wheel balancing weights to the air, surface water, ground water, and soil (particularly regarding potential releases in the proximity of roadways and potential releases to particularly sensitive environments or human and ecological populations). Some estimates of potential releases of lead from lead wheel balancing weights to the environment are available within references noted within the petition, or within other sources available in the literature. However, EPA needs additional, verifiable data in order to develop an adequate understanding of the environmental and human exposure associated with releases to the environment from lead wheel balancing weights.

While the hazard of lead and the fate and transport of lead in the environment are well-characterized, without additional information EPA cannot adequately estimate potential exposures and, thus, potential risks. A literature search conducted by the Agency identified little data beyond that cited by the petitioner. In particular, EPA is interested in the following data:

- The number of sites and number of workers involved in the manufacture, processing, recycling, use, and disposal of lead wheel balancing weights, and any associated exposure of workers to lead.

• Quantities and releases of lead from the point of manufacture of lead wheel weights to the point of deposition on roadways.
• Whether abrasion of lead wheel balancing weights occurs on the road, and if so, the extent of the abrasion and the mass of lead lost from the abrasion.
• The contribution of lead from wheel balancing weights to the overall levels of lead near roadways.
• The quantity of lead from lead wheel balancing weights deposited on roadways that subsequently enters various environmental pathways.
• The percentage of deposited lead that enters each pathway (to determine which pathways are of concern).
• The number of salvage yards, automobile shredders, steel mills, and secondary smelting sites and the quantities of lead that are released from recycling and disposal of lead wheel weights.
• Exposures to hobbyists who melt lead wheel weights to manufacture other items such as fishing sinkers, toy soldiers, and bullets.

While the Agency does not believe information in all of these areas would be necessary, the data currently available are not adequate in any of these areas to support granting the petition or initiating the requested rulemaking; there is insufficient information to adequately estimate potential risks for any one exposure pathway.

In evaluating the petition, the Agency assessed a number of plausible exposure scenarios and associated releases of lead from lead wheel balancing weights in order to identify specific data gaps that should be filled in order to allow a meaningful, realistic assessment of risk. The data gaps are summarized above and the details are presented in the following documents, which are found in the public docket for today's notice:

• *Preliminary Exposure Assessment Support Document for the TSCA Section 21 Petition on Lead Wheel-Balancing Weights*, Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency.
• *Occupational Exposures and Environmental Releases of Lead Wheel-Balancing Weights*, Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency.

In addition, the data that are available have significant uncertainties and limitations. The analyses provided by the petitioner in support of statements regarding potential exposure raise several concerns, including: (1) Limitations in scope, both geographically and temporally; (2) potential limitations in the calculated lead wheel balancing weight releases during the weekly surveys that supported these analyses; (3) lack of data on potential routes of exposure from roadways to humans and the environment; and (4) lack of data on lead in soil, dust, and water near the test area to help establish a link between lead wheel balancing weights and measured lead in the environment.

Consequently, the Agency concludes that there are currently not enough data on human or environmental exposures to adequately assess the risks from the manufacturing, processing, distribution in commerce, use, or improper disposal of lead wheel balancing weights, and to initiate a TSCA section 6 rulemaking to prohibit these activities, as requested by the petitioner. In addition, due to the data limitations, the Agency has no basis to determine how significant the contribution of lead to the environment from wheel weights is and whether a rulemaking to address lead wheel weights would be an effective use of Agency resources.

However, while EPA cannot at present initiate a rulemaking under TSCA section 6, the Agency is concerned about the potential contribution of lead wheel weights and other products that contain lead to elevated blood lead levels in children. Nationally, the primary source of elevated blood lead levels in children is lead-based paint used before the product was banned in 1978. There are other sources, however, which may contribute to elevated blood lead levels, perhaps significantly. These sources include certain products that contain lead (such as wheel weights), historical contamination of soil, certain foods and folk remedies that contain lead, and releases from stationary sources. (For more information, see*http://www.cdc.gov/nceh/lead/faq/about.htm*.) As part of the Federal Government's effort to meet its goal to eliminate lead poisoning in children by 2010, EPA is working with the Centers for Disease Control and Prevention and other Federal Partners to characterize and address these other sources of lead exposure in children. As part of its focus on children's exposure to lead, EPA is developing an approach to prioritize for further analysis and action the variety of products containing lead, that would be subject to TSCA and/or voluntary initiatives, including lead wheel weights.

IV. Comments Received

EPA received nine comments in response to the **Federal Register** notice published June 21, 2005 (70 FR 35667) (FRL–7720–5), announcing EPA's receipt of this TSCA section 21 petition.

Three comments were received from members of the public and one from an environmental organization (The Department of the Planet Earth) supporting the petition. These commenters cited the toxicity of lead. None provided any technical data regarding exposure to lead from wheel balancing weights.

Two States (Maine and Minnesota) submitted comments and supported the petition. The State of Maine noted that State water quality data indicate many locations where lead in road and parking lot runoff exceed Ambient Water Quality Standards. This commenter stated that lead is a persistent, bioaccumulative toxic chemical and that a transition to non-lead wheel weights would be a good practical step if less-toxic alternatives are cost effective and available. However, the comment provided no basis for attributing the lead in road and parking lot runoff to wheel weights. The Minnesota Office of Environmental Assistance noted that their State fleet of vehicles had participated in a pilot project to evaluate alternative wheel balancing weights and believes that the lead weights could be replaced with alternatives. They also noted their concern with exposures to people who make products from used lead wheel balancing weights and problems with lead in the waste streams from electric arc furnaces that recycle scrap automobiles.

Three trade associations submitted comments. The Association of Battery Recyclers (ABR) and the Tire Industry Association opposed the petition on the basis that no information is available to demonstrate any exposure to lead from wheel balancing weights. The Steel Manufacturers Association supports the petition, noting that a prohibition would reduce the contamination of scrap metal feedstock with lead, which contributes to the hazardous waste stream from electric arc furnaces that process scrap automobiles. They provided no information on lead exposure from wheel balancing weights.

BFS Retail Commercial Operations, LLC, which operates more than 2,200 consumer and commercial vehicle service and tire locations across the United States and Canada, commented that it did not support a ban on lead wheel balancing weights at this time. The commenter opined that there is a lack of substitute materials readily available in the marketplace, a lack of manufacturing capacity for such substitutes, and a lack of consensus in the industry on substitute materials that would be likely to lead to confusion and additional costs in the marketplace. Further, the commenter noted a lack of basic research on the environmental consequences of substitute materials and their effectiveness as a replacement for lead in wheel balancing weights.

ABR initially requested an extension of the comment period but later timely submitted its comments. EPA has considered these comments in responding to the petition.

List of Subjects

Environmental protection.

Dated: August 10, 2005.

Susan B. Hazen,

Acting Assistant Administrator, Office of Prevention, Pesticides and Toxic Substances.

[FR Doc. 05–17129 Filed 8–26–05; 8:45 am]

BILLING CODE 6560–50–S

FEDERAL RESERVE SYSTEM

Proposed Agency Information Collection Activities; Comment Request

AGENCY: Board of Governors of the Federal Reserve System.

SUMMARY

Background

On June 15, 1984, the Office of Management and Budget (OMB) delegated to the Board of Governors of the Federal Reserve System (Board) its approval authority under the Paperwork Reduction Act, as per 5 CFR 1320.16, to approve of and assign OMB control numbers to collection of information requests and requirements conducted or sponsored by the Board under conditions set forth in 5 CFR 1320 Appendix A.1. Board-approved collections of information are incorporated into the official OMB inventory of currently approved collections of information. Copies of the OMB 83-Is and supporting statements and approved collection of information instruments are placed into OMB's public docket files. The Federal Reserve may not conduct or sponsor, and the respondent is not required to respond to, an information collection that has been extended, revised, or implemented on or after October 1, 1995, unless it displays a currently valid OMB control number.

Request for Comment on Information Collection Proposal

The following information collection, which is being handled under this delegated authority, has received initial Board approval and is hereby published for comment. At the end of the comment period, the proposed information collection, along with an analysis of comments and recommendations received, will be submitted to the Board for final approval under OMB delegated authority. Comments are invited on the following:

a. Whether the proposed collection of information is necessary for the proper performance of the Federal Reserve's functions; including whether the information has practical utility;

b. The accuracy of the Federal Reserve's estimate of the burden of the proposed information collection, including the validity of the methodology and assumptions used;

c. Ways to enhance the quality, utility, and clarity of the information to be collected; and

d. Ways to minimize the burden of information collection on respondents, including through the use of automated collection techniques or other forms of information technology.

DATES: Comments must be submitted on or before October 28, 2005.

ADDRESSES: You may submit comments, identified by unnum Regulation M, by any of the following methods:

- Agency Web site: *http://www.federalreserve.gov*. Follow the instructions for submitting comments at *http://www.federalreserve.gov/generalinfo/foia/ProposedRegs.cfm*.
- Federal eRulemaking Portal: *http://www.regulations.gov*. Follow the instructions for submitting comments.
- E-mail: *regs.comments@federalreserve.gov*. Include docket number in the subject line of the message.
- FAX: 202/452–3819 or 202/452–3102.
- Mail: Jennifer J. Johnson, Secretary, Board of Governors of the Federal Reserve System, 20th Street and Constitution Avenue, NW., Washington, DC 20551.

All public comments are available from the Board's Web site at *http://www.federalreserve.gov/generalinfo/foia/ProposedRegs.cfm* as submitted, unless modified for technical reasons. Accordingly, your comments will not be edited to remove any identifying or contact information. Public comments may also be viewed electronically or in paper in Room MP–500 of the Board's Martin Building (20th and C Streets, NW.), between 9 a.m. and 5 p.m. on weekdays.

FOR FURTHER INFORMATION CONTACT: A copy of the proposed form and instructions, the Paperwork Reduction Act Submission (OMB 83–I), supporting statement, and other documents that will be placed into OMB's public docket files once approved may be requested from the agency clearance officer, whose name appears below.

Michelle Long, Federal Reserve Board Clearance Officer (202–452–3829), Division of Research and Statistics, Board of Governors of the Federal Reserve System, Washington, DC 20551. Telecommunications Device for the Deaf (TDD) users may contact (202–263–4869), Board of Governors of the Federal Reserve System, Washington, DC 20551.

Proposal to approve under OMB delegated authority the extension for three years, without revision, of the following report:

Report title: The Recordkeeping and Disclosure Requirements in Connection with Regulation M (Consumer Leasing).

Agency form number: Reg M.

OMB control number: 7100–0202.

Frequency: On occasion.

Reporters: Consumer lessors.

Annual reporting hours: Disclosures, 3,509 hours; and advertising, 25 hours.

Estimated average hours per response: Disclosures, 6.5 minutes; and advertising, 25 minutes.

Number of respondents: 270.

General description of report: This information collection is mandatory sections 105(a) and 187 of TILA (15 U.S.C. 1604(a) and 1667(f)) is not given confidential treatment.

Abstract: The Consumer Leasing Act and Regulation M are intended to provide consumers with meaningful disclosures about the costs and terms of leases for personal property. The disclosures enable consumers to compare the terms for a particular lease with those for other leases and, when appropriate, to compare lease terms with those for credit transactions. The act and regulation also contain rules about advertising consumer leases and limit the size of balloon payments in consumer lease transactions. The information collection pursuant to Regulation M is triggered by specific events. All disclosures must be provided to the lessee prior to the consummation of the lease and when the availability of consumer leases on particular terms is advertised.

Board of Governors of the Federal Reserve System, August 24, 2005.

Jennifer J. Johnson,

Secretary of the Board.

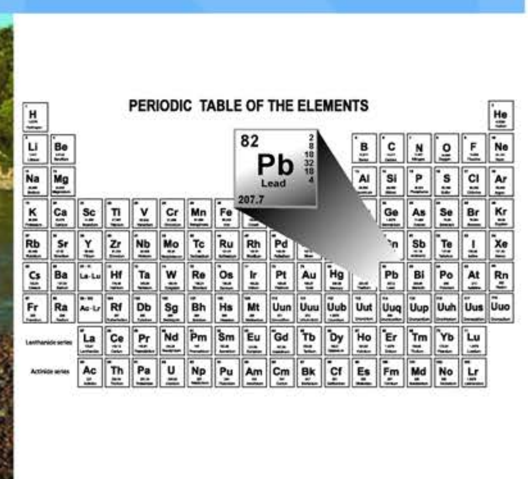
[FR Doc. 05–17134 Filed 8–26–05; 8:45 am]

BILLING CODE 6210–01–P

United States Environmental Protection Agency

EPA/600/R-10/075F | June 2013 | www.epa.gov

Integrated Science Assessment for Lead



Contains Errata Sheet created 5/12/2014

Office of Research and Development
National Center for Environmental Assessment, Research Triangle Park, NC

EPA United States Environmental Protection Agency

June 2013
EPA/600/R-10/075F
Errata Sheet created 5/12/2014

Integrated Science Assessment for Lead

National Center for Environmental Assessment-RTP Division
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC

Table ES-1 Summary of causal determinations for the relationship between exposure to Pb and health effects.

Health Outcome	Causality Determination[a] (Table with Key Evidence)
Nervous System Effects (Section 1.6.1)	
Children – Nervous System Effects (Section 1.6.1.1)	
Cognitive Function Decrements	Causal Relationship (Table 4-17)
Clear evidence of cognitive function decrements (as measured by Full Scale IQ, academic performance, and executive function) in young children (4 to 11 years old) with mean or group blood Pb levels measured at various lifestages and time periods between 2 and 8 µg/dL. Clear support from animal toxicological studies that demonstrate decrements in learning, memory, and executive function with dietary exposures resulting in relevant blood Pb levels of 10-25 µg/dL. Plausible MOAs are demonstrated.	
Externalizing Behaviors: Attention, Impulsivity and Hyperactivity[b,d, e]	Causal Relationship (Table 4-17)
Clear evidence of attention decrements, impulsivity and hyperactivity (assessed using objective neuropsychological tests and parent and teacher ratings) in children 7-17 years and young adults ages 19-20 years. The strongest evidence for blood Pb-associated increases in these behaviors was found in prospective studies examining prenatal (maternal or cord), age 3-60 months, age 6 years, or lifetime average (to age 11-13 years) mean blood Pb levels of 7 to 14 µg/dL and groups with early childhood (age 30 months) blood Pb levels >10 µg/dL. Biological plausibility is provided by animal toxicological studies demonstrating impulsivity or impaired response inhibition with relevant prenatal, lactational, post-lactational and lifetime Pb exposures. Plausible MOAs are demonstrated.	
Externalizing Behaviors: Conduct Disorders in Children and Young Adults[c, d]	Likely Causal Relationship (Table 4-17)
Prospective epidemiologic studies find that early childhood (age 30 months, 6 years) or lifetime average (to age 11-13 years) blood Pb levels or tooth Pb levels (from ages 6-8 years) are associated with criminal offenses in young adults ages 19-24 years and with higher parent and teacher ratings of behaviors related to conduct disorders in children ages 8-17 years. Pb-associated increases in conduct disorders were found in populations with mean blood Pb levels 7 to14 µg/dL; associations with lower blood Pb levels as observed in cross-sectional studies were likely to be influenced by higher earlier Pb exposures. There is coherence in epidemiologic findings among related measures of conduct disorders. Evidence of Pb induced aggression in animals was mixed, with increases in aggression found in some studies of adult animals with gestational plus lifetime Pb exposure but not juvenile animals. The lack of clear biological plausibility produces some uncertainty.	
Internalizing Behaviors	Likely Causal Relationship (Table 4-17)
Prospective epidemiologic studies find associations of higher lifetime average blood (mean: ~14 µg/dL) or childhood tooth (from ages 6-8 years) Pb levels with higher parent and teacher ratings of internalizing behaviors such as symptoms of depression or anxiety, and withdrawn behavior in children ages 8-13 years. Consideration of potential confounding by parental caregiving was not consistent and findings from cross-sectional studies in populations ages 5 and 7 years with mean blood Pb levels of 5 µg/dL were mixed. Animal toxicological studies demonstrate depression-like behaviors and increases in emotionality with relevant lactational exposures. Plausible MOAs are demonstrated.	
Auditory Function Decrements	Likely Causal Relationship (Table 4-17)
A prospective epidemiologic study and large cross-sectional studies indicate associations between blood Pb levels and increased hearing thresholds at ages 4-19 years. Across studies, associations were found with blood Pb levels measured at various time periods, including prenatal maternal, neonatal (10 day, mean 4.8 µg/dL), lifetime average, and concurrent (ages 4-19 years) blood Pb levels (median 8 µg/dL). Plausible MOAs are demonstrated. The lack of biological plausibility in animals with relevant exposures produces some uncertainty.	

Table ES-1 (Continued): Summary of causal determinations for the relationship between exposure to Pb and health effects.

Health Outcome	Causality Determination[a] (Table with Key Evidence)
Visual Function Decrements	Inadequate to Infer a Causal Relationship (Table 4-17)
The available epidemiologic and toxicological evidence is of insufficient, quantity, quality and consistency.	
Motor Function Decrements	Likely Causal Relationship (Table 4-17)
Prospective epidemiologic studies provide evidence of associations of fine and gross motor function decrements in children ages 4-17 years with lifetime average blood Pb levels and with blood Pb levels measured at various time periods with means generally ranging from 4.8 to 12 µg/dL. Results were inconsistent in cross sectional studies with concurrent blood Pb level means 2-5 µg/dL. Limited evidence in animal toxicological studies with relevant Pb exposures.	
Adults – Nervous System Effects (Section 1.6.1.2)	
Cognitive Function Decrements	Likely Causal Relationship (Table 4-17)
Prospective studies indicate associations of higher baseline bone Pb levels with declines in cognitive function (executive function, visuospatial skills, learning and memory) in adults (>age 50 years) over 2- to 4-year periods. Cross-sectional studies provide additional support. Uncertainties remain regarding the timing, frequency, duration and level of the Pb exposures contributing to the effects observed and residual confounding by age. Biological plausibility is provided by findings that relevant lifetime Pb exposures from gestation, birth, or after weaning induce learning impairments in adult animals and by evidence demonstrating plausible MOAs.	
Psychopathological Effects	Likely Causal Relationship (Table 4-17)
Cross-sectional studies in a few populations demonstrate associations of higher concurrent blood or tibia Pb levels with self-reported symptoms of depression and anxiety in adults. Uncertainties remain regarding the timing, frequency, duration and level of Pb exposures contributing to the observed associations and residual confounding by age. Observations of depression-like behavior in animals with dietary lactational Pb exposure, with some evidence at relevant blood Pb levels, and evidence demonstrating plausible MOAs in experimental animals provides support.	
Auditory Function Decrements	Suggestive of a Causal Relationship (Table 4-17)
A high-quality prospective epidemiologic study finds associations of higher tibia Pb level with a greater rate of elevations in hearing threshold over 20 years. Some evidence indicates effects on relevant MOAs but important uncertainties remain related to effects on auditory function in animals with relevant Pb exposures.	
Visual Function Decrements	Inadequate to Infer a Causal Relationship (Table 4-17)
The available epidemiologic and toxicological evidence is of insufficient, quantity, quality and consistency.	
Neurodegenerative Diseases	Inadequate to Infer a Causal Relationship (Table 4-17)
The available epidemiologic and toxicological evidence is of insufficient, quantity, quality and consistency.	
Cardiovascular Effects (Section 1.6.2)	
Hypertension	Causal Relationship (Table 4-24)
Prospective epidemiologic studies with adjustment for multiple potential confounders consistently find associations of blood and bone Pb levels with hypertension incidence and increased blood pressure (BP) in adults. Cross-sectional studies provide supporting evidence. Meta-analyses underscore the consistency and reproducibility of the Pb associated increase in blood pressure and hypertension (a doubling of concurrent blood Pb level (between 1 and 40 µg/dL) is associated with a 1 mmHg increase in systolic BP); however, uncertainties remain regarding the timing, frequency, duration and level of Pb exposures contributing to the effects observed in epidemiologic studies. Experimental animal studies demonstrate effects on BP after long-term Pb exposure resulting in mean blood Pb levels of 10 µg/dL or greater. Plausible MOAs are demonstrated.	
Subclinical Atherosclerosis	Suggestive of a Causal Relationship (Table 4-24)
Cross-sectional analyses of NHANES data find associations of blood Pb level with peripheral artery disease (PAD) in adults. Animal toxicological evidence is limited to studies of MOA (oxidative stress, inflammation, endothelial cell dysfunction) that demonstrate biologically plausible mechanisms through which Pb exposure may initiate atherosclerotic vessel disease.	

Table ES-1 (Continued): Summary of causal determinations for the relationship between exposure to Pb and health effects.

Health Outcome	Causality Determination[a] (Table with Key Evidence)
Coronary Heart Disease	Causal Relationship (Table 4-24)
Prospective epidemiologic studies consistently find associations of Pb biomarkers with cardiovascular mortality and morbidity, specifically myocardial infarction (MI), ischemic heart disease (IHD), or HRV; however, uncertainties remain regarding the timing, frequency, duration and level of Pb exposures contributing to the effects observed in epidemiologic studies. Thrombus formation was observed in animals after relevant long term exposure and MOAs (hypertension, decreased HRV, increased corrected QT (QTc) interval, and corrected QRS complex (QRSc) duration in electrocardiogram [ECG]) are demonstrated in humans and animals.	
Cerebrovascular Disease	Inadequate to Infer a Causal Relationship (Table 4-24)
The available epidemiologic and toxicological evidence is of insufficient, quantity, quality, and/or consistency. Plausible MOAs, which are shared with hypertension and atherosclerosis, are demonstrated.	
Renal Effects (Section 1.6.3)	
Reduced Kidney Function	Suggestive of a Causal Relationship (Table 4-31)
Multiple high quality epidemiologic studies provide evidence that Pb exposure is associated with reduced kidney function; however, uncertainty remains regarding the potential for reverse causality to explain findings in humans. Further, inconsistencies and limitations in occupational studies, epidemiologic studies of children and clinical trials of chelation of CKD patient preclude strong inferences to be drawn based on their results. Although longitudinal studies found Pb-associated decrements in renal function in populations with mean blood Pb levels of 7 and 9 µg/dL, the contributions of higher past Pb exposures cannot be excluded. Animal toxicological studies demonstrate Pb-induced kidney dysfunction at blood Pb levels greater than 30 µg/dL; however, evidence in animals with blood Pb levels < 20 µg/dL is generally not available. At blood Pb levels between 20 and 30 µg/dL studies provide some evidence for dysfunction in kidney function measures (e.g., decreased creatinine clearance, increased serum creatinine, increased BUN). Plausible MOAs (Pb induced hypertension, renal oxidative stress and inflammation, morphological changes, and increased uric acid) are demonstrated.	
Immune System Effects (Section 1.6.4)	
Atopic and Inflammatory Responses	Likely Causal Relationship (Table 4-34)
Prospective studies of children ages 1-5 years indicate associations of prenatal cord and childhood blood Pb levels with asthma and allergy. This evidence is supported by cross-sectional associations between higher concurrent blood Pb levels (>10 µg/dL) in children and higher IgE. Uncertainties related to potential confounding by SES, smoking or allergen exposure are reduced through consideration of the evidence from experimental animal studies. The biological plausibility for the effects of Pb on IgE is provided by consistent findings in animals with gestational or gestational-lactational Pb exposures, with some evidence at blood Pb levels relevant to humans. Strong evidence of Pb-induced increases in Th2 cytokine production and inflammation in animals demonstrates MOA.	
Decreased Host Resistance	Likely Causal Relationship (Table 4-34)
Animal toxicological studies provide the majority of the evidence for Pb-induced decreased host resistance. Dietary Pb exposure producing relevant blood Pb levels (7-25 µg/dL) results in increased susceptibility to bacterial infection and suppressed delayed type hypersensitivity. Further, evidence demonstrating plausible MOA, including suppressed production of Th1 cytokines and decreased macrophage function in animals, provides coherence.	
Autoimmunity	Inadequate to Infer a Causal Relationship (Table 4-34)
The available toxicological and epidemiologic studies do not sufficiently inform Pb-induced generation of auto-antibodies with relevant Pb exposures.	

Table ES-1 (Continued): Summary of causal determinations for the relationship between exposure to Pb and health effects.

Health Outcome	Causality Determination[a] (Table with Key Evidence)
Hematologic Effects (Section 1.6.5)	
Decreased Red Blood Cell (RBC) Survival and Function	Causal Relationship (Table 4-35)
Animal toxicological studies demonstrate that exposures resulting in blood Pb levels relevant to humans (2-7 µg/dL) alter several hematological parameters (Hemoglobin [Hb], Hematocrit [Hct], and mean corpuscular volume [MCV]),increase measures of oxidative stress and increase cytotoxicity in red blood cell (RBC) precursor cells. Limited body of epidemiologic studies provides additional support for the association of Pb exposure with these endpoints. Plausible MOAs are demonstrated in experimental animals.	
Altered Heme Synthesis	Causal Relationship (Table 4-35)
Consistent findings from studies in experimental adult animal studies report that relevant exposures (e.g. blood Pb levels of 6.5 µg/dL) cause decreased ALAD and ferrochelatase activities. Additional support is garnered from a larger body of ecotoxicological studies demonstrating decreased ALAD activity across a wide range of species and a limited body of epidemiologic studies. Plausible MOAs are demonstrated in experimental animals.	
Reproductive and Developmental Effects (Section 1.6.6)	
Development	Causal Relationship (Table 4-48)
Multiple cross-sectional epidemiologic studies report associations between concurrent blood Pb levels and delayed pubertal onset for girls (6-18 years) and boys (8-15 years). These associations are consistently observed in populations with concurrent blood Pb levels 1.2-9.5 µg/dL. Few studies consider confounding by nutrition. Uncertainties remain regarding the timing, frequency, duration and level of Pb exposures contributing to the effects observed in epidemiologic studies of older children. Experimental animal studies demonstrate delayed onset of puberty in female pups with blood Pb levels of 1.3-13 µg/dL and delayed male sexual maturity at blood Pb levels of 34 µg/dL.	
Birth Outcomes (e.g., low birth weight, spontaneous abortion)	Suggestive of Causal Relationship (Table 4-48)
Some well-conducted epidemiologic studies report associations of maternal Pb biomarkers or cord blood Pb with preterm birth and low birth weight/fetal growth; however, the epidemiologic evidence is inconsistent overall and findings from experimental animal studies are mixed.	
Male Reproductive Function	Causal Relationship (Table 4-48)
Key evidence is provided by toxicological studies in rodents, non-human primates, and rabbits showing detrimental effects on semen quality, sperm and fecundity/fertility with supporting evidence in epidemiologic studies. Toxicological studies with relevant Pb exposure routes leading to blood Pb concentrations ranging from 5-43 µg/dL reported effects on sperm quality and sperm production rate, sperm DNA damage, and histological or ultrastructural damage to the male reproductive organs. Consistent associations in studies of occupational populations with concurrent blood Pb levels of 25 µg/dL and greater, report detrimental effects of Pb on sperm; however, uncertainties remain regarding the timing, frequency, duration and level of Pb exposures contributing to the effects observed in epidemiologic studies.	
Female Reproductive Function	Suggestive of Causal Relationship (Table 4-48)
Although findings are mixed overall, the body of evidence include some high-quality epidemiologic and toxicological studies, suggesting that Pb may affect some aspects of female reproductive function (hormone level, placental pathology).	

Table ES-1 (Continued): Summary of causal determinations for the relationship between exposure to Pb and health effects.

Health Outcome	Causality Determination[a] (Table with Key Evidence)
Cancer (Section 1.6.7)	
Cancer	Likely Causal Relationship (Table 4-50)
The animal toxicological literature provides the strong evidence for long-term exposure (i.e., 18 months or 2 years) to high concentrations of Pb (> 2,600 ppm) inducing tumor development; findings from epidemiologic studies inconsistent. Plausible MOAs are demonstrated.	

[a] In drawing conclusions regarding the causal relationship between Pb exposure and human health effects, evidence in the range of relevant pollutant exposures or biomarker levels was considered. Specifically, population-based epidemiology studies were emphasized with the recognition that many of the U.S populations studied included individuals with higher past than recent Pb exposures. Evidence from toxicological studies of effects observed in experimental animals at biomarker levels (e.g. blood Pb) comparable to those currently experienced by the U.S. general population were emphasized. Generally, studies with dietary exposures resulting in blood Pb levels within one order of magnitude above the upper end of the distribution of U.S. blood Pb levels were considered in forming concusions, with the majority of studies reporting blood Pb levels below 30 µg/dL. Studies with higher blood Pb levels were considered if they informed the evaluation of MOA, mechanisms, or kinetics. (Preamble, Section 1.1).

[b] Within the attention deficit hyperactivity disorder domain of externalizing behaviors, studies of Pb exposure have focused primarily on attention, impulsivity, and hyperactivity. Because the studies of ADHD were limited in terms of their design and did not adequately consider potential confounding by factors such as SES, parental education, or parental caregiving quality, they were not a major consideration in drawing conclusions about the relationship between Pb exposure and attention, impulsivity, and hyperactivity.

[c] Two domains of conduct disorders,(i.e., undersocialized aggressive conduct disorder and socialized aggressive conduct disorder), are combined for the purpose of this assessment because it is difficult to differentiate between these two domains in the available epidemiologic studies, which examine multiple endpoints such as delinquent behavior, aggression, antisocial behavior. Criminal offenses are included in the evaluation because they can be predicted by earlier conduct disorders (Section 4.3.3.2).

[d] There was limited evaluation of potential confounding by parental psychopathology, which is a strong risk factor for externalizing behaviors, in the majority of the epidemiologic studies; however, evidence of an association of between psychopathology in parents and Pb exposure in their children is not available (Section 4.3.3).

[e] Strong evidence from experimental animal studies reduces uncertainty related to confounding generally.

Effects of Pb Exposure in Children

Multiple epidemiologic studies conducted in diverse populations of children consistently demonstrate the harmful effects of Pb exposure on cognitive function (as measured by IQ decrements, decreased academic performance and poorer performance on tests of executive function). Blood Pb-associated effects on cognitive function were found in populations of children (ages 4-10) with mean or group blood Pb levels measured concurrently or earlier in the range of 2-8 µg/dL[1]. Evidence suggests that some Pb-related cognitive effects may be irreversible and that the neurodevelopmental effects of Pb exposure may persist into adulthood (Section 1.9.4). Epidemiologic studies also demonstrate that Pb 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 analogous effects and biological plausibility at relevant exposure levels. Pb 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),

[1] The age range and blood Pb levels are based on studies described in detail in Section 4.3.2.

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 Pb exposures contributing to the effects and blood Pb levels observed in epidemiologic studies; however, these uncertainties are greater in studies of older children and adults than in studies of young children (Section 1.9.5). Despite these uncertainties, it is clear that Pb exposure in childhood presents a risk; further, there is no evidence of a threshold below which there are no harmful effects on cognition from Pb exposure.

Effects of Pb Exposure in Adults

A large body of evidence from both epidemiologic studies of adults and experimental studies in animals demonstrates the effect of long-term Pb exposure on increased blood pressure (BP) and hypertension (Section 1.6.2). In addition to its effect on BP, Pb exposure can also lead to coronary heart disease and death from cardiovascular causes and is associated with cognitive function decrements, symptoms of depression and anxiety, and immune effects in adult humans. The extent to which the effects of Pb on the cardiovascular system are reversible is not well-characterized. Additionally, the frequency, timing, level, and duration of Pb exposure causing the effects observed in adults has not been pinpointed, and higher past exposures may contribute to the development of health effects measured later in life. It is clear however, that Pb exposure can result in harm to the cardiovascular system that is evident in adulthood and may also affect a broad array of organ systems.

Ecological Effects of Pb

Ecological effects of Pb are summarized for terrestrial, freshwater and saltwater ecosystems, and the ISA discusses endpoints common to plants, invertebrates and vertebrates along with considerations of uncertainties in relating atmospheric Pb concentrations to ecosystem effects. Effects of Pb in ecosystems are primarily associated with Pb deposition onto soil and water, subsequent transport, and exposure through environmental media (soil, water, sediment, biota). The 2006 Pb Air Quality Criteria Document (AQCD) (U.S. EPA, 2006b) and previous EPA assessments reported effects of Pb exposure on both terrestrial and aquatic organisms that included reduced survival, reproduction and growth as well as effects on behavior, development, and heme production. Studies reviewed in this ISA generally support the ecological findings of previous Pb assessments with some effects observed in additional species and at lower concentrations. Reproduction, growth, and survival are endpoints commonly used in ecological risk assessment because they can lead to effects at the population, community, levels of biological organization are confirmed by both laboratory and field experiments. In these experiments decreases in abundance, reduced species diversity, shifts in soil microbial and plant community composition (in terrestrial ecosystems), and sediment-associated and aquatic plant community composition (in freshwater ecosystems) have been observed following Pb exposure. However, such ecosystem-wide effects can only be tested directly in a few of the cases where individual organism effects are found. Quantitative characterization of exposure-response relationships is difficult at the community and ecosystem levels because potential confounders such as the presence of other metals, physico-chemical variables and other stressors cannot be controlled and their effects are incompletely characterized (Section 1.7.3.7).

Policy Relevant Considerations

Public Health Significance

The 2006 Pb AQCD (U.S. EPA, 2006b) concluded that neurodevelopmental effects in children and cardiovascular effects in adults were of the greatest public health concern because the evidence indicated that these effects occurred at the lowest blood Pb levels, compared to other health effects. The evidence reviewed in the current assessment supports and builds upon this conclusion. Small shifts in the population mean IQ can be highly significant from a public health perspective because such shifts could translate into a larger proportion of the population functioning at the low end of the IQ distribution (Section 1.9.1), as well as a smaller proportion of population functioning at the high end of the distribution[1]. Additionally, small Pb-associated increases in the population mean blood pressure could result in an increase in the proportion of the population with hypertension that is significant from a public health perspective.

Air Lead(Pb)-to-Blood Lead(Pb) Relationships

A limited number of epidemiologic studies evaluated relationships between air Pb and blood Pb (Section 1.9.2). Regression models are typically used to produce slopes that estimate the change in blood Pb per change in air Pb concentration (µg/dL per µg Pb/m^3). The larger the slope, the larger is the estimated contribution of air Pb to the blood Pb level in exposed populations.

The range of air-to-blood slope estimates is 4 to 9 µg/dL per µg/m^3 in studies of children. The differences in the estimates across studies, at least in part, reflect the choice of model

[1] This statement follows from the conceptual model described by Weiss et al. (1988), which assumes that the incremental concentration-response between Pb exposure and IQ is similar across the full range of IQ and is not based on actual data.

1.3 Exposure to Ambient Pb

Human Pb exposure is difficult to assess because Pb has multiple sources in the environment and passes through various media (Section 3.1). Air-related pathways of Pb exposure are the focus of this assessment. In addition to inhalation of Pb in ambient air, air-related Pb exposure pathways include inhalation and ingestion of Pb in indoor dust and/or outdoor soil that originated from recent or historic ambient air (e.g., air Pb that has penetrated into the residence either via the air or tracking of soil), ingestion of Pb in drinking water drawn from surface water contaminated from atmospheric deposition or contaminated from surface runoff of deposited Pb, and ingestion of Pb in dietary sources after uptake by plants or grazing animals. Soil can act as a reservoir for deposited Pb emissions. Exposure to soil contaminated with deposited Pb can occur through resuspended PM as well as hand-to-mouth contact, which is the main pathway of childhood air-related exposure to Pb. The primary contribution of ambient air Pb to young children's blood Pb concentrations is generally due to ingestion of Pb following its deposition in soils and dusts rather than inhalation of ambient air (Section 3.1.1.2). Non-ambient air-related exposures include hand-to-mouth contact with dust or chips of peeling Pb-containing paint, or ingestion of Pb in drinking water conveyed through Pb pipes. Several study results indicate that Pb-containing paint in the home and home age (often a surrogate for the presence of Pb paint) are important residential factors that increase risk of elevated blood Pb (Sections 1.9.6 and 5.2.6). Most Pb biomarker studies do not indicate species or isotopic signature. As a consequence, non-air exposures are reviewed in this section, because they can also contribute to Pb body burden.

A number of monitoring and modeling techniques have been employed for ambient Pb exposure assessment. Environmental Pb concentration data can be collected from ambient air Pb monitors, soil Pb samples, dust Pb samples, and dietary Pb samples to estimate human exposure. Exposure estimation error depends in part on the collection efficiency of these methods; collection efficiency for ambient air Pb FRM samplers is described in Section 2.4. Models, such as the Integrated Exposure Uptake Biokinetic (IEUBK) model, simulate human exposure to Pb from multiple sources and through various routes including inhalation and ingestion. IEUBK model inputs include soil-Pb concentration, air-Pb concentration, dietary-Pb intake including drinking water, Pb-dust ingestion, human activity, and biokinetic factors. The relative contribution from specific exposure pathways (e.g., water, diet, soil, ambient air) to blood Pb concentrations is situation specific. Measurements and/or assumptions can be utilized when formulating the model inputs; errors in measurements and assumptions thus have the potential to propagate through exposure models.

1.7.1 Summary of Effects on Terrestrial Ecosystems

Historically, Pb poisoning is one of the earliest recognized toxicoses of terrestrial biota, occurring primarily through ingestion of spent shot by birds (Section 6.3.4.3). At the time of the 1977 Pb AQCD, few studies of Pb exposure and effects in wild animals other than birds were available. A limited number of rodent trapping studies and observations from grazing animals near smelters provided evidence for differences in Pb sensitivity among species and these findings were further supported in the 1986 and 2006 Pb AQCDs (U.S. EPA, 2006b, 1986b, 1977). Commonly observed effects of Pb on terrestrial organisms include decreased survival, reproduction, and growth, as well as effects on development, behavior, and ALAD activity (U.S. EPA, 2006b, 1986b, 1977).

In plants, Pb effects have been studied for several decades. At the time of the 1977 Pb AQCD, it was understood that Pb uptake in plants varied with species and with the size of the pool of Pb in the soil, and that most of the Pb taken up from the soil by plants other than trees remains in the roots, with translocation to other portions of the plant varying with species (U.S. EPA, 1977). Plant growth was recognized as an endpoint of Pb toxicity in plants in the 1977 Pb AQCD and additional effects of Pb on growth processes were reported in subsequent Pb AQCDs (U.S. EPA, 2006b, 1986b, 1977). In the 1977 Pb AQCD evidence for effects of Pb on forest-nutrient cycling and shifts in arthropod community composition was found in one study conducted in the vicinity of a smelting complex. In subsequent AQCDs, other ecosystem-level effects, including decreased species diversity, changes in floral and faunal community composition, and decreasing vigor of terrestrial vegetation have been reported near stationary sources of Pb (U.S. EPA, 2006b, 1986b, 1977; Watson et al., 1976).

Pb is either deposited directly onto plant surfaces, or onto soil where it can bind with organic matter or dissolve in pore water. The amount of Pb dissolved in soil pore water determines the impact of soil Pb on terrestrial ecosystems to a much greater extent than the total amount present. It has long been established that the amount of Pb dissolved in soil solution is controlled by at least six factors: (1) solubility equilibria; (2) adsorption-desorption relationship of total Pb with inorganic compounds; (3) adsorption-desorption reactions of dissolved Pb phases on soil organic matter; (4) pH; (5) cation exchange capacity (CEC); and (6) aging. Since 2006, further studies have contributed to the understanding of the role of pH, CEC, organic matter, and aging. Smolders et al. (2009) demonstrated that the two most important determinants of both Pb solubility and toxicity in soils are pH and CEC. However, they had previously shown that experimental aging, primarily in the form of initial leaching following addition of Pb, decreases soluble metal fraction by approximately one order of magnitude (Smolders et al., 2009). Since 2006, organic matter has been confirmed as an important influence on vertebrates. Other effects of Pb on vertebrates reviewed in Pb AQCDs and the current document include decreased white blood cell counts and behavioral anomalies observed in amphibians and reptiles. However, large differences in effects were observed at the same concentration of Pb in soil, depending on whether the soil was freshly amended or field-collected from contaminated areas. As in most studies where the comparison was made, effects were smaller when field-collected soils were used. In some birds, maternal elevated blood Pb level was associated in recent studies with decreased hatching success, smaller clutch size, high corticosteroid level, and abnormal behavior. Some species evidenced little or no effect of elevated blood Pb level. Effects of dietary exposure were studied in several mammalian species, and cognitive, endocrine, immunological, and growth effects were observed.

Recent evidence reviewed in Sections 6.3.6 and 6.3.12.7 demonstrates that exposure to Pb is generally associated with negative effects in terrestrial ecosystems. It also demonstrates that many factors, including species and various soil physiochemical properties, interact strongly with Pb concentration to modify those effects. In these ecosystems, where soil is generally the main component of the exposure route, Pb aging is a particularly important factor, and one that may be difficult to reproduce experimentally. Without quantitative characterization of those interactions, characterizations of exposure-response relationships would likely not be transferable outside of experimental settings. Since the 2006 Pb AQCD, few studies of exposure-response have been conducted, and results have been inconsistent. Table 6-4 summarizes studies of reproduction, growth, and survival in terrestrial organisms that have been published since 2006, and in which concentration-response data were reported.

Recent evidence of effects of Pb at the community and ecosystem levels of biological organization include several studies of the ameliorative effects of mycorrhizal fungi on plant growth in the presence of Pb, attributed to decreased uptake of Pb by plants, although both mycorrhizal fungus and plant were negatively affected at the exposures assessed. Most recently published research on community and ecosystem-level effects of Pb has focused on soil microbial communities, which have been shown to be impacted in both composition and activity. Many of the recent studies of effects on soil microbial communities have taken place in environments contaminated with multiple metals, and some have attempted to separate the effects of individual metals when possible. Soil microbial activity was generally diminished, but in some cases recovered over time. Species and genotype composition were consistently altered, and those changes were long-lasting or permanent. Recent studies have addressed differences in sensitivity between species explicitly, and have clearly demonstrated high variability between related species, as well as within larger taxonomic groupings. Mammalian no observed effect concentration (NOEC) values expressed as blood Pb levels were shown to vary by a factor of 8, while avian blood NOECs varied by a factor of 50 (Buekers et al., 2009). Protective effects of dietary Ca^{2+} have been found in plants, birds, and invertebrates.

1.7.2 Summary of Effects on Aquatic Ecosystems

Effects of Pb on plants, invertebrates, and vertebrates are reported for both freshwater and saltwater ecosystems. Although effects of Pb exposure are likely mediated through common mode(s) of action across freshwater and marine/estuarine taxa, these ecosystems are considered separately because of different environmental and physiological factors that influence Pb toxicity such as bioavailability of the metal, form of Pb, water quality parameters and adaptations in freshwater and saltwater organisms. Toxicity of Pb also varies by organism, lifestage and duration of exposure. (U.S. EPA, 2006b, 1986a). Closely related organisms can vary greatly in bioaccumulation of Pb and other non-essential metals as well as in their susceptibility to Pb. Pb effects on aquatic biota were previously assessed in the 1977 Pb AQCD, the 1986 Pb AQCD and the 2006 Pb AQCD (U.S. EPA, 2006b, 1986a, 1977).

Exposure of freshwater and estuarine organisms to Pb, and associated effects, are tied to terrestrial systems via watershed processes (Section 6.2). Atmospherically-derived Pb can enter aquatic systems through runoff from terrestrial systems or via direct deposition over a water surface. In aquatic ecosystems affected by Pb, exposures are most likely characterized as low dose, chronic exposures. Once Pb enters surface waters, its solubility and subsequent bioavailability are influenced by Ca^{2+} concentration, pH, alkalinity, total suspended solids, and dissolved organic carbon (DOC), including humic acids. In saltwater, higher levels of ions additionally affect Pb bioavailability. In sediments, Pb bioavailability may be influenced by the presence of other metals, sulfides, iron (Fe-) and manganese (Mn-)oxides, and physical disturbance. Recent studies provide further evidence for the role of modifying factors such as pH, DOC, and hardness. Toxicity of the same concentration of Pb can vary greatly under different experimental conditions.

As recognized in the 2006 Pb AQCD and further supported in this review, uptake of Pb by aquatic invertebrates and vertebrates may preferentially occur via exposure routes other than direct absorption from the water column such as ingestion of contaminated food and water, uptake from sediment pore waters, or incidental ingestion of sediment (U.S. EPA, 2006b). Currently available models for predicting bioavailability focus on acute toxicity and do not consider all possible routes of uptake. They are therefore of limited applicability, especially when considering species-dependent differences in uptake and bioaccumulation of Pb. Recent evidence supports the 2006 Pb AQCD conclusion that processes such as Pb adsorption, complexation, and chelation alter bioavailability to aquatic organisms.

Biological Effects of Pb on Freshwater Plants, Invertebrates and Vertebrates

Recent evidence further supports the findings of the previous Pb AQCDs that waterborne Pb is highly toxic to freshwater plants, invertebrates and vertebrates, with toxicity varying with species and lifestage, duration of exposure, form of Pb, and water quality characteristics. Concentration-response data from freshwater organisms indicate that there is a gradient of response to increasing Pb concentration and that some effects in sensitive species are observed at concentrations of Pb quantified in U.S. surface waters (Table 1-2).

The toxicity of Pb to aquatic algae and plants has been recognized in earlier EPA reviews of this metal. In the 1977 Pb AQCD, differences in sensitivity to Pb among different species of algae were reported and concentrations of Pb varied within and between genera. This observation was subsequently generalized across aquatic taxa (U.S. EPA, 1977). At the time of the 1977 Pb AQCD, the information available on effects of Pb on freshwater plants was limited. For plants in general, Pb was recognized to affect photosynthesis, mitosis, and growth, but at concentrations much higher than typically found in the environment. Effects of Pb on plants reported in subsequent Pb AQCDs included decreased growth, deformation of cells, and blocking of the pathways that lead to pigment synthesis, thus affecting photosynthesis.

Effects of Pb on aquatic plants supported by additional evidence in this review include oxidative damage, decreased photosynthesis, and reduced growth. Most recent studies report effects on growth at concentrations much higher than Pb typically encountered in the environment, however, some sublethal endpoints such as effects on chlorophyll were reported at concentrations in the 100 to 200 μg Pb/L range, albeit still much higher than those typically encountered in U.S. surface waters (Table 1-1). Elevated levels of antioxidant enzymes are commonly observed in aquatic plant, algae, and moss species exposed to Pb (U.S. EPA, 1977) and recent evidence continues to support this observation. Recent studies on uptake of Pb by aquatic plants support the findings of previous Pb AQCDs that all such plants with roots tend to sequester larger amounts of Pb in their roots than in their shoots, and provide additional evidence for species differences in compartmentalization of sequestered Pb and in responses to Pb in water and sediments. Exposure-response relationships in which increasing concentrations of Pb leads to increasing effects have consistently been reported in freshwater algae and macrophytes, suggesting that effects on growth and antioxidant activity are also occurring at lower concentrations, however, most current observations of Pb effects in freshwater plants are at concentrations that exceed Pb concentration values available for U.S. surface waters (Table 1-1).

The largest body of evidence for effects of Pb at or near concentrations encountered in U.S. surface waters is from invertebrates. In the 1986 Pb AQCD (U.S. EPA, 1986a) and 2006 Pb AQCD (U.S. EPA, 2006b), reduced reproduction, growth, and survival were reported in various species of freshwater invertebrates. In the 2006 Pb AQCD, concentrations at which effects were observed in aquatic invertebrates ranged from 5 to 8,000 µg Pb/L. Recent evidence for effects of Pb on reproduction, growth, and survival supports findings in previous Pb AQCDs (Table 6-5). In a series of 48-hour acute toxicity tests using a variety of natural waters across North America, LC_{50} values ranged from 29 to 180 µg Pb/L tests with the cladoceran *Ceriodaphnia dubia* (Esbaugh et al., 2011). In this same species, increased DOC leads to an increased mean EC_{50} for reproduction as low as 25 µg Pb/L. Reproductive and growth effects have also been reported in rotifer, midge and mayfly species near the range of Pb concentrations encountered in freshwater habitats. Several studies in this review have provided evidence of growth effects at lower concentrations. Among the most sensitive species, growth of juvenile freshwater snails (*Lymnaea stagnalis*) was inhibited at an EC_{20} of <4 µg Pb/L (Grosell and Brix, 2009; Grosell et al., 2006b). A chronic value of 10 µg Pb/L, obtained in 28-day exposures of 2-month-old freshwater mussel (*Lampsilis siliquoidea*) juveniles, was the lowest genus-mean chronic value ever reported for Pb (Wang et al., 2010f).

Since the 2006 Pb AQCD, there is additional evidence for Pb effects on antioxidant enzymes, lipid peroxidation, stress response and osmoregulation in aquatic invertebrates, as well as additional information on Pb bioaccumulation. Recent studies using stable isotopes have enabled simultaneous measurement of uptake and elimination in several aquatic organisms to assess the relative importance of water versus dietary uptake. In uptake studies of various invertebrates, Pb was mainly found in the gills and digestive gland/hepatopancreas.

Pb effects on freshwater vertebrates were previously assessed in the 1977 Pb AQCD, the 1986 Pb AQCD and the 2006 Pb AQCD (U.S. EPA, 2006b, 1986a, 1977). Evidence of toxicity of Pb and other metals to freshwater organisms goes back to early observations of contamination of natural areas by Pb mining leading to extirpation of fish from streams (U.S. EPA, 1977). Recent evidence supports the findings of effects on survival, reproduction, and behavior reported in previous Pb AQCDs for freshwater vertebrates. In a series of 96-hour acute toxicity tests with fathead minnow conducted in a variety of natural waters across North America, LC_{50} values ranged from 41 to 3,598 µg Pb/L (Esbaugh et al., 2011). Reproductive effects associated with water quality parameters were also noted with this species (Mager et al., 2010). In fish, several recent studies on behavioral effects of Pb indicate decreased prey capture rate, slower swim speed and decline in startle response and visual contrast with Pb exposure. These reported effects provide additional evidence for toxicity of Pb to fish. Chronic NOEC and EC_{10} values reported for trout, a sensitive species, are within the range of Pb occasionally encountered in U.S. surface waters (Table 6-2).

Observed responses of fish to Pb reported in the 1986 Pb AQCD and the 2006 Pb AQCD included inhibition of heme formation, alterations in brain receptors, effects on blood chemistry and hormonal systems, and decreases in some enzyme activities (U.S. EPA, 2006b, 1986a). Since the 2006 Pb AQCD, possible molecular targets for Pb neurotoxicity have been identified in fish and additional mechanisms of Pb toxicity have been elucidated in the fish gill and the fish renal system. In the 2006 Pb AQCD, amphibians were considered to be relatively tolerant to Pb. Observed responses to Pb exposure included decreased enzyme activity (e.g., ALAD reduction) and changes in behavior. Since the 2006 Pb AQCD, studies conducted at concentrations approaching environmental levels of Pb have indicated sublethal effects on tadpoles including deformities and decrements in growth and swimming ability.

In the 2006 Pb AQCD, adverse effects were found in freshwater fish at concentrations ranging from 10 to >5,400 µg Pb/L, generally depending on water quality variables (e.g., pH, hardness, salinity). Additional testing of Pb toxicity under conditions of varied alkalinity, DOC, and pH has been conducted since the last review. Effects in fish observed in recent studies fall within the range of concentrations observed in the previous Pb AQCD. Recent evidence also supports the 2006 conclusions that the gill is a major site of Pb uptake in fish, and that there are species differences in the rate of Pb accumulation and distribution of Pb within the organism. The anterior intestine has been newly identified as a site of uptake of Pb through dietary exposure studies. At the time of the publication of the 2006 Pb AQCD, trophic transfer of Pb through aquatic food chains was considered to be negligible. Measured concentrations of Pb in the tissues of aquatic organisms were generally higher in algae and benthic organisms than in consumers at higher trophic levels, indicating that Pb was bioconcentrated but not biomagnified. Some studies published since the 2006 Pb AQCD support the potential for transfer of Pb in aquatic food webs, while other studies indicate that Pb concentration decreases with increasing trophic level.

Ecosystem-level effects associated with Pb reported in previous Pb AQCDs include alteration of predator-prey dynamics, species richness, species composition, and biodiversity. Since the 2006 Pb AQCD, additional evidence for community and ecosystem level effects of Pb reviewed in Sections 6.4.7 and 6.4.12.7 have been observed primarily in microcosm studies or field studies near contaminated areas (mining, effluent). Findings from field studies of aquatic communities in the vicinity of heavily contaminated sites include changes in species composition and species richness, predator/prey interactions, nutrient cycling and energy flow; however, Pb is often found coexisting with other metals and other stressors, which risk confounding the observed effects. Recent studies provide evidence in additional habitats for these community and ecological-level effects, specifically in aquatic macrophyte communities and sediment-associated communities. Different species may exhibit different responses to Pb-impacted ecosystems dependent not only upon other environmental factors (e.g., temperature, pH), but also on species sensitivity, lifestage, or seasonally-affected physiological state. Aquatic ecosystems with low pH and low dissolved organic matter are likely to be the most sensitive to the effects of atmospherically-deposited Pb.

Biological Effects of Pb on Saltwater Plants, Invertebrates and Vertebrates

In general, Pb toxicity to marine/estuarine plants, invertebrates and vertebrates is less well characterized than toxicity to Pb in freshwater systems due to an insufficient quantity of studies on saltwater organisms. In marine algae, effects on growth are observed in the most sensitive species at Pb concentrations that exceed amounts measured in the open sea or estuaries (Table 1-1). The majority of available studies of Pb effects on saltwater organisms are for invertebrate species. Evidence for Pb effects on reproduction, growth and survival as well as neurobehavioral, hematological and physiological stress endpoints are coherent with findings in freshwater invertebrates although most effects are observed at concentrations above 100 µg Pb/L which exceeds Pb typically encountered in seawater (Table 1-1). Fewer studies are available for Pb in marine sediments. In the amphipod, *Elasmopus laevis*, onset to reproduction was significantly delayed at 118 mg/Pb kg sediment; a concentration that the authors indicate is below the current marine sediment regulatory guideline for Pb (218 mg Pb/kg sediment) (Ringenary et al., 2007; NOAA, 1999). In the same study, no effects of Pb on adult survival in 28-day or 60-day sediment exposures were observed. Additional studies on reproduction, growth, and survival in marine invertebrates report effects above the range considered for causal determinations (Table II, Preamble). Several field monitoring studies with marine bivalves have used ALAD as a biomarker for Pb exposure and correlated ALAD inhibition to increased Pb tissue content. Field and laboratory studies provide evidence for antioxidant response to Pb exposure, however, most effects are observed at concentrations of Pb that are higher than concentrations detected in marine environments. No recent evidence for effects of Pb on marine vertebrates in controlled exposures was available for review.

methylation, mitogenesis, and gene expression. Altered gene expression may come about through Pb displacing Zn from multiple transcriptional factors, and thus perturbing their normal cellular activities. Consistently positive results have provided evidence of increased apoptosis of various cell types following Pb exposure.

Overall, Pb-induced health and ecological effects can occur through a number of interconnected and evolutionarily well conserved modes of action that generally originate with the alteration of ion status.

1.9 Policy Relevant Considerations

1.9.1 Public Health Significance

The rationale for establishing the public health significance of the various health endpoints associated with Pb exposure is multifaceted. The 2006 Pb AQCD (U.S. EPA, 2006b) concluded that neurodevelopmental effects in children and cardiovascular effects in adults were among the effects best substantiated as occurring at the lowest blood Pb levels, and that these categories of effects were clearly of the greatest public health concern. The evidence reviewed in the current assessment supports and builds upon this conclusion. Evidence in a few cohorts of children that indicated the supralinear concentration-response blood Pb-FSIQ relationships, did not identify a threshold for Pb-associated neurodevelopmental effects in the range of blood Pb levels examined (Sections 1.9.3 and 4.3.13).

The World Health Organization (WHO) definition of "health" is "the state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1948). By this definition, decrements in health status that are not severe enough to result in the assignment of a clinical diagnosis might reflect a decrement in the well-being of an individual. Further, deficits in subtle indices of health or well-being may not be observable except in aggregate, at the population level, so the critical distinction between population and individual risk is essential for interpreting the public health significance of study findings. This concept of population risk is relevant to the interpretation of findings regarding both IQ and blood pressure in the assessment of their public health significance.

Weiss et al. (1988) discusses the hypothetical impact of a small shift in a population distribution of IQ Score. As shown in Figure 1-1, these authors anticipate that even a small shift in the population mean IQ may be significant from a public health perspective because such a shift could yield a larger proportion of individuals functioning in the low of greater than 7 µg/dL, who were followed for a week, there was a dramatic drop in the blood Pb (Carbone et al., 1998).

Epidemiologic studies consistently show that blood Pb levels measured during various lifestages or time periods throughout childhood, as well as averaged over multiple years during childhood, are associated with cognitive function decrements (Section 4.3.11). An international pooled analysis of seven prospective studies found that increments in concurrent and peak blood Pb levels were associated with a decrease in FSIQ measured between ages 5 and 10 years (Lanphear et al., 2005). In individual studies, postnatal (early childhood and concurrent) blood Pb levels are also consistently associated with cognitive function decrements in children and adolescents (Figure 4-2, Table 4-3, Table 4-14).

Exposure metrics based on blood Pb measurements at different ages in childhood are typically highly correlated. For example, analyses of serial blood Pb concentrations measured in longitudinal epidemiologic studies find relatively strong correlations (e.g., r = 0.5-0.8) among each child's individual blood Pb concentrations measured after 6-12 months of age (Section 3.3.2). Consequently, the relative importance of various exposure metrics, which are measured during different lifestages and time periods, is difficult to discern in epidemiologic studies. Evidence in rodents and monkeys, however, indicates that Pb exposures during multiple lifestages and time periods, including prenatal only, prenatal plus lactational, postnatal only, lifetime are observed to induce impairments in learning (Rice, 1992b, 1990; Rice and Gilbert, 1990b). These findings are consistent with the understanding that the nervous system continues to develop (i.e., synaptogenesis and synaptic pruning remains active) throughout childhood and into adolescence.

1.9.5 Reversibility and Persistence of Neurotoxic Effects of Pb

The 2006 Pb AQCD concluded that the human and animal evidence suggest that the neurotoxic effects of Pb are not generally reversible (U.S. EPA, 2006b). Chelation studies in humans and animals show that chelation decreases total body Pb burden, but does not necessarily exert evident effects on Pb-induced cognitive deficits. For example, analysis of multi-center study data indicates that medical interventions involving chelation therapy (e.g., Succimer use) do not fully reverse cognitive deficits associated with early Pb exposure (Liu et al., 2002).

The persistence of neurodevelopmental effects from comparatively low-level Pb exposure was considered in the 2006 Pb AQCD (U.S. EPA, 2006b), with some evidence suggesting that the effects of Pb on neurodevelopmental outcomes persisted into adolescence and young adulthood. The toxicological evidence continues to support a not reflective of concurrent blood Pb levels at the age of manifestation of the pathology but instead are associated with an earlier life Pb exposure.

1.9.6 Populations Potentially At-Risk for Health Effects

The NAAQS are intended to protect public health with an adequate margin of safety. In so doing, protection is provided for both the population as a whole and those groups potentially at increased risk for health effects from exposure to the air pollutant for which each NAAQS is set (Preface to this ISA). To facilitate the identification of populations at increased risk for Pb-related health effects, studies have evaluated various factors that may contribute to susceptibility and/or vulnerability to Pb. These factors include genetic background, race and ethnicity, sex, age, diet, pre-existing disease, SES, and characteristics that may modify exposure or the response to Pb. Table 1-7 and Table 5-5 provide an overview of the factors examined as potentially increasing the risk of Pb-related health effects based on the recent evidence integrated across disciplines. They are classified according to the criteria discussed in the introduction to Chapter 5.

In consideration of the evidence base as a whole (e.g., stratified and longitudinal analyses) and integrating across disciplines of toxicokinetics, exposure, and health, there is adequate evidence to conclude that children are an at-risk population. It is recognized that Pb can cross the placenta and affect the developing nervous system of the fetus (Section 3.2.2.4). Children may have increased exposure to Pb compared with adults because children's behaviors and activities (including increased hand-to-mouth contact, crawling, and poor hand-washing), differences in diets, and biokinetic factors. There is evidence of increased risk to the cognitive effects of Pb exposure during several lifestages and time periods throughout gestation, childhood, and into adolescence (Section 4.3.12). Findings from magnetic resonance imaging (MRI) studies indicate that normal brain development remains dynamic throughout adolescence, and epidemiologic studies have linked concurrent blood Pb level (as well as other blood Pb metrics) in adolescents to cognitive function decrements and delinquent or criminal behavior (Section 4.3.4). Delays in puberty onset (Section 4.8.1), and renal effects (Section 4.5.2.2), are also observed in association with concurrent blood Pb level in cross-sectional studies of adolescents. Since the populations of older children in these studies generally had higher past exposures, the current evidence does not clearly establish the link between a time and duration of Pb exposure and the observed health effects in the adolescent populations studied. Elevated biomarkers levels, which may be related to remobilization of stored Pb during bone loss and/or higher historical Pb exposures, are observed in older adults. Studies of older adults report inconsistent findings for effect measure modification of Pb-related mortality by age and no

2.2.2.6 Roadway-Related Sources

Contemporary Emissions from Vehicle Parts

Contemporary Pb emissions from motor vehicles may occur because several vehicle parts still contain Pb. Wheel weights, used to balance tires, are clipped to the rims of tire wheels in order to balance the tires, and may become loose and fall off. Pb wheel weights have been banned in several states including Washington, Maine, and Vermont with legislation considered in Iowa, California, and Maryland. However, Pb wheel weights are a source in most states for the period of time covered in this assessment. Ambient air Pb concentrations near heavily trafficked areas may be related to use of Pb-based wheel weights that are prone to dislodgement. Root (2000) and Aucott and Caldarelli (2012) estimated that 7.5 kg/km per year are deposited and that, among deposited weights, 2.7-5% of the mass is lost from the roadway daily. Aucott and Caldarelli (2012) extrapolated their results for Mercer County, NJ to the U.S. to estimate that 480 tons of Pb are deposited to roadways each year. On pavement they may be ground into dust by the pounding forces of traffic (Root, 2000). For example, Aucott and Caldarelli (2012) estimated that 13.8 ± 5.0% of the deposited mass of wheel weights are dispersed each year through abrasion and grinding by traffic. Schauer et al. (2006) measured Pb emissions in two traffic tunnels and found that the Pb-$PM_{2.5}$ concentration did not exceed 17% of the Pb-PM_{10} concentration in any of the runs. Schauer et al. (2006) suggested that enrichment in the coarse fraction may have been related to wheel weights. Additionally, Schauer et al. (2006) measured PM_{10} and $PM_{2.5}$ composition from brake dust and found concentrations that were low but statistically significantly greater than zero for Pb in PM_{10} (0.02 ± 0.01 mg/g) and Pb in $PM_{2.5}$ (0.01 ± 0.00 mg/g) for semi-metallic brake pads and for Pb in PM_{10} (0.01 ± 0.00 mg/g) for low-metallic brake pads. Song and Gao (2011) speciated coarse and fine PM samples obtained next to the New Jersey Turnpike in winter and summer of 2007-2008. Using principal component analysis, they found that Pb was prevalent in the factor including automobile exhaust and brake wear. Pb was observed to have a similar size distribution as Zn in the winter and Zn and Cd in the summer, with higher concentrations in the fine fraction at a mode of 0.18-0.32 µm. Fauser (1999) observed that 92% of particles generated by tire abrasion have aerodynamic diameter smaller than 1 µm. Additionally, Hjortenkrans et al. (2007) used material metal concentrations, traffic volume, emissions factors, and sales data to estimate the quantity of Pb emitted from brake wear and tires in Stockholm, Sweden in 2005. They observed that 24 kg (0.026 ton) of Pb were emitted from brake wear each year, compared with 2.6 kg (0.0029 ton) of Pb from tire tread wear; an estimated 549 kg (0.61 ton) was estimated to have been emitted from brake wear in 1998. McKenzie et al. (2009) determined the composition of various vehicle components including tires and

Breast Milk

Studies of breastfeeding women suggest that infants may be exposed to Pb in breast milk. Ettinger et al. (2004a) observed in a 1994-1995 study of Mexico City women that at 1 month postpartum, 88 women breastfeeding exclusively (with mean blood Pb level of 9.4 µg/dL) had breast milk Pb concentrations of 1.4 ± 1.1 µg/L, and 165 women breastfeeding partially (with mean blood Pb level of 9.5 µg/dL) had breast milk Pb concentrations of 1.5 ± 1.2 µg/L. During the same time period, Ettinger et al. (2006) studied breastfeeding women in Mexico City over a child's first year of life and sampled Pb concentration in breast milk at 1, 4, and 7 mo post-partum. They observed that mean breast milk concentrations dropped from 1.4 µg/L at 1 mo (mean maternal blood Pb = 9.3 µg/dL) to a mean of 1.2 µg/L at 4 mo (mean maternal blood Pb = 9.0 µg/dL) to 0.9 µg/L at 7 mo (mean maternal blood Pb = 8.1 µg/dL); this reduction was statistically significant ($p < 0.00001$). Among the 310 women included in the study, 181 had previous pregnancies. In one study of nursing mothers living in Port Pirie, Australia near a Pb smelter, 10 of the 11 mothers had breast milk concentrations <5 µg/L (Simon et al., 2007). The authors hypothesized that breast milk concentration was too low to be a major contributor to blood Pb level in these infants relative to other factors such as hand loading of Pb. However, one mother with a blood Pb level of 25 µg/dL had a breast milk Pb level of 28 µg/L (Simon et al., 2007).

In summary, several sources of dietary Pb can originate from atmospheric Pb emissions, including drinking water, vegetables, game, fish, and breast milk. Drinking water Pb levels are affected by source strength and proximity, runoff, and water treatment processes and chemicals. Among plants grown for agriculture, Pb content is highest in grasses, followed by leafy vegetables, then root vegetables. Pb in soil or dust can also collect on the surfaces of vegetables. Pb contamination of vegetables depends on a number of factors, including presence of nearby sources of atmospheric Pb, soil type and chemistry, land use, and land treatment. Other sources of Pb, such as international consumer products or historic emissions, also have the potential to introduce Pb into the U.S. diet. Pb contamination through the food chain potentially leads to elevated Pb levels in meat. Likewise, Pb contamination of surface waters can lead to elevated levels of Pb in fish used for consumption. Breastfeeding also presents a potential Pb exposure to newborn babies, and exposure drops off as the mothers nurse and as the babies age and add more food to their diet.

engine exhaust from fuel containing tetraethyllead at a concentration of 1 µg/m^3 for a period of months could produce a 1 µg/dL increment in blood Pb.

3.2.1.2 Ingestion

The extent and rate of GI absorption of ingested inorganic Pb are influenced by physiological states of the exposed individual (e.g., age, fasting, nutritional calcium (Ca^{2+}) and iron (Fe) status, pregnancy) and physicochemical characteristics of the Pb-bearing material ingested (e.g., particle size, mineralogy, solubility). Pb absorption in humans may be a capacity-limited process, in which case the percentage of ingested Pb that is absorbed may decrease with increasing rate of Pb intake. Numerous observations of nonlinear relationships between blood Pb concentration and Pb intake in humans provide support for the likely existence of a saturable absorption mechanism or some other capacity-limited process in the distribution of Pb in humans (Sherlock and Quinn, 1986; Sherlock et al., 1984; Pocock et al., 1983; Sherlock et al., 1982). While evidence for capacity-limited processes at the level of the intestinal epithelium is compelling, the dose at which absorption becomes appreciably limited in humans is not known.

In adults, estimates of absorption of ingested water-soluble Pb compounds (e.g., Pb chloride, Pb nitrate, Pb acetate) range from 3 to 10% in fed subjects (Maddaloni et al., 1998; Watson et al., 1986; James et al., 1985; Heard and Chamberlain, 1982; Rabinowitz et al., 1980). The absence of food in the GI tract increases absorption of water-soluble Pb in adults. Reported estimates of soluble Pb absorption range from 26 to 70% in fasted adults (Maddaloni et al., 1998; James et al., 1985; Blake et al., 1983; Heard and Chamberlain, 1982; Rabinowitz et al., 1980). Reported fed:fasted ratios for soluble Pb absorption in adults range from 0.04 to 0.2 (James et al., 1985; Blake et al., 1983; Heard and Chamberlain, 1982; Rabinowitz et al., 1980).

Limited evidence demonstrates that GI absorption of water-soluble Pb is higher in children than in adults. Estimates derived from dietary balance studies conducted in infants and children (ages 2 weeks to 8 years) indicate that ~40-50% of ingested Pb is absorbed (Ziegler et al., 1978; Alexander et al., 1974). Experimental studies provide further evidence for greater absorption of Pb from the gut in young animals compared to adult animals (Aungst et al., 1981; Kostial et al., 1978; Pounds et al., 1978; Forbes and Reina, 1972). The mechanisms for an apparent age difference in GI absorption of Pb have not been completely elucidated and may include both physiological and dietary factors (Mushak, 1991). To further investigate the effects of the presence of food in the GI tract on Pb absorption, children (3-5 years old) who ate breakfast had lower blood Pb levels compared to children who did not eat breakfast (Liu et al., 2011a). This difference

Studies of the effect of hormone replacement therapy on bone Pb mobilization have yielded conflicting results (Popovic et al., 2005; Berkowitz et al., 2004; Garrido Latorre et al., 2003; Korrick et al., 2002; Webber et al., 1995). In women with severe weight loss (28% of BMI in 6 months) sufficient to increase bone turnover, increased blood Pb levels of approximately 2.1 µg/dL (250%) were reported, and these blood Pb increases were associated with biomarkers of increased bone turnover (e.g., urinary pyridinoline cross-links) (Riedt et al., 2009).

3.3.6 Relationship between Pb in Blood and Pb in Soft Tissues

Figure 3-13 shows simulations of blood and soft tissues Pb (including brain) for the same exposure scenarios previously displayed. Pb uptake and elimination in soft tissues is much faster than bone. As a result, following cessation of a period of elevated exposure, Pb in soft tissues is more quickly returned to blood. The terminal elimination phase from soft tissue mimics that of blood, and it is similarly influenced by the contribution of bone Pb returned to blood and being redistributed to soft tissue.

Information on Pb levels in human brain is limited to autopsy data. These data indicate brain/blood Pb ratios of approximately 0.5 in infancy which remain relatively constant over the lifetime (range 0.3 to 1.1) (Barry, 1981, 1975). The simulation of brain Pb shown in Figure 3-14 reflects general concepts derived from observations made in non-human primates, dogs and rodents. These observations suggest that peak Pb levels in the brain are reached 6 months following a bolus exposure and within two months approximately 80% of steady state brain Pb levels are reached (Leggett, 1993). There is a relatively slow elimination of Pb from brain ($t_{1/2} \approx 2$ years) compared to other soft tissues (Leggett, 1993). This slow elimination rate is reflected in the slower elimination phase kinetics is shown in Figure 3-14. Although in this model, brain Pb to blood Pb transfer half-times are assumed to be the same in children and adults, uptake kinetics are assumed to be faster during infancy and childhood, which achieves a higher fraction of the soft tissue burden in brain, consistent with higher brain/body mass relationships. The uptake half times predicted by Leggett (1993) vary from 0.9 to 3.7 days, depending on age. Brain Pb kinetics represented in the simulations are simple outcomes of modeling assumptions and cannot currently be verified with available observations in humans.

4.3.10.5 Blood Brain Barrier

Two barrier systems exist in the body to separate the brain or the CNS from the blood: the blood brain barrier (BBB) and the blood cerebrospinal fluid barrier (BCB). The BBB, formed by tight junctions at endothelial capillaries forming the zonulae occludens (occludins, claudins, and cytoplasmic proteins), separates the brain from the blood and its oncotic and osmotic forces, allowing for selective transport of materials across the BBB.

Pb exposure during various developmental windows has been shown to increase the permeability of the BBB of animals (Dyatlov et al., 1998; Struzynska et al., 1997b; Moorhouse et al., 1988; Sundstrom et al., 1985). Possibly due the underdevelopment of the BBB early in life, prenatal and perinatal Pb exposure has been found to result in higher brain Pb accumulation than have similar exposures later in life (Moorhouse et al., 1988). The choroid plexus and cerebral endothelial cells that form the BBB and BCB tight junctions have been shown to accumulate Pb more than other cell types and regions of the CNS. Studies reviewed in the 2006 Pb AQCD showed that the chemical form of Pb and its capability to interact with proteins and other blood components affect its capability to penetrate the BBB (U.S. EPA, 2006b). Pb also has been shown to compromise the BCB and decrease the cerebrospinal fluid level of transthyretin, which binds thyroid hormone in the cerebrospinal fluid. Low thyroid hormone levels in pregnant women have been linked with IQ deficits in their children (Lazarus, 2005).

Recent research with male weanling rats exposed to Pb acetate via drinking water showed leaky cerebral vasculature, an indication of a compromised BBB, as detected histologically with lanthanum nitrate staining of the brain parenchyma (Wang et al., 2007b). Cerebral vasculature leakiness was ameliorated or resembled that of controls after Fe supplementation. The cerebral vasculature leakiness may by explained by observations of significant Pb-induced decreases in the BBB tight junction protein occludin in the hippocampus, brain cortex, and cerebellum of these weanling animals. Occludin levels were rescued to control levels with Fe supplementation. This loss of integrity at the junctional protein level was affirmed with additional experiments using the rat brain vascular endothelial cell line RBE4, in which 10 μM Pb acetate exposure for 2, 4, 8, 16 and 24 hours resulted in decreases in junctional proteins occludin and claudin 5 as well as scaffold proteins ZO1 and ZO2 (Balbuena et al., 2011). Because gene expression for these junctional and scaffold proteins did not show decrements, it was determined that these protein decrements were due to post-translational modifications.

Pb exposure also was found to contribute to leakiness of the BBB by decreasing the resistance across the junction (Balbuena et al., 2010). An in vitro co-culture system employing endothelial cells (RBE4 or bovine brain microvascular endothelial cells) and astrocytes (primary Sprague-Dawley neonatal pup astrocytes, GD21) served as the barrier

4.8 Reproductive and Developmental Effects

The effect of Pb on reproductive and developmental outcomes has been of interest for years, starting in cohorts of occupationally-exposed individuals. More recently, researchers have begun to focus on reproductive and developmental effects in populations without occupational exposures, with more environmentally-relevant levels of Pb exposure. The toxicological and epidemiologic literature on reproductive effects of Pb includes research on female and male reproductive function such as hormone levels, fertility, spontaneous abortions, effects on sperm, estrus, and effects on reproductive organs. Evaluation of effects on development includes effects on puberty onset, postnatal growth, and effects on the development of the teeth, sensory organs, and other systems. Research on birth outcomes includes birth defects, infant mortality, preterm birth, and low birth weight. A few studies of pregnancy-induced hypertension and eclampsia have been conducted and are reported on in the section on hypertension (Section 4.4.2.1). Briefly, the relatively small number of studies found consistently positive associations between blood Pb levels and pregnancy-induced hypertension. Biomarkers of Pb exposure, including blood Pb and bone Pb, are used in the epidemiologic studies reviewed in this section. Bone Pb typically indicates cumulative exposure to Pb, whereas, blood Pb may indicate more recent exposure. However, Pb can also be remobilized from the bone during times of active bone remodeling, such as pregnancy or lactation. Therefore, blood Pb also may reflect cumulative Pb exposure. Toxicological studies typically report exposure using blood Pb. More detailed discussion of these measures and Pb transfer via umbilical cord blood Pb across the placenta, and via lactation is given in Section 3.2.2.4 on Pb Toxicokinetics.

Overall, the recent literature on reproductive effects of Pb exposure continues to support associations reported in earlier Pb AQCDs between Pb exposure and effects on various parameters of sperm (function, motility, count, integrity, histology). The toxicological and epidemiologic literature of developmental effects of Pb exposure also indicates that Pb exposure is associated with delayed onset of puberty in both males and females. Associations between Pb exposure and other reproductive and developmental effects have less consistent findings. The recent information from epidemiologic and toxicological studies is integrated with conclusions from previous Pb AQCDs.

4.8.1 Effects on Development

The 2006 Pb AQCD (U.S. EPA, 2006b) reported Pb-associated developmental effects on teeth, sensory organs, the GI system, the liver, and postnatal growth as well as delayed puberty onset (U.S. EPA, 2006b). There was recognition that Pb is transferred across the placenta and through the breast milk, contributing to exposure during development. The 2006 Pb AQCD reported delayed puberty onset in both male and female populations in animal toxicology studies showing associations with dam blood Pb levels of ~40 µg/dL and pup blood Pb levels of 26 µg/dL. The research reported in this ISA continues to find delayed puberty onset with Pb exposure at even lower Pb doses in animal toxicology studies as is detailed below. Mechanistic understanding of delayed puberty onset is also reported in this ISA. Lower dose Pb exposure studies in animal toxicology are also reported in studies of retinal function and postnatal growth in this ISA. Studies included in this ISA expand upon evidence reported in previous Pb AQCDs for the aforementioned systems sensitive to developmental effects with recent studies showing effects at lower doses of Pb. This section does not cover associations between Pb and neurodevelopmental impacts, which are discussed in detail in Section 4.3. The studies presented in the following text and tables are grouped by study design and methodological strength.

4.8.1.1 Effects on Puberty among Females

Recent toxicological studies of rodents have examined the effects of Pb on pubertal and reproductive organ development and on biomarkers of pubertal development among females. There have also been recent epidemiologic studies examining associations between blood Pb levels and onset of puberty among girls, which are summarized in Table 4-36 and in the text below. All of the epidemiologic studies examined concurrently measured blood Pb and puberty and are reported below. Additionally, while there was a longitudinal investigation by Naicker et al. (2010), who followed girls to determine their age of menarche, blood Pb levels were measured once at 13 years of age.

where more information on overall biokinetic and physiological factors affecting Pb distribution is provided.

5.2 Population Characteristics Potentially Related to Differential Pb Exposure

Elevated or differential Pb exposure and related biomarker levels (such as blood Pb), have been shown to be statistically related to several population characteristics, including age, sex, race and ethnicity, SES, proximity to Pb sources, and residential factors (U.S. EPA, 2006b). In most cases, exposure, absorption, and biokinetics of Pb are all influenced to varying degrees by such characteristics. Additionally, the relative importance of such population characteristics in affecting exposure, absorption, and biokinetics varies among individuals in a population and is difficult to quantify. This section presents recent studies demonstrating a relationship between each population characteristic and exposure status. The studies presented in this section build upon the current body of literature suggesting that population characteristics differentially influence Pb exposure; the new literature does not alter previous understanding of the differential influence of population characteristics on Pb exposure. Differential response to given Pb exposures is discussed in Section 5.3.

5.2.1 Age

5.2.1.1 Early Childhood

Typically, children have higher exposure to Pb compared with adults because children's behaviors and activities include hand-to-mouth contact, crawling, and poor hand-washing that typically result in greater Pb ingestion compared with adults (U.S. EPA, 2006b). Children can also have increased Pb exposure because outdoor activities can lead to hand-to-mouth contact with contaminated soil. For example, Zahran et al. (2010) observed that a 1% reduction in soil Pb concentration led to a 1.55 µg/dL reduction in median blood Pb levels ($p < 0.05$) among New Orleans children.

Age of the children may influence blood Pb levels through a combination of behavioral and biokinetic factors. The 2009-2010 NHANES data are presented in Table 5-2 by age and sex. Among children, highest blood Pb levels occurred in the 1-5 year age group (children under age 1 were not included), and within this subgroup (not shown on the table), 1-year old children had the highest blood Pb levels (99th percentile: 9.47 µg/dL)

Table 5-3 Percentage of children within six categories/brackets of blood Pb levels, 1999-2004 NHANES.

	N	Geometric mean[a]	Percentage (%) of children within categories/brackets (95% CIs)					
			<1 µg/dL	1 to <2.5 µg/dL	2.5 to <5 µg/dL	5 to <7.5 µg/dL	7.5 to <10 µg/dL	≥ 10 µg/dL
Overall	2,532	1.9 (1.8-2.0)	14.0 (11.6-16.6)	55.0 (52.1-57.9)	23.6 (21.1-26.1)	4.5 (3.3-5.9)	1.5 (1.0-2.1)	1.4 (1.0-2.0)
Sex								
Female	1,211	1.9 (1.7-2.0)	14.1 (10.8-17.7)	54.5 (51.1-57.8)	23.9 (20.3-27.8)	4.5 (3.3-5.8)	1.4 (0.8-2.3)	1.7 (0.9-2.6)
Male	1,321	1.9 (1.7-2.0)	14.0 (11.4-16.7)	55.5 (51.4-59.5)	23.2 (20.3-26.3)	4.6 (3.0-6.5)	1.5 (0.9-2.3)	1.3 (0.7-2.6)
Age								
1-2 yr	1,231	2.1 (2.0-2.2)	10.6 (7.7-13.9)	51.0 (46.7-55.3)	27.9 (24.9-31.0)	6.7 (5.0-8.6)	1.4 (0.8-2.2)	2.4 (1.4-3.5)
3-5 yr	1,301	1.7 (1.6-1.9)	16.2 (12.9-19.9)	57.6 (53.8-61.4)	20.7 (17.9-23.7)	3.1 (1.9-4.6)	1.5 (0.8-2.3)	0.9 (0.4-1.5)
Race/Ethnicity								
Non-Hispanic Black	755	2.8 (2.5-3.0)	4.0 (2.5-5.7)	42.5 (37.8-47.2)	36.2 (33.1-39.3)	9.4 (6.9-12.2)	4.6 (3.0-6.5)	3.4 (1.8-5.5)
Mexican American	812	1.9 (1.7-2.0)	10.9 (8.6-13.4)	61.0 (56.9-65.1)	22.1 (18.0-26.5)	3.4 (2.2-5.0)	1.3 (0.6-2.2)	1.2 (0.4-2.6)
Non-Hispanic White	731	1.7 (1.6-1.8)	17.6 (14.0-21.5)	57.1 (52.4-61.7)	19.7 (16.1-23.5)	3.6 (1.9-5.8)	0.8 (0.3-1.6)	1.2 (0.6-2.0)
Poverty-Income Ratio (PIR)								
≤ 1.3	1,302	2.4 (2.2-2.5)	6.7 (4.6-9.2)	49.3 (44.9-53.7)	32.5 (28.6-36.4)	6.9 (2.2-8.8)	2.8 (1.7-4.1)	1.8 (1.1-2.7)
>1.3	1,070	1.5 (1.4-1.6)	19.9 (16.3-23.8)	60.4 (56.9-63.8)	16.0 (12.9-19.3)	2.3 (1.2-3.7)	0.6 (0.1-1.4)	0.8 (0.3-1.6)

[a]Geometric mean Pb Units: µg/dL (95% CI)

Source: Reprinted with permission of the American Academy of Pediatrics; Jones et al. (2009a)

Fetal and child Pb biomarkers have been demonstrated to relate to maternal Pb biomarkers as reported in the 2006 Pb AQCD (U.S. EPA, 2006b). Kordas et al. (2010) observed that maternal hair Pb concentration was a statistically significant predictor of child hair Pb concentration ($\beta = 0.37 \pm 0.07$, $p < 0.01$). Elevated blood Pb levels among mothers present a potential exposure route to their children in utero or through breast milk; see Miranda et al. (2010).

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 745

[EPA–HQ–OPPT–2023–0231; FRL–8524–01–OCSPP]

RIN 2070–AK91

Reconsideration of the Dust-Lead Hazard Standards and Dust-Lead Post-Abatement Clearance Levels

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: Addressing childhood lead exposure is a priority for the Environmental Protection Agency (EPA). This rule addresses health concerns for all affected communities, including children living in communities with environmental justice concerns, who have significantly higher blood lead levels (BLLs) than other children. As part of EPA's efforts to reduce childhood lead exposure, and in accordance with a U.S. Court of Appeals for the Ninth Circuit 2021 opinion, EPA is proposing to lower the dust-lead hazard standards (DLHS) from 10 micrograms per square foot (µg/ft²) and 100 µg/ft² for floors and window sills to any reportable level as analyzed by a laboratory recognized by EPA's National Lead Laboratory Accreditation Program. This is a non-numeric value that the Agency refers to as greater than zero µg/ft² and may vary based on laboratory or test. While EPA's DLHS do not compel property owners or occupants to evaluate their property for lead-based paint (LBP) hazards nor take control actions, if an LBP activity such as an abatement is performed, then EPA's regulations set requirements for doing so. EPA is also proposing to change the dust-lead clearance levels (DLCL), which are the values used to determine when abatement work can be considered complete, from 10 µg/ft², 100 µg/ft² and 400 µg/ft² for floors, window sills, and window troughs to 3 µg/ft², 20 µg/ft², and 25 µg/ft², respectively. Under this proposal, the DLHS for floors and window sills would not be the same as the DLCL for floors and window sills (*i.e.,* the DLHS and DLCL would be decoupled). Accordingly, dust-lead hazards could remain after an abatement due to the different statutory direction that Congress provided EPA with respect to the DLCL. Additionally, EPA is proposing to change the definition of abatement so that the recommendation for action applies when dust-lead loadings are at or above the DLCL, as well as several other amendments, including revising the definition of target housing to conform with the statute.

DATES: Comments must be received on or before October 2, 2023. Under the Paperwork Reduction Act (PRA), comments on the information collection provisions are best assured of consideration if the Office of Management and Budget (OMB) receives a copy of your comments on or before August 31, 2023.

ADDRESSES: Submit your comments, identified by docket identification (ID) number EPA–HQ–OPPT–2023–0231, through the Federal eRulemaking Portal at *https://www.regulations.gov.* Follow the online instructions for submitting comments. Do not submit electronically any information you consider to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Additional instructions on commenting and visiting the docket, along with more information about dockets generally, is available at *https://www.epa.gov/dockets.*

FOR FURTHER INFORMATION CONTACT:

For technical information contact: Claire Brisse, Existing Chemicals Risk Management Division, Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Washington, DC 20460–0001; telephone number: (202) 564–9004; email address: *brisse.claire@epa.gov.* Hearing- or speech-impaired persons may reach the telephone numbers for the contacts through TTY by calling the toll-free Federal Communications Commission's Telecommunications Relay Service at 711.

For general information contact: The TSCA Hotline, ABVI-Goodwill, 422 South Clinton Ave., Rochester, NY 14620; telephone number: (202) 554–1404; email address: *TSCA-Hotline@epa.gov.*

SUPPLEMENTARY INFORMATION:

I. Executive Summary

A. Does this action apply to me?

You may be potentially affected by this action if you conduct lead-based paint (LBP) activities in accordance with 40 CFR 745.227; if you operate a training program required to be accredited under 40 CFR 745.225; if you are a firm or individual who must be certified to conduct LBP activities or renovations in accordance with 40 CFR 745.226; or if you own, manage, and/or conduct abatement, rehabilitations or maintenance activities in most pre-1978 housing that is covered by a Federal housing assistance program in accordance with 24 CFR part 35. You may also be affected by this action if you operate a laboratory that is recognized by EPA's National Lead Laboratory Accreditation Program (NLLAP) in accordance with 40 CFR 745.90, 745.223, 745.227, and 745.327. You may also be affected by this action, in accordance with 40 CFR 745.107 and 24 CFR 35.88, as the seller or lessor of target housing, which is most pre-1978 housing. See 40 CFR 745.103 and 24 CFR 35.86. You may also be affected by this action if you are a resident of target housing, even if you would not be subject to the proposed requirements of this action. Due to the change in the definition of ''target housing,'' you may also be affected if you are a firm or individual who must be certified to perform renovations in target housing or child-occupied facilities (COFs) in accordance with 40 CFR part 745, subpart E.

The following list of North American Industrial Classification System (NAICS) codes is not intended to be exhaustive, but rather provides a guide to help readers determine whether this document applies to them. Potentially affected entities may include:

- Building construction (NAICS code 236), *e.g.,* single-family housing construction, multi-family housing construction, residential remodelers.
- Specialty trade contractors (NAICS code 238), *e.g.,* plumbing, heating, and air-conditioning contractors, painting, and wall covering contractors, electrical contractors, finish carpentry contractors, drywall and insulation contractors, siding contractors, tile and terrazzo contractors, glass, and glazing contractors.
- Real estate (NAICS code 531), *e.g.,* lessors of residential buildings and dwellings, residential property managers, and property owners, as well as those property owners that receive assistance through Federal housing programs.
- Child day care services (NAICS code 624410).
- Elementary and secondary schools (NAICS code 611110), *e.g.,* elementary schools with kindergarten classrooms.
- Other technical and trade schools (NAICS code 611519), *e.g.,* training providers.
- Engineering services (NAICS code 541330) and building inspection services (NAICS code 541350), *e.g.,* dust sampling technicians.
- Lead abatement professionals (NAICS code 562910), *e.g.,* firms and supervisors engaged in LBP activities.

- Testing laboratories (NAICS code 541380) that analyze dust wipe samples for lead.
- Federal agencies that own residential property (NAICS code 92511, 92811).

B. What is the Agency's authority for taking this action?

EPA is proposing this rule under the authority of sections 401, 402, 403, 404, and 406 of the Toxic Substances Control Act (TSCA), *15 U.S.C. 2601 et seq.,* as amended by Title X of the Housing and Community Development Act of 1992 (also known as the Residential Lead-Based Paint Hazard Reduction Act of 1992 or ''Title X'') (Pub. L. 102–550) (Ref. 1) and section 237(c) of Title II of Division K of the Consolidated Appropriations Act, 2017 (Pub. L. 115–31, 131 Stat. 789), as well as sections 1004 and 1018 of Title X (42 U.S.C. 4851b, 4852d), as amended by section 237(b) of Title II of Division K of the Consolidated Appropriations Act, 2017.

Regarding the dust-lead hazard standards (DLHS), TSCA section 403 (15 U.S.C. 2683) mandates EPA to identify LBP hazards for purposes of administering Title X and TSCA Title IV. Under TSCA section 401, LBP hazards are defined as conditions of LBP and lead-contaminated dust and soil that ''would result in adverse human health effects,'' (15 U.S.C. 2681(10)) and lead-contaminated dust is defined as ''surface dust in residential dwellings'' that contains lead in excess of levels determined ''to pose a threat of adverse health effects . . .'' (15 U.S.C. 2681(11)).

As relevant to the dust-lead clearance levels (DLCL), TSCA section 402 (15 U.S.C. 2682) directs EPA to regulate LBP activities, which include risk assessments, inspections, and abatements. TSCA section 401 (15 U.S.C. 2681) defines abatements as ''measures designed to permanently eliminate lead-based paint hazards'' and the term includes ''all . . . cleanup . . . and post[-]abatement clearance testing activities'' (15 U.S.C. 2681(1)). EPA's statutory authority for setting the DLCL was laid out differently in Title X and TSCA Title IV than those for the DLHS. As a result, distinct from the DLHS, EPA is further directed, in promulgating the DLCL regulations, to ''tak[e] into account reliability, effectiveness, and safety'' (15 U.S.C. 2682(a)(1)).

Pertaining to the other amendments presented in Unit IV.F. of this preamble, TSCA section 406 (15 U.S.C. 2686) requires EPA, in consultation with the Secretary of the U.S. Department of Housing and Urban Development (HUD) and with the Secretary of the U.S. Department of Health and Human Services (HHS) to ''publish, and from time to time revise, a lead hazard information pamphlet to be used in connection with this subchapter and section 4852d of title 42.'' TSCA section 406 (15 U.S.C. 2686) also requires EPA's regulations to require any person performing for compensation a renovation of target housing to provide the pamphlet to the owner and occupant prior to commencing the renovation. Additionally, section 1018 of Title X (42 U.S.C. 4852d) mandates that the Lead Warning Statement to be provided in contracts for the purchase or sale of target housing include, among other language, the following text: ''. . . The seller of any interest in residential real property is required to provide the buyer with any information on lead-based paint hazards from risk assessments or inspections in the seller's possession and notify the buyer of any known lead-based paint hazards'' (emphasis added). TSCA section 401 (15 U.S.C. 2681(17)) and section 1004 of Title X (42 U.S.C. 4851b), as amended by section 237(b) and (c) of Title II of Division K of the Consolidated Appropriations Act, 2017 (Pub. L. 115–31, 131 Stat. 789), define target housing 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) . . . .'' In this context, ''elderly'' refers to 62 years of age or more (40 CFR 745.103).

C. What action is the Agency taking?

In 2019, EPA promulgated a final rule to lower the DLHS to 10 μg/ft² for floors and 100 μg/ft² for window sills (the 2019 DLHS Rule) (Ref. 2). In 2021, EPA promulgated a final rule to lower the DLCL to 10 μg/ft² for floors and 100 μg/ft² for window sills (the 2021 DLCL Rule) (Ref. 3). The 2019 DLHS Rule and the 2021 DLCL Rule continued a long-standing practice of setting the same levels for the DLHS and the DLCL and basing those levels in part on consideration of factors such as laboratory capacity and capabilities.

In keeping with an opinion issued by the U.S. Court of Appeals for the Ninth Circuit in 2021 (described in Unit I.D.) that instructed EPA to consider only health factors when setting the DLHS, EPA is now proposing to change the DLHS from 10 μg/ft² for floors and 100 μg/ft² for window sills, as established in the 2019 DLHS Rule, to any reportable level of dust-lead analyzed by a NLLAP-recognized laboratory. The Agency refers to this level as greater than zero (GTZ). It is not a specific numeric level set by EPA but rather the numerically reportable level as analyzed by a NLLAP-recognized laboratory, which is sometimes referred to as a ''non-numeric'' value. However, that term, as used in this document, refers only to the GTZ level and should not be confused with non-numeric standards such as work practice standards. EPA believes GTZ and the standard of ''any reportable level'' is an appropriate DLHS based on health effects, given there is no identified level of lead in blood that does not cause adverse cognitive impacts in children, and this more protective approach is consistent with the statutory language in TSCA Section 401 that defines what a ''LBP hazard'' is (*i.e.,* as conditions of LBP and lead-contaminated dust and soil that ''would result in adverse human health effects''), and with the results from the Technical Support Document (TSD). There is no evidence of a threshold below which there are not harmful effects from lead exposure, including neurobehavioral and cognitive effects on children (Refs. 4 and 5). The proposed GTZ approach represents a shift in the LBP activities program to a more inclusive DLHS, identifying dust-lead hazards in the context of TSCA Title IV as any condition that causes exposure to lead from lead-contaminated dust in target housing and child-occupied facilities. If finalized as proposed, the GTZ approach will be inclusive of any reportable level of dust-lead and will not distinguish between severe, less severe, or negligible risks. Additional discussion on GTZ can be found in Unit IV.A.1.

Additionally, EPA is proposing to revise the DLCL, set by the 2021 DLCL Rule, from 10 μg/ft² to 3 μg/ft² for dust-lead for floors, from 100 μg/ft² to 20 μg/ft² dust-lead for window sills and from 400 μg/ft² to 25 μg/ft² dust-lead for window troughs, following a consideration of reliability, effectiveness, and safety, including non-health factors such as laboratory capabilities/capacity and achievability after an abatement. EPA is also requesting comment on an alternative DLCL option of 5 μg/ft² dust-lead for floors, 40 μg/ft² dust-lead for window sills, and 100 μg/ft² for window troughs. If finalized as proposed, the DLHS for floors and window sills would not be the same as the DLCL for floors and window sills (*i.e.,* the DLHS and DLCL would be decoupled), acknowledging the different statutory direction that Congress provided EPA with respect to the DLCL. Although EPA has in the past promulgated rules setting the DLHS and

DLCL to be the same values, an opinion by the U.S. Court of Appeals for the Ninth Circuit in May 2021 instructed EPA to consider only health factors when setting the DLHS and affirmed that EPA could consider non-health factors (*e.g.,* laboratory capabilities/capacity, and achievability after an abatement) when setting the DLCL.

The proposed DLCL would not impose retroactive requirements on regulated entities that have previously performed post-abatement dust wipe testing using the current DLCL of 10 µg/ft² for floors, 100 µg/ft² for window sills, and 400 µg/ft² for troughs, or the previous DLCL of 40 µg/ft² for floors, 250 µg/ft² for window sills, and 400 µg/ft² for troughs (Ref. 6). They would apply to post-abatement clearance sampling and analysis conducted after the compliance date for that portion of the regulations (*i.e.,* one year after publication of the final rule). Additionally, while EPA's DLHS do not compel property owners or occupants to evaluate their property for LBP hazards or take control actions (40 CFR 745.61(c)), if an LBP activity such as an abatement is performed, then EPA's regulations set requirements for doing so (40 CFR 745.220(d)). This rule, if finalized, would change the LBP activities regulations' definition of abatement to be any measure or set of measures designed to eliminate LBP hazards, in the case of dust-lead hazards, to a level below the new proposed DLCL, and would require an additional statement in the final abatement reports that states that LBP hazards (particularly dust-lead hazards) remain after an abatement if clearance testing has found that they do remain.

EPA is also proposing several other amendments, including: conforming changes to the definition of ''target housing;'' conforming the age requirements throughout the LBP regulations to under six years old; requiring that application payments, applications, and notices be submitted electronically; updating the Disclosure Rule warning statement (Ref. 7); as well as correcting an incorrect reference to the lead-hazard control pamphlet; and deleting obsolete regulatory text where language is out of date or no longer applicable. EPA is also considering adding incorporations by reference of two voluntary consensus standards already included in a relevant definition.

EPA is requesting comment on the changes described in this proposal, in particular the reliability, effectiveness, and safety of the primary and alternative DLCL options, and all other amendments discussed in Unit IV.

D. Why is the Agency taking this action?

Lead exposure has the potential to impact individuals of all ages, but it is especially harmful to young children because the developing brain can be particularly sensitive to environmental contaminants (Refs. 4 and 8). Because of this, reducing childhood lead exposure is a priority for both EPA and the Federal Government. In December 2018, the President's Task Force on Environmental Health Risks and Safety Risks to Children released the *Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts* (Federal Lead Action Plan) (Ref. 9) to enhance the Federal Government's efforts to identify and reduce lead exposure while ensuring children impacted by such exposure are getting the support and care they need to prevent or mitigate any associated health effects. The Federal Lead Action Plan is helping Federal agencies to work strategically and collaboratively to reduce exposure to lead and improve children's health. On October 27, 2022, EPA released the *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities* (Lead Strategy). The Lead Strategy lays out Agency and government-wide approaches to strengthen public health protections, address legacy lead contamination for communities with the greatest exposures and promote environmental justice. It describes how the Agency will utilize the full suite of EPA authorities, expertise, and resources to continue to reduce lead exposure. This proposed rule, which revises the DLHS and the DLCL (among other proposed regulatory changes), is an action that EPA committed to undertake in the Lead Strategy (Ref. 10).

In 2019, EPA re-evaluated the DLHS (Ref. 2). Based on that evaluation, the final rule revised the DLHS from 40 µg/ft² and 250 µg/ft² to 10 µg/ft² and 100 µg/ft² for floors and window sills, respectively. However, public health advocates filed a lawsuit in the U.S. Court of Appeals for the Ninth Circuit (the Court) seeking judicial review of the 2019 DLHS Rule as insufficiently protective. On May 14, 2021, the Court issued its opinion on the 2019 DLHS Rule. The Court held that ''the 2019 Rule lowers the lead hazard level but not to a level sufficient to protect health as Congress has directed, because the EPA has looked to factors in addition to health.'' *A Cmty. Voice* v. *U.S. Env't Prot. Agency,* 997 F.3d 983, 992 (9th Cir. 2021). The remedy the Court granted was a remand without vacatur (of the lowered DLHS), and the Court instructed EPA to consider only health factors when setting the DLHS (Ref. 11). This proposed rule is being issued to reconsider the DLHS and DLCL in light of the 2021 Court Opinion, which directed EPA to ''reconsider the DLHS . . . [and] the dust-lead clearance levels . . . in the same proceeding'' and affirmed that EPA could consider non-health factors when setting the DLCL. *A Cmty. Voice,* 997 F.3d at 995. This 2021 Court Opinion led EPA to undertake a major shift from its approach in the 2019 and 2021 final rules to the residential LBP hazard control and the LBP activities program because the Opinion found that EPA did not have the authority, when setting the DLHS, to consider non-health factors. Consistent with the 2021 Court Opinion, EPA is proposing to revise the DLHS in this rulemaking based on only health considerations. See Unit IV for more information on the proposed revisions to the DLHS and DLCL.

Additionally, Executive Order 13990, entitled *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,* directed agencies to, among other things, review certain regulations promulgated between January 20, 2017, and January 20, 2021 (Ref. 12). The 2019 DLHS and 2021 DLCL final rules were among those specifically designated for review in accordance with Executive Order 13990 (Ref. 13). As a result, the Agency was tasked with immediately considering whether the final rules were aligned with the identified national objectives from Executive Order 13990, such as listening to the science, improving public health and protecting our environment, and limiting exposure to dangerous chemicals. As a result of its own review in response to Executive Order 13990 and the 2021 Court Opinion, EPA has reconsidered the 2019 DLHS and 2021 DLCL final rules. If finalized as proposed, EPA believes this rule will result in a reduction of exposure to dust-lead (beyond the 2019 and 2021 rules).

E. What are the estimated incremental impacts of this action?

EPA has prepared an Economic Analysis (EA), which is available in the docket, of the potential incremental impacts associated with this rulemaking (Ref. 14). The analysis focused specifically on the subset of target housing and child-occupied facilities affected by this rule. Although the DLHS and DLCL do not compel specific actions under the LBP Activities Rule to address identified LBP hazards, the DLHS and DLCL are directly incorporated by reference into certain requirements mandated by HUD in the housing subject to HUD's Lead Safe Housing Rule (LSHR). As such, the analysis estimates incremental costs and benefits for two categories of events: (1) where dust-wipe testing occurs to comply with HUD's Lead-Safe Housing Rule and (2) where dust wipe testing occurs in response to blood lead testing that detects a blood lead level (BLL) above state or Federal action levels. The following is a brief outline of the estimated incremental impacts of this rulemaking.

1. Benefits

This rule would result in reduced exposure to lead, yielding benefits to residents of pre-1978 housing from avoided adverse health effects. For the subset of adverse health effects that were quantified (*i.e.,* the effect of avoided IQ decreases on lifetime earnings as an indicator of improved cognitive function), the estimated monetized and annualized benefits are $1.069 billion to $4.684 billion per year using a 3% discount rate, and $231 million to $1.013 billion per year using a 7% discount rate. These benefits calculations are sensitive to the discount rate used and the range in the estimated number of lead hazard reduction events triggered by children with tested BLLs above state or Federal action levels. With respect to the latter, the wide range is driven largely by uncertainty about the BLLs at which action might be taken, since in many states the action level is currently higher than the Federal blood lead reference value.

Additionally, there are unquantified benefits. These additional benefits include avoided adverse health effects in children, including decreased attention-related behavioral problems, decreased cognitive performance, reduced post-natal growth, delayed puberty, and decreased kidney function. These additional unquantified benefits also include avoided adverse health effects in adults, including cardiovascular mortality and impacts on reproductive function and outcomes.

2. Costs

This rule is estimated to result in quantified costs of $536 million to $784 million per year. These costs are expected to accrue to landlords, owners and operators of child-occupied facilities, residential remodelers, and abatement firms. Real estate agents and brokers may incur negligible costs related to the target housing definition amendment. The cost calculations are highly sensitive to the range in the estimated number of lead hazard reduction events triggered by children with elevated BLLs. In the events affected by this rule, incremental costs can be incurred for specialized cleaning used to reduce dust-lead loadings (*i.e.,* quantity of lead per unit of surface area) to below the clearance levels. In some instances, floors will also be sealed, overlaid, or replaced, or window sills will be sealed or repainted. Additional costs may result from the retesting of lead dust levels. Because of the lower laboratory reporting limits necessary for testing lead dust levels under this rule, incremental laboratory test costs are likely to increase. Additional potential impacts to HUD programs and their beneficiaries are discussed in Unit V.

3. Small Entity Impacts

This rule would directly impact approximately 39,000 small businesses of which 87% to 91% have cost impacts less than 1% of revenues, 9% to 12% have impacts between 1% and 3%, and 1% have impacts greater than 3% of revenues. These small entities include landlords, owners and operators of child-occupied facilities, residential remodelers, abatement firms, and real estate agents and brokers.

4. Environmental Justice

EPA is proposing this rulemaking under TSCA Title IV, as explained in Unit I.B. This rule would address lead exposure, as discussed throughout this proposal. EPA prepared an Economic Impact Analysis for this rulemaking that assessed whether there are disproportionate effects to communities from lead exposure. EPA identified an existing concern: children living in communities with environmental justice concerns have significantly higher BLLs than other children (Ref. 15). This rule addresses health concerns for all affected communities, including those identified with environmental justice concerns. As identified in EPA's Economic Impact Analysis, this rule would reduce identified disproportionate impacts to communities with environmental justice concerns. The primary and alternative regulatory options under consideration are expected to affect housing units receiving Federal assistance under HUD's LSHR and housing units with a child with a blood lead level above a Federal, state, or local blood lead threshold. Because, in general, only lower income households are eligible to receive Federal housing assistance, the occupants of housing subject to the LSHR (and thus benefitting from the proposed regulation) are considered an overburdened community. Additional details on any identified disproportionate impacts to communities with environmental justice concerns are contained in Unit IX.J. of this preamble and Section 8.6 of the economic impact analysis.

5. Children's Environmental Health

Consistent with Executive Order 13045, EPA evaluated the health and safety effects of this action on children. Children are disproportionately impacted by lead exposure. Children can have greater exposures than adults because they crawl on floors and often put their hands and other objects (that can have lead from dust on them) into their mouths and are more susceptible than adults to adverse health effects due to their rapid anatomical growth and physiological differences in lead uptake and metabolism. This rule protects children from these disproportionate environmental health risks.

This action is subject to EPA's Policy on Children's Health (*https://www.epa.gov/children/childrens-health-policy-and-plan*) because the rule has considerations for human health and early life exposures. Accordingly, we have evaluated the environmental health or safety effects of dust-lead exposure on children. The results of this evaluation are contained in the EA and the TSD, where the health impacts of lead exposure on children are discussed more fully (Refs. 14 and 16). The documents referenced above are available in the public docket for this action.

The primary purpose of this rule is to reduce exposure to dust-lead hazards in target housing where children reside and in child-occupied facilities. EPA's analysis indicates that there will be approximately 217,432 to 436,642 children under age six per year affected by the rule (Ref. 14). Proposing GTZ for the DLHS is a more protective approach, supported by the modeled results from the TSD and that the current state of the science does not support identifying a threshold of dust-lead exposure below which there would be no adverse human health effects. Additionally, the proposed DLCL of 3/20/25 µg/ft^2 for floors, window sills and troughs respectively, is the lowest option under consideration and according to the TSD it is estimated to be the most protective of children's IQ when compared to the other options evaluated for this proposed rulemaking.

6. Effects on State, Local, and Tribal Governments

EPA has concluded that this action has federalism implications because it imposes substantial direct compliance costs on public housing authorities that state or local governments may be obligated to offset. These compliance costs result from application of EPA's standards in HUD's LSHR. While some HUD funding for LBP projects exists, the Federal Government may not provide the funds necessary to pay the entirety of the costs. These costs to public housing authorities—estimated at $143 million for the primary option—cover additional lead hazard reduction activities, cleaning, and dust-lead testing to ensure that public housing units are in compliance with the LSHR. EPA also estimates annual compliance costs of approximately $904 thousand to public school districts that operate a child-occupied facility built before 1978. Additionally, states that have authorized LBP Activities programs must demonstrate that they have DLHS and DLCL at least as protective as the levels at 40 CFR 745.65 and 40 CFR 745.227. However, authorized states are under no obligation to continue to administer the LBP Activities program, and if they do not wish to adopt the new DLHS and DLCL they can relinquish their authorization. In the absence of a state authorization, EPA will administer these requirements. EPA provides a preliminary federalism summary impact statement, which is found in Unit IX.E.

Additionally, this action contains a Federal mandate under the Unfunded Mandates Reform Act (UMRA), 2 U.S.C. 1531–1538, that may result in expenditures of $100 million or more for State, local, and Tribal governments, in the aggregate, or the private sector in any one year. Accordingly, EPA has prepared a written statement as required under section 202 of UMRA, which is summarized in Unit IX.D. and included in the public docket (Ref. 17). This action is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that exceed the inflation-adjusted cost significance threshold or uniquely affect small governments.

This action would not have substantial direct effects (as specified in Executive Order 13175) on one or more federally recognized Indian Tribes. This action neither creates an obligation for Tribes to administer LBP Activities programs nor alters EPA's authority to administer these programs. However, through a live consultation on this rulemaking the Agency will solicit input from Tribal officials from the four Indian Tribes currently with authorized programs during the public comment period. EPA will ensure that the consultation materials are accessible to Tribal officials so that they may view it later as they consider submitting feedback during the public comment period. The consultation will also be open to any Tribal officials who would like to participate. If a Tribal official is interested in attending the consultation on behalf of an Indian Tribe, please consult the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

Additionally, this rule would not have any significant or unique effects on small governments. See Unit IX. for more information on the Executive Orders.

II. Background

A. Health Effects of Lead

Lead exposure has the potential to impact individuals of all ages, but it is especially harmful to young children because the developing brain can be particularly sensitive to environmental contaminants (Refs. 4, 5, and 8). Ingestion of lead-contaminated dust is a major contributor to BLLs in children, particularly those who reside in homes built prior to 1978 (Refs. 17 and 18). Throughout early childhood, floor dust contamination is a source of lead exposure with the potential to affect children's BLLs (Ref. 20). Infants, toddlers, and young children are more highly exposed to lead through dust on floors and other surfaces at home and in child-care facilities than older children and adults because they crawl on floors and often put their hands and other objects that can have lead from dust on them into their mouths. This is the main pathway of childhood exposure to lead (Ref. 4).

Lead exposure in young children can cause neurocognitive decrements, such as reduction in intelligence as measured by IQ. Depending on the exposure and other factors, the effect may persist into adolescence and adulthood (Refs. 4, 8 and 20). In children, lead exposure can also cause adverse developmental, neurobehavioral, hematological, and immunological effects, as well as sensory effects such as hearing loss (Refs. 4, 5, and 8). In adults, lead exposure can cause adverse cardiovascular, hematological, renal, neurocognitive, neurobehavioral, immunological, and reproductive effects (Refs. 4, 5, and 8). Lead is also classified as ''reasonably anticipated to be a human carcinogen by the National Toxicology Program (NTP) (Ref. 21) and the EPA has concluded that lead exposure has a ''likely causal relationship'' with carcinogenesis (Ref. 4). In addition to the harmful effects experienced by the mother, lead can be transferred to the fetus during pregnancy and there is evidence that suggests adverse effects on the developing fetus including inhibited fetal growth (Refs. 4 and 5). Given young children's disproportionate exposure to dust-lead in target housing, this rulemaking principally considers their exposure and associated adverse health effects.

The best available science informs EPA's understanding of the relationships between exposures to dust-lead, BLLs, and adverse human health effects. These relationships are summarized in the Integrated Science Assessment (ISA) for Lead, finalized in June 2013 (known as the 2013 Lead ISA) (Ref. 4), and the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Lead, which was released by the Department of Health and Human Services in August 2020 (''ATSDR Tox Profile for Lead'') (Ref. 8). The 2013 Lead ISA is a synthesis and evaluation of scientific information on the health and environmental effects of lead, including cognitive function decrements in children (Ref. 4). The 2013 Lead ISA, as well as NIEHS' 2012 National Toxicology Program (NTP) monograph on lead, summarize the scientific evidence regarding potential health effects associated with low-level lead exposure and acknowledge uncertainties in the data (Refs. 4 and 5). Based on the epidemiological studies and the evidence available at that time, the EPA stated in the 2013 ISA that harmful effects on children's cognition as measured by IQ were observed in groups with mean BLLs as low as 2 µg/dL, and further that ''A threshold for cognitive function decrements is not discernable from the available evidence (*i.e.,* examination of early childhood blood Pb or concurrent blood Pb in the range of < 1 to 10 µg/dL).'' (Ref. 4). Additionally, the Federal Lead Action Plan, which was written by the President's Task Force on Environmental Health Risks and Safety Risks to Children, consisting of 17 Federal departments and offices, states that ''Lead exposure to children can result from multiple sources and can cause irreversible and life-long health effects. No safe blood lead level in children has been identified.'' (Refs. 9 and 22).

For further information regarding lead and its health effects, see the TSD for this rulemaking and the 2013 ISA for lead (Refs. 4 and 16).

B. Federal Actions To Reduce Lead Exposures

Title X of the Housing and Community Development Act (also known as the Residential Lead-Based Paint Hazard Reduction Act of 1992 or ''Title X''), codified primarily at 42

U.S.C. 4822 and 4851 *et seq.* (Ref. 1), was a Federal response to the national crisis of childhood lead exposure and assigned responsibilities to Federal agencies with the overall goal of developing a ''national strategy to build the infrastructure necessary to eliminate lead-based paint hazards in all housing as expeditiously as possible'' (42 U.S.C. 4851(a)(1)). Subtitle B of Title X (106 Stat. 3912 through 3924), addressing lead exposure reduction, added Title IV to TSCA (codified at 15 U.S.C. 2681 *et seq.*) (Ref. 23).

Since the establishment of Title X, EPA and HUD have promulgated both joint and separate regulatory actions in an effort to eliminate LBP hazards. Those actions include requirements for disclosure of known LBP or any known LBP hazards (Ref. 7), training and certification requirements for contractors performing LBP activities (Ref. 24), the establishment of standards that identify lead-based paint hazards and post-abatement clearance levels (*i.e.,* the DLHS and DLCL) (Refs. 2, 3 and 6), regulations covering renovation or remodeling activities (Refs. 25, 26 and 27), provisions for interested states, territories, and Tribes to apply for and receive authorization to administer their own LBP Activities and renovation, repair and painting (RRP) programs, and requirements to control LBP and LBP hazards in federally-assisted target housing (Ref. 28). Additional description of and background on Federal actions to reduce lead exposure to can be found in the 2021 DLCL rulemaking (Ref. 3).

In addition, EPA has developed a Lead Strategy to lay out an all-of-EPA plan to strengthen public health protections and address legacy lead contamination for communities with the greatest exposures and promote environmental justice (*https://www.epa.gov/lead/final-strategy-reduce-lead-exposures-and-disparities-us-communities*). EPA plans to continue its work to equally protect people of all races, ethnic groups, income levels, disabilities, and life stages, including young children and pregnant women, who are the most vulnerable to the toxic effects of lead. The proposed actions in this notice are part of those efforts, as dust-lead from lead-based paint remains one of the leading causes of lead exposure in the United States (Ref. 10).

C. Applicability and Uses of DLHS and DLCL

The DLHS and DLCL reconsidered in this regulation support EPA's lead-based paint (LBP) activities program (*i.e.,* inspections, risk assessments, and abatements) and disclosure program, both of which apply to target housing (*i.e.,* most pre-1978 housing) and COFs (pre-1978 non-residential properties where under the current regulation, children 6 years of age or under spend a significant amount of time such as daycare centers and kindergartens) (codified at 40 CFR part 745, subpart L). The statutory definition of target housing was amended by Congress in 2017, and EPA is planning to make the necessary conforming regulatory changes, including changing the age to under six years of age, within this rulemaking; see Unit IV.F.1. for more information. Apart from COFs, no other public or commercial buildings are covered by this proposal.

The DLHS and DLCL are incorporated into requirements for risk assessment and post-abatement work. When conducted, LBP activities must be performed by a certified individual or firm (40 CFR 745.220) in accordance with the work practices outlined in the 1996 LBP Activities Rule (40 CFR 745.227). EPA administers the LBP activities program only where states (including the District of Columbia and the Commonwealth of Puerto Rico), territories, or Tribes are not authorized by EPA to operate their own lead abatement programs (see 40 CFR part 745, subpart Q). Currently the states in which the LBP program is administered by EPA are Alaska, Arizona, Florida, Idaho, Montana, Nevada, New Mexico, New York, South Carolina, South Dakota, and Wyoming. In addition, EPA administers the LBP program in the territories of American Samoa, Guam, Northern Marianas, and the U.S. Virgin Islands, as well as most Tribal Lands. All other states have EPA-authorized LBP programs. Additionally, the Cherokee Nation, Upper Sioux Community, Lower Sioux Indian Community, and the Bois Forte Band of Chippewa have EPA-authorized LBP programs.

To administer the disclosure program, EPA and HUD jointly developed regulations (known as the Disclosure Rule under section 1018 of Title X (42 U.S.C. 4852d)) requiring a seller or lessor of most pre-1978 housing to disclose the presence of any known LBP and/or LBP hazards, such as soil-lead hazards or dust-lead hazards, to the purchaser or lessee (24 CFR part 35, subpart A; 40 CFR part 745, subpart F). Under these regulations, the seller or lessor also must provide the purchaser or lessee any available records or reports ''pertaining to'' LBP and/or LBP hazards (40 CFR 745.107(a)(4); 24 CFR 35.88(a)(4)). Leases of target housing are exempt from disclosure requirements in limited circumstances, such as where the housing has been found to be LBP free by a certified inspector (24 CFR 35.82; 40 CFR 745.101). For more information on how the DLHS and DLCL revisions impact various EPA and HUD programs, see Unit V.A. and Unit V.B.

1. Dust-Lead Hazard Standards

The DLHS support and implement major provisions of TSCA Title IV and provide the basis for risk assessors to determine whether dust-lead hazards are present during a risk assessment or a lead hazard screen. A risk assessment may be required by the LSHR where dust wipe testing occurs to comply with the LSHR (*e.g.,* for certain properties receiving Federal assistance) or by other law or regulation where dust-lead testing occurs in response to the discovery of a child with a BLL that exceeds a Federal, state, or local threshold. Additional information on the LSHR and the subparts which require risk evaluation is discussed in the EA (Ref. 14). The objective of a risk assessment is to determine, and then report the existence, nature, severity, and location of LBP hazards in residential dwellings and COFs through an on-site investigation, which includes both a visual assessment and a collection of environmental samples. The environmental samples include, among other things, dust wipe samples (taken using documented methodologies as defined in 40 CFR 745.227(a)(3)) from floors and window sills. Those samples are required to be analyzed by a laboratory that is recognized under NLLAP, which is an EPA program that defines the minimum requirements and abilities that laboratories must meet to attain EPA recognition as an accredited testing laboratory (the standards for the program are laid out in the Laboratory Quality System Requirements) (Ref. 29). A risk assessor compares the results of the dust wipe samples to the current DLHS. If the dust-lead loadings from the samples are at or above the applicable DLHS, then a dust-lead hazard is present (40 CFR 745.227(d)).

Ultimately, the risk assessor prepares a risk assessment report for the property owner or manager, which lists any LBP hazards (including a dust-lead hazard) that were found and includes any recommendations for next steps, such as acceptable options for controlling the hazards via interim controls and/or abatement. These options are intended to allow the property owner to make an informed decision about what actions to take to protect the health of current and future residents. Under EPA's rule, a risk assessment/risk assessment report does not compel or require action;

rather it simply provides property owners with recommendations as appropriate (40 CFR 745.227(d)).

A lead hazard screen also includes a visual inspection and collection of environmental samples, although it is not as comprehensive as a risk assessment or conducted as often. A lead hazard screen may be used to determine if a full risk assessment is necessary. During a lead hazard screen, a risk assessor checks for deteriorated LBP and collects two composite dust samples (in residential dwellings), one from floors and one from window sills (more composite dust samples are required in multi-family dwellings or COFs). Samples are taken using documented methodologies. The risk assessor prepares a lead hazard screen report but is not required to include determinations about the LBP hazards or recommendations for interim controls and/or abatement but could include information on whether a follow-up risk assessment is warranted (40 CFR 745.227(c)).

Both risk assessments and lead hazard screens can only be performed by risk assessors certified according to the procedures in 40 CFR 745.226.

2. Dust-Lead Clearance Levels

The DLCL are incorporated into the post-abatement work practices outlined in the LBP Activities Rule and represent ''the amount of lead in dust on a surface following completion of an abatement activity'' (40 CFR 745.227, 745.223) (Ref. 24). TSCA section 401 defines abatements as, ''measures designed to permanently eliminate lead-based paint hazards,'' (15 U.S.C. 2681(1)), while interim controls are ''designed to temporarily reduce human exposure or likely exposure to lead-based paint hazards,'' (40 CFR 745.83 and 745.223). Abatement and/or interim controls could be recommended in a risk assessment report to inform the property owner about potential future action(s) they could take. After an abatement is complete, a risk assessor or inspector determines whether there are any ''visible amounts of dust, debris or residue,'' which will need to be removed before clearance sampling takes place (40 CFR 745.227(e)(8)). Once the area is free of visible dust, debris, and residue, and one hour or more after final post-abatement cleaning ceases, clearance sampling for dust-lead (via dust wipe samples) can take place and will be conducted ''using documented methodologies that incorporate adequate quality control procedures'' (40 CFR 745.227(e)(8)). Only a properly trained and certified risk assessor or inspector can conduct clearance sampling. An NLLAP-recognized laboratory must analyze the dust wipe samples and a risk assessor or inspector must compare the results from window sills, floors, and window troughs to the appropriate DLCL.

Every post-abatement sample must test below the DLCL in order to fulfill the post-abatement work practices of the LBP Activities Rule. If a single sample is equal to or greater than the corresponding DLCL, then the abatement fails clearance and the components represented by the failing sample must be recleaned and retested (40 CFR 745.227(e)(8)). After all dust wipe samples show dust-lead loadings below the DLCL, an abatement report is prepared (in accordance with the requirements in 40 CFR 745.227(e)(10)), copies of any reports required under the LBP Activities Rule are provided to the building owner (and to potential lessees and purchasers under the LBP Disclosure Rule by those building owners or their agents), and all required records are retained by the abatement firm or by the individuals who developed each report for no fewer than three years (40 CFR 745.227(i)).

D. Limitations of DLHS and DLCL

The DLHS are intended to identify dust-lead hazards during risk assessments, while the DLCL are part of post-abatement work practices, ensuring that clearance is achieved. Both regulatory values have several key limitations. Since the DLHS and DLCL were established and revised for the purposes of Title X and TSCA Title IV only, they do not apply to housing and COFs built during or after 1978, nor do they apply to pre-1978 housing that does not meet the definition of target housing (40 CFR 745.61 and 745.223). If one chooses to apply the DLHS or the DLCL to situations beyond the scope of Title X and TSCA Title IV, care must be taken to ensure that the action taken in such settings is appropriate, and that the action is adequate to provide any necessary protection for children or other individuals exposed.

These standards cannot be used to identify that housing is free from all risks from exposure to lead including but not limited to dust-lead, soil-lead, or lead in drinking water, as risks are dependent on many factors. For instance, the physical condition of a property that contains LBP may change over time, resulting in an increase in risk. Plus, EPA's DLHS do not require the owners of properties covered by this proposal to evaluate their properties for the presence of dust-lead hazards, nor to take action if dust-lead hazards are identified (although these standards can be incorporated into certain requirements mandated by state, Tribal and local governments, as well as other Federal agencies). Additionally, consistent with the 2021 Court Opinion which instructed EPA to consider only health factors when setting the DLHS and affirmed that EPA could consider other factors (*i.e.,* reliability, effectiveness, and safety) when setting the DLCL, EPA is proposing that the DLCL would be greater than the DLHS based on its consideration of other factors (*e.g.,* laboratory capabilities/capacity, and achievability after an abatement). As a result, and given the change in the definition of abatement discussed in Unit IV.D. of this preamble, there may be dust-lead left behind that meets the definition of an LBP hazard after an abatement is considered complete, due to dust-lead levels that are reportable but are less than the proposed DLCL. Also, as has been the case historically, achieving the DLCL after an abatement does not mean that the home is free from all exposure to lead, including from other media such as soil-lead or lead in drinking water. EPA will continue coordinating with other Federal agencies to encourage best practices for owners and occupants of post-abatement properties to conduct ongoing maintenance that will help to continue to lower dust-lead levels, as well as work collectively as an Agency to reduce overall lead exposure through all pathways.

E. Litigation Overview

As previously discussed, EPA revised the DLHS to 10 µg/ft^2 for floors and 100 µg/ft^2 for window sills in a final rule in July 2019 (Ref. 2). Later that same year, multiple organizations, including A Community Voice, California Communities Against Toxics, Healthy Homes Collaborative, New Jersey Citizen Action, New York City Coalition to End Lead Poisoning, Sierra Club, United Parents Against Lead National, and We Act for Environmental Justice, petitioned the U.S. Court of Appeals for the Ninth Circuit to review the 2019 DLHS Rule (Ref. 30).

In response to the Petition for Review, on May 14, 2021, the Court remanded the 2019 DLHS Rule without vacatur and directed EPA to revisit it in conjunction with a reconsideration of the DLCL (Ref. 11). In its opinion accompanying the remand, the Court instructed EPA to consider only health factors when setting the DLHS and affirmed that EPA could continue to consider non-health factors when setting the DLCL. Specifically, the 2021 Court Opinion held that EPA's 2019 DLHS Rule ''looked to other factors, including feasibility and efficacy,'' when setting the DLHS, instead of ''set[ting] the hazard standards at the point at which the level [of] dust-lead creates hazards to human health'' *A Cmty. Voice,* 997 F.3d at 989 and 990. The Court also held that ''TSCA [Title] IV gives the EPA latitude to consider 'reliability, effectiveness, and safety''' when promulgating regulations ''[w]ith respect to implementation, including abatement,'' thus enabling consideration of practicability when setting the DLCL. *Id.* at 995. The Court explained that ''[t]his is in line with the overall statutory scheme that differentiates between identification of hazards and implementation of remedial measures.'' *Id.* The Court also explained elsewhere in the 2021 Court Opinion that, if an agency relies on uncertainty for regulatory action or inaction, the agency must ''provide reasons why uncertainty justifies their actions'' *Id.* at 993. Consistent with the 2021 Court Opinion, EPA is proposing to revise the DLHS in this rulemaking based only on health considerations.

In addition, the Court held that EPA violated TSCA Title IV by leaving the soil-lead hazard standards (SLHS) at the values set in 2001, reasoning that EPA had an ongoing duty to update the standards. The SLHS identify lead-contaminated soil at target housing and pre-1978 COFs that would result in adverse human health effects. Soils that contain lead at levels determined to be hazardous to human health are considered contaminated. Lead inspectors, risk assessors, and abatement professionals use the SLHS to determine if soil-lead hazards are present and to inform options for reducing risk. Due to resource considerations and to act as expeditiously as possible to revise the DLHS and DLCL, EPA will address the SLHS in a separate rulemaking. (For more background on resource constraints under TSCA, please see Congressional testimony from EPA leadership (Refs. 31 and 32)). EPA listed this SLHS rulemaking in the Spring 2023 Unified Agenda of Regulatory and Deregulatory Actions under RIN 2070–AL12 as a long-term action, indicating the Agency's commitment to meet the statutory requirement of addressing the SLHS revision but indicating that the Agency does not expect to propose this action in the next 12 months (Ref. 33). EPA has however, initiated work on the SLHS rulemaking and, as this rulemaking on the DLHS and DLCL progresses and as resources allow, EPA intends to work further on the technical analysis for SLHS in preparation for the SLHS rulemaking. The Agency also intends to build off of the technical analysis utilized for this rulemaking for the SLHS rulemaking, mirroring where possible so as to reduce resource constraints and considerations.

The Court also held that, to be consistent with its health-only interpretation of an LBP hazard (*i.e.,* soil, dust), the definition of LBP must ''encompass all levels of lead in paint that lead to adverse human health effects.'' *A Cmty. Voice,* 997 F.3d at 992. The Court stated that ''EPA ha[d] not explained why uncertainty justifies its decision to leave the definition of lead-paint as-is.'' *Id.* at 993. The Court also noted that much knowledge has been gained since Congress adopted the 1992 definition and that the U.S. Consumer Product Safety Commission (CPSC) has adopted a regulation that bans the production of paint with lead content of over 0.009 percent by weight. The CPSC standard, however, applies to *new* paint while TSCA is concerned with the hazards posed by *existing* paint in pre-1978 structures and different information and considerations are relevant in that context. The definition of LBP (1.0 milligrams per square centimeter or more than 0.5 percent by weight) is incorporated throughout the LBP regulations, and application of this definition is central to how the LBP program functions. In the 2019 DLHS Rule, EPA discussed the Agency's need for more information to establish a statistically valid causal relationship between concentrations of lead at low levels in paint and dust lead loadings that cause lead exposure. Additionally, information is still needed to quantify the direct ingestion of paint through consumption of paint chips or through teething on painted surfaces. Finally, it is important to understand how capabilities among various LBP testing technologies would be affected under a possible revision to the definition, such as field portable X-ray fluorescent devices which are the primary tools for lead inspections and risk assessments. They are calibrated to the current definition of LBP, and so EPA needs to fully understand the repercussions such a revision to the definition may have on these portable field technologies to ensure the technological feasibility.

EPA plans to sponsor a technical workshop to obtain additional information needed to address data gaps related to the definition of LBP that were outlined in the 2019 DLHS Rule. In preparation for the LBP technical workshop, the Agency performed a literature review for sources relevant to the definition of LBP, consulted other Federal agencies, and refreshed materials done for the 2019 rulemaking. With this information the data gaps have been refined to add further specificity, which allows for a more targeted scope for both continued investigation and for the technical workshop. The more specific data gaps that EPA continues to investigate include empirical data on the relationship between low levels of lead in paint and dust-lead, as well as data on the common exposure scenarios that may inform this relationship (for example, dust-lead generation during a renovation scenario versus slowly deteriorating paint). Currently the available empirical data and modeling approaches for estimating the relationship between lead content in on-the-wall paint and lead in related environmental media, including dust, are applicable at or above the current LBP definition. EPA believes that to use the available empirical data and modeling approaches to estimate dust-lead loadings at low levels of lead in paint (particularly levels that are lower than the current definition by an order of magnitude or more) will introduce significant uncertainty to any estimations. Data and models applicable to lower levels of lead in paint are needed to develop an approach to estimate dust-lead from low levels of lead in paint, which will allow EPA to estimate incremental blood lead changes and associated health effect changes that may occur due to low levels of lead in paint. For the ingestion exposure pathway, EPA is exploring possible modeling solutions as well as seeking quantitative measures of ingestion and exposure (such as data on duration and frequency of consumption, and common paint chip characteristics). Studies on this subject have documented this behavior as a risk factor for exposure to lead from LBP, however the studies have not provided quantitative estimates of paint ingestion, which are needed to quantify exposure. Lastly, EPA continues to investigate constraints to the field measurement options for low levels of lead in paint. Different technologies have different limitations in accuracy, processing time, detection limits, accessibility, and destructiveness among other factors. These practical considerations are important to consider in understanding how a change in the definition may affect the ability of the regulated community to use certain technologies, potentially impacting the residents of target housing and occupants of COFs. On top of these data gaps, EPA is exploring the relationship between the two different units used in the current definition (milligram per square centimeter and percent by weight) to inform whether and how to develop a conversion between the two. The search for relevant information to develop the conversion and exploration of the uncertainty involved with such a conversion is underway. EPA intends the technical workshop to explore these issues and position the Agency to reconsider the definition of LBP in light of the most current scientific information. EPA will collaborate with HUD on the technical workshop regarding these lead-based paint definition data needs.

Similar to the SLHS rulemaking, due to resource considerations and EPA's interest in acting as expeditiously as possible to revise the DLHS and DLCL and to hold the aforementioned LBP technical workshop, EPA will address the definition of lead-based paint in a separate rulemaking. EPA has listed this rulemaking on the definition of LBP in the Spring 2023 Unified Agenda of Regulatory and Deregulatory Actions under RIN 2070–AL11 as a long-term action, indicating the Agency's commitment to meet the statutory requirement of addressing the definition of LBP revision but that the Agency does not expect to propose this action in the next 12 months (Ref. 33).

Rulemakings such as those necessary for revisions to SLHS and the definition of LBP are complex, highly resource-intensive activities that usually occur as part of options development and decision-making. A rulemaking's development generally entails scientific, economic, legal, and other technical analyses. For many rulemakings, this includes research and data gathering, which itself can sometimes necessitate exercising other information collection tools and following appropriate procedural requirements (*e.g.,* Paperwork Reduction Act). To develop a rulemaking, EPA also often consults with governments and key stakeholders. Federal law may require such consultations based on anticipated regulatory impacts (*e.g.,* the Unfunded Mandates Reform Act and the Regulatory Flexibility Act). Additionally, various executive orders may also require the Agency to engage in such consultations.

A rulemaking package often requires the development of complex supporting documents including an EA and a TSD, similar to those included alongside this reconsideration rulemaking (Refs. 14 and 16). A complete TSD includes several components which may require internal and external stakeholder dialogue and scientific peer review, including model and input data revisions, health and exposure metrics of interest, environmental fate and exposure mechanisms for either soil or the definition of LBP, characterization of uncertainties in modeling, and literature reviews (which have not been done for soil since before the 2001 LBP Rule was finalized). If existing models and analytical methods are insufficient to conduct the analysis to support the rulemaking, then they must be developed as part of the technical work done in support of the rulemaking effort. Developing new models can take a considerable length of time and novel analyses may require peer-review, further extending the rulemaking timeline. The magnitude and effort of an SLHS TSD would mirror previous DLHS and DLCL TSDs; see the technical documents prepared in support of the 2019 DLHS Final Rule, the 2021 DLCL Final Rule, or this reconsideration rulemaking (Refs. 16, 19, and 34).

An EA includes various components such as a description of the need for Federal regulation; a profile of affected industries and populations; an overview of existing Federal, state and local regulations; a specification of the baseline state of the world and estimate of the number of events affected by the regulation; thorough analysis on the consequences of regulatory policy being considered and how regulated entities will respond; quantification and monetization of the regulation's costs, benefits, and net benefits; a description of unquantified or qualitative benefit descriptions; and an assessment of uncertainty surrounding estimates. An EA also includes various additional analyses related to statutory compliance and Executive orders, including but not limited to RFA/SBREFA (Small Business Impacts), UMRA (Unfunded State, Local, or Tribal Mandates), PRA (Paperwork Reduction), Executive Order 12898 (Environmental Justice), Executive Order 13045 (Protection of Children), Executive Order 13132 (Federalism), Executive Order 13175 (Coordination with Tribal Governments), and Executive Order 13211 (Energy Effects). A rulemaking also involves preparing **Federal Register** documents to present, generally, the preamble to and regulatory text of the proposed and final rule. Such published documents reflect the culmination of the development and review of the complex supporting documents and the resulting decision-making, which includes internal steps at the Agency to reach office wide agreement, as well as external to the Agency, such as holding potential public consultations, completing interagency review and convening a Small Business Advocacy Review (SBAR) Panel as necessary. These processes can also take many months or years. The proposed and final rules also present statutory and Executive Order review analyses. The Agency may also need to publish **Federal Register** documents to extend or reopen public comment periods—or even to announce new public comment periods related to a Notice of Data Availability or a supplemental Notice of Proposed Rulemaking—should new information become available, or the Agency determine that it needs to alter its proposal before taking final action.

The current rulemaking on the DLHS and DLCL is one more step toward complete implementation of TSCA Title IV. Given existing resource constraints and the additional complications for the SLHS and the definition of LBP discussed earlier in this section, EPA does not believe that either the SLHS or the definition of LBP could have been reconsidered on this current rulemaking's timeline. Instead, EPA will reconsider the SLHS and the definition of LBP as important next steps. Courts ''have recognized that, under the 'pragmatic' one-step-at-a-time doctrine, 'agencies have great discretion to treat a problem partially' and 'regulat[e] in a piecemeal fashion.' '' *Transportation Div. of the Int'l Ass'n of Sheet Metal, Air, Rail & Transportation Workers* v. *Fed. R.R. Admin.,* 10 F.4th 869, 875 (D.C. Cir. 2021) (quoting *Ctr. for Biological Diversity* v. *EPA,* 722 F.3d 401, 409–10 (D.C. Cir. 2013)); *cf. Massachusetts* v. *EPA,* 549 U.S. 497, 524 (2007) (recognizing that ''[a]gencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop''). EPA intends to conduct rulemakings on the SLHS and the definition of LBP, as identified in the Spring 2023 Unified Agenda of Regulatory and Deregulatory Actions, to address the issues identified by the Ninth Circuit in its May 2021 opinion (Refs. 11 and 33).

III. Technical Analyses

In its evaluation of options for reconsidering the DLHS and DLCL, EPA estimated children's BLL and associated IQ decrements. Estimated BLL and IQ decrements provide the means to quantify the effects that long-term exposure to the analyzed dust-lead loading levels can have on young children. The TSD (Ref. 16) and EA (Ref. 14) accompanying this proposed rulemaking estimated the expected impacts of the candidate DLHS and DLCL options on BLLs and associated IQ decrements of exposed children in target housing. See Unit IV. on the approaches for developing the options for DLHS and DLCL.

The TSD uses both mechanistic and empirical models to predict the possible BLLs of children in target housing exposed to homogenous candidate values for dust-lead levels (*e.g.,* candidate options for the DLHS) and characterizes the probabilistic variability due to biological response and variation in other sources of lead exposure at each possible candidate dust-lead level. The first approach used mechanistic modeling that includes use of age-specific ingestion rates, activity patterns, and background exposures. The second approach used empirical data that includes co-reported dust-lead and BLL measurements in the homes of children; these dust-lead and BLL data are used to develop an empirical relationship to estimate BLLs for each candidate dust-lead level. Both approaches (mechanistic and empirical) are compared to increase our confidence in the estimates of the relationship between dust-lead loadings and BLL (Section 6.3 of the TSD). The various components of the model and input parameters used in this rulemaking have been the subject of multiple Science Advisory Board Reviews, workshops and publications in the peer reviewed literature focused on dust-lead (Refs. 18, 35, 36, 37, 38, and 39). Specifically, the mechanistic blood lead modeling for this rulemaking reflects the application of an extensively peer-reviewed model by EPA (the Stochastic Human Exposure and Dose Simulation—Integrated Exposure Uptake Biokinetic model coded in R, referred to as R–SHEDS–IEUBK) using updated data sources and tailored to the dust-lead target housing scenario, described in depth in Appendix E of the TSD.

Detailed discussion of the limitations and uncertainties in blood lead modeling at the low BLL and exposure levels considered for this rulemaking can be found in Section 8 of the TSD (Ref. 16). In brief, IEUBK, as a standalone biokinetic model, was evaluated for performance in groups for which the geometric mean BLL is as low as 2.3 µg/dL. Some of the groups at the lowest levels of dust lead exposure modeled for this rulemaking had mean estimated BLL lower than this value (between 0.81 and 1.12 µg/dL depending upon age), which are outside the range for which the underlying biokinetic model (IEUBK) was evaluated. In order to address this concern, EPA conducted an evaluation of the R–SHEDS–IEUBK model used in this analysis with a dataset for which the geometric mean BLL in children aged 1 to 2 years old is 1.09 µg/dL. This evaluation found that the R–SHEDS–IEUBK model had good agreement with the reference dataset at low percentiles, as well as at the median and at the 95th percentile. See Table 8–2 and Appendix D in the TSD (Ref. 16).

In contrast to the TSD, which estimates the health risk and exposure associated with dust-lead loading candidates for a hypothetical subpopulation of children in target housing without consideration to how many children are actually affected by the rule, the EA estimates benefits that accrue to only the subpopulation which would be impacted by the DLHS and DLCL revisions. Rather than assuming all households living in target housing are impacted by the regulatory change, the EA instead estimates benefits solely for instances when dust-lead levels would be tested. These instances of dust wipe testing are henceforth referred to as ''triggering events.'' For the subpopulation of children who are affected by these events, the EA estimates quantified benefits from avoided IQ losses. The EA uses real world data to characterize (1) variability in the housing stock that is affected, (2) how surface-by-surface dust-lead loadings change due to the DLHS/DLCL, (3) the number of children living in affected housing units, and (4) resultant changes in BLLs and IQ that are expected. In modeling the relationships between dust-lead loadings and BLL/IQ, the EA presents results based on both the empirical and mechanistic approaches laid out in the TSD. EPA considered several methods to impute the relationship between BLL and IQ below the lowest BLLs observed in the underlying empirical data, and a range of IQ loss results based on the methods considered are presented in the EA (see TSD section 5 and EA section 6.4). The IQ loss estimates presented in Unit IV. and in Section 7 of the TSD result from a linearization method, which resulted in the most conservative estimates of IQ loss.

Both the TSD and the EA present probabilistic distributions of estimated change in BLL or IQ decrement for young children up to the age of six. However, these distributions represent subpopulations of exposed children characterized in differing ways. The TSD presents the expected response for a hypothetical exposure, accounting for varying sources of background exposure (*e.g.,* food, soil, water) and biological variability. The EA estimates expected results from triggering events, recognizing exposure to the hypothetical conditions in the TSD are rare as dust-lead levels across target housing are generally quite low and existing abatements/interim controls typically overshoot the clearance levels considerably. Thus, the distributions of BLLs and IQ decrements presented in the TSD represent the impact of children's exposures to hypothetical dust-lead levels while the EA estimates distributions of BLLs and IQ decrements across all children living in housing that would be directly impacted by this proposed rule.

The analyses that EPA developed and presented in the TSD and EA for this rule were specifically designed to estimate BLLs and associated effects on IQ that might accrue to the subpopulation, *i.e.,* children living in pre-1978 housing. EPA notes that its different program offices estimate exposures for different populations, different media, and under different statutory requirements and thus different models or parameters may be a better fit for their purposes. As such, the approach and modeling parameters chosen for this rulemaking should not necessarily be construed as appropriate for, or consistent with, those of other EPA programs.

IV. Proposed Rule

As explained in Unit II.E., the 2021 Court Opinion of the U.S. Court of Appeals for the Ninth Circuit held that EPA must reconsider the DLHS in conjunction with the DLCL (Ref. 11). Accordingly, EPA is proposing to change the DLHS from 10 µg/ft^2 and 100 µg/ft^2 for floors and window sills to a non-numeric value called GTZ or any reportable level of dust-lead analyzed by an NLLAP-recognized laboratory. Lowering the DLHS (independent of the DLCL revisions) provides the regulatory benefit of additional disclosure of LBP hazards in target housing and COFs. This results in an estimated increase in individuals who are aware of the presence of dust-lead and the various actions that can be taken to minimize dust-lead hazards and take actions to protect themselves from exposure. See Unit IV.A.1. for additional information describing the proposed DLHS of ''any reportable level.'' EPA is also proposing to revise the DLCL from 10 µg/ft^2, 100 µg/ft^2 and 400 µg/ft^2 for floors, window sills, and troughs to 3 µg/ft^2, 20 µg/ft^2, and 25 µg/ft^2, and requesting comment on an alternative DLCL option of 5 µg/ft^2, 40 µg/ft^2, and 100 µg/ft^2.

A. Dust-Lead Hazard Standards Approach

In the 2001 LBP Hazards Rule EPA discussed the dilemma the Agency faced when establishing a dust-lead hazard, especially the challenges associated with choosing ''which [BLLs] are truly hazardous'' and how to interpret the statutory criteria from TSCA Section 401 (*i.e.,* ''would result in adverse human health effects'' (15 U.S.C. 2681(10)) given the uncertainties that existed (Ref. 6). As a result, EPA took a pragmatic approach to setting the DLHS and focused on the potential for risk reduction, cost-benefit balancing and other relevant factors, establishing the standards at 40 µg/ft^2 and 250 µg/ft^2 for floors and sills, respectively. As an aside, at that time the Agency did not establish a DLHS for troughs as it found that window sills and troughs were highly correlated and concluded that testing both surfaces would not improve a risk assessor's ability to characterize risk. Building off the precedent established in 2001, the 2019 DLHS Rule ''evaluated the relationship between dust-lead levels and children's health, and . . . the application of those standards in lead risk reduction programs.'' In addition, when establishing the 2019 DLHS, EPA also assessed laboratory capabilities, resources for addressing LBP hazards and consistency across the Federal Government (Ref. 2). At that time EPA reasonably believed it had the discretion to set the DLHS based on both risk reduction and whether the standards were achievable, especially given the existing programs in place to reduce LBP hazards and revised the DLHS to 10 µg/ft^2 and 100 µg/ft^2 for floors and sills, respectively (Ref. 2).

Ultimately, the 2021 Court Opinion, which is discussed in Unit II.E., led EPA to undertake a major shift in its approach to residential LBP hazard control and the LBP activities program because the Opinion found that EPA did not have the authority, when setting the DLHS, to consider non-health factors (*e.g.,* laboratory capabilities, resources for addressing LBP hazards, consistency across the Federal Government, or cost-benefit balancing). Consistent with the 2021 Court Opinion, EPA is proposing to revise the DLHS in this rulemaking based only on health considerations. EPA intends health-only considerations in this DLHS context to refer to the effects of lead on health after exposure to dust-lead loadings, considering the statutory definition's focus on ''any condition that causes exposure to lead from lead-contaminated dust . . . that would result in adverse human health effects'' (15 U.S.C. 2681(10)). These health-only considerations do not include broader public health concerns (such as health trade-offs and policy impacts on public housing).

1. Rationale for Selecting the Proposed DLHS

EPA is proposing a non-numeric DLHS that is any reportable level of dust-lead for floors and window sills as analyzed by an NLLAP-recognized laboratory. Proposing a DLHS for floors and window sills only, is consistent with current practice and regulatory history which has not included a hazard standard specifically for troughs.

''Reportable level'' is not defined in EPA's 40 CFR 745 or EPA's current guidance for NLLAP-recognized laboratories, titled Laboratory Quality System Requirements (or LQSR 3.0). EPA is proposing to define ''reportable level'' in the regulations to mean the lowest analyte concentration (or amount) that does not contain a ''less than'' qualifier and that is reported with confidence for a specific method by an NLLAP-recognized laboratory. In other words, EPA interprets ''any reportable level'' of dust-lead to be any level greater than or equal to the lowest value a laboratory can reliably report to a client or the regulated community (*i.e.,* any reportable level of dust-lead in a laboratory sample result report that does not contain a ''less than'' (''<'') qualifier).

Under the LQSR, an NLLAP-recognized laboratory must demonstrate it can achieve a quantitation limit equal to or less than 50% of the lowest action level for dust wipe samples (more discussion on the ''action level'' is found in Unit IV.A.1.c). In addition, a report of zero concentration is not permitted and laboratories must establish a method of limiting the lower reported values to a positive finite lead level that is appropriate for the technology being used. Measured lead levels below this positive finite value must be reported with a qualifier ''less than'' (''<'') this positive finite value (Ref. 29).

Based on these current minimum standards for NLLAP-recognized laboratories and previous laboratory stakeholder input, EPA expects that the lowest reportable level will be equivalent to the laboratory's quantitation limit in some cases, but could be lower depending on laboratory capabilities. Ultimately, the proposed DLHS of ''any reportable level'' is not dependent on the DLCL or quantitation limit, but rather is based on the capabilities of individual laboratories. EPA is requesting comment on the appropriateness of this interpretation and of the proposed definition of ''reportable level.''

EPA refers to this non-numeric DLHS approach as GTZ. Given the statutory language in TSCA Section 401 that defines what a ''LBP hazard'' is (*i.e.,* as conditions of LBP and lead-contaminated dust and soil that ''would result in adverse human health effects''), EPA believes that it cannot set the DLHS at zero because zero does not identify a level of exposure to dust-lead loadings that would cause adverse health effects. Rather EPA believes the proposed standard of ''any reportable level'' is an appropriate DLHS based on dust-lead exposure related health factors only, and in accordance with the 2021 Court Opinion by taking into consideration the modeling data outlined in TSD and the current state of the science on lead exposure and children's BLL. The proposed GTZ approach represents a shift in the LBP activities program to a more inclusive and protective DLHS, compared to the current 2019 and 2021 levels. If finalized as proposed, the GTZ approach will be inclusive of any reportable level of dust-lead and will not distinguish between severe, less severe, or negligible risks.

As discussed further in Unit IV.A.2 *Other DLHS Options EPA Considered,* two other approaches were also considered for revising the DLHS, including a numeric standard based entirely on the modeling data laid out in the TSD (summarized in TSD Table 2–2), and an approach that would use the background dust-lead levels of housing built in or after 1978 (called post-1977 background). EPA seeks comment on its proposed and potential alternative approaches to updating the DLHS.

a. GTZ Rationale: Modeled Discussion

The GTZ approach is primarily supported by the modeling results provided in the TSD and discussed further in Unit IV.A.3. In the TSD (which is introduced in Unit III) EPA estimated BLL and related changes in IQ (a measure of cognitive function) in young children. The results show that as dust-lead levels in housing decrease below the current standard (*i.e.,* 10 µg/ft^2 and 100 µg/ft^2 for floors and window sills), so do children's BLL and IQ decrement from lead exposure. When modeling GTZ, EPA used estimated dust-lead loadings ranging from 0.7 to 2.2 µg/ft^2 for floors and 0.8 to 4.4 µg/ft^2 for window sills. These are assumed values for a GTZ DLHS paired with the proposed or alternative DLCL, and account for the lower reporting thresholds that EPA estimates laboratories will realistically attain under this proposal. EPA collected information on real-world laboratory reporting limits from stakeholder outreach conversations as well as publicly available sources. GTZ values listed above are based on the average of reporting limits at laboratories that currently report numeric dust wipe loadings at levels 50% below the proposed DLCL options. For the details of these calculations, see Sections 4.1 and 2.4.6 of the EA (Ref. 14). EPA also used a hypothetical dust-lead loading value of zero. Details about how the TSD results are interpreted are described in Unit IV.A.2., and the modeled results themselves, which are supportive of the GTZ approach, are described in Unit IV.A.3.

b. GTZ Rationale: No Threshold Has Been Identified

According to TSCA Title IV, the DLHS should identify the level of dust-lead exposure that ''would result in adverse human health effects'' (15 U.S.C. 2681(10)). GTZ is a more protective approach compared to the current regulatory landscape and all the options that were considered for this rulemaking (except post-77 background). GTZ also acknowledges that the current state of scientific evidence does not identify a BLL threshold below which there is no association of adverse effects on children's cognition. Depending on the exposure and other factors, the effects on IQ associated with childhood lead exposure may persist into adolescence and adulthood (Refs. 4 and 8). EPA also favored such an approach for the DLHS under TSCA Title IV in part because a more protective approach to DLHS, such as GTZ, aligns with the Congressional purpose for disclosure elsewhere under Title X (notably, as implemented in the Lead Disclosure Rule) and because Congress used the word ''hazard'' in the ''lead-based paint hazard'' term, even though the definition uses more risk-like language by introducing consideration of the level of *exposure* that would result in adverse health effects.

EPA's 2013 Lead ISA stated that harmful effects on children's cognition as measured by IQ were observed in groups with mean BLLs as low as 2 µg/dL, and further that despite there being some uncertainty in epidemiological studies on lead exposure and BLLs (especially for older children and adults) that ''A threshold for cognitive function decrements is not discernable from the available evidence (*i.e.,* examination of early childhood blood Pb or concurrent blood Pb in the range of <1 to 10 µg/dL).'' (Ref. 4)). This statement was based on a synthesis of the extensive literature examining the relationship between BLL and cognitive function, including a landmark pooled cohort study meta-analysis by Lanphear et al. (Refs. 40 and 41), the results of which have been confirmed by repeated re-analysis (Refs. 42 and 43). While the 2013 ISA went on to state that ''the current evidence does not preclude the possibility of a threshold for neurodevelopmental effects in children existing with lower blood levels than those currently examined'', the Federal Lead Action Plan articulated the U.S. Government position that ''no safe blood lead level in children has been identified.'' (Ref. 9). Further, the analysis that supports this rule examined the 95th percentile of children's modeled BLLs and the associated IQ losses (Ref. 16), which for all options considered is at or above the group mean BLLs for which IQ loss is observed in the literature examined in the ISA (Ref. 4 and 16).

EPA understands the limitations of the epidemiological analyses, the lack of scientific studies evaluating low BLLs and acknowledges that a threshold could exist that is currently unidentified; but ultimately in its assessment of the available scientific research findings in the 2013 ISA for lead, the Agency observed that there is no evidence of a threshold below which there are no harmful health effects from lead exposure. EPA continues to acknowledge the aforementioned uncertainties and notes that science is constantly evolving and, as additional data become available (*e.g.,* exposure and health impacts), then EPA may undertake a new rulemaking to propose changing the standards in the future to reflect any new data or information about an acceptable threshold of effects on cognition in children.

Additionally, the Centers for Disease Control and Prevention (CDC) acknowledges that ''[s]cientific evidence suggests that there is no known safe [BLL], because even small amounts of lead can be harmful to a child's developing brain'' (Ref. 44). When the original DLHS and DLCL were proposed and finalized in 1998 and 2001 the CDC had set a ''level of concern'' for children's BLL at ≥10 µg/dL (Refs. 45 and 46). In 1991, when that level was established as a level that should prompt public health actions, the CDC concurrently recognized that a BLL of 10 µg/dL did not define a threshold for the harmful effects of lead (Ref. 45). One goal for the level was that ''all lead poisoning prevention activities should be to reduce children's BLLs below 10 µg/dL'' (Ref. 45). Accordingly, in the 1998 proposal EPA stated that, ''[a]lthough the scientific community has not been able to identify a threshold of exposure below which adverse health effects do not occur, the evidence of health effects below 10 µg/dL is not sufficiently strong to warrant concern'' (Ref. 47). In the final rule in 2001, EPA determined the lowest candidate DLHS by using a 1 to 5% probability of an individual child developing a BLL of 10 µg/dL (Ref. 6).

In the 2019 DLHS Rule, EPA recognized that ''[a]lthough health risks to young children decrease with decreasing dust-lead levels, no non-zero lead level, including background levels, can be shown to eliminate health risk entirely.'' At that time, EPA also recognized the CDC's 2012 decision to discontinue its use of a 10 µg/dL blood lead ''level of concern'' and to introduce a population-based blood lead reference value (BLRV) to identify children exposed to more lead than most other children in the United States (Ref. 48). The BLRV represents the 97.5th percentile of the U.S. population BLL distribution in children ages 1 to 5 from the National Health and Nutrition Examination Surveys (NHANES). This means that by definition 2.5 percent of children ages 1 to 5 in the NHANES survey have a BLL greater than the BLRV. This metric was established in part because ''no safe blood lead level in children ha[d] been identified,'' (Ref. 48). In 2012 the BLRV was 5 µg/dL, based on young children's BLL in the 2007–2010 NHANES, and in 2021 it was lowered to 3.5 µg/dL based on the children's lower BLLs observed in the 2015–2018 NHANES (Ref. 46). The BLRV is not based on a health endpoint, but rather is a statistical point in the distribution of children's BLLs in the U.S. used as a screening tool to identify children who have higher levels of lead in their blood compared with most children.

Establishing a health-based only standard for dust-lead hazard, as well as clearance levels that consider other factors (*i.e.,* take into account reliability, effectiveness, and safety), is similar to EPA's implementation of some other programs governing lead exposure. For example, under the Safe Drinking Water Act (SDWA), EPA is required to establish a maximum contaminant level goal (MCLG) at a level at which, in the Administrator's judgement, ''no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety.'' Section 1412(b)(4). EPA established a health-based MCLG of zero for lead in drinking water. National Primary Drinking Water Regulations include either an enforceable maximum contaminant level (MCL) or treatment technique requirements, EPA can set a treatment technique requirement in lieu of an MCL if ''it is not economically or technologically feasible to ascertain the level of the contaminant.'' SDWA Section 1412(b)(7)(A). In addition to the MCLG, EPA established treatment technique requirements for lead taking into account several factors (56 FR 26460). Unlike many other drinking water contaminants, lead is generally not present in source water but enters drinking water from corrosion of plumbing materials that contain lead including lead service lines and premise plumbing. Occurrence of lead in drinking water is variable within a system and across systems due to factors such as amount of lead in any individual site's plumbing, physical and chemical characteristics of the water, and consumer use patterns. Additionally, sources of lead can be beyond the control of the water system to replace, such as premise plumbing. Water systems can adjust or add treatment to control the corrosivity of the water to reduce lead leaching from lead pipes and premise plumbing. EPA is required to consider technical feasibility and costs when establishing the treatment technique, which is analogous to EPA's development of the clearance levels that also include non-health-based factors. Under EPA's treatment technique rule for lead in drinking water, EPA established a non-health-based action level which, if exceeded, requires water systems to take actions to reduce elevated levels of lead in drinking water.

Because of the 2021 Court Opinion remanding the DLHS for reconsideration based only on health factors, the results of the analysis in the TSD, and the lack of a discernible threshold in the evidence for the association of blood lead with harmful effects on cognition in young children, EPA proposes to change the DLHS to any reportable level of lead analyzed by an NLLAP-recognized laboratory.

c. LQSR Action Level

Given that GTZ is a non-numeric value, if finalized as proposed, the DLCL, rather than the DLHS, would become the ''action level'' as described in the Laboratory Quality System Requirements (LQSR 3.0), as well as for when a risk assessor would recommend an abatement (see Unit IV.D. for more information on EPA's proposed change to the definition of abatement). According to the current LQSR, NLLAP-recognized laboratories that analyze dust wipe samples for lead must show that they can achieve a quantitation limit ''equal to or less than . . . 50% of the lowest action level [*i.e.,* regulatory limit] for dust wipe samples'' (Ref. 29). The quantitation limit must also be ''at least 2 times but no greater than 10 times the method detection limit'' (Ref. 29). Therefore, due to the non-numeric nature of the proposed DLHS of ''any reportable level,'' these current testing requirements will rely on the numerical DLCL to establish the quantitation limit that any laboratory (that wishes to maintain or obtain NLLAP recognition) must be able to demonstrate. Note however, that the proposed DLHS of ''any reportable level'' is still considered distinct from the DLCL and the quantitation limit.

2. Other DLHS Approaches EPA Considered

EPA considered two other approaches for revising the DLHS: a numeric standard based on the probability of exceedance of one or more IQ or BLL metrics as determined by the Agency, and an approach that would use the background dust-lead levels of housing built in 1978 and beyond as the DLHS (known as ''post-1977 background''). The three approaches (*i.e.,* GTZ, numeric standard, and post-1977 background) take different analytical paths to revising the DLHS based only on health considerations. EPA is proposing the GTZ approach, given the discussion laid out in Unit IV.A.1. but welcomes comment on the other two approaches outlined in both the preamble and in the TSD (Ref. 16).

a. Numeric Standard Approach

In addition to the GTZ approach, EPA also explored a ''numeric standard'' approach, meaning that the Agency would propose a numerical DLHS with a rationale based solely on the interpretation of the TSD results. To do so, the Agency would need to establish a health or exposure metric of interest (*i.e.,* target BLL or IQ change) that would be acceptably protective of human health. Estimated BLL and IQ decrements in children exposed to hypothetical dust-lead loading values are included in the TSD for every DLHS candidate considered for all three approaches (*i.e.,* GTZ, numeric standard and post-1977 background), as well as the primary and alternative DLCL options. These values are estimated to help EPA analyze the impacts of this proposed rulemaking on the health (*i.e.,* IQ decrement) and dust-lead exposure of the subpopulation in question (*i.e.,* young children in pre-1978 buildings and COFs) and to inform a costs and benefits analysis in the EA.

In 2001 and 2019, EPA expressed the challenges of meeting the statutory criterion for defining an LBP hazard (15 U.S.C. 2681(10)) because it requires EPA to choose a cutoff for when unacceptable risk exists. EPA noted in 2001, even if the science and environmental-lead prevalence data were perfect, there would likely be no agreement on the level, or certainty, of risk that is envisioned in the phrase ''would result in adverse human health effects.'' Thus, EPA explained that it ''would not be appropriate to base a [LBP] hazard standard on any specific probability of exceeding any specific [BLL].'' (Refs. 2 and 6). EPA continues to agree with the challenges highlighted in 2001 and 2019.

When choosing health or exposure metrics to evaluate the DLHS approaches based on the TSD results, the Agency has considered three factors: (1) the CDC's BLRV (which is a not a health-based end point but rather is a statistical measure of relative exposure), (2) responsiveness to feedback received previously from various scientific bodies, and (3) Agency precedent. The TSD considers BLL and IQ changes in two ways: relative to aggregate/total lead exposure (which includes exposure from other media: soil, diet, water, and air in addition to dust) and relative to incremental/dust-only lead exposure (Ref. 16). For example, in 2001 the lowest DLHS candidate was identified by using a 1 to 5% probability of an individual child developing a BLL of 10 μg/dL (Ref. 6), which represented total BLL, inclusive of exposure to lead through other media.

In the TSD analyses for this proposal, EPA compared BLL in young children, with an emphasis on 2-year-old children because this is the age of greatest modeled exposure, from aggregate or total exposure from all media (*i.e.,* dust, soil, diet, water, and air) to the CDC BLRV of 3.5 μg/dL. This BLL value is not-health based and does not represent a toxicity threshold (and is subject to change over time, since the CDC BLRV changes as the BLLs in the population change); however, CDC explains that it can still be used as a tool to '' (1) help determine whether medical or environmental follow-up actions should be initiated for an individual child and (2) prioritize communities with the most need for primary prevention of exposure and evaluate the effectiveness of prevention efforts'' (Ref. 46). Importantly, even at zero dust-lead, children are already estimated to have a 5.7% probability of exceeding the BLRV given the impact of background lead exposures from other media (*e.g.,* soil, diet, water, and air) (Ref. 16).

TABLE 1—PERCENT EXCEEDANCE VALUES FOR ZERO, AGE: 2 YR OLD (30 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total BLL >3.5 µg/dL	Total BLL >5 µg/dL	Dust only BLL >1 µg/dL	Dust only BLL >2.5 µg/dL
Zero [1]	0	0	5.7%	2.2%	0.0%	0.0%

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

In 2011, EPA's Scientific Advisory Board (SAB) and in 2012 the Children's Health Protection Advisory Committee (CHPAC) both expressed support for an incremental BLL approach that focuses on dust-lead exposure only. In 2011 SAB reviewed EPA's *Approach for Developing Lead Dust Hazard Standards for Residences (November 2010 Draft)* and *Approach for Developing Lead Dust Hazard Standards for Public and Commercial Buildings (November 2010 Draft)* and provided feedback that there are several key advantages to the incremental approach (*e.g.,* reducing uncertainty from estimating exposures from other media) and provided that a change in BLL ''of 1 or 2 µg/dL at the 90th percentile'' could be an example of a target risk level. Similarly, CHPAC expressed support for using an incremental approach and preferred levels such that an adverse change in BLL is ''no greater than 1 or 2.5 µg/dL'' (Ref. 49).

As a result, EPA also estimated what dust-lead levels (considering only the dust-lead component in the multi-media exposure modeling) would result in incremental BLL change ranging between 1 and 2.5 µg/dL based on exposure assumptions described in the TSD (Ref. 16).

For this reconsideration rulemaking the Agency considered the estimated total/aggregate IQ change (*i.e.,* the estimated total or aggregate IQ change from modeled BLL including all modeled sources of lead exposure) at age six and compared it to a threshold of 1 to 2 points. IQ changes due to background exposures to lead in other media (*e.g.,* soil, diet, water, and air) are estimated to already have a 48.7% probability to exceed 2 points for children in target housing without also considering additional dust-lead exposure (Ref. 16).

TABLE 2—PERCENT EXCEEDANCE VALUES FOR ZERO, AGE: 6 YR OLD (72 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total IQ >1pt	Total IQ >2pt	Dust only IQ >1pt	Dust only IQ >2pt
Zero [1]	0	0	88.9%	48.7%	0.0%	0.0%

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

In addition to total/aggregate IQ change, EPA determined BLLs that were estimated to result in an incremental loss of 1 to 2 IQ points from exposure to only dust-lead (*i.e.,* exclusive of lead in other media such as soil, diet, water, and air). This metric is explicitly health-based, in that it is an estimated health effect. There is EPA precedence for using the metric of an incremental change in IQ with a range of values of 1 to 2 points to inform national standards decisions. This includes the 2008 and 2016 decisions on the primary national ambient air quality standard (NAAQS) for lead, which was informed by consideration of air-related IQ decrement estimates based on an evidence-based framework, with a focus on the at-risk subpopulation of children living near sources who are likely to be most highly exposed (Ref. 50). In their review of various technical documents supporting both the 2008 and 2016 NAAQS reviews, the Clean Air Scientific Advisory Committee (CASAC) supported using an incremental 1 to 2 point IQ decrement approach for consideration during development of the air standard (Refs. 50 and 51).

As reported in the TSD, EPA evaluated several numeric DLHS candidates that the Agency thought were appropriate given the health and exposure metrics of interest, and the uncertainty of the model at low loading values. The numeric DLHS candidates were 1/10 µg/ft² (*i.e.,* 1 µg/ft² for floors and 10 µg/ft² for sills), 2/20 µg/ft², 3/30 µg/ft², and 5/40 µg/ft² and those values were compared to the specified BLL and IQ metrics to estimate the probability of exceeding the BLL or IQ targets. For example, a 2-year-old living in pre-1978 housing exposed to 3 µg/ft² on floors and 30 µg/ft² on window sills would have a 4.8% probability of exceeding, for example, 5 total µg/dL BLL. Under this numeric standard approach, EPA would plan to use the threshold of 5% probability of exceedance for a child from the sub-population of interest (*i.e.,* young children living in pre-1978 housing and COFs). This is similar to the 1 to 5% probability that was used in 2001 for the lowest DLHS candidate (Ref. 6).

Due to the aforementioned complexities with identifying a cutoff of risk or specific IQ/BLL metrics of interest that would be acceptable for purposes of setting the DLHS, as well as the reasons for favoring GTZ, EPA is not proposing the numeric standard approach for the DLHS as the Agency's preferred option. For specific discussion on the modeled numeric DLHS candidates and IQ/BLL metrics, see Unit IV.A.3. EPA welcomes comment on this numeric standard approach including the IQ/BLL metrics under consideration (*i.e.,* the target values of interest) and the use of a 5% probability of exceedance.

b. Post-1977 Background Approach

EPA also considered an approach to revise the DLHS that would align target housing dust-lead levels with dust-lead levels in housing built after lead-based paint was banned. This approach would result in lowering the DLHS to the dust-lead background levels of housing built after 1977 (known as ''post-1977 background''), which are presumably not from LBP. In 1978, the CPSC banned lead in paint and similar surface-coating materials for consumer use in excess of 0.06% and revised the level in 2009 to 0.009% following the Consumer Product Safety Improvement Act of

2008 (Pub. L. 110–314). As a result of CPSC's 1978 lead paint ban, the focus of EPA's LBP activities program is target housing which includes most pre-1978 housing and COFs.

Post-1977 background dust-lead values were calculated from a weighted geometric mean of the dust-lead loadings from the American Healthy Homes Survey II and were found to be 0.2 µg/ft² for floors and 0.8 µg/ft² for window sills (Refs. 14 and 52). Setting the DLHS at the post-1977 background dust-lead levels would allow EPA to focus on dust-lead hazards above what is expected in housing without LBP (*i.e.,* after CPSC established a maximum level of lead in paint for consumer products, including home paints). Establishing DLHS for target housing and COFs in this way, using post-1977 background dust-lead levels, would address disparities in the dust-lead levels that children in target housing may be exposed to and the corresponding disparate health risks. This approach would also align with the focus of Title X on lead hazards in housing constructed before 1978. Using this approach, DLHS would be established at 0.2 µg/ft² for floors and 0.8 µg/ft² for window sills as the dust-lead levels that would result in adverse human health effects. However, there are questions about whether the post-1977 background approach would as directly address the 2021 Court Opinion as the GTZ approach. Due to those concerns and the reasons for favoring GTZ, EPA is not proposing the post-1977 background approach for the DLHS as the Agency's preferred option.

As statistical points in a distribution of environmental data, the calculation of the average background value is highly influenced by the way in which data/measurements below the analytical detection limit are treated. Further discussion on deriving these candidates can be found in the TSD Section 2.3. The TSD models the health and exposure outcomes based on these candidate DLHS of 0.2 µg/ft² for floors and 0.8 µg/ft² for window sills, as described in Unit IV.A.3. EPA welcomes comment on this background approach, and its appropriateness given the description above, 2021 Court Opinion and the statutory authority.

3. Modeled Results for All Three DLHS Approaches

The TSD that accompanies this proposal evaluated the DLHS candidates of all three approaches (*i.e.,* GTZ, numeric standard, and post-1977 background). Estimates for BLLs of children exposed to the DLHS dust-lead loadings were evaluated for children at each age up to age six, including age two (generally, age two is the age of greatest modeled exposure), and lead-related reduction in IQ at age six was estimated from the lifetime average BLL (average of BLLs across the period prior to age six). This approach is consistent with the study from which the BLL concentration-IQ response function was drawn. This study related IQ quantified at about six years of age to each child's lifetime average BLLs (based on blood Pb measurements taken from six months up to age of the IQ test (Refs. 40 and 41). In the following discussion, both the model results for two-year BLL and the estimates of IQ change at six-years, are represented, referring to them as the results for ''young children'' for brevity. EPA considered numerous dust-lead loadings, including: 0.7/0.8 µg/ft², (*i.e.,* 0.7 µg/ft² for floors and 0.8 µg/ft² for window sills) which is the GTZ option partnered with the primary DLCL option (3/20/25 µg/ft² for floors, window sills, and window troughs respectively) and 2.2/4.4 µg/ft², which is the GTZ partnered with the alternative DLCL option (5/40/100 µg/ft²). Other modeled dust-lead loadings are 0.2/0.8 µg/ft², which is the post-1977 background dust-lead level, 1/10 µg/ft², 2/20 µg/ft², 3/30 µg/ft², 5/40 µg/ft², and 10/100 µg/ft², which is the 2019 DLHS. Zero was also provided for comparison purposes with the DLHS candidates and is not itself a candidate value. More information on the TSD and the health/exposure metrics (*i.e.,* IQ and BLL decrements) that were analyzed can be found in Unit III. and Unit IV.A.2.a.

DLHS candidates associated with GTZ, post-1977 background, and the numeric standard (1/10 µg/ft²) approaches are associated with the lowest BLLs when compared to the other numeric DLHS candidates (2/20 µg/ft², 3/30 µg/ft² and 5/40 µg/ft² and the current DLHS of 10/100 µg/ft² for floors and window sills). The TSD modeling results for young children exposed to dust-lead associated with the loading candidates from the GTZ approach (which range from 0.7 to 2.2 µg/ft² for floors and 0.8 to 4.4 µg/ft² for window sills depending on which DLCL it is coupled with, see Unit IV.A.1.a. for more information) show that young children would have a 0.0 to 10.6% probability of exceeding an incremental BLL of 1 to 2.5 µg/dL (Tables 7–2 and 7–3 in the TSD). However, the results for GTZ partnered with the primary DLCL option (0.7/0.8 µg/ft²), and post-1977 background (0.2/0.8 µg/ft²) are the only two DLHS candidates that keep both the percentage of exceedance of incremental BLL of 1 to 2.5 µg/dL below 5% probability (which is the threshold of interest EPA identified).

When comparing the three DLHS approaches to total BLL, the modeling includes exposure from other media such as soil, diet, water, and air. Importantly, even at zero dust-lead, children would still have a 5.7% probability of exceeding the BLRV given the impact of these other exposures. Thus, none of the considered DLHS candidates resulted in less than 5% probability of exposed children's BLL exceeding the CDC BLRV. However, the TSD modeling results did show that for young children exposed to dust-lead loadings using the GTZ approach, the post-1977 background approach or the numeric DLHS candidate of 1/10 µg/ft² would have approximately a 7.3 to 9.1% probability of exceeding a total BLL of 3.5 µg/dL, the CDC's BLRV. This is lower than the 10.3 to 13.9% probability when exposed to other numeric DLHS candidates (2/20 µg/ft², 3/30 µg/ft² and 5/40 µg/ft² for floors and window sills) and the 18.0% probability when exposed to the current DLHS of 10 µg/ft² for floors and 100 µg/ft² for window sills. Therefore, while no DLHS option results in a less than 5.7% probability of exposed children's BLL exceeding the CDC BLRV given their likely exposures to other sources of lead, the options with the lowest levels (GTZ, post-1977 background, and 1/10 µg/ft²) result in exposed children experiencing about a two to three times less likelihood of exceeding the CDC BLRV compared to the current DLHS.

TABLE 3—PERCENT EXCEEDANCE VALUES FOR DLHS CANDIDATES, AGE: 2 YR OLD (30 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total BLL >3.5 µg/dL (%)	Total BLL >5 µg/dL (%)	Dust only BLL >1 µg/dL (%)	Dust only BLL >2.5 µg/dL (%)
Zero [1]	0	0	5.7	2.2	0.0	0.0

TABLE 3—PERCENT EXCEEDANCE VALUES FOR DLHS CANDIDATES, AGE: 2 YR OLD (30 MONTHS)—Continued

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total BLL >3.5 µg/dL (%)	Total BLL >5 µg/dL (%)	Dust only BLL >1 µg/dL (%)	Dust only BLL >2.5 µg/dL (%)
Post-1977 Background	0.2	0.8	7.3	2.8	1.0	0.0
GTZ With 3/20 DLCL	0.7	0.8	8.2	3.0	3.7	0.1
Numeric	1	10	9.1	3.3	6.6	0.5
GTZ With 5/40 DLCL	2.2	4.4	10.1	3.9	10.6	1.0
Numeric	2	20	10.3	4.1	12.5	1.2
Numeric	3	30	11.8	4.8	17.2	2.0
Numeric	5	40	13.9	5.5	23.0	3.2
Current Standard	10	100	18.0	7.5	36.7	6.5

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

DLHS candidates associated with GTZ and post-1977 background are also estimated to be associated with the lowest IQ decrements when compared to the other DLHS candidates (GTZ partnered with the alternative DLCL, 1/10 µg/ft², 2/20 µg/ft², 3/30 µg/ft² and 5/40 µg/ft², and the current DLHS of 10/100 µg/ft² for floors and window sills). GTZ partnered with the primary DLCL option (0.7/0.8 µg/ft²), and post-1977 background (0.2/0.8 µg/ft²) are the only two DLHS candidates estimated to have a 0.6 to 2.5% probability of exceeding 2 points of incremental IQ loss from dust-exposure, keeping the percentage of exceedance of 2 points of IQ loss below 5% probability.

TABLE 4—PERCENT EXCEEDANCE VALUES FOR DLHS CANDIDATES, AGE: 6 YR OLD (72 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total IQ 1pt (%)	Total IQ >2pt (%)	Dust only IQ >1pt (%)	Dust only IQ >2pt (%)
Zero [1]	0	0	88.9	48.7	0.0	0.0
Post-1977 Background	0.2	0.8	94.7	63.1	6.2	0.6
GTZ With 3/20 DLCL	0.7	0.8	96.4	70.4	18.5	2.5
Numeric	1	10	97.0	74.5	30.2	5.2
GTZ With 5/40 DLCL	2.2	4.4	97.7	78.5	40.7	9.0
Numeric	2	20	97.9	80.0	44.6	11.0
Numeric	3	30	98.5	82.3	53.6	16.0
Numeric	5	40	98.8	85.1	62.7	22.4
Current Standard	10	100	99.4	90.3	75.8	37.9

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

B. Dust-Lead Clearance Levels Approach

TSCA Title IV granted EPA the authority to regulate LBP activities, and to take into account reliability, effectiveness, and safety (15 U.S.C. 2682(a)(1)) when setting the DLCL. While considering those three criteria, the 2001 LBP Hazards Rule modified the work practice standards to include DLCL, which ''are used to evaluate the effectiveness of cleaning following an abatement'' (Ref. 6). In both the 2001 LBP Hazards Rule and the 2021 DLCL Rule, the DLCL were finalized as the same value as the DLHS for floors and window sills. When originally established, EPA considered the DLCL in the broader context of Title X, and selected DLCL that were compatible with a ''workable framework for lead-based paint hazard evaluation and reduction.'' EPA chose DLCL that were consistent with the DLHS in part to ensure they were ''as easy as possible to understand and implement'' (Ref. 47). At that time EPA established the DLCL and the DLHS at 40 µg/ft² and 250 µg/ft² for floors and window sills, with a separate DLCL of 400 µg/ft² for troughs.

In 2021 the DLCL set by EPA continued to mirror the DLHS as it had done historically, as the Agency explained that it wanted to update the DLCL to achievable levels that would demonstrate elimination of dust-lead hazards under the 2019 DLHS of 10 µg/ft² for floors and 100 µg/ft² for window sills. The 2021 updates to the DLCL restored consistency between the DLCL and DLHS, which had been lowered in 2019 without a corresponding amendment to the DLCL. Previous public comments received on the 2018 DLHS proposal and 2020 DLCL proposal favored lowering the DLCL to be consistent with the DLHS (Refs. 53 and 54). As a result, in 2021 EPA finalized DLCL of 10 µg/ft² for floors and 100 µg/ft² for window sills (the same levels as the DLHS), and ''EPA considered the achievability of these levels, how the lower dust-lead loadings can be reliably detected by laboratories, the effectiveness of these levels, and consistency with the revised 2019 standards and across the Federal Government'' (Ref. 3).

The 2021 Court Opinion affirmed that ''TSCA [Title] IV gives the EPA latitude to consider 'reliability, effectiveness, and safety''' when promulgating regulations ''[w]ith respect to implementation, including abatement.'' *A Cmty. Voice,* 997 F.3d at 995 (Ref. 11). This would include the DLCL as they represent part of post-abatement work practices. The Court continued by emphasizing that this gives EPA more discretion when setting the DLCL because they are relevant to the implementation of remedial measures, rather than the identification of a hazard (*i.e.,* DLHS). The Court analogized this dichotomy to other environmental statutory schemes (see also Unit IV.A.1.b. for EPA's discussion of the

SDWA). The Court also held that the DLCL and DLHS are directly related and must be reconsidered together. Yet the Court recognized the difference in statutory authority and considerations (see Unit IV.A. for more information on DLHS).

In accordance with the 2021 Court Opinion, EPA is proposing to revise the DLCL in the same proceeding as the reconsideration of the 2019 DLHS, and given the Court's direction for how to revise the DLHS and DLCL, EPA is proposing clearance levels that are decoupled from the DLHS (see Unit I.B and C. for more background on decoupling). EPA evaluated the 2021 DLCL in accordance with the statute and is proposing to revise the DLCL from 10 µg/ft², 100 µg/ft² and 400 µg/ft² for floors, window sills, and troughs, respectively, to 3 µg/ft², 20 µg/ft², and 25 µg/ft². EPA is proposing to revise the DLCL in order to reduce exposure to dust-lead beyond the 2021 levels. Additionally, New York City (NYC) has lowered their clearance levels since the 2021 DLCL final rule, which shows that levels below EPA's 2021 DLCL are achievable. Discussion on NYC's clearance levels can be found in Unit IV.B.2.d. Accordingly, EPA is also requesting comment on an alternative DLCL of 5 µg/ft², 40 µg/ft², and 100 µg/ft², as well as whether another DLCL is appropriate given reliability, effectiveness and safety and why, see Unit VII.

1. Selecting the Proposed DLCL

EPA is proposing to revise the DLCL given the statutory criteria of reliability, effectiveness, and safety, based on consideration of HUD's Lead Hazard Control Clearance Survey (LHCCS), the potential for risk reduction by lowering exposure to dust-lead, and an evaluation of laboratory capabilities and capacity.

a. Lead Hazard Control Clearance Survey

EPA collaborated with HUD to develop the 2015 LHCCS to examine whether HUD's Office of Lead Hazard Control and Healthy Homes (OLHCHH) Lead Hazard Control (LHC) grantees could achieve DLCL below the standards at that time (40 µg/ft², 250 µg/ft² and 400 µg/ft² for floors, window sills and troughs, respectively). LHC work performed by the grantees must be conducted by LBP certified individuals. Since most of the LHC grantees use commercial firms in their area, HUD OLHCHH believes that the grantees are conducting a large percentage of these activities and are therefore representative of the regulated community.

At that time, 98 LHC grantees completed the survey, giving HUD information from housing units in which lead hazard control activities took place from 2010 through 2012, for a total dataset of 1,552 housing units including 7,211 floor samples and 4,893 window sill samples (Ref. 55). The data were analyzed to determine the percentage of samples cleared at or below specific values. Numerical modeling was performed to estimate loadings that fell below laboratory detection limits. For more information on how that analysis was conducted please see Appendix D of the EA (Ref. 14). Since the 2015 LHCCS report was published, to the Agency's knowledge, there has not been any data or source of information of this magnitude in terms of DLCL samples alongside the details of the clearance process, including the number of tests performed (with results) and the type of additional work or cleaning performed. EPA found this 2015 LHCCS report still relevant and recent enough to provide meaningful input to inform this reconsideration rulemaking.

In terms of the primary DLCL option EPA is proposing, 64% of the 2010 to 2012 samples showed dust-lead levels at or below 3 µg/ft² for floors, 64% were at or below 20 µg/ft² for window sills, and 64% were at or below 25 µg/ft² for window troughs. As a result, approximately 64% of samples from the LHCCS data had dust-lead levels at or below the primary DLCL option of 3 µg/ft² for floors, 20 µg/ft² for window sills and 25 µg/ft² for troughs, which EPA believes is achievable, especially since the survey respondents were only required to achieve clearance below the 2001 DLCL at that time (40/250/400 µg/ft² for floors, window sills and troughs, respectively). It is possible that the percentage of samples achieving clearance may be even higher today, due to the 2021 revision of the DLCL to 10/100 µg/ft², meaning clearance has had to be achieved at these lower levels or below, since that time. Given lead-hazard control work has been subject to the current DLCL of 10/100 µg/ft² for some time, EPA is requesting comment from the regulated community regarding their ability to clear to 3/20/25 µg/ft² after various lead hazard control activities and given any additional cleaning necessary to make sure the dust-lead levels fall below the DLCL. See Unit IV.B.2.a. for more information on the LHCCS results for the alternative DLCL of 5/40/100 µg/ft² for floors, window sills and troughs, respectively.

b. Primary DLCL Modeling Results

EPA must understand the estimated health impacts of dust-lead exposure when selecting a DLCL that is reliable, effective, and safe, and in order to inform the EA. The TSD that accompanies this proposal includes evaluation of the 2021 DLCL (10/100 µg/ft² for floors and window sills), and the primary DLCL (3/20 µg/ft² for floors/window sills) and alternative DLCL (5/40 µg/ft² for floors/window sills) options. The unique dust-lead contribution to exposure from window troughs cannot be distinguished from window sills given the strong correlation between dust-lead loadings on the two surface types, the lack of data on access to window troughs versus window sills by children, and the paired impacts in window sills and window troughs from intervention studies addressing lead paint in window trim and casings. Further discussion on exposure to window troughs can be found in the TSD in Appendix C. As a result, exposure to window trough dust-lead and resultant benefits from a lowered DLCL for troughs is not calculated separately for this rulemaking.

The TSD also describes modeling of dust-lead exposures at the specific DLCL options for window sills and floors only and estimates of both BLLs that were evaluated for children at each age up to age six, including age two (generally, this is the age of greatest modeled exposure), and lead-related reduction in IQ at age six was estimated from the lifetime average BLL (average of BLLs across the period prior to age six). More information on estimated potential impacts from dust-lead exposures analyzed in the TSD, can be found in Unit III. *Technical Analyses* and Unit IV.A.2.a. *Modeled Approach.*

Compared to the alternative DLCL option, the primary option (3/20/25 µg/ft² for floors, window sills and troughs) is expected to be more health protective in that it results in the least amount of dust-lead left on a surface after the completion of an abatement. The modeling results provided in the TSD show that young children in pre-1978 housing exposed to dust-lead loadings of 3 µg/ft² for floors and 20 µg/ft² for sills would have a 11.3% probability of exceeding a total BLL of 3.5 µg/dL (CDC's BLRV). This is lower than the 18.0% probability when exposed to the current DLCL of 10 µg/ft² for floors and 100 µg/ft² for window sills and the 13.9% probability when exposed to the alternative DLCL. Total BLL includes exposure from other media such as soil, diet, water, and air; even at zero dust-lead, children would still have a 5.7% probability of exceeding the CDC's BLRV from these other sources. When considering dust-lead exposure only, the primary option for DLCL (3/20/25 µg/ft²), is estimated to result in 1.6 to 16.0% probability of young children's BLL exceeding 1 to 2.5 µg/dL, compared to 3.2 to 23.0% probability for the alternative DLCL (5/40/100 µg/ft²). The primary DLCL is also estimated to have a 14.6% probability of exceeding 2 IQ points decrement from dust exposure, while the alternative DLCL is estimated to result in a 22.4% probability of exceeding 2 IQ points decrement from dust exposure. Ultimately, the primary DLCL option is expected to result in a higher reduction of dust-lead exposure than the alternative DLCL.

TABLE 5—PERCENT EXCEEDANCE VALUES FOR DLHS CANDIDATES, AGE: 2 YR OLD (30 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total BLL >3.5 µg/dL (%)	Total BLL >5 µg/dL (%)	Dust only BLL >1 µg/dL (%)	Dust only BLL >2.5 µg/dL (%)
Zero [1]	0	0	5.7	2.2	0.0	0.0
3/20 DLCL	3	20	11.3	4.5	16.0	1.6
5/40 DLCL	5	40	13.9	5.5	23.0	3.2
Current Standard	10	100	18.0	7.5	36.7	6.5

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

TABLE 6—PERCENT EXCEEDANCE VALUES FOR DLHS CANDIDATES, AGE: 6 YR OLD (72 MONTHS)

Approach	Floor (µg/ft²)	Sill (µg/ft²)	Probability			
			Total IQ >1pt (%)	Total IQ >2pt (%)	Dust only IQ >1pt (%)	Dust only IQ >2pt (%)
Zero [1]	0	0	88.9%	48.7%	0.0%	0.0%
3/20 DLCL	3	20	98.2%	81.8%	51.4%	14.6%
5/40 DLCL	5	40	98.8%	85.1%	62.7%	22.4%
Current Standard	10	100	99.4%	90.3%	75.8%	37.9%

[1] The exceedance values for zero dust-lead are provided for comparison with the DLHS candidates; it is not a candidate value.

c. Laboratory Capabilities for Primary DLCL

To better understand current laboratory capabilities for specific equipment types, and the impact that the primary and alternative DLCL options, especially given that a non-numeric DLHS would shift the LQSR ''action level'' to the DLCL, EPA spoke with nine NLLAP-recognized laboratories about their dust wipe testing programs (Refs. 56, 57, 58, 59, 60, 61, 62, 63 and 64). EPA was interested in information from laboratories who had high dust wipe testing capacity and laboratories that had both a flame atomic absorption spectroscopy (FAAS) and the more sensitive laboratory instruments such as inductively coupled plasma atomic emission spectroscopy (ICP–AES) or an inductively coupled plasma mass spectroscopy (ICP–MS). The Agency wanted additional background on ICP instruments and their use for dust wipe testing in general. Among the laboratories EPA spoke to, six were accredited to use FAAS, five were accredited to use ICP–AES, and two were accredited to use ICP–MS to analyze dust wipe samples for lead. Eight of the nine laboratories provide commercial testing services, four of which are the largest U.S. lead laboratories by dust wipe test volume.

The information received from stakeholder outreach indicates that laboratories using ICP–AES equipment for dust wipe testing have a reporting limit of ≤3 µg/wipe. The five laboratories with ICP–AES capabilities have current reporting limits ranging from 0.5 µg/wipe to 3 µg/wipe. EPA believes that laboratories with more up-to-date instruments and optimized methods should be able to satisfy the LQSR dust wipe recommendations and the regulatory limit of the primary DLCL option of 3/20/25 µg/ft² and the quantitation limit of equal to or less than 50% of that level (*i.e.,* 1.5/10/12.5 µg/ft²). If finalized as proposed, EPA believes that ICP–AES would likely become the instrument standard for dust wipe testing for lead at the NLLAP laboratories, as other technologies were not reported to consistently meet the quantitation limit described above. For more information on the on how the alternative DLCL compares or the impact it could have on NLLAP-recognized laboratories, see Unit IV.B.2.c.

FAAS has been the most popular choice for lead dust wipe testing because it has a lower purchase price and operating cost, is fast and easy to use, and was sensitive enough for the 2019 and 2021 rules' DLHS and DLCL of 10 µg/ft² on floors and 100 µg/ft² on window sills. As shown in the table below, Table 2–9 of the EA, over two-thirds of laboratories recognized under the NLLAP for lead dust wipe testing currently use FAAS, and over half of these NLLAP laboratories rely solely on FAAS (Ref. 14). EPA seeks information on whether and the extent to which labs that do not have any or have only limited ICP capabilities would adopt ICP technology for dust wipe testing if it were to effectively become the standard for dust wipe testing for lead. In addition, EPA requests comment on the timing, benefits, and challenges associated with ICP adoption.

TABLE 7—ANALYTICAL EQUIPMENT USED FOR LEAD DUST WIPE TESTING BY LABORATORIES RECOGNIZED UNDER NLLAP PROGRAM

Equipment	Total number of laboratories accredited	Commercial laboratories accredited
FAAS	56	54
ICP–AES	27	19
ICP–MS	5	1
FAAS and ICP–AES	10	10
FAAS and ICP–MS	2	2
ICP–AES and ICP–MS	1	1
Total	101	87

Sources: Methods described in accreditation certificates for NLLAP laboratories, and descriptions on laboratory websites.

Several concerns about switching to ICP instruments were raised by laboratories, such as, a reduction in the throughput rate, need for additional equipment and staff due to the complexity of the machines (compared to FAAS), higher prices, delayed turnaround, and concerns over maintaining the current sample volume and ultimately whether to continue keeping dust wipe testing for lead in their portfolio/revisiting their business model. Based on the outreach conducted, laboratories indicated that the throughput rate on ICP–AES machines is roughly seven to 12 times slower than FAAS throughput. One major laboratory EPA spoke to estimated that they would have to purchase three to six new instruments, hire several highly qualified technicians, and run the laboratory on shifts over 24 hours to meet current demand for dust wipe tests conducted solely by ICP. This shift in instrumentation is estimated to increase both cost per sample as well as turnaround time. Laboratories mentioned that for clearance a substantial portion of their dust wipe testing clients request same-day or next-day turnaround on samples so that residents can quickly reoccupy their homes. Several laboratories doubted the technical feasibility of providing same-day or next-day turnarounds at sufficient volume should they switch to ICP technology thereby, potentially delaying homeowners from quickly reoccupying their homes and renters from quickly beginning occupancy or from quickly reoccupying their rental housing. Dust wipe testing by ICP–AES is also estimated to be about 125% more expensive per sample than testing by FAAS, and laboratories expressed concerned that less overall dust wipe testing will occur because state and local municipalities often have a fixed budget for their housing and health programs. See the EA for more specific information on the breakdown of the cost estimates of dust wipe testing. EPA also seeks information on the potential geographic impacts of the proposal on laboratory testing for lead dust wipes.

Finally, EPA found that several high-volume laboratories forecast that dust wipe test volumes will continue to grow over the next decade (Refs. 60 and 61). First, a growing proportion of laboratories' dust wipe testing business comes from landlords who need to comply with municipal housing regulations set by states or localities. Laboratories expect similar regulations to be enacted in the coming years, increasing demand for dust wipe testing for clearance (Ref. 61). Second, in recent years laboratories have received an increased volume of test samples generated by disaster recovery programs. When there is a natural disaster (such as a major flood) that requires clean-up and re-construction of pre-1978 housing, laboratories can receive an unexpected spike in dust wipe tests. Laboratories pointed out that the increasing rate of disaster-related demand spikes may overwhelm their capacity if only ICP can be used for dust wipe testing. If finalized as proposed, this rulemaking will also likely increase the amount of dust wipe testing required given the proposed regulatory levels. EPA seeks comment on the extent to which laboratories would be able to accommodate increased or emergency demand for dust wipe testing if this proposal is finalized.

The Agency is proposing 3/20/25 µg/ft² as the primary DLCL option due to the potential for risk reduction as discussed in Unit IV.B.1.b. Given information gathered via EPA's outreach to laboratories, EPA is concerned that setting clearance levels too low may deter participation in lead-hazard control programs and activities that require dust wipe testing or cause a market failure that does not allow the current volume of testing to continue. As a result, EPA is requesting comment on the reliability, effectiveness, and safety of the primary DLCL of 3/20/25 µg/ft² for floors, window sills, and troughs, including specifically the impact on laboratory capability as well as the accuracy of the information presented. See Unit VII. *Request for Comments* for more information.

2. Alternative DLCL

EPA is requesting comment on an alternative option to revise the DLCL for floors, window sills, and troughs from 10 µg/ft², 100 µg/ft² and 400 µg/ft², respectively to 5 µg/ft², 40 µg/ft², and 100 µg/ft², respectively. EPA chose 5/40/100 µg/ft² as the alternate DLCL based on consideration of HUD's LHCCS, potential for risk reduction, an evaluation of laboratory capabilities as well as high confidence that these standards can be successfully implemented, as shown by the use of these clearance levels currently in NYC. Another consideration supporting the alternative DLCL option is to avoid potentially spreading the resources for LBP hazard mitigation so broadly that they may be diverted from scenarios that present the greatest risk. EPA notes that the EA indicates that the alternative DLCL option is estimated to have positive net benefits. See EA, Table ES–11.

a. Lead Hazard Control Clearance Survey

The LHCCS indicates that 73% of samples from 2010 to 2012 showed dust-lead levels at or below 5 µg/ft² for floors, 89% were at or below 40 µg/ft² for window sills, and 94% were at or below 100 µg/ft² for window troughs. As such, overall more than 72% of samples had dust-lead levels at or below the alternative DLCL option of 5/40/100 µg/ft² for floors, window sills and window troughs. This is compared to 64% of samples clearing at or below the primary DLCL option of 3/20/25 µg/ft². As a result, EPA has high confidence that the alternative DLCL option is achievable, while considering reliability and effectiveness. EPA is requesting comment on whether the LHCCS data support the reliability and effectiveness of the alternative DLCL option, and whether the regulated community can clear to 5/40/100 µg/ft² after various lead hazard control activities and specialized cleaning.

b. Alternative DLCL Modeling Results

The alternative (5/40/100 µg/ft² for floors, window sills and troughs) represents a 50% or more reduction of dust-lead left on a surface following the completion of an abatement, when compared to the current DLCL (10/100/400 µg/ft²). This alternative DLCL option would be beneficial to maintaining lower children's BLLs and protecting against associated health outcomes such as decreased IQ. The modeling results provided in the TSD show that young children in pre-1978 housing exposed to dust-lead loadings of 5 µg/ft² for floors and 40 µg/ft² for window sills would have an estimated 13.9% probability of exceeding a total BLL of 3.5 µg/dL (CDC's BLRV); this is compared to the primary DLCL option (3/20/25 µg/ft²) which would result in a 11.3% probability of exceedance (a difference of 2.6% between the primary and alternative DLCL options). Ultimately, both options are lower than the 18.0% probability of exceedance of the BLRV when exposed to the current DLCL of 10 µg/ft² for floors and 100 µg/ft² on window sills.

When considering dust-lead exposure only, young children in pre-1978 housing exposed to the alternative DLCL would have a 3.2 to 23.0% probability of exceeding a BLL of 1 to 2.5 µg/dL based on the modeled results, compared to 1.6 to 16.0% probability for the primary DLCL (3/20/25 µg/ft²). The alternative DLCL is also estimated to have a 22.4% probability of exceeding 2 points of IQ loss. As with total BLL, this is a considerable reduction from the 37.9% chance of exceeding 2 points of IQ loss for young children living in target housing who are exposed the current DLCL, but still higher than the primary DLCL estimate of 14.6%. EPA must understand the impact on health effects when selecting a DLCL that is reliable, effective, and safe, and to inform the EA. Overall, the modeling within the TSD indicated that the alternative DLCL (5/40/100 µg/ft² for floors, window sills and troughs) represents a reduction in risk from the current clearance levels of 10/100/400 µg/ft², but that risk is still higher than the estimated results for the primary DLCL. For a table representation of these modeling results, please see Unit IV.B.1.b. (Tables 5 and 6).

c. Laboratory Capabilities for Alternative DLCL

EPA spoke with nine NLLAP-recognized laboratories about their dust wipe testing programs. For additional details about the laboratory outreach see Unit IV.B.1.c. *Laboratory Capabilities* and the EA (Ref. 14). Based on EPA's laboratory outreach, EPA has increased confidence relative to the proposed DLCL (*i.e.,* 3/20/25 µg/ft²), that laboratories can numerically quantify dust-lead levels of 5 µg/wipe with FAAS technology and attain a quantitation limit of equal to or less than 50% of that level (*i.e.,* 2.5/20/50 µg/ft²). Three major laboratories EPA spoke with already report at this level with FAAS, and the remaining three laboratories using FAAS that EPA talked to expressed no concern about attaining this level in the future if they ask their customers to wipe 2 ft² instead of 1 ft² (Refs. 57, 60 and 64). EPA is requesting comment on whether the alternative DLCL option (*i.e.,* 5/40/100 µg/ft² for floors, window sills and troughs) would allow NLLAP-recognized laboratories to continue using FAAS technology, if it would mitigate any unintended reductions in dust wipe capacity (due to throughput time, cost, labor, etc.) and avoid any negative impacts on other programs that require specific testing using ICP–AES or FAAS.

Should EPA finalize the DLCL at 5/40/100 µg/ft² and given no changes to the LQSR, EPA's laboratory outreach suggests that a handful of smaller laboratories with dated FAAS equipment may elect to discontinue their dust wipe programs for lead. Due to the expected continuing participation of other smaller as well as large-volume laboratories, EPA believes that these limited discontinuations are unlikely to impact the nationwide availability or market pricing of tests (see the EA for a breakdown of cost estimates). Additionally, EPA does not foresee any concerns reporting to 40 µg/ft² on window sill or 100 µg/ft² on troughs (even with the small surface areas) if laboratories successfully attain a regulatory limit of 5 µg/ft².

EPA also received feedback that the alternative DLCL option (5/40/100 µg/ft²) could better mitigate any negative impacts on other programs that require specific testing using ICP–AES or FAAS equipment. Laboratories currently use their ICP–AES machines for a variety of purposes. Most notably, this equipment is regularly used for the characterization of metals in hazardous waste and measuring lead in drinking water. Under the primary DLCL option 3/20/25 µg/ft², laboratories would face a significant increase in demand for use of their ICP machines, which could result in substantial downstream effects on the availability and price of testing for other lead and non-lead programs. Additionally, some laboratories mentioned they might eliminate use of their FAAS machines to streamline laboratory functionality. This may have downstream effects on testing for lead in soil, paint chips, and air; laboratories currently test these matrices by FAAS with some frequency. If laboratories decide maintaining FAAS is no longer viable for their primary line of business (dust wipes), all lead matrices could be added to ICP queue, which would worsen availability issues and increase prices.

The Agency is requesting comment on whether reliability, effectiveness and safety support the DLCL alternative option of 5/40/100 µg/ft². EPA is interested in setting a DLCL that has a high potential for risk reduction; however, the Agency also wants to finalize an option that is achievable and encourages (not deters) participation in lead-hazard control programs and activities that require dust wipe testing. As a result, EPA is requesting comment on the alternative DLCL option of 5/40/100 µg/ft² for floors, window sills, and troughs (compared to the primary DLCL option), the impact that level could have on laboratories, and the accuracy of the information presented. See Unit VII. *Request for Comments* for more details.

d. New York City

Between 2019 and 2021 NYC Department of Health and Mental Hygiene lowered their lead dust clearance and lead dust hazard risk assessment testing standards twice. NYC lowered their standards for floors, window sills and window wells (*i.e.,* troughs), respectively, from 40 µg/ft², 250 µg/ft², and 400 µg/ft² to 10 µg/ft², 50 µg/ft², and 100 µg/ft² in 2019 (effective June 12, 2019) and again to 5 µg/ft², 40 µg/ft², 100 µg/ft² in 2021 (effective June 1, 2021) (Refs. 65 and 66). The Agency spoke to the New York City Department of Health and Mental Hygiene and received feedback that although there was a transitionary period that lasted several months and had various challenges, overall, the regulated community was able to adjust and comply with the new lower standards (Ref. 67). Based on NYC's experience, EPA believes that the alternative DLCL option (*i.e.,* 5 µg/ft², 40 µg/ft², 100 µg/ft² for floors, window sills and window troughs) can be considered effective and reliable.

C. Cross Reference With HUD Regulations

EPA is proposing to modify 40 CFR 745.227(h) to clarify that the proposed DLCL would differ from the DLHS, that the Agency does not intend to compel clearance down to the DLHS, and to alleviate potential regulatory confusion surrounding clearance. HUD's LSHR's clearance regulations at 24 CFR 35.1340(d), which apply to both abatement and non-abatement activities, currently refer to 24 CFR 35.1320(b)(2), which in turn cross-references EPA's regulations at 40 CFR 745.227(h), which currently discusses EPA's DLHS but not EPA's DLCL. See Unit III.A.3.f the 2019 DLHS Rule for additional background on this topic (Ref. 2). As explained earlier in this preamble, prompted by analysis conducted following the 2021 Court Opinion, EPA is proposing a DLHS that is no longer the same value as the DLCL. As a result, EPA is proposing to clarify the language at 40 CFR 745.227(h), so it is clear, including when referenced by the LSHR, that EPA does not intend to compel clearance to the DLHS, whether in federally assisted housing or not.

D. Definition of Abatement

EPA is proposing to amend the definition of abatement in EPA's LBP activities regulations and thus modify the trigger for when EPA recommends an abatement. This change is intended to align with the proposed decoupling of the DLHS and DLCL and to focus impacted entity resources (*e.g.,* HUD, city, state) on the situations that present the most risk. TSCA Section 401(1) defines an abatement as ''any set of measures designed to permanently eliminate lead-based paint hazards . . .'' and includes ''the removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint . . . and all preparation, cleanup, disposal, and postabatement clearance testing activities associated with such measures.'' EPA included a definition of abatement, which closely resembles the statutory language, within the LBP activities regulations at 40 CFR 745.223. An abatement under the LBP activities regulations is described as ''any measure or set of measures designed to permanently eliminate lead-based paint hazards'' and specifically includes ''projects resulting in permanent elimination of lead-based paint hazards . . .''

The 2021 Court Opinion stated that ''TSCA [Title] IV gives the EPA latitude to consider 'reliability, effectiveness, and safety''' when promulgating regulations ''[w]ith respect to implementation, including abatement'' (Ref. 11). Hence, in considering revising the DLCL, EPA must and has considered whether reliability, effectiveness and safety support changing the regulatory definition of abatement. Given that under this statutory scheme EPA only intends to compel post-abatement clearance to the proposed DLCL, the Agency is proposing to change the regulatory definition of abatement so that the recommendation for action applies when dust-lead loadings are at or above the DLCL (which continues to incorporate non-health-based factors such as reliability), rather than at or above the DLHS as has been the case historically (but which, going forward in accordance with the 2021 Court Opinion, can no longer incorporate non-health-based factors such as reliability). This is deemed necessary due to the decoupling of the DLHS from the DLCL, and EPA's desire to avoid situations where abatements are designed to eliminate dust-lead levels to the DLHS and are unable to do so in a reliable and effective manner. Otherwise, EPA would be recommending an abatement if dust-lead levels are between the DLHS and the DLCL, even though such an abatement would only need to pass clearance below the DLCL. Also, where an abatement is conducted, a cyclical pattern could result, where an abatement successfully passes clearance below the DLCL but an abatement is still recommended by EPA if dust-lead levels are at or above the DLHS. Thus, EPA is proposing to change the regulatory definition to require that abatements eliminate dust-lead hazards to below the DLCL to ensure that successful abatements can be considered complete. Relatedly, as explained in Unit IV.E, EPA is proposing amendments to the abatement report to help protect from exposure even after the abatement is complete.

An additional benefit to modifying the trigger for when EPA recommends an abatement is that it allows the regulated community to focus resources on situations that present more risk. As discussed in the 2001 and 2019 final rules, an important concern for EPA is having the resources for LBP hazard mitigation distributed so broadly that they may be diverted from situations that present the greatest risk. As a result, EPA is proposing to change the regulatory definition of abatement to permanently eliminate dust-lead hazards to below the DLCL and requesting public comment on this proposal. EPA believes that this proposed amendment to the regulatory definition appropriately applies the statutory definition in the context of this rule, where the statute requires EPA to consider reliability, effectiveness, and safety for purposes of EPA's TSCA section 402 DLCL regulations. Furthermore, the statutory definition of abatement in TSCA section 401 states that the set of measures covered by the term are to be ''in accordance with the standards established by the Administrator'' under TSCA Title IV, which refers to the ''standards for performing [LBP] activities'' as what EPA's TSCA section 402 regulations shall contain. Note that nothing in this rulemaking changes the fact that owners of properties covered by the LBP Activities Rule are not compelled to evaluate their properties for the presence of dust-lead hazards, nor compelled by EPA to take action (such as an abatement) if dust-lead hazards are identified at or above the DLCL, although HUD and some state or local governments may require action.

E. Abatement Report

As explained in Units IV.A. and B., EPA is proposing to lower the current DLHS to any reportable level analyzed by an NLLAP-recognized laboratory, and the DLCL to 3 µg/ft^2, 20 µg/ft^2, and 25 µg/ft^2 for floors, window sills and troughs, respectively. The DLHS identify when pre-1978 housing or a COF has a dust-lead hazard present. If finalized as proposed, it is likely that once a project passes clearance and the abatement can be considered complete, there could still be dust-lead hazards present due to the DLHS being any reportable level. The Agency realizes the challenge this creates for the regulated community and to keep dust-lead levels down and mitigate exposure, EPA is proposing to amend the requirements for what needs to be included in an abatement report.

After the completion of an abatement, a report is required to be developed by a certified supervisor or project designer. The list of what needs to be included in the abatement report is described at 40 CFR 745.227(e)(10), and consists of elements such as the start and completion dates of the abatement, information about the risk assessor or inspector conducting the sampling, any clearance testing and soil analyses, etc. EPA is proposing to modify 40 CFR 745.227(e)(10) to include a requirement to add specific language into each abatement report, when dust-lead levels are between the DLHS and the DLCL. That language refers the public to a useful reference titled ''*Protect Your Family From Lead in Your Home*'' and acknowledges that LBP hazards (particularly dust-lead hazards) could remain after an abatement. The goal of including this language in an abatement report is to ensure that occupants are provided information and tools available to them to minimize dust-lead hazards and take actions to protect themselves from exposure even after the abatement is complete.

The certified firm (or individual who prepared the report) must keep the abatement reports for at least 3 years and must provide a copy to the individual or entity who ''contracted for its services'' (40 CFR 745.227(i)). EPA is requesting comment on the proposed language to be added to the abatement report.

F. Other Amendments

In order to conform the regulations to a statutory change, make several other amendments to improve efficiency of the program and make several regulatory text corrections, EPA is proposing to amend 40 CFR part 745, subparts E (Residential Property Renovation), F (Disclosure of Known Lead-Based Paint and/or Lead-Based Paint Hazards Upon Sale or Lease of Residential Property), and L (Lead-Based Paint Activities).

1. Definition of Target Housing

EPA is proposing to update the definition of target housing in 40 CFR 745.103 and 40 CFR 745.223 to align with the statutory changes made in 2017, and to make conforming edits to language in 40 CFR 745.223 and 40 CFR 745.227. Target housing defines which housing is subject to EPA's LBP rules. Within section 237(a) through (c) of Title II of Division K of the Consolidated Appropriations Act, 2017 (Pub. L. 115–31, 131 Stat. 788 and 789), Congress amended HUD and EPA's statutory definitions of target housing to include 0-bedroom dwellings if a child less than 6 years of age resides or is expected to reside in such housing (42 U.S.C. 4822(e); 42 U.S.C. 4851(b)(27); 15 U.S.C. 2681(17)). The proposed change to the definition of target housing in 40 CFR 745.103 and 40 CFR 745.223 would conform to the statutory language by defining target housing as any housing constructed prior to 1978, except housing for older adults 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). For consistency, EPA is also proposing to revise the definition of living area in 40 CFR 745.223 to change the age from 6 and under to less than 6 years of age. Similarly, language describing the age of children in 40 CFR 745.227(c)(2)(i), (c)(2)(iv), (c)(2)(v), (d)(3), (d)(5), and (d)(6)(ii) would be updated from 6 years of age and under to under age 6 to conform to the statutory language as amended.

2. Definition of Child-Occupied Facility (COF) and Living Areas

EPA is proposing to revise the definition of COF in 40 CFR 745.223 and related regulatory language in 40 CFR 745.227 to establish consistency throughout the LBP regulations. The LBP Activities regulations define COFs as buildings or portions of buildings, constructed prior to 1978, in which the same child regularly visits on at least two different days within any given week, with their visits lasting at least 3 hours with combined visits of at least 6 hours, and combined annual visits lasting at least 60 hours. COFs may include, but are not limited to, day-care centers, preschools and kindergarten classrooms. Living areas define any area of a residential dwelling used by one or more children which include, but are not limited to, living rooms, kitchen areas, dens, play rooms, and children's bedrooms. Currently, the definition of COF at 40 CFR 745.223 identifies children impacted by the LBP Activities regulations as age 6 and under, while the definition of COF in the RRP regulations at 40 CFR 745.83 identifies children impacted by the RRP regulations as under 6 years of age. In order to establish consistency in age throughout the LBP regulations, including with the definition of target housing and the RRP regulations' definition of COF, EPA is proposing to change the language in the definition of COF in 40 CFR 745.223 to less than 6 years of age. Language describing the age of children in 40 CFR 745.227(d)(7) would also be updated from 6 years of age and under to under age 6 to conform.

3. Electronic Submissions

EPA is proposing to require submissions for application payments, applications, and notices to be done electronically. Under this proposal, this rule would specifically define ''electronic'' in 40 CFR 745.83 and 40 CFR 745.223 to mean ''the submission of an application, payment, or notice using the Agency's Central Data Exchange (CDX), or a successor platform.'' In 2016, the U.S. Treasury Department changed their process so that paper checks would no longer be allowed for payment of fees associated with RRP or abatement programs. Since that time, applications that require payment, such as individual and firm certifications as well as training provider accreditation applications, have been submitted electronically via CDX. Therefore, EPA is proposing to amend 40 CFR 745.89 (a)(1), 40 CFR 745.92(c)(2), and 40 CFR 745.238(e)(2) to conform to the 2016 U.S. Treasury Department process and require payments to be made only electronically via CDX or a successor platform.

Currently there's no specific submission method defining how to submit applications in EPA's LBP regulations. This ambiguity allows for the potential of written applications to be submitted which requires time consuming activities such as data entry and accrues administrative costs. Therefore, EPA is proposing to amend 40 CFR 745.89 (a)(1), (b)(1), (b)(1)(i), and (c)(1); 40 CFR 745.225(b)(1), (e)(5), (f)(2), and (j)(2); 40 CFR 745.226(a), (e), (f), and (h)(1)(iii); 40 CFR 745.227(e)(4)(vii) and 40 CFR 745.238(d), and (e) to reflect the proposed requirement of submitting applications electronically via CDX or a successor platform. This will add further clarification and uniformity to this process.

Additionally, EPA is proposing to require that abatement and training notifications be submitted electronically via CDX or a successor platform. Requiring electronic submissions and eliminating fax submissions would remove the need for fax machine maintenance and would also reduce phone service costs. Therefore, EPA is proposing to amend 40 CFR 745.225(c)(13)(vi) and (14)(iii) to require submission of abatement and training notifications to occur electronically via CDX or a successor platform.

4. Disclosure Rule Warning Statement

EPA is proposing to update the Disclosure Rule's Lead Warning Statement in 40 CFR 745.113(b)(1) to address a drafting error. Both the preamble of the Disclosure Rule (required by Section 1018 of Title X), and the relevant public sample form include the following language: ''Before renting pre-1978 housing, lessors must disclose the presence of known lead-based paint and/or lead-based paint hazards in the dwelling,'' which is consistent with EPA and HUD's adaptation to leasing contracts of the statutory language in Section 1018 (Ref. 7). However, the Lead Warning Statement in 40 CFR 745.113(b)(1) does not include the word ''known.'' To conform this regulatory text with the statutory and preamble language, EPA is proposing to amend the Lead Warning Statement to include the word ''known'' when discussing lessors disclosing the presence of LBP and/or LBP hazards in the dwelling.

5. Disclosure Rule Reference

EPA is proposing to amend the Disclosure Rule at 40 CFR 745.113(a)(4) and 40 CFR 745.113(b)(4) to include the correct lead hazard information pamphlet reference, 15 U.S.C. 2686. This reference further discusses the requirements for the lead hazard information pamphlet and is the basis for its statutory authority. The current reference of 15 U.S.C. 2696 does not exist and was a drafting error.

6. Definition of Housing for the Elderly

EPA is proposing to add the definition of ''housing for the elderly'' to 40 CFR 745.223 in order to clarify the term ''elderly'' used in the definition of ''target housing,'' also in 40 CFR 745.223. EPA already defines ''housing for the elderly'' in 40 CFR 745.103 as ''retirement communities or similar types of housing reserved for households composed of one or more persons 62 years of age or more at the time of initial occupancy'' under Subpart F, ''Disclosure of Known Lead-Based Paint and/or Lead-Based Paint Hazards Upon Sale or Lease of Residential Property.'' The proposal to include the same definition in Subpart L, ''Lead-Based Paint Activities'' would add clarity and consistency throughout the LBP program.

7. Obsolete Regulatory Text

EPA is proposing to revise and delete obsolete regulatory text where language is out of date or no longer applicable in 40 CFR 745.81(a)(4)(i) and (b); 40 CFR 745.90(a)(3), and (4); 40 CFR 745.225(i)(2); and 40 CFR 745.226(f)(5). For example, 40 CFR 745.81(b) currently reads: ''Before December 22, 2008, renovators or firms performing renovations in State and Indian Tribal areas without an authorized program may provide owners and occupants with either of the following EPA pamphlets: *Protect Your Family From Lead in Your Home* or *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.* After that date, *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools* must be used exclusively.'' This information is outdated; therefore, EPA is proposing to update and consolidate this section to read: ''After December 22, 2008, renovators or firms performing renovations in States and Indian Tribal areas without an authorized program must provide owners and occupants the following EPA pamphlet: *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.*''

8. Incorporation by Reference

EPA is also considering adding incorporations by reference for two voluntary consensus standards, each of which is already included in the definition of ''wipe sample'' at 40 CFR 745.63: American Society for Testing and Materials (ASTM) E1728 and ASTM E1792. EPA intends to incorporate by reference the most recent version of each standard (*i.e.,* ASTM E1728–20 and ASTM E1792–20). Copies of these materials may be obtained from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428–2959, or by calling (877) 909–ASTM, or at *https://www.astm.org.* ASTM standards referenced in this rule are also available for public review in read-only format in the ASTM Reading Room at *https://www.astm.org/epa.htm* only for the duration of the public comment period.

If you have a disability and the format of these materials intended for incorporation by reference interferes with your ability to access the information, please contact EPA's Rehabilitation Act Section 508 (29 U.S.C. 794d) Program at *https://www.epa.gov/accessibility/forms/contact-us-about-section-508-accessibility* or via email at *section508@epa.gov.* To enable us to respond in a manner most helpful to you, please indicate the nature of the accessibility issue, the web address of the requested material, your preferred format in which you want to receive the material (electronic format (ASCII, etc.), standard print, large print, etc.), and your contact information.

V. Implications of Proposed Rule for Existing HUD and EPA Programs

A. HUD Programs

1. Lead-Safe Housing Rule

HUD has specific authority to control LBP and LBP hazards in certain federally owned and federally-assisted target housing (Ref. 28). HUD's regulations at 24 CFR 35.1320(b)(2) cross-reference EPA's regulations at 40 CFR 745.227(h), which currently discusses EPA's DLHS but not EPA's DLCL. Due to the current cross-reference, the HUD regulations have been read as requiring entities receiving government funding currently to conduct post-abatement clearance until the levels are below EPA's DLHS, which at the time this cross-reference was made, were the same values as EPA's DLCL. Due to the 2021 Court Opinion, EPA is now proposing approaches for these standards that would result in decoupling the DLHS and DLCL as explained in Unit IV. EPA is proposing modifications to 40 CFR 745.227(h) to clarify that the Agency does not intend to compel clearance down to the DLHS and to alleviate potential regulatory confusion surrounding clearance (as discussed in Unit IV.C of this notice).

Other impacts of EPA's proposal could include a possible decrease in the number of landlords participating in certain HUD programs, as well as families potentially shifting from assisted housing to unassisted housing, which has been shown to be associated with a higher prevalence of LBP hazards (Refs. 68 and 69) and higher BLLs (Ref. 70). As discussed in Unit II.A., lead exposure, even in small amounts, can cause substantial and long-lasting health problems, particularly through its effects on children's development. Access to secure housing is also an important social determinant of health (Ref. 71). Research finds negative health effects resulting from three key mechanisms of housing insecurity: lack of housing affordability leading to stress and material deprivation (Refs. 72, 73, 74 and 75), lack of housing stability (Refs. 76, 77, 78, 79 and 80), and lack of safe and adequate housing (Refs. 81, 82, 83, 84 and 85). HUD's housing assistance programs play a critical role in helping nearly 5 million households (Ref. 86) avoid housing insecurity and its harmful effects on physical and mental health (Refs. 70, 87, 88, 89, and 90). Despite such Federal assistance, the nation faces a critical shortage of affordable rental housing affecting about 8 million very low-income households (Ref. 91). EPA considered the proposed changes to the DLHS and DLCL and the potential impacts on HUD's housing programs within the EA (see Section 10.2 for this discussion) (Ref. 14). Existing research on landlord participation in the Housing Choice Voucher program (Refs. 92, 93, 94 and 95) suggests that more stringent standards or uncertainty as to how to meet those standards could be a disincentive for private target housing providers to participate in HUD's rental assistance programs including the Housing Choice Voucher program (tenant-based rental assistance program) and the project-based assistance programs, which could in turn reduce access to affordable and stable housing associated with a relatively lower prevalence of LBP hazards than unassisted housing. As a result, EPA is requesting information and comment on whether adoption of the proposed DLHS and DLCL or alternative regulatory options under consideration would lead to an increase in housing insecurity or

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lead exposures. If so, EPA is requesting comment on whether there would be any adverse health effects due to this potential increase in housing insecurity alongside the health benefits of reduced lead exposure, as well as whether there are changes that EPA could make to the rule that maintain landlord participation in rental assistance programs while achieving the objectives of the statute.

EPA expects relatively limited impacts on housing supply due to this rulemaking for some housing types subject to HUD's LSHR. Subpart F of the LSHR covers HUD-owned single family housing properties for sale that are sold under a HUD mortgage program. HUD (*i.e.* the Federal Government) would be responsible for all costs associated with compliance to a stricter DLHS/DLCL before selling the property. While modest delays may occur in closing on sale transactions for these properties, a reduction in housing supply covered under this subpart is unlikely. Subpart G of the LSHR covers multi-family housing where either HUD is the owner of a mortgage or the owner of a property receives mortgage insurance under a program run by HUD. Housing covered under this subpart of the LSHR has risk assessment, interim control, and LBP maintenance requirements, but private landlords for these properties directly seek out Federal funds, and even if some of the federally-provided money is spent complying with a stricter DLHS/DLCL to comply with the LSHR, participating grantees should typically have a positive net return. To ensure all potential impacts of the rule are considered, EPA is requesting comment on impacts to housing covered under these other LSHR subparts as well as additional factors that should be considered as part of the EA.

2. Grantee Programs

On February 16, 2017, HUD issued policy guidance to establish new and more protective requirements for dust-lead action levels for its Lead-Based Paint Hazard Control (LBPHC) and Lead Hazard Reduction Demonstration (LHRD) grantees (the requirements also apply to related HUD grants authorized by Title X, section 1011 (42 U.S.C. 4852), under similar names, including Lead Hazard Reduction grants and their High Impact Neighborhoods and Highest Lead-Based Paint Abatement Needs grant categories) (Ref. 96). The guidance adopted dust-lead action levels of 10 µg/ft² for floors and 100 µg/ft² for window sills, respectively, for initiating lead hazard control activities under these grant programs, and lead clearance action levels of 10 µg/ft² for floors, and 100 µg/ft² for window sills and troughs, respectively, for clearing such lead hazard control activities. If the proposed changes to the DLCL discussed in Unit IV are finalized, LBPHC and LHRD grantees would be required by EPA's regulations to clear lead abatement projects to the updated DLCL of 3 µg/ft², 20 µg/ft², and 25 µg/ft² for floors, window sills, and troughs respectively. If EPA finalizes the proposed changes to the DLHS and DLCL, HUD has informed the Agency that it would likely issue new policy guidance on initiating lead hazard control activities and on clearing lead abatement projects under these grant programs, and that it would consider issuing new policy guidance on clearing interim control projects under these grant programs.

3. EPA–HUD Disclosure Rule

Under the Disclosure Rule (Ref. 7), prospective sellers and lessors of target housing, which is most pre-1978 housing, must provide purchasers and renters with a federally approved lead hazard information pamphlet and disclose known LBP and/or LBP hazards, and any available records, reports, and additional information pertaining to LBP and/or LBP hazards. The information disclosure activities are required before a purchaser or renter is obligated under a contract to purchase or lease target housing. The records or reports pertaining to LBP and/or LBP hazards include, among other things, results from risk assessments, regardless of whether the levels of dust-lead are above or below the dust-lead hazard standards, and from post-abatement dust wipe testing, above or below the clearance levels. Because disclosure is required in target housing regardless of whether dust levels are above or below the DLHS or DLCL, finalizing the GTZ approach for the dust-lead hazard standards and lowering the dust-lead clearance levels would not result in more disclosures; rather it would result in more disclosures indicating that a lead-based paint hazard is present (since the proposed GTZ is lower than the current DLHS from 2019). EPA is also proposing changes to the definition of ''target housing'' (40 CFR 745.223) which expands the universe of housing subject to the Disclosure Rule requirements. This is reflective of a change to the statutory definition (Pub. L. 115–37, Consolidated Appropriations Act, 2017, Division K, Title II, section 237(c)). This proposed conforming change to the regulatory definition of target housing to include 0-bedroom dwellings where a child resides may slightly increase the number of disclosures issued.

4. HUD Guidelines

The HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (*https://www.hud.gov/program_offices/healthy_homes/lbp/hudguidelines*) were developed in 1995 under section 1017 of Title X. The Guidelines provide detailed, comprehensive, and technical information on how to identify LBP hazards in residential housing and COFs, and how to control such hazards safely and efficiently. The Guidelines were revised in 2012 to incorporate new information, technological advances, and new Federal regulations, including EPA's LBP hazard standards. If EPA finalizes changes to the DLHS and DLCL as proposed, HUD has informed the Agency that it would likely revise Chapter 5 of the Guidelines on risk assessment and reevaluation, Chapter 12 on abatement, and Chapter 15 on clearance, and make conforming changes elsewhere as needed (Ref. 97).

B. EPA LBP Programs

1. LBP Activities Rule

LBP activities include risk assessments, inspections, and abatements. If this rule is finalized as proposed, it will have impacts to LBP activities, including: the definition of abatement, what is considered a DLHS, the DLCL used to determine whether an abatement can be considered complete, and the definition of target housing.

As stated earlier in this preamble, EPA's risk assessment work practice standards provide the basis for risk assessors to determine whether LBP hazards are present in target housing and COFs. As part of a risk assessment, dust samples are taken from floors and window sills to determine if dust-lead levels exceed the DLHS. The results of the sampling, among other things, are documented in a risk assessment report which is required under the LBP Activities Rule (Ref. 24). In addition to the sampling results, the report must describe the location and severity of any dust-lead hazards found and describe interim controls or abatement measures needed to address the hazards.

Under this proposed rule, sampling results reporting any level of lead analyzed by an NLLAP-recognized laboratory will indicate that a dust-lead hazard is present on the surfaces tested. EPA expects that the proposed DLHS will result in more hazards being identified in a portion of target housing and COFs that undergo risk assessments. This proposed rule does not change any other risk assessment requirements; however, it does recommend changes to the definition of abatement, which is discussed in the following paragraph.

Abatements are currently defined as any measures or set of measures designed to permanently eliminate lead-based paint hazards and include activities such as the removal of paint and dust, the permanent enclosure or encapsulation of lead-based paint, the replacement of painted surfaces or fixtures, and all preparation, cleanup, disposal, and post-abatement dust wipe testing activities associated with such measures. The proposed change to the definition of abatement would shift the recommendation for an abatement to when the dust-lead loadings are at or above the DLCL. Because the proposed DLCL are lower than the 2019 DLHS, more recommendations for abatement are expected. However, not every circumstance where dust-lead hazards are identified will result in an EPA recommendation for abatement, *i.e.,* when dust-lead loadings are at or above the DLHS, but below the DLCL. Similarly, EPA recommends interim controls only in circumstances when dust-lead loadings are at or above the DLCL, rather than the DLHS, for the reasons explained above.

After LBP abatements are conducted, EPA's regulations require a certified inspector or risk assessor to conduct post-abatement dust wipe testing of the abated area. If the dust wipe sample results show dust-lead loadings equal to or exceeding the applicable DLCL, ''the components represented by the failed sample shall be recleaned and retested.'' See 40 CFR part 745.227(e)(8)(vii). In other words, the abatement is not cleared until the dust wipe samples in the work area are below the DLCL. If this rule is finalized as proposed, inspectors and risk assessors would compare dust wipe sampling results for floors, window sills and troughs to the revised DLCL of 3 $\mu g/ft^2$, 20 $\mu g/ft^2$, and 25 $\mu g/ft^2$, respectively. Dust wipe sampling results at or above the DLCL would indicate that the components represented by the sample must be recleaned and retested.

Lastly, as described in Unit IV.F.1, this proposed rule conforms the regulatory definition of target housing with the statute to include any 0-bedroom dwellings constructed prior to 1978 if a child less than 6 years of age, resides or is expected to reside in such housing, which could increase the number of homes covered by this regulation. In addition, EPA is proposing regulatory changes to adjust the age requirements from 6 years of age and under, to under age 6 for the definition of target housing, COFs and living area, which could reduce the number of homes and COFs covered by this regulation; see Units IV.F.1. and 2. for more information.

2. Previous LBP-Related Activities

Since the DLHS do not compel specific EPA actions, revisions to the DLHS would not in and of themselves compel any actions under the LBP Activities Rule, retroactively or otherwise, but actions would be compelled under other laws or regulations, including HUD's LSHR and possibly those of some state, local, Tribal or territorial governments. Inspection reports and risk assessments describe conditions at a specific time. A report that indicates no presence of LBP and/or an LBP hazard should not imply the absence of those conditions in perpetuity. Additionally, the DLHS may be incorporated into requirements mandated by state, Federal, Tribal, and other programs that may require actions based on the revised DLHS. Those other authorities may want to consider guidance or other communications with their regulated communities, so those entities understand how to comply with the various programs that reference the DLHS.

The DLCL however, are used to evaluate the effectiveness of a cleaning following an abatement. After the dust wipe samples show dust-lead loadings below the DLCL, an abatement report is prepared, copies of any reports required under the LBP Activities Rule are provided to the building owner (and to potential lessees and purchasers under the LBP Disclosure Rule by those building owners or their agents), and all required records are also retained by the abatement firm or by the individuals who developed each report. The proposed DLCL of 3 $\mu g/ft^2$ for floors, 20 $\mu g/ft^2$ for window sills, and 25 $\mu g/ft^2$ for troughs would not impose retroactive requirements on regulated entities that have previously performed post-abatement clearance. These updated DLCL would only apply to post-abatement clearance sampling and analysis conducted after the compliance date for that portion of the final rule (*i.e.,* one year after publication of the final rule).

In addition, this rulemaking does not impose retroactive requirements to regulated entities that have previously complied with the Disclosure Rule. In accordance with 40 CFR 745.107, a seller or lessor generally must properly disclose any available records or reports pertaining to LBP and/or LBP hazards before the purchaser or lessee is obligated under any contract to purchase or lease target housing. The seller or lessor is not required to disclose reports or records that may be created in the future, after the close of that transaction. Additionally, any LBP-free certification that was issued by a certified inspector, and was issued before the effective date of this rulemaking, is still valid going forward and may continue to be used for exemption to the Disclosure Rule.

3. Renovation, Repair, and Painting Rule

The proposed DLHS and DLCL would not trigger new requirements under the existing RRP Rule (40 CFR part 745, subpart E). The existing RRP work practices are required where LBP is present (or assumed to be present) and are not predicated by dust-lead loadings exceeding the DLHS. The existing RRP regulations do not require dust-lead sampling prior to or at the conclusion of a renovation and are not affected by a change to the DLHS or DLCL. Therefore, RRP regulations will not be directly affected by the proposed revisions to the DLHS or the DLCL.

The RRP Rule does require specific post-renovation cleaning verification under 40 CFR 745.85(b), but the rule does not require dust wipe sampling and analysis using the DLCL. However, although optional under the RRP Rule, dust wipe sampling for clearance using the DLCL in accordance with the LBP Activities Rule (40 CFR 745.227(e)(8)) may be required by contract or by another Federal, state, territorial, Tribal, or local law or regulation. At this time, other than HUD's Lead Safe Housing Rule, for renovations of assisted target housing, EPA is not aware of other laws and regulations that require clearance testing using EPA's DLCL. EPA seeks information on this point and welcomes public comments.

4. Laboratory Quality System Requirements

As discussed previously in Unit II.C., NLLAP is an EPA program under which an accrediting organization assesses whether a paint chip, dust, or soil testing laboratory meets minimum standards for laboratory analysis to attain EPA recognition as an accredited lead testing laboratory (*https://www.epa.gov/lead/national-lead-laboratory-accreditation-program-nllap*). Laboratories and other testing firms recognized under NLLAP follow the LQSR. This rulemaking does not modify the minimum standards outlined in the latest LQSR version 3.0. However, changes to the action level (*i.e.,* the proposed DLCL) would impact the quantitation limit that NLLAP-recognized laboratories would attain to participate in the NLLAP, as that must be equal to or less than 50% of the lowest action level for dust wipe samples per specific surface area (*i.e.,* floors, window sills, window troughs) (Ref. 29). If finalized as proposed, the lowest action level for dust wipe samples would be the DLCL of 3 µg/ft² for floors, 20 µg/ft² for window sills and 25 µg/ft² for troughs. As a result, the quantitation limit for NLLAP-recognized labs would be equal to or less than 1.5 µg/ft² for floors, 10 µg/ft² for window sills and 12.5 µg/ft² for troughs.

C. Authorized Programs

Pursuant to TSCA section 404 and EPA's regulations at 40 CFR part 745, subpart Q, interested states, territories, and federally recognized Tribes may apply for and receive authorization to administer their own LBP Activities programs (as briefly described in Unit II.C.), as long as their programs are at least as protective of human health and the environment as EPA's program, and provide adequate enforcement.

As part of the authorization process, states, territories, and federally recognized Tribes must demonstrate to EPA that they meet the requirements of the LBP Activities Rule. A state, territory, or federally recognized Tribe must demonstrate that it meets any new requirements imposed by this rulemaking upon finalization in its application for authorization or, if already authorized, in a report submitted under 40 CFR 745.324(h) no later than two years after the effective date of the new requirements. If an application for authorization has been submitted but not yet approved, the state, territory, or federally recognized Tribe must demonstrate that it meets the proposed requirements either by amending its application, or in a report it submits under 40 CFR 745.324(h) no later than two years after the effective date of the new requirements (40 CFR 745.325(e)).

VI. Proposed Effective and Compliance Dates

EPA is proposing that the final rule would become effective on the date that is 60 days after publication in the **Federal Register**. The Agency is proposing an extended compliance date of one year for the DLHS, the DLCL, and the change to the abatement report requirements (40 CFR 745.65 definition ''dust-lead hazard''; 40 CFR 227(h)(3)(i); 40 CFR 745.227(e)(8)(viii) and (10)(vii)). EPA seeks comment on the appropriate compliance date, including whether the compliance date should be six months, eighteen months, two years or another longer timeframe, as well as the justification for the change.

EPA has considered the impacts of the proposed DLHS and DLCL on NLLAP-recognized laboratories and is proposing a subsequent compliance date of one year after publication of the final rule in **Federal Register** for certain provisions under this rulemaking. The proposed compliance date is intended to provide a reasonable amount of time for NLLAP-recognized laboratories to take actions to meet the lower LQSR quantitation limit (50% of the lowest action level for dust wipe samples) so they can continue providing dust wipe testing services to the regulated community and in emergent situations by the compliance date for the revised standards.

To obtain a better understanding of laboratories' capability and capacity for dust wipe testing, EPA conducted teleconferences with nine NLLAP-recognized laboratories (Refs. 56, 57, 58, 59, 60, 61, 62, 63 and 64). As explained in Unit IV.B., based on the information EPA received from this outreach, EPA believes that laboratories with more up to date ICP–AES instruments and optimized methods should be able to satisfy the LQSR dust wipe testing procedures and the regulatory limit of the primary DLCL option of 3 µg/ft² for floors, 20 µg/ft² for window sills and 25 µg/ft² for troughs (quantitation limit of 1.5 µg/ft² for floors, 10 µg/ft² for window sills and 12.5 µg/ft² for troughs). However, FAAS is the most ubiquitous equipment used, and EPA is estimating that accredited laboratories may buy new equipment to meet the lower LQSR limits. Based on the outreach performed, laboratories may need as little as six months but as much as 18 months to finance and obtain new equipment (such as ICP–AES), hire and train staff, and potentially receive new NLLAP accreditation (Refs. 56, 57 and 62). Two laboratories said it could take as much as two years to adjust to hypothetical regulatory changes such as the ones being proposed (Refs. 58 and 59).

EPA therefore believes that the proposed compliance date provides the needed flexibility for laboratories while ensuring that the revised DLHS and DLCL become effective in a timely manner. However, in consideration of the feedback received from NLLAP-recognized laboratories during the Agency's outreach efforts, EPA is requesting comment on the proposed compliance date, whether six-months is appropriate for the primary DLCL option (*i.e.,* 3/20/25 µg/ft²) or if 12 months, 18 months, or some other amount of time is necessary, and why the extra time is needed.

Additionally, if the alternative DLCL is finalized (*i.e.,* 5/40/100 µg/ft²), based on the laboratory outreach, EPA has increased confidence that laboratories can numerically quantify dust-lead levels of 5 µg/wipe and attain a quantitation limit of equal to or less than 50% of that level (*i.e.,* 2.5/20/50 µg/ft²) with FAAS technology, especially if the area tested is doubled from one square foot to two. EPA is also requesting comment on whether NLLAP-recognized laboratories would still need a six-month compliance date if the Agency finalized the alternative DLCL, or if 12-months, 18-months, or some other amount of time would be necessary to provide the flexibility that laboratories need in that scenario and why.

EPA is also proposing a six-month compliance date for the DLHS along with the DLCL and is interested in revising both standards at the same time to reduce any confusion and avoid any concerns within the regulated community that may be caused by staggering the DLHS and the DLCL compliance dates. EPA believes that since the DLHS are non-numeric which is different than they have been historically, and as the program is shifting to the DLCL becoming the ''action level'' for the LQSR, it is important to allow ample time for the regulated community to adapt to the revised DLHS and DLCL. Additionally, if the DLHS compliance date occurred before the DLCL compliance date, EPA is concerned it may trigger unnecessary confusion for laboratories. EPA is requesting comment on the appropriateness of the DLHS and the DLCL having the same compliance date.

VII. Request for Comments

A. Proposed Dust-Lead Hazard Standards

EPA is seeking input on its proposal to lower the DLHS to any reportable level of dust-lead analyzed by an NLLAP-recognized laboratory, and the two alternative approaches to revising the DLHS—the numeric standard approach and the post-1977 background approach. EPA is requesting feedback not only on all the approaches considered but also on all the DLHS options themselves outlined in the preamble and within the TSD. EPA is requesting comment on the appropriateness of EPA's interpretation of ''any reportable level.'' EPA is also requesting comment on whether laboratories believe there are potential inconsistencies with the lowest reportable level within any one laboratory or across the industry, the extent of these inconsistencies, and if laboratories foresee this causing any concern for their clients. EPA is also requesting comment on the effects of not setting the DLHS at a fixed numeric value, and whether any potential inconsistencies with individual laboratory reporting levels (when interpreting dust-lead results in relation to the hazard standards), would cause challenges for the regulated community or other stakeholders, *e.g.,* building owners or residents.

EPA is also seeking any information or data for a level of dust-lead exposure that would not result in adverse health effects, and any information on how much exposure in terms of BLL or change in IQ decrement would be the most scientifically appropriate to compare to the modeled results or as a rationale to set the DLHS, including the appropriate threshold of probability of exceedance for a child from the sub-population of interest.

B. Proposed Dust-Lead Clearance Levels and Alternatives

EPA is requesting comment on its proposal to lower the DLCL to 3 µg/ft^2 for floors, 20 µg/ft^2 for window sills, and 25 µg/ft^2 for troughs. EPA is requesting comment on NLLAP-recognized laboratories' ability to test to these clearance levels, especially given that, if finalized as proposed, the quantitation limit would be 50% of the DLCL (*i.e.,* 1.5/10/12.5 µg/ft^2) for laboratories that remain in NLLAP. EPA is also requesting comment on whether LBP professionals can clean/achieve clearance at these levels. EPA is also interested in feedback on whether the primary or alternative DLCL option is preferred and if they appropriately take into account reliability, effectiveness, and safety. Also, in some cases, window sills and troughs may have a small surface area, and therefore, EPA is requesting comment on the ability to collect a sufficient amount of dust-lead to meet all laboratories' quantitation limits with their existing analytical equipment or any other equipment that might be necessary for the DLCL primary and secondary options presented. EPA is also requesting comment on whether there is any data or information on whether window sills and window troughs should have the same clearance values, and why or why not. EPA is interested in both feedback and justification for whether a higher trough value such as 100 µg/ft^2 or if another DLCL combination (for floors, window sills and window troughs) besides the primary and alternative options considered is appropriate given the statutory criteria of reliability, effectiveness, and safety. Lastly, EPA requests comment on whether or not the proposed DLCL would discourage initiation of elective dust-lead remediation altogether.

Additionally, EPA is seeking input on a phased approach of establishing the alternative, higher DLCL first (5/40/100 µg/ft^2) and then in a specific amount of time, *e.g.,* three years, lowering it to the primary DLCL value (3/20/25 µg/ft^2). This phased approach would give laboratories with FAAS equipment time to purchase the more sensitive equipment needed to achieve the lower levels, hire new employees, become accredited with the new equipment, etc. EPA requests feedback on whether this is an approach that should be considered and, if so, what would be an appropriate amount of time between the first and second lowering of the DLCL.

C. Other Amendments

EPA is seeking comment on whether the changes to the definition of abatement make it clear that abatements should only be recommended when the dust-lead loadings are at or above the DLCL, rather than at or above the DLHS as it has been historically. EPA is also interested in receiving feedback on its proposed changes to 40 CFR 745.227(h) (to alleviate potential regulatory confusion surrounding clearance); as well as the additional language being added to the abatement report requirements, including whether EPA should make similar modifications to the risk assessment report requirements to add specific language explaining that abatements should only be recommended when the dust-lead loadings are at or above DLCL. EPA is also requesting comment on the effectiveness of the proposed language in the abatement report requirements to educate the public on remaining dust-lead hazards, promote behavior change, and point them to educational materials such as *Protect Your Family.* In those circumstances where the additional language would be added to abatement reports, EPA is also interested in feedback on whether the *Protect Your Family* materials themselves should be included alongside the abatement report and why *Protect Your Family* should be included. Separately, due to feedback received during the UMRA/federalism consultation: EPA is also interested in feedback on whether additional communication materials would be beneficial for public housing authorities to have access to in order to provide to residents living in homes with dust-lead hazards. If so, EPA is requesting information on what type of materials, for what DLHS and DLCL options, and for which type of stakeholder/end user (if there are any besides public housing authorities) would be helpful.

EPA is seeking comment on all other amendments including the conforming change to the definition of target housing to provide consistency with the statutory change to the definition, as well as the conforming edits to children's age (*i.e.,* under six) to provide consistency within the LBP regulations. EPA is requesting comment on how long after final rule publication the compliance date should be. EPA is proposing to establish a compliance date for the DLHS and DLCL that would occur on the date that is one year after the publication date of the final rule in the **Federal Register**. The Agency invites public comment on the adequacy of the proposed compliance date. EPA is also seeking feedback from states, territories, or Tribes that are authorized by EPA to operate their own LBP activities programs, on the impact of this proposed rule and if it will have substantial direct effects on the states, territories, or Tribes, on the relationship between the U.S. government and the states, territories, or Tribes, or on the distribution of power and responsibilities among the various levels of government or between the Federal Government and Indian Tribes, such as whether states, territories, or Tribes may relinquish their programs back to EPA.

D. Methods, Models and Data

EPA is also requesting comment on the methods, models and data used in the EA and the TSD that accompany this proposal. In particular, EPA requests comment on the EA's use of the lifetime IQ concentration-response function to calculate IQ loss for ages for young children, particularly at low exposure levels (see section 6.4 in the EA). Additionally, EPA solicits comment and peer reviewed information on evidence relevant to quantifying and monetizing the incremental contribution of blood lead concentrations to other health and/or behavioral endpoints, including adult cardiovascular mortality.

EPA is proposing to update its regulatory definition of target housing to conform to the 2017 revised statutory language (see Unit IV.F.1.). EPA estimates that there are 10,850 pre-1978 dwellings that would be affected because they have zero bedrooms and a child under the age of 6 resides in them. EPA's EA for this action (Ref. 14) estimates that the total annual cost (including complying with existing lead-based paint program requirements for disclosure for real estate transactions, disclosure for renovation activities, abatement, and the renovation, repair and painting rule) in newly defined target housing would be $0.2 million. EPA's analysis also estimates that the annual benefits of these requirements would be $3.7 million using a 3% discount rate and $0.8 million using a 7% discount rate. EPA requests comment on its estimate of the number of affected housing units, and on the methods and assumptions it used to estimate the costs and benefits resulting from aligning its regulatory definition with the revised statutory definition.

EPA is proposing to require submissions for applications, application payments, and abatement and training notifications notices for the lead paint program be made electronically, instead of through mail, fax, or hand delivery (see Unit IV.F.3.). Based on its EA for this action (Ref. 14), EPA expects that this automation would save firms switching to electronic reporting an average of 5 hours per firm in labor, and that across all affected firms the change would result in total annual savings of approximately $20,000 using a 3% discount rate and $10,000 using a 7% discount rate. EPA solicits comment on the benefits and costs of requiring such electronic reporting.

Certain provisions of the HUD LSHR require lead hazard reduction activities when dust-lead levels exceed the DLHS. Given the nature of the proposed GTZ approach, in order to account for these activities in its EA (Ref. 14), EPA estimated what the reportable levels would be under the GTZ options, based on the analytical equipment that laboratories would likely use under these options. According to the LQSR, NLLAP-recognized laboratories must be able to demonstrate a quantitation limit less than or equal to half of the action level in order to maintain or obtain NLLAP recognition. Since the action level under the GTZ options would be the DLCL, the floor and window sill reporting levels estimated for analytical purposes for the GTZ options vary depending on the DLCL levels that the GTZ is paired with. Because some types of laboratory equipment have quantitation levels well below half of the DLCL options, EPA estimated the reporting limits for the mix of analytical instruments likely to be used under the GTZ options in order for the quantitation limits to be at least half of the DLCL. EPA solicits data on the distribution of quantitation limits for different types of analytical instruments in order to allow the Agency to refine its estimates of the reportable levels under the GTZ/DLCL options that the Agency is considering. EPA also requests data on the false positive and false negative rates for testing lead in dust using different types of analytical equipment (*e.g.,* FAAS, ICP–AES, and ICP–MS).

EPA requests data on costs for dust-lead testing that the Agency can use to refine its EA for the final rule. EPA also solicits information and comments related to any other data, assumptions, or methodology that EPA used to estimate the costs of the proposed rule, or on any costs that EPA did not quantify. EPA also requests comment on potential changes to the proposed rule that would reduce impacts on small entities while being consistent with statutory requirements and still achieving the rule's objectives.

Also, due to feedback from the UMRA/federalism consultation EPA is interested in any comments that can provide information on COFs, particularly any information that could help inform an EA, such as data on the number and cost of abatements partnered with recent dust-lead loading results, how many children under six were present in the COF at the time, etc. Based on the information available to it at the time of the proposal, EPA was unable to quantify benefits to children visiting COFs that would be affected by this rule. Since the data EPA used were only associated with the abatements in states, territories and tribes where the Agency administers the lead-based paint activities program, EPA specifically requests data on COF abatements in the jurisdictions that are authorized to administer their own lead abatement programs. EPA also requests information on the typical practices of environmental investigations at child-occupied facilities, and whether or how these practices may differ by type of COF (*e.g.,* public school, private school, daycare center). EPA is interested in whether state/local requirements ever require routine dust wipe testing at COFs in the absence of a child with a blood lead level above a state or Federal action level, or how often COFs proactively have their dust-lead levels voluntarily tested. EPA would also welcome information on whether, in real-world practice, COFs always undergo dust wipe testing when a child who frequents the facility has a BLL above state or Federal action levels, or whether COFs are only tested if an investigation of the affected child's home reports no LBP, and if there are other circumstances that might lead to dust wipe testing at a COF.

Based on the information available to it at the time of the proposal, EPA was unable to quantify benefits to children visiting COFs that would be affected by this rule. EPA requests information that would allow it to estimate such benefits for the final rule. EPA requests comment on data sources for parameterizing the R–SHEDS–IEUBK model used in the TSD and EA to estimate changes in blood lead levels for COFs (given that children's activity and exposure patterns may differ between housing and COFs, and the model is not calibrated or validated for predicting blood lead level changes in COFs), as well as how to avoid double-counting benefits between activities in target housing and COFs. EPA requests comment on sources of data including: children's activity patterns while attending COFs, physical parameters of COFs including area covered by different flooring material types, number and type of windows, and information on frequency of maintenance and cleaning. EPA also requests information on the range of baseline blood lead levels or lead exposures across the population of children that visit a COF where an abatement occurs.

EPA also requests information and data on the potential economic and health impacts to current residents and landlords of housing that is subsidized by tenant-based rental or project assistance programs run by HUD or USDA. EPA also requests comment on whether there are other types of assisted housing programs where there is a significant risk of landlords withdrawing from the program due to this rulemaking; specific factors that determine whether landlords would stop participating in Federal assistance programs; and estimates of the cost elasticity of landlord participation in such programs. EPA also welcomes comment and/or data that provides evidence for direct or indirect health impacts associated with relatively higher potential lead exposures in regard to housing insecurity attributable to housing quality standards (both generally and specific to lead-related standards).

EPA is requesting comment on research, studies, modeling, data, and any other information on the effects of the availability of target housing units for low-income families, including assisted target housing units, due to housing quality standards. Furthermore, EPA requests comment on potential impacts to the non-federally-assisted rental housing market, particularly naturally-occurring low-income housing, due to housing quality standards, including quantitative evidence of housing instability or differential housing outcomes or lead exposures for families with young children that have resulted from local, state, or Federal lead paint regulations.

E. Other Requests for Comment

Finally, EPA is requesting comment on the impacts on NLLAP-recognized dust-lead laboratories, through considerations such as: added turnaround time for testing analysis (affecting re-occupancy, including temporary housing costs adding to overall project costs); added laboratory costs and the possibility of increasing project costs; and possible loss to NLLAP-recognized laboratories that cannot or do not want to make the investment and/or reduce their throughput at the proposed lower DLHS and DLCL. EPA is also interested in information about possible solutions for any unintended consequences of the lower DLHS and DLCL (which are consistent with the 2021 Court Opinion that instructed EPA to consider only health factors when setting the DLHS and affirmed that EPA could consider other factors *i.e.,* reliability, effectiveness, and safety, when setting the DLCL).

In addition to the areas which EPA has specifically requested comment, EPA requests comment on all other aspects of this proposed rule.

VIII. References

The following is a list of the documents that are specifically referenced in this document. The docket includes these documents and other information considered by EPA, including documents that are referenced within the documents that are included in the docket, even if the referenced document is not physically located in the docket. For assistance in locating these other documents, please consult the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

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9. President's Task Force on Environmental Health Risks and Safety Risks to Children. *Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts.* December 2018. *https://www.epa.gov/lead/federal-action-plan-reduce-childhood-lead-exposure.*
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11. U.S. Court of Appeals for the Ninth Circuit. *A Community Voice* v. *EPA,* No. 19–71930, Opinion. May 14, 2021. *https://cdn.ca9.uscourts.gov/datastore/opinions/2021/05/14/19-71930.pdf.*
12. Executive Order 13990. Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis. **Federal Register** (86 FR 7037, January 25, 2021). *https://www.govinfo.gov/content/pkg/FR-2021-01-25/pdf/2021-01765.pdf.*
13. The White House. Fact Sheet: List of Agency Actions for Review. January 20, 2021. *https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/20/fact-sheet-list-of-agency-actions-for-review/.*
14. EPA. Economic Analysis of the Proposed Reconsideration of the Dust-Lead Hazard Standards and Post-Abatement Clearance Levels. June 2023.
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IX. Statutory and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at *https://www.epa.gov/laws-regulations/laws-and-executive-orders.*

A. Executive Orders 12866: Regulatory Planning and Review and 14094: Modernizing Regulatory Review

This action is a ''significant regulatory action'' as defined under section 3(f)(1) of Executive Order 12866 (58 FR 51735, October 4, 1993), as amended by Executive Order 14094 (88 FR 21879, April 11, 2023). Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under Executive Order 12866. Documentation of any changes made in response to the Executive Order 12866 review is available in the docket. The Agency prepared an analysis of the potential costs and benefits associated with this action, this analysis (Ref. 14), is available in the docket.

B. Paperwork Reduction Act (PRA)

The information collection activities in this proposed rule have been submitted for review and approval to OMB under the PRA, 44 U.S.C. 3501 *et seq.* The Information Collection Request (ICR) document that the EPA prepared has been assigned EPA ICR No. 2760.01 (Ref. 98). You can find a copy of the ICR in the docket for this rule, and it is briefly summarized here.

The ICR addresses the incremental changes to the existing reporting, notification, and recordkeeping programs that are currently approved under OMB Control Nos. 2070–0151 and 2070–0195. As approved under OMB Control No. 2070–0151 and pursuant to 24 CFR part 35, subpart A, and 40 CFR 745, subpart F, sellers and lessors of target housing must already provide purchasers or lessees any available records or reports ''pertaining to'' LBP and/or LBP hazards available to the seller or lessor. Accordingly, a seller or lessor must disclose any reports showing dust-lead levels, regardless of the value. A lower hazard standard may prompt a different response on the already required lead disclosure form, *i.e.,* that a lead-based paint hazard is present rather than not, which would occur when a dust-lead level is below the current standard but at or above a lower final standard. However, for existing target housing, this action would not result in additional disclosures because the lead disclosure form is required regardless of whether dust-lead is present at or below the hazard standard. Nevertheless, due to the change in target housing definition, EPA estimates an additional 967 disclosure events will occur annually, which will affect 3,040 respondents at an average burden and cost of 0.08 hours and $4.37 per respondent, resulting in a total annual burden of 337 hours at a total annual cost of $13,272.

Next, as approved under OMB Control No. 2070–0195, the ICR addresses the information collection activities associated with the reporting and recordkeeping requirements for individuals, firms and state and local government entities conducting LBP activities or renovations of target housing and COFs; training providers; and states/territories/Tribes/Alaska Native villages. These information collection activities include the following:

- LBP activity firm pre-abatement reports and occupant protection plans, abatement activity notifications, post-abatement reports and recordkeeping;
- Applications for certification of individuals performing LBP activities, and related recordkeeping;
- LBP activities training provider accreditation applications, training notifications, and recordkeeping;
- LBP activity firm certification applications and recordkeeping;
- Distribution of pre-renovation lead hazard information pamphlet and post-renovation checklists documenting lead-safe work practices;
- RRP and LBP professionals classroom training time related to recordkeeping compliance;
- RRP training provider accreditation applications, training notifications, and recordkeeping;
- Private RRP firm and Government-employed RRP professional certification applications and recordkeeping; and
- Submission of related fees.

Incremental abatement notifications would be required when an abatement occurs due to the revised DLHS/DLCL and does not occur in the baseline; EPA estimates that 1,618 to 2,404 such notifications will incur average annual paperwork-associated costs of $149. Additional LBP workers may need to be hired and subsequently trained and certified to accommodate the additional dust-lead remediation activities triggered by the revised DLHS/DLCL. EPA estimates that 2,237 to 3,971 respondents will incur average annual paperwork-associated costs of $432. Because the EA finds that the revised DLHS/DLCL would increase the number of new lead hazard reduction events by no more than 5 per firm per year, EPA assumes that existing LBP activity firms would cover this new work and new entrants are unlikely to emerge. As such, EPA does not estimate any paperwork costs associated with LBP activity firm certification. Similarly, the EA finds that there would be fewer than 1 incremental event per affected RRP firm and therefore EPA assumes no new RRP firms or employees will enter the market in response to the DLHS/DLCL revision. As such, EPA does not estimate any paperwork costs associated with RRP firm certification or RRP training.

The revisions to the definition of target housing will result in paperwork costs in two dimensions. First, abatement firms operating in newly defined target housing are expected to incur reporting and recordkeeping costs for those additional events. EPA estimates that 25 respondents will incur an average annual cost of $89.21 for these activities. Second, renovation service firms performing renovation activities in newly defined target housing are required to perform disclosure activities. This will result in recurring disclosure event, recordkeeping, and materials costs. EPA estimates that 1,977 respondents will incur an average annual cost of $14.73.

In addition, EPA currently receives approximately 90 percent of required notifications as well as applications for accreditation, certification, and re-certification from training providers, firms, and lead abatement individuals through EPA's Central Data Exchange (CDX). The paperwork activities, related burden and costs with CDX user registration for those who elect to exercise the electronic submission option established under the Agency's Cross-media Electronic Reporting Rule (CROMERR) (40 CFR 3) are described in an ICR approved under OMB Control No. 2025–0003. The amended information collection activities contained in this proposed rule are designed to assist the Agency in meeting its responsibility under TSCA to receive, process, and review reports, data, and other information. Accordingly, this proposed rule would require regulated parties to submit notifications and applications through CDX.

The ICR prepared for this proposed rule addresses the incremental burden changes related to the expected increase in the number of responses to the activities considered in the other existing ICRs, as well as the changing response obligation for the use of CDX from voluntary to mandatory.

Respondents/affected entities: Persons engaged in selling or leasing certain residential dwellings built before 1978; persons who are engaged in lead-based paint activities and/or perform renovations of target housing or child-occupied facilities for compensation, dust sampling, or dust testing; persons who perform lead-based paint inspections, lead hazard screens, risk assessments or abatements in target housing or child-occupied facilities; persons who provide training or operate a training program for individuals who perform any of these activities; state, territorial or Tribal agencies that administer lead-based paint activities and/or renovation programs. See also Unit I.A.

Respondent's obligation to respond: Mandatory (40 CFR part 745).

Estimated number of respondents: 8,897 to 11,417 (per year).

Frequency of response: On occasion.

Total estimated burden: 23,329 to 38,985 hours (per year). Burden is defined at 5 CFR 1320.3(b).

Total estimated cost: $1.3 million to $2.1 million (per year), includes no annualized capital or operation and maintenance costs.

Under the PRA, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for certain EPA's regulations in 40 CFR are listed in 40 CFR part 9, and on associated collection instruments.

Submit your comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the EPA using the docket identified at the beginning of this rule. You may also send your ICR-related comments to OMB's Office of Information and Regulatory Affairs using the interface at *www.reginfo.gov/public/do/PRAMain.* Find this particular information collection by selecting ''Currently under Review—Open for Public Comments'' or by using the search function. EPA will respond to ICR-related comments in the context of the final rule.

C. Regulatory Flexibility Act (RFA)

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA, 5 U.S.C. 601 *et seq.* The small entities subject to the requirements of the revised DLHS and DLCL are small businesses that are landlords who may incur costs for lead hazard reduction measures in compliance with the HUD's LSHR; elementary and secondary schools or child day care services (who make incur costs associated with COFs); residential remodelers (who may incur costs associated with additional cleaning and sealing in houses undergoing rehabilitation or ongoing lead-based paint maintenance subject to the HUD LSHR); and abatement firms (who may also incur costs associated with additional cleaning and sealing under the LSHR). The Agency has determined that approximately 39,000 small businesses would be directly affected by the revised DLHS and DLCL, of which 87% to 91% have cost impacts less than 1% of revenues, 9% to 12% have impacts between 1% and 3% of revenues, and 1% have impacts greater than 3% of revenues. The total estimated costs to small businesses are between $303.1 million and $414.4 million per year.

Additionally, the rule's other amendments may potentially affect four types of small entities: property owners that will incur recordkeeping and material costs for real estate disclosures in newly defined target housing; renovation firms that will incur renovation disclosure costs and lead-safe work practice costs in newly defined target housing; LBP activities firms that will incur reporting and recordkeeping costs for abatement activities in newly defined target housing; and EPA-certified training providers that may incur costs for submitting reports electronically. The Agency has determined that approximately 2,998 small businesses would be directly affected by the amendment to the target housing definition, of which 100% have cost impacts less than 1% of revenues. The Agency has determined that approximately 86 small businesses would be directly affected by the amendment to the electronic reporting requirement, of which 100% have cost impacts less than 1% of revenues. All details of the analysis of potential costs and benefits associated with this action are presented in EPA's EA, which is available in the docket (Ref. 14).

The EA estimates potential costs from the revised DLHS and DLCL for activities in two types of target housing and COFs—those subject to the HUD LSHR and those where a child with a blood lead level exceeding a Federal or state threshold lives. Importantly, the DLHS do not require the owners of properties covered by this proposed rule to evaluate their properties for the presence of dust-lead hazards, or to act if dust-lead hazards are identified. Although the DLHS and DLCL do not compel specific actions under the LBP Activities Rule to address identified LBP hazards, the DLHS and DLCL are directly incorporated by reference into certain requirements mandated by HUD in the housing subject to the LSHR. Aside from the HUD regulations, and, perhaps some state or local regulations, the DLHS and DLCL do not impose new Federal requirements on small entities.

D. Unfunded Mandates Reform Act (UMRA)

This action contains a Federal mandate under UMRA, 2 U.S.C. 1531–1538, that may result in expenditures of $100 million or more for State, local, and Tribal governments, in the aggregate, or the private sector in any one year. Accordingly, EPA has prepared the written statement required under section 202 of UMRA (Ref. 17). The statement is included in the docket for this action and is briefly summarized here.

1. Authorizing Legislation

This rulemaking is issued under the authority of TSCA sections 401, 402, 403, 404, and 406, 15 U.S.C. 2601 *et seq.,* as amended by Title X of the Housing and Community Development Act of 1992 (also known as the Residential Lead-Based Paint Hazard Reduction Act of 1992 or ''Title X'') (Pub. L. 102–550) (Ref. 1) and section 237(c) of Title II of Division K of the Consolidated Appropriations Act, 2017 (Pub. L. 115–31, 131 Stat. 789), as well as sections 1004 and 1018 of Title X (42 U.S.C. 4851b, 4852d), as amended by section 237(b) of Title II of Division K of the Consolidated Appropriations Act, 2017.

2. Cost-Benefit Analysis

The EA (Ref. 14) presents the costs of the rule as well as various regulatory options, and is summarized in Unit I.E. The rule is estimated to result in total compliance costs of $536 million to $784 million per year. Thus, the annual cost of the rule to the private sector (and State, local, and Tribal governments) in the aggregate exceeds the inflation-adjusted $100 million UMRA threshold.

This rule will reduce exposures to lead, resulting in benefits from avoided adverse health effects. For the subset of health effects where the results were quantified, the estimated annualized benefits are $1.069 billion to $4.684 billion per year using a 3% discount rate and $231 million to $1.013 billion per year using a 7% discount rate. There are additional unquantified benefits due to other avoided health effects.

Net benefits are the difference between benefits and costs. The rule is estimated to result in quantified net benefits of $532 million to $3.899 billion per year using a 3% discount rate and −$302 million to $231 million per year using a 7% discount rate. EPA considers unquantified health benefits to be potentially important non-monetized impacts that contribute to the overall net benefits of this rule.

3. State, Local, and Tribal Government Input

EPA sought input from State and local government representatives early in the rulemaking process during the joint intergovernmental consultation initiated in November 2022 and will continue to engage these partners throughout the rulemaking process. EPA's experience in administering the existing LBP activities program under TSCA section 402 suggests that these governments will play a critical role in the successful implementation of the national program to reduce exposures to LBP hazards.

This action is not subject to the requirements of UMRA section 203 because it contains no regulatory requirements that exceed the inflation-adjusted cost significance threshold or uniquely affect small governments. Additionally, although EPA does not believe that this action would impose an unfunded mandate on Tribal governments or otherwise have substantial direct effects on one or more federally recognized Indian Tribes as specified in Executive Order 13175, the Agency is soliciting input from Tribal officials during the public comment period.

E. Executive Order 13132: Federalism

EPA has concluded that this action has federalism implications, as specified in Executive Order 13132 (64 FR 43255, August 10, 1999), because it imposes substantial direct compliance costs on public housing authorities that state or local governments may be obligated to offset, and while some HUD funding for LBP projects exists, the Federal Government may not provide the funds necessary to pay the entirety of the costs. These costs to public housing authorities—estimated at $143 million for the primary option—cover additional lead hazard reduction activities, cleaning, and dust-lead testing to ensure that public housing units are in compliance with the LSHR. Public school districts that administer COFs are also estimated to have annual compliance costs of approximately $904 thousand. Additionally, states that have authorized LBP Activities programs must demonstrate that they have DLHS and DLCL at least as protective as the levels at 40 CFR 745.65 and 40 CFR 745.227. However, authorized states are under no obligation to continue to administer the LBP Activities program, and if they do not wish to adopt the new DLHS and DLCL they can relinquish their authorization. In the absence of a state authorization, EPA will administer these requirements.

EPA provides the following federalism summary impact statement. EPA consulted with state and local officials early in the process of developing the proposed action to permit them to have meaningful and timely input into its development. EPA invited the following national organizations representing state and local elected officials to a consultation meeting on November 10, 2022: National Governors' Association, National Conference of State Legislatures, U.S. Conference of Mayors, National League of Cities, Council of State Governments, International City/County Management Association, National Association of Counties, National Association of Towns and Townships, County Executives of America, and Environmental Council of the States. Additionally, the agency invited professional organizations that represent or have state and local government members, such as Public Housing Authorities Directors Association, Council of Large Public Housing Authorities, Association of State and Territorial Health Officials, American Public Works Association, and other groups to participate in the meeting.

During the consultation EPA presented an overview on LBP terminology, authorized programs and background on the DLHS and the DLCL, including the relevant statutory authority and regulatory and litigation history. EPA also discussed potentially impacted entities, especially those relevant to the organizations present, as well as the three regulatory approaches for DLHS (*i.e.,* GTZ, numeric standard, and the post-1977 background) and what the Agency is considering while revising the DLCL. EPA concluded the consultation with a description of the preliminary costs and benefits, an update on target housing revisions, and a series of targeted questions for organizations' consideration.

Throughout the presentation several clarifying questions/comments were posed and responded to about the program requirements, triggers, and impacted entities. One commenter inquired whether cost estimates were included for COFs. EPA responded that the costs to COFs had not been considered; these costs are now included in the analysis. The Agency has also added a request for comment seeking additional data on COFs, see Unit VII.

Additionally, two commenters expressed concerns about having adequate funding for public housing authorities to meet their basic needs, such as electricity, and the inability to be proactive about issues such as lead, due to those same financial concerns. EPA appreciates those concerns being highlighted and will note that according to the 2021 Court Opinion the Agency cannot take into account non-health factors, such as costs, when revising the DLHS. However, the Agency can consider non-health factors when revising the DLCL. In this proposal EPA has a lower primary and higher alternative DLCL, which the Agency is requesting comment on. EPA has also spoken to nine NLLAP laboratories and has incorporated their feedback into the discussion surrounding DLCL within Unit IV.B. EPA is also requesting comment on a phased approach for the DLCL (*i.e.,* lowering the DLCL to the alternative and then the primary options), and on whether this proposal will have impacts on tenants or landlords of public housing, including the potential to impact availability of federally assisted housing.

After the consultation was complete, EPA provided the organizations and officials an opportunity to provide follow-up comments in writing. The Agency received one comment from a non-profit organization whose members consist of over seventy large public housing authorities (Ref. 99). The commenter highlighted that a large portion of public housing properties are dated, resulting in many families and children who are living in dated housing units. They explained that public housing authorities have unmet financial needs and strongly encouraged the Agency to consider costs when revising the DLCL. The commenter expressed concerns about the lower DLCL resulting in a need to switch laboratory technology to ICP, which could require a larger surface area, increase turnaround time and an increase in costs. Feedback on all three DLHS approaches was also provided, notably that the post-1977 background approach would incur the highest costs and was ''undesirable as currently presented'' and the commenter emphasized the importance of communication materials and clear communication surrounding the GTZ approach.

The Agency appreciates the feedback provided to the EPA during the consultation process. Regarding concerns over the laboratories moving to ICP, EPA conducted laboratory outreach and included their feedback in this proposed rule. EPA is proposing the primary DLCL of 3/20/25 µg/ft² and is also proposing an alternative DLCL of 5/40/100 µg/ft² and requesting comment on both options. As mentioned above, EPA is also requesting comment on a phased approach to lowering the DLCL, as well as the proposal to extend the compliance date by one year and whether it should be shorter or longer to allow laboratories adequate time to adjust. Additionally, the Agency agrees that communication surrounding the GTZ approach may be an important element of this rulemaking and has added in an additional request for comment in Unit VII.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have Tribal implications as specified in Executive Order 13175 (65 FR 67249, November 9, 2000), because it will not have substantial direct effects on Tribal governments, on the relationship between the Federal Government and the Indian Tribes, or on the distribution of power and responsibilities between the Federal Government and Indian Tribes. Federally recognized Tribes that have authorized LBP Activities programs must demonstrate that they have DLHS and DLCL at least as protective as the levels at 40 CFR 745.65 and 40 CFR 745.227. However, these authorized Tribes are under no obligation to continue to administer the LBP Activities program, and if they do not wish to adopt the new DLHS and DLCL they can relinquish their authorization. In the absence of a Tribal authorization, EPA will administer these requirements. This action does not create an obligation for Tribes to administer LBP Activities programs or alter EPA's authority to administer these programs. For these reasons, Executive Order 13175 does not apply to this action. However, EPA still intends to hold a Tribal consultation on this rulemaking in order to solicit input from Tribal officials from the four Indian Tribes with authorized programs during the public comment period. This consultation will also be open to any Tribal officials who would like to participate. EPA will ensure that the consultation materials are accessible to Tribal officials so that they may view it later as they consider submitting feedback during the public comment period. If a Tribal official is interested in attending the consultation on behalf of an Indian Tribe, please consult the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

Executive Order 13045 (62 FR 19885, April 23, 1997) directs Federal agencies that Federal health and safety standards must include an evaluation of the health and safety effects of the planned regulation on children. This action is subject to Executive Order 13045 because it is a significant regulatory action under section 3(f)(1) of Executive Order 12866, and EPA believes that the environmental health or safety risk addressed by this action has a disproportionate effect on children as they are more susceptible to the adverse health effects of lead due to their behavior and physiology. Accordingly, we have evaluated the environmental health or safety effects of dust-lead exposure on children.

The results of this evaluation are contained in Unit I.E. and in the EA and TSD, where the health impacts of lead exposure on children are discussed more fully (Refs. 14 and 16). The documents referenced above are available in the public docket for this action.

The proposed DLHS aligns with the current state of the science, which does not support identifying a threshold of dust-lead exposure below which there would be no adverse human health effects; while the proposed DLCL is more health protective than the alternative in that it results in the least amount of dust-lead left on a surface after the completion of an abatement. EPA is proposing to revise the DLCL given the statutory criteria of reliability, effectiveness, and safety. Furthermore, EPA's Policy on Children's Health also applies to this action. Discussion about how the Agency applied this policy is presented in Unit I.E.6.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

This action is not a ''significant energy action'' as defined in Executive Order 13211 (66 FR 28355, May 22, 2001), because it is not likely to have a significant adverse effect on the supply, distribution or use of energy.

I. National Technology Transfer and Advancement Act (NTTAA) and 1 CFR Part 51

This action involves technical standards under NTTAA section 12(d), 15 U.S.C. 272 *note.* ASTM E1728 and ASTM E1792 are already cited in an existing regulatory definition of ''wipe sample'' at 40 CFR 745.63. EPA is proposing to formally incorporate the most current version of these standards (*i.e.,* ASTM E1728–20 and ASTM E1792–20). Additional information about these standards, including how to access them, is provided in Unit IV.F.8.

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629, February 16, 1994) directs Federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations (people of color and/or indigenous peoples) and low-income populations.

EPA believes that the human health or environmental conditions that exist prior to this action result in or have the potential to result in disproportionate and adverse human health or environmental effects on people of color, low-income populations and/or Indigenous peoples. See discussion in Section 8.6 of the EA concerning existing disproportionate impacts of lead pollution faced by children in low-income households and households of people of color and/or Indigenous peoples, and the measured extent to which this action particularly benefits the health of children in low-income households.

EPA believes that this action is likely to reduce existing disproportionate and adverse effects on communities with environmental justice concerns. For example, 49% of children who will benefit from the rule are members of households below the poverty line, compared to 17% of children nationally who live below the poverty line. An estimated 44% of total monetized benefits from this rule accrue to children living in a household below the poverty line. 22–27% of children who will benefit from the rule are non-Hispanic Black, compared to 12% of children nationally who are non-Hispanic Black. An estimated 23% of total monetized benefits from this rule accrue to non-Hispanic Black children.

There is some uncertainty, however, regarding the environmental justice implications of this rule on HUD-assisted housing. If the rule inadvertently limits the availability of federally-assisted affordable housing, a subset of low-income individuals or families currently residing in assisted housing may face higher housing costs on the private market, disruptions caused by an involuntary loss of housing, and the potential for dust lead levels that exceed those in their baseline LSHR-regulated housing.

EPA additionally identified and addressed environmental justice concerns through public comment and collaboration with state, Tribal, and other co-regulatory bodies related to the EJ2020 action agenda and the development of the Lead Strategy. Through the agency-wide Lead Strategy, EPA has engaged with key stakeholders, communities, and organizations with vested interests in addressing lead exposures. Disparities in lead pollution are a national area of focus in the EJ2020 action agenda (Ref. 100), and this rulemaking's protective standards will deliver demonstrative progress on addressing childhood lead exposure and health disparities to members of overburdened communities.

The information supporting the Executive Order 12898 review is contained in the EA (Ref. 14) and Lead Strategy (Ref. 10), both of which are available in the docket.

List of Subjects in 40 CFR Part 745

Environmental protection, Abatement, Child-occupied facility, Clearance levels, Hazardous substances, Lead, Lead poisoning, Lead-based paint, Target housing.

Michael S. Regan,

Administrator.

Therefore, for the reasons set forth in the preamble, it is proposed that 40 CFR chapter I be amended as follows:

PART 745—LEAD-BASED PAINT POISONING PREVENTION IN CERTAIN RESIDENTIAL STRUCTURES

■ 1. The authority citation for part 745 continues to read as follows:

Authority: 15 U.S.C. 2605, 2607, 2681–2692 and 42 U.S.C. 4852d.

■ 2. Amend § 745.63 by adding in alphabetical order a definition for ''Reportable level'' to read as follows:

§ 745.63 Definitions.

* * * * *

Reportable level means the lowest analyte concentration (or amount) that does not contain a ''less than'' qualifier and that is reported with confidence for a specific method by a laboratory recognized by EPA under TSCA section 405(b).

* * * * *

■ 3. Amend § 745.65 by revising paragraph (b) to read as follows:

§ 745.65 Lead-based paint hazards.

* * * * *

(b) *Dust-lead hazard.* Before [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], a dust-lead hazard is surface dust in a residential dwelling or child-occupied facility that contains a mass-per-area concentration of lead equal to or exceeding 10 µg/ft^2 for floors or 100 µg/ft^2 for interior window sills based on wipe samples. On or after [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], a dust-lead hazard is surface dust in a residential dwelling or child-occupied facility that contains a mass-per-area concentration of any reportable level of lead for floors or for interior window sills based on wipe samples analyzed by an NLLAP-recognized laboratory.

* * * * *

■ 4. Amend § 745.81 by:

■ a. Removing paragraph (a)(4)(i) and redesignating paragraph (a)(4)(ii) as paragraph (a)(4); and

■ b. Revising paragraph (b).

The revisions read as follows:

§ 745.81 Effective dates.

(a) * * *

(4) *Work practices.* * * *

* * * * *

(b) *Renovation-specific pamphlet.* On or after December 22, 2008, renovators or firms performing renovations in States and Indian Tribal areas without an authorized program must provide owners and occupants the following EPA pamphlet: *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.*

* * * * *

■ 5. Amend § 745.83, by adding in alphabetical order a definition for ''Electronic'' to read as follows:

§ 745.83 Definitions.

* * * * *

Electronic means the submission of an application, payment, or notification using the Agency's Central Data Exchange (CDX), or successor platform.

* * * * *

■ 6. Amend § 745.89 by revising paragraphs (a)(1), (b)(1), and (c)(1) to read as follows:

§ 745.89 Firm certification.

(a) * * *

(1) Firms that perform renovations for compensation must electronically apply to EPA for certification to perform renovations or dust sampling. To apply, a firm must submit to EPA a completed ''Application for Firms,'' signed by an authorized agent of the firm, and pay electronically at least the correct amount of fees. If a firm pays more than the correct amount of fees, EPA will reimburse the firm for the excess amount.

* * * * *

(b) * * *

(1) *Timely and complete application.* To be re-certified, a firm must submit a complete electronic application for re-certification. A complete application for re-certification includes a completed ''Application for Firms'' which contains all of the information requested by the form and is signed by an authorized agent of the firm, noting on the form that it is submitted as a re-certification. A complete application must also include at least the correct amount of fees. If a firm pays more than the correct amount of fees, EPA will reimburse the firm for the excess amount.

(i) An application for re-certification is timely if it is electronically submitted 90 days or more before the date the firm's current certification expires. If the firm's application is complete and timely, the firm's current certification will remain in effect until its expiration date or until EPA has made a final decision to approve or disapprove the re-certification application, whichever is later.

* * * * *

(c) * * *

(1) To amend certification, a firm must electronically submit a completed ''Application for Firms,'' signed by an authorized agent of the firm, noting on the form that it is submitted as an amendment and indicating the information that has changed. The firm must also pay at least the correct amount of fees.

* * * * *

■ 7. Amend § 745.90 by revising paragraphs (a)(3) and (4) to read as follows:

§ 745.90 Renovator certification and dust sampling technician certification.

(a) * * *

(3) Individuals who have successfully completed an accredited lead-based paint inspector or risk assessor course before October 4, 2011, may take an accredited refresher dust sampling technician course in lieu of the initial training to become a certified dust sampling technician. Individuals who are currently certified as lead-based paint inspectors or risk assessors may act as certified dust sampling technicians without further training.

(4) To maintain renovator certification or dust sampling technician certification, an individual must complete a renovator or dust sampling technician refresher course accredited by EPA under § 745.225 or by a State or Tribal program that is authorized under subpart Q of this part within 5 years of the date the individual completed the initial course described in paragraph (a)(1) of this section. If the individual does not complete a refresher course within this time, the individual must re-take the initial course to become certified again. Individuals who take a renovator refresher course that does not include hands-on training will be certified for 3 years from the date they complete the training. Individuals who take a refresher training course that includes hands-on training will be certified for 5 years. Individuals who take the renovator refresher without hands-on training must, for their next refresher course, take a refresher course that includes hands-on training to maintain renovator certification.

* * * * *

■ 8. Amend § 745.92 by revising paragraph (c)(2) to read as follows:

§ 745.92 Fees for the accreditation of renovation and dust sampling technician training and the certification of renovation firms.

* * * * *

(c) * * *

(2) Submit the application and a payment of $15 electronically in accordance with the instructions provided with the application package.

* * * * *

■ 9. Amend § 745.103 by revising the definition for ''Target housing'' to read as follows:

§ 745.103 Definitions.

* * * * *

Target housing means 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).

* * * * *

■ 10. Amend § 745.113 by revising paragraphs (a)(4), (b)(1) and (4) to read as follows:

§ 745.113 Certification and acknowledgement of disclosure.

(a) * * *

(4) A statement by the purchaser affirming receipt of the information set out in paragraphs (a)(2) and (3) of this section and the lead hazard information pamphlet required under 15 U.S.C. 2686.

* * * * *

(b) * * *

(1) A Lead Warning Statement with the following language:

Housing built before 1978 may contain lead-based paint. Lead from paint, paint chips, and dust can pose health hazards if not managed properly. Lead exposure is especially harmful to young children and pregnant women. Before renting pre-1978 housing, lessors must disclose the presence of known lead-based paint and/or lead-based paint hazards in the dwelling. Lessees must also receive a federally approved pamphlet on lead poisoning prevention.

* * * * *

(4) A statement by the lessee affirming receipt of the information set out in paragraphs (b)(2) and (3) of this section and the lead hazard information pamphlet required under 15 U.S.C. 2686.

* * * * *

■ 11. Amend § 745.223 by:

■ a. Revising the introductory text and paragraphs (1), (3)(i) through (iii), and (4) of the definition for ''Abatement'';

■ b. Revising the definition for ''Child-occupied facility'';

■ c. Adding in alphabetical order the definitions for ''Electronic'' and ''Housing for the elderly''; and

■ d. Revising the definitions for ''Living area'' and ''Target housing''.

The revisions and additions read as follows:

§ 745.223 Definitions.

* * * * *

Abatement means any measure or set of measures designed to permanently eliminate lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels. Abatement includes, but is not limited to:

(1) The removal of paint and dust (in the case of dust-lead hazards to below the clearance levels), the permanent enclosure or encapsulation of lead-based paint, the replacement of painted surfaces or fixtures, or the removal or permanent covering of soil, when lead-based paint hazards are present in such paint, dust or soil; and

* * * * *

(3) * * *

(i) * * *

(A) Shall result in the permanent elimination of lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels; or

(B) Are designed to permanently eliminate lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels, and are described in paragraphs (1) and (2) of this definition.

(ii) Projects resulting in the permanent elimination of lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels, conducted by firms or individuals certified in accordance with § 745.226, unless such projects are covered by paragraph (4) of this definition;

(iii) Projects resulting in the permanent elimination of lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels, conducted by firms or individuals who, through their company name or promotional literature, represent, advertise, or hold themselves out to be in the business of performing lead-based paint activities as identified and defined by this section, unless such projects are covered by paragraph (4) of this definition; or

* * * * *

(4) Abatement does not include renovation, remodeling, landscaping or other activities, when such activities are not designed to permanently eliminate lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels, but, instead, are designed to repair, restore, or remodel a given structure or dwelling, even though these activities may incidentally result in a reduction or elimination of lead-based paint hazards. Furthermore, abatement does not include interim controls, operations and maintenance activities, or other measures and activities designed to temporarily, but not permanently, reduce lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels.

* * * * *

Child-occupied facility means a building, or portion of a building, constructed prior to 1978, visited regularly by the same child, under 6 years of age, on at least two different days within any week (Sunday through Saturday period), provided that each day's visit lasts at least 3 hours and the combined weekly visit lasts at least 6 hours, and the combined annual visits last at least 60 hours. Child-occupied facilities may include, but are not limited to, day-care centers, preschools and kindergarten classrooms.

* * * * *

Electronic means the submission of an application, payment, or notification using the Agency's Central Data Exchange (CDX), or successor platform.

* * * * *

Housing for the elderly means retirement communities or similar types of housing reserved for households composed of one or more persons 62 years of age or more at the time of initial occupancy.

* * * * *

Living area means any area of a residential dwelling used by one or more children under age 6 including, but not limited to, living rooms, kitchen areas, dens, play rooms, and children's bedrooms.

* * * * *

Target housing means 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).

* * * * *

■ 12. Amend § 745.225 by:

■ a. Revising the introductory text of paragraph (b)(1), paragraphs (c)(13)(vi) and (14)(iii), the introductory text of paragraph (e)(5) and paragraph (f)(2);

■ b. Removing and reserving paragraph (i)(2)(ii); and

■ c. Revising paragraph (j)(2).

The revisions read as follows:

§ 745.225 Accreditation of training programs: target housing and child-occupied facilities.

* * * * *

(b) * * *

(1) A training program seeking accreditation shall submit an electronic

application to EPA containing the following information:

* * * * *

(c) * * *

(13) * * *

(vi) Notification must be accomplished electronically. Instructions can be obtained online at *https://www.epa.gov/lead* or from the NLIC at 1–800–424–LEAD (5323). Hearing- or speech-impaired persons may reach the above telephone number through TTY by calling the toll-free Federal Communications Commission's Telecommunications Relay Service at 711.

* * * * *

(14) * * *

(iii) Notification must be accomplished electronically. Instructions can be obtained online at *https://www.epa.gov/lead* or from the NLIC at 1–800–424–LEAD (5323).

* * * * *

(e) * * *

(5) A training program seeking accreditation to offer refresher training courses only shall submit an electronic application to EPA containing the following information:

* * * * *

(f) * * *

(2) A training program seeking re-accreditation shall submit an electronic application to EPA no later than 180 days before its accreditation expires. If a training program does not submit its application for re-accreditation by that date, EPA cannot guarantee that the program will be re-accredited before the end of the accreditation period.

* * * * *

(i) * * *

(2) * * *

(ii) [Reserved]

* * * * *

(j) * * *

(2) To amend an accreditation, a training program must electronically submit a completed ''Accreditation Application for Training Providers,'' signed by an authorized agent of the training provider, noting on the form that it is submitted as an amendment and indicating the information that has changed.

* * * * *

■ 13. Amend § 745.226 by:

■ a. Revising paragraph (a)(1), introductory text of paragraph (e)(1), paragraphs (e)(2), (f)(2) and (3);

■ b. Removing and reserving paragraph (f)(5); and

■ c. Revising paragraph (h)(1)(iii).

The revisions read as follows:

§ 745.226 Certification of individuals and firms engaged in lead-based paint activities: target housing and child-occupied facilities.

(a) * * *

(1) * * *

(i) Submit to EPA an electronic application demonstrating that they meet the requirements established in paragraphs (b) or (c) of this section for the particular discipline for which certification is sought; or

(ii) Submit to EPA an electronic application attaching a valid lead-based paint activities certification (or equivalent) from a State or Tribal program that has been authorized by EPA pursuant to subpart Q of this part.

(2) [Reserved]

(3) Following the submission of an electronic application demonstrating that all the requirements of this section have been meet, EPA shall certify an applicant as an inspector, risk assessor, supervisor, project designer, or abatement worker, as appropriate.

* * * * *

(e) * * *

(1) To maintain certification in a particular discipline, a certified individual shall apply electronically to and be re-certified by EPA in that discipline by EPA either:

* * * * *

(2) An individual shall be re-certified if the individual successfully completes the appropriate accredited refresher training course and electronically submits a valid copy of the appropriate refresher course completion certificate.

* * * * *

(f) * * *

(2) A firm seeking certification shall electronically submit to EPA an application attesting that the firm shall only employ appropriately certified employees to conduct lead-based paint activities, and that the firm and its employees shall follow the work practice standards in § 745.227 for conducting lead-based paint activities.

(3) From the date of receiving the firm's electronic application requesting certification, EPA shall have 90 days to approve or disapprove the firm's request for certification. Within that time, EPA shall respond with either a certificate of approval or a letter describing the reasons for a disapproval.

* * * * *

(5) [Reserved]

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(h) * * *

(1) * * *

(iii) Misrepresented facts in its electronic application for certification to EPA.

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■ 14. Amend § 745.227 by:

■ a. Revising paragraphs (c)(2)(i), (iv) and (v), (d)(3), (5), (6)(ii) and (7), (e)(4)(ii), (vii) and (8)(viii);

■ b. Adding paragraph (e)(10)(vii); and

■ c. Revising paragraph (h)(3).

The revisions and additions read as follows:

§ 745.227 Work practice standards for conducting lead-based paint activities: target housing and child-occupied facilities.

* * * * *

(c) * * *

(2) * * *

(i) Background information regarding the physical characteristics of the residential dwelling or child-occupied facility and occupant use patterns that may cause lead-based paint exposure to one or more children under age 6 shall be collected.

* * * * *

(iv) In residential dwellings, two composite dust samples shall be collected, one from the floors and the other from the windows, in rooms, hallways or stairwells where one or more children, under age 6, are most likely to come in contact with dust.

(v) In multi-family dwellings and child-occupied facilities, in addition to the floor and window samples required in paragraph (c)(1)(iii) of this section, the risk assessor shall also collect composite dust samples from common areas where one or more children, under age 6, are most likely to come into contact with dust.

* * * * *

(d) * * *

(3) Background information regarding the physical characteristics of the residential dwelling or child-occupied facility and occupant use patterns that may cause lead-based paint exposure to one or more children under age 6 shall be collected.

* * * * *

(5) In residential dwellings, dust samples (either composite or single-surface samples) from the interior window sill(s) and floor shall be collected and analyzed for lead concentration in all living areas where one or more children, under age 6, are most likely to come into contact with dust.

(6) * * *

(ii) Other common areas in the building where the risk assessor determines that one or more children, under age 6, are likely to come into contact with dust.

(7) For child-occupied facilities, interior window sill and floor dust samples (either composite or single-surface samples) shall be collected and

analyzed for lead concentration in each room, hallway or stairwell utilized by one or more children, under age 6, and in other common areas in the child-occupied facility where one or more children, under age 6, are likely to come into contact with dust.

* * * * *

(e) * * *

(4) * * *

(ii) Notification for lead-based paint abatement activities required in response to an elevated blood lead level (EBL) determination, or Federal, State, Tribal, or local emergency abatement order should be received by EPA as early as possible before, but must be received no later than, the start date of the lead-based paint abatement activities. Should the start date and/or location provided to EPA change, an updated notification must be received by EPA on or before the start date provided to EPA. Documentation showing evidence of an EBL determination or a copy of the Federal/State/Tribal/local emergency abatement order must be included in the notification to take advantage of this abbreviated notification period.

* * * * *

(vii) Notification must be accomplished electronically. Instructions can be obtained online at *https://www.epa.gov/lead,* or from the NLIC at 1–800–424–LEAD (5323).

* * * * *

(8) * * *

(viii) Before [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], the clearance levels for lead in dust are 10 µg/ft² for floors, 100 µg/ft² for interior window sills, and 400 µg/ft² for window troughs; on or after [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], the clearance levels for lead in dust are 3 µg/ft² for floors, 20 µg/ft² for interior window sills, and 25 µg/ft² for window troughs.

* * * * *

(10) * * *

(vii) On or after [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], when dust-lead clearance sampling results are below the dust-lead clearance levels and at or above the dust-lead hazard standards, a dust-lead hazard statement with the following language must be included:

Although the completed abatement project achieved dust-lead levels below clearance, some dust-lead hazards remain because any reportable level of dust-lead is considered a dust-lead hazard. In order for abatement work to be considered complete, dust-lead levels must be below clearance levels, which are established based on reliability, effectiveness and safety. To continue to reduce lead exposure from dust, the EPA pamphlet entitled *Protect Your Family From Lead in Your Home* includes recommendations such as: using a vacuum with a high-efficiency particulate air (HEPA) filter on furniture and other items returned to the work area and regularly cleaning hard surfaces with a damp cloth or sponge and a general all-purpose cleaner. For more information on how to continue to reduce lead exposure see *Protect Your Family From Lead in Your Home.*

* * * * *

(h) * * *

(3) Dust-lead hazards and dust-lead clearance levels are identified for residential dwellings and child-occupied facilities as follows:

(i) Before [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], a dust lead-hazard is present in a residential dwelling on floors and interior window sills when the weighted arithmetic mean lead loading for all single surface or composite samples of floors and interior window sills are equal to or greater than 10 µg/ft² for floors and 100 µg/ft² for interior window sills, respectively; for projects where clearance sampling is required or otherwise performed, levels of lead in dust must be below 10 µg/ft² for floors, 100 µg/ft² for interior window sills, and 400 µg/ft² for window troughs for purposes of clearance; on or after [DATE 12 MONTHS AFTER THE DATE OF PUBLICATION OF THE FINAL RULE IN THE **FEDERAL REGISTER**], a dust lead-hazard is present in a residential dwelling on floors and interior window sills when the lead loading for any single surface or composite sample of floors and interior window sills is equal to or greater than any reportable level of dust-lead for floors and for interior window sills; for projects where clearance sampling is required or otherwise performed, levels of lead in dust must be below 3 µg/ft² for floors, 20 µg/ft² for interior window sills, and 25 µg/ft² for window troughs for purposes of clearance;

(ii) A dust lead-hazard is present on floors or interior window sills in an unsampled residential dwelling in a multi-family dwelling, if a dust-lead hazard is present on floors or interior window sills, respectively, in at least one sampled residential unit on the property (and, for projects where clearance sampling is required or otherwise performed, levels of lead in dust must be below the applicable value from paragraph (h)(3)(i) of this section for purposes of clearance); and

(iii) A dust lead-hazard is present on floors or interior window sills in an unsampled common area in a multi-family dwelling, if a dust-lead hazard is present on floors or interior window sills, respectively, in at least one sampled common area in the same common area group on the property (and, for projects where clearance sampling is required or otherwise performed, levels of lead in dust must be below the applicable value from paragraph (h)(3)(i) of this section for purposes of clearance).

* * * * *

■ 15. Amend § 745.238 by:

■ a. Revising paragraphs (d)(1) and (2),

■ b. Removing paragraph (d)(3),

■ c. Revising paragraphs (e)(1) and (2).

The revisions read as follows:

§ 745.238 Fees for accreditation and certification of lead-based paint activities.

* * * * *

(d) * * *

(1) *Certification and re-certification.*

(i) *Individuals.* Submit a completed application electronically (titled ''Application for Individuals to Conduct Lead-based Paint Activities''), the materials described at § 745.226, and the application fee(s) described in paragraph (c) of this section.

(ii) *Firms.* Submit a completed application electronically (titled ''Application for Firms''), the materials described at § 745.226, and the application fee(s) described in paragraph (c) of this section.

(2) *Accreditation and re-accreditation.* Submit a completed application electronically (titled ''Accreditation Application for Training Programs''), the materials described at § 745.225, and the application fee described in paragraph (c) of this section.

(e) * * *

(1) Parties seeking identification card or certificate replacement shall electronically complete the applicable portions of the appropriate application in accordance with the instructions provided.

The appropriate applications are:

* * * * *

(2) Submit application and payment electronically in the amount specified in paragraph (c)(3) of this section in accordance with the instructions.

* * * * *

■ 16. Amend § 745.325 by revising paragraph (d)(3)(ii) to read as follows:

§ 745.325 Lead-based paint activities: State and Tribal program requirements.

* * * * *

(d) * * *

(3) * * *

(ii) Abatements permanently eliminate lead-based paint hazards, in the case of dust-lead hazards to below the clearance levels, and are conducted in a way that does not increase the hazards of lead-based paint to the occupants of the dwelling or child-occupied facility.

* * * * *

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Toxicological Profile for Lead

August 2020

ATSDR
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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exposure history; however, the CBLI will not capture shorter-term variation in exposure that may occur between measurements. Direct, noninvasive measurements of bone Pb concentrations have been used as a metric of long-term exposure on the basis that most of the absorbed Pb retained in the body will reside in bone (see Section 3.1). The health effects of Pb are the same, regardless of the route of exposure (e.g., inhalation or ingestion). Given that exposure is quantified by internal exposure metrics (e.g., PbB, bone Pb), epidemiological studies do not attempt to define the route of exposure. Environmental exposure to Pb occurs continuously over a lifetime and Pb is retained in the body for decades. Because internal dose metrics cannot define the complete history of exposure, the exposure duration and timing that correlates most strongly with the observed health effect are typically unknown or highly uncertain.

Toxic effects of Pb have been observed in every organ system that has been rigorously studied. Clinical significance of some of the organ system effects at low levels of exposure and blood Pb is more substantial than for others (e.g., neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental effects). This is not surprising because the mechanisms that induce toxicity are common to all cell types and because Pb is widely distributed throughout the body. Adverse health effects have been observed in these systems at PbB ≤10 µg/dL. Exposure thresholds for effects on specific organ systems have not been identified (i.e., no safe level has been identified). Cognitive deficits in children occurring at the lowest PbBs (≤5 µg/dL) are the best substantiated effects. However, data for some organ systems results are inconsistent, and insufficient data are available to provide information on dose-response relationships. It is also important to note that effects observed in adults, especially older adults, may be due to higher environmental or occupational exposures in the past; therefore, exposure history is an important consideration in epidemiological studies on the health effects of Pb.

The most extensively studied health outcomes, as described below, are neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental effects. Neurological effects of Pb are of greatest concern because effects are observed in infants and children and may result in life-long decrements in neurological function. Infants are born with a Pb burden derived from maternal transfer *in utero* and subsequently can continue to absorb maternal Pb from ingestion of breast milk. Children are also more vulnerable because of behaviors that increase ingestion of Pb surface dusts (e.g., hand-to-mouth activity) and because gastrointestinal absorption of ingested Pb is higher in children compared to adults, possibly due to a combination of physiological differences and differences in diet and nutrition. The following briefly summarizes health effects of chronic exposure to Pb observed in humans. More detailed information, including reference citations, is provided in Chapter 2.

Other Health Effects Associated with Pb. In addition to the effects summarized above, health effects to other organ systems have been reported. The epidemiological databases for these effects are much less extensive than for the effects reviewed above. Effects described below occur over a wide range of PbBs, including PbB ≤10 μg/dL. However, results for most endpoints are inconsistent and insufficient data are available to provide information on dose-response relationships.

- ***Respiratory Effects.*** Associations have been observed between PbB and decreased lung function, increased bronchial hyperreactivity, symptoms of respiratory disease, and increased risk of respiratory diseases (e.g., asthma and obstructive lung disease).
- ***Endocrine Effects (Excluding Reproductive Hormones).*** Studies in adults, adolescents, and children show effects on thyroid function, cortisol levels, vitamin D levels, and serum levels of growth factors. Effects on thyroid function are the most studied effect, although results do not demonstrate a consistent pattern of effect.
- ***Hepatic Effects.*** Most studies were conducted in workers with PbB >10 μg/dL. Several studies show altered plasma levels of liver enzymes, although no consistent pattern of effects has been observed. Liver enlargement and increased gall bladder wall thickness have been associated with PbB.
- ***Musculoskeletal Effects.*** Studies provide evidence of bone loss, increased markers of bone metabolism/turn over, and adverse periodontal and dental effects (periodontal bone loss, tooth loss, periodontal disease, dental caries) in adults and children.
- ***Gastrointestinal Effects.*** Gastrointestinal colic is a predominant clinical symptom of acute Pb poisoning. Epidemiological studies provide evidence of gastrointestinal symptoms (abdominal colic/pain, nausea, vomiting, diarrhea, and/or constipation) associated with PbB ranging from 8 μg/dL to approximately 100 μg/dL. However, most studies are survey or cross-sectional studies of small populations of workers.
- ***Body Weight Effects.*** A few studies evaluating effects of PbB ≤10 μg/dL on body weight provide some evidence of decreased body weight in children and adults, although inconsistent results have been reported.
- ***Ocular Effects (Excluding Neurological Effects).*** Limited data provide some evidence that exposure to Pb is associated with macular degeneration in adults and increased risk of cataracts.

Cancer. Numerous epidemiological studies have evaluated associations between Pb exposure and cancer. Although studies provide limited evidence of carcinogenicity of Pb in humans, results are inconsistent, with several negative studies, and interpretation of data may be limited due to confounding factors (e.g., smoking status, family history of cancer, co-exposure to other carcinogens). At PbB ≤10 μg/dL, increased risks were reported for all cancers and lung cancer. At PbB >10 μg/dL, increased risks were observed for all cancer, respiratory tract cancer, stomach cancer, intestinal cancer, cancer of the larynx, and glioma.

The Department of Health and Human Services classified Pb and Pb compounds as reasonably anticipated to be human carcinogens (NTP 2016). In 1988, EPA classified Pb as a probable human carcinogen based on sufficient evidence in animals; evidence in humans was considered inadequate (IRIS 2004). The International Agency for Research on Cancer (IARC) has classified inorganic Pb compounds as probably carcinogenic to humans (Group 2A) based on sufficient evidence in animals and limited evidence in humans; evidence for organic Pb compounds was considered to be inadequate in humans and animals (IARC 2006).

1.3 MINIMAL RISK LEVELS (MRLs)

As reviewed in Section 1.2, epidemiological studies have evaluated the health effects of Pb in all organ systems. For the most studied endpoints (neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental), effects occur at the lowest PbBs studied (≤5 μg/dL). Because the lowest PbBs are associated with serious adverse effects (e.g., declining cognitive function in children), MRLs for Pb have not been derived.

cumulative exposure, in the case of CBLI or bone Pb. However, neither metric offers a confident estimate of exposure duration or of changes in Pb exposure over time (including peak exposure periods that may have occurred in the past), and, in general, the complete exposure history is not known. Health outcomes associated with acute exposures is available from clinical case studies of Pb poisoning (see Section 2.2). However, even in these cases, the exposure duration that proceeded the identification of the case is rarely known with certainty.

Routes of Exposure. For the general population, exposure to Pb occurs primarily via the oral route, with some contribution from the inhalation route, whereas inhalation exposures can be more important in occupational settings, depending on particle size. In addition, occupational exposure to organic Pb compounds may involve dermal absorption as a significant exposure route. This profile does not attempt to separate health effects by route of exposure. As noted previously, epidemiology studies have relied on internal dose metrics (e.g., PbB, bone Pb), which reflect Pb body burden (to varying degrees), irrespective of the route of exposure. The primary systemic toxic effects of Pb are the same regardless of the route of entry into the body,

Exposure Metric. To quantify exposure in humans, data are expressed in terms of absorbed Pb, and not in terms of external exposure levels (e.g., concentration in water) or dose (e.g., mg/kg/day). The most common metric of absorbed dose for Pb is the concentration of lead in blood (PbB), although other measures of exposure (e.g., concentration of Pb in bone, hair, teeth, or urine) are used; however, measurements of Pb in urine, teeth, and hair are not as reliable as measurements in blood or bone. PbB mainly reflects exposure history of the previous few months and does not necessarily reflect the larger burden and much slower elimination kinetics of Pb in bone (see Section 3.1). Pb in bone is considered a biomarker of cumulative or long-term exposure because Pb accumulates in bone over the lifetime and most of the Pb body burden resides in bone. Most of the body burden of Pb (the total amount of Pb in the body) is distributed to the bone, with approximately 94 and 76% of the body burden found in bone in adults and children, respectively. The remainder is distributed to blood and soft tissues. However, the concentration of Pb in blood can vary considerably with age and physiology/lifestage (e.g., pregnancy, lactation, menopause). For this reason, measurement of Pb in bone has seen wider application in epidemiological studies of adults in which measures of cumulative lifetime exposures are of interest. However, bone Pb measurements require specialized radiologic equipment (e.g., K-shell x-ray fluorescence; XRF) and, as a result, are used less commonly than PbB in human epidemiology. Since most of the epidemiology has relied on PbB as the dose metric, this profile has focused on describing dose-response relationships based on PbB to facilitate comparisons across studies and endpoints. This

The following cancers have been associated with PbB:

- ≤10 µg/dL:
  - Increased risk of all cancer; evaluated in multiple studies with mixed results.
  - Increased risk of lung cancer; evaluated in multiple studies with mixed results.
- >10 µg/dL:
  - Increased risk of all cancer; evaluated in multiple studies with mixed results.
  - Increased risk of respiratory tract cancers (bronchus, trachea, lung); evaluated in multiple studies with mixed results.
  - Increased risk of stomach cancer; evaluated in multiple studies with mixed results.
  - Increased risk of intestinal cancer.
  - Increased risk of cancer of the larynx.
  - Increased risk of glioma.

Carcinogenicity Classifications of Pb and Pb Compounds. IARC has classified inorganic Pb compounds as probably carcinogenic to humans (Group 2A) based on sufficient evidence in animals and limited evidence in humans; evidence for organic Pb compounds was considered to be inadequate in humans and animals (IARC 2006). The National Toxicology Program 14th Report on Carcinogens classified Pb and Pb compounds as reasonably anticipated to be human carcinogens (NTP 2016). As the basis of the Group 2A classification for inorganic Pb compounds, IARC (2006) cited multiple animal studies showing kidney cancer following chronic oral and parenteral exposure (Azar et al. 1973; Balo et al. 1965; Fears et al. 1989; Kasprzak et al. 1985; Koller et al. 1985; Van Esch and Kroes 1969; Zawirska 1981; Zollinger 1953), renal tubular adenoma in offspring of mice exposed during gestation and lactation (Waalkes et al. 1995), and brain gliomas following oral exposure of rats (Zawirska 1981; Zawirska and Medras 1972). For epidemiological studies of occupational cohorts, IARC (2006) noted limited evidence of carcinogenicity of the lung, stomach, kidney, and brain/nervous system, although studies yielded inconsistent results, and interpretation of results was compromised due to potential confounding factors (e.g., smoking, occupational exposure to other carcinogens such as arsenic).

Confounding Factors and Effect Modifiers. Numerous factors can influence results of epidemiological studies evaluating associations between Pb exposure and cancer, including smoking status, family history of cancer, and co-exposure to other carcinogens. Failure to account for these factors may attenuate or strengthen the apparent associations between Pb exposure and the outcome, depending on the direction of plasma Pb pool and, as a result, bone Pb is a reservoir for replenishment of Pb eliminated from blood by excretion (Alessio 1988; Behinaein et al. 2012, 2014; Chettle et al. 1991; Hryhorczuk et al. 1985; Nie et al. 2005; Nilsson et al. 1991; Rabinowitz et al. 1976). Pb in adult bone can serve to maintain blood Pb levels long after exposure has ended (Fleming et al. 1997; Inskip et al. 1996; Kehoe 1987; O'Flaherty et al. 1982; Smith et al. 1996). It can also serve as a source of Pb transfer to the fetus when maternal bone is resorbed for the production of the fetal skeleton (Franklin et al. 1997; Gulson et al. 1997b, 1999b, 2003).

Pb forms highly stable complexes with phosphate and can replace calcium in the calcium-phosphate salt, hydroxyapatite, which comprises the primary crystalline matrix of bone (Bres et al. 1986; Lloyd et al. 1975; Meirer et al. 2011; Miyake 1986; Verbeeck et al. 1981). As a result, Pb deposits in bone during the normal mineralization process that occurs during bone growth and remodeling and is released to the blood during the process of bone resorption (Aufderheide and Wittmers 1992; O'Flaherty 1991b, 1993). During infancy and childhood, bone calcification is most active in trabecular bone, whereas in adulthood, calcification occurs at sites of remodeling in cortical and trabecular bone. This suggests that Pb accumulation will occur predominantly in trabecular bone during childhood, and in both cortical and trabecular bone in adulthood (Aufderheide and Wittmers 1992). The association of Pb uptake and release from bone with the normal physiological processes of bone formation and resorption renders Pb biokinetics sensitive to these processes. Physiological states (e.g., pregnancy, menopause, advanced age) or disease-related states (e.g., osteoporosis, prolonged immobilization) that are associated with increased bone resorption will tend to promote the release of Pb from bone, which, in turn, may contribute to an increase in the concentration of Pb in blood (Berkowtiz et al. 2004; Bonithon-Kopp et al. 1985; Garrido Latorre et al. 2003; Hernandez-Avila et al. 2000; Jackson et al. 2010; Markowitz and Weinberger 1990; Mendola et al. 2013; Nash et al. 2004; Nie et al. 2009; Popovic et al. 2005; Silbergeld et al. 1988; Symanski and Hertz-Picciotto 1995; Thompson et al. 1985).

Two physiological compartments appear to exist for Pb in cortical and trabecular bone, to varying degrees. In one compartment, bone Pb is essentially inert, having an elimination half-time of several decades. A labile compartment exists as well that allows for maintenance of an equilibrium of Pb between bone and soft tissue or blood (Rabinowitz et al. 1976). Although a high bone formation rate in early childhood results in the rapid uptake of circulating Pb into mineralizing bone, bone Pb is also recycled to other tissue compartments or excreted in accordance with a high bone resorption rate (O'Flaherty 1995a). Thus, most of the Pb acquired early in life is not permanently fixed in the bone (O'Flaherty 1995a). In general, bone turnover rates decrease as a function of age, resulting in slowly increasing bone Pb levels among adults (Barry 1975; Gross et al. 1975; Schroeder and Tipton 1968).

Bone Pb burdens in adults are slowly lost by diffusion (heteroionic exchange) as well as by resorption (O'Flaherty 1995a, 1995b). An XRF study of tibia Pb concentrations in individuals >10 years old showed a gradual increase in bone Pb after age 20 (Kosnett et al. 1994). In 60–70-year-old men, the total bone Pb burden may be ≥200 mg, while children <16 years old have been shown to have a total bone Pb burden of 8 mg (Barry 1975). However, in some bones (i.e., mid femur and pelvic bone), the increase in Pb content plateaus at middle age and then decreases at higher ages; the decrease with age was more pronounced in females (Drasch et al. 1987). Osteoporosis and release of Pb from resorbed bone to blood may contribute to decreasing bone Pb content in females (Gulson et al. 2002).

Evidence for the exchange of bone Pb and soft tissue Pb stores comes from analyses of stable Pb isotope signatures of Pb in bone and blood. A comparison of blood and bone Pb stable isotope signatures in five adults indicated that bone Pb stores contributed to approximately 40–70% of the Pb in blood (Smith et al. 1996). During pregnancy, the mobilization of bone Pb increases, as the bone is resorbed to produce the fetal skeleton. Analysis for kinetics of changes in the stable isotope signatures of blood Pb in pregnant women as they came into equilibrium with a novel environmental Pb isotope signature indicated that 10–88% of the Pb in blood may derive from the mobilization of bone Pb store and approximately 80% of cord blood may be contributed from maternal bone Pb (Gulson 2000; Gulson et al. 1997b, 1999c, 2003). The mobilization of bone Pb during pregnancy may contribute, along with other mechanisms (e.g., increased absorption), to the increase in Pb concentration that has been observed during the later stages of pregnancy (Gulson et al. 1997b, 2016; Lagerkvist et al. 1996; Schuhmacher et al. 1996). Bone resorption during pregnancy can be reduced by ingestion of calcium supplements (Janakiraman et al. 2003). Additional evidence for increased mobilization of bone Pb into blood during pregnancy is provided from studies in nonhuman primates and rats (Franklin et al. 1997; Maldonado-Vega et al. 1996). Direct evidence for transfer of maternal bone Pb to the fetus has been provided from stable Pb isotope studies in Cynomolgus monkeys (*Macaca fascicularis*) that were dosed with Pb having a different stable isotope ratio than the Pb to which the monkeys were exposed at an earlier age; approximately 7–39% of the maternal Pb burden that was transferred to the fetus appeared to have been derived from the maternal skeleton (Franklin et al. 1997).

In addition to pregnancy, other states of increased bone resorption appear to result in release of bone Pb to blood; these include lactation, osteoporosis, and severe weight loss. Analysis of kinetics of changes in the stable isotope signatures of blood Pb in postpartum women as they came into equilibrium with a novel environmental Pb isotope signature indicated that the release of maternal bone Pb to blood appears to accelerate during lactation (Gulson et al. 2002, 2003, 2004). This is consistent with declines in patella expression (Fowler and DuVal 1991; Mistry et al. 1985, 1986). Other high-affinity Pb binding proteins (Kd approximately 14 nM) have been isolated in human kidney, two of which have been identified as a 5 kD peptide, thymosin 4, and a 9 kD peptide, acyl-CoA binding protein (Smith et al. 1998b). Pb also binds to metallothionein, but does not appear to be a significant inducer of the protein in comparison with the inducers of cadmium and zinc (Eaton et al. 1980; Waalkes and Klaassen 1985). *In vivo*, only a small fraction of the Pb in the kidney is bound to metallothionein, and appears to have a binding affinity that is less than Cd^{2+}, but higher than Zn^{2+} (Ulmer and Vallee 1969); thus, Pb will more readily displace zinc from metallothionein than cadmium (Goering and Fowler 1987; Nielson et al. 1985; Waalkes et al. 1984).

Pb Distribution during Pregnancy and Maternal-Fetal-Infant Transfer. PbBs tend to be lower in pregnant women compared to non-pregnant women of similar age, BMI, iron status, and smoking status (Jain 2013a; Liu et al. 2013). This difference may reflect increased elimination of Pb from the maternal system (Jain 2013b). Maternal PbB changes during and following pregnancy. A U-shaped temporal pattern has been observed in which maternal PbBs decrease during the second trimester and increase during the third trimester and postpartum period (Gulson et al. 2004, 1997b, 2016; Hertz-Picciotto et al. 2000; Lagerkvist et al. 1996; Lamadrid-Figueroa et al. 2006; Rothenberg et al. 1994). Several factors appear to contribute to these changes. During the second trimester, increased plasma volume contributes to hemodilution of maternal blood Pb and a lowering in the PbB (Hytten 1985). During the third trimester, growth of the fetal skeleton accelerates, which results in increased mobilization of calcium and Pb from the maternal skeleton, increasing maternal PbB (Gulson et al. 1998b, 2003). Postpartum calcium demand increases further during lactation and breastfeeding, which promotes further mobilization of calcium and Pb from bone and sustains or increases maternal PbBs (Gulson et al. 1998b; Hansen 2011; Tellez-Rojo et al. 2002). Increased demand for calcium in the third trimester and postpartum (to supply calcium for breast milk) is also evident from studies of the effects of dietary calcium supplementation during pregnancy. Calcium supplementation of the maternal diet decreased or delayed the onset of the increase in maternal PbB during the third trimester and postpartum period and delayed mobilization of maternal bone Pb in the third trimester (Ettinger et al. 2009; Gulson et al. 2004, 2016; Manton et al. 2003). The increase in PbB associated with late pregnancy was greater in older women who had a longer history of Pb exposure and, presumably, higher bone Pb levels (Miranda et al. 2010). Pb has been detected in follicular fluid at concentrations similar to that in blood plasma (Silberstein et al. 2006).

A portion of the maternal Pb burden is transferred to the placenta and fetus during pregnancy (Esteban-Vasaloo et al. 2012; Franklin et al. 1997; Gulson et al. 2003, 2016; Irwinda et al. 2019; Kayaalti et al.

2016; Kazi et al. 2014; O'Flaherty 1998; Reddy et al. 2014). Measurements of stable Pb isotope ratios in pregnant women and cord blood, as they came into equilibrium with a novel environmental Pb isotope signature, indicated that approximately 80% of Pb in fetal cord blood appears to derive from maternal bone stores (Gulson et al. 1997b, 1999c, 2000, 2003, 2016). Stable isotope studies have also demonstrated transfer of Pb from the maternal skeleton to fetus in nonhuman primates (Franklin et al. 1997; O'Flaherty 1998). Transplacental transfer of Pb may be facilitated by an increase in the plasma/PbB ratio during pregnancy (Lamadrid-Figueroa et al. 2006; Montenegro et al. 2008).

Fetal and maternal PbBs and placental Pb concentrations are correlated (Amaral et al. 2010; Baeyens et al. 2014; Baranowska-Boisiacka et al. 2016; Carbone et al. 1998; Chen et al. 2014; Goyer 1990; Graziano et al. 1990; Gulson et al. 2016; Kayaalti et al. 2015b; Kazi et al. 2014; Kim et al. 2015; Kordas et al. 2009; Patel and Prabhu 2009; Reddy et al. 2014). Estimates of the maternal/fetal PbB ratio, based on cord blood Pb measurements at the time of delivery, range from 0.7 to 1.0 at mean maternal PbBs ranging from 1 to 9 μg/dL. In one of the larger studies of fetal PbB, maternal and cord PbB were measured at delivery in 888 mother-infant pairs; the cord/maternal ratio was relatively constant, 0.93, over a blood Pb range of approximately 3–40 μg/dL (Graziano et al. 1990). An analysis of data from 159 mother-infant pairs revealed that higher blood pressure and alcohol consumption late in pregnancy were associated with higher concentrations of Pb in cord blood relative to maternal blood, while higher hemoglobin and sickle cell trait were associated with lower cord blood Pb relative to maternal blood Pb (Harville et al. 2005). No associations were found for calcium intake, physical activity, or smoking. Placental Pb concentrations were found to correlate with ALAD polymorphisms, with higher concentrations observed in association with ALAD2 (Kayaalti et al. 2015b).

Maternal Pb is transferred to infants during breastfeeding. Stable Pb isotope dilution studies suggested that Pb in breast milk can contribute substantially to the isotope profile of infant blood (approximately 40–80%; Gulson et al. 1998b). Numerous studies have reported Pb concentrations in maternal blood and breast milk. In general, these studies indicate that Pb concentrations in breast milk are correlated with Pb concentrations in maternal blood or plasma. Milk/maternal concentration ratios are <0.1, although values of 0.9 have been reported (Baranowska-Boisiacka et al. 2016; Counter et al. 2014; Ettinger et al. 2006, 2014; Gulson et al. 1998a; Koyashiki et al. 2010). Ettinger et al. (2004, 2006) assessed factors influencing breast milk Pb concentration in a group of 367 women and found that PbB (mean 8–9 μg/dL; range 2–30) was a stronger predictor of breast milk Pb (mean 0.9–1.4 μg/dL; range 0.2–8 μg/dL) than bone Pb, and that tibia Pb (mean 9.5 μg/g; range <1–76.5 μg/dL) was a stronger predictor of breast milk Pb than patella bone Pb (mean 14.6 μg/dL; range <1–67.2 μg/dL). Dietary intake of polyunsaturated fatty acids (PUFA) may decrease transfer of Pb from bone to breast milk (Arora et al. 2008). Pb concentrations in maternal blood and breast milk have been shown to correlate with PbBs in breastfeeding infants (Ettinger et al. 2014; Farhat et al. 2013). Breast milk Pb concentrations explained 37% of the variation in infant blood Pb of breastfeeding infants (Ettinger et al. 2014).

Organic Pb. Information on the distribution of Pb in humans following exposures to organic Pb is extremely limited. One hour following 1–2-minute inhalation exposures to ^{203}Pb tetraethyl or tetramethyl Pb (1 mg/m^3), approximately 50% of the ^{203}Pb body burden was associated with liver and 5% was associated with kidney; the remaining ^{203}Pb was widely distributed throughout the body (Heard et al. 1979). The kinetics of ^{203}Pb in blood of these subjects showed an initial declining phase during the first 4 hours (tetramethyl Pb) or 10 hours (tetraethyl Pb) after the exposure, followed by a phase of gradual increase in PbB that lasted for up to 500 hours after the exposure. Radioactive Pb in blood was highly volatile immediately after the exposure and transitioned to a nonvolatile state thereafter. These observations may reflect an early distribution of organic Pb from the respiratory tract, followed by a redistribution of de-alkylated Pb compounds (see Section 3.1.3 for further discussion of alkyl Pb metabolism).

In a man and woman who accidentally inhaled a solvent containing 31% tetraethyl Pb (17.6% Pb by weight), Pb concentrations in the tissues, from highest to lowest, were liver, kidney, brain, pancreas, muscle, and heart (Bolanowska et al. 1967). In another incident, a man ingested a chemical containing 59% tetraethyl Pb (38% Pb w/w); Pb concentration was highest in the liver followed by kidney, pancreas, brain, and heart (Bolanowska et al. 1967).

3.1.3 Metabolism

Inorganic Pb. Metabolism of inorganic Pb consists of formation of complexes with a variety of protein and nonprotein ligands (see Section 3.1.2 for further discussion). Major extracellular ligands include albumen and nonprotein sulfhydryls. The major intracellular ligand in red blood cells is ALAD. Pb also forms complexes with proteins in the cell nucleus and cytosol.

Organic Pb. Alkyl Pb compounds are actively metabolized in the liver by oxidative dealkylation catalyzed by cytochrome P-450. Relatively few studies that address the metabolism of alkyl Pb compounds in humans have been reported. Studies of workers who were exposed to tetraethyl Pb have shown that tetraethyl Pb is excreted in the urine as diethyl Pb, ethyl Pb, and inorganic Pb (Turlakiewicz

World Health Organization

©

Lead poisoning

Overview | Symptoms | Treatment

Lead is a well-recognized toxicant that has wide-ranging health impacts, affecting the neurological, cardiovascular, gastrointestinal and haematological systems. Young children are particularly vulnerable because they have higher exposures than adults and because lead affects the developing brain, potentially resulting in reduced intellectual ability. Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates over time. Lead in bone is released into blood during pregnancy and becomes a source of exposure to the developing fetus.

Human exposure is usually assessed through the measurement of lead in blood. There is no known safe blood lead concentration; even blood lead concentrations as low as 5 µg/dL may be associated with decreased intelligence in children, behavioural difficulties and learning problems. As lead exposure increases, the range and severity of symptoms and effects also increase.

Encouragingly, the successful phasing out of leaded gasoline in most countries, together with other lead control measures, has resulted in a significant decline in population-level blood lead concentrations. As of July 2021, leaded fuel for cars and lorries is no longer sold anywhere in the world. However, more needs to be done to phase out of lead paint: so far, only 43% of countries have introduced legally binding controls on lead paint.

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EPA STRATEGY TO REDUCE LEAD EXPOSURES AND DISPARITIES IN U.S. COMMUNITIES

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OCTOBER 2022

EPA Strategy to Reduce Lead Exposures and Disparities in U.S. Communities

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PREFACE

At EPA, our mission is to protect people's health and the environment. Fulfilling our mission requires that all people – regardless of the color of their skin, money in their pocket, or the community they live in –benefit equally from the protections of our environmental laws and policies.

Although naturally occurring, lead is undoubtedly one of society's most pervasive environmental toxins. Lead exposure can have devastating impacts to human health and can be especially harmful to developing children. We also know that because of existing racial and socioeconomic disparities, communities that have been historically marginalized and overburdened suffer the most. That's why on day one, President Biden committed to advancing environmental justice and equity and directed every member of his Cabinet to embed environmental justice into our decision-making.

At EPA, we have been hard at work embedding these values into the Agency's DNA. As part of our commitment to advancing environmental justice and equity, I'm proud to present the U.S. Environmental Protection Agency's (EPA) *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities*. The Lead Strategy will advance EPA's work to protect all people from lead with an emphasis on high-risk communities. The strategy also reflects EPA's commitment to fulfilling the Biden-Harris Administration's historic deployment of resources to replace lead pipes and support lead paint removal under the *Lead Pipe and Paint Action Plan*.

I've traveled a lot as Administrator, but earlier this year I took a trip I'll never forget. Vice President Harris and I visited Milwaukee to discuss how, with the help of Bipartisan Infrastructure Law funding, we are working to remove lead pipes in communities across the country. We met with a mother whose life had been turned upside down after she discovered lead in her home. Her little boy was lead-poisoned and hospitalized repeatedly. Tragedies like this unfortunately are not unique. Far too many families have a similar story, and the time to do better is now.

EPA developed the Lead Strategy to lay out an ambitious plan to strengthen public health protections and address legacy lead contamination for communities with the greatest exposures. Through transformative funding from both the Bipartisan Infrastructure Law and the Inflation Reduction Act, we will help communities identify and remove lead service lines and eliminate lead from contaminated soil. EPA's Lead Strategy builds on the goals and objectives set forth in the Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts published in 2018, and emphasizes efforts to protect children's health while also addressing the racial and socioeconomic disparities of lead exposures in U.S. communities.

Engaging with communities across the country, as well as with federal, Tribal, state, and local government partners, was an integral part of developing the Lead Strategy. In fact, EPA engaged in an unprecedented effort to host public listening sessions in each of its 10 geographic regions and hosted an engagement session for Tribes. EPA carefully considered the feedback provided during these sessions and the input brought us to a final version of the Lead Strategy.

The Lead Strategy also includes meaningful performance measures that will track the Agency's progress toward meeting the goals of the strategy. These performance measures demonstrate our commitment to addressing led contamination and will hold EPA accountable to our obligation to protect public health. EPA will provide annual reporting on its progress on our website.

I want to thank the co-chairs of EPA's Lead Strategy Team—Carlton Waterhouse, Deputy Assistant Administrator for EPA's Office of Land and Emergency Management, and Deborah Jordan, Deputy Regional Administrator in EPA Region 9, as well as the co-chairs of the Lead Coordinating Committee — Paul Amato and Ken Davidson in EPA Region 9, as well as Matthew Lambert and Stiven Foster of EPA's Office of Land and Emergency Management — for their leadership in developing and finalizing the Lead Strategy.

Every day, we are a step closer to achieving a lead-free future for all, and together, I know we will make this vision a reality.

Michael S. Regan
Administrator, U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) developed this *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities* (Lead Strategy) to lay out an all-of-EPA plan to strengthen public health protections, address legacy lead contamination for communities with the greatest exposures, and promote environmental justice and equity.

Engaging with federal, tribal, state, and local government partners and the Agency's many stakeholders was an integral part of developing this Lead Strategy. On October 28, 2021, EPA released the draft and solicited feedback from the public through March of 2022. During the public comment period, EPA hosted 11 public listening sessions on the draft, one in each of EPA's 10 regions and an engagement session for tribes. The public also submitted hundreds of substantive comments about the draft and thousands of additional comments were submitted through mass comment campaigns. As a result of this concerted outreach, EPA received feedback from a wide array of stakeholders and community members from around the country. Public commenters shared many thoughtful ideas and impassioned perspectives on how to improve the Lead Strategy and how EPA and the whole of government can better address lead contamination in communities. EPA has carefully considered the comments received on the draft, and public input has substantially improved the final version. The final Lead Strategy also includes measures for tracking the Agency's progress in meeting the actions described within the strategy, as well as milestones for regulatory actions and updates to guidance and communication products.

Very low levels of lead in children's blood have been linked to adverse effects on intellect, concentration, and academic achievement.[1] The United States has made substantial progress in reducing lead exposure, but significant disparities remain along racial, ethnic, and socioeconomic lines. For example, Black children and those from low-income households have persistently been found to have higher blood lead levels than non-Hispanic white children and those from higher income households.[2] Under this strategy, EPA will focus on eliminating the disparities in blood lead levels by taking specific actions to prevent childhood exposures and exposure inequities that could lead to lifelong health effects and barriers to social and economic well-being.

The Biden-Harris Administration and EPA Administrator Michael Regan are committed to addressing ongoing exposures to lead, exposure inequities, and associated health impacts in communities across the nation. EPA developed the Lead Strategy to build on 40 years of progress in reducing lead in the environment and to focus attention on overburdened communities with environmental justice and civil rights concerns, consistent with the *Executive Order on Advancing Equity and Support for Underserved Communities Through the Federal*

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[1] U.S. Environmental Protection Agency (2013) https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721
[2] Egan et al. "Blood Lead Levels in U.S. Children Ages 1 – 11 Years, 1976 - 2016" Env. Health Pers. (2021) 129(3): https://doi.org/10.1289/EHP7932

Government.[3] The Lead Strategy also reflects EPA's commitment to fulfilling the Biden-Harris Administration's historic commitment of resources to replace lead pipes and support lead paint removal under the Lead Pipe and Paint Action Plan.[4]

The *Fiscal Year 2022-2026 EPA Strategic Plan* commits the Agency to taking actions that minimize public health disparities.[5] EPA's Lead Strategy will help achieve that ambitious objective by significantly reducing lead exposure for all people and eliminating inequities in elevated blood lead levels across population groups and life stages. To accomplish this objective, the Lead Strategy sets out four key goals:

1) Reduce community exposures to lead sources.
2) Identify communities with high lead exposures and improve their health outcomes.
3) Communicate more effectively with stakeholders.
4) Support and conduct critical research to inform efforts to reduce lead exposures and related health risks.

These four goals align with the goals in the *2018 Federal Action Plan to Reduce Childhood Lead Exposure,* which focused broadly on protecting children's environmental health.[6] EPA's Lead Strategy also seeks to protect children's health but particularly emphasizes reducing lead exposure in communities with persistent disparities in children's blood lead levels and promoting environmental justice and equity.

The Lead Strategy defines challenges to achieving each of these goals and identifies actions the Agency will take to address them. Despite great progress over the past few decades to reduce lead exposure, EPA still has important work to do, especially in communities already burdened by pollution and other stressors. Exposure sources and pathways for lead are complex and numerous, including lead-based paint, house dust, drinking water, soil, and air. Exposures can be greatest and pose significant health risks to young children, who may also be exposed in utero. Working locally, nationally, and with a whole of government approach, EPA is determined to take ambitious actions that follow the science and advance justice and equity to rid communities of harmful lead exposure and the resulting toxic effects.

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[3] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/
[4] https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/16/fact-sheet-the-biden-harris-lead-pipe-and-paint-action-plan/
[5] https://www.epa.gov/system/files/documents/2022-03/fy-2022-2026-epa-strategic-plan.pdf
[6] https://www.epa.gov/sites/default/files/2018-12/documents/fedactionplan_lead_final.pdf

LIST OF ABBREVIATIONS AND ACRONYMS

ATSDR - Agency for Toxic Substances and Disease Registry
Avgas – Aviation Gasoline
BIL – Bipartisan Infrastructure Law
CDC – Centers for Disease Control and Prevention
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CHPAC – Children's Health Protection Advisory Committee
CPSC – Consumer Product Safety Commission
DLCL – Dust-Lead Clearance Levels
DLHS – Dust-Lead Hazard Standards
DOJ – Department of Justice
DWSRF – Drinking Water State Revolving Fund
EAGLE - Eliminate Aviation Gasoline Lead Emissions
ELSWPEO - Enhancing Lead-Safe Work Practices through Education and Outreach
EPA – Environmental Protection Agency
FAA – Federal Aviation Administration
FDA – Food and Drug Administration
FY – Fiscal Year
HHS – Department of Health and Human Services
HUD – Department of Housing and Urban Development
IEUBK - Integrated Exposure Uptake Biokinetic Model
IQ – Intelligence Quotient
ISA – Integrated Science Assessment
LCR – Lead and Copper Rule
LCRI – Lead and Copper Rule Improvements
LCRR – Lead and Copper Rule Revisions
LSL – Lead Service Line
LSLR – Lead Service Line Replacement
MOU – Memorandum of Understanding
NAAQS – National Ambient Air Quality Standard
NLPPW – National Lead Poisoning Prevention Week
NPDWR - National Primary Drinking Water Regulation
P&CBs – Public and Commercial Buildings
PAFI - Piston Aviation Fuels Initiative
Pb - Lead
PEHSU - Pediatric Environmental Health Specialty Units
PPA - Prospective Purchaser Agreement
RCRA – Resource Conservation and Recovery Act
RRP – Renovation, Repair and Painting
SC DHEC - South Carolina Department of Health and Environmental Control
SDWIS - Safe Drinking Water Information System
SEP – Supplemental Environmental Project
SHEDS - Stochastic Human Exposure and Dose Simulation Model

SRF – State Revolving Fund
TSCA – Toxic Substances Control Act
USDA – United States Department of Agriculture
WIIN – Water Infrastructure Improvements for the Nation Act

GLOSSARY OF TERMS

Blood Lead Level: The amount of lead in blood is referred to as the blood lead level, which is measured in micrograms of lead per deciliter of blood (μg/dL).

Cumulative Impacts: The total burden (i.e., health, ecological, aesthetic, historic, cultural, economic, and/or social effects) that may result from chemical and non-chemical stressors, exposures from multiple routes or sources, and factors that differentially affect exposure or toxicity to communities.

Disadvantaged: Historically marginalized and overburdened.

Disproportionate Effects/Impacts: Situations of concern where there exists significantly higher and more adverse health and environmental effects on people of color, low-income populations or indigenous peoples.

Environmental Justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies.

Equity: The consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.

Exposure: Human contact with contaminants, such as lead, in media including air, water, soil, dust, paint, food, and consumer/cultural products.

Fair Treatment: Fair treatment means no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies.

Hot Spot: A geographic area with a high level of pollution/contamination within a larger geographic area of lower or more “normal” environmental quality.

Life Stage: A distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth that are characterized by economic resources.

Low-income: A reference to populations characterized by limited economic resources.

Meaningful Involvement: Meaningful involvement means people have an opportunity to participate in decisions about activities that may affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; community concerns will be considered in the decision-making process; and decision makers will seek out and facilitate the involvement of those potentially affected.

Overburdened: People of color, low-income, tribal, or indigenous populations or geographic locations in the United States that potentially experience disproportionate environmental harms and risks. This disproportionality can be as a result of greater vulnerability to environmental hazards, lack of opportunity for public participation, or other factors. Increased vulnerability may be attributable to an accumulation of negative or lack of positive environmental, health, economic, or social conditions within these populations or places. The term describes situations where multiple factors, including both environmental and socio-economic stressors, may act cumulatively to affect health and the environment and contribute to persistent environmental health disparities.

Risk: The probability of an adverse effect in an organism, system, or population caused under specified circumstances by exposure to a contaminant, such as lead, or stressor.

Risk Management: In the context of human health, a decision-making process that accounts for political, social, economic, and engineering implications together with risk-related information in order to develop, analyze, and compare management options and select the appropriate managerial response to a potential chronic health hazard.

Stakeholders: Broadly defined as persons concerned with the decisions made about how a risk may be avoided, mitigated, or eliminated, as well as those who may be affected by regulatory decisions.

Stressor: A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact.

Underserved Communities: Populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified in the preceding definition of "equity."

INTRODUCTION

In March of 2022, the U.S. Environmental Protection Agency (EPA) released the *Fiscal Year (FY) 2022-2026 EPA Strategic Plan* (Strategic Plan). The Strategic Plan communicates the Agency's priorities and provides a roadmap for achieving its mission to protect human health and the environment.[7] One of the Strategic Plan's goals is to take action to advance environmental justice and civil rights by achieving tangible progress for historically overburdened and underserved communities. EPA's *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities* (Lead Strategy) will help achieve the Strategic Plan's ambitious objective by addressing elevated blood lead levels in children at the greatest risk of exposure. This Lead Strategy provides a framework to help achieve this goal and emphasizes the importance of addressing racial, ethnic, and socioeconomic disparities in lead exposure from all sources.

EPA also has as one of its priorities ensuring that entities receiving any federal financial assistance from EPA comply with Title VI of the Civil Rights Act of 1964, which prohibits discrimination on the basis of race, color, or national origin (including limited English proficiency), and with other federal civil rights laws that prohibit discrimination on the basis of disability, sex, and age, as well as with EPA's nondiscrimination regulation at 40 C.F.R. Parts 5 and 7. Recipients of financial assistance from EPA have an affirmative obligation to ensure their actions do not involve discriminatory treatment and do not have discriminatory effects. EPA will work to ensure that the relevant actions described in the Lead Strategy will adhere to these civil rights requirements.

Regulatory actions by EPA and other federal agencies have significantly reduced the use of lead in automotive gasoline, paint, lead-soldered food containers, and plumbing water system components (e.g., pipes, fittings, solder, and fixtures) in the past 40 years. Despite significant progress in reducing lead exposures, EPA needs to continue its work to equitably protect people of all races, ethnic groups, income levels, disabilities, and life stages, including young children and pregnant women, who are the most vulnerable to the toxic effects of lead. Children living in communities overburdened by pollution and other health and social stressors, often communities of color and lower socioeconomic status, are at greater risk. For example, lead-based paint, lead service lines (LSLs), and plumbing fixtures containing lead are more likely to be found in older houses in lower-income areas. Communities of color can also face greater risk due to the legacy of redlining, historic racial segregation in housing, and reduced access to environmentally safe and affordable housing.[8] Industrial sources of lead are more likely to be closer to lower income neighborhoods and communities of color where soils in residential and public places can be contaminated.

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[7] https://www.epa.gov/system/files/documents/2022-03/fy-2022-2026-epa-strategic-plan.pdf. Note that EPA's "fiscal year" begins on October 1st and ends on September 30th of each year.
[8] Williams, David R., et.al. "Racism and Health: Evidence and Needed Research" Annual Review of Public Health (2019) 40:105-125. https://doi.org/10.1146/annurev-publhealth-040218-043750.

Children are more susceptible than adults to an array of adverse health effects associated with lead.[9,10] This can relate to exposures across all childhood life stages. For example, exposures of pregnant and nursing women can increase prenatal exposures. Fetuses can be exposed through the placenta, and infants can be exposed through breast milk and formula made with lead-contaminated water. Children can be exposed through "take home" exposures such as lead carried home on a work uniform or work shoes, from their care givers, and other people. Even very low levels of lead in children's blood have been linked to adverse effects on intellect, concentration, and academic achievement. These effects may have later-in-life impacts on an exposed individual's quality of life. Additionally, longer-term lead exposure over a lifetime is associated with increased risk of other effects, such as increased blood pressure and hypertension, which can lead to coronary heart disease.

Numerous and disparate sources of lead, coupled with many federal, tribal, state, and local agencies having separate legal authorities to address those sources, create a challenging landscape for tackling the problem. EPA and its federal partners need new approaches to protect communities still experiencing the highest childhood blood lead levels by reducing children's exposures to lead sources. EPA's Lead Strategy focuses the Agency's efforts to reduce lead exposures in communities by addressing multi-media exposure pathways with all our applicable statutory authorities and other tools, across all our relevant programs, and in coordination with our federal partners, tribes, and other stakeholders.[11]

Engaging with federal, tribal, state, and local government partners and the Agency's many stakeholders is an integral part of strategic planning. On October 28, 2021, EPA released the draft Lead Strategy and solicited feedback from the public through March of 2022. During the public comment period, EPA hosted 11 public listening sessions on the draft, one in each of EPA's 10 regions and an engagement session for tribes.[12] Participants were provided an opportunity to provide verbal comments during these sessions, the transcripts of which were submitted to the public docket that was created for the Lead Strategy.[13]

The public also submitted to the docket hundreds of substantive comments about the draft Lead Strategy and thousands of additional comments submitted through mass comment

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[9] Environmental Protection Agency, Integrated Science Assessment for Lead: https://www.epa.gov/isa/integrated-science-assessment-isa-lead

[10] Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for Lead. (2020) Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. DOI: 10.15620/cdc:95222

[11] EPA also recognizes that the effect of cumulative impacts (i.e., the total burden from chemical and non-chemical stressors) is best understood and addressed in specific situations to appropriately address public health risk. EPA is currently developing a consistent and comprehensive framework for assessing and considering cumulative impacts on populations and communities in its policies, programs, and activities. Such a framework will incorporate the vulnerabilities and susceptibilities related to the accumulation of multiple environmental and social stressors, which include those associated with lead. We anticipate that in the future, the Lead Strategy will reflect this cumulative impacts framework as appropriate.

[12] Recordings of these listening sessions are available at this website: https://www.epa.gov/lead/draft-strategy-reduce-lead-exposures-and-disparities-us-communities.

[13] https://www.regulations.gov/docket/EPA-HQ-OLEM-2021-0762

campaigns. EPA received feedback from a wide array of stakeholders and community members from around the country. Public commenters shared many thoughtful ideas and impassioned perspectives on how to improve the Lead Strategy and how EPA and the whole of government can better address lead contamination in communities. EPA has carefully considered the comments it received and has summarized the key themes from this public engagement in the strategy. The public input the Agency received has substantially improved the final version of the Lead Strategy.

As EPA implements this Lead Strategy, it will rely on scientific research and evidence as the basis for decision making to mitigate lead exposure from all environmental sources of lead.[14] For example, we will continue advancing and applying science for children's blood lead modeling and exposure mapping, for contaminated soils remediation, and location of drinking water LSLs. EPA expects that this strategy will be updated to ensure that we continue to engage with stakeholders, to rely on the best available science, and to use clear relevant measures and milestones to track our progress towards the goals of this strategy. The period for this strategy is aligned with the *Fiscal Year (FY) 2022-2026 EPA Strategic Plan* and the measures and milestones described below are generally expected to be completed annually or by the fall of 2026.

The remainder of the Lead Strategy is organized as follows. The first section outlines the goals of the strategy, as well as the broad approaches the Agency has developed to achieve them. The second section describes each Lead Strategy goal in detail. For each goal there is a description of the problem, a summary of the relevant key themes the Agency received from public comments, a list of the performance measures and milestones the Agency will use to track and report progress associated with each goal, and detailed descriptions of specific actions the Agency is taking, or will take, to achieve each goal. The final section provides conclusions and next steps for EPA's Lead Strategy. An Appendix at the end of this document lists all the performance measures and milestones that are included in the Lead Strategy.

[14] Foundations of Evidence-Based Policymaking Act of 2018: https://www.epa.gov/data/foundations-evidence-based-policymaking-act-2018

LEAD STRATEGY STRUCTURE AND APPROACHES

EPA's Lead Strategy is organized around goals that align with those developed in the 2018 *Federal Action Plan to Reduce Childhood Lead Exposure* (Federal Lead Action Plan). The Federal Lead Action Plan was produced by 17 federal agencies, including EPA, that serve on the President's Task Force on Environmental Health Risks and Safety Risks to Children.[15] Like the 2018 Federal Lead Action Plan, EPA's Lead Strategy seeks to protect children's health but places a particular emphasis on reducing lead exposure in communities as a means to reduce persistent inequities in children's blood lead levels and promoting environmental justice.

The four key goals of the Lead Strategy include:

Goal 1: Reduce Community Exposures to Lead Sources
Goal 2: Identify Communities with High Lead Exposures 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

The Lead Strategy defines challenges to achieving each of these goals and, for each goal, describes specific actions the Agency will take to address them. EPA has organized each of these actions by three "approaches" that will guide how and where the Agency will accelerate efforts to reduce lead exposures and eliminate racial and socioeconomic disparities in blood lead levels across the United States. Those approaches are:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

EPA will work with our partners to identify communities where lead exposure and blood lead levels persist and are known or reasonably suspected to be highest, and then will determine the dominant sources and cumulative exposure pathways. EPA will subsequently use this knowledge and evidence-based best practices to focus the Agency's actions, using all its tools to reduce health risk. EPA will also ensure that regulations are developed and implemented so that they protect communities from local exposures to lead.

APPROACH 2: Reduce lead exposures nationally through updated protective standards, analytical tools, and outreach

EPA will work to prevent and reduce lead exposures by developing and implementing national standards, policy, and guidance; updating regulations; enforcing regulations and statutory requirements; using analytical tools, conducting research, and applying

[15] https://www.epa.gov/lead/federal-action-plan-reduce-childhood-lead-exposure

evidence to improve the scientific foundations for methods to reduce and mitigate lead exposure; and soliciting stakeholder input to inform Agency decisions.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

EPA will create and target opportunities to collaborate across EPA programs and with federal partners and other governmental stakeholders, including states, tribes, cities, and counties, as well as non-governmental organizations and industry stakeholders, to focus the full range of resources to reduce lead exposures from all sources in the most vulnerable communities across the country.[16] The Agency will use evidence-based strategies for communication and outreach designed to reduce these exposures.

EPA will use scientific research and evidence-based approaches to prioritize and focus the Agency's actions. EPA's national program offices and ten regions will take a multi-pronged approach by working at the national and community levels; tackling lead contamination across all exposure pathways; and partnering with other federal agencies to combine resources and authorities to take on the challenge of reducing blood lead level disparities in specific communities.

The actions EPA will take to achieve these ambitious goals reflect consideration of the many thoughtful comments the Agency received during the public comment period. EPA has also identified performance measures and milestones the Agency will use to track and measure its progress in meeting these goals and objectives. The development of performance measures and milestones that accompany the Lead Strategy demonstrates EPA's commitment to addressing legacy lead contamination by strengthening public health protections from all routes of lead exposure. But there is still work to do; the Agency has not developed a performance measure or milestone for every action described in this strategy. Many of the actions described in this strategy have not yet been, or have only recently been, initiated and funded. These out-year activities are subject to the availability of appropriations. As these programs mature, so too will EPA's ability to set targets for measuring performance.

Where relevant, the Lead Strategy also presents specific case studies of past or ongoing EPA actions to reduce lead exposure that can serve as models for future work.

[16] Breysse, P, et.al. "Targeting Coordinated Federal Efforts to Address Persistent Hazardous Exposures to Lead" *American Journal of Public Health* (2022) *112, S640_S646,* https://doi.org/10.2105/AJPH.2022.306972

LEAD STRATEGY GOALS AND OBJECTIVES

GOAL 1: REDUCE COMMUNITY EXPOSURES TO LEAD SOURCES

Problem: Lead exposure results from multiple sources. For example, longstanding sources of lead exposure remain in homes, schools, child care facilities, and other buildings with lead-based paint, old water distribution systems, and household plumbing. Soils of residential yards, parks, and schoolgrounds across the United States also can be contaminated with lead. Underserved and under-resourced communities are especially vulnerable to lead contamination due to aging infrastructure and poor maintenance. EPA will leverage all its regulatory, technical advisory, and risk management tools to provide greater protection to communities from the effects of lead.

Because the actions necessary to reduce community exposures to lead are spread across multiple routes of exposure, the Lead Strategy has identified five separate objectives specific to achieving Goal 1:

Objective A: Reduce Exposure to Lead in Homes and Child-Occupied Facilities with Lead-Based Paint and Other Hazards
Objective B: Reduce Exposure to Lead from Drinking Water
Objective C: Reduce Exposure to Lead in Soils
Objective D: Reduce Exposure to Lead Associated with Emissions to Ambient Air
Objective E: Reduce Exposure to Lead Through Enforcement and Compliance Assurance

Objective A: Reduce Exposure to Lead in Homes and Child-Occupied Facilities with Lead-Based Paint and Other Hazards

Problem: Millions of people, especially those living in communities with environmental justice concerns, continue to be exposed to lead at home and in other buildings where lead-based paint is found in deteriorating condition (peeling, chipping, cracking, or damaged). Communities that have a high percentage of housing or buildings built before 1978 —and especially those built before 1940 — are at higher risk from historical use of lead-based paint.

Public Input:

Community and Contractor Training: Commenters on the draft Lead Strategy were widely supportive of the Enhancing Lead-Safe Work Practices through Education and Outreach (ELSWPEO) initiative. The initiative's purpose is to serve local communities and advance environmental justice by increasing both the number of Renovation, Repair and Painting (RRP) certified firms and the consumer demand for lead-safe work practices. This two-pronged approach was designed to raise awareness about potential lead exposure while renovating older homes and making certified contractors more readily available in overburdened and underserved communities across the country. Commenters requested more training and more resources for communities with environmental justice concerns.

EPA appreciates support for the initiative, begun in 2021. In the future, EPA is committed to supporting communities with environmental justice concerns by ensuring that certified contractors are readily available to these communities. EPA is also committed to increasing awareness of the hazards of lead in communities with environmental justice concerns through training and outreach, thus increasing demand for certified contractors and improving the public health of the community. To emphasize the dual goals of improving the general understanding of lead dangers and increasing the supply of contractors available in communities with environmental justice concerns, EPA will take two separate actions consistent with *Approach 1: Reduce Lead Exposures Locally*: one to ensure that certified contractors are more readily available in underserved communities, and another to improve awareness in underserved communities of the dangers of lead-based paint.

Addressing Demolitions: Commenters requested that EPA address ongoing contamination from demolitions and deconstruction in housing and public and commercial buildings (P&CBs). Commenters stated that large amounts of dust and debris can be created during demolitions which eventually end up in soil. Dust can spread to nearby properties and contaminate soil and the interiors of homes.

EPA regulates partial demolitions of target housing and child-occupied facilities under the existing RRP rule. In addition, the Toxic Substances Control Act (TSCA) Title IV provides EPA the authority to regulate demolitions (and deleading) of P&CBs under Lead-based Paint Activities. While EPA is not currently taking steps to promulgate additional regulations under Lead-based Paint Activities authority, EPA is working on addressing P&CBs under a RRP rule that could cover partial demolitions.

Rulemaking Timelines: Commenters expressed concern about EPA's progress in addressing TSCA Title IV rulemaking obligations, including the Definition of Lead Based Paint, Soil Lead Hazard Standards, and renovations in P&CBs, and urged EPA to commit to specific outcomes of the rulemaking process, considering impacts to housing and exposure within communities with environmental justice concerns.

EPA is committed to setting health protective standards and will use the best available science for these rulemakings. The regulatory impact analyses for these rules will specifically consider the impact on communities with environmental justice concerns. However, EPA cannot prejudge the results of the analyses conducted to support the rulemaking and therefore cannot commit to specific outcomes of the process.

TSCA Section 6 Authority: Commenters requested that EPA designate lead as a "high priority" substance under TSCA for Section 6 risk evaluation and risk management. Stakeholders suggested this would be the most expeditious way to address total demolition, recreational consumer products, non-residential lead paint, multimedia exposure, and legacy disposal.

EPA must have at least 20 chemical risk evaluations ongoing at any given time on High-Priority Substances with at least half of those risk evaluation on chemicals drawn from the 2014 TSCA Work Plan. Therefore, because lead and lead compounds are on the TSCA Work Plan, they will at some point be brought into the TSCA existing chemicals prioritization process and if designated as high priority, will undergo evaluation under section 6(b) of TSCA.

Cultural and Religious Products: Public comments on the draft Strategy included the importance of raising awareness of lead from non-traditional sources such as cultural and religious products and cookware and their disproportionate impact on certain communities, such as recently settled refugees. Public commenters recommended dissemination of information regarding lead exposure in these products through culturally informed public awareness campaigns.

Performance Measures and Milestones:

- By September 30, 2023, provide free or low-cost training to 500 contractors that are located in and around communities with environmental justice concerns spread throughout the U.S. over fiscal years 2022 and 2023.
- By September 30, 2023, host national and community-based Lead Awareness Curriculum sessions for 515 community leaders and Understanding Lead sessions for 340 community members, which reflects a 10% increase in participation from fiscal year 2022 to fiscal year 2023.
- By March 2023, publish the *Heavy Metals in Cultural Products: Outreach and Educational Resources Toolkit* on the EPA website.
- By February 2023, propose, and by June 2024, finalize the Dust-lead Hazard Standards (DLHS) and Dust-lead Clearance Levels (DLCL) Rule.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Ensure that certified contractors are more readily available in underserved communities:** EPA's Lead RRP Rule requires that firms performing RRP projects that disturb lead-based paint in homes, child care facilities and preschools built before 1978 be certified by EPA (or an EPA-authorized state, tribe, or territory) and use certified contractors who follow lead-safe work practices. It can be difficult for people to find certified contractors to perform these renovations. Free or low-cost RRP training, in either English or Spanish depending on location, provided by EPA will increase the number of certified contractors located in and around underserved and low-income communities. This encourages lead-safe work practices and reduces lead exposure during renovations of pre-1978 housing. For fiscal years 2022 and 2023, EPA is providing this training in conjunction with community training in the *ELSWPEO* initiative.

- **Improve awareness in underserved communities of the dangers of lead-based paint:** An important step in improving a community's health is raising awareness of the dangers of lead-based paint and other lead hazards. EPA will continue to increase awareness by offering free virtual webinars and/or in-person sessions in English and, when requested, will provide simultaneous Spanish interpretation of the "Lead Awareness Curriculum Train-the-Trainer" and "Understanding Lead" sessions. EPA is also striving to provide Understanding Lead sessions in additional languages to address the needs of other communities with limited English proficiency as they are identified. EPA will offer Lead Awareness Curriculum Train-the-Trainer sessions for community leaders on how to educate their communities about lead, lead exposures and actions that can be taken to reduce lead exposure, with a focus on how to use and modify the *Lead Awareness in Indian Country: Keeping our Children Healthy!* Curriculum for each community leader's specific audience. EPA will also offer Understanding Lead sessions for anyone interested in learning about lead. For fiscal years 2022 and 2023, EPA is providing these sessions as part of the *ELSWPEO* initiative, which also includes training for contractors.

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Revisit the DLHS and DLCL:** EPA has initiated a rule to reconsider the DLHS and DLCL in accordance with the Executive Order 13990 and consistent with a May 2021 court decision by the Ninth Circuit.[17,18] Lead inspectors, risk assessors, and abatement professionals use the DLHS to determine if dust-lead hazards are present and the DLCL to evaluate the effectiveness of cleaning following an abatement in target housing (i.e., built before 1978) and child-occupied facilities. As part of this rule, EPA plans to amend its regulatory definition of target housing to conform with a 2017 statutory change to clear up regulatory ambiguity and extend the regulatory coverage to zero-bedroom dwellings (e.g., studio apartments) where children live.

- **Revisit the definition of lead-based paint:** EPA will, in collaboration with the Department of Housing and Urban Development (HUD), revisit the definition of lead-based paint, assess the relevant scientific evidence, and if appropriate, revise the definition to make it more protective. The definition is incorporated throughout the lead-based paint regulations, and application of this definition is central to how the lead-based paint program functions. EPA is currently evaluating next steps on this issue in light of the May 2021 court decision by the Ninth Circuit.[19]

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[17] https://www.federalregister.gov/executive-order/13990
[18] *A Cmty. Voice v. U.S. EPA*, 997 F.3d 983 (9th Cir. 2021), https://cdn.ca9.uscourts.gov/datastore/opinions/2021/05/14/19-71930.pdf
[19] *A Cmty. Voice v. U.S. EPA*, 997 F.3d 983 (9th Cir. 2021), https://cdn.ca9.uscourts.gov/datastore/opinions/2021/05/14/19-71930.pdf

- **Support lead-safe renovations in public and commercial buildings:** EPA will continue its work to evaluate risk from renovations of public and commercial buildings pursuant to TSCA § 402(c)(3) that directs EPA to promulgate regulations for renovations in target housing, public buildings built before 1978, and commercial buildings that create lead-based paint hazards. EPA will determine whether such renovations create lead-based paint hazards, and, if they do, EPA will address any lead-based paint hazards by promulgating work practice, training, and certification requirements for public and commercial buildings.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Collaborate on lead paint rulemakings:** EPA will collaborate with HUD and other federal agencies on rulemakings to address lead-based paint hazards, including dust, soil, and the definition of lead-based paint. Closer coordination will improve the federal government's ability to collectively address lead-based paint hazards.

- **Collaborate to address potential exposures to lead from food, cosmetics and consumer products, and cultural/religious products:** EPA will collaborate with the Food and Drug Administration and the Consumer Product Safety Commission (CPSC) to address other sources of potential lead exposure, such as foods, cosmetics, art supplies, herbal and folk remedies, non-commercial pottery, recalled toys, jewelry, furniture, and other consumer goods.

- **Develop an education and outreach toolkit focused on children's health and pregnant women that identifies existing resources on lead (and other heavy metals) in cultural products and cookware:** This toolkit will serve as a resource for culturally competent educational and outreach materials for members of various communities concerned about lead contamination in culturally specific products.

- **Work internationally to assist other countries to establish laws to protect children and consumers from lead-containing paint:** More than 100 countries still allow the manufacture and sale of paint with high levels of lead; most of them are lower- and middle-income countries. Communities in lower- and middle-income countries, especially underserved and vulnerable populations with children living in poverty, are disproportionately at risk for health impacts from exposures to lead paint and other lead sources. Building on the success of phasing out lead in gasoline globally, EPA is working through a multi-stakeholder, international partnership to provide individual countries with guidance on drafting strong and effective laws to regulate lead-based paint.

REGIONAL COMMUNITY CASE STUDY

St. Joseph, Missouri is a beautiful, vibrant city on the Missouri River that struggles with a high incidence of elevated blood lead levels in children. Blood lead level testing data from 2014-2017 showed between 16 and 20 percent of children tested in St. Joseph zip code 64501 had blood lead levels at or above 5 ug/dl. Although the U.S. government banned consumer lead-based paint in 1978, lead-based paint, including lead-contaminated dust generated from it, remains one of the leading causes of lead exposure in the United States. In St. Joseph, most residential lead hazards come from homes built before 1978.

To combat this critical public health problem, EPA's Region 7 formed a cross-program outreach team to raise awareness about lead-based paint hazards in the home. The team focused on child care providers, renovators (professional and do-it-yourself), and the public. The team held numerous events with state, local, and federal partners that educated child care providers, trained home renovators, facilitated discussions with community leaders, conducted lead screening in children, and provided important information to St. Joseph residents. In addition, the St. Joseph Health Department, Kansas City Missouri Health Department, EPA, and HUD held partnership meetings focused on leveraging resources and acquiring new ones to address lead hazards in the community. This resulted in $90,000 to provide lead abatement work for low-income families living in pre-1978 housing. The team's effort culminated in a lead education summit, where federal, state, and local agencies, local nonprofits, and health providers came together to discuss next steps for preventing lead poisoning in St. Joseph. While the effort to reduce blood lead levels is ongoing, Region 7 is proud of the great strides St. Joseph and other partners have made to prevent exposures to lead in their community.

Objective B: Reduce Exposure to Lead from Drinking Water

Problem: Lead exposure through drinking water continues to be a serious risk in many communities, including those facing other environmental justice concerns. Lead can enter drinking water from plumbing materials that contain lead or from lead pipes that connect the home to the water main, also known as LSLs. In homes with LSLs, these pipes are typically the most significant source of lead in the water. Among homes without LSLs, the most common lead exposure problems are with old brass or chrome-plated brass faucets and plumbing with lead solder. The amount of lead allowed in new pipes, solder, flux fittings or fixtures was limited in 1986 and further reduced in 2014. Galvanized pipes are also a concern because they may accumulate lead from upstream sources.

There are still 6 to 10 million LSLs in cities and towns across the country.[20] Many of these are in communities of color or low-income communities. The Biden-Harris Administration has set a goal of removing 100% of LSLs. The Bipartisan Infrastructure Law (BIL)[21] will provide a historic $15 billion in funding – the first-ever dedicated federal funding – to address lead in drinking water by replacing service lines and carrying out associated activities that are directly connected to identifying, planning, designing, and replacing LSLs. All LSL replacement projects funded by the BIL must replace the entire LSL. To address household affordability concerns, EPA strongly encourages states to fund the private portion of service line replacements at no additional cost to the homeowner This means that a significant potential source of lead exposure from drinking water will be eliminated for millions of families.

Unfortunately, the locations of lead pipes, solder, faucets, and fixtures are not always known, which presents challenges for eliminating lead exposure from drinking water. Although replacing LSLs and in-home water systems is quite costly, reducing drinking water lead exposure generates significant health benefits for communities. EPA's 2021 economic analysis of the costs and benefits of LSL replacement estimates that the labor and material costs of identifying, excavating, and replacing LSLs are accompanied by significant increases in lifetime earnings associated with avoided intelligence quotient (IQ) loss in children, and also noted that other adverse health effects might be reduced as well.[22]

Public Input: Public comments related to lead and drinking water fell into several categories. Many comments focused on the importance of ensuring equitable access and distribution of BIL funding and resources in disadvantaged[23] and tribal communities, improving lead regulations, and enhancing programs for better protection of children in schools and child care facilities.

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[20] Cornwell, D.A, et.al. "National Survey of Lead Service Line Occurrence. Journal American Water Works Association" (2016) 108(4): E182-E191. https://awwa.onlinelibrary.wiley.com/doi/abs/10.5942/jawwa.2016.108.0086

[21] Also referred to as the Infrastructure Investment and Jobs Act, P.L. 117-58 (Nov. 15, 2021).

[22] https://www.regulations.gov/document/EPA-HQ-OW-2017-0300-1769

[23] For the purposes of Goal 1, Objective B, a small or disadvantaged community is one: that the state determines to be a disadvantaged community under SDWA section 1452(d)(3) or may become a disadvantaged community as a result of carrying out a project or activity; or, with a population of less than 10,000 individuals that does not have

Public comments related to lead regulations focused on actions EPA should take to update the Lead and Copper Rule Revisions, ensure equity in lead service line replacement (LSLR), develop protective health-based standards, and improve public education. In addition, many comments proposed creating incentives to encourage states, utilities, communities, and others to embark upon full LSLR. The comments noted utilizing loans (e.g., Drinking Water State Revolving Funds (DWSRF)), grants (e.g., Water Infrastructure Improvements for the Nation Act (WIIN)), and voluntary programs.

Public comments related to how disadvantaged communities, and other communities such as tribes, can access the resources they need to adequately address lead in drinking water focused on use of BIL funds through the DWSRF to ensure equitable distribution of funds and resources.

Public comments related to protecting children in schools and child care facilities focused on actions EPA should take to ensure disadvantaged communities have access to funds (e.g., WIIN grants, BIL funds) for lead testing and remediation and asking EPA to ensure a coordinated federal response providing resources, requiring lead testing and remediation, and addressing all sources of lead exposure to children. In addition, public comments indicated EPA should continue to provide training, outreach, and technical assistance to schools and child care facilities.

EPA responds to this input through the actions described below. EPA is working to improve its regulations to control lead in drinking water and has prioritized resources and technical assistance to tribal communities as well as disadvantaged communities focused on replacing lead services lines and reducing lead in drinking water. EPA continues to actively engage with other agencies to leverage resources and better coordinate across the federal government, tribes, water utilities, non-federal organizations, and the public health community. Together with our federal partners, EPA intends to work with stakeholder communities in developing and strengthening initiatives to reduce drinking water lead exposure in disadvantaged communities and elsewhere.

Performance Measures and Milestones:

- Track and report total funds to disadvantaged communities for projects that support reduction of lead in drinking water.
- By the end of 2022, partner with four states to establish LSLR Accelerators, which will provide targeted technical assistance and develop best practices to help address the barriers disadvantaged communities face in replacing LSLs.
- By the end of 2022, conduct outreach on the new "*Guidance for Developing and Maintaining a Service Line Inventory*" to help water systems develop LSL inventories as soon

the capacity to incur debt sufficient to finance a project to comply with the SDWA. Source: https://www.epa.gov/sites/default/files/2019-03/documents/assistance_for_small_and_disadvantaged_communities_factsheet_508.pdf as possible to begin replacement programs and no later than the Lead and Copper Rule Revisions compliance deadline of October 2024.[24]

- By the end of 2023, propose, and by October 2024, take final action on the Lead and Copper Rule Improvements to strengthen the regulatory framework and address lead in drinking water.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with environmental justice concerns

- **Target communities with lead in drinking water concerns:** EPA will identify community water systems with lead in drinking water concerns. EPA will then work with the states to target technical assistance and provide funding to reduce lead exposure within these communities, particularly in disadvantaged communities. The Agency understands the effects of LSLs on communities, including those with environmental justice concerns, and will focus on identifying and implementing solutions to identify and replace LSLs. EPA's strategies, which continue to be tailored through community engagement, include improving public outreach and education, encouraging the proactive and full replacement of LSLs, providing technical assistance on proper sampling techniques, improving corrosion control treatment, and supporting the 3Ts (*Training, Testing, and Taking Action*) programs to reduce lead in drinking water at schools and child care facilities.

  Consistent with the public comments, EPA continues to engage federal and non-federal partners to coordinate data sharing to better target disadvantaged and other communities with high levels of lead in drinking water. For example, EPA plans to collaborate with state partners to launch a new EPA technical assistance initiative called LSLR Accelerators. Starting in fall 2022, EPA will pilot the Accelerators in partnership with four states. The Accelerators will address existing barriers and accelerate progress towards the Biden-Harris Administration's goal of 100 percent LSLR. Disadvantaged communities struggling with LSL identification and replacement may have limited technical, operational, and financial resources. This technical assistance initiative will help those communities address barriers by providing the tools needed to accelerate LSLR. EPA and the participating states will also work to actively share lessons learned with other states, tribes, territories, local municipalities, and public water systems.

- **Provide DWSRF assistance to reduce lead in drinking water:** The BIL provides $15 billion through the DWSRF to replace LSLs and carry out associated activities that are directly connected to the identification, planning, design, and replacement of LSLs. There is no state match requirement for these funds, and 49% of the money will be provided as grants or principal forgiveness loans to communities. States can also use funds from the additional

[24] https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule

$11.7 billion in general-purpose DWSRF funds appropriated through the BIL for the identification, planning, design, and replacement of LSLs.

EPA will increase awareness, particularly in small, underserved communities and communities of color, about programs and funding opportunities to replace LSLs, regardless of ownership, and reduce lead in drinking water. Funding from these programs can replace LSLs, including lines on private property; develop LSL inventories; install or improve corrosion control treatment (using BIL general supplemental funds); and remove lead from drinking water in schools and child care facilities.

EPA will encourage states to ensure that BIL LSLR funding reaches disadvantaged communities and will encourage states to leverage other funds, such as base and BIL supplemental DWSRF funds to meet their LSLR needs. EPA released an implementation memorandum in March 2022 that provides information and guidelines on how EPA will implement the State Revolving Fund (SRF) program, including the capitalization grants appropriated to states under the law.[25] The implementation memorandum is expected to be applicable to all five years of BIL appropriations. In addition, to address household affordability concerns and encourage full and rapid LSLR, EPA encourages state DWSRF programs to fund the private portion of LSLR projects at no additional cost to private property owners. In particular, EPA encourages states and water systems to include low-income homeowners, and landlords or property owners providing housing to low-income renters in LSLR prioritization and private-side funding programs.

EPA will collaborate with state SRF programs to share models and guidance, and to build state capacity to assist local communities and ensure LSL funding is effectively and equitably deployed. In particular, EPA will work with state partners to ensure that small, underserved communities, communities of color, and other communities with high infrastructure resource needs benefit from this funding. Finally, EPA will evaluate additional reporting requirements for DWSRF projects to capture the impact of funding, including funds reaching disadvantaged communities, LSL inventory information, and additional lead-reduction steps that water systems are taking. These actions are consistent with public comments. EPA is working on several efforts to ensure equitable distribution of BIL funds to support LSLR in disadvantaged communities.

- **Award funding for and support implementation of the Lead Testing in School and Child Care Program Drinking Water Grant Program:** EPA awards funding to participating states, territories, and tribal consortia to support training and technical assistance for schools and child care programs to train staff and test drinking water for lead. The funding also supports technical assistance to schools and child care facilities on follow-up options.[26] The BIL

[25] https://www.epa.gov/dwsrf/bipartisan-infrastructure-law-srf-memorandum

[26] Follow-up options include activities such as turning off or removing the specific outlet that has tested high for lead, posting signs to not use certain outlets for drinking or cooking, conducting follow-up sampling to identify specific components that might be the source(s) of lead, instituting flushing programs, installing filters, and/or replacing plumbing, fittings, and fixtures.

expanded existing grant authority to include lead remediation and compliance monitoring as eligible projects and activities. EPA relies on Congressional appropriations to fund these drinking water grants.

EPA has awarded funds through the *Voluntary School and Child Care Lead Testing and Reduction Grant Program* to seven tribal consortia,[27] all 50 states, the District of Columbia, Puerto Rico, U.S. Virgin Islands, and American Samoa to provide lead testing in drinking water in schools and/or child care facilities. New eligibilities under this grant program that allow for lead remediation activities as authorized by the BIL are available to all grantees.[28] Further, EPA is working with the Centers for Disease Control and Prevention (CDC) to inform nationwide surveillance of blood lead levels, provide education and outreach to communities, and provide technical assistance. In addition, through its *Reducing Lead in Drinking Water* Grant competition, EPA awarded millions in funding to two areas:

Reducing Children's Exposure to Lead in Drinking Water in Schools and Child Care Facilities. This funding prioritizes projects aimed at the removal of potential sources of lead in hundreds of schools and child care facilities across the United States. EPA distributed approximately $25M in fiscal year 2020. In October 2022, EPA announced $10.5M in grants for new projects; and

Reduction of Lead Exposure in the Nation's Drinking Water Systems through Infrastructure and Treatment Improvements. EPA awarded more than $15M in fiscal year 2020 for thousands of LSL replacements and implementing treatment improvement projects. In October 2022, EPA announced $20.5M in grants for new projects in disadvantaged communities.

This more than $30M total in grant funding, and additional funding through the BIL, will help make rapid progress on the goal of addressing lead and removing lead pipes across the country in disadvantaged communities and schools.[29]

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Lead and Copper Rule Improvements (LCRI)**: In January 2021, EPA issued the Lead and Copper Rule Revisions (LCRR) (86 FR 4198) and subsequently reviewed those revisions to further evaluate if the LCRR protected families and communities (86 FR 71574), particularly those who have been disproportionately impacted by lead in drinking water.[30] Through this review, the Agency concluded that there are significant opportunities to improve the LCRR

[27] https://www.epa.gov/dwcapacity/wiin-grant-voluntary-school-and-child-care-lead-testing-and-reduction-grant-program#tribal
[28] Guide planned for publication by the end of 2022.
[29] https://www.epa.gov/newsreleases/epa-announces-30-million-grants-projects-reduce-lead-drinking-water-disadvantaged
[30] https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule

(86 FR 71574).[31] EPA is developing a new proposed National Primary Drinking Water Regulation (NPDWR), the LCRI, to strengthen the regulatory framework and address lead in drinking water. EPA identified the following priority areas for improvement: Proactive and equitable LSLR; strengthening compliance tap sampling to better identify communities most at risk of lead in drinking water and to compel lead reduction actions; and reducing the complexity of the regulation through improvement of the action and trigger level construct.

- **Implement the LSL inventory requirements in the LCRR:**[32] In December 2021, EPA published the findings of its review of the LCRR and announced that it does not expect to propose changes to the requirements related to the information to be submitted in the initial LSL inventory. EPA also urged continued progress to identify LSLs as integral to lead reduction efforts regardless of potential revisions to the rule. EPA continues to provide oversight of Lead and Copper Rule implementation.

  EPA developed the following guidance to support public water systems and primacy agencies, "Guidance for Developing and Maintaining Service Line Inventories," and plans to develop the LCRR Small Entity Compliance Guidance to assist small water systems with creation of their inventories. This work includes supporting LSL inventory development, encouraging full LSLR programs, and discouraging partial replacement.

  EPA is updating the Safe Drinking Water Information System (SDWIS) to support data on the counts of lead, unknown, and non-LSLs at each water system. This data is required to be reported to EPA by States under the LCRR and water systems must make their inventories publicly accessible by the October 16, 2024, compliance deadline.[33] EPA will consider how to report on progress to identify and replace LSLs over time as the information is provided to the Agency by its state and tribal partners.

  Consistent with public comments to improve education, other planned work includes improving guidance and templates to help states and public water systems communicate lead risk to households and communities with LSLs; revising the Consumer Confidence Report Rule to include more information about actions public water systems are taking to control lead; and developing materials that describe the risks posed by partial LSLR and measures to reduce lead concentrations following replacement (e.g., flushing plumbing, use of filters, and follow-up testing).[34]

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[31] The Federal Register Notice. Review of the National Primary Drinking Water Regulation: Lead and Copper Rule Revisions (LCRR), December 17, 2021: https://www.federalregister.gov/documents/2021/12/17/2021-27457/review-of-the-national-primary-drinking-water-regulation-lead-and-copper-rule-revisions-lcrr.

[32] EPA authorizes states and tribes to have primary enforcement responsibility (also called primacy) for public water systems if they meet certain requirements.

[33] https://www.epa.gov/ground-water-and-drinking-water/safe-drinking-water-information-system-sdwis-federal-reporting

[34] https://www.epa.gov/ccr/consumer-confidence-report-rule-and-rule-history-water-systems

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Provide resources to schools, child care facilities, and states:** EPA will continue to chair a federal interagency and stakeholder group under the Memorandum of Understanding (MOU) on Reducing Lead Levels in Drinking Water in Schools and Child Care Facilities. This interagency group includes EPA; several offices within the Department of Health and Human Services (HHS), including the CDC, Indian Health Service, and the Administration for Children and Families' Office of Head Start and Office of Early Childhood Development; and the Departments of Agriculture (USDA), Education, and Interior, as well as nine non-federal associations.[35]

  This interagency group works together to provide schools, child care facilities, and states with education on health concerns associated with lead in drinking water; helps develop lead testing programs using EPA's *3Ts (Training, Testing, and Taking Action) for Reducing Lead in Drinking Water in School and Child Care Facilities*; works with schools and child care facilities to establish a sustainable and effective lead in drinking water testing program; and connects schools and child care facilities that find lead in their drinking water with funding resources for remediation, such as USDA's Community Facilities grant programs and HHS's Head Start funds through its program improvement requests. EPA will continue to develop tools and trainings through the 3Ts program and work with MOU partners to provide input on and review of products and to help promote final products.

  Consistent with the public comments requesting a holistic federal approach, EPA continues to leverage federal and non-federal programs to protect children's health in schools and child care facilities. EPA activities with partners of the MOU on Reducing Lead in Drinking Water in Schools and Child Care facilities include:

  > *Collaborating with HHS and USDA* to identify opportunities to align funds, address data gaps on lead contamination, and develop coordinated policies and guidance to leverage respective agency authorities in schools and early childhood facilities; and
  >
  > *Providing technical assistance and training* as USDA pursues actions through its Rural Development mission area, including the Community Facilities program efforts to prevent lead poisoning through renovation and repair work on child occupied facilities and installation of water filter stations in schools and child care facilities.

- **Collaborate on lead testing for drinking water:** EPA is working with HHS to promote lead testing best practices in drinking water at facilities funded by its Office of Head Start and the Office of Child Care.

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[35] https://www.epa.gov/sites/production/files/2019-10/documents/mou_reducing_lead_in_drinking_water_in_schools_final.pdf

Consistent with public comments to provide education and technical assistance to schools and child care facilities, EPA is collaborating with HHS to provide training at the local level and to leverage authorities and policies to increase lead testing and remediation in early childhood and child care communities.

REGIONAL COMMUNITY CASE STUDY

Elevated levels of lead were identified while evaluating nitrate contamination in the drinking water at an affordable housing complex in Massachusetts (MA), EPA Region 1. The complex is a 36-unit, elderly and disabled residential home. The community is in rural central MA. The complex is a public water system and is subject to the Lead and Copper Rule along with other NPDWRs as a Community Water System.

The Massachusetts Department of Environmental Protection (Mass Dep) issued a “Do Not Drink Order” for the complex due to a nitrate contamination issue. During the evaluation period, the complex’s corrosion control water treatment system failed, causing highly acidic water to corrode the building’s pipes. As a result, the lead levels in the drinking water increased to above the action limit set by Mass DEP. Also, the water had a blue/green tinge, which caused the sinks, toilets and tubs to stain, and residents were advised not to wash light colored clothes as they could also become stained. As a result, residents were provided bottled water dispensers and free bottled water supplies in each apartment unit.

Using funding from EPA’s Training and Technical Assistance Grant and HHS grants, a team of technical specialists from Rural Community Assistance Partnership (RCAP) Solutions, with extensive background in water and environmental issues, worked with the property management of the complex. The technical assistance team identified the nitrate contamination source by fully evaluating the property’s onsite wastewater treatment system. They discovered the system was not installed as designed and was leaking into the source water. The technical assistance team oversaw the re-construction of the on-site wastewater system; since that repair, the nitrate levels have abated to levels acceptable under state drinking water standards. Further, the RCAP team replaced many faucets and plumbing that were potential sources of lead and assisted the complex to install a new pH control system which abated the corrosion caused by the acidic water. Reducing the corrosion removed the identified issues with the water’s blue coloration and high lead levels. In addition, the technical assistance team assisted the complex with a variety of compliance issues including previous sanitary survey consent orders and developed a long-term plan for the complex’s drinking water system to ensure continued compliance and long-term sustainability. The community’s drinking water continues to meet compliance standards, including for lead.

Objective C: Reduce Exposure to Lead in Soils

Problem: Lead is a naturally occurring element generally found in soil at low levels. In many locations across the United States, however, the concentrations of lead in soils can be much higher because of human activities – especially in and around urban areas, in areas with lead mining and smelting activities, and near older homes with lead-based paint. Today, this legacy of lead overburdens communities impacted by the activities of lead producing and using industries; often these are communities of color and low-income neighborhoods. Soil-lead contamination can occur from past industrial operations that involved lead, from lead-based paint cracking, flaking, and peeling off homes and buildings, and from past use of leaded gasoline, especially in housing near highways or heavily travelled city streets. Lead contamination from the past, often from multiple sources, can accumulate and remain an ongoing threat.

Children and adults can be exposed to lead in soil and dust through incidental ingestion of contaminated soils by touching their mouth with their hands (typically in young children), but also by adults working in soils or gardening. Children may also ingest soil and dust by placing non-food items in their mouths.[36] Soil contaminated with lead can be tracked into homes or other buildings, which can result in ingestion of contaminated house dust.[37] In some cases, eating fruits and vegetables grown in lead-contaminated soil is another route of exposure.

Public Input: A key message from the public comments on the draft strategy was that EPA should address lead-contaminated soils regardless of the source of the pollution. Commenters noted that higher blood lead levels are typically due to multiple sources of lead. Others urged EPA to coordinate the use of its authorities to address all lead exposures in communities and to collaborate with other federal, tribal, state, and municipal agencies so that sources of lead are not left unaddressed. Another key message from the public comments was that EPA's standards for lead in soil are out of date. Commenters mentioned the cleanup standards for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal and remedial sites and Resource Conservation and Recovery Act (RCRA) corrective action facilities, as well as the Soil Lead Hazard Standard, and recommended that EPA align its standards with the CDC's blood lead reference value, which is currently 3.5 µg/dL.[38] Public comments also emphasized the need to focus efforts to address lead contamination in communities with environmental justice concerns as these communities are typically exposed to lead from multiple sources. Other commenters noted that there should be a mechanism to clean up lead contaminated soils that do not qualify for a CERCLA response, that communities need technical assistance from EPA to address lead, and that EPA should consider alternative

[36] EPA Exposure Factors Handbook, chapter 5. https://www.epa.gov/sites/default/files/2018-01/documents/efh-chapter05_2017.pdf.
[37] Clark S, et. al. "The Influence of Exterior 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 (2004) 1:5, 273-282, https://doi.org/10.1080/15459620490439036
[38] CDC Blood Lead Reference Value: https://www.cdc.gov/nceh/lead/data/blood-lead-reference-value.htm.

remedial technologies, such as capping, landscaping, and soil amendments. The actions below reflect EPA's consideration of these comments.

Performance Measures and Milestones:

- By September 30, 2026, complete 225 Superfund cleanup projects that address lead as a contaminant (averaging 45 each year).
- By June 30, 2023, evaluate and revise the Residential Soil Lead Guidance for Contaminated Sites to protect communities by further reducing the potential for exposure to lead in soil.
- By September 30, 2023, review results of the Superfund Lead Collaboration Pilot projects and where appropriate, update Superfund guidance to reflect best practices.
- Report annually the number of Brownfields cleanups that addressed lead contamination, as reported by grant recipients.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Clean up lead contaminated sites:** EPA will prioritize cleaning up lead in communities contaminated by lead from CERCLA (Superfund) or RCRA releases. Risk of potential adverse health effects, level of exposure, promotion of environmental justice, and other factors will guide EPA's efforts. EPA will work with states, tribes, communities, and other stakeholders at Superfund removal and remedial sites and at RCRA corrective action facilities to address lead contamination under applicable statutory authorities. Cleanup at lead-contaminated sites impacting tribal nations will evaluate exposure pathways unique to tribal members, as well as any Traditional Ecological Knowledge or Indigenous Knowledge provided by the tribe.[39] Furthermore, EPA will continue to update tools to characterize, assess, and address sites with lead-contaminated soil.[40]

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Revise the Residential Soil Lead Guidance for Contaminated Sites to further reduce the potential for exposure to lead in soil:** The soil lead guidance for assessing and remediating contaminated sites, last updated in 1998, provides recommendations to help identify and define areas that may require further investigation and to help prioritize sites with the most

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[39] Considering Traditional Ecological Knowledge (TEK) During the Cleanup Process. EPA, OLEM, 2017, https://www.epa.gov/sites/default/files/2018-02/documents/considering_traditional_ecological_knowledge_tek_during_the_cleanup_process.pdf. In addition, EPA may provide additional knowledge when government-wide guidance on TEK/IK in federal decision-making is final.

[40] Guidance, exposure models, tools, and technical support can be found on EPA's Technical Review Workgroup, Lead Committee website: https://www.epa.gov/superfund/lead-superfund-sites.

immediate threats associated with lead contaminated soils at Superfund sites and RCRA facilities.[41] EPA is in the process of reviewing the 1998 guidance to determine if new recommendations for screening sites and facilities with residential exposures are appropriate. EPA will account for the multiple and complex lead exposures to children when setting screening levels and cleanup goals to reduce lead exposure in communities and protect human health and the environment.

- **Revisit the soil-lead hazard standards:** In light of a May 2021 court decision by the Ninth Circuit,[42] EPA will reconsider the 2001 soil-lead hazard standards.[43] The soil-lead hazard standards, issued under Title IV of TSCA, identify lead-contaminated soils at target housing (i.e., built before 1978) and pre-1978 child-occupied facilities that would result in adverse human health effects. Soils that contain lead at levels determined to be hazardous to human health are considered contaminated. Lead inspectors, risk assessors, and abatement professionals use the soil-lead hazard standards in target housing and pre-1978 child-occupied facilities to determine if soil-lead hazards are present and to inform options for reducing risk of exposure.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Work with HUD to reduce lead exposure to protect families, particularly children, in overburdened and underserved communities:** EPA will work with HUD to reduce exposure to lead to protect families, particularly children, in overburdened and underserved communities. Where HUD authorities are used to address indoor or outdoor environmental hazards in housing at or near sites and EPA is addressing Superfund lead cleanup projects, EPA will coordinate Superfund efforts with HUD. In a separate effort, under a current Memorandum of Understanding, EPA and HUD are identifying HUD-assisted housing properties on and around Superfund sites to inform HUD and EPA staff of the sites to facilitate faster and more effective sampling and clean up.

- **Use a collaborative approach to reduce lead at Superfund sites:** EPA is working to promote more effective collaboration at the local, state, territorial, tribal, and federal levels to address multiple sources of lead in communities near Superfund sites where lead is a contaminant of concern. EPA's Superfund program is conducting the Superfund Lead Collaboration Pilot to gather best practices for enhancing collaboration to address multiple sources of lead in communities near Superfund lead sites with the ultimate goal of improved health outcomes for children who are being exposed to lead. EPA is working with a broad range of stakeholders to leverage multiple authorities and tools to address lead exposures at Superfund sites such as lead-based paint, lead from air sources, and lead in drinking water. These collaborative stakeholders may include other EPA programs, other

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[41] https://www.epa.gov/superfund/lead-superfund-sites-guidance
[42] *A Cmty. Voice v. U.S. EPA*, 997 F.3d 983 (9th Cir. 2021), https://cdn.ca9.uscourts.gov/datastore/opinions/2021/05/14/19-71930.pdf
[43] https://www.govinfo.gov/content/pkg/FR-2001-01-05/pdf/01-84.pdf

federal agencies such as HUD and HHS, state and local environmental and health departments, community groups/organizations, and other entities as appropriate.

- **Support community-driven Brownfields assessment, cleanup, and revitalization:** When site risks and contamination levels are not addressed under a Superfund-based cleanup action, EPA will continue to respond to requests for technical assistance to help community-driven cleanups to revitalize sites with lead and other contaminants. EPA will also organize annual Brownfields grant competitions that allow tribes, states, and communities to seek funds to assess, clean, and plan for the safe reuse of Brownfields, including the creation of community lead-safe spaces. States and tribes determine actionable lead contaminant levels at these Brownfields sites, and remediation of these sites are subject to those levels, as established under risk-based cleanup programs. The Technical Assistance to Brownfield Communities program can provide technical assistance to communities and stakeholders to help address their Brownfield sites, and to increase their understanding and involvement in Brownfields cleanup, revitalization and reuse.[44] Organizations can contact EPA Regional programs directly to seek free Targeted Brownfield Assessments, which can help with a specific site to collect site-specific information or investigate environmental conditions that may be beyond the scope of many community-based organizations.[45]

[44] https://www.epa.gov/brownfields/brownfields-technical-assistance-training-and-research
[45] https://www.epa.gov/brownfields/targeted-brownfields-assessments-tba

REGIONAL COMMUNITY CASE STUDY

EPA began cleanup of the U.S. Smelting and Lead Refinery Inc. site (USS Lead Superfund) in East Chicago, Indiana in 2008 and listed the site on the National Priorities List in April 2009. At that time, nearby residents were concerned about the risks they faced from past and ongoing lead exposures and had limited information about the EPA cleanup process. In response to the affected community's desire for better communication and outreach, EPA employed numerous community engagement strategies including establishment of a local phone hotline, a local staffed office with drop-in visit time, an online data viewer, and a regular newsletter. EPA also engaged in frequent public availability sessions and meetings to engage with the community throughout the cleanup.

This large-scale residential yard cleanup began with an emergency response to lead contamination in soil at several hundred homes, drawing media, community, and political interest. Because of the intensive and comprehensive team effort, all 807 properties in Zones 2 and 3 (including non-residential) that required cleanup were safely cleaned up by the fall of 2021, nearly a year ahead of schedule. This extraordinary effort was the result of dedicated coordination between all EPA Region 5 programs involved, the U.S. Department of Justice (DOJ), the Agency for Toxic Substances and Disease Registry (ATSDR), HUD, and state and local health departments.

EPA prioritized the USS Lead site after Region 5 recognized that more than 1,000 residential properties could be contaminated with high levels of lead and arsenic in the soil. Initial plans and actions involved requiring those responsible for the contamination to complete or pay for all sampling and cleanup at these residential properties by late 2020 or early 2021, with intensive EPA oversight. To engage with the impacted residents under this aggressive cleanup schedule, Region 5 implemented innovative efforts, including the Superfund Jobs Training Initiative program and a creative community event. The Jobs Training Initiative program for East Chicago residents resulted in the hiring of 10 trainees by site cleanup contractors to help with the lead cleanup in their own community. EPA also partnered with the ATSDR and local health agencies to host a superhero-themed community event with free entertainment and food trucks and a mobile blood testing unit to encourage families to have their children's blood lead tested.

With these actions and more, the affected community at the USS Lead Site remained engaged in their cleanup work and helped move the cleanup along expeditiously. EPA's efforts fostered a positive relationship with the community and at the same time accelerated removal of contaminated soils from the impacted residential properties in East Chicago. Going forward, EPA, with the assistance of the DOJ, has finalized a Prospective Purchaser Agreement (PPA) with a company that specializes in redevelopment of properties that contain or once contained hazardous substances. Under the PPA, part of the USS Lead Site would be further cleaned up and redeveloped as a commercial warehouse.

Objective D: Reduce Exposure to Lead Associated with Emissions to Ambient Air

Problem: Lead emitted into the air can contribute to multiple pathways of exposure that can pose risks to human health and the environment. For example, lead from ambient air can contribute to lead in soil and related pathways, as well as indoor air and dust. The extent of air-related pathway contributions to exposures and risk depends largely on source and community characteristics. On a national scale, the largest aggregated source of lead air emissions is piston-engine aircraft operating on leaded aviation fuel, which can contribute to increased air lead concentrations at some general aviation airports. Locally, however, areas of the U.S. with the highest concentrations are generally near metals industries, such as battery recycling facilities and other metal processing facilities.

The U.S. has made enormous progress in reducing lead emissions and associated ambient air concentrations. Between 1980 and 2018, concentrations of lead in ambient air at a set of continuously monitored sites have decreased by 99 percent.[46] Substantial progress has also been made in addressing areas of the U.S. with lead concentrations exceeding the National Ambient Air Quality Standards (NAAQS) for lead. All but two of the 22 areas that were initially identified as not meeting the NAAQS are currently meeting the NAAQS.[47] EPA will continue to assess and reach conclusions on hazards, potential exposures, and risks; set and implement standards to limit emissions and air concentrations; and work with state and local agencies to monitor air quality near sources and ensure compliance with the standards. Further, EPA will continue to track airborne lead concentrations through state-led ambient air monitoring and emissions inventory reporting and will share the national status in future air trends reports.

Public Input: Public comments on the draft strategy included concerns regarding sources of lead emissions to ambient air. Many commenters raised concerns regarding emissions from piston-engine aircraft using leaded aviation gasoline (avgas), and comments were also received regarding emissions from other types of sources, such as metals industries. The comments urged the Agency to act promptly to restrict emissions from all of these sources. Additionally, some comments emphasized the need to bring all areas of the country into attainment with the existing NAAQS, and to ensure monitors are sited near sources. Further, comments emphasized the importance of the ongoing review of the NAAQS to ensure the national standards reflect the current scientific information. The actions identified below reflect consideration of these comments.

Performance Measures and Milestones:

- **Lead NAAQS**: Projected completion of the current lead NAAQS review in 2026.

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[46] The annual air quality trends report includes information on trends in lead emissions and ambient air concentrations (https://www.epa.gov/air-trends/lead-trends).

[47] This reflects designations made in the years after the NAAQS was most recently revised in 2008. The "Green Book" describes areas designated attainment and nonattainment for the 2008 lead NAAQS (https://www3.epa.gov/airquality/greenbook/mbtc.html).

- **Emissions Standards for Lead Sources**: Anticipated completion of rulemakings for important lead emissions sources over the next two years:
  - In 2023, secondary lead smelters, lead acid battery manufacturing, and integrated iron and steel manufacturing.
  - In 2024, primary copper smelters and large municipal waste combustors.
- **Aircraft Lead Emissions Endangerment Finding Evaluation:** In October 2022, EPA issued a proposed finding that lead emissions from aircraft engines that operate on leaded fuel cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare. After evaluating comments on the proposal, EPA plans to issue any final endangerment determination in 2023.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Continue to implement the National Ambient Air Quality Standards for lead to reduce emissions to ambient air in communities:** Air emissions of lead have the greatest impact near the pollution source. As a result, violations of the lead NAAQS can impact communities that are close to lead-emitting sources. EPA will continue to work with state, local and tribal air agencies in these communities to help reduce lead emissions and address such violations to protect public health.

- **Continue to coordinate state, local, and tribal surveillance networks to ensure ambient air monitoring near pollution sources.** EPA will continue to review monitoring networks, identify opportunities to improve monitoring near sources with the potential to violate the NAAQS, and work with air monitoring agencies to ensure the ambient air monitoring networks comply with requirements for lead NAAQS surveillance.

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Review the National Ambient Air Quality Standards for lead:** To inform the review of the lead NAAQS that is currently underway and projected for completion in 2026, EPA will develop a new Integrated Science Assessment (ISA) for lead. The new ISA will contain a concise policy-relevant evaluation and synthesis of the current scientific information on lead, including sources, environmental distribution, and exposures to ambient air lead (both airborne and deposited), and EPA's conclusions on the health and welfare effects of lead. Based on the new ISA and current information on air quality, exposure, and risk, the Office of Air and Radiation will develop an assessment of the policy implications regarding the adequacy of protection provided by the existing NAAQS and any potential alternative policy options. EPA will rely on the findings in these documents, advice from the Clean Air Scientific Advisory Committee, and public comments to inform the Agency's decision whether to retain or revise the current NAAQS for lead.

- **Update emissions standards for lead-emitting sources:** EPA is reviewing emissions standards, including National Emissions Standards for Hazardous Air Pollutants and New Source Performance Standards, for lead-emitting sources to incorporate developments in technologies and/or address risk concerns. The Office of Air and Radiation intends to make regulatory decisions over the next two years for important lead-emitting source categories, including primary copper smelters, lead acid battery manufacturing, secondary lead smelters, integrated iron and steel manufacturing, and large municipal waste combustors. Updating these standards will strengthen regulatory tools for minimizing impacts of these lead sources in nearby communities.

- **Examine lead pollution from aircraft:** EPA is evaluating, under the Clean Air Act, whether to make a determination that emissions of lead from aircraft engines that operate on leaded fuel cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. For convenience, EPA sometimes refers to this determination collectively as the "endangerment finding." Aircraft that use leaded aviation gas are primarily piston-engine aircraft. In October 2022, EPA issued a proposed endangerment finding for lead emissions from aircraft operating on leaded fuel, providing an opportunity for public notice and comment.[48] After evaluating comments on the proposal, EPA plans to issue any final endangerment finding in 2023. If a final determination is issued, that determination would not itself apply new requirements to entities other than EPA and the Federal Aviation Administration (FAA). EPA is not at this time proposing aircraft engine lead emission standards. However, if EPA makes a final determination that lead emissions from aircraft engines cause or contribute to lead air pollution that may reasonably be anticipated to endanger public health or welfare, EPA will subsequently propose regulatory standards for lead emissions from aircraft engines. Such a finding also would trigger the FAA's statutory mandate to prescribe standards for the composition or chemical or physical properties of an aircraft fuel or fuel additive to control or eliminate aircraft emissions of lead.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Nonregulatory approaches to address lead emissions from use of leaded fuel in aircraft engines:** The FAA has two integrated initiatives focused on transitioning safely away from the use of leaded fuel: The Piston Aviation Fuels Initiative (PAFI), and the FAA-industry partnership to Eliminate Aviation Gasoline Lead Emissions (EAGLE).[49] PAFI provides the testing and evaluation of unleaded avgas candidates and determines if they are qualified as a replacement for leaded avgas. The EAGLE initiative focuses on transitioning the entire

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[48] More information on EPA's proposed endangerment finding for lead emissions from aircraft operating on leaded fuel is available at https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft.

[49]Recent activities at FAA (https://www.faa.gov/about/initiatives/avgas/env_airports) focus on the PAFI (https://www.faa.gov/about/initiatives/avgas/) and EAGLE (https://www.faa.gov/unleaded).

industry sector to a lead-free fuel, including fuel production, distribution, and infrastructure. In addition, the FAA has approved the safe use of an unleaded fuel that can be used in a large number of piston-engine aircraft, along with other unleaded fuels for specific aircraft. EPA collaborates and coordinates with the FAA and other agencies on lead reduction opportunities from the use of leaded avgas while these fuel replacement programs are in development. This collaborative work will include responding to National Academy of Sciences recommendations regarding options for reducing lead emissions from these aircraft.[50]

REGIONAL COMMUNITY CASE STUDY

In 2018, the State of Indiana issued a 10-year minor source air permit renewal to Whiting Metals, Limited Liability Company (LLC), a lead metal reclamation facility located in Hammond, Indiana. During the permit review, EPA identified an incorrect emissions factor resulting in a large underestimate of potential lead emissions to the air. EPA conducted air dispersion modeling, using the corrected emissions levels, and discovered that there was potential for violations of the lead NAAQS. In addition to the concerns about air emissions from the facility, EPA's Superfund and Emergency Management Division was conducting remediation activity in the surrounding community to remove lead-contaminated soil deposited by a former secondary smelter that operated on the Whiting Metals, LLC property from 1937 to 1983. The soil surrounding multiple households and other publicly accessible areas exceeded the removal management level for lead.
EPA worked with the state to deploy ambient lead monitors adjacent to the facility's property in August 2018 and sampled daily. Within the first month of monitoring, recorded concentrations exceeded the NAAQS. In November 2018, EPA and the state issued a joint notice of violation to the facility.

Due to the remediation activities and an earlier incomplete RCRA cleanup on the Whiting Metals, LLC property (2001-2005), re-entrainment - where past contamination deposited onto the ground is resuspended into the air - was another potential source of ambient lead. To further investigate the source of the lead, EPA deployed a continuous air monitoring instrument, capable of assessing hourly ambient air concentrations of many metal elements and corresponding meteorological information. This additional information provided hourly rather than daily measurements, which can be used to better assess and identify the sources of pollution. Over the next year, EPA collected hourly monitoring data and was able to accurately attribute the primary source of ambient lead to Whiting Metals, LLC's operations, rather than to any remediation activities or other deposited contamination from historical emissions. The facility ceased operations in June 2020, and the state revoked its permit at the end of calendar year 2020, eliminating an ongoing source of lead emissions to the community.

[50] https://www.nap.edu/catalog/26050/options-for-reducing-lead-emissions-from-piston-engine-aircraft

Objective E: Reduce Exposure to Lead Through Enforcement and Compliance Assurance

Problem: Americans continue to be exposed to lead in lead-based paint, soil, dust, sediment, air, and drinking water. Some of these exposures result from noncompliance with laws designed to reduce or eliminate exposure. In addition to working to prevent new lead exposures and clean up legacy contamination, EPA will address exposures associated with noncompliance and environmental liability. EPA will continue to implement its wide range of authorities to address noncompliance, obtain cleanups, deter future violations, and mitigate harm using available resources.

Public Input: EPA received comments from the public concerning enforcement and compliance related to lead in soil, air, drinking water, and paint. The comments cited the range of legal authorities that the Agency is authorized to use to address noncompliance and reduce lead exposures, while acknowledging the need for sufficient resources to utilize those authorities fully. Commenters also noted that the elimination of certain gaps in EPA's legal authorities would help optimize the Agency's efforts to address lead.

Numerous public comments urged EPA to take more enforcement actions to address lead-based paint and lead in drinking water, and multiple comments focused on enforcement related to lead in soil and air emissions. In addition, many commenters suggested approaches for enhanced targeting, and collaborations with state, local, and tribal authorities.

EPA has modified this final strategy to highlight planned collaborations with co-regulators, and the Agency's interest in using new tools that our partners may have to help support or enhance our enforcement and compliance activities.

Performance Measures and Milestones:

- Each year, direct enforcement resources to at least one community with environmental justice concerns in each Region, to help address the exposures to lead in that community and take appropriate enforcement action.
- Each year, publicly report on national statistics related to lead cleanups and inspections, including whether the inspections occurred in communities with environmental justice concerns.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Enhance enforcement and compliance assurance in overburdened communities:** EPA will prioritize high-impact cases that address the needs of communities experiencing adverse disproportionate environmental and health risks and harms from lead.

- **Increase impact of lead exposure reduction projects:** EPA will identify and support opportunities to implement lead exposure reduction projects that are obtained through enforcement actions, including through voluntary Supplemental Environmental Projects (SEPs) agreed to as part of a settlement agreement.

- **Promote geographic initiatives and activities to address lead in multiple media:** The Agency will promote geographic initiatives in its ten Regions, focusing efforts on a specific area or community with more than one source of lead exposure. EPA will use mapping, predictive screening, and other tools to identify areas of concern and prioritize enforcement and compliance assurance activities. EPA will continue implementing lead-based paint geographic initiatives, particularly in areas with significant lead exposures, and will collaborate across EPA programs and with interested external stakeholders to identify opportunities to use enforcement and compliance assurance to reduce lead exposures from other media, such as in drinking water, air emissions, or soils.

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Improve compliance monitoring and enforcement to reduce lead exposure:** EPA will develop tools to improve compliance monitoring and enforcement and address lead exposures from all media sources, including exploring tools and approaches suggested by the public and co-regulators.

    - To ensure proper evaluation of sampling and treatment to support Lead and Copper Rule (LCR) enforcement, EPA will issue a national LCR Inspection Protocol for federal, tribal, and state drinking water inspectors.
    - EPA will collaborate with Customs and Border Protection on compliance activities to support the "lead free" plumbing requirements of the Safe Drinking Water Act section 1417.
    - EPA will develop guidance, protocols and/or compliance information to improve enforcement including in communities with significant lead exposures and will support approaches to address lead contamination in these communities.
    - EPA will optimize use of existing and newly acquired tools and authorities to provide more effective enforcement and to ensure compliance with lead-safe work practice standards and other requirements by property management companies that perform renovations using outside contractors.

    Actions will focus on high-impact cases using EPA's various compliance assurance authorities and tools to address violations related to lead in all environmental media and paint, particularly violations affecting overburdened communities.

- **Increase enforcement for lead site and facility cleanups:** EPA will use all appropriate enforcement authorities to clean up lead contaminated sites and facilities and continue to pursue responsible entities for cleanup of lead released into the environment, including in residential yards, play areas, and other locations where children are commonly exposed to lead. EPA will increase internal collaboration to identify situations, consistent with current law and policy, where the Agency will seek to have responsible entities or others as appropriate perform or pay for cleanup to address lead contamination inside residential housing or other structures where children and other sensitive subpopulations may face exposure to lead.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Identify sources of potential lead exposure to improve targeting:** EPA will work across the Agency, with other federal agencies, and with state, tribal and local co-regulators to enable national enforcement programs to identify locations where people may be exposed to lead in drinking water, paint, soils and/or air emissions, and what authorities EPA may apply to address those exposures. This includes continuing to work within EPA and with external partners to incorporate and share data and to map locations of significant potential lead exposure at national, state, tribal, and local scales. As resources allow and in partnership with others, EPA will further refine the Agency's analytical lead mapping capabilities (currently the Lead Occurrence and Source Tool) to assist in identifying these locations.

- **Enhance collaborative relationships with key federal agencies, states, tribes, and local partners:** EPA will identify opportunities to share information and pursue partnerships with federal, state, tribal and local authorities that leverage our respective authorities and resources to address lead exposures. These include:

    - EPA will engage with the Department of Defense to address lead exposures at privatized military housing.
    - EPA will partner with health agencies to obtain blood lead level data for purposes of enforcement and compliance assurance.
    - EPA will partner with states and tribes to support local drinking water systems in developing LSL information and to enforce the prohibition on use of non-lead-free plumbing materials.
    - EPA will partner with HUD to explore collaboration opportunities and to acquire and analyze data on pre-1978 housing.

  EPA will use such engagement and data to further refine EPA's mapping capabilities and ability to identify disproportionately impacted communities. These partnerships will also support EPA's goal of exploring suggested tools and approaches that help co-regulators build their capacity to address lead exposures in local communities under their respective authorities.

MULTI-REGIONAL COMMUNITY CASE STUDY

When large renovation firms such as Home Depot U.S.A. Inc.,[51] do not comply with the law, the noncompliance may disproportionately affect communities with environmental justice concerns. EPA targeted compliance monitoring in communities overburdened by exposure to lead-based paint and found that Home Depot was in violation of the Agency's lead-based paint RRP Rule, and of EPA-approved federally equivalent state renovation rules. As a result, Home Depot is implementing the provisions of a settlement reached in 2020, including payment of a penalty of $20.75 million, to resolve an enforcement action brought by EPA and the Department of Justice, joined by the States of Utah, Massachusetts, and Rhode Island. The civil penalty is the highest to date for any settlement under the Toxic Substances Control Act.

Under the settlement, Home Depot is implementing a company-wide program to ensure that its contractors comply with the RRP Rule that applies to renovations of homes built before 1978. The settlement also requires Home Depot to conduct thousands of on-site inspections of work performed by its contractors to ensure they comply with lead-safe work practices. The Home Depot must also investigate and respond to customer complaints, and EPA is monitoring Home Depot's response. Where the contractor has not complied with lead-safe work practices, Home Depot must perform an inspection for dust-lead hazards and, if found, provide a specialized cleaning. Also, Home Depot is providing important information concerning following lead-safe work practices to its professional and do-it-yourself customers in its stores, on its website, on YouTube, and in workshops.

GOAL 2: IDENTIFY COMMUNITIES WITH HIGH LEAD EXPOSURES AND IMPROVE THEIR HEALTH OUTCOMES

Problem: Exposure to lead across the country is inequitable, with communities of color and lower socioeconomic status neighborhoods often facing the greatest exposure and risks of health impacts that can exacerbate existing health inequities.

In many instances, locations with high lead exposures are identified only after the exposures have taken place and higher levels of lead are detected in children's blood. This often impacts children from underserved communities due to living conditions in unsafe housing, occupations of family members, and living within proximity to industrial facilities that release lead. Blood lead testing programs and practices vary widely state to state, ranging from several states with mandatory testing requirements to others without any requirements. States also differ in how and to what extent they report available blood lead level data to the CDC. With variations in testing and reporting, whatever data are available nationwide very likely represent an

[51] Mention of this company name does not imply endorsement.

underreporting of children who have higher blood lead levels and are exposed to lead hazards. Recent research has shown that spatial, analytical, and statistical methods can identify lead exposure hotspots that have not been identified by other means and that may benefit from increased blood lead level surveillance.[52,53]

Public Input: A key theme repeated in the comments concerned the challenge of adequate data availability, the quality of available data, and whether data are provided at a scale that allows for community-scale analysis. To address these challenges, commenters suggested that EPA work with states to create and enhance blood lead testing and surveillance programs, and work with all its partners to develop consistent and transparent community identification methods. Commenters suggested that a national organization of state and local lead health agencies could also help to address these challenges.

Commenters suggested that EPA account for a broad range of data when identifying hot spots, including (but not limited to) environmental indicators, socioeconomic and demographic indicators, housing data, and health data. It was recommended that EPA make community identification data easily available to the public and that the Agency should work with community-based organizations and institutions to exchange information about hot spot identification.

Finally, commenters recommended that EPA support the pediatric clinical care community through increased funding and support to increase blood testing and surveillance as well to provide health services and information to children and their families.

The actions identified below reflect the Agency's ongoing consideration of these comments.

Performance Measures and Milestones:

- By December 31, 2023, develop an interim blueprint for identifying high lead exposure risk locations based on research identifying lead exposure hotspots in Michigan, to be shared with internal and external public health partners for broader applicability and capacity building in the U.S.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

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[52] Xue, Jianping, et al. "A generalizable evaluated approach, applying advanced geospatial statistical methods, to identify high lead exposure locations at census tract scale: Michigan case study" Environmental Health Perspectives (2022) 130.7: 077004. https://pubmed.ncbi.nlm.nih.gov/35894594/

[53] Zartarian, Valerie, et al. "Lead Data Mapping to Prioritize US Locations for Whole-of-Government Exposure Prevention Efforts: State of the Science, Federal Collaborations, and Remaining Challenges." American Journal of Public Health 112.S7 (2022): S658-S669. https://pubmed.ncbi.nlm.nih.gov/36179290/

- **Identify lead 'hot spots':** EPA, in collaboration with HHS and HUD, will implement science-based approaches for identifying communities and subsections of communities at the census tract or other local geographies with high lead exposure potential and probable sources of exposure in those communities.[54] This information can inform where to provide enhanced community outreach and EPA actions. These approaches will use available data, statistical models, and geospatial analysis including blood lead level surveillance data collected by states, tribes, territories, federal agencies, and local governments; and environmental, socioeconomic, and demographic data, including indices from the EJSCREEN environmental justice screening and mapping tool,[55] as surrogates for potential exposures.

- **Ascertain local dominant lead exposure pathways**: Subject to the availability of data and resources, EPA will identify and evaluate local-scale information (e.g., presence of lead-based paint and lead-based paint hazards, lead in drinking water, and other exposure pathways) to supplement known mapping and scientific information with local knowledge; and use 'on the ground' efforts, typically facilitated by government entities and, as appropriate, incorporate community science approaches.

- **Focus EPA lead reduction actions on overburdened communities where lead exposures and blood lead levels are among the highest**: Targeting technical and financial resources to address documented priorities will generally provide the largest public health protection and the most efficient use of resources. In partnership with communities, EPA will develop and implement action plans for interventions in these areas. Interventions may include collaboration on funding (e.g., grants, technical assistance); partnerships with community organizations, faith-based institutions, foundations; and coordinated actions to achieve compliance. EPA's Regional Children's Health Coordinators will support regional actions to reduce and address children's exposure to lead in all media and enhance caretaker knowledge to better protect children from exposures to lead.

- **Provide more job training for reducing or removing lead hazards:** Identifying and addressing lead hazards requires training, skills building, work experience, and certification. For lead-based paint, EPA supports job training for contractors/renovators who disturb lead-based paint in homes. Individual contractors and their firms are both required to be trained and certified in RRP activities (See Goal 1, Objective A for more details). EPA will also educate communities about the Brownfields Job Training Grants and the Superfund Job Training Initiative workforce-development partnerships with local training organizations and employers, and local markets that seek certified staff in remediation of contaminated sites and for lead-based paint abatement.[56]

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[54] Zartarian, Valerie, et. al." Lead Data Mapping to Prioritize US Locations for Whole-of-Government Exposure Prevention Efforts: State of the Science, Federal Collaborations, and Remaining Challenges" American Journal of Public Health 112, (2022) S658_S669, https://doi.org/10.2105/AJPH.2022.307051

[55] https://www.epa.gov/ejscreen

[56] Brownfields Job Training Grants: https://www.epa.gov/brownfields/brownfields-job-training-jt-grants.
Superfund Job Training Initiative: https://www.epa.gov/superfund/superfund-job-training-initiative.
Lead-based paint abatement: https://www.epa.gov/lead/lead-abatement-inspection-and-risk-assessment.

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Increase cross-agency coordination on lead policies and regulations, and invest in community science and monitoring:** EPA staff will engage in a range of intra- and inter-agency activities to help focus risk management actions to address lead exposures in overburdened communities. Efforts will include working with the Lead Subcommittee of the *President's Task Force on Environmental Health Risks and Safety Risks to Children,* and its seventeen White House office and federal agency members, which serves as a forum to foster interagency collaborations.

- **Enhance participatory science on lead:** EPA will support the use of community-based participatory science through the development of easy-to-use, reliable, and accurate data monitoring tools, systems for facilitating data sharing with communities, and systems and platforms to make data analysis and interpretation readily accessible to community stakeholders and decision makers at all levels of government.

- **Increase cross-agency coordination of analytical tools**: EPA offices will continue to coordinate on the application of "fit-for-purpose" lead exposure and blood lead models to inform policy decisions to address lead contamination in multiple environmental media, and provide support to interagency partners (e.g., HUD) exploring options to further reduce exposure to environmental lead.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Collaborate across agencies and departments to identify and address lead hotspots in the U.S.:** The CDC, EPA, and HUD will coordinate their efforts to identify lead hot spots by sharing information and collaborating on mapping and other tools.[57] These agencies will also collaborate to identify measures that can be taken to address lead exposure for other at-risk groups including seniors and individuals with disabilities.

- **Support the pediatric clinical care community to protect children from exposures to lead:** EPA will continue to work with the ATSDR to support the Pediatric Environmental Health Specialty Units (PEHSUs). The PEHSUs, located in each of EPA's ten Regions, are a group of experts in the prevention, diagnosis, management, and treatment of health issues that arise from environmental exposures from preconception through adolescence.[58] Their focus on clinical care and public health from an environmental health perspective is vital to supporting communities and addressing historical and ongoing environmental justice

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[57] Zartarian, Valerie, et. al. "Lead Data Mapping to Prioritize US Locations for Whole-of-Government Exposure Prevention Efforts: State of the Science, Federal Collaborations, and Remaining Challenges" American Journal of Public Health 112, (2022) S658_S669, https://doi.org/10.2105/AJPH.2022.307051

[58] Pediatric Environmental Health Specialty Units. https://www.pehsu.net.

concerns. Support of PEHSUs not only allows capacity for community outreach, medical consultations, and guidance for care of children exposed to high levels of lead, but also important programs such as the Pediatric and Reproductive Environmental Health Scholars (PREHS) program, which helps foster a pipeline of healthcare professionals who possess the skills and knowledge to address the complexities of pediatric and reproductive environmental health.[59]

REGIONAL COMMUNITY CASE STUDY

Starting in 2001, EPA worked with many local partners to identify remaining areas and sources of lead risk in Boston, Massachusetts communities and invested resources with a goal to "Virtually End Childhood Lead Poisoning in Boston by 2010." At the time of this effort, children with blood lead levels ≥ 10 micrograms per deciliter were top priority and this case study includes data at that level. EPA used Geographic Information System mapping with data from census layers including housing built before 1950 and areas with children under the age of six to identify focus areas. Additional information from the local health department illustrated that about 70 percent of the childhood elevated blood lead cases were in only a handful of Boston neighborhoods. Dorchester and Roxbury had the highest number of children with elevated blood lead levels. Recognizing that lead risk was not spread equally across neighborhoods, Region 1 and its partners focused on neighborhoods that needed the most help. Region 1 worked with local nonprofit organizations including the Lead Action Collaborative to create a visual exterior assessment checklist deployed by EPA staff and volunteers to over 15,000 houses in high-risk areas to assess housing conditions for items that may indicate presence of lead risk including peeling paint, presence of bare soil and/or paint chips, and other factors.

Region 1 brought the full power of available Agency resources, including inspections, technical assistance, soil sampling, and grants, and its partners' resources including abatement funds, LSLR, and outreach, directly to the neighborhoods to help across programs. Region 1 conducted over 60 lead inspections for TSCA Lead Disclosure Rule and Pre-Renovation Education Rule compliance and followed with appropriate enforcement actions. Cases were settled for over $1 million in penalties and more than $5.7 million in SEPs, including one of the largest enforcement actions of its kind, which removed lead hazards from 10,400 apartments in the state. Region 1's soil sampling identified hot spots for action. LSLR was prioritized in target areas along with education, outreach, and assistance to regulated entities, schools, and families on how to minimize lead exposure from paint, dust, drinking water, and soil.

Since launching joint targeting efforts with state, local government, and many community partners in 2001, the number of elevated blood lead levels in Boston children dropped from 1,123 cases in 2001 to 163 cases in 2010. Although Region 1's initiative ended in 2010, progress continued. Reported data available from 2019 indicated 46 confirmed cases at the 10

[59] Pediatric and Reproductive Environmental Health Scholars program. https://grants.nih.gov/grants/guide/rfa-files/RFA-ES-20-007.html

micrograms per deciliter or higher benchmark. This case study demonstrates that sustained EPA and partner investment in a geographic area across media can achieve impressive and sustainable results. Because a safe level of lead in children's blood has not been identified, Region 1 is working on new strategies with communities in New England to focus on reducing or preventing childhood lead exposure from these sources in the future.

GOAL 3: COMMUNICATE MORE EFFECTIVELY WITH STAKEHOLDERS

Problem: In many communities, parents, families, and child care providers are often not aware of lead until it is measured in the blood of children or adults. Under federal, state, and tribal authorities, the education of primary caregivers on potential lead risks and exposure pathways is often insufficient. Community stakeholders need additional support to give parents, families, and other caregivers, including those with limited English proficiency and those with disabilities, the right information at the right time in multiple languages. Often, information to prevent lead exposure is not provided in plain language, nor does it use accessible electronic and information technology. Improved education and outreach efforts can help better inform communities about minimizing lead exposure from all key sources including lead-based paint, lead dust, drinking water, soil, air, and other sources of lead, such as religious or cultural products, that may be particularly relevant for certain communities.

Public Input: Many of the public comments the Agency received were supportive of efforts to reach out to communities with training, brochures, websites, and other outreach tools. Commenters asked for more direct outreach to communities, including local health officials, community organizations, and others to further inform the community of lead risks. Commenters also asked that the Agency support development of interagency work groups and advisory committees to identify communities with increased risks of lead exposure and develop plans to reduce disparities in exposure.

Other public comments suggested EPA work with its federal partners to create clear, consistent communications materials that clarify how the agencies regulate lead, describe how the agencies work together to prevent exposures, and clarify where lead-related policies overlap and where gaps exist.

Commenters recognized that digital literacy and availability are not equal across communities and recommended that EPA take this into account when developing communications materials to inform communities about lead exposures, health risks, and steps the Agency is taking to reduce those risks. Similarly, commenters also requested that EPA adopt, and make standard, best practices for engagement with communities, including the use of plain language, appropriate context for statistics and measures, the use of visual aids, and the use of inclusive language.

EPA appreciates the public comments and will continue to provide outreach to communities, both from headquarters outreach programs and associated regional coordinators. Examples of outreach include multimedia outreach for the National Lead Poisoning and Prevention Week,[60] guidance on Do-It-Yourself renovations, and lead-awareness training for the community such as EPA's *Lead Awareness in Indian Country: Keeping our Children Healthy!* The amount, types of training, and communities to which the Agency can provide outreach is contingent on the resources available. The actions identified below reflect the Agency's ongoing consideration of these comments.

Performance Measures and Milestones:

- EPA's Lead-Based Paint Program is a co-author of the Protect Your Family pamphlet, with HUD and CPSC. The pamphlet explains the dangers of lead in the home and how to protect families from lead-based paint hazards. To ensure this critical information is meaningfully accessible to persons with limited English proficiency, the brochure is available in 12 languages: English, Arabic, Chinese Simplified and Traditional, French, Korean, Polish, Russian, Somali, Spanish, Tagalog, and Vietnamese. This key document is required by law to be provided in pre-1978 house purchase and rentals to consumers. EPA commits to reviewing the information annually for possible updating as new requirements are developed.
- By September 30, 2023, publish online a Spanish-language version of the *Lead Awareness in Indian Country: Keeping our Children Healthy!* Curriculum. Additionally, work with partners to determine if there is a need for the development of additional examples and materials.
- By September 30, 2023, solicit advice from the Children's Health Protection Advisory Committee (CHPAC) on how to better protect children from exposure to lead and enhance the "whole of EPA" and "whole of government" approach.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Create targeted plain language multi-media education, training, and outreach materials**: EPA will raise public awareness in communities with the highest number of children with blood lead levels above the CDC blood lead reference value to give parents, families, and other stakeholders information on how to prevent lead exposure from lead-based paint dust, drinking water, soil, and air (if applicable). Efforts will also include outreach to the lead-based paint renovation and repair stakeholders (discussed in greater detail in Goal 1, Objective A). Materials will be translated for and made available to persons with limited English proficiency and made accessible for persons with disabilities to reach all populations at risk in targeted geographic areas as well as local businesses, including contractors, plumbers, and realtors.

[60] https://www.epa.gov/lead/national-lead-poisoning-prevention-week

- **Support development of community-based tools**: EPA will work with other federal agencies, state, tribal, and local governments to support community-based tools. For example, the Flint Registry[61] is a tool built by the community to connect people to services to promote health and wellness. This tool was developed with a grant from HHS and has been recognized for its value in addressing the communities' needs for data and collaboration.[62]

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Develop and deploy coordinated educational and prevention messages at a national scale**: EPA will work with the other federal agencies to develop a national repository of materials on lead and make it available to the public. EPA will use evidence-based strategies to develop community-scale interventions to assess which approaches are most effective in achieving the goals of reducing lead exposures and adverse health effects.

- **Develop and improve guidance, templates, and risk communication materials to support training, outreach, and community engagement:** EPA will improve guidance and templates to help states and communities communicate lead risk to households with higher risks for lead exposure (e.g., from lead-based paint, LSLs) and measures to reduce lead exposures. Efforts will also include revisions of drinking water regulations and guidance (discussed in greater detail in Goal 1 Objective B). Materials will be translated for and made available to persons with limited English proficiency and made accessible for persons with disabilities as needed to reach all populations at risk in targeted geographic areas. EPA will use a wide range of approaches to distribute new guidance and communication material, including in-person and virtual events, social media messaging, videos, press releases, and web publications, as well as outreach through partner agencies and stakeholders.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Promote National Lead Poisoning Prevention Week (NLPPW):** Each October, EPA partners with CDC, HUD, and other interested federal agencies and stakeholders, to heighten awareness of lead exposure and lead poisoning by providing resources for the public to use to encourage preventive actions to reduce childhood lead exposure during NLPPW and throughout the year. These efforts will aim to bring together individuals, organizations, industry, and tribal, state, and local governments to reduce childhood exposure to lead by increasing lead poisoning prevention awareness with a focus on children's health and communities with greatest exposures to lead. Objectives include highlighting the many ways parents, caregivers, and communities can prevent the serious health effects of lead by

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[61] https://www.flintregistry.org
[62] Indiana Advisory Committee to the U.S. Commission on Civil Rights (2020)

reducing children's exposure to lead, with a focus on the hazards of lead-based paint in pre-1978 housing, schools, and child care facilities; and increasing awareness of the Lead RRP rule.

- **Support use of the Tribal Lead Curriculum/Lead Awareness Curriculum:** Using the *Lead Awareness in Indian Country: Keeping our Children Healthy!* Curriculum, EPA is preparing tribes and community leaders to teach the robust set of educational tools that provide practical, on-the-ground, community-based resources to reduce childhood lead exposure within their own communities. The Curriculum, also referred to as the Tribal Lead Curriculum or Lead Awareness Curriculum, was developed with tribes and designed with the idea that it would be used and modified by all communities across the U.S. and its territories. The Curriculum creates a starting point to hold informed conversations within communities to teach parents and caregivers about lead. This Curriculum empowers individuals to act within their own homes to protect their children and communities from potential lead exposure. By the Fall of 2023, EPA plans to publish on its website a Spanish-language version of the over 200 pages of materials included in this training.

- **Consult with children's environmental health experts through the CHPAC federal advisory committee:** EPA will seek advice from the CHPAC to better focus and improve the Agency's efforts to protect and provide protective remedies for children from exposure to lead and to enhance our "whole of EPA" and "whole of government" approach. CHPAC is a body of external researchers, academicians, health care providers, environmentalists, state and tribal government employees, and members of the public who advise EPA on regulations, research, and communications related to children's health. CHPAC provides advice on topics such as air and water pollution regulations, chemical safety programs, risk assessment policies, risk communication materials/strategies, and research, which reflect the wide-ranging environmental issues which affect the health of children.[63] Charge questions submitted to CHPAC could include a request for review of the Lead Strategy, review of the strategy's performance measures and milestones, and advice on the Agency's actions to protect children from exposures to lead.

[63] U.S. Environmental Protection Agency. Children's Health Protection Advisory Committee. https://www.epa.gov/children/chpac.

REGIONAL COMMUNITY CASE STUDY

Clemson University Extension worked with EPA to provide outreach and education to schools and child care centers in two low-income school districts. EPA's Children's Environmental Health Program provided Clemson's College of Agriculture, Forestry and Life Sciences a $25,000 grant to educate the public in hazards of lead exposure in drinking water. This work was completed in partnership with South Carolina Department of Health and Environmental Control (SC DHEC) to support the EPA's WIIN Act Grant 2107: Lead Testing in Schools and Child Care Facilities. This grant is managed by SC DHEC and allows for public schools and licensed child care centers to voluntarily participate in testing their facilities for lead in drinking water at no cost. Clemson's goal was to provide targeted outreach and education in support of WIIN Grant 2107 to 25 schools/child care centers that were serving younger children in underserved and low-income communities.

Clemson University staff and students exceeded their goal and provided outreach and education to 32 schools located in Pickens and Lexington counties. They also developed a stand-alone webpage that showcased videos, written content, and resources. The students created a series of 8 short videos that included: identifying sources of lead, flushing drinking water lines and lead management in school facilities. They also developed five written documents that consisted of rack cards, factsheets, and infographics. Both staff and students made valuable connections with SC DHEC and Charleston County Schools District throughout the project.

GOAL 4: SUPPORT AND CONDUCT CRITICAL RESEARCH TO INFORM EFFORTS TO REDUCE LEAD EXPOSURES AND RELATED HEALTH RISKS

Problem: Scientific approaches to support EPA and community actions are needed to inform Goals 1, 2, and 3 – including in the areas of lead integrated exposure and health science assessment, blood lead level modeling, lead hotspot mapping, analysis of environmental information, development of methods to measure and reduce bioavailability and bioaccessibility, and use of drinking water science to inform corrosion control and identification of LSL and treatment strategies. EPA has prioritized research on source identification and mitigation, understanding exposure routes, and identifying high lead exposure locations for targeting actions. EPA also acknowledges the need to better understand what predicts health and developmental outcomes (and the variability/disparities in those outcomes) among children who have already been exposed to lead. EPA will work in collaboration with Federal partners in the President's Task Force on Environmental Health Risks and Safety Risks to Children (for example, National Institutes of Health and CDC/ATSDR) who have prioritized this issue. This collaboration will inform efforts by other agencies to mitigate the health and developmental effects following exposure to lead.

Public Input: Public comments related to EPA's research to inform efforts to reduce lead exposures fell into several categories. Multiple commenters asked that expanded categories of lead-related human health benefits be considered. EPA is currently developing methods to quantify cardiovascular mortality benefits in regulatory analysis and will continue to develop methodologies for additional endpoints affected by current lead exposures.

Commenters noted the need for coordinated approaches and better definition of a blood lead level or modeling strategy. Commenters also provided very specific recommendations for modeling and modeling parameters. EPA will consider these comments in several ways. EPA will continue development of the All-Ages Lead Model for estimation of blood lead levels for children, adolescents, and adults of all ages under both chronic and episodic lead exposure scenarios. EPA will also continue its support of the Integrated Exposure Uptake Biokinetic (IEUBK) 2.0 model[64] to estimate risks of children's blood lead levels for site specific assessments and the Stochastic Human Exposure and Dose Simulation Model for multimedia chemicals[65] coupled with IEUBK 2.0 for national scale probabilistic modeling. Finally, EPA will continue to coordinate on the application of "fit-for-purpose" lead exposure and blood lead models to make informed policy decisions to address lead contamination.

Public commenters recognized the importance of identifying and replacing LSLs while maintaining optimized corrosion control to mitigate the release of lead from sources within plumbing systems. In response to these comments, EPA has both added and revised actions associated with LSL research, including LSL identification, quantifying lead in drinking water, and evaluating filter effectiveness. EPA also updated text that clarifies multiple areas of research to understand and reduce lead in drinking water including LSL identification strategies, corrosion control strategies, point-of-use filter effectiveness, and particulate lead. EPA intends to continue providing state-of-the-science small water system training to tribes and state, municipal, and utility water operators.

In response to comments related to lead in soil and dust, EPA added a description of intramural and extramural research designed to better understand soil and dust ingestion. This is a critical parameter in estimating lead exposure from sources of lead such as deteriorating house paint and contaminated soil.

EPA appreciates the wide-ranging public comments it received in response to EPA's Draft Lead Strategy, Goal 4. The actions identified below reflect the Agency's ongoing consideration of public comments. Comments the Agency did not respond to generally applied to policy issues outside the purview of research or detailed research issues that were not appropriate for inclusion in a broad strategy document.

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[64] https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals
[65] https://www.epa.gov/chemical-research/stochastic-human-exposure-and-dose-simulation-sheds-estimate-human-exposure

Performance Measures and Milestones:

- Over a 5-year period, develop tools and informational resources for LSL identification technologies to assist small and underserved water systems to efficiently complete LSL inventories.
- Each year, updates to these LSL identification technology resources will be shared at the EPA Drinking Water Workshop: *Small Systems Challenges and Solutions*.

EPA ACTIONS:

APPROACH 1: Reduce lead exposures locally with a focus on communities with disparities and promote environmental justice

- **Extend mapping methods to identify lead hotspots in the U.S. for informing targeted actions in disproportionately impacted communities:** EPA will apply a science-based approach, based on available data and local knowledge, for characterizing areas of the U.S. regarding lead exposure potential. EPA will extend and apply mapping efforts focusing on identifying high potential exposure areas with co-occurrence of risk factors (e.g., higher blood lead levels, older housing stock, socio-demographic factors, and environmental lead sources).

- **Identify LSLs and collect drinking water samples***:* EPA will work with municipalities and utilities on solutions-based research designed to implement and evaluate water sampling strategies and approaches for LSL identification.

- **Quantify and monitor lead and copper in drinking water and assess filter effectiveness:** EPA will continue to develop sampling strategies and methods to quantify lead in drinking water and enhance the ability of community participatory scientists to contribute useful data to regulators' decision-making. EPA will also assess the efficacy of point-of-use filters for removing lead nanoparticles from drinking water.

APPROACH 2: Reduce lead exposures nationally through protective standards, analytical tools, and outreach

- **Quantify additional benefits from reducing exposures to lead for regulatory impact assessments:** EPA is developing new analyses to estimate the social benefits of reducing lead exposures. Current practice is to include only effects on children's cognitive function in economic analyses of EPA policies and programs. However, lead can have a variety of other adverse health effects on children and adults, such as attention disorders and cardiovascular morbidity and mortality. EPA has developed an approach to quantify potential reductions in cardiovascular mortality related to lead exposure reductions. EPA will continue to develop methodologies to estimate the benefits of reducing lead exposures.

- **Conduct multimedia lead modeling and related research to inform regulatory decisions and site assessments:** EPA will update the software, user guide, and technical support documentation for the *All-Ages Lead Model* to incorporate recommendations of the EPA Science Advisory Board. Support will continue for the *IEUBK Model 2.0* to use environmental lead exposures to estimate risks of children's elevated blood lead for site specific assessments. National-scale probabilistic modeling will be applied with the SHEDS-IEUBK model (Stochastic Human Exposure and Dose Simulation Model for multimedia chemicals coupled with IEUBK) to inform regulatory decisions and guidance by EPA and HUD.

  EPA has awarded grants for "Estimating Children's Soil and Dust Ingestion Rates for Exposure Science" that will support research to address critical life stage-specific exposure factors for exposure modeling.[66] A series of peer-reviewed publications on soil and dust ingestion will be completed to inform model input parameters for estimating blood lead levels from environmental exposures. With new data available in the literature, EPA will work to update soil and dust ingestion estimates presented in the EPA's Exposure Factors Handbook.[67]

- **Conduct lead bioavailability and isotope research to inform Agency actions:** EPA will work with HUD to continue the analysis of lead content and bioavailability in water, soil, and dust samples from the American Healthy Homes Survey II.[68] EPA is working on lead isotope analysis that will help inform identification of environmental lead sources to support risk management and other potential Agency activities. EPA is developing an *in vitro* cell line assay for bioavailability for determining site specific cleanup levels. The Agency will advance research methods to immobilize or reduce the bioavailability of lead in soil.

- **Evaluate soil-lead and dust-lead relationship for target housing:** EPA will review the relationship between soil-lead and dust-lead in pre-1978 homes, considering data from HUD's American Healthy Homes Survey II and the Lead ISA.[69] EPA will use this information to support regulatory actions to reduce and prevent lead exposures.

- **Address lead-based paint definition data needs:** EPA may address some of the data gaps related to the definition of lead-based paint under TSCA by sponsoring a technical conference. The objectives of the workshop may include characterizing the capabilities of field portable XRF and other technologies at lower levels of lead in paint and identifying opportunities, limitations, and constraints for measurement and detection of low levels of lead in paint.

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[66] https://www.epa.gov/research-grants/estimating-childrens-soil-and-dust-ingestion-rates-exposure-science
[67] https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252
[68] https://www.epa.gov/americaschildrenenvironment/american-healthy-homes-survey-ahhs
[69] https://www.epa.gov/isa/integrated-science-assessment-isa-lead

- **Conduct research to better understand and reduce lead in drinking water***:* EPA will conduct research related to strategies to identify LSLs including research on innovative detection methods. EPA will also conduct laboratory and field research, with a focus on mitigation methods to reduce exposure to lead from drinking water.

  EPA will conduct research on corrosion control treatment and control strategies to reduce soluble lead in drinking water. EPA will evaluate point-of-use treatment device effectiveness under a variety of field and lab conditions considering soluble and particulate lead under a range of concentrations. Research will also focus on understanding how changes in water treatment practices affect the release of particulate lead into water.

  Other lead reduction research will include the refinement of plumbing modeling to predict concentrations of lead in single-family and multifamily homes with different plumbing materials, pipe layouts, and usage patterns. EPA will also conduct research on lead source characterization and assessment to better understand lead release mechanisms and corrosion control effectiveness.

- **Small water system workshops and training:** To support the efforts of state and local officials to assist small systems, EPA's Office of Research and Development (ORD) and Office of Water (OW), in cooperation with Association of State Drinking Water Administrators (ASDWA), has held an annual workshop for the past 19 years to provide timely information on a variety of drinking water topics relevant to small systems. These provide a forum for EPA scientists and water experts from across the U.S. to present state of the science training and progress updates to state, tribal, and municipal officials, and utility water operators. Corrosion control technology, LSL identification and replacement, and regulatory updates affecting lead in drinking water are perennial topics. EPA will continue to hold these workshops.

APPROACH 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach

- **Collaborate on science-based mapping efforts to identify lead hotspot locations for informing targeted risk reduction actions:** EPA will engage with HUD and CDC to improve data mapping for identifying and addressing multimedia lead exposures in underserved communities.[70]

- **Increase cross-agency coordination on data collection and analytical tools**: EPA offices will continue to coordinate on the application of "fit-for-purpose" lead exposure and blood lead models to inform policy decisions to address lead contamination in multiple environmental

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[70] Valerie Zartarian, Antonios Poulakos, Veronica Helms Garrison, Nicholas Spalt, Rogelio Tornero-Velez, Jianping Xue, Kathryn Egan, and Joseph Courtney, 2022: Lead Data Mapping to Prioritize US Locations for Whole-of-Government Exposure Prevention Efforts: State of the Science, Federal Collaborations, and Remaining Challenges American Journal of Public Health 112, S658_S669, https://doi.org/10.2105/AJPH.2022.307051

media, and provide support to interagency partners (e.g., HUD) exploring options to further reduce exposure to environmental lead. Improved data collection will enhance the ability of EPA and its federal partners to design and evaluate lead reduction programs.

- **Collaborate with HUD and other federal agencies on lead-based paint issues:** EPA will collaborate with HUD and potentially the CPSC, National Institute of Standards and Technology, and the CDC on a virtual public meeting and technical conference regarding lead-based paint definition data needs.

REGIONAL COMMUNITY CASE STUDY

EPA's research on particulate and soluble lead in drinking water was used to help address elevated lead levels found in the drinking water of University Park, Illinois. The village had changed the source of its drinking water from groundwater to surface water, and the treated surface water had a different water quality (i.e., lower alkalinity and hardness) than did the previously used groundwater. Not long after this change in source water, during compliance sampling for the EPA's Lead and Copper Rule, the system was found to have exceeded the lead action level. Although there are no known LSLs in the village, there were other sources of lead in the household plumbing, such as leaded solder and brass fixtures.

The community and the state of Illinois reacted rapidly and issued a "Do Not Drink" order for the community; they also reached out to EPA to ask for assistance in understanding why this exceedance occurred when no LSLs were present. The Agency conducted a field sampling study in University Park to help identify the cause and mechanisms of elevated lead release. The objective of the sampling was to characterize the form, size, and composition of lead particles in University Park's drinking water. Samples were sent to the EPA's analytical laboratory to conduct multiple analyses including lead in water concentrations, particle size fractionation, electron microscopy, and x-ray diffraction techniques. These analyses showed the types of particles that were being formed in their water and provided insight into the mechanism of lead release which was an important piece of the decisions on how to improve corrosion control treatment for their specific water quality parameters. EPA's experts also participated in meetings with the community to help explain the scientific data they had collected. This research and technical support helped to inform guidance to the state and village on lead solder corrosion, which has not received the same amount of research as LSL corrosion. The complicated situation at University Park has seen improvements in drinking water lead levels with additional monitoring needed.

CONCLUSION AND IMPLEMENTATION OF EPA's LEAD STRATEGY

Implementation of EPA's Lead Strategy will result in the Agency taking more effective and efficient actions to minimize lead exposures with an emphasis on overburdened communities and promoting environmental justice and equity. EPA's enhanced actions described in this strategy will further reduce exposures from lead-based paint, dust, drinking water, soils, and air to all Americans with focused attention on significant near-term reductions in exposures for life stages and population groups currently burdened with disproportionately higher lead exposures. EPA is committed to applying a whole of government approach to its efforts to reduce exposures to lead, using best available science and technology and all available resources and regulatory authorities to achieve that goal.

EPA's Lead Strategy is closely aligned with the priorities set forth in the EPA's *Fiscal Year 2022 – 2026 Strategic Plan*. Specifically, Goal 2 of the Strategic Plan is to *Take Decisive Action to Advance Environmental Justice and Civil Rights*. This goal is designed to achieve tangible progress for historically overburdened and underserved communities and to ensure the fair treatment and meaningful involvement of all people regardless of race, color, national origin, income, disability, age or sex in developing and implementing environmental laws, regulations, and policies.

EPA is currently developing several indicators of disparity that will assess the Agency's performance under Goal 2 of the Strategic Plan. The indicators are meant to characterize health disparities and disparities in environmental conditions, and, where applicable, highlight progress in eliminating the disparities. EPA will measure progress against these indicators each year. We expect that at least one of the Goal 2 Strategic Plan indicators will be associated with lead exposures and health outcomes. The actions to minimize lead exposures described in the Lead Strategy will be integral to the demonstration of progress against lead-related indicators of disparity. EPA is targeting the Fall of 2023 for the finalization and public release of these indicators.

This strategy is an important step forward for EPA as we work to strengthen public health protections and address legacy lead contamination in communities, especially those with the greatest exposures. Many of the actions described in this strategy have only recently been initiated and funded. As these programs mature, EPA expects to continue to review the effectiveness of its actions to reduce lead exposures and to revise or set new targets for measuring performance. We anticipate that in the future, the Lead Strategy will be updated to reflect new initiatives, address newly identified gaps, and add new performance measures and milestones to meaningfully track EPA's progress to reduce the health burdens associated with exposures to lead pollution. We also plan to incorporate the relevant lead-related Goal 2 Strategic Plan indicators of disparity described above. Future updates, plans, and progress will be made available at EPA's lead website, www.epa.gov/lead.

APPENDIX: PERFORMANCE MEASURES AND MILESTONES

Performance Measures and Milestones

GOAL 1: REDUCE COMMUNITY EXPOSURES TO LEAD SOURCES		
Objective A: **Reduce Exposure to Lead in Homes and Child-Occupied Facilities with Lead-Based Paint and Other Hazards**	***Measures*** • By September 30, 2023, provide free or low-cost training to 500 contractors that are located in and around communities with environmental justice concerns spread throughout the U.S. over fiscal years 2022 and 2023. • By September 30, 2023, host national and community-based Lead Awareness Curriculum sessions for 515 community leaders and Understanding Lead sessions for 340 community members, which reflects a 10% increase in participation from fiscal year 2022 to fiscal year 2023.	***Milestones*** • By March 2023, publish the *Heavy Metals in Cultural Products: Outreach and Educational Resources Toolkit* on the EPA website. • By February 2023, propose, and by June 2024, finalize the Dust-lead Hazard Standards (DLHS) and Dust-lead Clearance Levels (DLCL) Rule.
Objective B: **Reduce Exposure to Lead from Drinking Water**	***Measures*** • Track and report total funds to disadvantaged communities for projects that support reduction of lead in drinking water. • By the end of 2022, partner with four states to establish LSLR Accelerators, which will provide targeted technical assistance and develop best practices to help address the barriers disadvantaged communities face in replacing LSLs. • By the end of 2022, conduct outreach on the new "*Guidance for Developing and Maintaining a Service Line Inventory*" to help water systems develop LSL inventories as soon as possible to begin replacement programs and no later than the Lead and Copper Rule Revisions compliance deadline of October 2024.	***Milestone*** • By the end of 2023, propose, and by October 2024, take final action on the Lead and Copper Rule Improvements to strengthen the regulatory framework and address lead in drinking water.

<table>
<tr><th colspan="3">GOAL 1: REDUCE COMMUNITY EXPOSURES TO LEAD SOURCES</th></tr>
<tr><td>Objective C:
Reduce Exposure to Lead in Soils</td><td>Measures
• By September 30, 2026, complete 225 Superfund cleanup projects that address lead as a contaminant (averaging 45 each year).
• By September 30, 2023, review results of the Superfund Lead Collaboration Pilot projects and where appropriate, update Superfund guidance to reflect best practices.
• Report annually the number of Brownfields cleanups that addressed lead contamination, as reported by grant recipients.</td><td>Milestone
• By June 30, 2023, evaluate and revise the Residential Soil Lead Guidance for Contaminated Sites to protect communities by further reducing the potential for exposure to lead in soil.</td></tr>
<tr><td>Objective D:
Reduce Exposure to Lead Associated with Emissions to Ambient Air</td><td colspan="2">Milestones
• Projected completion of the current lead NAAQS review in 2026.
• Anticipated completion of rulemakings for important lead emissions sources over the next two years:
o In 2023, secondary lead smelters, lead acid battery manufacturing, and integrated iron and steel manufacturing.
o In 2024, primary copper smelters and large municipal waste combustors.
• In October 2022, EPA issued a proposed finding that lead emissions from aircraft engines that operate on leaded fuel cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare. After evaluating comments on the proposal, EPA plans to issue any final endangerment determination in 2023.</td></tr>
<tr><td>Objective E:
Reduce Exposure to Lead Through Enforcement and Compliance Assurance</td><td colspan="2">Measures
• Each year, direct enforcement resources to at least one community with environmental justice concerns in each Region, to help address the exposures to lead in that community and take appropriate enforcement action.
• Each year, publicly report on national statistics related to lead cleanups and inspections, including whether the inspections occurred in communities with environmental justice concerns.</td></tr>
</table>

GOAL 2: IDENTIFY COMMUNITIES WITH HIGH LEAD EXPOSURES AND IMPROVE THEIR HEALTH OUTCOMES
Milestone • By December 31, 2023, develop an interim blueprint for identifying high lead exposure risk locations based on research identifying lead exposure hotspots in Michigan, to be shared with internal and external public health partners for broader applicability and capacity building in the U.S.

GOAL 3: COMMUNICATE MORE EFFECTIVELY WITH STAKEHOLDERS	
Measure • EPA's Lead-Based Paint Program is a co-author of the Protect Your Family pamphlet, with HUD and CPSC. The pamphlet explains the dangers of lead in the home and how to protect families from lead-based paint hazards. To ensure this critical information is meaningfully accessible to persons with limited English proficiency, the brochure is available in 12 languages: English, Arabic, Chinese Simplified and Traditional, French, Korean, Polish, Russian, Somali, Spanish, Tagalog, and Vietnamese. This key document is required by law to be provided in pre-1978 house purchase and rentals to consumers. EPA commits to reviewing the information annually for possible updating as new requirements are developed.	***Milestones*** • By September 30, 2023, publish online a Spanish-language version of the *Lead Awareness in Indian Country: Keeping our Children Healthy!* Curriculum. Additionally, work with partners to determine if there is a need for the development of additional examples and materials. • By September 30, 2023, solicit advice from the Children's Health Protection Advisory Committee (CHPAC) on how to better protect children from exposure to lead and enhance the "whole of EPA" and "whole of government" approach.

GOAL 4: SUPPORT AND CONDUCT CRITICAL RESEARCH TO INFORM EFFORTS TO REDUCE LEAD EXPOSURES AND RELATED HEALTH RISKS
Measures • Over a 5-year period, develop tools and informational resources for LSL identification technologies to assist small and underserved water systems to efficiently complete LSL inventories. • Each year, updates to these LSL identification technology resources will be shared at the EPA Drinking Water Workshop: *Small Systems Challenges and Solutions*.

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An exterior and interior leaded dust deposition survey in New York City: Results of a 2-year study

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Abstract

Environmental concentrations of leaded dust were monitored by weekly sample collection of interior and exterior settled dust that had accumulated due to atmospheric deposition. The weekly deposition amounts were measured and the cumulative rates of lead in dust that deposited on a weekly basis over 2 year's time were determined. The sampling analysis revealed that the median values of leaded dust for the interior plate (adjacent to the open window), unsheltered exterior plate, and the sheltered exterior plate were 4.8, 14.2, and 32.3 μg/feet^2/week, respectively. The data supports the existence of a continuous source of deposited leaded dust in interior and exterior locations within New York City. Additional data from a control plate (interior plate with the window closed) demonstrate that the source of the interior lead deposition was from exterior (environmental) sources. Because of the ubiquitous nature of lead in our environment and the toxic threat of lead to the cognitive health of children, this data provides a framework for the understanding of environmental exposure to lead and its potential for continuing accumulation within an urban environment.

Keywords: Lead; Dust; Indoor; Outdoor; Lead poisoning; Sources; Air; Exposure; Ambient; Background; Atmospheric deposition; Lead loading; Urban

1. Introduction

Mild to moderately elevated blood lead (EBL) levels in children are a major public health concern (Agency for Toxic Substances and Disease Registry, 1988). Recent studies have demonstrated toxicological effects including a decrease in cognitive function at blood lead levels previously thought to be safe (Canfield et al., 2003; Needleman, 2004). Significant environmental source reductions have been implemented over the past three decades (Agency for Toxic Substances and Disease Registry, 1988; Breen and Stroup, 1995). This has aided in lowering the number of children with elevated lead levels (CDC, 2000, 2005; Meyer et al., 2003). The number of children reported with confirmed EBL levels greater than 10 μg/dL has steadily decreased from 130,512 in 1997 to 74,887 in 2001 (Meyer et al., 2003).

Settled as well as airborne lead contaminated dust within the household and the environment represents a dynamic and continuous source of exposure (Lanphear et al., 1998a). Lead dust is present on almost any object that a child might contact or mouth. Thus, a continuously varying diet of lead would not be unreasonable to assume in children with even minor hand-to-mouth activity (Arbiter and Black, 1991; Duggan and Inskip, 1985; Lanphear et al., 1998b; Lin-Fu, 1973). Such activity need not rise to the level of pica. Based on the data presented in this investigation, we offer the observation that one source of lead exposure in children may arise from interior dust contaminated with external atmospheric deposition of leaded dust and need not be solely from flaking or peeling lead-based paint chips.

The sources of environmental lead are multifaceted and often dependent on past industry (Farfel et al., 2003;

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Table 1
Sampling locations and influencing parameters

Sampling plate	Influencing parameter				
	Number of weeks sampled	Direct atmospheric deposition (fallout)	Precipitation (dew, rain, snow)	Wind	Wafting
#1—interior	104	No	No	No	Yes
#2—exterior unsheltered	104	Yes	Yes	Yes	No
#3—exterior sheltered	36	Yes	No	Yes	No
#4—control	7	No	No	No	No

Lanphear et al., 1998a; Roychowdhury, 1998). Given the ubiquitous nature of environmental lead, identification of its origin is difficult. However, lead-based paint within a residence is often the prime suspect as the source(s) when a child in that residence presents with an EBL (Centers for Disease Control, 1991).

The prevalence of lead-based paint hazards increases with the age of housing, but many painted surfaces do not have lead-based paint (Jacobs et al., 2002). It has been reported that between 2% and 25% of painted building components were coated with lead-based paint (Jacobs et al., 2002). Thus, in excess of 75% of the etiology of lead is unaccounted for. Therein lies the difficulty, namely, to assign an attributable risk to any one lead source and then, to estimate the extent of contribution of each potential source(s) of lead to an EBL in children, whether they are urban or rural. The published scientific literature does contain studies that support exterior lead sources (those that are outside of a residence) as contributing sources of interior lead (Bushnell and Jaeger, 1986; Farfel et al., 2003; Lanphear et al., 1998b; Roberts et al., 1999; Wong et al., 2000).

This paper demonstrates that settled leaded dust, from ambient, exterior sources, is a continuous and varying source of lead exposure to all individuals, but especially to children who reside in urban areas. We present 2 years of both interior and exterior sampling data of settled dust deposition. The purpose of this research is two-fold: first, our goal is to understand the distribution of quantities of settled lead dust on exterior and interior surfaces in New York City; and second, we expect to establish background levels of lead dust loading on interior and exterior surfaces.

2. Materials and methods

Historically, the quantification of atmospheric dust fallout involved either of two collection methods; open face "bucket" or "inverted Frisbee" devices. Both these methods involve 1-month sampling periods with relatively small surface areas. However, due to the small surface areas involved and our desire to determine weekly fallout quantities these collection methods proved inadequate. In short, the weekly lead dust values from small collectors risked being below analytical detection limits. In addition, the above methods collected wet deposition (rain would collect in the "buckets") and we sought to explore the steady state surface dust loading of weather-exposed surfaces and other interior and exterior surfaces.

2.1. Thick glass plate collectors

Dust wipe samples were collected each week from horizontal one-quarter inch thick glass plates measuring 3×3 feet^2 (total area of 9 feet^2). This large sampling surface was judged necessary to ensure adequate collection of material for analytical detection. All of the glass plates were placed on 30-in high, plastic sawhorses that were located on the southeast side of a second story rooftop of the Health Sciences Building at Hunter College. The facility is located at the intersection of First Avenue and 25th Street in Manhattan, New York.[1] To ensure the glass plates were not a source of lead, a small section of the glass plate was tested for lead leachability as per American Society for Testing and Materials (ASTM) Method C738 (ASTM International, 1999); there was no detectable leachable lead. At our sampling location in New York City, there was little, if any, immediate source of paint (leaded or not), as the outside of these buildings was brick. A total of four sampling plates were installed at the test facility. Table 1 describes the influencing parameters for each sampling location including direct atmospheric deposition, precipitation, wind and wafting.

2.2. Interior glass plate (adjacent to open window)

One glass plate was placed indoors in an unused emergency rooftop stairwell (see Fig. 1); it was adjacent (within 25 feet) of the exterior location of an identical (outdoor) glass plate; both were sampled for 104 weeks. The stairwell, constructed of masonry (ceramic coated cinder block) and free of lead-based paint[2] contained two windows (south and north). The steam heating unit (a metal radiator) was painted and the paint was uniform, intact and lead-free, per results of X-ray fluorescence (XRF) testing. The ventilation unit was not a forced hot air system, but was a convection unit and provided no positive or negative pressure gradient. In an effort to stimulate interior/exterior air exchange typical of residential living, an adjacent window (south side) was opened slightly (1"). Air movement from the outside to the inside of the room was confirmed using smoke tubes.

2.3. Unsheltered exterior glass plate

The exterior sampling site was located on the northeast corner of the roof (see Fig. 2), and completely open to the ambient environment (i.e. susceptible to the influence of rain, snow, wind). This plate is referred to as the unsheltered outdoor sample. As noted, leaded dust was collected from this plate on a weekly basis for 104 weeks (2 years).

[1]This location is approximately midtown of the 14-mile long Manhattan island close to the east side, two blocks from the East River. The area is a mixture of downtown offices and residential apartment buildings with large medical facilities. It is strictly a high-density urban area with high vehicular traffic.

[2]Inspected by J. Caravanos, NJ licensed lead inspector. A NITON XL 309 XRF lead detection device was used.

Fig. 1. Interior sample location viewed from the east side room entry.

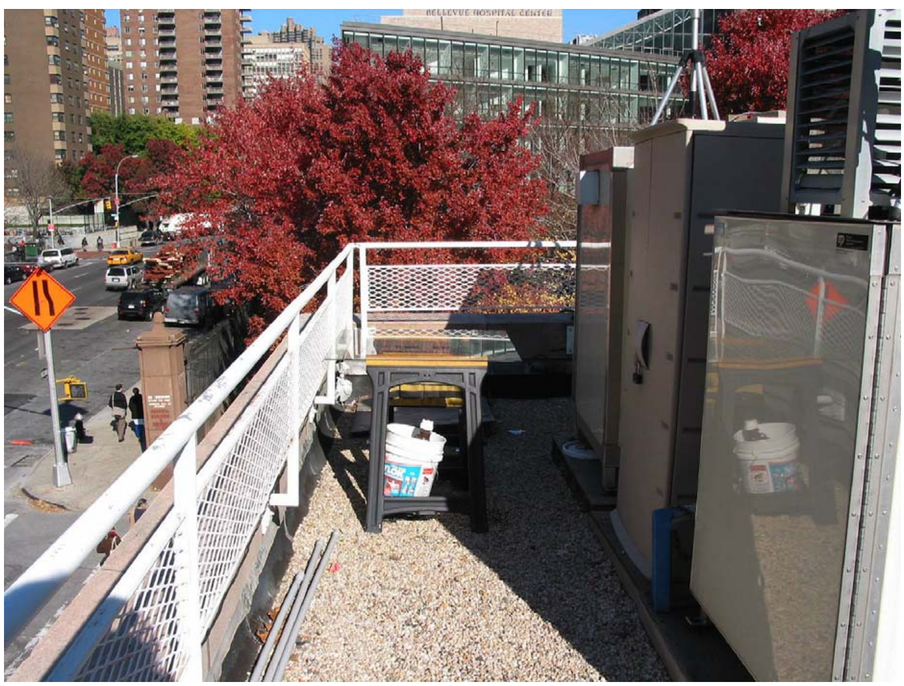

Fig. 2. Exterior unsheltered sample plate viewed from the south.

2.4. Sheltered exterior glass plate

A third glass plate was placed outside the stairwell; however, this outdoor plate was shielded by a portico and therefore the sample site did not receive rainfall or experience atmospheric washout as did the second (outdoor and uncovered) glass plate. The purpose of the second outdoor plate was to examine the effect of precipitation. Sampling of this plate was only performed during the final 36 weeks of the study. This plate will be referred to as "sheltered."

2.5. Interior control glass plate (adjacent to closed window)

Lastly, a fourth glass plate was installed in another nearby (also unused) emergency rooftop stairwell; this served as an interior control site. In this stairwell, the windows were kept closed and none to very little air exchange with the exterior occurred. This stairwell was identical to the other interior site including the ventilation unit. Sampling of this location was performed concurrently with the other sample sites. A sampling time of 7 weeks was used. Sampling was abandoned due to resource limitations and a continuing negative result.

Dust deposited on each glass plate was collected once per week by careful wiping. At 1-week time intervals, the technician, using clean, single use, disposable latex gloves, wiped the surface. The established protocol consisted of thoroughly wiping the glass plate until all visible mass was removed, then using one additional (final) wipe to ensure complete collection. Quality control testing confirmed this protocol collected all deposited material at 'reasonable' dust loading. Thus, a minimum of 2 wipes was used. However, on occasion, four wipes were necessary due to the magnitude of dust deposition (especially for the sheltered plate). Standard Housing and Urban Development (HUD) lead dust wiping techniques (Appendix 13.1 HUD Guidelines) (Jacobs, 1995) were employed. The wipes (Pallintest, Erlanger, KY) complied with the ASTM E 1792 guideline.

All samples were packaged in plastic 50 mL centrifuge tubes and were sent to an American Industrial Hygiene Association/Environmental Lead Laboratory Accreditation Program (AIHA/ELLAP) accredited commercial laboratory.[3] Samples were prepared following HUD Appendix 14.2 Guidelines (Jacobs, 1995). Flame atomic absorption spectrophotometry (EPA Method 7420)(EPA, 1986) was used to quantify lead in the dust samples. Weekly sampling occurred every Monday (noon) and began in March 2003 and continued to March 2005. This document reports on the 104 weeks for the exterior and interior lead samples; the exterior sheltered plate was sampled for the last 36 weeks of the project while the control was sampled for 7 weeks.

3. Results

Table 2 shows the mean and median lead dust loading as well as the minimum and maximum values for the four glass plates. At the time of weekly sampling, three of the four glass plates tested disclosed measurable amounts of leaded dust. The interior control plate did not have any lead as surficial dust. This fourth glass plate, acting as the interior control, was located in an interior stairwell with closed windows; there was little to no traffic and this location revealed no lead accumulation (sampling abandoned after 7 weeks of negative lead dust loadings). As this served as the control for the other interior plate) adjacent to the open window, the result demonstrates that the source of the interior leaded dust was from air being carried or wafted through the open window. Based on this, the source of lead on the interior glass plate adjacent to the open window was from dust carried through the window opening. We conclude this since the stairwell was not otherwise used; it contained no source of leaded dust.

With respect to the lead deposition, three of the four glass plates showed the weekly presence of lead. The sample analysis revealed that the minimum and maximum values for leaded dust for the interior plate (adjacent to the open window) were 1.6 μg/feet^2/week and 40.8 μg/feet^2/week, respectively, with a corresponding median value of 4.8 μg/feet^2/week. Similarly, the minimum and maximum values for leaded dust for the exterior unsheltered plate were 1.6 and 62.0 μg/feet^2/week, respectively, with a corresponding median value of 14.2 μg/feet^2/week. The third glass plate, placed outdoors but sheltered from the rain and snow by a portico, also revealed increasing lead amounts at greater concentrations than the unsheltered plate. The minimum and maximum values for leaded dust on the sheltered exterior plate were 10.6 and 53.5 μg/feet^2/week, respectively, with a corresponding median value of 32.3 μg/feet^2/week. A comparison between both exterior plates demonstrates the effect of precipitation prior to sampling. Since the plates were sampled every Monday, the precipitation and wind patterns during the previous week clearly impacted the deposition and accumulation of leaded dust.

Fig. 3 demonstrates the cumulative lead deposition in μg/feet^2 over the sampled periods. The shape of the graph supports the dynamic and continual deposition of leaded dust in this urban environment. The US Environmental Protection Agency (EPA) Standard for interior floor dust lead hazard level is currently 40 μg/feet^2. The data show that, based on mean values, this amount is likely to be exceeded in five or six weeks time. Depending on the rate of deposition and location, within any given week, the standard for the lead content in floor dust may be exceeded in less time.

As noted, the sheltered plate, the unsheltered plate, as well as the interior plate adjacent to the open window all accumulated lead. Both exterior surfaces accumulated lead more rapidly with a steeper accumulation curve than did the interior glass plate (see Fig. 4). The 36-week sampling of the sheltered glass plate reveals a greater rate of lead accumulation than the unsheltered plate, most likely due to the lack of an effect of precipitation (wash-off) that occurred on the unsheltered plate. In this regard, the mean slopes measured were as follows:

- Pb loading exterior (unsheltered)17.5 μg/feet^2/week,
- Pb loading exterior (sheltered)33.1 μg/feet^2/week,
- Pb loading interior7.4 μg/feet^2/week.

These slopes were remained relatively constant for both year one and two. The lead accumulation rate for the sheltered exterior plate was generally double the exterior

Table 2
Atmospheric lead deposition in μg/sf/week at locations that accumulated lead during March 4, 2003–March 3, 2005

	Pb (μg/sf/week) interior	Pb (μg/sf/week) unsheltered	Pb (μg/sf/week) sheltered[a]
Year 1			
Mean	8.4	17.1	—
Median	4.9	13.1	—
Ninetieth percentile	20.6	31.2	—
Minimum	1.6	1.6	—
Maximum	40.8	62.0	—
Year 2			
Mean	6.4	17.9	33.1
Ninetieth percentile	11.9	34.5	49.0
Minimum	1.6	1.6	10.6
Maximum	25.1	48.3	53.5
Combined[b]			
Mean	7.4	17.5	33.1
Median	4.8	14.2	32.3
Ninetieth percentile	15.8	33.9	49.0
Minimum	1.6	1.6	10.6
Maximum	40.8	62.0	53.5
Std. deviation	7.0	12.6	11.4

Note: The interior control plate was negative (i.e. <1.6 μg/sf/week) as sampled.
[a]Only 36 weeks of sampling was done at this location.
[b]There no statistical difference between years 1 and 2 sampling mean values.

[3]Lab analyses by Schneider Laboratories Inc. (Richmond, VA)

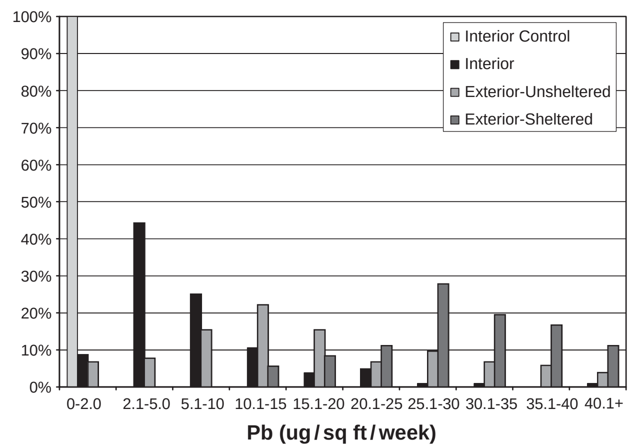

Fig. 3. Distribution of the cumulative lead deposition in μg/feet²/week over the sampled periods for the four sampling locations. (*Note*: 100% of the interior control values were below detectable limits).

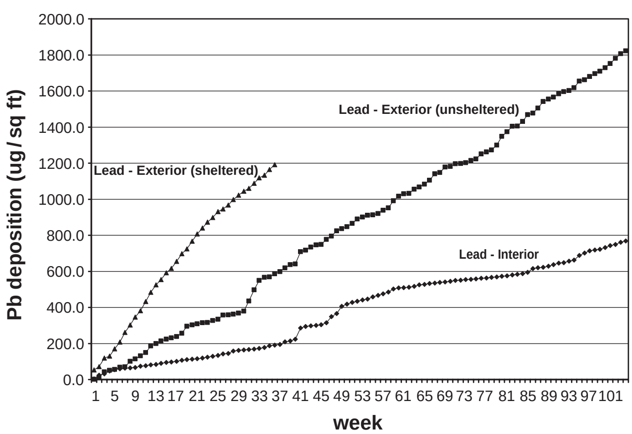

Fig. 4. Cumulative exterior and interior lead dust surface loading of samples for the interior and the unsheltered exterior glass plates over 104 weeks. The exterior sheltered glass plate actually corresponds to week 68 of sampling for the other two plates.

unsheltered plate. This was true for both year 1 and 2 and the 36 weeks overlapping time period.

4. Discussion

This study demonstrates the ubiquitous nature of lead in the urban atmospheric environment. We do not know the exact sources of the exterior leaded dust. However, several likely sources are present in the urban environment (Agency for Toxic Substances and Disease Registry, 1988; Mielke, 1993). Additional data on the deposition of lead in the five boroughs that comprise New York City is in press.[4] With respect to lead, road grit contains lead from many sources including atmospheric fallout from past use of leaded gasoline, lead weights used to balance tires and industrial uses of lead in electronics and automotive parts as well as leaded paint. Exterior paint on the road (yellow lines) and a variety of street fixtures often contain leaded paint on their surface. Lead chromate is a widely used pigment on exterior signage. Furthermore, building renovation and demolition as well as bridge repair may release dust from lead-based paint. This occurs despite "best" efforts to control the release of leaded dust. Soil contamination is especially common alongside streets and near high-traffic areas (Agency for Toxic Substances and Disease Registry, 1988). Although lead is no longer used as an additive in gasoline, lead weights are currently used to balance tires. These weights are lost and deposited along urban streets; they accumulate along the curb(s) and are rapidly abraded and ground into tiny pieces by vehicle traffic. Lead from this source (wheel weights) is continuous, significant, and widespread. These lead particles, dusts, and scrapings may be deposited in the soil in heavily trafficked areas (Root, 2000).

The data presented in this study demonstrates that interior dust contaminated with lead most likely results from dust being wafted and blown inside a residence/building. The only source of the lead on the interior glass plate was derived from exterior sources. The results of our study are consistent with other studies in the published literature (Aschengrau et al., 1997; Bornschein et al., 1986; Clark et al., 2004; Laidlaw et al., 2005). Clark et al. (2004) demonstrated through statistical modeling a pathway from exterior entry dust lead loading to loadings on interior entryway floors, other interior floors, and windowsills. Hunter (1977) demonstrated that children's lead levels are higher in the summer months than during the winter months when they are more often indoors. This is consistent with more dust in the house because of open windows and the frequency of passage inside and outside. Recent data by Laidlaw et al. (2005) has demonstrated that when the temperature is high and evapotranspiration maximized, soil moisture decreases and soil dust is mobilized.

In another study, investigators assessed the relationship between lead-based paint and associated surficial dust by using isotopic ratio analysis (Jaeger et al., 1998). They reported that paint samples from one house did not match the associated surficial dust in the house in four out of the five samples taken. They observed that when the paint was intact, the lead in the dust did not match isotopically to the lead in the paint on the test surface. Isotopic ratio measurements can be useful for a 'fingerprinting' of the source by virtue of sample match and by placement of the ratio on the spectrum of isotopic ratio values for lead (Angle et al., 1995; Manton, 1977; Rabinowitz, 1987; Rabinowitz, 1995).

Atmospheric deposition of lead is dynamic and continual as evidenced by the data obtained in this study over a 2-year period. It is startling to find that the interior lead dust standards may be exceeded after only 3 weeks of

[4]Caravanos, J., A.L. Weiss, M.J. Blaise, R.J. Jaeger. 2005 A survey of spatially distributed dust lead loadings in New York City. Environmental Research, in press.

accumulation. This suggests that in some households, hygiene practices may be critical to the mitigation of lead exposure to young children. Hygiene practices would include increased cleanliness within the residence and frequent wiping of floors and windowsills for accumulated dust. The extent and length of the window openings may affect the interior lead dust accumulation. However, this study was not designed a priori to address this variable and is worth consideration in a future study. Interior lead dust accumulation will also be influenced by atmospheric deposition rate, precipitation, and wind speed and direction. In addition, interior dust management (frequent wiping and mopping) should be routine hygienic practices, especially in urban and high traffic areas. The outdoor accumulation of lead dust appears to remain a major issue and that a new method must be found to remedy the accumulated lead dust in the city to reduce exposure to urban children.

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Last updated on 2/22/2016

Wastes - Hazardous Waste - Waste Minimization

You are here: EPA Home Wastes Hazardous Waste Waste Minimization National Lead Free Wheel Weight Initiative (NLFWWI)

National Lead Free Wheel Weight Initiative (NLFWWI)

Note: EPA no longer updates this information, but it may be useful as a reference or resource.

Lead Wheel Weight Topics

- Basic Information
- Quick Facts
- Why Join the NLFWWI?
- Links

Basic Information on Lead Wheel Weights

Wheel weights are clipped to the rims of every automobile wheel in the United States in order to balance the tires. These weights often come loose and fall off. They are either washed into storm sewers and end up in waterways or are gathered during street cleaning and placed in municipal landfills. The weights are susceptible to atmospheric corrosion. Currently, there are no regulatory controls governing the use of lead wheel weights.

Lead (PDF) (2 pp, 11K, About PDF) is a highly toxic chemical that has been designated as one of 31 Priority Chemicals targeted for reduction by EPA. Read more about the properties, uses, and hazards of lead.

Lead Wheel Weight Quick Facts

- There are 200 million autos and light trucks on the nation's roadways.
- Sixteen million new autos are produced annually in the United States.
- An average of 4.5 ounces of lead is clipped to the wheel rims of every automobile in the United States.
- Approximately 50 million pounds of lead is used annually to produce tire weights worldwide in autos and light trucks.
- 75% is recycled by secondary lead smelters.
- 25% (or 12.5 million pounds annually) is uncontrolled or unmanaged in the environment.
- 13% of the 12.5 million pounds (1.6 million pounds) is lost when wheel weights fall off during normal driving conditions (e.g., hitting a pot hole).
- 87% of the 12.5 millions pounds (10.9 million pounds) is sold or given to hobbyists for recreational purposes (e.g., melting down to make fishing sinkers).

Why Should You Join NPEP's National Lead Free Wheel Weight Initiative (NLFWWI)?

- You will be protecting yourself, your employees, and your community from exposure to lead.
- Public recognition for achieving voluntary reductions of a Priority Chemical.
- Information about your organization and your project posted on this website.
- Your environmental achievements and Success Stories posted on this website.
- Use of EPA's NPEP logo to identify your organization as a partner (please note that EPA cannot endorse the purchase of a particular company's products or services).
- The opportunity to display your NPEP membership plaques and achievement awards to customers, suppliers, employees, and stockholders.
- At your request, EPA will notify your local media of your program accomplishments.
- Minimize or eliminate the cost and liability of managing lead.
- Decrease or eliminate the cost of managing lead.
- Reduce lead in the environment. Join the ranks of other responsible companies committed to eliminating lead-free wheel weights.

Links

- NLFWWI Recognition Ceremony Press Release
- NLFWWI Charter Members

- Lead-Free Wheels EXIT Disclaimer works with independent tire dealers and public fleets in Michigan and the Midwest to install non-lead wheel weights.
- Clean Car Campaign EXIT Disclaimer A national campaign coordinated by state, regional and national environmental organizations promoting a clean revolution in the motor vehicle industry.
- ECOS Resolution: Phasing Out the Sale and Installation of Lead Wheel Weights EXIT Disclaimer

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ECOS

Resolution 08-9
Approved April 15, 2008
New Orleans, Louisiana

Revised March 29, 2011
Alexandria, Virginia

Revised April 2, 2014
Sausalito, California

Revised April 8, 2017
Washington, DC

Revised April 27, 2020
All Members Call

Revised March 30, 2023
Arlington, Virginia

As certified by
Ben Grumbles
Executive Director

PHASING OUT THE SALE AND INSTALLATION OF LEAD WHEEL WEIGHTS

WHEREAS, lead is a persistent, bioaccumulative, and toxic substance; and

WHEREAS, the U.S. Environmental Protection Agency (U.S. EPA) in June 2012 listed lead and lead compounds on the work plan of 83 chemicals for further assessment under the Toxic Substances Control Act (TSCA) to enhance the agency's existing chemicals management program; and

WHEREAS, the federal interagency strategy for Healthy People 2020 and proposals for Healthy People 2030 include several objectives for reducing environmental release of and exposure to lead from occupational and industrial sources, manufactured products, and hazardous sites, for the general population and sensitive groups such as children aged one to five years; and

WHEREAS, U.S. EPA in October 2022 released its Final Strategy to Reduce Lead Exposures and Disparities in U.S. Communities, which calls for addressing exposures related to lead products through 'Approach 3: Reduce lead exposures with a "whole of EPA" and "whole of government" approach;' and

WHEREAS, the American Public Health Association in September 2022 published a special issue of the American Journal of Public Health, Supplement 7: "Ubiquitous Lead: Risks, Prevention-Mitigation Programs, and Emerging Sources of Exposure," that covers ongoing unaddressed issues of release, exposure, and resulting health impacts from manufacturing, use, recycling, and disposal as long as lead remains in commerce; and

WHEREAS, the economic value of preventing lead exposure in the U.S. per each year's cohort of children is estimated at $213 billion, based on conservative assumptions about both the effect of IQ on earnings and the effect of lead on IQ ("Economic Gains Resulting from the Reduction in Children's Exposure to Lead in the United States," Grosse et al., EHP 110:563-569 (2002)); and

WHEREAS, lead wheel weights have been used in the U.S. for 70 years and the U.S. Geological Survey (USGS) estimates that approximately 2,000 metric tons of lead from lead wheel weights fall off onto U.S. roads annually (USGS Open-File Report 2006-1111, "Stocks and Flows of Lead-Based Wheel Weights in the United States," Donald I. Bleiwas, 2006. http://pubs.usgs.gov/of/2006/1111/); and

WHEREAS, lead wheel weights degrading on the side of the road are suspected to contribute to levels of lead in runoff that are toxic to aquatic organisms and may contribute to lead levels in roadside dust ("Loading of Urban Streets by Motor Vehicle Wheel Weights," Root, EHP 108:937-940 (2000)); and

WHEREAS, lead has successfully been phased out of other consumer products such as can solder (1978-1992), paint (1976 and 2008), children's products (2008), gasoline (1979-1996), plumbing fixtures and drinking water systems (1991, 1996, 2011), and duck shot (1986-1991), with corresponding decreases in blood lead levels (R.J. Jackson, CDC Healthy Places Presentation. Maine, Oct. 2003); and

WHEREAS, lead-free wheel weights with cost and performance superior or equal to that of lead wheel weights are readily available in the U.S. and world markets; and

WHEREAS, lead wheel weights have been banned on new vehicles and after-market tire balancing in Europe since July 2005; and

WHEREAS, all new cars and light trucks sold in the U.S. have used non-lead wheel weights since early 2011; and

WHEREAS, several federal agencies, state governments, vehicle manufacturers, tire retailers, and private fleets have evaluated lead-free weights and have made public commitments to procure and install lead-free wheel weights; and

WHEREAS, U.S. EPA has convened a stakeholder group with U.S. manufacturers of lead wheel weights and others with a stated goal to "remove lead tire weights from commerce as soon as possible;" and

WHEREAS, nine states – California, Illinois, Maine, Maryland, Minnesota, New Jersey, New York, Vermont, and Washington – have passed legislation with industry support banning the sale, distribution, and/or use of lead wheel weights; and

WHEREAS, wheel weight manufacturing and distribution companies face a number of marketing and regulatory compliance issues arising from a patchwork of state laws addressing the sale, distribution, and/or use of lead wheel weights; and

WHEREAS, U.S. EPA on August 26, 2009 granted, but has not acted upon, the Ecology Center and Sierra Club's petition under Section 21 of TSCA requesting that U.S. EPA initiate a proceeding for the issuance of a rule to prohibit the manufacture, processing, and distribution in commerce of lead wheel balancing weights; and

WHEREAS, U.S. EPA has not provided any public information on the status of the rulemaking since the publication of the Fall 2011 Semiannual Regulatory Agenda, which identified the NPRM date as October 2012; and

WHEREAS, the executive and legislative branches in other states put lead wheel weight phaseout proposals on hold in the belief that U.S. EPA would take timely action under the 2009 petition and issue a proposed rule in 2012; and

WHEREAS, a national rule promulgated in a timely manner pursuant to the granted TSCA Section 21 petition is the best means of consistently addressing environmental and public health issues associated with the use and loss of lead wheel weights across the country, and is the best means of eliminating industry marketing and compliance difficulties that arise from a patchwork of state laws; and

WHEREAS, the Commission on Environmental Cooperation (CEC) works to promote cooperation on ecosystem protection and sustainable economic development, including supporting chemical management actions across North America on priority pollutants; and

WHEREAS, Environment Canada in 2014 and 2017 held public consultations on voluntary and regulatory approaches to phase out the manufacture and import of lead wheel weights, in July 2021 published a proposed regulation, and on February 15, 2023, published a final regulation that will come into force on February 3, 2024.

NOW, THEREFORE, BE IT RESOLVED THAT:

ECOS requests that U.S. EPA move forward in an expedited manner on its 2009 granted petition and notice under TSCA to initiate regulatory action to address lead hazards associated with the manufacture, processing, and distribution in commerce of lead wheel balancing weights in the United States, including measures for proper management of lead wheel weights removed from service;

ECOS requests that U.S. EPA, CEC, and other stakeholders take necessary and appropriate actions to achieve a U.S. phaseout of lead wheel weight import, manufacturing, sale, and installation as soon as practical and in coordination with the effective date of Canada's final regulation;

ECOS recommends that federal agencies phase out their purchase, use, and disposal of lead wheel weights under Executive Order 14057 on Catalyzing Clean Energy Industries and Jobs through Federal Sustainability, Sec. 207, Reducing Waste and Pollution, and Sec. 208, Sustainable Acquisition and Procurement (signed by President Biden on December 8, 2021); and

Copies of this resolution should be transmitted to U.S. EPA, CEC, the Centers for Disease Control and Prevention, the Department of Commerce, the Department of Defense, the Department of Health and Human Services, the Department of Transportation, the General Services Administration, the Occupational Safety and Health Administration, and the National Association of Attorneys General.

Lead Loading of Urban Streets by Motor Vehicle Wheel Weights

Robert A. Root

Albuquerque, New Mexico, USA

This study documents that lead weights, which are used to balance motor vehicle wheels, are lost and deposited in urban streets, that they accumulate along the outer curb, and that they are rapidly abraded and ground into tiny pieces by vehicle traffic. The lead is so soft that half the lead deposited in the street is no longer visible after little more than 1 week. This lead loading of urban streets by motor vehicle wheel weights is continuous, significant, and widespread, and is potentially a major source of human lead exposure because the lead is concentrated along the outer curb where pedestrians are likely to step. Lead deposition at one intersection in Albuquerque, New Mexico, ranged from 50 to 70 kg/km/year (almost 11 g/ft^2/year along the outer curb), a mass loading rate that, if accumulated for a year, would exceed federal lead hazard guidelines more than 10,000 times. Lead loading of major Albuquerque thoroughfares is estimated to be 3,730 kg/year. Wheel weight lead may be dispersed as fugitive dust, flushed periodically by storm water into nearby waterways and aquatic ecosystems, or may adhere to the shoes of pedestrians or the feet of pets, where it can be tracked into the home. I propose that lead from wheel weights contributes to the lead burden of urban populations. *Key words*: antimony, antimonious lead, lead, lead loading, lead poisoning, lead pollution, motor vehicle wheel weights, street lead, urban lead, wheel weights. *Environ Health Perspect* 108:937–940 (2000). [Online 29 August 2000]
http://ehpnet1.niehs.nih.gov/docs/2000/108p937-940root/abstract.html

In 1997, the U.S. Public Health Service reaffirmed its 1991 call for a society-wide effort to eliminate childhood lead poisoning, one of the most common and preventable pediatric health problems (*1*). Lead affects virtually every system in the body, especially the developing brain and nervous system of fetuses and young children (*2*). Some 890,000 children in the United States have blood lead levels high enough to cause adverse effects on their ability to learn, and 2.7 million children have increased dental cavities attributable to lead exposure (*1*,*3*). A highly significant association has been found between lead exposure and children's IQ, and there is no evidence of a threshold down to blood lead concentrations as low as 1 µg/dL (*4*). Virtually all children are at risk for lead poisoning, and the risk for lead exposure is disproportionately high for children living in large metropolitan areas (*2*,*5*). Lead-contaminated dusts and soils are one of the primary pathways of lead exposure for children, especially in urban populations (*2*,*6*,*7*).

Lead levels in roadside soil along some heavily traveled roads have been reported as high as 10,000 ppm (*2*,*7*,*8*). The U.S. Environmental Protection Agency (U.S. EPA) assumes that the large amount of lead near busy streets comes from the prior use of leaded gasoline (*9*). Motor vehicle wheel weights, which are 95% lead, are potentially a major source of lead exposure that heretofore has not been recognized.

Automobile and light truck wheel weights are lead castings 5–150 mm long and weigh 7–113 g. They contain approximately 5% antimony to increase hardness. This alloy is known as antimonious lead. To ensure that a newly balanced wheel runs smoothly, wheel weights are affixed at appropriate locations by a steel clip to both the inner and outer wheel rims. A few wheels are balanced by gluing the weights to the inside of the rim with adhesive strips. Automobile and light truck wheels typically require one and usually two weights per wheel to achieve balance.

Methods and Results

I conducted studies in Albuquerque, New Mexico, to ascertain the baseline or steady state amount of metallic lead found in urban streets, the rate of lead deposition, and the rate of lead abrasion.

Steady-state surveys. To estimate the steady-state amount of lead found in urban streets, I surveyed eight six-lane divided street segments, totaling 19.2 km, by walking along the sidewalk adjacent to the outer lane and retrieving any lead found along the outer curb, in the street, and on the sidewalk. The sidewalk was adjacent to the outer curb along most segments. Along some segments the sidewalk was set back approximately 1 m and the space between the sidewalk and curb was occupied by gravel, cobbles, or low shrubs. These obstacles made searching for wheel weights more difficult. Curbside parking did not occur on any of the streets surveyed. I attempted only one survey along the median because of the potential danger; the posted speed limit on these streets is 65 km/hr, and the average weekday traffic volume is as high as 45,000 vehicles/day (*10*).

These initial surveys are referred to as steady-state surveys because the amount of lead deposited and worn away, if undisturbed, should not change substantially over time. The cleaning history of the eight streets is unknown; however, they appear, based on the interstreet consistency of the amount of lead found, to have achieved a steady-state condition. The pieces of lead found in the street averaged 21 g each; the smallest found was approximately 3 g. Virtually all lead was found in either the 0.6-m-wide outer curb area (i.e., the concrete gutter) or the 25-cm-wide median curb area. Approximately 1% of the lead was found outside the curb area—about half in the street and half on the sidewalk. Metallic lead is very soft and highly malleable (*11*). Once the wheel weights are deposited in the street they are easily abraded and broken into tiny pieces as vehicles run over them. Figure 1 shows street-abraded wheel weights.

I weighed lead found during these eight steady-state surveys to the nearest 0.1 g. The lead ranged from 0.35 to 1.1 kg/km, with a geometric mean of 0.50 kg/km. More than 97% of the lead found was recognizable as whole or pieces of wheel weights. I resurveyed two of the eight street segments to confirm that their steady states were consistent over time. Total lead for each resurveyed street varied by 25% from the mean, and right-side versus left-side deposition varied approximately 5% for each.

The survey results are considered conservative (in the sense that the quantity of lead deposited is underestimated) because it is impossible to ensure complete recovery of all lead pieces by visual inspection. Many pieces of lead are the size, shape, and color of roadside debris. Indeed, on several occasions when the survey route was immediately retraced, approximately 10% more lead was found.

Biweekly surveys. To determine the rate of wheel weight deposition, I conducted surveys in the same manner as the steady-state surveys every other week for 46 weeks along a 2.4-km six-lane divided street segment, designated JTML. JTML was selected

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because more wheel weights were found in the initial steady-state survey along this segment than along any of the other seven streets. JTML has an average daily traffic flow of 41,500 vehicles/day (*10*). These biweekly surveys were conducted at midday to ensure that the lead was not obscured by curbside shadows. Figure 2 presents the JTML steady-state and biweekly survey results. The mean steady-state level was 1.09 kg/km. On average, 0.35 kg/km was found during the biweekly surveys, an accumulation equivalent to 9.1 kg/km/year.

During the steady-state and biweekly surveys, approximately 60% of the lead was found on the west side of JTML and 40% on the east side (Figure 3). Knowledge of Albuquerque's terrain and the fact that the middle of streets usually has a crown to promote drainage are important in understanding this pattern of deposition. East of the Rio Grande, the terrain dips gently to the west from the base of the Sandia Mountains. JTML runs north–south perpendicular to the slope, such that the east side of JTML is somewhat uphill and the west side is somewhat downhill. Thus, the street slopes less on the east side and more on the west side. In general, the east side of the JTML street surface is flatter and at some intersections slopes toward the median. Conversely, the west side of the street is more steeply sloped, its surface is rarely level, and it has no surfaces that slope toward the median except for left turn lanes carved into the median. Street slope is significant because it affects the direction and time it takes for wheel weights to migrate to the side of the street. Longer migration time would result in greater wheel weight wear. Wheel weight deposition on relatively flat urban streets is therefore likely to be underestimated.

The effect of street slope is illustrated by the steady-state survey of the JTML median. On the east side of JTML, where the street slope is reduced by the dipping terrain and where 40% of the wheel weight lead was found, wheel weights along the median were 50% of the steady state. On the west side, with steeper slopes and 60% of the wheel weight lead, the wheel weights along the median were 10% of the steady state. Overall, wheel weights along the median were 25% of the steady state.

Wheel weight deposition was more frequent in the vicinity of businesses, side streets, and intersections where motorists slow down rapidly. For example, 90% of the lead found on the west side of JTML was concentrated along the southwestern quarter of the street segment (Figure 4). (Deposition along two blocks at the southern end of the west side of JTML, a distance of 600 m, was significantly greater than for any other street segment. This two-block segment, which was one-quarter of the west side of JTML, is referred to as the southwestern quarter. The remainder of the west side of JTML is referred to as the northwestern three-quarters.) The 1,800-m northwestern three-quarters has few businesses frequented by motorists, whereas the southwestern quarter has six such business (brake repair, two tire shops, donut shop, restaurant, supermarket), two frequently used side streets, and a traffic light intersection whose incoming lanes all slope toward the outer curb. Wheel weight deposition on the east side of JTML, where business and intersections are more evenly distributed, was more uniform.

Degradation study. To determine the rate at which wheel weights are abraded in the street, I conducted a degradation study on the same street but not within the JTML segment included in the surveys. The study was initiated by clearing all lead from the study area. Then, every day for 14 days, I scattered five or six previously used wheel weights ranging from 14 to 84 g near the center of each of three lanes on one side of the street; each day's weights totaled approximately 0.50 kg. A total of 7.0 kg was deposited in this way. On the 15th day, I searched the entire area and retrieved lead from along the outer curb, the sidewalk, the paved area beyond the sidewalk, the street, along the median curb area, and from the median itself.

Only 4.0 kg of the 7.0 kg of wheel weights was found on the 15th day. Approximately 2.7 kg, or 38% of the amount deposited, was found in the street, along the outer curb, and on the sidewalk—the areas searched during the biweekly surveys. No adjustment was made for wheel weights potentially lost from motor vehicles because the biweekly survey estimated that only 14 g would, on average, have been deposited. This bias is small and would increase slightly the lead found, and thereby reduce the estimate of lead apparently lost through abrasion. Most wheel weights were found along the outer curb "upstream" from their original locations. Apparently, as vehicles run over wheel weights, the torque from the vehicle's drive wheels skids the weights against the traffic flow. Most wheel weights showed signs of abrasion, some severe, as shown in Figure 1. Many of the weights were broken into two or more pieces. About two-thirds migrated laterally to the outer curb and one-third to the median curb. In the degradation study, half of the wheel weight lead deposited in the street was not visible after 8 days.

Rate of lead deposition. Comparison of the amount of steady-state lead with the lead accumulated biweekly (Figure 2) and the rapid rate of lead abrasion found during the degradation study indicate that lead deposited in a busy street is rapidly worn away, to the extent that a significant fraction of the amount deposited would not be found in

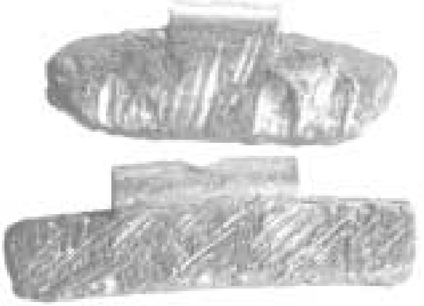

Figure 1. Abraded wheel weights. Note the scratches, scrapes, and gouges resulting from the weights being run over by motor vehicles.

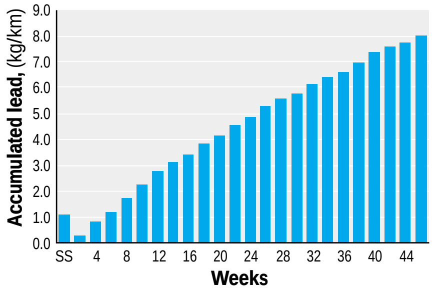

Figure 2. JTML steady-state (SS) and biweekly survey results. Bars indicate the accumulated total of lead found biweekly.

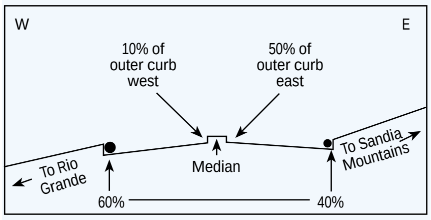

Figure 3. A schematic profile of JTML showing the effect of terrain on the deposition of wheel weights. Approximately 60% of lead was found on the steeper sloping west side of the street and 40% on the east. The inner (median) curb on the east side had 50% as much lead as the outer curb on that side, whereas the inner curb on the west side had only 10% as much as the outer curb.

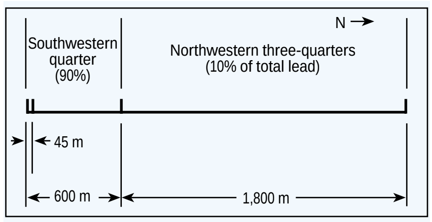

Figure 4. A schematic of the west side of JTML showing the uneven deposition of wheel weight lead. Of the lead found along the southwestern quarter, 15–22% was found within 45 m of the intersection at the southern end of JTML.

the biweekly surveys. I used two approaches to adjust for this lead loss. First, the daily fraction of lead that is worn away was obtained mathematically from the results of the steady-state and biweekly surveys, as shown below.

The relationship between the lead deposited in kilograms per kilometer per day (D) and the lead retrieved at the end of 2 weeks in kilograms per kilometer (R_{14}) can be expressed as follows:

$$R_{14} = \frac{Dp\left(1-p^{14}\right)}{\left(1-p\right)}, \qquad [1]$$

where D is the amount of lead deposited per kilometer per day, and p is the fraction remaining each day from the previous day's lead deposition. The steady state amount of lead in kilograms per kilometer (S) is, therefore,

$$S = R_{\infty} = \frac{Dp}{\left(1-p\right)}. \qquad [2]$$

To estimate p from the observed values of R_{14} and S, divide Equation 1 by Equation 2:

$$\frac{R_{14}}{S} = 1 - p^{14},$$

which is equivalent to

$$p = \sqrt[14]{1-\frac{R_{14}}{S}}. \qquad [3]$$

Accumulation during the biweekly surveys, R_{14}, was 0.35 kg/km. The steady-state surveys yielded a value for S of 1.094 kg/km. Using Equation 3, the estimated value for p is 0.9728, implying that 2.72% of the lead deposited each day is worn away by the next day.

To estimate the actual rate of lead deposition, I adjusted the biweekly survey rate to account for the amount of lead worn away by the grinding action of traffic. The "wear adjustment factor" is estimated to be the ratio of lead deposited per kilometer per 14 days to the lead retrieved in the biweekly surveys (0.35 kg/km). From Equation 2, D is estimated to be the amount of lead deposited per kilometer per day, as $D = (1-p)S = (0.0272)(1.094) = 0.0297$ kg/km/day. Thus,

$$\text{Wear adjustment factor} = \frac{\left(14 \times 0.0297\right)}{0.35} = 1.2 .$$

Second, I conducted daily surveys of the southwestern quarter of JTML for 4 weeks, presented as Figure 5, and compared them with the biweekly surveys for this 600-m segment. From this study, a wear adjustment factor was estimated to be nearly 1.4 by dividing the daily survey rate of 26.0 kg/km/year by the biweekly survey rate of 18.9 kg/km/year. A combined wear adjustment factor of 1.3 was adopted.

To estimate the amount of lead deposited along the outer curb in JTML, I multiplied the annual rate of wheel weight deposition (9.1 kg/km) by the wear adjustment factor of 1.3 and then by 0.95 as a lead adjustment factor to compensate for the 5% antimony content of the weights. The resultant deposition rate does not include lead abraded from the wheel weights between their deposition in the street and the time it takes for them to migrate to the outer curb. No adjustment was made to include lead deposited along the median because that lead would probably not migrate to the outer curb. Accordingly, lead deposition along JTML is conservatively estimated to average 11.8 kg/km/year along the outer curb of both sides of the street along the entire 2.4-km street segment and 24.5 kg/km/year along the southwestern 600-m interval on one side of the street. During the weekly surveys of this southwestern quarter, 15% of the wheel weights found were along a 45-m curb interval at the southernmost intersection; during the steady-state surveys, 22% was found along the same 45 m. Using these percentages, lead deposition is estimated to be 50–70 kg/km/year for this 45-m interval.

Discussion

Although lead weights may be found anywhere motor vehicles go, they most commonly fall off where vehicles rapidly change momentum—for example, when slowing down for a traffic light or turning onto a side street or into a business. Thus, one would expect to find higher deposition of lead weights in these areas.

The federal guideline for the amount of lead needed to create a lead hazard on an outdoor surface such as a sidewalk is 800 µg/ft^2 (*1,12,13*). If accumulated for a year, the lead deposited along the 45 m of outer curb at the southernmost JTML intersection would, using the deposition rates estimated by this study, meet the lead hazard guideline 10,200–13,400 times/year (more frequently than once per hour), which is sufficient to create a continuous hazardous environment. Furthermore, this 45-m curb area at a traffic-light intersection is one where pedestrians are likely to step.

The results of this study can be used to estimate the lead loading of Albuquerque's major thoroughfares by motor vehicle wheel weights. To arrive at this estimate, the geometric mean of lead found along the eight streets included in the steady-state surveys was multiplied by the number of steady states reached per year, and then multiplied by the number of kilometers of major streets. The geometric mean of lead for the eight streets is 0.50 kg/km. JTML results indicate that wheel weight deposition is equivalent to 10 steady states per year. The city of Albuquerque has 330 km of six-lane principal traffic arteries and 200 km of four-lane minor traffic arteries (*10*). At this time, the wheel weight steady state for minor traffic arteries is not known. However, minor arteries were included by estimating their per-kilometer contribution to be two-thirds that of the principal arteries. The lead deposition rates included the wear adjustment factor of 1.3, the lead adjustment factor of 0.95, and the median adjustment factor of 1.25. Using these factors, lead loading of major Albuquerque thoroughfares by motor vehicle wheel weights is estimated at 3,730 kg/year: 2,650 kg/year for principal traffic arteries and 1,080 kg/year for minor traffic arteries. Similar results should be anticipated wherever lead weights are used to balance motor vehicle wheels.

An estimated 64 million kg/year of lead is consumed worldwide for wheel weights (*14*). The pool of lead rolling over U.S. highways is estimated to be on the order of 25 million kg, based on 200 million automobiles and light trucks (*15*) and assuming 130 g of wheel weights per vehicle. Approximately 15 million kg of the total is urban, because 60% of roadway vehicle-kilometers traveled are urban (*16*). Scaling the estimated Albuquerque deposition to the entire United States indicates that a significant amount of this rolling lead, perhaps 10% (1.5 million kg/year), is deposited in urban streets.

The ramifications of this lead loading are numerous. Small lead particles from abraded wheel weights likely contribute to the lead found in urban runoff. Storm water can sweep this lead into nearby culverts and arroyos, and ultimately washes it into nearby waterways where it can adversely affect water quality and aquatic ecosystems. In Albuquerque the storm-water runoff flows down concrete-lined drainage ditches into the Rio Grande. Such flushing accounts for a large part of the

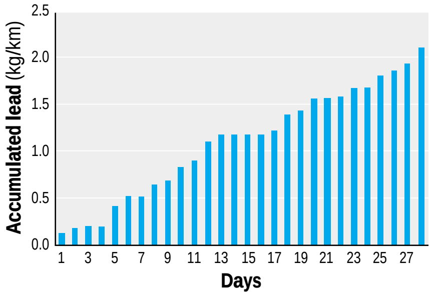

Figure 5. Daily survey results for southwestern JTML showing accumulated metallic lead found along the outer curb on the west side of JTML.

nonpoint urban pollution (*17*). Wheel weight lead can also be dispersed as fugitive dust. In semiarid environments such as that of Albuquerque, dust is common, and the air turbulence that vehicles create as they speed along urban streets can increase the suspension and dispersal of street dust. Finally, lead particles may adhere to pedestrian shoes or the feet of pets. Because contact with exterior leaded soil and dust is a potential hazard wherever it can be easily tracked into the home (*1*,*12*,*13*), I propose that wheel weight lead contributes to the lead burden of urban populations. In the absence of leaded gasoline, therefore, lead wheel weights are potentially a major source of lead exposure.

Consistent with U.S. policy to eliminate lead poisoning and protect the environment, the federal government should sponsor research to further document the deposition of wheel weights and evaluate the contribution to total lead exposure and effects on human health and ecosystems. In addition, the federal government should establish performance standards for the attachment of wheel weights to wheels, encourage the manufacture of wheel weights from benign materials, and ultimately phase out the lawful use of lead and other potentially hazardous materials in wheel weights. These findings also indicate that urban streets should be regularly swept and washed, and the street debris taken to a licensed hazardous waste disposal facility. Once motor vehicle wheel weights are no longer made of antimonious lead, the lead hazard in urban streets will subside.

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NEW YORK STATE | Department of Environmental Conservation

Lead and Mercury-Added Wheel Weights

Lead and Mercury-added Wheel Weights Prohibition

New York State law (ECL 37-0113) (link leaves DEC's website) prohibits both the sale and use of wheel weights containing lead and also prohibits the sale and use of wheel weights or other rotational balancing products containing mercury which was intentionally added during the manufacture of the product.

Provisions of the Law

- As of April 1, 2011 any person replacing or balancing a tire on a motor vehicle (that is required to be registered under article fourteen of title four of the vehicle and traffic law), shall not use a wheel weight or other product for balancing motor vehicle wheels if the weight or other balancing product contains more than 0.1 percent lead by weight.
- After April 1, 2011 no person shall sell, offer to sell or distribute weights or other products used for balancing tires that contain more than 0.1 percent of lead by weight.
- After April 1, 2012 a person may not sell a new motor vehicle that is equipped with a weight or other wheel balancing product that contains more than 0.1 percent lead by weight.
- As of April 1, 2018, any person replacing or balancing a tire on a motor vehicle (that is required to be registered under article fourteen of title four of the vehicle and traffic law), shall not use a wheel weight or other product for balancing motor vehicle wheels if the weight or other balancing product contains mercury that was intentionally added during the manufacture of the product.
- As of April 1, 2018, a person shall not sell or offer to sell or distribute weights or other products for balancing motor vehicle wheels if the weight or other balancing product contains mercury that was intentionally added during the manufacture of the product.

Use of Lead Wheel Weights

Lead wheel weights are clipped to the rims of motor vehicle wheels to balance tires during rotation. The weight, price, and malleability have made lead the long-time preferred choice for this purpose. An average of 4.5 ounces of lead is clipped to the wheel rims of every automobile in the United States.

The Problem

Hitting curbs and potholes, rapid accelerations and decelerations, sharp turning, and other driving conditions where a vehicle can rapidly change momentum can cause wheel weights to loosen and fall off. These lost wheel weights are gradually abraded into lead dust which can contaminate surrounding soils and adjacent waterways. In urban and other developed areas, these "lost" wheel weights are collected during street cleaning and sent for landfill disposal. Lead from lead wheel weights can also enter the environment vehicles are improperly processed at end-of-life. This is a problem since lead is designated as one of 31 Priority Chemicals targeted to be reduced by the US Environmental Protection Agency (EPA).

The Solution

To mitigate the potential harmful effects of lead in the environment, public health, and drinking water supplies, a handful of states have enacted legislation to prohibit the use of lead wheel weights. Alternatives to lead wheel weights are available and using an alternative not only protects the environment, but also protects employees for lead exposure.

Use of Mercury-Added Wheel Weights or Rotational Balancing Products

Mercury-added wheel weights, or more accurately, mercury-added rotational balancing products, are disc-shaped devices that are installed between the wheel and the hub that continuously balances the wheel as it rotates. The hollow disc contains mercury, a known neurotoxin. These devices are often used on large trucks, recreational vehicles and on motorcycles.

The Problem

Unless the mercury-added rotational balancing product is removed and properly managed at the vehicle's end-of-life processing, the contained mercury can be released to the environment. Vehicle dismantling facilities are required to remove all mercury-containing devices prior to crushing end-of-life vehicles. Since these products are generally after-market, they are easily overlooked.

The Solution

As with non-lead alternatives to lead wheel weights, there are non-mercury alternatives for rotational balancing products on the market. An internet search can locate non-mercury-added rotational balancing products.

Determining if lead or mercury is present

Wheel weights may have a chemical symbol written on them. For weights made of steel you may see the chemical abbreviation "Fe" (for iron, the primary component of steel). The chemical symbol "Zn may be visible on weights made of zinc. Both metals tend to be a little lighter in weight than those made of lead, so those weights should be larger than lead weights. You may want to contact the manufacturer if you have questions about the materials in your wheel weights.

Since 2005, mercury-added consumer products have been required to be labeled to indicate the presence of mercury. If there is no apparent label, you should contact the manufacturer, if known.

Legal requirements

The law does not require that lead wheel weights or mercury-added rotational balancing devices be replaced. However, if any work is done on a vehicle's tire(s) that requires an old lead wheel weight or mercury-added rotational balancing product to be removed or a lost wheel weight to be replaced, or if a lead wheel weight falls off in the process of working on a tire, the old lead wheel weight or mercury-added rotational balancing product cannot be placed back on the tire. Any wheel weight or rotational balancing product installed on the tire will need to comply with the law. Also note, if you add or replace a wheel weight or rotational balancing product you must replace it with a compliant product. The same holds true for repair shops. If they remove a lead wheel weight and replace it, it must be replaced with a compliant wheel weight.

Old Stock

If you have stock of unwanted lead weights options may include returning the wheel weights to your supplier to see if they will exchange them for the type that comply with the law, sending them for recycling as scrap metal, and disposing of them as a regulated hazardous waste. You cannot discard them in the trash. It is important to note that the law does not require distributors, suppliers, or manufacturers to exchanged lead wheel weights with complaints wheel weights, but you can contact your distributor or manufacturer for more information about what to do with your noncompliant lead wheel weights.

Vehicles Sales

After April 1, 2021, a new motor vehicle could not be sold with wheel weights containing lead. In reference to used vehicles with lead wheel weights -- they can be sold. However, if lead wheel weights are removed from a tire for any reason prior to sale, the old lead wheel weight cannot be placed back on the tire. A wheel weight that complies with the law will need to be installed.

Legal Penalties

There are penalty provisions, under Environmental Conservation Law section 71-3703, that apply to a person that improperly stores or releases lead in lead wheel weights to the environment. This section of law provides that any person who violates any of the provisions of, or who fails to perform any duty imposed by, section 37-0107 or any rule or regulation promulgated pursuant hereto, shall be liable for a civil penalty not to exceed $2,500 for each such violation and an additional penalty of not more than $500 each day during which such violation continues and, in addition, such person may be enjoined from continuing such violation.

Remember to recycle

Lead wheel weights should be recycled: recycling facilities can be found in an on-line search. Mercury-added consumer products must be brought to a solid waste or hazardous waste facility authorized to accept such material. Mercury-added consumer products cannot be placed in the trash.

Translation Services

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Maine Department of Environmental Protection

Home → Waste Management → Programs > Lead Hazard Prevention > Maine's Lead & Mercury Wheel Weight Ban

Maine's Lead & Mercury Wheel Weight Ban

http://www.mainelegislature.org/legis/statutes/38/title38sec1606-A.html (http://www.mainelegislature.org/legis/statutes/38/title38sec1606-A.html)

Starting January 1, 2011 - A person may not sell, distribute or use wheel weights or other products for balancing motor vehicle tires that contain intentionally added lead or mercury. This ban also applies to mail order or internet sales into Maine.

Starting January 1, 2012 - A person may not sell a new motor vehicle required to be registered in Maine that is equipped with a wheel weight or other balancing material containing intentionally added lead or mercury.

Wheel weights and other wheel balancing products that do not contain intentionally added lead or mercury are available from auto parts suppliers. Information on a variety of alternatives and sources is available at the Lead-Free Wheels website: http://www.leadfreewheels.org/sources.shtml (http://www.leadfreewheels.org/sources.shtml) (Off Site)

What are wheel weights? Why are some made of lead?

Wheel weights are small objects designed to be fastened to wheel rims to prevent uneven tire wear that could shorten the life of the tire and to ensure a smoother ride. Lead has been a popular material to balance vehicle tires because it is dense, soft, is inexpensive and doesn't rust. Most new vehicles are delivered with wheel balancing products other than lead reflecting industry change from a 2005 European ban, an EPA focus and voluntary phase out efforts by US industry and passage of an increasing number of state laws.

Why are lead wheel weights and mercury balancing products a problem?

Lead and mercury are toxic. People are exposed to lead fragments and dust when lead wheel weights fall from motor vehicles onto roadways and are then crushed and worn down by traffic. An estimated 20,000 lbs of lead wheel weights fall off each year onto Maine roads. Lead wheel weights on and alongside roadways can pollute soil, lakes, streams, and groundwater and can poison fish and wildlife.

What kinds of wheel weights are legal?

A legal wheel weight is one that does not include lead or mercury that was intentionally added during the manufacture of the wheel weights. Coated steel, composite, and zinc weights are popular alternatives and are legal as long as they do not contain intentionally added lead or mercury. Other methods for balancing tires such as internal liquid balancing or internal beads are also available.

What do I do with old lead wheel weights?

Lead wheel weights must be recycled as scrap metal or disposed of as hazardous waste. If a lead wheel weight is to be recycled, an ongoing recycling arrangement with a scrap metal recycler is needed. Most garages who have been removing or installing wheel weights already have these recycling arrangements in place. It may also be possible to return existing stock of new lead wheel weights with some vendors.

Alternatives to lead and mercury wheel weights

Internal wheel balancing products do not fall off and therefore avoid the time and costs of rebalancing. Some internal balancing products will work only on larger diameter/heavy duty vehicle wheels. Auto parts suppliers can provide you with additional information

State of Maine fleet experience with alternative exterior wheel weights (primarily coated steel) indicated similar performance to lead. Fit problems with specialist rims have occasionally occurred with lead weights and some of the alternatives but options were found.

Steel or zinc clip-on weights may not be as malleable as lead weights. The clip style must match the wheel flange and it is therefore useful to check the application chart to find the appropriate weight. Stick on weights require the surface to be clean for proper adhesion. Reusing clip-on weights is sometimes problematic.

Maine DOT piloted numerous products for the heavy duty fleet and has moved to an internal balancing product that has improved performance and saved money by avoiding the need for rebalancing.

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RIN Data

EPA/OPPTS **RIN:** 2070-AJ64 **Publication ID:** Spring 2010

Title: ●Lead Wheel Weights; Regulatory Investigation

Abstract: In 2009, EPA initiated a proceeding under Toxics Substances and Control Act (TSCA) to investigate potential lead hazards associated with the manufacture, processing, and distribution in commerce of lead wheel balancing weights ("wheel weights"). Lead is highly toxic, especially to young children. According to a U.S. Geological Survey study in 2003, 65,000 tons of lead wheel weights were in use in the United States and approximately 2,000 tons of these weights were lost from vehicles into the environment. Voluntary actions on the part of U.S. auto manufactures and an European Union ban on their use has reduced the number of lead wheel weights, but they continue to be the predominate product in the tire replacement market.

Agency: Environmental Protection Agency(EPA)
Priority: Other Significant
RIN Status: First time published in the Unified Agenda
Agenda Stage of Rulemaking: Long-Term Actions
Major: No
Unfunded Mandates: Undetermined
CFR Citation: Not Yet Determined (To search for a specific CFR, visit the Code of Federal Regulations.)
Legal Authority: Not Yet Determined
Legal Deadline: None
Timetable:

Action	Date	FR Cite
NPRM	05/00/2011	

Additional Information: SAN No. 5398.
Regulatory Flexibility Analysis Required: Undetermined
Government Levels Affected: Local, State, Tribal
Small Entities Affected: No
Federalism: Undetermined
Included in the Regulatory Plan: No
RIN Information URL: www.epa.gov/lead
RIN Data Printed in the FR: No

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RIN Data

EPA/OCSPP **RIN:** 2070-AJ64 **Publication ID:** Fall 2010

Title: Lead Wheel Weights; Regulatory Investigation

Abstract: In 2009, EPA initiated a proceeding under the Toxics Substances Control Act (TSCA) to investigate potential lead hazards associated with the manufacture, processing, and distribution in commerce of lead wheel balancing weights ("wheel weights"). Lead is highly toxic, especially to young children. According to a U.S. Geological Survey study in 2003, 65,000 tons of lead wheel weights were in use in the United States and approximately 2,000 tons of these weights were lost from vehicles into the environment. Voluntary actions on the part of U.S. auto manufactures and an European Union ban on their use has reduced the number of lead wheel weights, but they continue to be predominant product in the tire replacement market.

Agency: Environmental Protection Agency(EPA)
Priority: Other Significant
RIN Status: Previously published in the Unified Agenda
Agenda Stage of Rulemaking: Long-Term Actions
Major: Undetermined
Unfunded Mandates: Undetermined
CFR Citation: Not Yet Determined (To search for a specific CFR, visit the Code of Federal Regulations.)
Legal Authority: Not Yet Determined

Legal Deadline: None

Timetable:

Action	Date	FR Cite
NPRM	03/00/2012	

Additional Information: SAN No. 5398

Regulatory Flexibility Analysis Required: Undetermined
Government Levels Affected: Local, State, Tribal
Small Entities Affected: No
Federalism: Undetermined
Included in the Regulatory Plan: No
RIN Information URL: http://www.epa.gov/lead/
RIN Data Printed in the FR: No

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Agency: Environmental Protection Agency(EPA)

Priority: Other Significant

RIN Status: Previously published in the Unified Agenda

Agenda Stage of Rulemaking: Long-Term Actions

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Unfunded Mandates: Undetermined

CFR Citation: Not Yet Determined (To search for a specific CFR, visit the Code of Federal Regulations.)

Legal Authority: 15 USC 2601 et seq

Legal Deadline: None

Timetable:

Action	Date	FR Cite
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Additional Information: SAN No. 5398

Regulatory Flexibility Analysis Required: Undetermined

Government Levels Affected: Local, State, Tribal

Small Entities Affected: No

Federalism: Undetermined

Included in the Regulatory Plan: No

RIN Information URL: http://www.epa.gov/lead/

RIN Data Printed in the FR: No

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Agency: Environmental Protection Agency(EPA)

Priority: Other Significant

RIN Status: Previously published in the Unified Agenda

Agenda Stage of Rulemaking: Proposed Rule Stage

Major: Undetermined

Unfunded Mandates: Undetermined

CFR Citation: Not Yet Determined (To search for a specific CFR, visit the Code of Federal Regulations.)

Legal Authority: 15 USC 2601 et seq

Legal Deadline: None

Timetable:

Action	Date	FR Cite
NPRM	10/00/2012	
Final Action	To Be Determined	

Additional Information: SAN No. 5398

Regulatory Flexibility Analysis Required: Undetermined

Government Levels Affected: Local, State, Tribal

Small Entities Affected: No

Federalism: Undetermined

Included in the Regulatory Plan: No

RIN Information URL: http://www.epa.gov/lead/

RIN Data Printed in the FR: No

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Low-level lead exposure and mortality in US adults: a population-based cohort study

Bruce P Lanphear, Stephen Rauch, Peggy Auinger, Ryan W Allen, Richard W Hornung

Summary

Background Lead exposure is a risk factor for cardiovascular disease mortality, but the number of deaths in the USA attributable to lead exposure is poorly defined. We aimed to quantify the relative contribution of environmental lead exposure to all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality.

Methods Our study population comprised a nationally representative sample of adults aged 20 years or older who were enrolled in the Third National Health and Nutrition Examination Survey (NHANES-III) between 1988 and 1994 and followed up to Dec 31, 2011. Participants had completed a medical examination and home interview and had results for concentrations of lead in blood, cadmium in urine, and other relevant covariates. Individuals were linked with the National Death Index. This study presents extended follow-up of an earlier analysis.

Findings We included 14 289 adults in our study. The geometric mean concentration of lead in blood was 2·71 μg/dL (geometric SE 1·31). 3632 (20%) participants had a concentration of lead in blood of at least 5 μg/dL (≥0·24 μmol/L). During median follow-up of 19·3 years (IQR 17·6–21·0), 4422 people died, 1801 (38%) from cardiovascular disease and 988 (22%) from ischaemic heart disease. An increase in the concentration of lead in blood from 1·0 μg/dL to 6·7 μg/dL (0·048 μmol/L to 0·324 μmol/L), which represents the tenth to 90th percentiles, was associated with all-cause mortality (hazard ratio 1·37, 95% CI 1·17–1·60), cardiovascular disease mortality (1·70, 1·30–2·22), and ischaemic heart disease mortality (2·08, 1·52–2·85). The population attributable fraction of the concentration of lead in blood for all-cause mortality was 18·0% (95% CI 10·9–26·1), which is equivalent to 412 000 deaths annually. Respective fractions were 28·7% (15·5–39·5) for cardiovascular disease mortality and 37·4% (23·4–48·6) for ischaemic heart disease mortality, which correspond to 256 000 deaths a year from cardiovascular disease and 185 000 deaths a year from ischaemic heart disease.

Interpretation Low-level environmental lead exposure is an important, but largely overlooked, risk factor for cardiovascular disease mortality in the USA. A comprehensive strategy to prevent deaths from cardiovascular disease should include efforts to reduce lead exposure.

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Introduction

Deaths from cardiovascular disease have declined strikingly in the USA over the past 50 years, but this disease is still the leading cause of death.[1] In 2013, cardiovascular disease accounted for more than 800 000 deaths in the USA (about one in every three deaths), with total costs exceeding US$300 billion annually.[1] Cardiovascular disease mortality is usually attributed to tobacco use, hypertension, diabetes, and lack of physical activity.[2] Environmental lead exposure is an established risk factor for hypertension and a possible risk factor for cardiovascular disease mortality,[3,4] but its contribution to deaths in the USA is poorly defined.

Lead is one of many recognised risk factors for cardiovascular disease. In experimental studies,[3,4] chronic exposure to lead caused hypertension and enhanced the development of atherosclerosis by inactivating nitric oxide, increasing formation of hydrogen peroxide, inhibiting endothelial repair, impairing angiogenesis, and promoting thrombosis. In human beings, higher concentrations of lead in blood have been associated with hypertension, electrocardiographic abnormalities, peripheral arterial disease, left-ventricular hypertrophy, and cardiovascular disease mortality.[4–13] The concentration of lead in blood was associated with cardiovascular mortality in most, but not all, prospective cohort studies.[6–13] Previous studies of cardiovascular disease mortality in lead-exposed populations have been criticised because they did not account for other risk factors associated with cardiovascular disease mortality, such as cadmium.[4,14] No studies have estimated the number of deaths in the USA attributable to lead exposure using a nationally representative cohort, and it is unclear whether concentrations of lead in blood lower than 5 μg/dL (<0·24 μmol/L), which is the current action level for adults in the USA, are associated with cardiovascular mortality.

The aim of this study was to extend the duration of follow-up of a previously published analysis[7] and quantify the relative contribution of environmental lead exposure to all-cause mortality and cardiovascular disease mortality using data from the Third National Health and Nutrition

Research in context

Evidence before this study
We searched PubMed between 1980 and Oct 1, 2017, with terms including "mortality", "blood lead concentration", "cardiovascular mortality", and "population attributable risk". We also searched citations of all identified studies. We restricted our search to English language publications. We included human studies. Many studies have linked concentrations of lead in blood with hypertension and mortality from cardiovascular disease. The number of deaths in the USA attributable to lead exposure has not been estimated using a nationally representative cohort, and it is unclear if concentrations of lead in blood lower than 5 μg/dL (<0·24 μmol/L) are associated with all-cause mortality or cardiovascular disease mortality.

Added value of this study
Our study is, to our knowledge, the first to estimate in a nationally representative sample the contribution of concentrations of lead in blood to the number of deaths from all causes and from cardiovascular disease. Although we cannot exclude residual confounding, we estimate that about 400 000 deaths are attributable to lead exposure every year in the USA, of which 250 000 are from cardiovascular disease. Concentrations of lead in blood lower than 5 μg/dL (<0·24 μmol/L) are an important, but largely ignored, risk factor for death in the USA, particularly from cardiovascular disease.

Implications of all the available evidence
Quantifying the contribution of environmental lead exposure to cardiovascular disease mortality is essential to understand trends in mortality and develop comprehensive strategies to prevent cardiovascular disease.

Examination Survey (NHANES-III), a prospective, representative cohort of the US population enrolled from 1988 to 1994 and followed up to Dec 31, 2011.

Methods

Study population

NHANES-III is a multistage stratified survey designed to provide a detailed examination of the health and nutritional status of a nationally representative sample of non-institutionalised individuals in the USA. Consistent with an earlier analysis of this cohort,[7] we included individuals who were aged 20 years or older at baseline. The protocols for NHANES-III were approved by the National Center for Health Statistics of the Centers for Disease Control and Prevention Institutional Review Board. All participants gave informed consent.

Procedures

Baseline data in NHANES-III were gathered between 1988 and 1994, when individuals participated in a household interview and a medical examination, during which they provided blood and urine samples. Demographic information—including sex, age, ethnic origin, household income, education, residence, smoking status, and social support—was obtained during the household interview. Information on body-mass index (BMI), physical activity, blood pressure, diet, alcohol consumption, medical history, and prescription drug use was obtained during the medical examination.

See Online for appendix

Amounts of lead in blood, cadmium and creatinine in urine, cotinine and cholesterol in serum, and glycated haemoglobin (HbA_{1c}) were measured from blood and urine samples gathered during the medical examination. Laboratory methods for the processing of blood and urine samples are described in detail elsewhere.[15] Quantification of lead in whole blood samples, which entailed extensive quality control, was done using graphite furnace atomic absorption spectrophotometry.[16] The detection limit for lead in blood was 1·0 μg/dL (0·048 μmol/L). For study participants who had concentrations of lead in blood below the level of detection, we imputed an amount of 0·7 μg/dL (0·034 μmol/L), which is the level of detection divided by the square root of 2.[17]

A full description of mortality linkage methods is available from the National Center for Health Statistics (NCHS).[18] Briefly, NCHS staff linked participants in NHANES-III to underlying cause of death in the National Death Index with a series of identifiers—eg, social security number and date of birth—using probabilistic matching criteria. Individuals were followed up to Dec 31, 2011; if a match was not made with the National Death Index, that person was assumed to be alive as of that date. In a validation study using mortality-linked data from the first NHANES study (NHANES-I; 1971–75), 96% of deceased participants and 99% of those still alive were classified correctly.[19] The underlying cause of death was obtained using codes from the International Classification of Diseases ninth version (ICD-9; 1988–98) or tenth version (ICD-10; 1999–2006). We identified deaths from all causes, cardiovascular disease (ICD-9 390–459; ICD-10 I00–I99) and ischaemic heart disease (ICD-9 410–414; ICD-10 I20–I25; appendix p 1).

Statistical analysis

We have weighted results (percentiles, means, and point estimates) to account for the complex survey design of NHANES-III, and these data are representative of the US Census civilian non-institutionalised population. We calculated hazard ratios (HRs) for continuous concentrations of lead in blood, using Cox proportional hazards models. Every participant's survival—as defined by the

NHANES-III protocol—was the time between the medical examination and the date of death, the participant's 90th birthday, or Dec 31, 2011, whichever came first.[18]

We assessed concentrations of lead in blood both as a continuous variable and categorically with tertiles. We fitted five-knot restricted cubic splines to visualise the shape of the dose-response relation of concentrations of lead in blood for all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality, and to investigate whether the relations should be judged linear or log-linear.

We weighted demographic and environmental variables to approximate distributions in the USA by using the provided sample weights to account for oversampling of young children, older people, black people, and individuals of Mexican-American ethnic origin in the NHANES-III survey. We adjusted for variables recognised widely as potential confounders for cardiovascular disease mortality.[2–10] We adjusted all primary models for age (continuous and age-squared), sex, household income (<US$20 000 or ≥$20 000 per year), ethnic origin (white, black, Mexican-American), BMI (derived from participants' height and weight measurements and categorised as normal [<25·0 kg/m²], overweight [25·0–29·9 kg/m²], or obese [≥30·0 kg/m²]), smoking status (self-reported [never, current, and former] or amounts of cotinine in serum [≥10 ng/mL]), alcohol consumption (four or fewer drinks per month or more than four drinks per month), physical activity (categorised according to frequency of activity in the previous month [none, 1–14 times, or ≥15 times]), and amount of cadmium in urine (standardised by amount of creatinine in urine and categorised in tertiles). Blood pressure was measured three times during the NHANES-III household interview and three times during the medical examination. We excluded the first reading and used the average of all remaining blood pressure measurements to classify every participant's hypertension status (defined as systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg). The Healthy Eating Index, which was derived from food frequency questionnaires and scored on a scale from 1 to 100, was categorised in tertiles.[20] Finally, we included HbA_{1c} and amount of cholesterol in serum as continuous measures.

We calculated population attributable fractions for continuous concentrations of lead in blood using previously described methods[21] to estimate the proportional reduction in mortality that would occur if recorded amounts of lead in blood in the entire US population aged 20 years and older were reduced to 1·0 µg/dL (0·048 µmol/L). Absolute numbers of deaths were based on the average annual number of deaths from all causes, cardiovascular disease, and ischaemic heart disease from 1988 to 2011.[22,23] The standard method for calculating the population attributable fraction is a simple comparison of the relative risk in the exposed population weighted by the proportion exposed with the relative risk in the unexposed population weighted by the proportion unexposed. To utilise individual measures of lead in blood and their associated HR estimates, we calculated the population attributable fraction or population impact factor using the integral of the HR estimates weighted by the log-normal population distribution of measured concentrations of lead in blood over the total range (0·70–56·0 µg/dL [0·034–2·70 µmol/L]) for all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality, as described previously.[19] We calculated CIs for population

	Total	Concentration of lead in blood (tertiles)			p value
		Tertile 1 (<2·0 µg/dL)	Tertile 2 (2·0–3·7 µg/dL)	Tertile 3 (≥3·8 µg/dL)	
All deaths	4422	631	1340	2451	..
Cardiovascular disease deaths	1801	218	552	1031	..
Ischaemic heart disease deaths	988	112	284	592	..
Men	47·9%	24·6%	49·2%	68·3%	<0·0001
Ethnic origin					
White	77·1%	78·4%	78·8%	74·2%	0·02
Black	10·2%	9·1%	9·2%	12·2%	0·004
Mexican-American	5·2%	4·8%	5·0%	5·7%	0·15
High-school education	76·2%	84·5%	78·1%	66·6%	<0·0001
Income >US$20 000	68·1%	72·3%	69·7%	62·6%	<0·0001
Urban residence	47·8%	45·0%	48·2%	50·2%	0·21
Current smoker	34·9%	23·0%	33·0%	47·8%	<0·0001
Former smoker	21·9%	18·3%	22·4%	24·9%	0·0001
Alcohol intake (drinks per month)					
Four or fewer	63·2%	73·3%	62·3%	54·8%	<0·0001
More than four	36·8%	26·7%	37·7%	45·2%	<0·0001
Physical activity (per month)					
None	25·8%	22·8%	24·6%	29·8%	<0·0001
One to 14 times	37·5%	39·5%	37·2%	35·9%	0·07
15 or more times	36·7%	37·7%	38·2%	34·3%	0·06
Hypertension	17·5%	9·6%	18·0%	24·3%	<0·0001
Diabetes	16·5%	12·0%	18·0%	19·2%	<0·0001
Healthy eating index					
First tertile	33·3%	30·4%	31·8%	37·5%	<0·0001
Second tertile	33·3%	35·4%	31·2%	33·5%	0·20
Third tertile	33·4%	34·2%	37·0%	29·0%	<0·0005
Body-mass index					
Normal weight (<25·0 kg/m²)	44·6%	49·4%	42·8%	42·0%	<0·0002
Overweight (25·0–29·9 kg/m²)	33·0%	27·0%	24·5%	36·9%	<0·0001
Obese (≥30·0 kg/m²)	22·4%	23·6%	22·7%	21·1%	0·13
Age (years)*	44·1	37·8	44·8	48·2	<0·0001
Total cholesterol (mg/dL)*	203·8	195·7	204·7	210·6	<0·0001
HbA_{1c} (%)*	5·35	5·21	5·38	5·46	<0·0001
Serum cotinine (ng/mL)†	1·79	0·64	1·69	4·95	<0·0001
Urinary cadmium (µg/g)†‡	0·33	0·24	0·33	0·47	<0·0001

Data are number, %, or mean. Percentages and means are weighted to match the age, sex, and ethnic origin distribution of the US population. To convert values for lead from µg/dL to µmol/L, multiply by 0·0483. p values represent tests for linear trend across lead tertiles. *Age, total cholesterol, and glycated haemoglobin (HbA_{1c}) were treated as continuous variables. †Values represent geometric means. ‡Urinary cadmium is adjusted for urinary creatinine.

Table 1: **Baseline characteristics by tertiles of concentrations of lead in blood and deaths in the NHANES-III mortality follow-up study, 1988–94 to 2011 (n=14 289)**

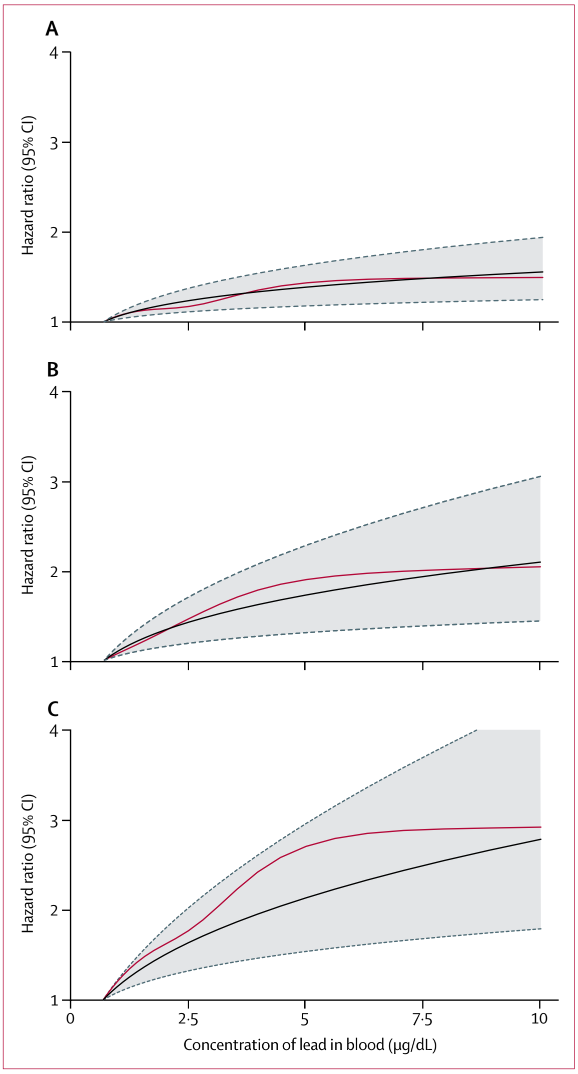

***Figure 1:* Dose-response curves for concentrations of lead in blood and mortality**
Adjusted hazard ratios (black lines) with 95% CIs (hatched lines) and restricted cubic spline (red lines) for (A) all-cause mortality, (B) cardiovascular disease mortality, and (C) ischaemic heart disease mortality.

attributable fractions using a substitution method proposed by Daly.[24] We evaluated the proportional hazards assumption using Schoenfeld residuals;[25] none of the models violated the assumption. Finally, we accommodated the complex survey design of NHANES-III using SUDAAN (version 10.0.1) to provide weighted national estimates and Taylor linearisation to obtain associated variance estimates.[26]

We also did several secondary analyses. To assess the effects of low-level exposure to lead, we restricted our analysis to participants who had amounts of lead in blood lower than 5 µg/dL (<0·24 µmol/L). We tested for confounding of concentrations of lead in blood and hypertension for all-cause mortality and cardiovascular disease mortality by examining the change in the estimates for amounts of lead in blood in models with and without hypertension. We also investigated the change in estimates for hypertension in models with and without concentrations of lead in blood. Next, we assessed whether characterising potential confounders—eg, diabetes, HDL, hypertension, alcohol intake, household income—differently than in our primary analyses would alter our results appreciably. We also investigated the effect of secular trends on HRs for concentrations of lead in blood by examining NHANES-III phase 1 (1988–91) and phase 2 (1991–94) data separately. Finally, we assessed effect modification of the relation between concentration of lead in blood and key characteristics (eg, sex, age, urban residence,[27] ethnic origin, smoking status, and diabetes).

Role of the funding source

The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

The sample population included 18 825 adults aged 20 years or older. Of these, 17 030 (90%) had a medical examination and home interview. 1419 (6%) participants were missing a result for either concentration of lead in blood or cadmium in urine, 1314 (7%) were missing other covariates, and eight (0·1%) had insufficient identifiers to link with the National Death Index. Thus, 14 289 (76%) participants were included in this analysis. 1150 (9%) individuals had concentrations of lead in blood below the level of detection and had an amount of 0·7 µg/dL (0·034 µmol/L) imputed. Characteristics of participants who were included in the analysis differed from those with missing data for some characteristics, such as ethnic origin, alcohol intake, and the prevalence of diabetes (appendix p 2).

During median follow-up of 19·3 years (IQR 17·6–21·0), 4422 participants died; 1801 (38%) were attributable to cardiovascular disease and 988 (22%) to ischaemic heart disease. Concentrations of lead in blood, which ranged from 1·0 µg/dL to 56 µg/dL (0·048 µmol/L to 2·70 µmol/L), were right-skewed with a geometric mean at baseline of 2·71 µg/dL (geometric SE 0·131); 3632 (20%) participants had amounts of lead in blood of 5 µg/dL or higher (≥0·24 µmol/L). Participants who had the highest concentrations of lead in blood were older, less educated, and more likely to be male, to smoke cigarettes, to consume larger amounts of alcohol, and to have less healthy diets (table 1). Participants who had high concentrations of lead in blood were also more likely to have elevated amounts of cholesterol in serum and higher rates of hypertension and diabetes.

Analysis of restricted cubic splines indicated that adjusted HRs were steeper at lower concentrations of lead in blood than at higher concentrations (figure 1).

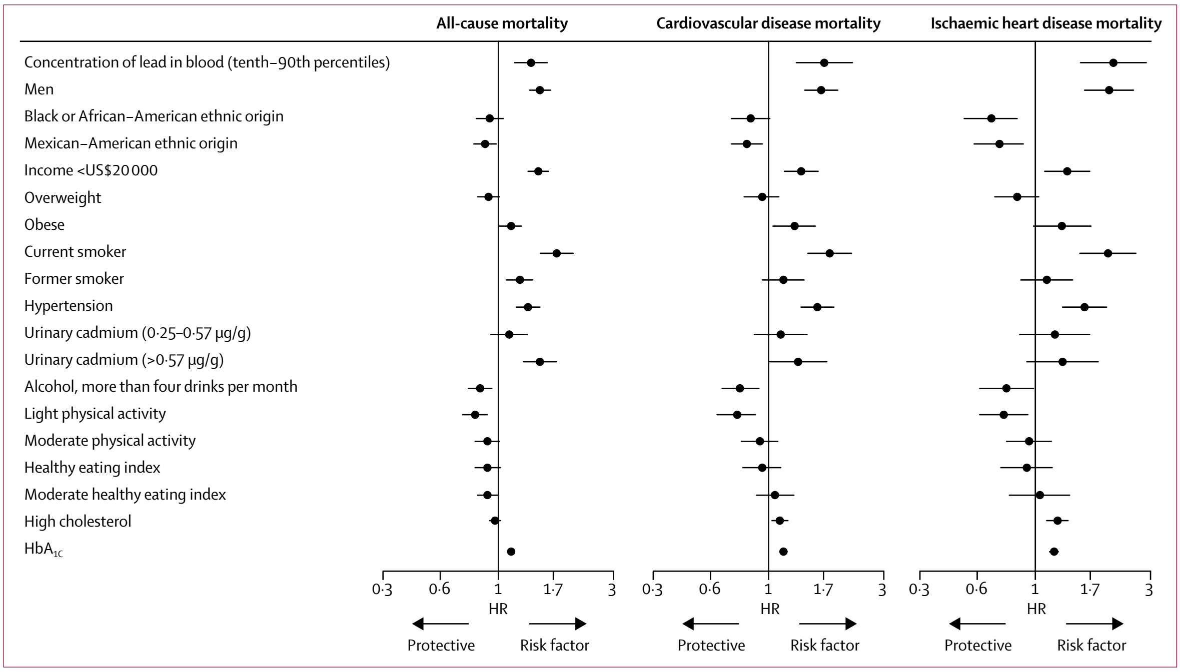

Figure 2: **Risk factors for all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality**
Adjusted hazard ratios (HRs) are shown as dots and 95% CIs as horizontal lines. HRs for cholesterol and glycated haemoglobin (HbA_{1c}) refer to an IQR-sized increase (56 mg/dL and 0·7%, respectively). HRs for age represent a 10-year increase.

A model was fitted using the log_{10} of measurements of lead in blood in the proportional hazards model and adjusted HRs and 95% CIs were calculated for all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality, as well as for other characteristics (figure 2). An increase in the concentration of lead in blood from 1·0 µg/dL to 6·7 µg/dL (0·048 µmol/L to 0·324 µmol/L), which represents the tenth to 90th percentiles, was associated significantly with all-cause mortality (HR 1·37, 95% CI 1·17–1·60), cardiovascular disease mortality (1·70, 1·30–2·22), and ischaemic heart disease mortality (2·08, 1·52–2·85; table 2).

Population attributable fractions were calculated to show the proportional reduction in all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality that would occur if recorded concentrations of lead in blood were reduced to 1·0 µg/dL or lower (≤0·048 µmol/L). The adjusted population attributable fraction for all-cause mortality was 18% (95% CI 10·9–26·1), equivalent to 412 000 (95% CI 250 000–598 000) deaths each year (table 2). Adjusted population attributable fractions were 28·7% (95% CI 15·5–39·5) for cardiovascular disease mortality and 37·4% (23·4–48·6) for ischaemic heart disease mortality, equivalent to 256 000 cardiovascular disease deaths and 185 000 ischaemic heart disease deaths annually (figure 3). In analyses restricted to participants who had concentrations of lead in blood lower than 5 µg/dL (<0·24 µmol/L), an increase in lead in blood from 1·0 µg/dL to 5·0 µg/dL (0·048 µmol/L to 0·242 µmol/L), which represents the tenth to 80th percentiles, was associated significantly with all-cause mortality (HR 1·38, 95% CI 1·15–1·66), cardiovascular disease mortality (1·95, 1·46–2·60), and ischaemic heart disease mortality (2·57, 1·56–4·52).

In secondary analyses, no appreciable attenuation or confounding of estimates for concentration of lead in blood or hypertension was noted when these variables were included or excluded consecutively in our primary model. The results of our primary analysis did not change substantially when we made several adjustments:

	Unadjusted HR (95% CI)	HR (95% CI)	Population attributable fraction (95% CI)	Avoidable deaths (95% CI)
All-cause mortality	3·79 (3·18–4·50)	1·37 (1·17–1·60)	18·0% (10·9–26·1)	412 000 (250 000–598 000)
Cardiovascular disease mortality	4·44 (3·47–5·68)	1·70 (1·30–2·22)	28·7% (15·5–39·5)	256 000 (138 000–352 000)
Ischaemic heart disease mortality	5·31 (4·06–6·93)	2·08 (1·52–2·85)	37·4% (23·4–48·6)	185 000 (116 000–241 000)

All models are adjusted for age (continuous and age-squared), sex, household income (<US$20 000 or ≥$20 000 per year), ethnic origin (white, black, or Mexican-American), body-mass index (normal [<25·0 kg/m²], overweight [25·0–29·9 kg/m²], or obese [≥30·0 kg/m²]), smoking status (never, current, or former), hypertension (systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg), urinary cadmium (tertiles [µg/g]), alcohol consumption (four or fewer or more than four drinks per month), physical activity in previous month (none, one to 14 times, 15 or more times), healthy eating index (tertiles), serum cholesterol (continuous), and glycated haemoglobin (continuous). Hazard ratios (HRs) for continuous concentrations of lead in blood represent the risk for an increase in log-transformed concentrations of lead in blood from 1·0 µg/dL to 6·7 µg/dL (0·048 µmol/L to 0·324 µmol/L (tenth to 90th percentiles).

Table 2: **Adjusted HRs, population attributable fractions, and avoidable deaths from all causes, cardiovascular disease, and ischaemic heart disease in the NHANES-III mortality follow-up study (n=14 289)**

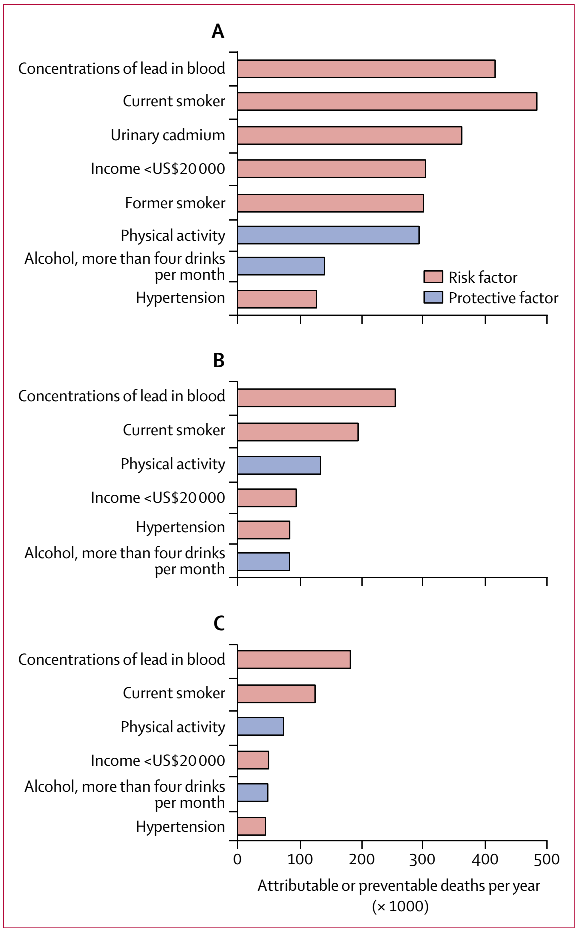

***Figure 3:* Attributable deaths associated with selected modifiable risk factors in the US population**
Panels show deaths from (A) all causes, (B) cardiovascular disease, and (C) ischaemic heart disease. Modifiable risk factors are presented in red and protective factors in blue. Deaths were calculated from population attributable fractions and average mortality in the USA from 1988 to 2011. Only significant risk factors are represented.

characterised diabetes as a categorical instead of a continuous measure; adjusted for both HDL and cholesterol; adjusted for hypertension status (ie, systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg and use of anti-hypertension drugs); adjusted for household income using the poverty index ratio (instead of <$20 000 or ≥$20 000 per year); characterised hypertension as a continuous measure of both systolic blood pressure and diastolic blood pressure instead of a categorical measure; characterised alcohol intake as one or no drink per day versus more than one drink per day (instead of four or fewer drinks versus more than four drinks per month); or excluded participants who had a concentration of lead in blood lower than 1·0 µg/dL (0·048 µmol/L; appendix pp 3, 4). Median concentrations of lead in blood decreased by 22% from NHANES-III phase 1 (1988–91) to phase 2 (1991–94). Consistent with the steeper increase in relative risk, at lower concentrations of lead in blood, the rate of increase in relative risk was steeper for participants who were studied during NHANES-III phase 2 (1991–94) than phase 1 (1988–91; appendix p 4).

Examination of effect modification of the relation between concentration of lead in blood and key characteristics showed that HRs for participants younger than 50 years were significantly larger than were those for participants aged 50 years or older, for all-cause mortality (HR 2·24, 95% CI 1·50–3·34 *vs* 1·53, 1·18–1·98; p=0·003 for interaction), cardiovascular disease mortality (2·93, 1·60–5·36 *vs* 2·08, 1·35–3·19; p=0·01), and ischaemic heart disease mortality (4·68, 2·42–9·05 *vs* 2·46, 1·51–4·01; p=0·02). The HR for cardiovascular disease mortality was significantly larger for non-smokers than smokers (HR 2·19, 95% CI 1·47–3·26 *vs* 1·32, 0·86–2·05; p=0·03 for interaction).

Discussion

Our findings suggest that, of 2·3 million deaths every year in the USA, about 400 000 are attributable to lead exposure, an estimate that is about ten times larger than the current one.[28] The key reason for this difference is because the previous estimate assumed cardiovascular disease was only evident at concentrations of lead in blood as low as 5 µg/dL.[28] Our findings show that concentrations of lead in blood lower than 5 µg/dL (<0·24 µmol/L) are associated with all-cause mortality, cardiovascular disease mortality, and ischaemic heart disease mortality. In other studies, amounts of lead in blood lower than 10 µg/dL (<0·483 µmol/L) were associated with cardiovascular disease mortality,[7,9,10] but our study is the first to test whether the relation with cardiovascular disease mortality was evident in a population with concentrations of lead in blood below 5 µg/dL (<0·24 µmol/L). These results suggest that low-level lead exposure is an important, largely overlooked, risk factor for death in the USA, particularly for cardiovascular disease deaths.

Our results accord with those of other population-based studies showing that concentrations of lead in either blood or bone are risk factors for all-cause mortality and cardiovascular disease mortality.[5–13] A significant association was noted between increased lead exposure and all-cause mortality in six prospective studies,[6,7,9,11–13,29] and a significant association was reported between increased lead exposure and cardiovascular mortality in five of six prospective studies.[6,7,9,11–13] No association between concentration of lead in blood and cardiovascular disease mortality was noted after adjustment for other risk factors in a study[29] that only included 19 deaths from cardiovascular disease.

In our study, the estimated number of deaths from all causes and cardiovascular disease that were attributable to concentrations of lead in blood were surprisingly large; indeed, they were comparable with the number of deaths from current tobacco smoke exposure. The HR for all-cause mortality from tobacco exposure was larger than that for concentration of lead in blood, but only 20% of the US population smoked tobacco. By contrast, 90% of participants were exposed to lead; a smaller relative risk for a prevalent exposure can result in a larger population attributable fraction.

Concentrations of lead in blood lower than 5 µg/dL (<0·24 µmol/L) were associated with an increased risk of cardiovascular disease mortality. This result contrasts with conclusions of the National Toxicology Report,[5] which noted that evidence was limited for an association between amounts of lead in blood less than 10 µg/dL and increased cardiovascular-related mortality. We also reported that risk coefficients for cardiovascular disease in the subset of participants with concentrations of lead in blood lower than 5 µg/dL (<0·24 µmol/L) were generally larger than coefficients in the total sample. Although the rate of increase in mortality was greatest with low amounts of lead in blood, HRs indicate that the risk of cardiovascular disease mortality is rising with higher amounts of lead in blood, but at a diminished rate. These results, which accord with those of an earlier study in this same cohort but of shorter duration,[7] should not be surprising; despite the striking reductions in concentrations of lead in blood over the past 50 years, amounts found nowadays in adults are still ten times to 100 times higher than people living in the preindustrial era (ie, 700–1000 years ago).[30] Moreover, the assumption that there are thresholds for specific toxicants—eg, lead, tobacco, and airborne particles—is slowly eroding.[31]

The cardiovascular toxicity of lead stems from various mechanisms. In experimental studies, lead causes hypertension, results in oxidative stress and inflammation, diminishes endothelium relaxation, and promotes development of atherosclerosis and thrombosis.[3,4] In human beings, lead is a recognised risk factor for hypertension and has been associated with peripheral arterial disease, electrocardiographic abnormalities, and left-ventricular hypertrophy.[4,10] In a randomised controlled trial of patients who had had a myocardial infarction, chelation with EDTA and multivitamin therapy led to an 18% reduction in cardiovascular events; patients with diabetes in the trial had a 34% reduction in cardiovascular events.[32] Collectively, these findings suggest, but do not prove, that atherosclerosis and hypertension both could serve as underlying mechanisms for the cardiovascular toxicity of lead.

Our study has limitations. The key limitation is that we relied on baseline measures of exposure to predict death over the subsequent two decades. Some measures (eg, concentration of lead in blood) might be more stable than other risk factors (eg, diet). Lead that is circulating in whole blood of adults is an indicator of both past and ongoing exposures. Serial measures of concentrations of lead in blood or bone, which are better indicators of cumulative exposure than one concentration of lead in blood,[9] would have strengthened this study; indeed, our reliance on one measurement for concentration of lead in blood might underestimate the contribution of lead exposure to mortality. Moreover, we relied on death certificates for the underlying cause of death, but they are imperfect. We adjusted for co-exposure to cadmium, but we were not able to adjust for air pollutants or arsenic, both of which are risk factors for cardiovascular disease mortality.[33] Finally, and perhaps most importantly, although we adjusted for an extensive array of potential confounders, we cannot exclude residual confounding that might result in an overestimation of the effect of concentrations of lead in blood, particularly from socioeconomic and occupational factors that were either not measured or measured inadequately. Yet, the shape of the dose-response argues against confounding to account for our results because the confounders, which are correlated positively with amounts of lead in blood, are found primarily in the highest risk groups (table 1); the steepest increase in risk occurs at the lower concentrations of lead in blood.

In conclusion, our study findings suggest that low-level environmental lead exposure is an important risk factor for death in the USA, particularly from cardiovascular disease. It is not surprising that lead exposure is overlooked; it is ubiquitous, but insidious and largely beyond the control of patients and clinicians. Although reducing the amount of lead in blood might cut a patient's risk of cardiovascular disease mortality,[32] it is more accurate to view this study as estimating how many deaths might have been prevented if historical exposures to lead had not occurred. Indeed, this study suggests that estimating the contribution of environmental lead exposure is essential to understand trends in cardiovascular disease mortality and develop comprehensive strategies to prevent cardiovascular disease.[34,35]

Contributors

All authors designed the study, contributed to data interpretation, and wrote the report. PA had access to raw data. SR, PA, and RWH analysed data.

Declaration of interests

We declare no competing interests. BPL serves as an expert witness in plaintiff cases of childhood lead poisoning in Milwaukee and Flint, MI, USA, but he receives no personal compensation.

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PROTECTING CHILDREN FROM LEAD EXPOSURES






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PROTECTING CHILDREN FROM LEAD EXPOSURES

Since the 1970s, the U.S. Environmental Protection Agency (EPA) and its state, tribal and local governmental partners have made tremendous progress in reducing children's lead exposures and lead-related health risks. EPA efforts to reduce lead exposures and prevent lead poisoning include a wide range of activities such as funding for community interventions and outreach, education and training, surveillance, and regulation and enforcement.

EPA'S MISSION

Protect human health and the environment.

Blood lead levels have fallen dramatically in the United States due to the promulgation, implementation, and enforcement of laws and regulations aimed at reducing lead exposure. The largest declines in blood lead levels occurred from the 1970s to the 1990s following the elimination of lead in motor-vehicle gasoline, the ban on lead paint for residential use, removal of lead from solder in food cans, and bans on the use of lead pipes and plumbing fixtures. Figure 1 depicts the timeline for major actions to prevent lead poisoning and reductions in mean blood lead levels (micrograms per deciliter (µg/dL)) among children ages 1 to 5 years from 1972 to 2012.

The Centers for Disease Control and Prevention (CDC) has stated that no safe blood lead level in children has been identified, and in 2012 set a reference level of 5 µg/dL as an elevated level for children. Despite the overall decline of blood lead levels over time, lead exposure remains a significant public health concern for some children because of persistent lead hazards in their environment. Childhood lead exposure is especially prevalent in many environmental justice (EJ) communities that represent the lowest income, most diverse populations with significant cumulative environmental risk from pollution. EPA is committed to reducing lead exposures from multiple sources including: paint, water, ambient air, and soil and dust contamination, especially among children who are the most vulnerable to the effects of lead.

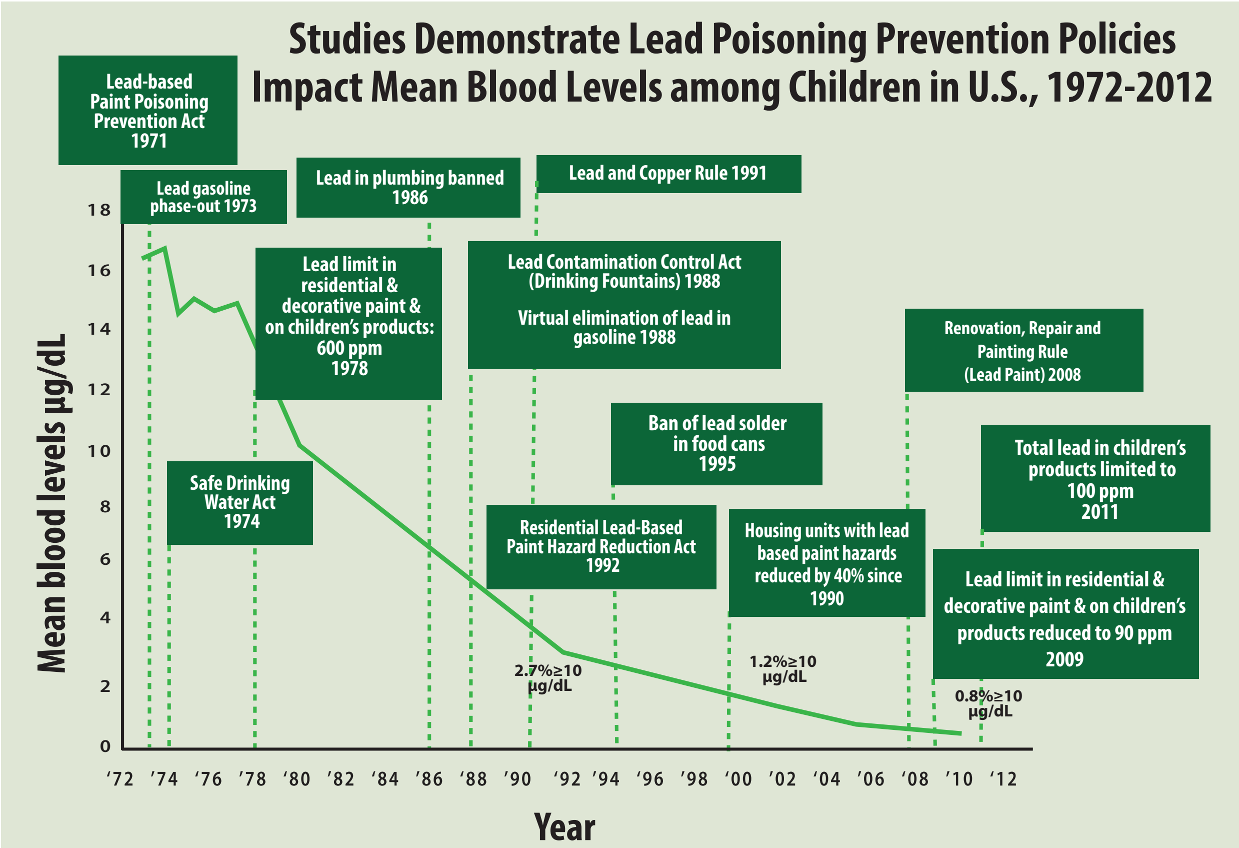


Figure 1: Source - Adapted from NIEHS - https://ptfceh.niehs.nih.gov/features/assets/files/key_federal_programs_to_reduce_childhood_lead_exposures_and_eliminate_associated_health_impactspresidents_508.pdf. Brown MJ and Falk H. Toolkit for establishing laws to control the use of lead paint. Module C.iii. Conducting blood lead prevalence studies. Global Alliance to Eliminate Lead Paint (2017)

On April 21, 1997, the President signed the Executive Order on the Protection of Children from Environmental Health Risks and Safety Risks. This Executive Order requires all federal agencies to assign a high priority for addressing health and safety risks to children, coordinating research priorities on children's health, and ensuring that their standards account for special risks to children. The Executive Order created a President's Task Force on Environmental Health Risks and Safety Risks to Children (Task Force) to implement the Executive Order.

The Task Force is co-chaired by EPA and the Department of Health and Human Services (HHS), and one of its current priorities to improve children's environmental health is focused on reducing lead exposures. EPA continues to make children's health a top priority and is committed to protecting children from lead exposures in their environments.

FEDERAL LEAD STRATEGY

EPA, along with the partner agencies of the President's Task Force, is developing a federal strategy designed to improve the effectiveness and efficiency of the federal government in reducing children's lead exposures and lead-related health risks.

As EPA works with its partner agencies to better coordinate activities and finalize the strategy, the Agency continues its efforts to reduce lead exposures as described in this document.

This document provides examples of some of EPA's most recent and/or ongoing activities related to reducing lead exposures.

REDUCING EXPOSURES ASSOCIATED WITH LEAD IN PAINT AND LEAD DUST

Legacy lead-based paint in housing and adjacent soil is considered the largest source on average of lead exposure in children. The following initiatives represent EPA's commitment to reduce exposures associated with lead in paint and lead dust.

Dust-lead Hazard Standard

The Trump EPA proposed strengthening the dust-lead hazard standard to help reduce childhood lead exposure.

- In June 2018, the Agency proposed to change the dust-lead hazard standards from 40 micrograms/square foot (µg/ft2) and 250 µg/ft2 to 10 µg/ft2 and 100 µg/ft2 on floors and window sills, respectively. These standards apply to most pre-1978 housing and child-occupied facilities, such as daycare centers and kindergarten facilities. Lead dust can be a major source of lead exposure in children, and the new proposed standards for lead in dust will be an important step to reduce lead exposure.
- EPA plans to issue a final rule by June 2019.

Renovation, Repair and Painting (RRP) Program

EPA regularly works with individuals and firms to reduce lead hazards by ensuring they are certified under the Lead Renovation, Repair and Painting (RRP) Rule and trained to use lead-safe work practices. Learn more at: https://www.epa.gov/lead/renovation-repair-and-painting-program.

Lead Poisoning Prevention Week

- Each year during National Lead Poisoning Prevention Week (always the last full week in October), EPA, along with the U.S. Department of Housing and Urban Development (HUD) and the CDC, design and distribute outreach materials about how communities can raise awareness of lead hazards and reduce childhood lead exposure and lead poisoning.
- Learn more at: https://www.epa.gov/lead/national-lead-poisoning-prevention-week.
- Each year EPA, along with the World Health Organization (WHO), the United Nations Environment Program (UNEP) and other organizations around the world join to promote International Lead Poisoning Prevention Week by developing a wide range of materials, including customizable posters, to allow partnering countries and local groups to share the messages with diverse audiences, and tools to help countries establish legal limits on lead paint.
- Learn more at: https://www.epa.gov/international-cooperation/epa-participation-international-lead-poisoning-prevention-week-action.

Lead Free KIDS for a Healthy Future

https://www.epa.gov/lead/national-lead-poisoning-prevention-week

Lead State and Tribal Assistance Grants ("STAG Grants"). Through the Lead Categorical Grant Program, EPA provides funding to authorized state and tribal programs that administer training and certification programs for lead professionals and renovation contractors.

- In both 2017 and 2018, EPA awarded approximately $11 million to authorized state and tribal lead RRP certification programs.
- In 2019, EPA plans to continue to award grant funding to support these local programs.

These grants help ensure contractors working on pre-1978 homes, childcare facilities, and pre-schools are trained and certified in lead-safe evaluation, work practices and abatement.

All Ages Lead Model. EPA developed the All Ages Lead Model (AALM) to provide a tool for rapidly evaluating the impact of possible sources of lead on blood and other tissue levels in humans from birth to 90 years of age. The AALM predicts lead concentration in body tissues and organs for a hypothetical individual, based on a simulated lifetime of lead exposure. This model will be peer reviewed by the Science Advisory Board in 2019

New Technical Assistance Tool: Model Law and Guidance for Regulating Lead Paint EPA provides guidance and technical assistance to other organizations around the world on lead-related rules/regulations and collaborates on how to reduce lead exposure.

- With assistance from EPA and the WHO, the UNEP developed a Model Law and Guidance for Regulating Lead Paint.
- In many countries lead is still used in paints **in high concentrations**, exposing children and workers to the potential health effects of lead. Released in November 2017, the Model Law and Guidance for Regulating Lead Paint is a technical assistance tool to support countries around the world in protecting human health and the environment by establishing new laws—or modifying existing laws—to limit lead content in paints. It is intended to be a practical "how to" resource for countries that are ready to establish such a law and includes model legal language and detailed guidance that describes key elements of effective and enforceable legal requirements.
- Learn more at: https://www.unenvironment.org/resources/publication/model-law-and-guidance-regulating-lead-paint.

Recent Activities to Reduce Exposures from Lead-Based Paint

- **Alaska and Idaho (2017–2018).** EPA staff participated in spring and fall home shows, reaching 500-600 consumers per home show, and conducted in-person outreach to Building Permitting Offices in Alaska and Idaho to help inform contractors during the permit application process about the RRP Rule Requirements. EPA staff distributed, "Renovate Right," pamphlets to paint stores, window stores, carpet and tile stores, daycare centers and preschools. EPA increased RRP compliance by engaging over 50 organizations. The word has gotten out to contractors in Alaska and Idaho that they need to be certified as an RRP Firm and Renovator, if they plan to work on pre-1978 target housing.
- **Nogales, Arizona (2018).** EPA awarded a $39,500 grant to the Sonora Environmental Research Institute (SERI) to expand Pima County's Healthy Homes and Healthy Childcare programs to Nogales, where the institute is based. SERI held hold workshops for community members and child care providers, and conducted home and child care visits to identify, prevent and address environmental hazards commonly found in homes and child care facilities. SERI's project will address multiple environmental health and safety hazards with a focus on lead-based paint, pest infestations, indoor air quality, hazardous chemicals, asthma and fire and safety hazards. SERI will also conduct outreach to medical providers on childhood lead poisoning prevention.
- **Santa Cruz County, Arizona (2018).** EPA awarded a $45,000 grant to the Mariposa Community Health Center in Arizona's Santa Cruz County to train Promotoras (community health workers) to educate local parents and caregivers on preventing exposure to lead, pesticides, and air pollutants in their homes. The goal is to reach at least 400 parents and caregivers, benefiting approximately 1,000 children.
- **Alameda County, California (2018).** EPA awarded a $25,000 grant to the Alameda County Community Development Agency to provide training courses to 120 code enforcement officers in California. The officers learned how to incorporate lead-safety requirements into their inspections, respond to unsafe renovation complaints, and improve compliance with lead regulations. The training course was offered to attendees of the California Association of Code Enforcement Officers' Annual Code Enforcement Seminar and Exhibitor Showcase to improve the ability of code enforcement officers to recognize and reduce lead hazards in homes.
- **Denver, Colorado (2015–On-going).** EPA is reaching out to increase public awareness of EPA's RRP Rule to increase consumer demand for lead-safe renovations and to protect vulnerable populations from exposure to lead-based paint hazards in the Denver area. In addition to EPA's compliance assistance efforts, the agency is inspecting work sites to ensure that renovators work in a lead-safe manner when disturbing paint in pre-1978 homes and child-occupied facilities.
  - EPA worked with the City and County of Denver building permitting department to get the word out on the Lead RRP Rule and lead-based paint testing to renovators and contractors.
  - EPA worked with the State of Colorado's Department of Public Health and Environment to promote lead poisoning prevention through their child care regulations and child care inspections.
  - EPA conducted 61 lead inspections that resulted in 32 enforcement actions, 10 penalty orders totaling over $100,000 in fines, and a supplemental environmental project resulting in lead-based paint testing.
  - EPA aired a series of public service announcement videos on English and Spanish-speaking television stations, on news station websites, and via a targeted email campaign, as well as publishing lead poisoning prevention awareness ads in local newspapers.
- **EPA Raises Awareness of Lead-Based Paint in St. Joseph, Missouri (2018).** EPA includes public education and outreach as part of its lead reduction strategy because addressing conditions before a child is exposed is still the best strategy to protect children from lead poisoning. In St. Joseph, Missouri, 15% of children tested from 2010-2015 had elevated blood-lead levels—more than three times the national average (4%). To help address this, EPA selected St. Joseph as the focal point of a geographic initiative throughout the coming year. EPA partnered closely with the City of St. Joseph, city health

department, and the Missouri Department of Health & Senior Services in outreach activities. Federal partners include the Agency for Toxic Substances and Disease Registry (ATSDR), HHS and HUD. Activities will include a variety of outreach, compliance assistance, and enforcement activities such as:

- Conducting lead-safe certified program training for commercial renovators, and compliance inspections;
- Working with area home improvement stores to share lead safety information, and demonstrate lead-safe practices for do-it-yourself home renovators;
- Visiting daycare facilities, including home daycares, to teach children and parents how to reduce exposure to lead-paint dust;
- Engaging with local community groups to determine how to best share resources and training opportunities with their members;
- And coordinating lead safety media coverage and radio public service announcements.

As part of the St. Joseph, Missouri, Geographic Initiative, four EPA team members participated in the annual Tiny Tot Town Event in St. Joseph, Missouri, on October 9, 2018. This event sought to create an interactive simulated community to introduce children to life in their town. Children explored Tiny Tot Town by strolling the streets, meeting with store owners, bankers, librarians, and other professionals in the community. Through experiential learning, children understand their town and their importance in the community. The EPA team set up a booth that highlighted how to avoid lead exposure, and educated children and parents about easy steps they can take to stay lead-free. They also passed out handbooks for parents and coloring books for children. Approximately 300 people stopped by the EPA booth to learn about living lead-free!

EPA staff participated in the Southside Fall Festival Parade on September 15, 2018 and distributed lead poisoning awareness and prevention materials to educate the community on how to reduce children's lead exposures. Approximately 1,000 people attended.

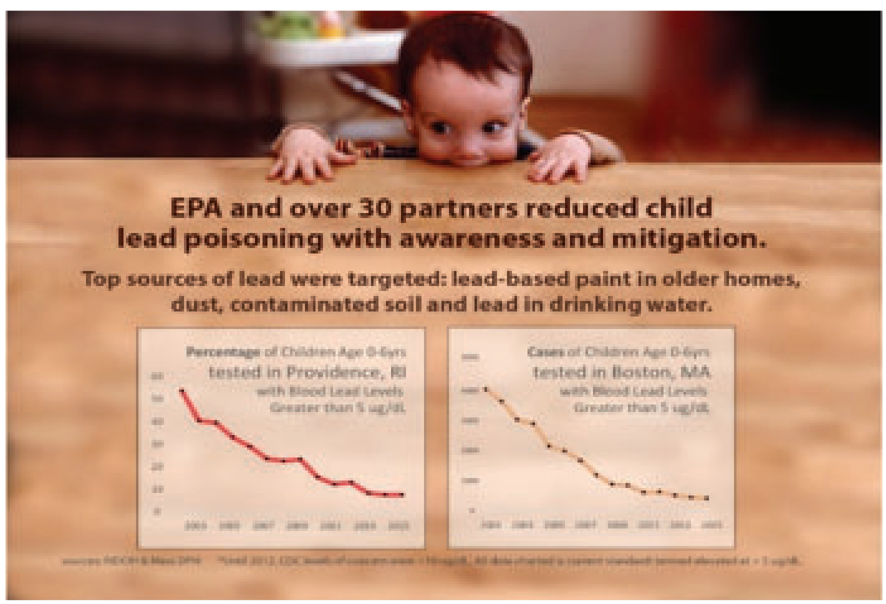
EPA's Marcus Rivas discusses the importance of lead safety with a participant in the Tiny Tot Town event in St. Joseph, Missouri on October 9, 2018.

- **Philadelphia, Mississippi (2015–2018).** EPA awarded the Mississippi Band of Choctaw Indians (MBCI) Tribal Lead Grant a $30,000 lead-based paint grant in 2018 to evaluate potential lead issues in the Philadelphia, Mississippi community. A second award of $30,000 is proposed for 2019. EPA will continue coordinating with MBCI to evaluate potential lead concerns and encourage MBCI to develop formal lead-based paint programs for protecting vulnerable populations from exposure to lead with specific emphasis on children under age 6 years and pregnant women.

- **EPA Provides Education and Training in Philadelphia, Pennsylvania (2018).** In the summer of 2018, EPA, along with partners from the City of Philadelphia, the Philadelphia School District, neighborhood associations, and independent non-profit organizations, are targeting communities where pre-1978 housing stock is prevalent. Outreach efforts include engaging with residents at in-person meetings, distributing technical assistance information, visiting paint/hardware stores to educate customers on safe lead work practices, training and providing technical assistance to city inspectors, and distributing information and educating contractors/renovators and property management firms regarding lead paint requirements. Information was also provided to daycare centers, childcare and healthcare-focused organizations.

EPA engages with local residents on ways to reduce or prevent childhood lead poisoning.

- **Catoosa, Oklahoma (2018).** EPA coordinated with the Cherokee Nation and hosted the first Tribal Children's Environmental Health Symposium on October 16-18, 2018.
- **EPA Works Closely with Community Partners and Achieves Reductions in Lead Poisoning in Rhode Island and Maine (2013–2018).** Since 2013, EPA has funded and managed six grants totaling approximately $126,064 to the Childhood Lead Action Project and the Environmental Health Strategy Center for community-based projects to protect children from lead poisoning in Rhode Island and Maine.The Childhood Lead Action Project is a nonprofit organization working to eliminate childhood lead poisoning in Rhode Island through education, parent support, training and advocacy. Their projects built on the existing education, training, and community-building efforts in Providence, Rhode Island, and expands the work to East Providence and Pawtucket, communities with higher than average rates of lead poisoning in the state. These projects convened stakeholder groups in each community to plan, implement, and evaluated the activities necessary to bring the cities into alignment with the laws and regulations that govern lead. City officials with lead enforcement responsibilities were provided education to improve their understanding of the state's Lead Hazard Mitigation Act and EPA's Renovation, Repair, & Paining Rule (RRP), and outreach and education was provided to contractors and others performing renovation or repair on properties in target communities to increase their understanding of the RRP Rule and the importance of following lead-safe work practices.



EPA worked closely with partners to achieve reductions in lead poisoning in Providence, Rhode Island and Boson, Massachusetts.

- **Memphis and Shelby Counties, Tennessee (2018).** EPA and Shelby County Lead Safe Collaborative facilitated a stakeholder engagement project, utilizing appreciative inquiry, alternative dispute resolution, and organizational leadership techniques to coordinate local and state agency efforts to address community concerns with exposure to lead in water and soil in Memphis, TN. Two webinars were conducted to assist the Memphis and Shelby County Lead Safe Collaborative (MSCLSC) in developing goals and strategies to address challenges regarding the presence of lead in water and other sources in Memphis, TN. OEJS staff conducted a two-day planning meeting for MSCLSC leadership in Memphis that covered the following: 1) a review of appreciative inquiry and how it has been used with MSCLSC and Memphis Light, Gas and Water, 2) identification and prioritization of goals, 3) creation of a leadership structure and designation of persons who will assume specific roles, and 4) development of tasks and timelines.
- **Dallas, Texas (2018).** EPA held a Children's Environmental Health Symposium and trained 100 people including child care providers, nurses, school administrators, health care providers, community health workers, policy makers, and others in the community in lead poisoning prevention. Case studies, lead poisoning prevention, asthma triggers, exposures during pregnancy, childhood cancer, and other important information about the environmental impacts of lead on children's health was presented, resulting in attendees learning the latest information on lead challenges.
- **Dallas and El Paso, Texas (2015–On-going).** EPA provided more than 1,000 Protecting Children's Health Tip Sheets in English and Spanish, materials on lead poisoning prevention, and other children's health issues at a parent's health fair and distributed 1,000 copies of the Play It Safe lead poisoning prevention brochure to Poison Control Centers in Dallas and El Paso.
- **El Paso, Texas (2017).** EPA trained 146 school nurses, coaches and health professionals at the Healthy Schools Symposium in El Paso that included lead poisoning prevention.
- **Louisiana and Texas (2017)**. EPA trained 70 EPA staff, renovation contractors, and citizens on ways to address environmental health risks to children.

INCREASING THE IDENTIFICATION OF AND ENFORCEMENT OF SOURCES NOT IN COMPLIANCE

- EPA and its partners use multiple statutory and regulatory authorities to prevent or reduce exposure to lead in environmental media. The Agency leads and supports a variety of compliance assurance activities conducted by EPA Regions and states, tribes, and territories implementing EPA-authorized programs. EPA collaborates with states, tribes, other federal agencies, communities, governmental and non-governmental stakeholders and industries to address lead.
- The primary goal of compliance assurance activities is to protect public health and the environment. Therefore, these activities aim to promote compliance with environmental requirements, ensure that violators are held accountable for noncompliance, deter would-be violators, and promote a level playing-field for entities that comply with the requirements.

COMPLIANCE ASSURANCE includes EPA's array of tools and activities to promote compliance and protectiveness, including:

- **Compliance assistance**
- **Compliance monitoring**
- **Enforcement**
- **Capacity-building with partners**
- **Grants**
- **Policy development**
- **Data and tool development**

PEDIATRIC ENVIRONMENTAL HEALTH SPECIALTY UNITS

Through Pediatric Environmental Health Specialty Units (PEHSU), EPA has provided training on lead poisoning prevention for multiple audiences including pediatricians, clinicians, nurses, and other medical and public health care experts on childhood lead exposure issues. EPA and PEHSUs have also recorded radio and television Public Service Announcements to raise awareness about the importance of getting children tested for lead.

PEHSUs are also developing and distributing informational posters for pediatricians to encourage them to counsel their patients about lead safety, and encourage parents to get vulnerable children tested. In addition, EPA participated in a Lead Roundtable workshop in April 2018 at the University of Washington with ATSDR, the Northwest PEHSU, state and local health departments, and local community groups to identify childhood lead exposure reduction awareness needs and efforts.

EPA awarded $224,500 to support education on pediatric environmental health risks to five organizations in three states that will address lead poisoning prevention, environmental asthma triggers, and other children's environmental health issues. Funding was awarded in 2018 and results will be reported in 2019.

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REDUCING EXPOSURES ASSOCIATED WITH LEAD IN DRINKING WATER

Improving America's water infrastructure is vital to protecting public health and reducing lead in drinking water. Over the years, EPA has provided states $19 billion through the Drinking Water State Revolving Fund program for infrastructure improvements, including lead service line replacement projects throughout the country.

In 2018, the Water Infrastructure Finance and Innovation Act (WIFIA) program prioritized projects that reduce exposure to lead and other contaminants in drinking water systems and update the nation's aging infrastructure. While the Agency recognizes that it will be a multi-year process to bring in applications for lead projects under the WIFIA program, the Agency is pleased that in 2017 the Indiana Finance Authority's loan application for $436 million dollars included $6 million dollars for two lead service line replacement projects in East Chicago and Crown Point, Indiana. In 2018, EPA will soon be inviting several entities to apply for WIFIA loans that would invest more than $300 million in lead-related projects. The Agency looks forward to investing in more projects that reduce lead in drinking in future years.

In addition, the America's Water Infrastructure Act of 2018 passed by Congress in October 2018 includes programs that could be used to strengthen the federal government's investment in reducing lead in drinking water.

Water Infrastructure Finance and Innovation Act

- On April 4, 2018, EPA announced the availability of Water Infrastructure Finance and Innovation Act (WIFIA) funding that could provide as much as $5.5 billion in loans, leveraging over $11 billion in water infrastructure projects.
- The 2018 WIFIA Notice of Funding Availability (NOFA) highlighted the importance of protecting public health, including reducing exposure to lead and other contaminants in drinking water systems and updating the nation's aging infrastructure.

- In response to the NOFA, potential borrowers submitted letters of interest (LOIs) requesting over $9 billion in loans for water infrastructure projects in 26 states and territories. More than half of the LOIs addressed one or both of 2018 NOFA priorities: reducing exposure to lead and other contaminants in drinking water systems and updating aging infrastructure. Learn more at: https://www.epa.gov/wifia.

Water Infrastructure Improvements for the Nation Act. EPA is supporting grant programs appropriated under the Water Infrastructure Improvements for the Nation Act (WIIN) that will directly target lead-related issues.

- The assistance for Small and Disadvantaged Communities is a $20 million grant that will allow EPA to partner with states to meet the needs of rural and disadvantaged areas.
- The Reducing Lead in Drinking Water grant will provide $10 million dollars that will focus on reducing lead in drinking water systems, including replacing lead service lines.

WIIN Grant Announcement. The Lead Testing in School and Child Care Program Drinking Water was announced in October 2018.

- This grant program will provide $20 million to support lead testing of drinking water at schools and child care centers.
- States that choose to participate in this voluntary grant program must submit their letters of intent by January 2019.
- Learn more at: https://www.epa.gov/dwcapacity/wiin-grant-lead-testing-school-and-child-care-program-drinking-water

Drinking Water State Revolving Fund. The Drinking Water State Revolving Fund (DWSRF) has provided loans that directly supported lead pipe replacement projects in cities across the United States.

- The DWSRF set-asides also funded state program activities that support lead-related projects.
- EPA collaborates with states and public water systems to update our nation's drinking water infrastructure, including important projects to reduce lead in drinking water through the distribution of EPA's DWSRFs, totaling $1.163 billion for the fiscal year 2018.

EPA Awards STAR Grants to Research Lead in Drinking Water. In April 2018, EPA announced nearly $4 million in funding to Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia, and the Water Research Foundation in Denver, Colorado, to research strategies to detect and eliminate lead exposure in drinking water. Learn more at: https://www.epa.gov/research-grants/water-research-grants.

Lead and Copper Rule. EPA conducted approximately 30 in-person trainings across the country in all ten EPA Regions over the last two years including a full-day training on optimal corrosion control treatment to improve compliance and reduce lead exposure at the tap through successful implementation of corrosion control treatment. The training provided participants including states, technical assistance providers and water utility operators, an opportunity to work through case studies, analyze actual water system data and participate in interactive activities. Additional examples of Lead and Copper Rule trainings held by EPA include:

- Lead and Copper Rule 3-Part Webinar series;
- Training with National Rural Water Association and the State of California;
- 3-day online training with Guam and Hawaii; and
- Training on Sample Site Selection being held on a regular basis.

National Drinking Water Workshop. In 2018, EPA hosted the National Drinking Water Workshop with 400 participants in attendance. This workshop included multiple sessions on lead testing, lead service line replacement, and other Lead and Copper Rule (LCR) topics. It also included a 2-hour discussion between states, EPA, academia experts and workshop participants on key issues and implementation challenges related to the LCR.

Protect Your Family from Lead in Your Home. EPA updated the Real Estate Disclosure document, *Protect Your Family from Lead in Your Home*, to provide additional information and actions related to lead in drinking water. The document provides basic information on identifying and controlling lead-based paint hazards , steps to take to reduce exposure and provides information on who to contact for questions. For homes built before 1978, federal law requires that, before being obligated under a contract to buy a home and before signing a lease, buyers and renters must be provided a copy of this document. Learn more at: https://www.epa.gov/lead/real-estate-disclosure.

Lead Infographic. EPA developed an infographic that can be used by the public to learn about lead in drinking water. Information on the infographic includes a diagram of the sources of drinking water, clear actions to take if residents are concerned about lead in drinking water and information on who to contact for questions. Learn more at: https://www.epa.gov/ground-water-and-drinking-water/infographic-lead-drinking-water.

EPA Infographic

Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water. EPA published a proposed regulation for Implementing Section 1417 of the Safe Drinking Water Act (SDWA) entitled "Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water," for public review and comment. The proposed regulation would modify the definition of lead-free plumbing products (e.g., pipes, fittings and fixtures) to conform to the statute enacted by Congress that prohibits a lead content level above 0.25 percent of the wetted surfaces. The proposal also includes other requirements that will ensure plumbing fixtures meet the new "lead free" definition. EPA is working to address comments and finalize the rule in 2019.

Leaders in Lead Service Line Replacement Story Map. EPA released an interactive website that allows the public to learn more about lead in drinking water. It also highlights drinking water systems that are actively engaging in lead service line replacement activities in their communities. Learn more at: https://www.epa.gov/ground-water-and-drinking-water/leaders-lead-service-line-replacement.

Small Systems Webinars. EPA conducts monthly webinars for Small Systems to provide training and technical assistance on new research and drinking water technologies, as well as regulatory compliance and implementation.

- Throughout 2017-2018, EPA gave various online trainings that focused on lead in drinking water.
- The most recent lead training in this series discussed EPA's 3Ts and identifying lead-free products. It attracted over 1,200 participants, providing over 800 Continuing Education Units.

3Ts for Reducing Lead in Drinking Water in Schools and Child Care Facilities. In October 2018, EPA released an updated 3Ts for Reducing Lead in Drinking Water document, which introduces the new 3Ts—Training, Testing, and Taking Action. The revised version is available in an interactive web-format and includes modules, customizable templates and tools that can help schools and child care facilities when implementing their lead testing programs.Learn more at: https://www.epa.gov/safewater/3Ts.

3Ts Training. EPA conducted national training for schools, water utilities, states, and others implementing voluntary lead testing programs.

- These trainings include a case study series from Massachusetts Department of Environmental Protection (MassDEP); Denver Water and Denver Public Schools; and New York Department of Health.
- EPA has also hosted several live webinars on the 3Ts toolkit and other EPA resources, and is hosting six webinars on 3Ts and WIIN in October 2018.

EPA's Small Business Innovation Research Program

EPA's Small Business Innovation Research (SBIR) program supports science- and technology-based small businesses to develop and commercialize innovative environmental technologies through monetary awards. SBIR-winning company NanoSafe, Inc. recently demonstrated an accurate and inexpensive lead testing platform for both soluble and insoluble lead compounds. This will allow users to quickly and affordably detect lead in their own drinking water. They are now competing for an SBIR Phase II award. Learn more at: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/10826/report/0

EPA's People, Prosperity, and the Planet (P3) Program

EPA's P3 (People, Prosperity, and the Planet) Program is a unique competition open to teams of college students working to design solutions for a sustainable future. A recent P3-winning team at Old Dominion University is designing a low-cost household water filter that uses biochar to remove lead from drinking water.

Biochar can be a cost-effective substitute to activated carbon in lead adsorption because of its porous structure, irregular surface, high surface to volume ratio and presence of oxygenated functional group. The team is working to design a household water filter that uses biochar as an adsorbent for removing lead from drinking water. The proposed filter integrates the conventional filter and adsorption potential of biochar to create a system that can eliminate lead from supplied water. It will significantly decrease the cost for abatement of lead pollution.

Learn more at: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/10860

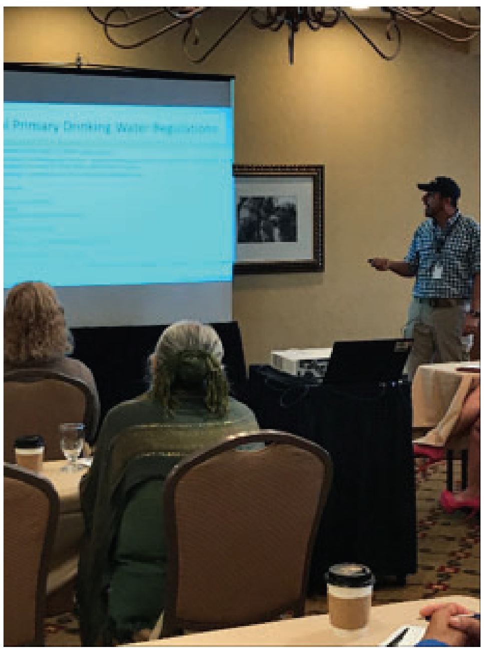
Recent Activities to Reduce Exposures to Lead in Drinking Water

- **Flint, Michigan (2017).** The City of Flint created the FAST Start program to identify and replace lead service lines across the city. Initial funding for the program was provided by the State of Michigan. In March 2017, EPA awarded $100 million in supplemental drinking water state revolving funds (DWSRF) pursuant to the WIIN to the Michigan Department of Environmental Quality to support infrastructure improvements in Flint. These supplemental DWSRF were provided to address the declared emergency under the Robert T. Stafford Disaster Relief and Emergency Assistance Act relating to the public health threats associated with the presence of lead or other contaminants in drinking water. The City allocated $40 million of WIIN funds toward lead service line replacements. Funding is also made available through the settlement of the Concerned Pastors for Social Action v Khouri case (finalized in April 2017) which is expected to provide an additional $47 million. The City reported that since FAST Start began, crews from five area companies have completed excavation at 15,592 homes. Overall, to date, service lines to 7,358 homes have been identified as lead and/or galvanized steel and have been replaced, including 1,130 homes found this year.
- **Nevada (2018).** EPA funded a multi-purpose grant for $89,000 to support exploration of lead in drinking water at Nevada elementary schools. This project will improve understanding school drinking water in Nevada. Public water suppliers generally have not included schools in their sampling plans as the Lead and Copper Rule (LCR) places a higher emphasis on single-family homes. The Nevada Department of Environmental Protection is undertaking a statewide sampling project for 400 public elementary and pre-kindergarten schools, prioritizing older and historic schools where the presence of lead is

more likely. In addition to sampling and analysis, a portion of the funding will provide resources for replacement of water fountains and culinary faucets. If sampling results indicate significant infrastructure replacement needs, referrals to the U.S. Department of Agriculture Rural Development Direct Loan and Grant Program are planned.

- **New England States (2018).** In response to EPA's, New England states', and water utility proactive measures, as of August 2018, more than 99% of the public water supply systems that are obligated to meet requirements of the Lead and Copper Rule are meeting the drinking water lead action levels.
- **Las Cruces and Gadsden, New Mexico (2018).** EPA conducted one-day workshops on EPA's 3Ts Reducing Lead in Drinking Water in Schools and Child Care Facilities in New Mexico. Utilizing a collaborative approach with its state partner, the New Mexico Environment Department, EPA hosted a 3Ts workshop for Las Cruces and Gadsden School District officials and environmental/custodial staff.

Tribal school sampling for lead conducted and documented to reduce exposure risks in children Sac and Fox Nation (Jeremy Fincher)



EPA's Miguel Moreno provides information on drinking water regulations during the 3Ts workshop in Las Cruces, New Mexico

- **Sac and Fox Nation, Oklahoma (2018).** EPA partnered with Indian Health Services, Bureau of Indian Affairs and the Bureau of Indian Education in conducting a voluntary sampling project of tribal schools, daycare centers, and Head Start programs, at tribes with public water systems regulated by EPA.
- **Sac and Fox Nation, Oklahoma (2018)**. Lead in Drinking Water Sampling for Tribal Schools. EPA initiated a project to sample drinking water for lead contamination at tribal schools, daycares, and Head Start facilities. The project targeted facilities where children consume water daily and providers volunteered to participate. By the end of 2018, EPA will have completed sampling at over 100 school sites and provided follow-up sampling and consultation to reduce exposure at sites that sampled above an action level of 15 parts per billion (ppb).

USS LEAD SUPERFUND SITE

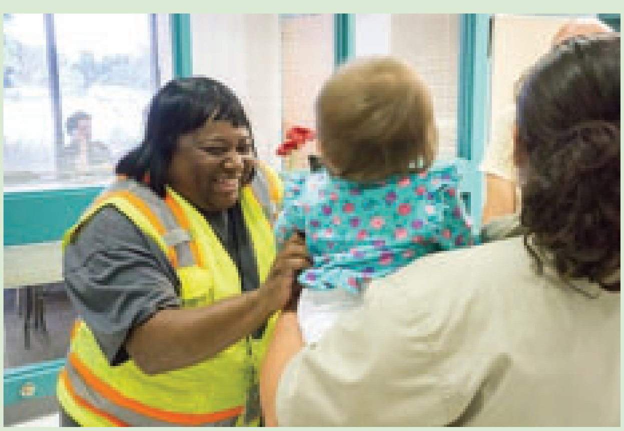
The U.S. Smelter and Lead Refinery, Inc. (USS Lead) Superfund Site is located in the city of East Chicago, Indiana. Part of the site is a 322-acre residential area with approximately 1,100 properties, including homes, various commercial businesses, parks, schools and public buildings. On November 30, 2012, EPA issued its final cleanup plan for the residential area that has been divided into three zones.

The plan includes removal and off-site disposal of soil with lead concentrations exceeding 400 milligrams per kilogram, or mg/kg, and arsenic concentrations exceeding 26 mg/kg. In September 2016, EPA began cleaning up soil at priority properties (high lead and/or arsenic concentrations at the surface and/or pregnant women and children under the age of seven present) in zones 2 and 3. Followed by soil removal actions with sampling of indoor dust at cleaned properties and providing indoor cleanup, if necessary. EPA cleaned up the soil at 55 properties before pausing work due to winter conditions.

As of November 2017, EPA had sampled almost all Zone 2 and 3 properties. In 2017 and 2018, EPA removed 37,614 tons of lead- and/or arsenic-contaminated soil from 287 properties in zone 2 of the site and 27,662 tons of lead- and/or arsenic-contaminated soil from 240 properties in zone 3 of the site. Indoor cleaning was conducted at residences where sampling identified indoor dust contamination above screening levels.

EPA updated its community engagement plan in 2017 to revamp communication and enhance service to the residents of the site. Several improvements were made including publishing a dedicated hotline number for the site, appointing a dedicated and experienced Community Involvement Coordinator as the full-time point-of-contact for residents and establishing a community information office at the former Carrier Gosch Elementary School.

The Department of Housing and Urban Development (HUD) and the East Chicago Housing Authority (EHCA) demolished the former West Calumet Housing Complex—part of Zone 1 of the Superfund site. All residents have moved out. EPA worked closely with ECHA and HUD to ensure demolition of the complex did not pose environmental or health risks to the surrounding neighborhoods.



In fall 2018, EPA expects to announce its proposed plan to cleanup lead and arsenic in soil in Zone 1 of the site—the former location of the now demolished West Calumet Housing Complex. EPA will take public comments on the plan for 60 days and hold a public hearing in the community.

In October 2018, EPA and local health agencies sponsored a blood lead level testing event in one of the neighborhoods in the Superfund site to encourage parents to have their children tested for lead. Forty-two children and 11 adults were tested at a mobile lab. EPA recently awarded a $50,000 Superfund Technical Assistance Grant for communities to the East Chicago Calumet Coalition.

REDUCING EXPOSURES TO LEAD IN SOIL

- Lead is a common soil contaminant because of past and current human activity or uses (e.g., mining, lead smelter). Children who live near or play on lead-contaminated soil can be exposed through incidental ingestion of small amounts of soil or soil-derived indoor dust. Contaminated soil can also be tracked into the home. Young children often have higher rates of soil and dust ingestion from crawling, as well as hand and object-to-mouth contact.
- EPA actions to reduce childhood exposure from lead in soil include:
  - Managing lead contamination at Superfund, Resource Conservation and Recovery Act Corrective Action, and other sites through removal, remedial and corrective actions;
  - Sponsoring lead education events in communities that include offering free testing of soil from residential yards and gardens and blood lead testing for children;
  - Updating the Superfund Lead-Contaminated Residential Sites Handbook; and
  - Offering technical assistance to brownfield communities to identify best management practices, and potential funding opportunities.
- More information is available at: https://www.epa.gov/superfund/lead-superfund-sites.

Superfund Cleanups Reduce Blood Lead Levels in Children

At many Superfund sites across the country, EPA has been and is continuing to clean up soil contaminated with lead to protect human health and the environment. Lead in soil can be toxic when ingested or inhaled. Local governments may test blood lead levels in children living near Superfund sites before, during, and after cleanup to confirm that exposure to lead has been reduced.

- To improve the Agency's understanding of the degree to which Superfund cleanups may lower blood lead levels at a wider range of lead contaminated sites, EPA's National Center for Environmental Economics (NCEE) and Office of Land and Emergency Management are investigating the effects of the Superfund program nationally on childhood lead poisoning. They have compiled a dataset that links two decades of blood lead level measurements from children in six states with EPA data on the location and characteristics of Superfund sites, as well as other determinants of lead exposure. The investigation uses advanced statistical methods to identify whether a causal relationship exists between proximity to Superfund cleanups and rates of elevated blood lead levels.
- Preliminary results indicate that Superfund cleanup lowers the risk of elevated blood lead levels by roughly 10% for children living within 2 kilometers of a Superfund National Priorities List (NPL) site where lead is a contaminant of concern.
- Watch for the NCEE Working Paper that will be posted at the following website before the end of the year: https://www.epa.gov/environmental-economics/research-environmental-economics-ncee-working-paper-series

Recent Progress in Cleaning Up Superfund Sites with Lead Contamination

- **Pueblo, Colorado (2014–2018).** EPA has increased funding and accelerated cleanup at the Colorado Smelter Superfund site. EPA listed the Colorado Smelter, a silver and lead smelter operated in Pueblo, Colorado, from 1883 to 1908, on the National Priorities List in December 2014. The site was listed due to high levels of arsenic and lead identified in smelter slag, in neighborhood soils and at approximately 1,700 residential properties both indoors and in yards.

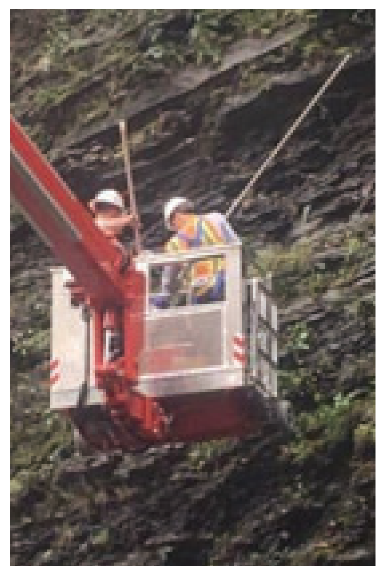
Colorado Smelter cleanup crews excavate contaminated soil from a residential property in Pueblo, Colorado

In summer of 2018, EPA announced $15 million a year for the next 5 years will be used to accelerate the cleanup of the Colorado Smelter Superfund site. The additional funding will speed up the sampling and cleanup activities in the residential area of the site and should result in the completion of the cleanup about six years sooner than previously estimated. EPA's work will help to significantly lower blood lead levels particularly in children, who are most vulnerable to the harmful effects of lead poisoning. In addition to accelerating the cleanup at the Smelter site, EPA has provided over $500,000 since 2014 to the Pueblo Department of Public Health and Environment for lead investigations, health education and outreach, blood lead screenings and in-home lead risk assessments.

- **American Lead Site, Indianapolis, Indiana (2018).** In spring of 2018, the removal program completed a federal-lead time-critical removal action at the American Lead site. EPA cleaned up 101 residential properties. In September 2018, the remedial program requested the removal program address two additional residential properties with lead results over 1,200 ppm discovered a during remedial sampling event. The two additional properties were cleaned up. In addition, the removal program may need to address a cleanup at a middle school pending analytical results.
- **Jacobsville, Evansville, Indiana (2018).** The Jacobsville Neighborhood Soil Contamination site includes the Jacobsville neighborhood as well as 12 other neighborhoods in Evansville, Indiana. Part of the Jacobsville neighborhood was formerly occupied by several manufacturing companies that date back

to the 1880s. The area includes residential, commercial and industrial properties, but the Superfund cleanup addresses residential properties only. The cleanup consists of ongoing excavation of residential properties (4.5 square miles) to remove lead- and arsenic-contaminated soil. Cleanup is approximately half-way completed, with over 2,000 of an estimated 4,000 properties remediated. The total estimated cost is over $100 million.

- **Smelterville, Idaho (2018).** New Signage at Bunker Hill Superfund Site Recreation Spots. Beginning in Summer 2018, new signs were posted at local recreation spots at the site. The signs give tips for reducing exposure to lead and other harmful metals while enjoying the outdoors. Signs are being placed in areas of known contamination: along the South Fork and Lower Coeur d'Alene River, the Chain Lakes and nearby floodplain, and historical mine sites. Panhandle Health District and the Idaho Department of Environmental Quality had the lead on developing the signs, with input from EPA and other partners.
- **Silver Bow Creek/Butte, Montana (2017–On-going).** As part of the ongoing clean up at the Butte-Silver Bow site, the Residential Metals Abatement Program under EPA oversight continues to conduct assessments and abatements of residential yards and inside homes. In 2017, the program completed 132 projects. The projects consisted of 30 soil abatements, 99 residential attic abatements, and 3 interior dust abatements. Children live or frequently visit most of the residences where abatement activities occurred. Over 400 children were tested and less than 0.02% had elevated blood lead as defined by the Centers for Disease Control and Prevention. In 2017, the program completed 200 environmental assessments that provided targets for 2018 projects. In 2018, 180 assessments and 86 abatements have been completed and 800 flyers and postcards have been sent out thus far. Approximately 75% of 3700 homes have been assessed and/or abated to date.



- **Ithaca, New York (2018).** Lead shot from the Ithaca Gun Company was dumped into a gorge and lead shot and lead contaminated soils have migrated onto a parcel of land popular with outdoor hiker and other outdoor enthusiasts. As part of its ongoing efforts in partnership with New York State and local officials to address soil contamination from the former Ithaca Gun Factory and Ithaca Falls Natural Gorge Trail area, EPA collected samples in September along the cliff face on the southern portion of the Fall Creek area. Because of the steep and difficult terrain in this area, EPA used specialized equipment to sample portions of the 200' high cliff face. The work is ongoing. EPA has already removed more than 6,000 tons of lead contaminated soil from above the gorge and 200 cubic yards of contaminated soil from a one-quarter acre area on the walkway, which has significantly reduced park-goers' exposure to lead contaminated soil.

Environmental Workforce Development and Job Training Program (2018)

This year EPA awarded seventeen grants nation-wide under the Environmental Workforce Development and Job Training Program to train and certify adults in courses related to hazardous and solid waste management, preparing them for jobs in the environmental field. For example, two grant recipients in Region 9, the Los Angeles Conservation Corps (Los Angeles) and Hunters Point Family (San Francisco) were each awarded $200,000 to conduct environmental training, including lead abatement, for unemployed and underemployed adults. By 2020, 108 students from these two programs will be trained and state-certified in lead abatement.

EPA CLEANUP LOWERING LEAD HEALTH RISKS IN NORTHERN IDAHO COMMUNITIES

A massive EPA Superfund cleanup under way in Northern Idaho is seeing big public health successes. Old mining and smelting practices left behind heavy metals like lead throughout the Bunker Hill Superfund Site. Children there once had historically high blood-lead levels, some of the highest recorded in the country. Today, with more than 7,000 residential and recreational properties cleaned up sitewide, those levels are down by more than 50 percent, to near the national average. The cleanup's habitat restoration, trail projects, and hillside re-vegetation have helped make the area a safer destination for outdoor recreation. To encourage people to "Play Clean" outdoors, an active lead health outreach and education program helps limit lead exposure.

The outreach program includes education for families at an annual Kids Health and Safety Fair, in-school activities for early grades, annual blood-lead testing, and much more. This year, EPA worked with partners to train local clinicians about children's blood-lead health.

Shoshone Medical Center's Kids Health and Safety Fair (2018). Annually, EPA partners with the Idaho Department of Environmental Quality and Panhandle Health District to staff an interagency booth at the fair. This event is an opportunity to engage directly with local families about ways to reduce exposures to lead and other toxic metals, while recreating or at home. In 2018, about 600 individuals came to the fair. It's one of our best opportunities for lead outreach and education.

Region 10 Panhandle Health District Fair

Region 10 Panhandle Health District Fair

Addressing Lead under The Brownfields Program

The Brownfields Program is grant-based. Communities compete nationally for either Assessment, Cleanup, Revolving Loan Fund (RLF) or Workforce Development and Job Training grants. Sites with lead contamination are only addressed if they are community priorities. Each EPA Regional office is also provided a small amount of contract funding for direct assessment of some sites under the Targeted Brownfields Assessment Program.

- **Benham, Kentucky (2015–2018).** The Brownfields program is grant-based. Communities compete nationally for either Assessment, Cleanup, Revolving Loan Fund (RLF) or Workforce Development and Job Training grants. Sites with lead contamination are only addressed if they are community priorities. Each Regional office is also provided a small amount of contract funding for direct assessment of some sites under the Targeted Brownfields Assessment Program. A Brownfields Cleanup Grant in the amount of $200,000 was awarded to the city of Benham, Kentucky for the removal of asbestos-containing material (ACM) and lead-based paint (LBP) from a former doctor's office and clinic that was constructed in 1919. Benham plans to the reuse the site as a community resourced, but there were lingering concerns from the building materials. All lead based paint removal from the exterior and interior of the building was performed and completed by Chase Environmental Group in accordance with all applicable removal requirements.

- **Vanceburg, Kentucky (2018).** A Brownfields Cleanup Grant in the amount of $200,000 was awarded to the city of Vanceburg, Kentucky for cleanup activities at the Old Shoe Factory, in 2015 with cleanup completed in September 2018. The grant was managed by the Buffalo Trace Area Development District. Cleanup addressed primarily Asbestos Containing Materials (ACM) but also significant Lead Based Paint (LBP). The lead was in the form of paint which covered the structural brick of the building. The building itself was a 2-story, dilapidated building in complete disrepair. During the cleanup all lead-based painted brick was segregated and disposed of properly. Future land use will be energy efficient, low income housing to support the inflow of new businesses.
- **Spirit Lake Nation, North Dakota (2018).** Using $229,146 in EPA Brownfields grants, the Spirit Lake Tribe cleaned up 12 buildings with lead, asbestos, and other hazardous contaminants. The presence of abandoned, lead-paint contaminated structures on the reservation increases risk of community members' exposure to lead. EPA has provided over $1.4 million in federal funding to support the cleanup of Spirit Lake Brownfields sites.

Brownfields Cleanup, Spirit Lake Reservation. Photo of an abandoned building contaminated with asbestos, lead-based paint, and lead in the soil.

New Testing Method for Lead in Contaminated Soil Protects Public Health and Saves Money

EPA scientists have been working on a bioavailability method that simulates how the human digestive system absorbs lead and arsenic in soil. "Bioavailability" refers to the amount of a substance that is absorbed by the body's gastrointestinal system following exposure. In May 2017, EPA validated the method after it was shown to meet rigorous regulatory acceptance criteria. This means that states and public health risk assessors can use the method during cleanups at EPA Superfund sites and other locations with lead and arsenic contamination issues. In addition to protecting public health, the bioavailability method improves the accuracy of human health risk assessments. Scientists and public health officials can now use the artificial stomach method to determine if arsenic and lead in contaminated soils are bioavailable and, if they are, can then remove those specific sections of soil.

EPA researcher Karen Bradham uses a "virtual stomach" that mimics human digestion to determine if lead and arsenic in contaminated soils are bioavailable.

Learn more at: https://www.epa.gov/sciencematters/new-testing-method-lead-and-arsenic-contaminated-soil-saves-money-and-protects-public.

Recent Activities to Prevent Exposures to Lead Contaminated Soil

- **Birmingham and Anniston, Alabama; Chattanooga, Tennessee; Fair Play and Anderson, South Carolina (2012–2018).** EPA continues to address instances where high lead levels contamination is endangering human health by deploying On-Scene Coordinators (OSCs) to assist with removing contaminated soil and replacing it with clean fill and topsoil. Through EPA's Emergency Response and Removal Program, EPA actively considers residential properties containing high levels of lead in soil a high priority for removal action based on available resources.

- **West Oakland, California (2018).** For more than 10 years, EPA, the California Department of Toxic Substances Control, City of Oakland and Alameda County have partnered to clean up properties in West Oakland contaminated by historical industrial activities. In the spring and summer of 2018, EPA and DTSC removed lead-contaminated soil at 11 residences located close to a former lead smelter. EPA is also conducting a soil study to better understand the presence of lead and other heavy metals in the soil in West Oakland. In 2018 EPA is collecting soil samples from about 200 locations. The results will be posted online and will help EPA and partner agencies identify next steps and prioritize areas requiring further evaluation.
- **Gibbsboro, New Jersey (2017).** In the spring of 2017, EPA reached an agreement with the Sherwin Williams Company to clean up lead-contaminated soil at the Route 561 Dump site. The dump site includes businesses, a vacant lot, White Sand Branch creek, and wetlands. Sherwin-Williams will pay an estimated $14 million to clean up the site and in this phase of the project will remove approximately 23,000 cubic yards of contaminated soil. The excavated areas will be backfilled and a soil cover will be placed over vegetated areas and an asphalt cap will be placed over portions of commercial properties, ensuring that property owners, occupants, and the general public will be protected from future lead exposure.
- **Vineland, New Jersey (2018).** The Former Kil-Tone Company manufactured arsenic-based pesticides from the late 1910s to the late 1930s on the property located in Vineland, NJ. EPA has found elevated concentrations of arsenic and lead related to the former Kil-Tone Company's operations at the facility property and in the soil at properties nearby the former manufacturing facility. Since 2015, EPA has sampled soil at more than 100 properties near the former Kil-Tone facility. In 2016, EPA issued a cleanup plan selecting a remedy of soil excavation, off-site disposal, backfilling and restoration of residential properties known to be impacted by the site. EPA completed sampling, soil removal and restoration work on six properties last fall and winter. This fall, EPA will sample 27 more residences prior to conducting additional cleanup work, thereby reducing potential lead exposure to property owners.
- **West Deptford, New Jersey (2017).** During a routine residential sewer line repair, buried lead battery casings, associated with Matteo and Sons Inc, were found on the property. Former operations at the Matteo site included crushing and recycling batteries, scrap metal recycling, and landfilling. In 2017, EPA finalized it's $9.4 million plan to address lead contaminated soils at approximately 20 residential properties that were impacted by Matteo. Under the EPA's final cleanup plan, soil contaminated at levels that pose a potential risk to people's health will be removed and disposed of properly at a facility licensed to handle the waste. Excavated areas will be covered with clean soil.
- **Lockport, New York (2018).** EPA finalized its nearly $7 million plan to clean up lead-contaminated soil at approximately 28 residences that are impacted by the former Flintkote Plant property at the Eighteen Mile Creek Superfund Site, in Lockport, New York. As part of a multi-phased, comprehensive cleanup of the Eighteen Mile Creek Site, EPA will remove and transport approximately 14,000 cubic yards of contaminated soil for off-site disposal at facilities licensed to handle the waste. The excavated areas will be restored with clean soil.
- **Red Hook, Brooklyn, New York (2018).** Under EPA oversight, the New York City Department of Parks and Recreation (NYC Parks) will begin the cleanup of lead contaminated ball fields in Red Hook Park, Brooklyn. The ball fields were contaminated with lead from a historic secondary lead smelting facility known as Columbia Smelting and Refining Works, which once stood atop what is now Ball Field 7. NYC Parks will remove all part features such as fencing, most of the trees, curbing, other structures and the top layer of soil. NYC Parks will place a visual barrier over the contaminated soil, and cover the barrier with one foot of clean material. Artificial turf will be installed over the ball fields. These actions will reduce potential lead exposures to children using the park for sports activities.
- **Arecibo, Puerto Rico (2017).** Before it temporarily stopped operating in the spring of 2014, The Battery Recycling Company, Inc. smelted lead batteries into lead ingots, which are bars of lead that can be reused in manufacturing. In the process of smelting the lead batteries, The Battery Recycling Company, Inc. generated large quantities of waste, including lead slag and lead-contaminated dust. Workers also

carried lead dust on their clothes into their cars and homes, putting their families and others potentially at risk. As a result of previous operations, the site is contaminated with lead, arsenic and heavy metals. EPA added this former battery recycling facility in Arecibo, Puerto Rico to its Superfund National Priorities List.

- **San Antonio, Texas (2018).** Remediation and removal. Following the Resource Conservation and Recovery Act program assessment of Wood Industries, a former plastic recycler in San Antonio with limited resources, the EPA removed the threat posed by the lead left on the site, approximately 4000 tons of cracked automotive batteries contaminated with 15% lead. While the site is now located in a sparsely developed commercial and industrial area, a new housing development has just started within sight of the facility. EPA will treat the battery casing, chips and ash with a proprietary reagent to allow for proper disposal off-site. The cleanup is expected to take six weeks. After that, efforts to put the property back into productive use will continue.

Clean up at Wood Industries, San Antonio, Texas

- **Coordinating Environmental Health Workshops in Portsmouth, Virginia.** On September 8, 2018, EPA coordinated an environmental health workshop in Portsmouth, Virginia, with federal, state and local partners. Virginia residents living near several Superfund sites attended the workshop to learn more about environmental health topics that impact their communities. The weekend workshop offered representatives from federal, state and local environmental and health organizations who were on hand to distribute literature, engage with residents and answer questions. In addition, the workshop offered free blood lead screening for children with results available in minutes. EPA also offered free soil lead screening. Residents were invited to bring soil samples from their yard or garden and have them screened for lead with same day results. Some of the partners in the workshop included the following: ATSDR; Virginia Department of Health; Virginia Department of Environmental Quality; Virginia Cooperative Extension; Portsmouth Health Department; Hampton Roads Community Health Center; Wesley Community Service Center; the Elizabeth River Project; and others.

EPA's Larry Brown, a Community Involvement Coordinator, discusses the free lead soil screening process with community members at the Portsmouth Environmental Health Fair.

Soil Screening, Health, Outreach and Partnerships — SoilSHOPs

A SoilSHOP (soil screening, health, outreach and partnership) is a community health educational event where people can learn more about potential lead contamination in their soil and how to prevent or reduce exposures. The purpose of a SoilSHOP is to increase community awareness about the hazards of lead in soil, and provide information on how to avoid exposures to lead while gardening or playing in the yard.

SoilSHOP events, performed hand-in-hand with other federal agencies, state and local groups, have had an impact and made a difference in the participating communities. SoilSHOPs are an excellent example of how a multi-disciplinary team can find ways to engage a local community with a known health concern and then take action to reduce the risk associated with the potential exposure to lead contamination in neighborhood soils.

Learn more about soilSHOPs at: https://www.atsdr.cdc.gov/soilshop/faq.html

- **Smelterville, Idaho (2018).** EPA partnered with ATSDR, Idaho Department of Environmental Quality, Panhandle Health District, Idaho Health and Welfare, Silver Valley Community Resource Center, and community members to bring an outreach event called a SoilSHOP to Idaho's Silver Valley. Working with partners, EPA helped deliver a SoilSHOP where community members could get their yard soil tested on the spot. Much work remains, and the cleanup continues, but EPA and our partners cleanup efforts have made the Silver Valley community safer and healthier for all who live, work and play there. Community members were encouraged to bring samples of soil from their homes and neighborhoods to the SoilSHOP to be screened for lead and other metals. The event was held in September 2018, in Smelterville, Idaho, during the Shoshone Medical Center's Kids Health and Safety Fair. It was the first SoilSHOP held at the Bunker Hill Superfund Site.

- **Newburgh, New York (2018).** In April 2018, EPA teamed up with ATSDR, Brooklyn College & USDA to offer Newburgh residents free soil testing at Newburgh's 3rd Annual Urban Farming Fair & SoilSHOP Event. Experts were on hand to interpret results and to provide residents with lead and gardening information. This was part of a broader ongoing effort launched through a partnership with local, state and federal agencies to tackle the serious problem of high blood lead levels in Newburgh's children.

- **Providence, Rhode Island (2018).** In April 2018, EPA, along with ATSDR, conducted their fourth annual event in a Providence, Rhode Island neighborhood with a long industrial history and many active Brownfields projects. EPA partnered with the City of Providence, Groundwork Rhode Island, the Childhood Lead Action Project, and the Southside Community Land Trust. Community members were encouraged to collect a sample of soil from their home or neighborhood and bring it to the SoilSHOP event for lead screening by the EPA Mobile Lab Unit. Forty-five soil samples were screened for lead. The City Parks Department Earth Day Cleanup on April 28th hosted the SoilSHOP event, which was attended by many community members. Feedback from the community and EPA's partners was extremely positive. Participants had an opportunity to talk with health and environmental partners about their results, and were offered additional information on ways to reduce lead exposure around the home and neighborhood, and how and where to get additional soil samples tested for those concerned about lead exposure.

- **Vashon, Washington (2018).** EPA participated in a soilSHOP and educational outreach event at the Vashon Farmer's Market with ATSDR, the University of Washington Pediatric Environmental Health Specialty Unit, state and local health departments, and local community groups. Vashon and Maury Islands are part of the Tacoma Smelter plume where the smelter released particles with lead and arsenic into the air which were deposited downwind in different directions and may still be found in soils.

REDUCING EXPOSURES TO LEAD IN THE AMBIENT AIR

As a result of several regulatory actions over the past two decades, ambient air lead emissions have decreased tremendously. Lead is still emitted into air from a variety of sources including metals processing facilities and combustion of leaded aviation fuel by aircraft with piston-engines. Currently, the source category with the greatest contribution to total U.S. air emissions is piston-engine aircraft operating on leaded fuel. The highest air concentrations in individual locations are currently found near secondary lead smelting operations, such as battery recycling facilities, and other metal processing facilities.

The EPA is taking several steps to identify and help reduce lead emissions from these sources.

- In 2008, EPA significantly strengthened the air quality standards for lead to provide health protection for at-risk groups, especially children. In 2016, the Agency completed a review of the 2008 standards and with regard to the primary (health-based) standard concluding it continues to reflect the current scientific information and provide the requisite protection of public health with an adequate margin of safety, including for at-risk groups. More information is available at: https://www.epa.gov/lead-air-pollution.
- EPA continues to work with state and local air agencies to monitor lead emissions and develop strategies to address high lead concentrations in areas across the U.S. EPA has designated 22 areas as not meeting the 2008 ambient air lead air quality standards. Due to the implementation of effective control measures, all 22 areas are expected to have lead concentrations below the standards by 2021.
- EPA has adopted standards that control lead emissions from specific categories of stationary sources, such as lead smelters and EPA is evaluating lead emissions from the combustion of leaded aviation fuel in small aircraft. In related action and amid concerns about lead emissions from small aircraft, FAA and their industry partners are conducting the Piston Aviation Fuel initiative to identify replacement unleaded

fuels. More information is available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/airport-lead-monitoring-and-modeling

- Information about reductions that have occurred in lead concentrations in ambient air and in lead emissions to ambient air is available at: https://gispub.epa.gov/air/trendsreport/2018/#naaqs_trends *(select "lead" from drop-down menu)*

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ORIGINAL ARTICLE

Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach

Nancy Tian[1], Jianping Xue[2] and Timothy M. Barzyk[3]

Previous studies have reported that lower-income and minority populations are more likely to live near major roads. This study quantifies associations between socioeconomic status, racial/ethnic variables, and traffic-related exposure metrics for the United States. Using geographic information systems (GIS), traffic-related exposure metrics were represented by road and traffic densities at the census tract level. Spearman's correlation coefficients estimated relationships between socio-demographic variables and traffic-related exposure metrics, and ANOVA was performed to test for significant differences in socio-demographic variables for census tracts with low and high traffic-related metrics. For all census tracts in the United States, %Whites, %Blacks, and %Hispanics (percent of tract population) had correlation coefficients greater than 0.38 and 0.16 with road density and traffic density, respectively. Regions and states had correlation coefficients as high as 0.78. Compared with tracts with low road and traffic densities (<25th percentile), tracts with high densities (>75th percentile) had values of %Blacks and %Hispanics that were more than twice as high, 20% greater poverty levels, and one-third fewer White residents. Census tracts that had mid-level values for road and traffic densities had the most affluent characteristics. Results suggest that racial/ethnic and socioeconomic disparities exist on national level with respect to lower-income and minority populations living near high traffic and road density areas.

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Keywords: road density; traffic density; traffic-related exposure; racial/ethnic and socioeconomic disparities; geographic information systems (GIS)

INTRODUCTION

Mobile source emissions are a significant contributor to air pollution levels across the United States. The US Environmental Protection Agency (US EPA) estimates that for 2007 national emission levels, on-road and off-road vehicles produced 68% of the carbon monoxide (CO), 34% of volatile organic compounds, and 57% of nitrogen oxides (NO_x).[1] Exposures to traffic emissions have been associated with multiple adverse health effects, including all-cause mortality,[2] cancer,[3] cardiovascular[4] and cardiopulmonary mortality,[5] adverse birth outcomes,[6] and respiratory diseases[7] including children's asthma.[8,9] These studies have used surrogates of traffic exposure such as proximity and traffic counts for epidemiological studies of health effects associated with vehicle exhaust.

Proximity to major roads has commonly served as an indicator, or representation, of near-road air pollutant concentrations and traffic-related exposures because of the relative consistency of spatial concentration gradients.[10,11] The highest air pollutant concentrations occur in the nearest 50–100 m of a roadway, and elevated spatial gradients extend up to 500 m.[12] For example, a study conducted at a busy expressway in Toronto reported that concentrations of NO_2, and NO_x exhibited a distance decay function and approached background concentrations within 400 m, whereas O_3 had inverse pattern with higher concentrations further away from the expressway.[13] In North American urban areas, 30% to 45% of the population lives or works in the exposure zone highly affected by traffic emissions, within a distance of up to 300–500 m of a highway or major road.[14]

Multiple distances within the near-road exposure zone have been used to represent traffic exposure in epidemiological studies. Respiratory symptoms in children have been associated with distances up to 300 m from major roads,[15] as well as 50 m,[9] 75 m,[16] 100 m,[17,18] and 150 m.[18] Based on a cohort of adults 45–75 years old in Germany, Hoffmann and colleagues[19,20] conducted two studies on residential exposure to traffic and found that the adjusted odds ratio for coronary heart disease and coronary artery calcification was significantly elevated to 1.85 (95% CI: 1.21–2.84) for participants living within 150 m from a major road and 1.63 (95% CI: 1.14–2.33) for participants living within 50 m compared with the ones living beyond 200 m. Sensitivity analyses that evaluate various distances from major roads as indicators of exposure in epidemiological studies have not yet to be fully examined.

The disproportionate distribution of air pollution sources and exposures in areas with lower-income and minority populations supports concerns of environmental injustice.[21,22] When compared with reference areas, disadvantaged neighborhoods with lower-income residents and people of color often bear disproportionate burdens from elevated pollutant concentrations, greater exposure to traffic emissions and increased incidences of adverse health end points. Previous studies reported that schools near

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major roads tend to have higher percentages of minority students, and more students enrolled in a meal program and residing in poor areas, when compared with reference schools.[23,24] Two studies in Southern California used emission inventories to assess lifetime cancer risks associated with air pollutant sources and found that transportation was most associated with cancer risks, especially among minority groups.[25,26]

Geographic scale is an important consideration for environmental equity studies, particularly in analyzing near-road exposure. The selection of appropriate scale has been challenging to capture the spatial gradients of traffic-related air pollutants because of the insufficient information available at finer scale such as 500 m away from major roads. A few studies found that high-poverty census block groups in California with greater concentrations of African Americans and Hispanic children were two to three times more likely to have higher traffic density measures based on vehicle miles traveled (VMT) per square mile.[27,28] Other studies evaluated associations between air pollution exposure, socio-demographic characteristics, and cancer risks at the census tract level.[23] In addition, census tract areas have been identified as an optimal scale to assess relationships between socioeconomic status (SES) and health disparities because census tracts with population size of about 4,000 are designed to have homogeneous population characteristics and SES.[29]

Research to-date remains limited in examining demographic information in the context of traffic-related air pollution to better understand possible environmental justice concerns, and has primarily focused on air pollution from stationary sources instead. Based on our review of the literature, no studies have yet evaluated traffic-related exposure and the demographics of people living near roads for a large geographic area at census tract resolution, such as for the entire United States. The purpose of this study is to evaluate associations between socio-demographic characteristics and traffic-related exposure metrics (road and traffic densities) at the national, regional, and state level.

MATERIALS AND METHODS

Because of the lack of air monitoring stations near roadways, other parameters were developed to characterize potential exposure to traffic emissions.[27] Two traffic indicators at the census tract level were used in this study: road density and traffic density (described below), because of their demonstrated correlations with measured mobile source pollutants.[27,30]

Road density is calculated as the ratio of road area to census tract area, which includes a buffer zone adjacent to the road, and is reported as a percent. In a childhood cancer study, Reynolds et al.[30] used a similar road density metric based on the total length of a road within a block group as a proxy for exposure to traffic emissions. Road density in this study is highly correlated with the road density metric that is based on the total length of major roads (Spearman correlation coefficient: 0.93). Air pollutants related to traffic generally disperse and reach to regional background level within 300–500 m away from roadways. Thus, the road density metric in this study takes into consideration the zone influenced by mobile source emissions. Major road network data sets were obtained from ESRI (http://www.esri.com) and represent interstate, US and state highways, and other major thoroughfares, which are classified based on feature classification codes. The basic assumption is that all major roads have the same impacted exposure zone regardless of the width of the major roads. We conducted sensitivity analyses of road densities that used buffer distances of 100, 150, 300, and 500 m.

Traffic density was estimated using the length of road segments and vehicle traffic counts. National traffic counts were obtained from the high-performance monitoring system (HPMS) maintained by the Bureau of Transportation Statistics, which reports the average daily traffic counts for a given road segment and is compiled periodically from state-collected data. For each road segment, VMT was calculated as the product of the road segment length and its average annual daily traffic (AADT). We estimated traffic density by summing VMT for all road segments within a census tract and dividing by the area of the census tract. Traffic density has units of VMT per square mile per day shown in Eq. (1). Two different road networks have been used to estimate road density and traffic density because only 35% portion of the major road network from ESRI has traffic count information recorded by HPMS.

$$\text{Traffic density} = \Sigma(\text{Length} * \text{AADT})/\text{Area} \qquad (1)$$

Census tracts with zero values for road and traffic densities were considered separately from the other census tracts as a different exposure category because of their lack of major roads. Based on a quartile distribution of road and traffic densities, the non-zero census tracts were further categorized into four groups for reporting purposes. Census tracts with the lowest quartile ($<$25th percentile) were considered the reference group of low exposure; census tracts in the second quartile ($<$25th–49th) were considered low-medium exposure; the third quartile (50th–75th) were medium–high exposure; and the highest quartile ($>$75th) was defined as the high-exposure group.

Socioeconomic and demographic variables at the census tract level were obtained from the 2000 Census. The three racial/ethnic variables, percent Whites (%Whites), percent Blacks (%Blacks), and percent Hispanics (%Hispanics), were calculated as a ratio of the corresponding racial/ethnic population and the total census tract population. The three SES indicators included the percent of households under the poverty line, the percent population greater than 25 years old with less than a high school education, and the median household income. We evaluated relationships between the two traffic metrics and socio-demographic variables using Spearman correlation coefficients calculated with SAS 9.2 statistical software (SAS Institute, Cary, NC, USA). ANOVA was performed to test for significant differences in socio-demographic variables for census tracts with low and high traffic-related metrics.

RESULTS

Road Density Values Ranged from 0 (Very Rural Areas) to 100% (Very Metropolitan Areas)

The national average road density increased from 25% with a 100 m buffer, to 34% for a 150 m buffer, to 53% for a 300 m buffer, and to 66% for a 500 m buffer. The national average traffic density was 33,444 VMT per day per square mile. For the United States, national average socio-demographic variables based on all census tracts were 74% Whites, 14% Blacks, 12% Hispanics, 13% households below poverty level, 21% of people older than 25 with less than high school education, and an average median household income of $43,957.

Spearman correlation coefficients describing associations of road and traffic densities with racial/ethnic and SES variables for the United States are reported in Table 1. Correlation coefficients based on road density showed negligible differences for buffer distances between 100 and 500 m. Thus, we selected the commonly used 300 m buffer as the distance for the road density metric for further analyses. Racial/ethnic and SES variables were significantly correlated with road and traffic densities with *P*-value $<$0.001. Based on the 300 m buffer, correlation coefficients of road density and traffic density with %Whites were $-$0.44 and $-$0.17, for %Blacks were 0.39 and 0.16, and for %Hispanics were 0.37 and 0.16, respectively. Negative coefficients indicate that tracts with higher %Whites had lower road and traffic densities. Compared with racial/ethnic variables, SES had relatively lower correlation coefficients for road and traffic density. The strongest correlation coefficients based on the SES indicators occurred for %Poverty. Median household income had a negative correlation coefficient of $-$0.07 for road density, and %Less than high school education had an insignificant correlation coefficient of 0.002 with $P>0.05$. Overall, SES indicators were more related to road density than traffic density, and racial/ethnic variables had stronger associations than SES with the two traffic metrics.

The correlation coefficients between the traffic metrics, SES, and racial/ethnic variables were spatially dependent, but remained significant ($P<0.05$) for different regions of the United States (Table 2). According to the 2000 Census, the Northeast region has 13,180 census tracts, the Midwest has 16,451, the West has 13,681, and the South has 21,839. The Northeast region had correlation coefficients of −0.63 for %Whites, 0.53 for %Blacks, and 0.60 for %Hispanics with road density. However, the South region had the lowest correlation coefficients of −0.33 to 0.31 for all racial/ethnic variables, suggesting perhaps those racial/ethnic groups are more spatially distributed in this region. Negative signs for the coefficients indicate that tracts with higher median household income and higher %Whites represent potentially lower traffic-related metrics. Among all the SES indicators, the Northeast region had the highest correlation coefficients between %Poverty and the traffic-related metrics. Compared with road density, the correlation between traffic density, SES, and race was relatively weaker and in some cases was not significant. Among all the regions, the West had the highest correlation coefficients for traffic density with %Whites (−0.38), %Blacks (0.29), and %Hispanic (0.23). With regard to SES, road density had higher correlation coefficients than traffic density. For example, the West region had significant and slightly weaker relationships between traffic density and %Poverty (0.11), %Less than high school (0.13), and a low but negative correlation with median household income (−0.05). The South and Midwest regions had coefficients for traffic density and SES indicators as low as 0.01 and P-values >0.05, further demonstrating the spatial dependence.

The 10 states with the highest correlation coefficients between traffic-related metrics, SES indicators, and race/ethnicity are shown in Table 3 with their respective values. These state-level correlation coefficients were more than twice as high as the ones for the regions. Specifically, correlation coefficients were substantially greater for associations between traffic density, the SES indicators, and racial/ethnic variables. Moreover, coefficients for all the racial/ethnic variables and SES indicators had different strengths with the two traffic-related metrics based on the state, primarily owing to spatial distributions of race/ethnicity, SES indicators, and traffic-related measures among the states. For example, Maine had the highest correlation coefficient between %Blacks and the road density metric (0.78), but overall, Maine did not have the highest values for all SES indicators with the traffic density metric. Instead, Rhode Island ranked as the state with the highest overall correlation coefficients for road density with −0.74 for %Whites, 0.71 for %Blacks, 0.74 for %Hispanics, 0.70 for %Poverty, and −0.74 for household median income. Figure 1 illustrates the spatial distributions of road and traffic density, race/ethnicity, and the SES indicators for Rhode Island. The Providence metropolitan areas had the higher %Blacks, %Hispanics, and %Poverty, %Less than high school with the highest road density, compared with the surrounding rural areas with lower %Whites, higher median household income, and higher traffic density. The top 10 states had relatively lower but still strong correlation coefficients for traffic density compared with road density. For traffic density, Iowa had the highest correlation coefficient of −0.48 for %Whites, Montana had the highest of 0.58 for %Blacks and New Hampshire had the highest for %Hispanics of 0.46. Rhode Island still had the highest coefficients overall for traffic density, with 0.41 for %Poverty, 0.38 for %Less than high school, and −0.46 for median household income (Table 3 and Figure 1).

All census tracts in the United States were further categorized into five groups including zero value and quartile distributions of non-zero values based on road and traffic densities. Table 4a shows the number of census tracts and the average values of the SES indicators and racial/ethnic variables among each group of traffic-related metrics, including Zero, Low, Low–Medium, Medium–High, and High. Out of 65,334 census tracts, 175 (0.3%) had zero values for road density and 14,271(21.8%) census tracts had zero values for traffic density. On average, tracts with high road

Table 1. Spearman correlation coefficients of traffic-related metrics with racial/ethnic and SES variables for all census tracts in the United States.

	Road density (buffer distance)				Traffic density
	100 m	150 m	300 m	500 m	
Race/ethnicity					
%Whites	−0.43	−0.43	−0.44	−0.45	−0.17
%Blacks	0.38	0.38	0.39	0.39	0.16
%Hispanics	0.37	0.37	0.37	0.38	0.16
SES					
%Poverty	0.14	0.15	0.15	0.14	0.01
%Less than high school	0.05	0.05	0.06	0.06	0.002*
Median household income	−0.07	−0.07	−0.07	−0.06	0.01

Abbreviation: SES, socioeconomic status.
*The correlation coefficient was not significant ($P>0.05$). There are 65,634 census tracts in total in the United States according to 2000 Census.

Table 2. Spearman correlation coefficients of traffic-related metrics with racial/ethnic and SES variables by region.

	Northeast		Midwest		West		South	
	Road density	Traffic density	Road density	Traffic density	Road density	Traffic density	Road density	Traffic density
Race/ethnicity								
%Whites	−0.63	−0.0008*	−0.66	−0.24	−0.38	−0.25	−0.33	−0.17
%Blacks	0.53	0.05	0.66	0.26	0.49	0.29	0.25	0.14
%Hispanics	0.60	0.01*	0.41	0.18	0.31	0.23	0.31	0.17
SES								
%Poverty	0.41	−0.07	0.21	−0.01*	0.15	0.11	0.03	0.01*
%Less than high school	0.35	−0.06	0.13	−0.01*	0.15	0.13	−0.12	−0.05
Median household income	−0.26	0.01	−0.15	0.04	−0.07	−0.05	−0.03	−0.01*

*The correlation coefficient was not significant ($P>0.05$). There are 13,180 census tracts in the Northeast, 16,451 census tracts in the Midwest, 13,681 census tracts in the West, and 21,839 tracts in the South.

Table 3. The top 10 states with the highest correlation coefficients of traffic-related metrics with racial/ethnic and SES variables: (1) %Whites, (2) %Blacks, (3) %Hispanics, (4) %Poverty, (5) %Less than high school education, and (6) median household income.

Rank	State (1)	%Whites	State (2)	%Blacks	State (3)	%Hispanics	State (4)	%Poverty	State (5)	%Less than high school	State (6)	Median household income
Road density												
1	RI	−0.74	MN	0.78	RI	0.74	RI	0.70	SD	0.46	RI	−0.74
2	IN	−0.73	NE	0.76	NH	0.70	MA	0.56	ND	0.38	CT	−0.55
3	IA	−0.71	OR	0.75	CT	0.65	NJ	0.53	MT	0.27	NJ	−0.46
4	MN	−0.71	IA	0.74	AK	0.65	CT	0.52	AK	0.24	MA	−0.45
5	WI	−0.70	IN	0.72	MA	0.62	NY	0.40	NV	0.21	IN	−0.42
6	NH	−0.70	NH	0.72	WI	0.62	IN	0.40	VT	0.17	OH	−0.40
7	IL	−0.69	WI	0.72	NY	0.59	PA	0.38	RI	0.16	PA	−0.37
8	NE	−0.67	RI	0.71	IA	0.58	OH	0.37	UT	0.16	MD	−0.34
9	MO	−0.67	KS	0.68	MN	0.56	MD	0.35	NJ	0.14	VT	−0.31
10	MA	−0.65	AK	0.67	NJ	0.55	VT	0.34	CT	0.10	WI	−0.26
Traffic density												
1	IA	−0.48	MT	0.58	NH	0.46	RI	0.41	RI	0.38	RI	−0.46
2	KY	−0.48	WY	0.52	MT	0.45	MA	0.217	HI	0.17	WA	−0.20
3	RI	−0.47	WA	0.51	RI	0.44	WA	0.19	UT	0.14	LA	−0.18
4	NH	−0.46	IA	0.49	IA	0.40	FL	0.18	CA	0.13	FL	−0.16
5	ME	−0.43	ME	0.48	AK	0.39	LA	0.16	FL	0.12	NV	−0.15
6	MI	−0.42	RI	0.47	ME	0.37	MI	0.14	MI	0.12	WY	−0.12
7	WA	−0.41	NM	0.47	OK	0.35	CA	0.14	WA	0.10	OH	−0.11
8	NE	−0.37	AK	0.46	KY	0.34	NV	0.13	NV	0.10	MA	−0.11
9	OR	−0.36	KY	0.44	OR	0.34	WY	0.11	NJ	0.10	CA	−0.10
10	MO	−0.36	NE	0.44	WI	0.34	UT	0.11	CT	0.10	TX	−0.10

density (>75th percentile) had up to 3.4 times greater values for %Blacks and 3.3 times greater for %Hispanics compared with the low road density tracts (<25th percentile) (Table 4a). In contrast, average values for the SES indicators of %Poverty and %Less than high school had ratios of 1.5 and 1.2, respectively, between the high and low road density categories. High road density tracts had one-third less White residents (ratio: 0.67) and slightly lower median household income than low road density tracts (ratio: 0.95). The difference between high and low road density census tracts were significant at *P*-value of 0.05, tested by ANOVA. Surprisingly, both low–medium and medium–high groups had lowest poverty (%Poverty and %Less than high school education) and highest affluence (median household income) than the low and high road density tracts. Overall, the medium categories suggest greater affluence and education compared with the low and high road density groups of census tracts.

For traffic density, the average values of SES indicators and race/ethnicity were less than those for road density for all quartile categories (Table 4b). There were 14,271 census tracts (21.7%) with zero traffic density because not all major roads had recorded traffic count information from HPMS. The zero traffic density group had similar values to those for the high density group, with an average 66.5% Whites, 18.2% Blacks, 13.8% Hispanics, 13.3% below poverty, 20.8% less than high school education, and a $45,922 median household income. The high traffic density group had 2.7 times greater %Blacks and 2.6 times greater %Hispanics than the low traffic density group. As traffic density increased, %Whites decreased and %Blacks and %Hispanics increased correspondingly. High traffic density tracts had 1.2 times greater %Poverty, 1.1 times greater %Less than high school education. Median household income was slightly higher in high traffic density tracts. Ratios less than 1 indicate that higher %Whites were more likely to live in low traffic density areas. ANOVA tests revealed significant differences for census tracts with high and low traffic density. Although %Blacks and %Hispanics increased and %Whites decreased from the low to high groups, low–medium and medium–high traffic density groups had the lowest poverty and highest SES similar to road density.

DISCUSSION AND CONCLUSIONS

By analyzing all census tracts in the United States, this research found that the two traffic metrics, road density and traffic density, were significantly correlated with race/ethnicity and SES indicators. We further found that the correlations spatially varied based on geographic regions and individual states, and were significant with correlation coefficients as high as 0.78. Minority populations and lower-income groups were more likely to live in census tracts with high road and traffic densities in contrast to Whites and affluent populations, suggesting a greater potential for exposure to traffic emissions. The two exposure surrogates of road and traffic density metrics could be used to evaluate health effects of road transportation-related air pollution exposure in epidemiological studies, which need to consider SES and racial/ethnic confounders as well. The study found that Black and Hispanic families with lower SES were more likely to live in census tracts with greater road and traffic densities compared with non-minority and higher-income populations. These results are consistent with prior studies that minority and lower-income neighborhoods are more likely to be associated with higher traffic exposures and greater health risks;[27,28] however, in contrast to the local-scale findings, results presented here are at the national scale.

Census tracts with higher traffic-metric values had higher poverty levels compared with census tracts with lower values for traffic metrics, whereas tracts within the mid-range of the traffic metrics had the highest SES, which suggests that affluent individuals might have convenient access to transportation, but can afford areas that are less-impacted in terms of air quality and road noise exposure.[31,32] Bae et al.[33] found that in the 1990s, single-family home developments in the freeway air-pollution shed of Seattle, Washington, were five times larger with lower housing values compared with the 1980s. Correspondingly, in the freeway air-pollution shed, the population of Blacks was two to three times higher, and the number of residents below poverty level was elevated 1.2–1.4 times compared with the corresponding urban growth area. Minority and lower-income groups had lower rent and housing costs at the cost of greater traffic-related exposure.

Sensitivity tests on the various buffer distances concluded that the correlation coefficients between road density, the SES indicators, and race/ethnicity did not vary much with buffer distance at the aggregate level. Empirical studies have shown that air pollutant concentrations decrease with distance and reach regional background levels within 300–500 m from roadways.[12] Although buffer distances and proximity have been used as alternatives to exposure monitoring,[5,16] few studies investigated what buffer distances should be used to categorize traffic exposure. For example, Ross et al.[34] found that traffic within 300 and 500 m buffer distances near $PM_{2.5}$ air monitors explained 33–47% of the variance in land use regression models. The sensitivity tests of buffer distance in this study supports that a 300 m buffer is suitable to capture

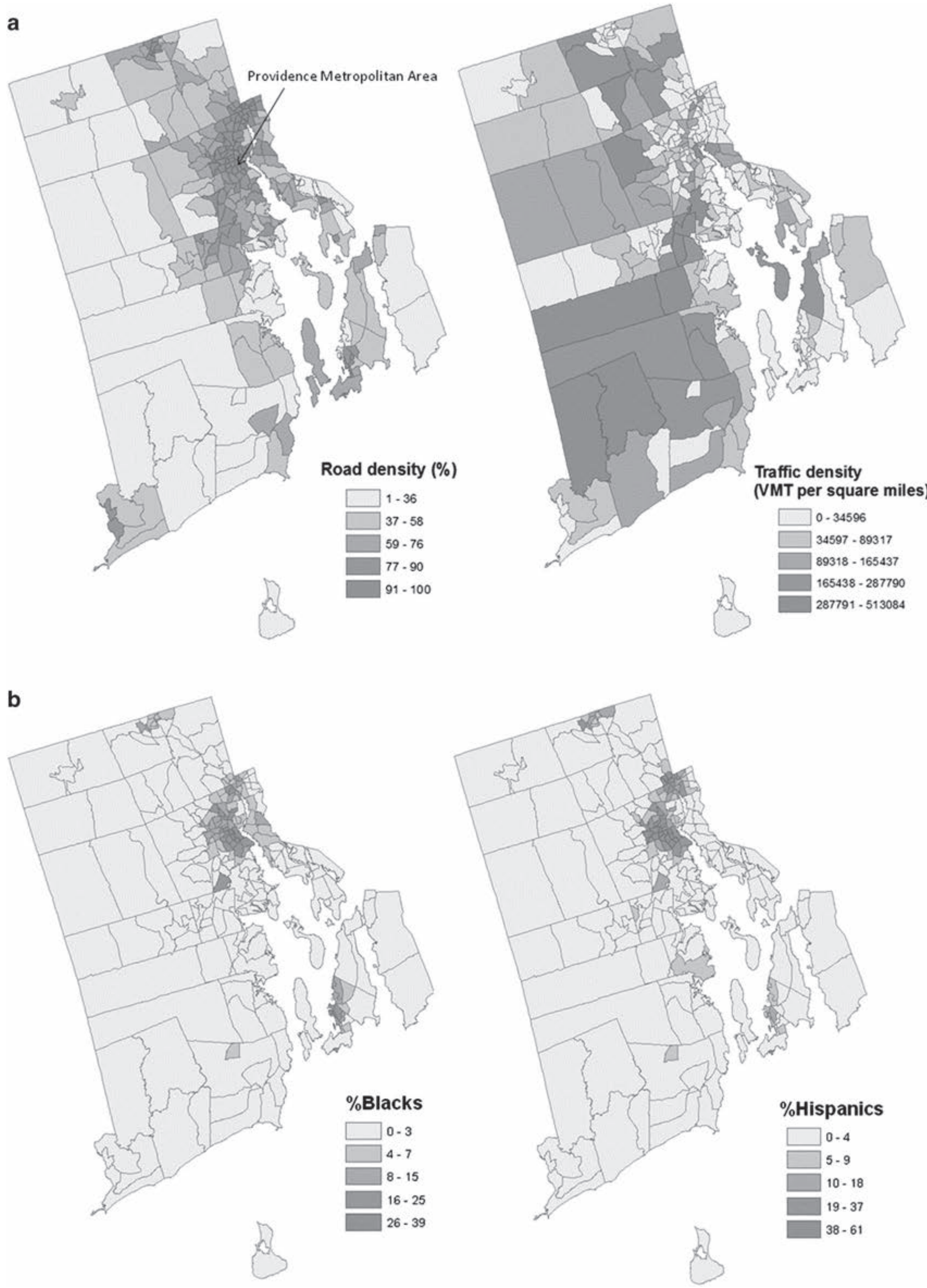

Figure 1. Spatial distributions of traffic-related metrics and racial/ethnic and SES variables in Rhode Island: (**a**) road and traffic densities, (**b**) %Blacks and %Hispanics, (**c**) %Poverty and %Less than high school education, and (**d**) %Whites and median household income.

Figure 1. Continued.

potential near-road exposures when using a buffer-based approach.

Results reveal a stronger association with the SES indicators, race/ethnicity, and road density than with traffic density at the census tract level. First, the difference between correlation coefficients for the two traffic metrics signify that road density may capture more aspects of social structure than traffic density. For example, the Southern California Children's Health Study[35] found that length-of-road within the 50 m–200 m buffer to the residence of the asthmatic children was the only significant indicator of the

Table 4. The average values of racial/ethnic and SES variables based on the groups of traffic-related metrics for all census tracts in the United States.

Exposure	Percentile	Census tracts (#)	%Whites	%Blacks	%Hispanics	%Poverty	%Less than high school	Median household income ($)
(a) Road density								
Zero	—[a]	175	45.6	10.8	6.4	11.4	15.7	29,696
Low	<25th	16,290	86.1	6.8	5.6	12.1	21.5	40,373
Low–Medium	25th–49th	16,290	80.9	10.3	8.4	9.7	17.0	50,463
Medium–High	50th–74th	16,290	71.5	15.0	13.3	11.6	19.0	46,942
High	>75th	16,290	58.1	22.9	18.7	18.0	25.6	38,400
High/low	—[a]	—[a]	0.67	3.4	3.3	1.5	1.2	0.95
(b) Traffic density								
Zero	—[a]	14,271	66.5	18.2	13.8	13.3	20.8	45,922
Low	<25th	12,766	86.1	7.1	5.8	12.7	21.7	38,812
Low–Medium	25th–49th	12,766	82.2	10.1	7.6	11.1	19.1	45,544
Medium–High	50th–74th	12,766	74.2	14.0	11.5	12.1	19.0	46,180
High	>75th	12,765	62.2	18.8	15.6	14.8	23.1	43,094
High/low	—[a]	—[a]	0.72	2.6	2.7	1.2	1.1	1.1

Rate ratio = high/low. The rate ratio between high and low traffic-related metric tracts was significant, tested by ANOVA.
[a]Not applied.

fractional concentration of nitric oxide in exhaled air, which is associated with traffic-related exposures. The length-of-road metric was similar to road density presented here, but the Children's Health Study did not find a correlation between length-of-road and other TRP metrics such as traffic density. The discrepancy for associations of socio-demographic variables between road density and traffic density may be explained in part by using two different road networks to calculate the road and traffic density metrics. The ESRI major road layer that estimated road density contains interstates, state highways, major streets, and other major thoroughfares and was well aligned with digital orthophotographs. However, AADT from HPMS includes only freeways, highways, principal arterials, and minor collector roads, and no other road types. For the United States, the total length of the road network from HPMS (for traffic counts) was only 35% of the total length of the major roads from ESRI (used to calculate road density). This disagreement between road network data indicates that the use of HPMS could underestimate exposure to traffic emissions and reduce the corresponding associations with socio-demographic variables. Thus, future research warrants attention as to how road type impacts the estimate of traffic-related metrics.

The study has the following limitations. First, traffic density based on AADT did not take into account truck fraction, which is unavailable at the census tracts level. This could raise bias in the SES and racial differences for the traffic density metric because a census tract with more heavy-duty vehicles could increase air pollution exposure compared with a lighter duty fleet. Second, there are a number of other factors that influence exposure to traffic but are beyond the scope of this study. These factors include meteorology (wind speed/direction, turbulent parameters, etc), topography, and the influence of the built environment (urban street canyons). However, the two area-based traffic metrics (road density and traffic density) have been empirically correlated with ambient monitoring data,[30] which suggests that they are suitable surrogates for exposure as well.

Interactions between multiple social factors and increased exposure to pollution have placed lower-income and minority groups at potentially higher risk of adverse health effects, with traffic emissions as a contributing factor.[36] Epidemiological research has focused in particular on susceptible life stages such as children and older adults. Previous studies reported that children who live near high traffic major roads demonstrate increased incidences of respiratory symptoms, especially related to children's asthma.[37,38] Studies on elderly subjects suggest that traffic particles had an adverse effect on heart rate variability and may alter autonomic balance, thus increasing cardiac risk.[39,40] However, relationships between health risks and traffic exposure are not always apparent. For example, a study in California found no evidence of a significant association between traffic exposure and childhood cancer using road and traffic density metrics.[3] More research is needed to quantify the relationships between exposure to mobile source emissions (type and quantity) and related health end points, to disentangle the health effects from air pollution exposure and SES, to understand the causality of traffic-related pollution on cardiovascular and respiratory diseases, and to more fully understand SES and race/ethnicity modifications to exposure and disease development. In 2011, US EPA revised the NO_2 and CO National Ambient Air Quality Standards (NAAQS) and required the collocation of one CO monitor with a near-road NO_2 monitor in urban areas with population greater than one million.[41] The new monitoring network will provide data for comparison to the NAAQS and indicators such as those identified in this study. This network will also help characterize traffic-related exposure for people who live and work close to major roads.

This study has implications for traffic-related exposure assessments that target communities with higher percentage of lower-income and minority populations and focus on exposure reduction actions, especially in neighborhoods with high proportions of susceptible sub-populations such as children and the elderly. An example of exposure reduction actions in California includes California Senate Bill 352, which prohibits setting a school within 500ft (168 m) of a freeway or other busy traffic corridor.[42] Urban planning zoning remedies may be efficient exposure reduction initiatives by stipulating land-use regulations for new housing developments. Alternative transportation strategies such as promoting public transportation also hold great promise to improve air quality and reduce health risks from vehicle exhaust.

In summary, the evidence from this large national study suggests that minority groups and people with lower SES tend to live in census tracts with higher road and traffic density metrics, which may be more impacted by traffic-related emission sources. Further studies are warranted to evaluate the area-based traffic-related metrics with the air pollutant monitoring. More refined exposure metrics are needed to assess the effects of near roadway air pollution on the human health outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

We are greatly thankful for all the technical reviewers of the manuscript, especially Andrew Geller and Karen Wesson of the Environmental Protection Agency.

Disclaimer

This article has been subject to review and approved for publication by the Office of Research and Development, the United States Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF EVE C. GARTNER
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, Eve C. Gartner, declare and state as follows:

1. I am the Director of Crosscutting Toxics Strategies at Earthjustice, a nonprofit public-interest environmental law firm, and am an attorney licensed to practice law in the state of New York. I have been employed as an attorney by Earthjustice since May of 2011. Prior to my current position, I served as the Managing Attorney of Earthjustice's Toxic Exposure and Health Program and, before that, as a Staff Attorney. The information in this declaration is based on my personal knowledge and experience.

2. In 2015, I began to work with Earthjustice's client Ecology Center, Inc. (the "Ecology Center"), a Petitioner in this case, to push the Environmental

Protection Agency ("EPA" or the "Agency") to make good on its 2009 commitment to ban lead wheel weights and to try to understand why EPA had not concluded the rulemaking it promised to undertake in the hope we might be able to help address any Agency roadblocks.

3. In May of 2015, Jeff Gearhart, the Ecology Center's Research Director, wrote to EPA inquiring about the status of EPA's work to develop a rule regulating lead wheel weights following EPA's grant of the Ecology Center's 2009 petition, which was based on section 21 of the Toxic Substances Control Act ("TSCA"). A true and correct copy of that letter, on which I was copied, is attached hereto as Exhibit 1.

4. In June of 2015, Earthjustice and the Ecology Center submitted a request under the Freedom of Information Act ("FOIA"), 5 U.S.C. § 552, seeking information related to EPA's decision to grant the 2009 petition, the proceeding EPA commenced, and any decision to abandon the rulemaking, as well as communications with entities within and outside the U.S. Government regarding the 2009 petition or the rulemaking process commenced in response to it.

5. One of the documents that EPA produced in response to that FOIA request was a peer draft report titled "Approach for Estimating Changes in Blood Lead Levels from Lead Wheel Weights." A true and correct copy of that produced draft report is attached hereto as Exhibit 2.

6. In May of 2016, Mr. Gearhart and I—along with several additional environmental and public-health advocates; representatives from lead wheel weight manufacturers, an aftermarket tire retailer, and a state pollution control agency; and a scientist who studied exposures to lead from lead wheel weights—met with EPA to discuss concerns about EPA's delay in proposing a rule to ban the manufacture, processing, and distribution of lead wheel weights under TSCA. Following that meeting, on June 15, 2016, Mr. Gearhart and I sent a follow-up letter to EPA summarizing what we and others conveyed to EPA during the meeting and explaining how a ban on lead wheel weights would fit within the amended TSCA that had just been presented to President Obama for signature. A true and correct copy of that letter is attached hereto as Exhibit 3.

7. EPA responded by letter dated July 11, 2016, stating that EPA was reviewing the new law and determining next steps related to lead wheel weights in light of the amended TSCA, which had, by that time, been signed into law. A true and accurate copy of that letter is attached to this declaration as Exhibit 4.

8. Since receipt of the July 2016 letter, I have received no further communication from EPA regarding the regulation of lead wheel weights or the granted 2009 petition.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 19, 2023 in Brooklyn, New York.

Eve C. Gartner

Exhibit 1 to Declaration of Eve C. Gartner in Support of Petition for Writ of Mandamus

ECOLOGYCENTER
Healthy People, Healthy Planet

May 27, 2015

Wendy Cleland-Hamnett, Director
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Dear Ms. Cleland-Hamnett, Ms. Golightly-Howell, Mr. Jones, and Mr. Tejada,

I write to inquire about the status of EPA's proceeding under the Toxic Substances Control Act ("TSCA") that was instituted in response to our May 28, 2009 TSCA Section 21 Citizens' Petition for a rule prohibiting the manufacture, processing and distribution in commerce of lead wheel balancing weights. By letter dated August 26, 2009, EPA granted our petition and stated that it "will promptly commence an appropriate proceeding under TSCA… through either an Advance Notice of Proposed Rulemaking or a Proposed Rule." According to EPA's Regulatory Development and Retrospective Review Tracker, a proceeding was initiated in October 2009, almost six years ago (**RIN:** 2070-AJ64). The Regulatory Tracker acknowledges that regulating lead wheel weights is likely to "address an adverse impact on" children and has environmental justice implications for children in urban environments who are the most affected by the continued, unnecessary use of lead wheel weights.

To date, EPA has not issued an Advance Notice of Proposed Rulemaking or a Proposed Rule as promised in the letter granting the TSCA Section 21 Citizens' Petition. Progress to address this significant ongoing release of lead to the environment has been effectively halted by EPA's lack of action on this rulemaking. We estimate that approximately 50% of the market continues to use the lead product, despite viable, lead-free alternatives being extensively used.

State environmental agencies, through The Environmental Council of the States (ECOS), have also supported federal action on this issue since 2008. ECOS Resolution 08-9 *"PHASING OUT THE SALE AND INSTALLATION OF LEAD WHEEL WEIGHTS*," was originally approved by ECOS in April 2008 and most recently revised and renewed in April 2014. The resolution "…requests that U.S. EPA move forward on its notice under TSCA to initiate regulatory action…"

Given the critical importance of moving forward with this rulemaking as soon as possible, the petitioners would like to set up a phone call to discuss the status of the Agency's work to commence a proceeding under TSCA regarding lead wheel weights.

Please let us know of your earliest availability for such a call. I can be reached by phone at (734) 369-9276 or by email at jeffg@ecocenter.org. Once we have a time set up, I will be in touch with the other petitioners to invite them to participate.

Sincerely,

Jeff Gearhart, Research Director
Ecology Center

cc: Eve C. Gartner, Earthjustice Staff Attorney
Todd Parfitt, ECOS Waste Committee Chair & Wyoming Department of Environmental Quality Director
Lia Parisien, ECOS Executive Project Manager

Exhibit 2 to Declaration of Eve C. Gartner in Support of Petition for Writ of Mandamus

Approach for Estimating Changes in Blood Lead Levels from Lead Wheel Weights

Peer Review Draft Report

November 9, 2011

Prepared by
Office of Pollution Prevention and Toxics
U.S. Environmental Protection Agency
Washington, DC

Contributors

The EPA staff responsible for this report are Christina Cinalli, Angela Howard, and David Lynch. Analytical and draft preparation support was provided by ICF International, Research Triangle Park, NC under EPA Contract No. EP-C-09-009.

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EXECUTIVE SUMMARY

EPA is evaluating options to address the potential risks posed by lead wheel weights. These wheel weights can be lost from cars and can enter the environment, leading to potential exposures to children and adults who inhale or ingest roadway particles containing wheel weight lead or who drink contaminated water. In addition, wheel weights may be collected by home hobbyists and melted for use in making bullets, fish sinkers, or other hobby items.

There is a large database of studies on the health effects associated with lead, focusing primarily on neurological, cardiovascular, immune, reproductive, and blood effects. However, there are also studies examining associations between lead exposure and effects on the hepatic system, gastrointestinal system, endocrine system, bone and teeth, ocular health, respiratory system, and cancer. Neurocognitive effects in children are of particular concern due to the increasingly lower levels at which they have been reported and the potential for lifelong impact. Recent studies have reported negative associations between blood lead concentrations in children and IQ, as well as neurocognitive effects such as reading and verbal skills, memory, learning, and visuospatial processing, at blood lead concentrations as low as 2 µg/dL. In addition, studies focusing on behavioral problems, such as anxiety, distractibility, conduct disorder and delinquent behavior, have noted effects at blood lead levels ranging from 3-11 µg/dL. These new studies, which have examined blood lead levels in the range of 0.8 to >10 µg/dL, strengthen the evidence that there may not be a threshold associated with blood lead exposures. Studies on other health outcomes have reported effects at blood lead concentrations between 5-10 µg/dL or higher.

This approach document investigates the exposure to lead wheel weights in two exposure scenarios. In the first case, wheel weights are lost from vehicles near the roadway and eroded due to abrasion with other vehicles or debris. The lead is then released to the air as part of the roadway dust due to turbulence from the wind field or from passing vehicles. As this lead migrates to nearby homes, it can enter the yard soil or the indoor dust. Children or adults living nearby can be exposed through inhalation of the contaminated air or ingestion of soil or dust particles.

To investigate this first exposure scenario, a series of modules were developed to estimate the 1) release of wheel weight lead from the roadway, 2) the dispersion and deposition of this lead in the air to nearby yards, 3) the associated soil concentration in the yard, 4) the indoor dust concentration due to track-in of contaminated yard soil, and 5) the associated blood lead for children and adults in a near-roadway home. Whenever possible, existing peer-reviewed models or equations were used as the estimation tools for each module. However, new analysis tools were created for this assessment to estimate the road dust emission, the soil concentration, and the dust concentration. For the road dust emission and soil concentration, the analysis tools are simple mass-balance equations. For the dust concentration, a regression relationship was developed based on house survey data to relate dust concentration to soil concentration and housing vintage.

The selection of all parameters and modeling techniques is thoroughly documented in the report.

The incremental increase in blood lead levels that result from lead wheel weights that degrade in the environment is the desired metric from the analysis, not absolute blood lead levels. The estimates of exposure to lead in wheel weights were calculated by subtracting blood lead levels when wheel weight exposure is zero from the total blood lead for five different exposure conditions. The conditions differ in terms of general location (urban, downtown rural, or suburban), housing vintage (either before 1940 or after 1980, with older homes having higher dust and soil background lead due to the presence of lead-containing paint), and soil concentration (either high or low background concentration). In each exposure condition, modeled homes were placed in different exposure categories according to the magnitude of the modeled air lead concentration.

For children aged 0 to 7, the changes in blood lead level from lead in wheel weights vary from under 0.01 to 0.25 μg/dL. For adults, the changes in blood lead level from lead in wheel weights vary from less than 0.01 to 0.07 μg/dL.

Several parameters, particularly those affecting the magnitude of lead released to the air from the roadway, are poorly described in the literature and are subject to large uncertainty. These include the wheel weight loss rate from vehicles, the wheel weight removal rate from the roadway, the wheel weight degradation rate, the roadway dust loss rate, the yard soil depth, and the yard soil lead residence time. Efforts have been made to select the most reasonable value for each parameter from those available. The effect of varying these parameters is examined in the uncertainty analysis. Changing each parameter one at a time to values giving lower blood lead levels (either higher or lower parameter values, depending on their use in the module equations) results in child blood lead levels that are two to five times lower than those reported in the main analysis.

The second exposure scenario captures high-end exposure for a home hobbyist who melts lead to make hobby items such as bullets or fish sinkers. Owing to the lack of specific descriptive data about these activities in the literature, air concentrations were estimated using a saturation vapor pressure equation. Floor lead dust loadings following the melting event were estimated using a simple mass balance model. The vapor pressure concentrations were estimated at two representative temperatures, 316^{o}C (600^{o}F) and 454^{o}C (850^{o}F). These temperatures resulted in air concentrations of 0.24 and 15.7 μg/m^3. The dust loadings from the melting event were 0.18 and 11.4 μg/ft^2.

In order to support the cost-benefit analysis for the lead wheel weights rule, IQ decrements due to the lead in wheel weights are estimated for the near-roadway scenario.

1. INTRODUCTION

EPA is evaluating options to address the potential risks posed by lead wheel weights. These wheel weights can be lost from cars and can enter the environment, leading to potential exposures to children and adults who inhale or ingest roadway particles containing wheel weight lead or who drink contaminated water. In addition, wheel weights may be collected by home hobbyists and melted for use in making bullets, fish sinkers, or other hobby items.

{Summary paragraph on lead hazard concerns under revision.}

This document describes an approach for estimating exposure concentrations and/or blood lead levels for two exposure scenarios. In the first, or "Near Roadway Scenario", an adult and child are considered to reside near a roadway in three case study locations: the residential portion of an urban environment, the downtown of a suburban environment, or the downtown of a rural environment. The general framework for the exposure assessment approach is shown in Figure 1. First, the exposure media concentrations are estimated. Lead is emitted from the roadway after the abrasion and pulverization of lead wheel weights, and the lead migrates to the yard, resulting in air lead concentrations and inhalation exposure. In addition, the lead deposits in the yard soil and migrates into the indoor environment as dust, resulting in oral exposure. These media exposures are modeled using a combination of peer-reviewed models and simple mass-balance techniques, as described in Sections 4.1 to 4.4. Media concentration results are provided in Section 4.6.

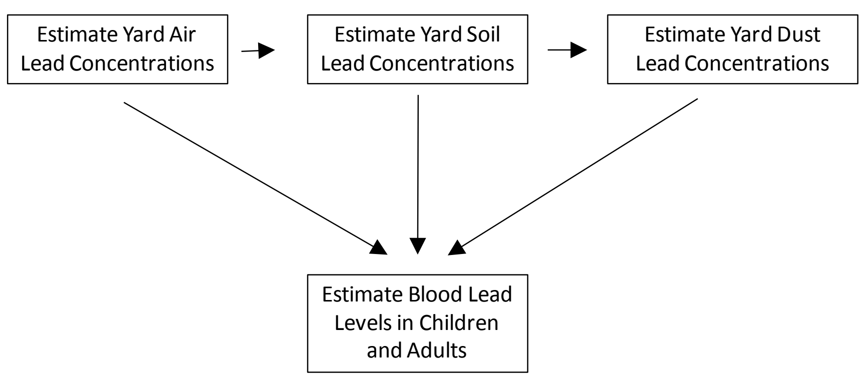

Figure 1. Flowchart Showing the Assessment Approach for the Near-Roadway Residence Exposure Scenario

After estimation of the media lead exposure concentrations, the model used to predict children's blood lead impacts was EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (USEPA 2010c). Because the IEUBK model can only be used up to an age of 84 months, the Adult Lead Methodology (ALM; U.S. EPA, 1996) was to estimate blood-lead impacts in adults. Section 4.5 provides details about the blood lead model implementation, while Sections 4.7 and 4.8 present the results.

In the second exposure scenario, or "Home Melting Scenario", a home hobbyist is assumed to melt lead from wheel weights in order to cast bullets, fishing weights, or other hobby items. The general framework for the exposure assessment approach is shown in Figure 2. The melting is assumed to occur inside a garage with the possibility of a child and adult present during the event. Air lead concentrations and garage dust loadings resulting from a single hour melting event are estimated using a saturation vapor pressure technique and a simple mass-balance technique, as described in Section 5. The Home Melting Scenario is characterized as a high end exposure estimate, which would fall in the upper end of the distribution of exposures. Many practices are used by home hobbyist to minimize exposure, the most significant being locating the melting pot outdoors. Due to the large number of permutations and combinations of exposure variables for the home melting scenario, a high end estimate is valuable for evaluation of the highest potential exposures for both children and adults to a hypothetical single hour-long event. Because of the uncertainties associated with the high-end estimate, blood lead levels were not estimated for this scenario. Finally, it should be noted that while hobbyists do use wheel weights as a potential source of lead for casting, other sources of lead are also available for hobbyist applications.

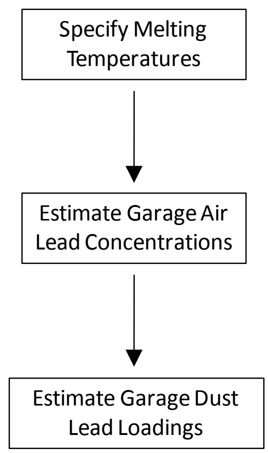

Figure 2. Flowchart Showing the Assessment Approach for the Home Melting Exposure Scenario

In order to facilitate an economic cost-benefit analysis in support of the proposed wheel weight rule, IQ decrements were selected as the health-endpoint for children. A piecewise-linear relationship from the Lanphear pooled analysis (Lanphear et al., 2005) was used to estimate IQ decrements from blood lead levels for the Near-Roadway Scenario only, as described in Section 6.

2. HEALTH HAZARD SUMMARY

This section is under revision and is not the subject of the Peer Review.

3. ENVIRONMENTAL FATE AND TRANSPORT

Lead wheel weights can be dislodged and then lost from vehicles, thus releasing lead into the environment. Root (2000) estimated that 1,650 tons (3.3 million pounds) per year of lead wheel weights are thrown from vehicle wheels and are deposited onto American streets in urban areas. The U.S. Geological Survey estimates that in 2003, 2,000 tons (4.0 million pounds) of lead wheel weights were lost on all of the nation's roads (USGS, 2006). When the wheel weights are lost from wheels they may fall onto road surfaces, where grinding and impacts between vehicle tires and road surfaces may break them into pieces or pulverize them into dust, to which exposure can occur. The amount of this breakage and pulverization will vary based on many factors including but not limited to: how far the lead wheel weight skids once it is thrown from the vehicle, the contact time with road surfaces during its travel when lost from the vehicle, whether it is hit by subsequent vehicles, and whether the lead wheel weight comes to rest on the median strips or curbs and is inaccessible for further abrasion/pulverization from vehicular traffic.

Lead sorbs strongly to soil constituents and is only weakly soluble in pore water; therefore it is essentially immobile in soil except under acidic conditions (ATSDR, 2007). The sorption of lead in soil is dependent on the pH, the organic matter content, the cation exchange capacity, the presence of inorganic colloids and iron oxides, soil type, particle size, and the amount of lead present. Lead is strongly chelated by humic or fulvic acids in the soil (ATSDR, 2007). In addition to sorption, lead can be immobilized by precipitation of insoluble salts such as carbonates, sulfates, sulfides and phosphates (HSDB, 2005). Most lead is retained strongly in soil, and very little is transported through runoff to surface water or leaching to groundwater. The solubility of lead in soil is dependent on pH, being sparingly soluble at pH 8 and becoming more soluble as the pH approaches 5. Between pH 5 and 3.3, large increases in lead solubility in soil are observed. These changes in lead solubility appear to correlate with the pH-dependent adsorption and dissolution of Fe-Mn oxyhydroxides (ATSDR, 2007). When released to soil, lead is expected to convert to more insoluble forms such as $PbSO_4$, $Pb_3(PO_4)_2$, PbS and PbO (HSDB, 2005). When metallic lead particles are released to soil, the lead surface reacts with air to form lead oxides. These lead oxides rapidly react with CO_2 from air or carbonates and sulfates from the soil to form a layer of cerussite ($PbCO_3$), hydrocerussite [$Pb_3(CO_3)_2(OH)_2$] and anglesite ($PbSO_4$) which appear on the surface as a white crust material. In the environment, these compounds form a protective surface coating that inhibits further corrosion of the metallic lead; however, cationic Pb^{2+} is eventually released (Vantelon et al, 2005, Lin et al., 1995).

When released to aquatic environments, a large fraction of lead introduced will be associated with suspended solids that settle down into the sediments. The amount of lead that can remain in solution in water is a function of the pH and the dissolved salt content. Equilibrium calculations show that the total solubility of lead in hard water (pH >5.4) and soft water (pH <5.4) is 30 µg/L and 500 µg/L respectively (U.S. EPA, 1977). At the low concentrations at which lead is normally found in the aquatic environment, most of the lead in the dissolved phase is complexed by organic compounds. The organic complexation increases with increasing pH and decreases with increasing water hardness (Callahan, 1979).

When released to the atmosphere, lead-bearing particles are transported to soil and water by wet deposition (rain and snow) and dry deposition (gravitational settling and deposition on water and soil surfaces). Approximately 40–70% of the deposition of lead is by wet deposition, and 20–60% of particulate lead once emitted from automobiles is deposited near the source. An important factor in determining the atmospheric transport of lead is particle size distribution. Large particles, particularly those with aerodynamic diameters of >2 μm, settle out of the atmosphere fairly rapidly and are deposited relatively close to emission sources (e.g., 25 m from the roadway for those size particles emitted in motor vehicle exhaust in the past); smaller particles may be transported thousands of kilometers (ATSDR, 2007). Lead particulates resulting from pulverized wheel weights are likely to exist as relatively large particles and are expected to deposit within a few meters of the roadside from which they were released. Such particles are not expected to possess the small aerodynamic diameters that would allow for long range transport.

4. NEAR-ROADWAY EXPOSURE SCENARIO

In the Near-Roadway Scenario, lead is released into the roadway environment due to degradation/pulverization of lost wheel weights, the lead migrates to the air surrounding the home, the deposition of lead particles contributes to yard soil concentrations, and indoor air and outdoor soil lead levels influence the indoor dust lead levels. Wheel weight lead may also contaminate groundwater. However, it was assumed that the exposed population obtained water from city reservoirs and the wheel weight lead contribution to drinking water was not included.

In order to estimate exposure to lead in this scenario, the fate and transport of lead from wheel weights in the air, soil, and indoor dust must be quantified. Next, the lead exposures in air, soil, and indoor dust can be combined with background exposure in all media to estimate the incremental effect of lead wheel weights on child and adult blood lead levels. A literature search was undertaken to determine what existing models and data could be used in the assessment. In general, data describing the physical process of lead wheel weight loss and degradation/pulverization on the roadway are sparse, making input parameters related to these processes uncertain. In keeping with the EPA exposure assessment guidelines where data is sparse, the analysis framework favors less data-intensive modeling techniques. Where possible, existing models used in other lead exposure assessments and suggested in EPA's Guidelines for Exposure Assessment were applied to this assessment. However, in cases where a suitable peer-reviewed model could not be found and applied, the scarcity of lead wheel weight data dictated the use of simple mass-balance models and empirical regression over the creation of more complicated models.

Figure 3 presents a flow chart that shows the inputs (free text), models (boxes), intermediate outputs (ovals) and final outputs (diamonds) used in the assessment framework. The gray boxes show the areas where simple mass-balance models and empirical regressions were adapted for this analysis, while the white boxes represent existing peer-reviewed models that were applied using protocols from other EPA lead exposure assessments. The overall framework is a system of connecting modules which estimates the necessary media concentrations (outdoor air, yard soil, and indoor air and dust) and the resulting blood lead (adults and children).

Estimates are first made for blood lead resulting from exposure to lead from all sources (both wheel weights and other sources) in all media (air, soil, dust, drinking water, and diet). This exposure is assumed to include the contribution from wheel weights and is called the "total" blood lead estimate. Then, the assessment modules are used to estimate the contribution to lead in air, soil, and dust from lead wheel weights alone. These media levels are used to find the hypothetical lead levels in the exposure media if the adult and child had not been exposed to lead from wheel weights by subtracting the wheel weights contribution from the total media lead level. These "no wheel weights" media levels are used to estimate the "no wheel weights" blood lead levels. Finally, the two blood lead estimates can be used to estimate the incremental change in blood lead due to the presence of lead from wheel weights by subtracting the "no wheel weights" blood lead estimates from the "total" blood lead estimates.

The assessment modules were applied to five case study locations: two urban scenarios, two rural scenarios, and one suburban scenario. These scenarios are not intended to be nationally representative. Instead, they are intended to capture exposures for five sets of hypothetical populations living near roadways. In each case, a proxy city was selected to aid in the development of input parameters for the assessment modules. The five case study scenarios are shown in Table 1. In each of the above scenarios, the particular proxy city was selected because it had the general characteristics of the target population locale and because there were existing data for some of the necessary parameters, such as traffic volume or soil concentration.

The urban scenario is intended to reflect the inner city section of a large metropolitan area with multi-unit homes and yard areas. As such, the soil concentrations are selected to be fairly high (see Section 4.3.2) to reflect the fact that many inner city locations have high soil concentrations due to the historic use of lead in gasoline and lead in paint. However, two different housing vintages (Scenarios A and B) were selected to reflect the fact that homes may be quite old (with higher background dust concentrations due to the presence of lead-containing paint) or may be of newer or refurbished construction (with lower background dust concentrations and no lead-containing paint). The city of Dorchester, MA was selected to serve as a proxy city for determining model parameters (see Sections 4.1.2, 4.2.2, and 4.3.2).

The rural scenario is intended to reflect the downtown area of a rural town. In such a town, homes may be of older or newer construction and may be built on areas of low or high historical soil lead contamination. For this reason, two scenarios (C and D) were constructed to represent a higher overall lead exposure (higher soil and older construction) and a lower overall lead exposure (lower soil and newer construction). The city of Boulder, MT was selected to serve as a proxy city for determining model parameters (see Sections 4.1.2, 4.2.2, and 4.3.2).

Finally, the suburban scenario is intended to reflect the downtown area of a suburban city. Most suburbs have relatively newer construction and lower overall historical soil contamination. Thus, only a single suburban scenario (E) was selected with lower soil and newer housing vintage. The city of Turners Falls, MA was selected to serve as a proxy city for determining model parameters (see Sections 4.1.2, 4.2.2, and 4.3.2).

Numerous inputs were needed for the different assessment modules. The data quality for each input varied according to the robustness of the data source and the degree of variability in the data. Variables shown in boldface type represent the most uncertain and/or variable parameters. In setting the input parameter values for the analysis, many parameters had a range of values in the literature. Parameters with a substantial amount of variation and uncertainty (such as the lead in soil residence time (Table 12)), were set at a value near the high end of its range in order to ensure that exposures in the hypothetical populations were not being underestimated. However, parameters that were well characterized in the literature or other exposure assessments, such as background dietary and water lead exposure concentrations, were selected as average or median values. Although each variable was selected based on the availability of quality data to yield a plausible value, no attempt was made to trace the probability of all parameters taking on the specific permutations and combination of values used in the assessment. However, the effect of choosing alternative values for the most uncertain and/or variable parameters which will yield lower wheel weight lead media concentrations is explored in the uncertainty analysis in Section 4.9.

Table 1. Assessment Scenarios in the Near Roadway Lead Wheel Weights Exposure Analysis

Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Urban, high soil, pre-1940 housing vintage	Urban, high soil, post-1980 housing vintage	Rural, high soil, pre-1940 housing vintage	Rural, low soil, post-1980 housing vintage	Suburban (low soil, post-1980 housing vintage)

Sections 4.1 to 4.5 describe the approach adopted for each assessment module and details about the selection of input parameters. Section 4.6 presents the lead exposure concentrations in the air, soil, and dust media. Section 4.7 presents the blood lead levels for children and Section 4.8 presents the blood lead levels for adults. Finally, Section 4.9 presents the uncertainty analysis.

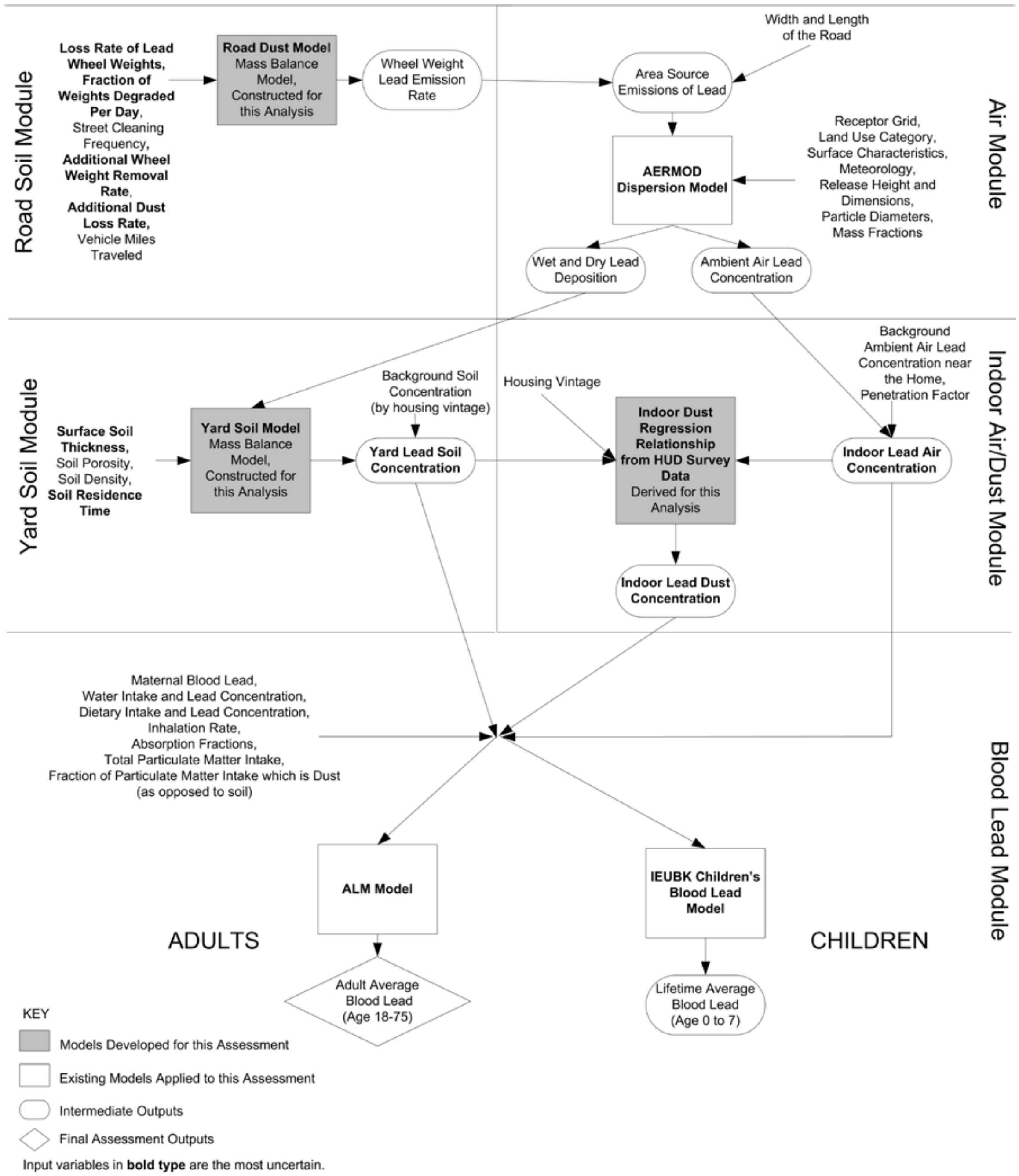

Figure 3. Flowchart Showing the Assessment Approach for the Near-Roadway Residence Exposure Scenario

4.1 Roadway Soil Module

The roadway soil module estimates the total emission rate of lead dust from the roadway for each modeling scenario, as depicted in Figure 4. Section 4.1.1 discusses the assessment method selected for this module, while Section 4.1.2 discusses how each input parameter value was selected.

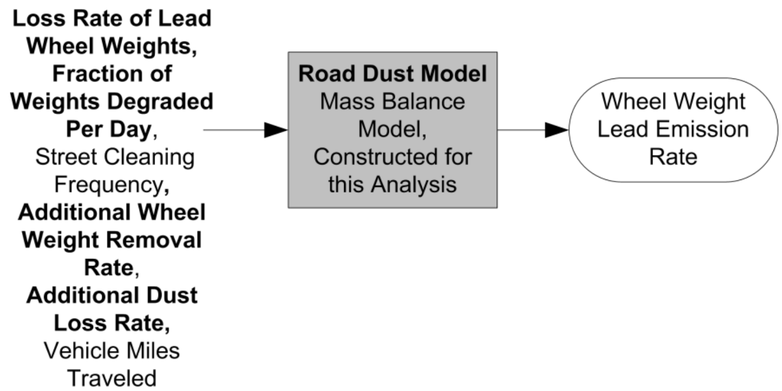

Figure 4. Flowchart Showing the Approach for the Roadway Soil Module

4.1.1 Assessment Method Selected

Wheel weights are lost from cars onto the road, and this loss rate is dependent on the traffic flow rate, the proportion of traffic vehicles that have lead wheel weights, the speed, and the degree to which the road requires braking and turning events. Then, lost wheel weights are degraded over time due to weathering and further traffic abrasion. Some of the lead that is abraded will be emitted to the air as part of roadway dust due to roadway turbulence and other dust emission mechanisms.

A literature search located a peer-reviewed article looking at lead wheel weight degradation, the Root (2000) study. This study estimates (i) the baseline or steady-state inventory of lead wheel weights on an urban street (ii) the average loss rate of lead wheel weights from passing automobiles and (iii) the average rate of lead wheel weight fractional degradation per day as a result of abrasion and pulverization by moving vehicles on the street. The study is based on measurements conducted on a 2.4km (1.5 mile) six-lane divided street segment in Albuquerque, New Mexico with an average daily traffic flow of 41,500 vehicles and a reported speed limit of 65 km/hour (40 miles/hour). Topographically, the street, which is identified in the study by the letters "JTML", is characterized by a slightly elevated crown in the middle of the street that slopes off to curbs at either side to facilitate storm water drainage. To estimate the steady-state inventory on the street, the author surveyed JTML and seven other streets in the same city by walking along the sidewalk adjacent to the outer lane and collecting any lead found along the outer curb, in the street, and on the sidewalk. In some segments, the sidewalk was set back from the curb with the intervening space occupied by gravel and shrubs. The author reports that these obstacles made searching for wheel weights more difficult. Curbside parking did not occur on the street in the surveyed area. The author conducted only one survey along the median end of the divided street because of the potential danger from passing vehicles. The cleaning history of the streets is reported as not known. Based on the inter-street consistency of the amount of lead found on the eight streets studied, the study concludes that the streets were in a steady-state condition. The author resurveyed two of the eight street segments to ensure that steady-states were consistent over time. Based on this method, a mean steady state inventory of 1.09 kg/km is reported for JTML. The study notes that the quantity of lead deposited may be underestimated because of the difficulty involved in ensuring complete recovery of all lead pieces. The study also reports that wheel weights along the median end of the street were 25% of the steady state.

The study estimates the average loss rate of lead wheel weights from passing automobiles and also the average rate of lead wheel weight fractional degradation per day by means of biweekly surveys conducted on the same JTML street segment for 42 weeks. The biweekly surveys were conducted using exactly the same process as the steady state inventory analysis described above. The amount of lead collected in each biweekly study represents the accumulated lead after 14 days of successive deposition less the amount pulverized in that period. By assuming a constant daily average loss rate from automobiles and a constant average daily fractional degradation rate, the study derives algebraic relationships that enable the estimation of the average loss rate and the fractional degradation rate per day from knowledge of the steady state inventory and the average biweekly inventory. Using this method, the study estimates the average deposition rate of lead wheel weights along the outer curb of both sides of JTML street as 11.8 kg/km/year and the average fractional degradation rate per day as 0.0272 (or 2.72%).

Given the limited sample of streets surveyed, precautions may also be advisable when extrapolating the findings to other roadway environments. Roadways with higher speed limits and with more roadway irregularities (such as pot holes) than the JTML street will be more likely to cause ejection of wheel weights onto the roadway. Also, the study assumes all missing wheel weights have been pulverized; it does not account for loss processes such as removal during street cleaning, collection by hobbyists or dispersal outside the area of the survey. A consequence of this assumption is that the estimated fractional degradation rate is in effect a fractional loss rate owing to all loss processes, which could represent a potential upper bound for the true fractional degradation rate. The use of the estimated fractional degradation rate could potentially result in estimates of risk from wheel weight-derived roadway lead dust that are biased high. The study estimates could also be biased (inaccurate) as a result of measurement error. The author concedes that the collection process may have overlooked some lead wheel weights fragments on the road. While there is the possibility that proportional measurement errors in the biweekly surveys and the steady state survey could cancel out, resulting in an unbiased estimate of the fractional degradation rate, it is also conceivable that the measurement errors in each type of survey were not proportional and could potentially result in a biased estimate of the fractional degradation rate. In addition, measurement error in the steady state inventory estimate could result in a biased estimate of the average loss rate. The logistic constraint that excluded collection from the median curbs of the divided street or from the central parts of the roadway is an additional source of uncertainty. Extrapolating the study's outer curb loss rate to derive a "whole street" loss rate would consequently create a further source of potential bias. The study is based on a single street segment in a single city. Finally, the study is deterministic in nature and provides only point estimates without any confidence intervals to bound potential variability or uncertainty.

Another study (Bodanyi, 2003) has not been published in a peer-reviewed publication. It was conducted by the author as part of a student thesis. One of the principal aims of the Bodanyi study appears to be a comparison of the author's estimate of lead wheel weight deposition onto urban roadways with the earlier published study by Root. The Bodanyi study was conducted on two thoroughfares in Ann Arbor, MI and estimates the number of lead wheel weights lost per vehicle mile traveled (VMT) on urban roadways. The study employed the same visual survey and recovery methods as Root (2000), but was limited to four weekly surveys. Based on the recovery rate from these surveys, the Bodanyi study estimates that 4.69E-5 wheels weights are lost per VMT. The study uses this loss rate to estimate the total deposition of lead onto U.S. highways at 2.7 million kg in the year 2001. According to Bodanyi, the Root study may be inferred to estimate a loss rate of 4.58E-5 wheel weights per VMT by assuming that the average wheel weight recovered from the roadway weighs 21 g (as reported by Root). This estimate indicates strong agreement between the Root and Bodanyi studies. However, in translating the lead wheel weights per VMT into the mass of lead deposited per VMT, the Bodanyi study appears not to account for roadway degradation. Bodanyi simply multiplies the estimated number of wheel weights deposited per VMT by the average weight of a *recovered* wheel weight to estimate the mass of lead wheel weights deposited per VMT. This is likely an underestimate because a recovered wheel weight has already been abraded to a certain extent. The Root study employs sounder principles in accounting for the effect of wear while estimating lead deposition. These data were not used in this exposure assessment but mentioned to show the corroboration that wheel weights are found on the street in degraded states.

A poster presented at the Geological Society of America, on 31 October – 4 November 2010, provided information on an on-going roadside wheel weight collection study being conducted by students in University of West Georgia under Professor Curtis Hollabaugh. Preliminary results of this program indicate that many wheel weights are found along urban and rural roads in Georgia. Many of these lead wheel weights are small, worn and weathered; several were small and without clips. Although quantitative data on degradation rates are not yet available from this program, it shows that wheel weights are falling onto the several roads in urban, suburban, and rural Georgia and are being degraded.

The loss rates and degradation rates calculated in the Root (2000) study are used in this analysis. It should be noted that wheel weights are 95% lead and 5% antimony. No attempt has been made to correct the degradation rate to include only the lead portion, since the error introduced into the analysis by assuming the wheel weight is 100% lead is small compared with the overall uncertainty in the loss and degradation rates. With the exception of street cleaning rates, information about the other wheel weight removal rates could not be found in the literature, but the module addresses them as discussed below.

The most general method of modeling lead emitted to the air as part of roadway dust would be by tracking the mass of intact wheel weights, the mass of lead dust on the roadway, and the mass of roadway dust emitted each day by accounting for time-varying source and loss rates. For this analysis, it was assumed that the system is in a nearly steady-state. The near-steady state assumption implies that the mechanisms dictating the accumulation of wheel weights on each segment of roadway (including all sources and removal mechanisms) are in balance so that the total inventory of wheel weights along the road segment is not changing in time. In this analysis, a road segment is set to one city block. In addition, the amount of lead dust generated each day from degradation would equal the sum of the removal due to emission and the removal due to other loss rates like runoff. The Root (2000) study observes that steady state conditions are rapidly achieved on a roadway; empirical calculations made for this analysis also support this conclusion, with steady state conditions typically being reached within one year.

Lead dust emissions have therefore been computed at "average" steady state conditions using a mass balance model designed for this analysis. The mathematical relationship between the fall off rate of intact wheel weights and the average lead dust emission rate at steady state conditions was derived as follows:

Let:

F = the loss (fall-off) rate of intact lead wheel weights from cars onto the roadway (in kg per day)

X = the mass of intact lead wheel weights on the roadway (in kg)

Y = the mass of lead dust (originating from the degradation of lead wheel weights) on the roadway (in kg)

d = degradation rate (the fraction of lead wheel weights that are converted to lead dust per day)

u= street cleaning rate (the fraction of lead wheel weights that are removed from the road per day)

h= the loss of partially intact wheel weights to loss mechanisms other than degradation and street cleaning

l = the loss of degraded mass due to loss mechanisms other than emission

e = emission rate (the fraction of roadway lead dust that is suspended into the air by vehicles per day)

Mass balance considerations dictate that:

(1) the change in mass of lead wheel weights on the roadway on a given day will equal the mass of lead wheel weights falling off from cars onto the roadway that day less the mass of wheel weights degraded into dust on the roadway that

day less the mass of wheel weights removed by road cleaning and other loss mechanisms that day (see Figure 5); and

(2) the change in mass of lead dust on the roadway on a given day will equal the mass of lead dust added to the roadway that day by degradation less the mass of lead dust suspended into the air by passing automobiles on that day and the mass of lead lost due to other mechanisms.

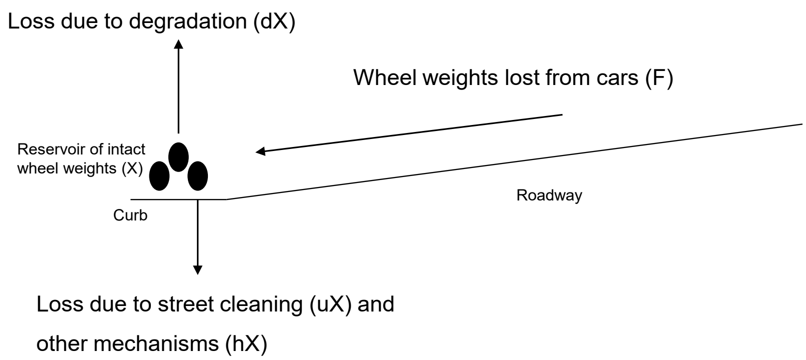

Figure 5. Diagram of the processes governing the stock of wheel weights in the curb

Using the symbols defined above, these mass balance equations may be expressed mathematically in terms of the following differential equations:

$$\frac{dX}{dt} = F - dX - uX - hX \qquad (1) \text{ and}$$

$$\frac{dY}{dt} = dX - eY - lY \qquad (2)$$

At steady state, the mass of intact wheel weights (X) and the mass of lead dust (Y) are constant, implying that $\frac{dX}{dt} = 0$ and $\frac{dY}{dt} = 0$ ..

Setting $\frac{dX}{dt} = 0$ and $\frac{dY}{dt} = 0$ in equations (1) and (2) above, results, after some algebraic manipulation, in the following steady state relationships:

$$X_{ss} = \frac{F}{d + u + h} \qquad (3)$$

$$\frac{eY_{ss}}{F} = \frac{d}{d + u + h}\,\frac{e}{e + l} \qquad (4)$$

Equation (4) illustrates how the steady state emission of lead dust to the air from the roadway (eY_{ss}) is a fraction of the loss rate of intact lead wheel weights onto the roadway (F). If street cleaning and the additional loss terms do not exist (u, h, and l), then at steady state the emission of lead dust equals wheel weight deposition on the roadway.

A complication that prevents a purely analytic estimation of the steady state emission rate of lead dust is that the street cleaning rate u in the equation above is not a constant but varies with time (to reflect the reality that street cleaning occurs not continuously but at a periodic frequency). For a street with a monthly cleaning frequency, it was assumed that u would equal zero for days 1-29 and then equal 1 on the thirtieth day, after which it would assume the value zero for the next 29 days, and so on. This assumes that street cleaning removes the entire stock of wheel weights on the curb on the days that it occurs. Consequently, the average steady state emission rate was estimated empirically using a dynamic spreadsheet model that directly simulates equations (1) and (2) above.

The occurrence of cyclical street cleaning prevents the realization of a true unvarying steady state; instead a "cyclical steady state" is achieved in which the emission rate and other variables repeat the same values on a cyclical basis related to the cleaning frequency. Figure 6 shows the wheel weight loss rate as well as the cyclical dust emission rate for the urban scenario. For the purposes of computing average exposure and risk, the average dust emission rate across the cycles was used. The ratio between the wheel weight loss rates and the average dust emission rate for each scenario was computed and used along with the estimated loss rates to estimate the total lead mass emission rate.

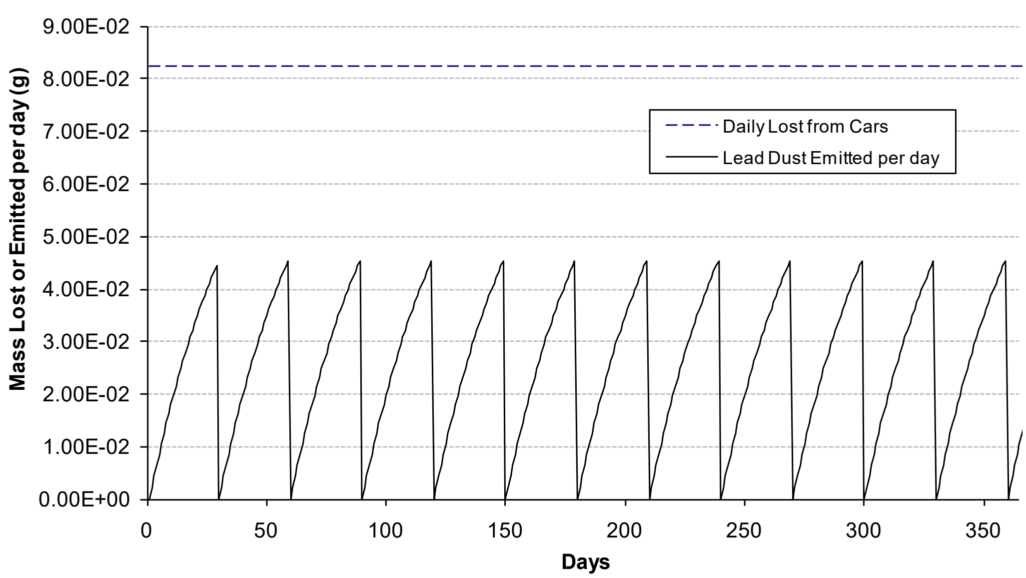

Figure 6. Mass of Wheel Weights Emitted Per Day in a 1 m Urban Segment of Road and the Cyclical Lead Dust Emitted from the Roadway Each Day

4.1.2 Parameter Selection

Loss Rate of Lead Wheel Weights

The loss rate of lead wheel weights is derived from information presented in Root (2000). The study estimates wheel weight lead deposition along the 2.4 km six-lane divided "JTML" road in Albuquerque, New Mexico at 11.8 kg/km/year. The study notes that this estimate represents the loss along the outer curb of both sides of the street. The study also observes that the median side deposition amounts to 25% of the curb side loss at steady state. To include loss along the median edge of both sides of the divided street, the curb side loss rate estimate was multiplied by a factor of 1.25 in order to estimate the loss rate for the entire street. Accordingly, it was assumed that the lead wheel weight loss rate was 1.25 x 11.8 = 14.75 kg/km/year, which is equivalent to 23.6 kg/mile/year along that street segment. To normalize the lead wheel weight loss rate by the vehicle miles traveled, an average daily traffic flow of 41,500 vehicles/day was used, which is the traffic flow rate for the surveyed JTML street segment as cited in the Root study. The estimated normalized wheel weight lead loss rate is therefore equal to 23.6/(41500 x 365) = 1.56 E-6 kg/VMT. This loss rate was multiplied by the vehicle counts discussed below to estimate the total mass per mile traveled.

Causes of other variations in the loss rate, such as the speed of traffic on the road and the mix of vehicles on the road, could not be accounted for since there was not enough information in the literature to inform a methodology. In the Root study, the speed limit was 65 km/hour or about 40 mph. This will be similar to high-traffic residential roads in the proxy cities but will overestimate the speed of traffic on the low-traffic residential roads (see Section 4.2.2, "AERMOD Grid"). Thus, the loss rate on the low-traffic roads may be overestimated, since more wheel weights will be lost to cars when they turn or hit pot holes and other bumps at higher speed. However, lower traffic roads may also have more bumps and road imperfections, as higher volume roads will be given priority for repairs. Thus, the effect of the speed cannot be determined from the existing information in the literature and is not accounted for in this analysis approach. The wheel weight loss rate remains an uncertain variable and is examined in the uncertainty analysis in Section 4.9.

Fraction of Weights Degraded Per Day

The fraction of lead wheel weights degraded per day is also obtained from the Root (2000) study, where it is estimated at 0.0272 or 2.72%. Although the Root study has numerous limitations, including the fact that the only loss mechanism considered was loss to degradation, no superior study on the subject could be found despite an extensive literature search. In the absence of any additional information about the particular street used in the study (including the cleaning history) and information about other loss processes in general, a daily degradation rate of 2.72% was used and the other loss processes were accounted for as described below. This may lead to an overestimate of the total loss of intact wheel weights; however, in the absence of data, this method was selected as the most systematic one available. The wheel weight degradation rate remains an uncertain variable and is examined in the uncertainty analysis in Section 4.9.

Street Cleaning Frequency

To determine the typical frequency of street cleaning, statistics of street cleaning from various cities were pulled from a compiled report (Schilling, 2005). The statistics show the frequency of street cleaning for a main artery, a central business district, and a residential area. Because the modeling domain includes the intersection of two busy streets in the urban, suburban, and rural scenarios and the highest concentration occurs at the crossroads (see Section 4.7), the central business district statistics were selected as the most appropriate descriptor of cleaning frequency. These frequencies are higher than in the purely residential area but reflect probable cleaning frequencies for high volume roads near residential areas.

For each city, the population, population density, and city type were determined from census information. The population corresponds to census information from 2006 while the population density (persons per square mile) corresponds to census information from 2000 (http://quickfacts.census.gov/qfd/). Using the population and population density, each city was mapped to a city type using the following census definitions:

- Urban Area (UA): 500 people per square mile with at least 50,000 people.
- Urban Cluster (UC): 500 people per square mile with a population of at least 2,500 people, but fewer than 50,000 people.
- Rural: anything outside of the definition of UC or UA

If a city did not have available population density information, the population alone was used to map the city to a classification. Then, the UA designation was used to capture the urban areas of modeling scenarios A and B, the UC designation was used to capture the suburban areas in modeling scenario E, and the rural designation was used to capture the rural areas in modeling scenarios C and D. In the dataset used, no cities had the rural designation, and the classifications of each city are shown in Table 2.

Then the frequencies of cleaning were averaged across each classification category to determine the average number of days between cleaning. These averages were rounded to regular frequencies. This resulted in a frequency of once every month in urban areas and six times per year in suburban areas. In the absence of any rural information, a cleaning frequency of two times a year, which is the lowest frequency reported in the survey, was selected for these locations. It was assumed that street cleaning has a 100% efficiency in removing wheel weights such that the entire reservoir of wheel weights along the curb is eliminated after each street cleaning event.

Table 2. Street Cleaning Statistics and City Classifications

City	State	Arterial	Central Business District	Residential	Population	Population Density	Classification
Oakland	CA	Daily		Biweekly	397,067	7,126	Urban Area
San Diego	CA		Weekly	Monthly	1,256,951	3,772	Urban Area
San Leandro	CA			Monthly	78,030	6,051	Urban Area
Long Beach	CA	Weekly	Weekly	Weekly	472,494	9,150	Urban Area
Mountain View	CA			Biweekly	70,090	5,863	Urban Area
San Jose	CA	Biweekly	Biweekly	Monthly	929,936	5,118	Urban Area
La Mesa	CA	2x/week	2x/week	Monthly	53,043	5,912	Urban Area
Sunnyvale	CA			Monthly	130,519	6,006	Urban Area
Union City	CA	Biweekly	Biweekly	Biweekly	69,477	3,474	Urban Area
Danville	CA	Monthly	Monthly	Monthly	41,540	2,306	Urban Cluster
Dublin	CA		Weekly	Biweekly	41,840	2,381	Urban Cluster
Elk Grove	CA	Monthly		3x/year	129,184	No data	Urban Area
Santee	CA	Weekly	Weekly	Biweekly	52,530	3,299	Urban Area
Greeley	CO	Biweekly	Weekly	5x/year	89,046	2,573	Urban Area
Fort Collins	CO		2x/week	2x/year	129,467	2,550	Urban Area
Denver	CO		Biweekly	8x/year	566,974	3,617	Urban Area
Thornton	CO	Biweekly		1x/year	109,155	3,067	Urban Area
Arvada	CO	6x-7x/year	6x – 7x/year	6x-7x/year	104,830	3,128	Urban Area
Tampa	FL	Weekly	Weekly	6x/year	332,888	2,708	Urban Area
Gainesville	FL	Monthly	2x/week	9x/year	108,655	1,981	Urban Area
Urbandale	IA	3x/year	3x/year	3x/year	37,173	1,405	Urban Cluster
Iowa City	IA	Monthly	Weekly	Monthly	62,649	2,575	Urban Area
Sioux City	IA	5x/year	5x/year	5x/year	83,262	1,551	Urban Area
Overland Park	KS	7x/year	Monthly	3x/year	166,722	2,627	Urban Area
Hanover Park	IL	8x/year	8x/year	8x/year	37,161	5,637	Urban Cluster
Evanston	IL	Biweekly		4x/year	75,543	9,579	Urban Area
Elgin	IL	Biweekly	2x/week	6x/year	101,903	3,780	Urban Area
Burr Ridge	IL	9x/year	9x/year	9x/year	10,408		Urban Cluster
Champaign	IL		Daily	8x/year	73,685	3,974	Urban Area
Fort Wayne	IN	Biweekly	Weekly	4x/year	248,637	2,606	Urban Area
Cambridge	MA	Biweekly		9x/year	101,365	15,763	Urban Area
Salem	MA			9x/year	41,343	4,989	Urban Cluster
Saco	ME	Biweekly		9x/year	16,822		Urban Cluster
Kansas City	MO	4x/year	Weekly	4x/year	447,306	1,408	Urban Area
St. Joseph	MO	2x/year	2x/year	2x/year	72,651	1,688	Urban Area
Great Falls	MT	Biweekly	Daily	4x/year	56,215	2,909	Urban Area
Lincoln	NE			3x/year	241,167	3,022	Urban Area
Manchester	NH	Monthly	2x/week	3x/year	109,497	3,242	Urban Area
Albuquerque	NM	Biweekly	2x/week	Biweekly	504,949	2,483	Urban Area
Rochester	NY	2x/week	Daily	Biweekly	208,123	6,134	Urban Area
Albany	NY	Weekly	Weekly	Weekly	93,963	4,474	Urban Area
Toledo	OH	9x/year	2x/week	9x/year	298,446	3,890	Urban Area
Fairfield	OH	Biweekly	Weekly	5x/year	42,248	2,006	Urban Cluster

Table 2. Street Cleaning Statistics and City Classifications

City	State	Arterial	Central Business District	Residential	Population	Population Density	Classification
Macedonia	OH	2x/year	2x/year	2x/year	9,224		Urban Cluster
Marysville	OH	Weekly	Weekly	Monthly	18,212		Urban Cluster
Tulsa	OK	8x/year		4x/year	382,872	2,152	Urban Area
Albany	OR	Biweekly	Weekly	Monthly	46,213	2,573	Urban Cluster
Eugene	OR	Weekly	2x/week	Monthly	146,356	3,403	Urban Area
Pittsburg	PA	Weekly	2x/week	2-4x/year	312,819	6,020	Urban Area
Town of Lower Marion	PA	3x/year		3x/year	59,850		Urban Area
Knoxville	TN		Weekly	Monthly	182,337	1,876.60	Urban Area
San Antonio	TX	4x/year		2x/year	1,296,682	2,809	Urban Area
Dallas	TX	Monthly	Daily	None	1,232,940	3,470	Urban Area
El Paso	TX	Biweekly	Daily	4x/year	609,415	2,263	Urban Area
Austin	TX		Daily	6x/year	709,893	2,610	Urban Area
Ogden	UT	3x/year	3x/year	3x/year	78,086	2,898.90	Urban Area
Hampton	VA	Monthly		Monthly	145,017	2,828	Urban Area
Janesville	WI		5x/year	4x/year	62,998	2,160	Urban Area
Eau Claire	WI	3x/year	3x/year	3x/year	63,297	2,037.80	Urban Area
Milwaukee	WI		Weekly	Monthly	573,358	6,215	Urban Area

Additional Intact Wheel Weight Removal Rate

Aside from street cleaning, partially intact wheel weights are removed from the roadway due to other mechanisms. Hobbyists may gather wheel weights from along the roadway. In addition, weights may be thrown into the median or into grassy areas and thus protected from further roadway abrasion. Ignoring the impact of these loss mechanisms will tend to an overestimate of the risks from lead wheel weights. However, there are no data available to inform the decision of the fraction removed and so the fraction of lead wheel weights lost due to these mechanisms per day was set at zero (0)   This variable remains highly uncertain, and it is examined in the uncertainty analysis in Section 4.9.

Additional Roadway Dust Loss Rate

Once wheel weights have been degraded, the lead remains on the roadway and curb as lead dust. Some of this dust will be emitted to the air due to wind and the turbulence generated by passing vehicles. However, this dust will also be removed from the roadway due to water runoff or other loss processes. During rain events, this removal may be significant. However, because the literature data provide no way to determine this fractional removal, this loss rate is set to 0 to represent a high-end estimate. This variable remains highly uncertain, and it is examined in the uncertainty analysis in Section 4.9. In addition, speciation can make lead more or less toxic, but this process is highly variable. Due to the complexity of factors that determine speciation, this process was not included.

Vehicle Miles Traveled

The total traffic counts for each scenario are shown in Table 3. In each scenario, the model grid consists of a series of intersecting roads. Roads are either designated as "high volume" or "low volume". The urban traffic counts were determined based on examination of traffic counts in the Northeast proxy city provided by the state department of transportation. For the high volume streets, a busy, four lane road near residences was selected (33,800 vehicles per day). The traffic counts on a strictly residential road (low volume) in the same proxy city were also determined, and the ratio between the low traffic street and the high traffic street was approximately 0.25. In addition, the higher volume streets occurred approximately every kilometer with lower volume streets between them. Thus, the urban model domain consists of a series of intersecting high volume streets with 33,800 vehicles per day every kilometer in both the north/south and east/west directions with lower volume streets with 8,450 vehicles per day spaced in the intervening blocks.

For the rural scenarios, traffic counts in a western proxy rural community were used to determine the traffic counts. The only available data were for a relatively high volume street through the town (755 vehicles per day). No data were available for the lower volume residential roads in the rural community. Thus, the same ratio between low volume and high volume streets used in the urban and suburban scenarios (0.25) was used to estimate a volume of 189 vehicles per day on low volume streets.

Traffic counts in a northeastern proxy suburban community were used to determine the traffic counts for the suburban scenario. The traffic count for the highest traffic volume street near residences (3,100 vehicles per day) was selected. In addition, the ratio between a lower volume residential street and this high volume street were determined to be approximately 0.25. Thus, the same ratio between low volume and high volume streets used in the urban and rural scenarios (0.25) was used to estimate a volume of 775 vehicles per day on low volume streets.

Table 3. Estimate of Average Daily Traffic Counts by Road Type for Each Scenario.

Scenario	High Traffic Volume Average Daily Traffic (vehicles/day)	Low Traffic Volume Average Daily Traffic (vehicles/day)
Urban	33,800	8,450
Rural	755	189
Suburban	3,100	775

Once the cleaning frequency and loss rates were determined for each scenario, the average steady-state mass balance model was applied to each scenario. Table 4 presents empirically computed ratios of average steady state roadway lead dust emission rates to lead wheel weight fall off rates. To estimate the final lead emission rates, the wheel weight fall off rate (1.56 E-6 kg/VMT, see above) was multiplied by this ratio and by the vehicle counts on the individual roads (high volume and low volume) in the domain for each scenario to get the total mass emitted per day.

Table 4. The Ratio of Lead Dust Emission to Wheel Weight Fall Off Rates in Urban, Suburban and Rural Areas

Scenario	d (Degradation Fraction per day)	Cleaning Frequency (in days)	$\frac{eY_{ss}}{F}$ (Ratio of Average Steady State Emission Rate of Lead Dust to Loss Rate of Wheel Weights)	Emission Rates on High Volume Streets (g m^{-2} s^{-1})	Emission Rates on Low Volume Streets (g m^{-2} s^{-1})
Urban	0.0272	30	0.31	1.47E-8	3.66E-9
Suburban	0.0272	60	0.53	2.30E-9	5.75E-10
Rural	0.0272	183	0.81	8.56E-10	2.14E-10

4.2 Air Module

In order to characterize the air concentrations and depositions resulting from the roadway lead wheel weight emissions, a dispersion model was needed. The method selected and the necessary input parameters are depicted in Figure 7. Section 4.2.1 discusses the assessment method selected for this module, while Section 4.2.2 discusses how each input parameter value was selected.

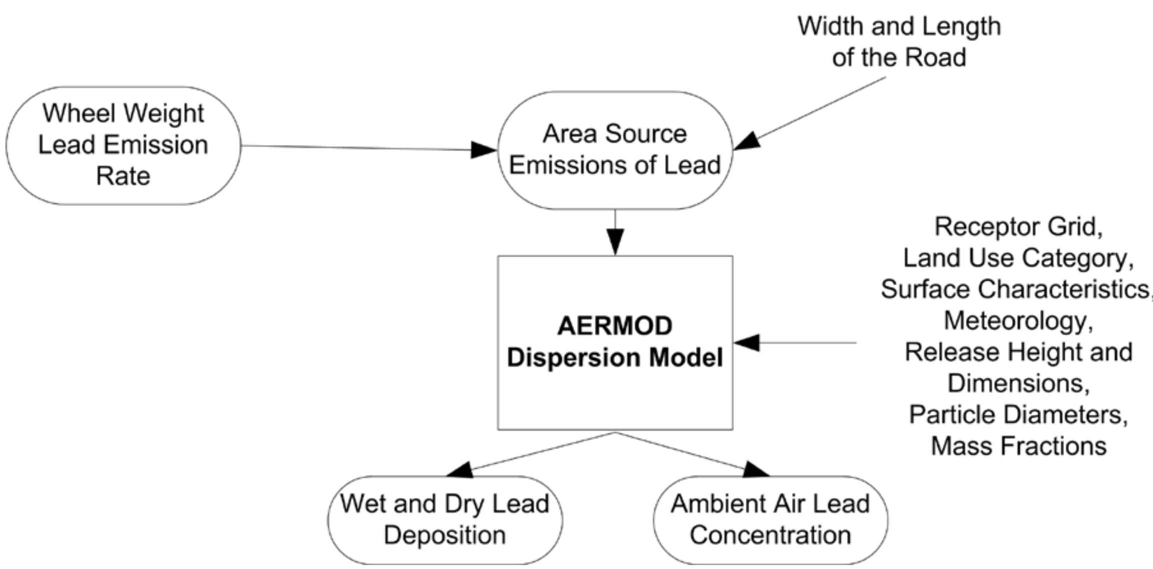

Figure 7. Flowchart Showing the Approach for the Air Module

4.2.1 Assessment Method Selected

In order to model the dispersion of wheel weight lead away from the roadway to neighboring homes, the AERMOD dispersion model was selected (U.S. EPA, 2009a).

According to the “Revision to the Guideline on Air Quality Models” (U.S. EPA, 2005b), AERMOD represents the most robust air quality model when evaluated against monitoring data. A multimedia model, the TRIM.FaTE model, was also considered since it allows explicit communication between air and soil compartments and would not require a separate yard soil module (see Section 4.3). However, TRIM.FaTE does not have as sophisticated a dispersion scheme, so AERMOD was selected to best capture the yard air concentrations.

Once the AERMOD model was selected, model options had to be selected in order to model the roadway dust emission and dispersion. To implement AERMOD, the modeled city was assumed to consist of a series of streets that intersect at regular intervals. Based on proxy cities for the urban, rural, and suburban scenarios, the block length, street width, and number of houses per block were used to create the emission grid (the roadways) and the receptor grids (individual yards). To account for different traffic patterns within a city, the grid contains both main arteries and residential streets, where each occurs at specified regular intervals (see Section 4.1.2). Then, road sources were modeled in AERMOD as area sources. According to “Revision to the Guideline on Air Quality Models”, re-entrained dust from roadway sources can be modeled as area, volume, or line sources (U.S. EPA 2005b, page 68235). Area sources were selected to be consistent with the OTAQ lead in aircraft exposure analysis, which modeled three roadways adjacent to the airport using this methodology (U.S. EPA 2010b, page 49). No obstructions due to the presence of other buildings were included in the modeling, since this introduces a level of detail to the modeling that the input data quality did not support. Obstructions can both enhance air concentrations and diminish air concentrations depending on the location of the model receptor with respect to the emission site and the obstruction. Instead, the surface characteristics needed for input into the model were determined to be consistent with the typical building characteristics in each scenario, as explained in Section 4.2.2 “Land Use Category and Surface Characteristics”. The roadway dimensions, traffic patterns, and lead emissions are combined to estimate the area source of lead from the roadway (see Table 4). This source represents the source of lead-containing dust which is lifted from the road surface due to turbulence due to passing traffic and then subsequently dispersed. Meteorological conditions, land use information, and particulate attributes are also input into AERMOD for the dispersion calculation. The model was run for a single year, and this year was considered to be representative of a typical year during the life of the child or adult. The outputs of this module are the estimated annual-average ambient air concentration, dry lead deposition, and wet lead deposition at each receptor (i.e., individual yard).

4.2.2 Parameter Selection

AERMOD Grid

For each scenario, the traffic volume and street grid were determined using general attributes of urban, suburban, and rural cities, as described below. In each case, the proxy city was used to represent a typical city. The grid included high volume roads and low volume roads, and the grid was constructed as discussed below.

For the urban scenarios, the proxy city is Dorchester, MA, which is characterized by multifamily homes and small yards. Measurement tools in GoogleEarth® were used to examine three different blocks in the center of Dorchester to determine that a typical block is rectangular with the dimensions 150 x 60 m and the streets are 8 m wide. Visual inspection in GoogleEarth® revealed that there are typically 8 yards x 2 yards per rectangular block. High traffic volume streets occur approximately every kilometer, with low volume streets occurring in between these using the block length as the spacing.

Then, a series of runs were performed using different total modeling domain sizes to determine how far the grid of source streets should extend to capture the full contribution of wheel weights at the home of highest air concentration. This home occurs at the intersection of two busy streets near the center of the domain. Initially, a grid size of 3 km was used. Then, because the wind direction is predominantly from the west-northwest (see below), an additional high volume street was added in the western direction, bringing the total extent in the east-west direction to 4km. In this case, the maximally exposed home increased by 4%. However, the addition of more receptors and street area sources greatly increased the runtime. Thus, the concentrations from the 3km run were used in the analysis. The 4km run suggests that these estimates could be under-predicting the lead concentration by up to 4% or more, and given the uncertainty in the emission rates, this amount of difference was deemed acceptable for this modeling effort.

For the rural scenario, the western rural community of Boulder, MT was used as the proxy city. Measurement tools in GoogleEarth® were used to examine the center of the city and one representative block to determine that a typical block is square with the dimensions 115 x 115 m and the streets are 8 m wide in the downtown area. Visual inspection in GoogleEarth® revealed that there are typically 3 yards x 2 yards per square block. The extent of the rural community was approximately 1 km with only a single high volume intersection. Thus, the model domain extended 1 km in the north/south and east/west directions with a single high volume intersection in the middle of the domain, with lower volume streets spaced in between at intervals equal to the block length. No sensitivity test was done to increase the grid size, since it was deemed unlikely a rural town would extend further than 1 km.

Finally, for the suburban scenario, the northeast suburban city of Turners Falls, MA was used as the proxy city. Measurement tools in GoogleEarth® were used to examine the center of the city and one representative block to determine that a typical block is rectangular with the dimensions 200 x 105 m and the streets are 8 m wide in the downtown area. Visual inspection in GoogleEarth® revealed that there are typically 5 yards x 2 yards per square block. Inspection of the pattern of roads indicated that higher volume streets occurred every 1 km in the suburban community. Thus, the domain consisted of a 2 km square with an intersection of higher volume roads in the center and higher volume roads along the perimeter, with lower volume roads along the intervening blocks. Owing to the lower emission rates from wheel weight dust release in this scenario, this domain size was sufficient to capture the air concentration and deposition estimates.

To estimate the area source emission rates, the lead emission rates (see Table 4) from the road soil module were multiplied by a factor of 1E8 (urban scenarios) or 1E9 (suburban and rural scenarios) to allow increased modeling precision. This factor was then divided out when calculating the modeled air concentrations and depositions at the maximally exposed home.

Land Use Category and Surface Characteristics

AERMOD (specifically, the meteorological preprocessor, AERMET) requires the land use distributions of the study sites in order to estimate monthly values of three important surface characteristics (surface roughness length, albedo, and Bowen ratio). AERMOD's land-use preprocessor, AERSURFACE, was developed to read in National Land Cover Database (NLCD) land use data (version 1992), calculate the distribution of land use types surrounding the study site, and use look-up tables where the values of the three surface characteristics depend on land use, season, snowfall, and rainfall amount. These surface characteristic look-up tables are available in Appendix A of the AERSURFACE User's Guide (U.S. EPA, 2008a). However, this study models a simplified grid of city blocks that each have the same land use characteristics within the same scenario (within the urban scenario, for example), rather than more realistic heterogeneous land use. As such, certain land use aspects of AERSURFACE (e.g., setting a land use radius for the surface roughness length, setting unique land use sectors) are not needed. Instead, the distribution of land use types surrounding the study sites was manually estimated, and, after also determining the climate characteristics, the look-up tables from U.S. EPA (2008a) were used to estimate the values of the three surface characteristics.

The land area covered by residential buildings was estimated by first estimating the ground footprint of the typical residential building at each study site in this study (urban, suburban, and rural). Residential buildings include apartment buildings and attached and detached single family homes. The 2005 Residential Energy Consumption Survey results from the U.S. Energy Information Administration (U.S. E.I.A., 2005) were used to estimate these footprints. Table 5 shows the estimated national number of the various types of residence buildings, the estimated percentage of each of these buildings at each of the study sites, and the estimated national average footprint of these buildings. The final column in Table 5 shows the assumptions that were made to estimate these numbers for this study. Note that towns are not used in this study but are shown in the table for completeness.

Table 6 shows the estimated average residence building footprint at each of the study sites. All of the footprints are between 190 and 205 m^2 (2,000 and 2,200 ft^2). Cities have the largest average footprint (203 m^2) due to a higher percentage of apartment buildings relative to single family homes, while rural areas have the smallest average footprint (193 m^2) due to a very small percentage of apartment buildings.

Assuming that urban residential buildings tend to be taller than rural and suburban residential buildings, residential buildings for the urban study site were linked to the land use type "High Intensity Residential" (USGS, 2010). Residential buildings for the rural and suburban study sites were linked to the land use type "Low Intensity Residential" (USGS, 2010). These land use designations are shown in Table 7. Table 7 also shows that cumulative footprint of residence buildings per city block, which was calculated by multiplying the average residence building footprint (Table 6) by the number of yards per city block. The cumulative footprint of residence buildings per city block ranges from about 1,160 m^2 at the rural study site to about 3,251 m^2 at the urban study site.

Table 5. Estimated U.S. Residence Building Characteristics

<table>
<tr><th rowspan="2"></th><th rowspan="2">National Total Count</th><th colspan="4">% of National Total in…</th><th rowspan="2">Avg Footprint (m^2)</th><th rowspan="2">Assumptions</th></tr>
<tr><th>Cities</th><th>Suburbs</th><th>Towns</th><th>Rural Areas</th></tr>
<tr><td>Detached Single Family Homes, 1 Floor</td><td>53,300,000</td><td rowspan="3">33%</td><td rowspan="3">22%</td><td rowspan="3">17%</td><td rowspan="3">27%</td><td>209</td><td>Detached single family homes include mobile homes, split-level, and 'other'</td></tr>
<tr><td>Detached Single family Homes, 2 Floors</td><td>24,000,000</td><td>161</td><td></td></tr>
<tr><td>Detached Single family Homes, 3+ Floors</td><td>1,700,000</td><td>130</td><td>All have only 3 floors</td></tr>
<tr><td>Attached Single Family Homes, 1 Floor</td><td>2,600,000</td><td rowspan="3">64%</td><td rowspan="3">20%</td><td rowspan="3">16%</td><td rowspan="3">N/A</td><td>209</td><td></td></tr>
<tr><td>Attached Single family Homes, 2 Floors</td><td>4,000,000</td><td>161</td><td></td></tr>
<tr><td>Attached Single Family Homes, 3+ Floors</td><td>800,000</td><td>130</td><td>All have only 3 floors</td></tr>
<tr><td>Apartment Buildings, 2-4 Units, 1-2 Floors</td><td>1,950,000</td><td>67%</td><td>12%</td><td>18%</td><td>4%</td><td>304</td><td>All have 4 units; building count split evenly between 1 and 2 floors</td></tr>
<tr><td>Apartment Buildings, 5+ Units, 1-2 Floors</td><td>820,000</td><td rowspan="4">66%</td><td rowspan="4">16%</td><td rowspan="4">16%</td><td rowspan="4">2%</td><td>612</td><td>All have 10 units; building count split evenly between 1 and 2 floors</td></tr>
<tr><td>Apartment Buildings, 5+ Units, 3-4 Floors</td><td>300,000</td><td>470</td><td>All have 20 units; building count split evenly between 3 and 4 floors</td></tr>
<tr><td>Apartment Buildings, 5+ Units, 5-10 Floors</td><td>32,000</td><td>532</td><td>All have 50 units; building count split evenly between 5 through 10 floors</td></tr>
<tr><td>Apartment Buildings, 5+ Units, 11-20 Floors</td><td>600</td><td>259</td><td>All have 100 units; building count split evenly between 11 through 20 floors</td></tr>
</table>

* Note that the building characteristics for towns are not used in this study, but they are shown here for completeness. To convert m^2 to ft^2, divide by about 0.093.

Table 6. Estimated Footprint of the Average Residence Building in each Location Type*

	Cities	Suburbs	Towns	Rural Areas
Avg Residence Building Footprint (m^2)	203	196	198	193

*Note that towns are not used in this study, but they are shown here for completeness. To convert m^2 to ft^2, divide by about 0.093.

For each study site, the land area covered by yards was estimated by subtracting the land area covered by residential buildings per city block from the area of each city block. The area of each city block was calculated by multiplying together the length and width of the city block. Yards were linked to the land-use type "Urban/Recreational Grasses", which is defined as "Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses" (USGS, 2010). This land use designation is shown in Table 7, which also shows that the cumulative yard area per city block ranges from about 5,749 m^2 at the urban study site to about 19,040 m^2 at the suburban study site.

For each study site, the land area covered by roads per city block was calculated by allocating to the block half the width of each road bordering the block. Roads were linked to the land use type "Commercial/Industrial/Transportation", which is defined as "Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential" (USGS, 2010). This land use designation is shown in Table 7, which also shows that the cumulative road area per city block ranges from about 1,744 m^2 at the urban study site to about 2,504 m^2 at the suburban study site.

These land use distributions are combined with season and rainfall information to determine the monthly values of the three surface characteristics. The climate information needed to determine seasons and rainfall quantities is described below.

Meteorology Parameters

All three scenario locations use meteorological data from Boston Logan International Airport. The wind direction was predominantly from the west-northwest, as shown in Figure 8. Exact windfields will vary throughout the country due to climatology and microclimatic factors. However, the predominant wind direction in this dataset is consistent with general mid-latitude westerly wind flow. The windspeed (on average 10 knots or 11 mph) is also generally reflective of typical northeastern and western-midwestern average windspeeds where the proxy cities are located (see http://hurricane.ncdc.noaa.gov/climaps/wnd60a13.pdf).

AERMET requires hourly surface data and twice-daily upper-air data. The hourly surface data for Boston Logan International Airport (Weather-Bureau-Army-Navy (WBAN) identifier 14739) were obtained from National Climatic Data Center (NCDC) and are in Integrated Surface Data Tape Data-3505 format (NCDC ISD, 2010). These surface hourly data were formatted as necessary for use in AERMET, and only the official end-of-hour observations were used. The closest upper-air station to Boston Logan International Airport is located in Chatham, MA (WBAN identifier 14684). The upper-air data for Chatham were obtained from the National Oceanic and Atmospheric Administration/Earth System Research Laboratory Radiosonde Database Access (NOAA ESRL, 2010). The upper-air data are in AERMET-friendly Forecast Systems Laboratory format, and only the official 00 Coordinated Universal Time (UTC) and 12 UTC observations at mandatory and significant atmospheric levels were used. In order to model air concentrations and deposition using the most recent 12-month meteorological data, the surface and upper-air data were obtained for August 2009 through July 2010.

AERMET also requires three important surface characteristics – surface roughness length, albedo, and Bowen ratio. The values of the surface characteristics for a given land use type can vary by season, so the user must define the seasons of the study sites.

Because Boston Logan International Airport is being used as the meteorological proxy for this study, the climatology of the airport area was analyzed in order to define which month is part of which season.

First, winter must be defined as snowy or not snowy, where snowy is defined as experiencing continuous snow cover for at least one month per year. As described in U.S. EPA (2009f), the shapefiles from the NCDC Climate Maps of the United States database (NCDC, 2005a) were used to analyze typical snow cover at any location in the lower 48 U.S. states. By this analysis, the Boston Logan International Airport location met this definition of snowy.

Table 7. The Land Use Characteristics of Each Study Site

	Urban Study Site	Rural Study Site	Suburban Study Site
Area of City Block, Including Half of Roads on Every Side (m^2)	10,744	15,129	23,504
Cumulative Area of Residence Buildings per City Block (m^2)	3,251	1,160	1,960
% of Area of City Block that is Comprised of Residence Buildings	30%	8%	8%
Land Use Type for Residence Buildings	High Intensity Residential	Low Intensity Residential	Low Intensity Residential
Cumulative Area of Yards per City Block (m^2)	5,749	12,065	19,040
% of Area of City Block that is Comprised of Yards	54%	80%	81%
Land Use Type for Yards	Urban/ Recreational Grasses	Urban/ Recreational Grasses	Urban/ Recreational Grasses
Cumulative Area of Roads per City Block, With Half of Roads Included on Every Side (m^2)	1,744	1,904	2,504
% of Area of City Block that is Comprised of Roads	16%	13%	11%
Land Use Type for Roads*	Commercial/Industrial /Transportation (non-airport)	Commercial/Industrial /Transportation (non-airport)	Commercial/Industrial /Transportation (non-airport)

* The land use types correspond to those contained in the 1992 NLCD (USGS, 2010).

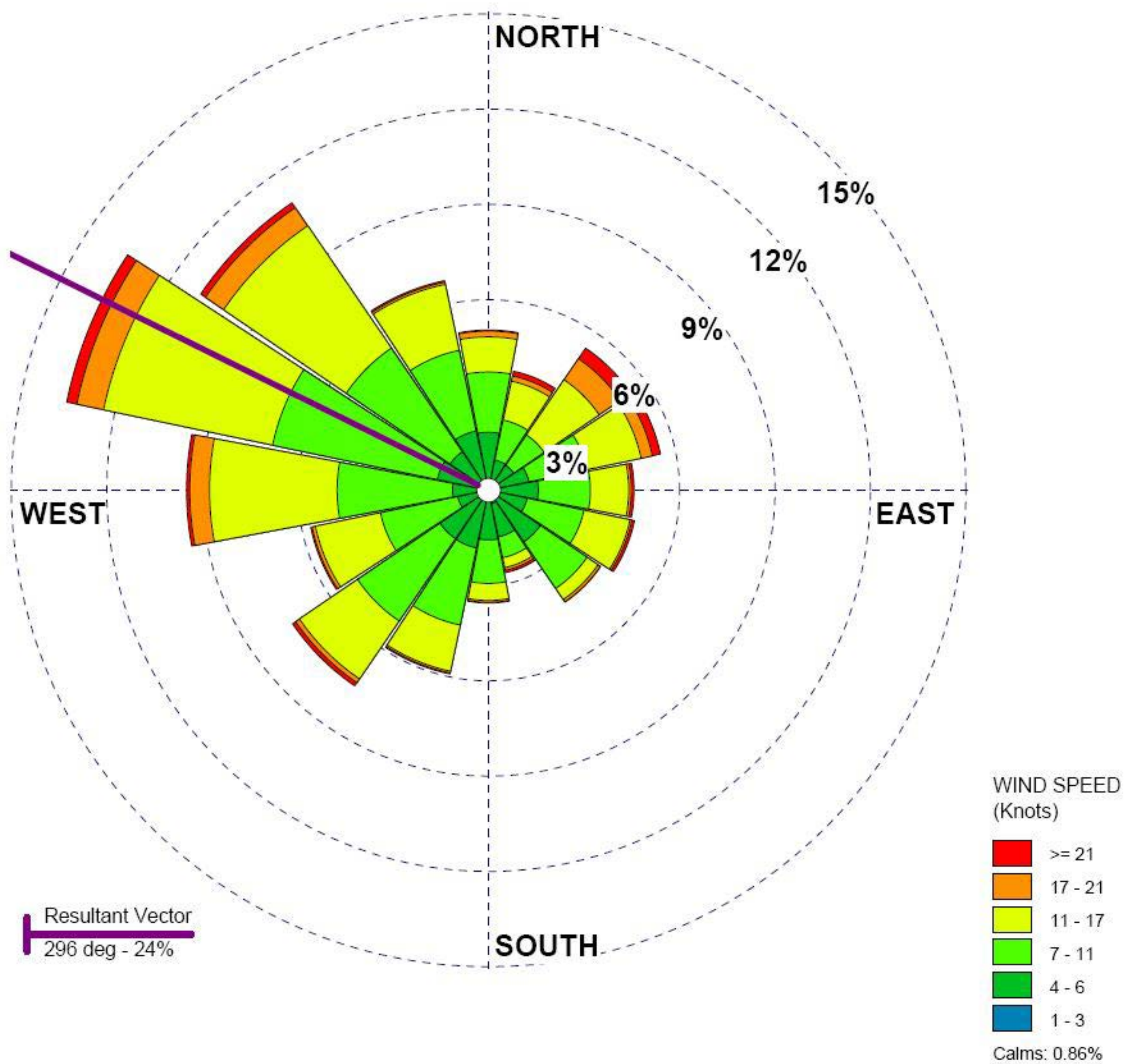

Figure 8. Wind Rose for Boston Logan Airport Meteorological Station

Second, each month must be assigned to a season. The same procedures used in *Risk and Exposure Assessment to Support the Review of the* SO_2 *Primary National Ambient Air Quality Standards* (U.S. EPA, 2009f) to determine seasons for the lower 48 U.S. states were used in this study. As with defining continuous snow cover, the procedures for defining seasons relied on data from NCDC (2005a). Based on these criteria, winter at the Boston Logan International Airport location was defined as December through February, spring was defined as March through May, summer was defined as June through August, and autumn was defined as September through November.

Finally, the AERSURFACE look-up tables require information as to whether the location was experiencing above average, below average, or average precipitation on a monthly basis. To determine the precipitation category, the AERSURFACE guidance recommends comparing the period of record of the meteorology data used in the modeling to the 30-year period of record for the same location and selecting above average if the modeling period is in the upper 30th percentile of the 30-year record, below average if in the lower 30th percentile, and average if otherwise. AERSURFACE applies this precipitation designation to the whole period of modeling. For the August 2009 through July 2010 period of modeling for this study, the 12-month total precipitation was 53.44 inches (135.7 cm) at the Boston Logan International Airport, which is 26% above the 1971-2000 Climate Normals annual precipitation amount of 42.53 inches (108 cm) (NCDC, 2005b).

Table 8. Comparison of Monthly Precipitation to Average Conditions to Determine Precipitation Category

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
August 2009-July 2010 Monthly Precipitation Amount (cm)	6.10	7.59	39.98	4.65	8.51	11.56	7.24	8.41	8.00	14.27	9.32	10.11	135.74
1971-2000 70th Percentile Monthly Precipitation Amount (cm)	12.30	8.98	10.89	11.16	9.13	7.75	10.15	11.08	11.66	10.87	13.03	12.88	115.61
1971-2000 30th Percentile Monthly Precipitation Amount (cm)	6.35	6.33	6.36	6.05	5.60	3.79	5.46	4.06	3.98	7.48	6.26	5.69	96.09
"Wetness" Category for 2009-2010 Data (used for AERSURFACE)	DRY	AVG	WET	DRY	AVG	WET	AVG	AVG	AVG	WET	AVG	AVG	WET
Season	Winter (snowy)	Winter (snowy)	Spring	Spring	Spring	Sum-mer	Sum-mer	Sum-mer	Autumn	Autumn	Autumn	Winter (snowy)	--

However, individual months of the period of modeling range from 49% drier than normal to over 300% wetter than normal. Because this study will calculate monthly values of surface roughness length, albedo, and Bowen ratio, and because of these large monthly variances in precipitation, it is useful to categorize the precipitation amounts on a monthly basis. Monthly precipitation categories were also used in the NO_2 NAAQS risk analysis (U.S. EPA, 2008c), where AERSURFACE was run three times (once per precipitation setting), and the monthly values of the three surface characteristics using the three precipitation settings were merged according to monthly precipitation.

Monthly precipitation amounts from NWS (2005) were compared against the August 2009 through July 2010 monthly precipitation amounts. As shown in Table 8, two of the 2009-2010 months experienced precipitation amounts that were less than their respective

30th percentile 1971-2000 values. Three of the months experienced precipitation amounts that were greater than their respective 70th percentile 1971-2000 values. The other seven months experienced precipitation amounts that were within their respective 30th and 70th percentile values.

The culmination of the land use and climate characteristics is shown in Table 9. It shows the values of the three surface characteristics (albedo, Bowen ratio, and surface roughness length) for each month and for each scenario location type (urban, rural, and suburban). For each location type, these values were determined by averaging together the values of each surface characteristic for each land use type specific to the location. The averaging is weighted by the area of each land use type per city block. The surface characteristic value look-up tables are provided in Appendix A of the AERSURFACE User's Guide (U.S. EPA, 2008a). The areas of each land use type per study site are shown in Table 7, and the season and "wetness" category assigned to each month are shown in Table 8.

Table 9. Model Values of Albedo, Bowen Ratio, and Surface Roughness Length for each of the Three Study Scenario Types *

Month	Season	"Wetness" Category	Albedo			Bowen Ratio			Surface Roughness Length (m)		
			Urban	Rural	Suburban	Urban	Rural	Suburban	Urban	Rural	Suburban
Jan	Winter	Dry	0.48	0.56	0.56	0.50	0.50	0.50	0.44	0.14	0.13
Feb	Winter	Avg	0.48	0.56	0.56	0.50	0.50	0.50	0.44	0.14	0.13
Mar	Spring	Wet	0.48	0.15	0.15	0.57	0.33	0.32	0.44	0.15	0.14
Apr	Spring	Dry	0.48	0.15	0.15	1.93	1.33	1.30	0.44	0.15	0.14
May	Spring	Avg	0.48	0.15	0.15	0.86	0.49	0.47	0.44	0.15	0.14
Jun	Summer	Wet	0.16	0.15	0.15	0.63	0.41	0.40	0.44	0.16	0.15
Jul	Summer	Avg	0.16	0.15	0.15	0.96	0.65	0.63	0.44	0.16	0.15
Aug	Summer	Avg	0.16	0.15	0.15	0.96	0.65	0.63	0.44	0.16	0.15
Sep	Autumn	Avg	0.16	0.15	0.15	1.07	0.82	0.81	0.44	0.15	0.14
Oct	Autumn	Wet	0.16	0.15	0.15	0.68	0.49	0.48	0.44	0.15	0.14
Nov	Autumn	Avg	0.16	0.15	0.15	1.07	0.82	0.81	0.44	0.15	0.14
Dec	Winter	Avg	0.48	0.56	0.56	0.50	0.50	0.50	0.44	0.14	0.13

* These values were derived from the tables in Appendix A of the AERSURFACE User's Guide (U.S. EPA, 2008a), along with the "wetness" and season designations shown in Table 5 and the land use characteristics shown in Table 7.

Release Height and Dimensions

AERMOD requires the following parameters to be assigned for each source: Emission Rate (Aermis), Release height (Relhgt), width of roadway (Xinit) and initial vertical dimension (Szinit) (U.S. EPA 2004). Average release heights and initial vertical dimensions for light-duty and heavy duty vehicles are presented in "Transportation Conformity Guidance for Quantitative Hot-spot Analysis in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas" (U.S. EPA 2010d). Table 10 below lists default values by vehicle type. The lead dust is assumed to be lifted from the ground due to turbulence from passing vehicles, and this turbulence leads to the further emission of lead dust from the roadway to the air. Because the turbulence extends approximately over the height of the vehicle creating it, the release heights correspond roughly to vehicle heights. Site specific vehicle type distributions were obtained from MOVES (U.S. EPA, 2009e) and a class-weighted average was applied to get site-specific release height and initial vertical dimension values for each scenario (see Table 11). This method is consistent with U.S. EPA (2010d) recommendations.

Table 10. Default Release Height and Initial Vertical Dimension for AERMOD modeling

Vehicle Type	Release Height (Relhgt)	Initial Vertical Dimension (Szinit)
Light-duty	1.3 m	1.2 m
Heavy-duty	3.4 m	3.2 m

Table 11. Calculation of Release Height and Sigma Z for Scenarios A-E

Location	Light-duty vehicle distribution*	Heavy-duty vehicle distribution*	Release Height (m)	Sigma Z (m)
Scenario A,B (urban)	85.3%	14.7%	= (1.3×0.853) + (3.4×0.147) = 1.61 m	= (1.2×0.853) + (3.2×0.147) = 1.49 m
Scenario C,D (downtown rural)	81.8%	18.2%	= (1.3×0.818) + (3.4×0.182) = 1.68 m	= (1.2×0.818) + (3.2×0.182) = 1.56 m
Scenario E (suburban)	82.8%	17.2%	= (1.3×0.828) + (3.4×0.172) = 1.66 m	= (1.2×0.828) + (3.2×0.172) = 1.54 m

* Calculated from MOVES; "Heavy Duty" is the sum of vehicle population for "Combination Long-Haul Truck", "Combination Short-Haul Truck", "Intercity Bus", "Light Commercial Truck", "Motor Home", "School Bus", "Single Unit Long-Haul Truck", "Single Unit Short-Haul truck", and "Transit Bus" divided by the total population; "Light-Duty" is the sum of vehicle population for "Motorcycle," "Passenger Car" and "Passenger Truck" divided by the total vehicle population.

Mass Fractions and Particle Diameters

A requirement of AERMOD deposition Method 2 is the fraction of fine particulate matter (< 2.5 μm) in total particulate matter for the road-dust which will be modeled and the mass-median particle diameter (MMAD). Samara and Voutsa (2005) reported size distributions of roadside particulate matter and the MMAD near a roadway in Thessaloniki, Greece. The average mass-median particle diameter was 0.85 ± 0.71 μm. Samara and Voutsa (2005) reported average concentrations of roadway dust for the following size categories:

Average concentration of PM by size (N=32), in $\mu g/m^3$:

< 0.8 μm: 54.2 ± 22.2

0.8 – 1.3 μm: 6.59 ± 6.79

1.3 – 2.7 µm: 5.68 ± 3.37

2.7 – 6.7 µm: 16.7 ± 9.34

> 6.7 µm: 23.0 ± 14.3

To calculate the fraction of fine particulate matter, the average concentrations in size categories below 2.7 µm were summed and divided by the sum of concentrations in all categories. This results in a fraction of fine particulate matter of 0.626 for road dust. Implicit in this calculation is the assumption that the lead-containing dust from wheel weights will follow the same size distribution as roadway dust of other sources, although this assumption cannot be verified in the literature.

4.3 Yard Soil Module

The yard soil module predicts the yard lead concentrations at the different receptor yards using the AERMOD wet and dry deposition values and other input values, as depicted in Figure 9. Section 4.3.1 describes the selected assessment method and Section 4.3.2 describes how each parameter value was selected.

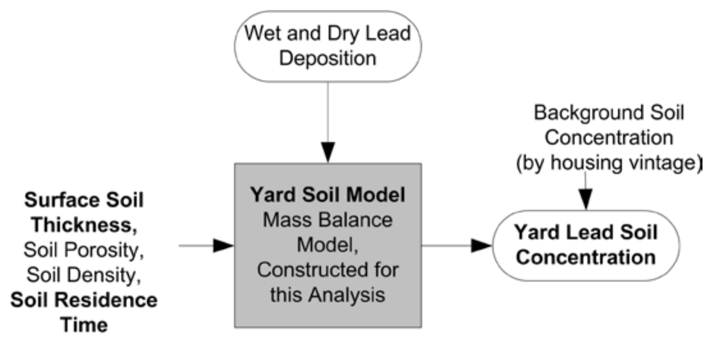

Figure 9. Flowchart Showing the Approach for the Yard Soil Module

4.3.1 Assessment Method Selected

Because AERMOD is strictly an air dispersion model and does not contain a soil module, another model must be found or built which estimates the soil concentrations based on the lead which is deposited from the air and any removal mechanisms. A multimedia model such as TRIM.FaTE models removal processes from colloidal transport from the surface soil compartment to deeper soil layers, lateral runoff, and lateral erosion. However, erosion and runoff will be dependent on the meteorology and the topography of the modeling domain, and uncertainties in each will introduce uncertainties in the results. Given the large uncertainties in the emission data, a simpler modeling approach was favored.

Thus, to estimate the contribution to the yard soil concentration from the wheel weight lead emission, a simple steady-state vertical mass balance model was constructed and parameterized.

Let:

M = the mass of lead in the soil (in μg)

C = the concentration of lead in the soil (in μg/g)

D = the deposition rate of lead into the soil (in μg/m^2/year)

τ = the residence time of lead in soil (in years)

ρ = the density of the soil (g/m^3)

ϕ = the porosity of the soil (fraction)

A = the area of the yard (m^2)

d= the depth of the top soil layer (m)

Mass balance considerations dictate that:

> The change in the mass of lead in the soil equals the deposition input from above less the loss due to vertical colloidal transport.

Using the symbols defined above, this mass balance equation may be expressed mathematically in terms of the following differential equation:

$$\frac{dM}{dt} = D \times A - \frac{M}{\tau} \qquad (5)$$

This equation assumes that the colloidal transport can be captured by first order removal with a rate constant equal to 1/τ (which is equivalent to the residence time). At steady state, the mass of lead in the soil is not changing, so

$$\frac{M}{\tau} = D \times A \qquad (6)$$

The mass of lead in the soil can be converted to concentration in units of mass of lead per mass of soil by using the soil density, porosity, and soil thickness,

$$C = \frac{D \times \tau}{d \times \rho \times (1-\phi)} \qquad (7)$$

Thus, given the total deposition of lead in the yard from the AERMOD model, the residence time in the soil, the soil depth, the soil density, and the porosity, the lead concentration due to wheel weights can be calculated using equation (7). Then, the wheel weights contribution can be subtracted from the total soil lead concentration to estimate a "no wheel weights" soil concentration.

The assessment framework for the near-roadway residence includes resuspension of road dust into the air and the subsequent dispersion and deposition of this lead-containing dust into nearby yards. However, the approach does not include the resuspension of contaminated yard soil into the air. In order to include this process, a full multi-media model that simultaneously models both air and soil processes would have to be used;

however, these models tend to have less sophisticated dispersion algorithms than the air-only AERMOD model.

To determine the possible uncertainty associated with excluding yard soil resuspension, a literature search was conducted. In general, the papers suggest that resuspension of contaminated soil can be a large contributor to ambient air concentrations. Harris and Davidson (2009) employ a mass balance model to conclude that sources of lead due to the resuspension of contaminated soil/dust are a factor of ten higher than direct sources of lead in the South Coast Air Basin in California. They cite the main contributor of lead in the soil to be from historical deposition in the era of leaded gasoline, and the current sources due to resuspension include both yard soil and roadway soil. Sabin et al. (2006), however, found that much of the airborne lead in Los Angeles was due to resuspension from roadways, and concentrations of lead in air returned to near-background levels within 10 to 150 m of the roadway. Hosiokangas et al. (2004) also found that roadways were a major contributor to airborne lead levels (27%) in Finland, and the windspeed tended to be the major determinant of how much lead was resuspended. These papers suggest that resuspension of contaminated soil/dust is a major contributor to airborne lead, but much of this resuspension occurs on roadways where car turbulence creates an effective mechanism for suspending the dust. Thus, excluding yard resuspension will tend to under-predict the yard air lead concentrations; however, the dominant source to a yard next to a roadway is likely the resuspended roadway lead rather than lead resuspended from the yard itself. The exclusion of yard resuspension remains a recognized limitation of the modeling approach.

4.3.2 Parameter Selection

Surface Soil Thickness

The thickness of the surface soil layer assumed in TRIM.FaTE model simulations performed for EPA OAQPS ranges from 1 cm for non-agricultural soils to 20 cm for tilled agricultural soils (U.S. EPA, 2009c). Although yard soils are not expected to be tilled, they may be mowed, raked, landscaped, or used for gardening. Due to the wide variability, a yard surface soil layer thickness of 1 cm was assumed. Because this parameter has a wide range in the literature, it is considered highly uncertain. An additional uncertainty analysis using an alternative thickness of 10 cm is presented in Section 4.9.

Soil Porosity and Density

The soil particle density of 2,600 kg/m^{3}was taken from the CalTOX model (McKone and Enoch, 2002). CalTOX is a model developed by funding from the U.S. EPA to model the environmental fate of chemical in air, soil and water and has been applied to a number of chemical risk assessments. In addition, the soil porosity was set to the CalTOX value of 20% or 0.2.

Soil Residence Time

A literature search was conducted to estimate the residence time of lead in surface soil. The following studies were reviewed: Tyler (1978), Miller and Friedland (1994), Erel (1998), U.S. EPA (2001), Kaste et al. (2003), Semali et al. (2004), Kaste et al. (2005), Klaminder et al. (2006a), Klaminder et al. (2006b), and Mireztky and Fernandez-Cirelli (2007), as shown in Table 12.

There were a number of variations in each of the studies reviewed. Studies were conducted in different areas of the world, including the Northeastern United States, Israel, Sweden, and France. Studies derived the residence time using a number of different methods, including experimental measurement of lead through soil, mass-balanced source models, tracer isotope tracking within soil, or chronosequencing lead in soil gradients. In addition, results were presented in numerous formats including residence times, response times, half lives, and 10% removal times. All half-life and 10% removal calculations were converted to response time, and calculations were made to ensure all definitions in the papers of residence time and response time were equivalent to each other.

Table 12. Lead in Soil Residence Time Literature Search Results

Paper	Year	Reported Time (yrs)	Residence Time (yrs)	Location
Tyler (1978)	1978	700-900 (10% removal)	6650-8550	Forest in Sweden
Miller and Friedland (1994)	1994	17-77 (response)	17-77	Northeast US
Erel (1998)	1998	100-200 (residence)	100-200	Israel, farmland and forest
U.S. EPA (2001)	2001	1000 (half life)	1442	Unknown
Kaste et al. (2003)	2003	60-150 (response)	60-150	Northeast US
Semali et al. (2004)	2004	700 (half life)	1000	France
Kaste et al. (2005)	2005	50-150 (response)	50-150	Northeast US
Klaminder et al. (2006a)	2006	150 (residence)	150	Forest in Sweden
Klaminder et al. (2006b)	2006	50-250 (residence)	50-250	Forest in Sweden
Mireztky and Fernandez-Cirelli (2007)	2007	740-5900 (half life)	1070-8500	Unknown

A number of factors affect the residence time of lead in the soil. The carbon flux within the soil layer is closely correlated with the residence time of lead. In newer growth forests, residence times are smaller than older growth forests. There is greater turnover of carbon in these newer growth forests. Older growth forests may have a higher organic carbon content in the upper layers or soil, but it may be broken down more slowly (Klaminder et al., 2006b). In addition, warmer climates may have quicker turnover of carbon and thus shorter lead residence times (Miller and Friedland, 1994).

Overall, the values reported in the studies vary over a wide range. For the yard soil module, a value of 1,000 years was selected. This value is in the middle of the range of literature values for the residence time. Because the range of values in the literature is so large, this variable is considered to be highly uncertain. In order to determine the effect of varying this parameter to a lower value, an uncertainty analysis using a residence time of 150 years is presented in Section 4.9.

Total Soil Concentration

Total home yard lead soil concentrations were determined for the model scenarios using proxy locations for each type, as shown in Table 13. For the urban location, a high soil concentration was used. The value was taken from a study of the concentrations in yards in Dorchester, MA (Hynes et al., 2001). The selected value represents the arithmetic mean of lead in surface soil in the North Dorchester section of Boston.

For the rural location, both high and low soil concentration areas are modeled. For the high soil concentration yard, values from a study measuring soil concentrations in residential Minnesota were used (Schmitt et al., 1988). The value represents the maximum value for the front yard lead concentrations for the "outstate" classification. For the low soil concentration area, values from a study measuring lead concentration in rural topsoil in South Carolina were used (Aelion et al., 2008). The value represents the mean lead concentration in the less contaminated strip of land from the study (strip 1).

For the suburban location, a low soil concentration area is modeled as it was assumed that this would be a post 1980's housing development. The Schmitt et al. study mentioned above for rural locations was used, and the selected value represents the median front yard lead concentrations for the "outstate" classification.

Table 13. Total Home Yard Lead Soil Concentration

Urban, High Soil Concentration (Scenarios A and B)	Rural, High Soil Concentration (Scenario C)	Rural, Low Soil Concentration (Scenario D)	Suburban, Low Soil Concentration (Scenario E)
1463 μg/g	656 μg/g	12 μg/g	37 μg/g

4.4 Indoor Air/Dust Module

The indoor air/dust module estimates the indoor air lead concentration from the ambient concentration using a penetration factor. It also estimates the indoor dust concentration using a regression model, the vintage of the home, and the calculated soil lead concentrations at the home, as depicted in Figure 10. Section 4.4.1 describes the assessment method selected for this module. Section 4.4.2 describes the selection of the input parameter values.

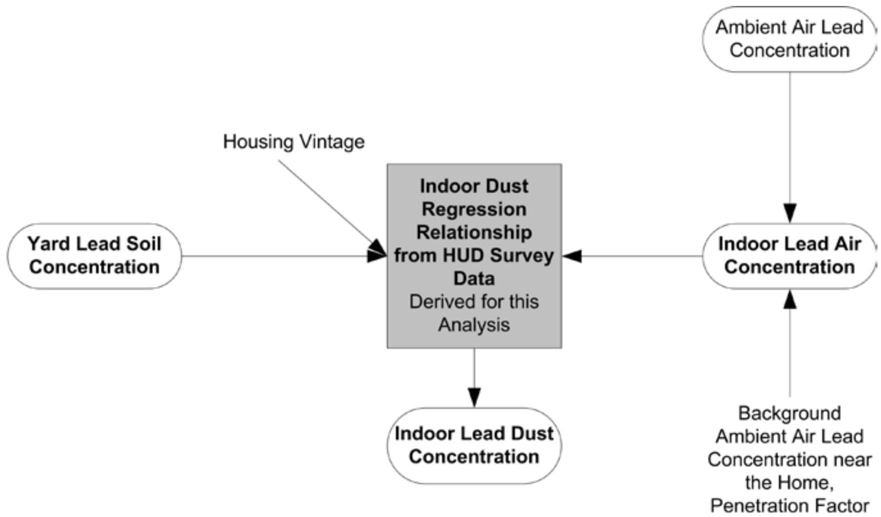

Figure 10. Flowchart Showing the Approach for the Indoor Air/Dust Module

4.4.1 Assessment Method Selected

The concentration of lead in indoor dust inside a home is determined by the outdoor soil concentration tracked into the home, the indoor lead paint concentration in the home, the ambient air concentration, the cleaning frequency, the occupancy level and characteristics, and the nature of non-lead particulate sources in the home. Lead wheel weights will contribute lead mass to the outdoor soil concentration and ambient air concentration, which will in turn affect the indoor lead dust concentration. In addition, different housing vintages in the different scenarios will have different levels of lead in the interior paint.

To fully capture the effect of the ambient air concentration and the soil concentration from wheel weights on the indoor lead levels, a fully physical model would need to be built that parameterizes the fate and transport of air particles and tracked-in soil particles in the home. In addition, because blood lead models generally accept only lead dust concentration (and not lead dust loading), a model would also need to be used to convert lead mass loadings to concentrations. However, in a fully physical model, all of the source and removal terms would include numerous parameters each with their own uncertainties. Given the uncertainties in the wheel weight loss and pulverization rates, a simpler assessment method was favored.

A literature search was conducted to find a dataset that simultaneously measured outdoor or indoor air concentrations, outdoor soil concentrations, and indoor dust concentrations. No such dataset at the national level could be identified. However, the National Survey of Lead-Based Paint in Housing ("HUD Survey Data", U.S. EPA, 1995) provides information on the lead dust concentration determined from particulate collected using

Blue Nozzle vacuum samplers, yard-wide average lead soil concentrations, the maximum observed indoor XRF lead paint concentrations, and the housing vintage for 312 homes. These data were used in this assessment to derive a regression equation relating the total interior dust concentration (including wheel weight sources and all other sources) with the outdoor soil concentration and the paint concentration. The ambient air concentrations were not captured in the survey, so these values could not be included in the regression equation.

Using Statistica®, a multiple linear regression equation was developed relating the indoor dust concentration to the outdoor soil concentration and indoor paint concentration. Both the untransformed and the natural-log-transformed variables were used in order to determine which linear regression captured the largest portion of the observed variance. Statistics from the two different fits are shown below in Table 14. The regression based on the untransformed variables captured little of the total variance and did not indicate significance at the p=0.01 level. Thus, the regression based on the natural-log-transformed variables was selected. This regression has an adjusted R^2 of 0.24, representing modest predictive power and indicating much of the variance is explained by other factors not included in the regression or captured in the survey, such as those mentioned above (ambient air concentration, cleaning frequency, occupancy level, etc.). The equation for the indoor dust concentration in μg/g becomes

$$\text{Dust} = 44.3 \times \text{Soil}^{0.33} \times \text{Paint}^{0.22}$$

where *Soil* is the concentration in the soil in μg/g and *Paint* is the concentration of lead in the interior paint in mg/cm^2. Figure 11 shows the predicted natural log of dust as a function of the observed natural log of dust, where the solid line denotes a 1:1 correspondence.

Paint concentrations are not explicitly considered in the overall wheel weight modeling approach. However, the housing vintage in each scenario has been specified. Thus, the average paint concentration across all homes in the HUD Survey in each specified vintage category was calculated and plugged into the dust equation to create vintage-specific equations, as shown in Table 15 below.

Table 14. Statistics of the Multiple Linear Regression for Dust Concentration

	R	R^2	Adjusted R^2	P level	Standard Error
Untransformed	0.047	0.0022	--	< 0.72	2961.8
Natural-log-transformed	0.5	0.25	0.24	< 1e-10	1.08

Figure 11. Predicted ln(Dust) as a Function of the Observed ln(Dust)

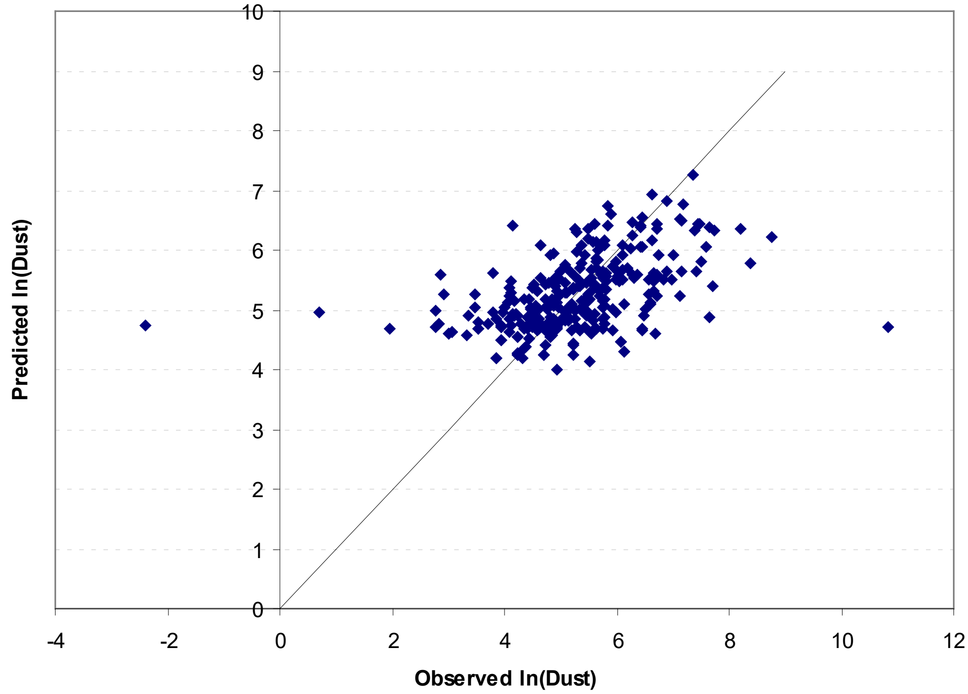

Table 15. Dust Regression Equation By Housing Vintage

	Pre 1940 Vintage (Scenarios A and C)	Post 1980 Vintage (Scenarios B, D, and E)
Average XRF Paint Concentration (mg/cm^2)	3.69	0.519
Dust Equation	$\text{Dust} = 59.0 \times \text{Soil}^{0.33}$	$\text{Dust} = 38.3 \times \text{Soil}^{0.33}$

4.4.2 Parameter Selection

Total Ambient Air Concentration

The total ambient air concentration was calculated using air monitoring information from the EPA's Air Quality System (AQS; U.S. EPA, 2010a) DataMart database. Average annual concentrations from all monitoring locations in the AQS system measuring lead total suspended particulate (TSP) at standard temperature and pressure (STP), or parameter ID 12128. Data from 2008 were used, since in 2009 monitors began using updated reporting methods due to the most recent lead NAAQS rules; however, because different monitors used different reporting methods, the statistical strength of averaging for any one reporting type was greatly diminished.

The AQS database includes a field named "Monitoring Objective" that specifies the reason that a monitor was placed in each location. Monitors labeled "source oriented", "quality assurance" (duplicate monitors at the same site, which may bias results), or "Unknown" were removed from the analysis, as it is likely that the results from these sites will bias total ambient air concentrations. In addition, numerous monitors were located in the town of Herculaneum, Missouri which is the site of the largest lead smelter in the United States. All sites located in Herculaneum were also removed, regardless of the stated monitoring objective.

Monitoring stations were assigned to rural, suburban, or urban locations in AQS using the "Location" field. If the location was unknown, the latitude and longitude was viewed in Google Earth® and an assignment was made by professional judgment. Only locations with residential and commercial land use types were included.

The remaining monitors' annual average concentrations in $\mu g/m^3$ for each station type (rural, suburban, or urban) were used to give estimates of the average, standard deviation, and median ambient air concentrations in each location, as shown in Table 16. The average concentrations were selected for use in the modeling framework.

Table 16. Ambient Air Concentrations from the AQS Monitoring Network

Description	N	Average ($\mu g/m^3$)	Standard Deviation ($\mu g/m^3$)	Median ($\mu g/m^3$)
Urban and City Center	31	0.025	0.054	0.0075
Rural	8	0.011	0.006	0.0130
Suburban	39	0.014	0.022	0.0067

Penetration Fraction of Ambient Air Into Home

The penetration fraction captures the ratio of the indoor concentration from outside sources to the ambient (outdoor) concentration. The penetration fraction was set equal to 1.0, taken from Thatcher and Layton (1995). The paper reported penetration for lead-containing particles in a home in California, and the penetration fraction was near one for all size classes. Thus, the indoor air concentrations used in the blood lead modeling are set equal to the outdoor air concentrations.

4.5 Blood Lead Module

The blood lead module uses the lead soil, air, and dust concentrations calculated above as inputs, as depicted in Figure 12. In addition, water and dietary concentrations as well as other exposure inputs are specified. The output of the module is the average blood lead in the child or adult living near the roadway. Section 4.5.1 describes the assessment methods selected for children and adults. Section 4.5.2 describes how the parameters for each model were selected.

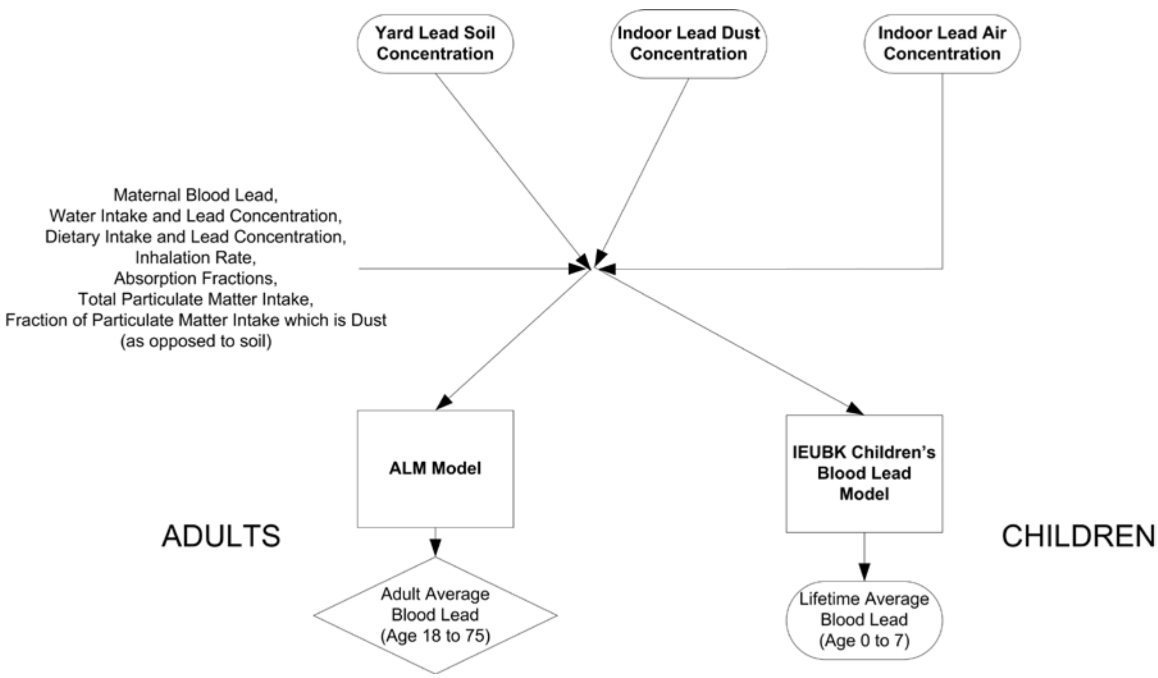

Figure 12. Flowchart Showing the Approach for the Blood Lead Module

4.5.1 Assessment Method Selected

Several models are available to estimate the blood lead levels for children and adults. The relative merits of each are discussed in recent EPA publications (e.g., U.S. EPA, 2007a and U.S. EPA, 2007b). The Integrated Exposure Uptake Biokinetic (IEUBK) model (U.S. EPA, 2010c) is a model for children from birth up to age seven. It has undergone extensive evaluation and validation by EPA scientists and outside reviewers (Mickle, 1998). Another model, the Leggett model (Leggett, 1992), can be used for children or adults and allows exposure concentrations and biokinetic parameters to change from birth to age seventy-five and above. It tends to predict childhood exposures which are two to three times higher than the IEUBK model (U.S. EPA, 2007a). IEUBK has been compared with measurements in NHANES and tends to predict blood lead values that are more consistent with population means than the Leggett model (U.S. EPA, 2007a). However, the Leggett model is better at capturing acute exposures to high lead levels in the exposure media, since biokinetic parameters and exposure values can vary on timescales shorter than a month in the Leggett model but not the IEUBK model.

Because the current exposures are assumed to remain constant throughout the life of the child (as opposed to a very short duration "spike" of exposure during a renovation activity) and because the IEUBK model tends to compare more favorably with NHANES data for children, the IEUBK model was selected to estimate children's exposure to lead in wheel weights. The model was run for each year age 0 to7 and then a lifetime-average blood lead was calculated.

The IEUBK model, which can estimate blood lead levels only in children up to age 84 months, was not used to predict adult blood lead levels. As an alternative, EPA's Adult Lead Methodology (ALM) (U.S. EPA, 1996; U.S. EPA, 2003), which uses a linear "biokinetic slope factor" (BKSF) to estimate lead dose from soil exposure, was adapted as described below. For comparison purposes, the Leggett model was also used to estimate exposures for adults and the results are shown in the appendix.

EPA originally developed the ALM (U.S. EPA, 1996) to estimate blood-lead impacts of exposures to lead-contaminated soil near "Superfund" sites. The approach was subsequently modified and refined, with a focus on evaluating blood lead impacts in women of childbearing age (U.S. EPA 2003) and predicting the proportion of exposed women and fetuses with blood-lead levels above levels of 10 µg/dL. The structure of the ALM is simple: estimates of steady-state (long-term) blood-lead concentrations are estimated as a linear function of soil exposures. Exposure concentrations are used to estimate time-averaged blood-lead uptake (absorbed dose) based on exposure factors (exposure frequency, soil ingestion rate, gastrointestinal absorption fraction) that are judged to be typical of the exposed population. In the simplest form of the ALM, the predicted central tendency blood-concentration is given by:

$$PbB_{adult} = PbB_{adult,0} + BKSF \times UP_S$$

$$UP_S = \frac{PbS * IR_S * AF_S * EF_S}{AT}$$

where:

$PbB_{adult,0}$= typical central tendency blood lead concentration in the absence of soil exposures (µg/dL)

BKSF = biokinetic slope factor (µg/dL per µg/day lead uptake)

UP_S = total soil lead uptake (µg/day)

PbS = soil lead concentration (µg/g)
IR_S = average soil ingestion rate (g/day)
AF_S = gastrointestinal absorption fraction for lead in soil
EF_S = exposure frequency (days/year)
AT = averaging time (365 days/year for chronic exposures)

In order to adapt the model to apply to wheel weight exposures, the total soil uptake in the model was recharacterized as uptake from ingestion of both lead soil and dust. The biokinetic slope factor can then be applied to the total particulate ingestion rather than just the soil particulate ingestion. The dust lead concentration, the total soil and dust ingestion, and the fraction of total soil and dust ingestion derived from soil were added to the equation in the following way:

$$PbB_{adult} = PbB_{adult,0} + BKSF \times UP_{S+D}$$

$$UP_{S+D} = (PbS \times W_S + PbD \times (1 - W_S)) \times IR_{S+D} \times AF_{S+D} \times EF_{S+D} \times AT$$

where:

$PbB_{adult,\,0}$= typical central tendency blood lead concentration in the absence of soil and dust exposures (µg/dL)
BKSF = biokinetic slope factor (µg/dL per µg/day lead uptake)
UP_{S+D} = total soil and dust lead uptake (µg/day)
PbS = soil lead concentration (µg/g)
PbD = dust lead concentration (µg/g)
W_S = weighting factor indicating fraction of soil and dust ingestion from soil
IR_{S+D} = average soil and dust ingestion rate (g/day)
AF_{S+D} = gastrointestinal absorption fraction for lead in soil and dust
EF_{S+D} = exposure frequency (days/year), set equal to 365
AT = averaging time (365 days/year for chronic exposures)

By adapting the model in this way, the dust and soil contributions to blood lead from lead wheel weights can be explicitly estimated. However, the air contribution of wheel weight lead to blood lead is not explicitly included. Because the ALM was specifically developed for Superfund applications and exposure due to particulate ingestion, the model was not adapted to include inhalation exposure. However, the uptakes from inhalation exposures to lead in wheel weights are a small proportion of the total uptake (see Section 4.7 for a discussion in children; similar conclusions apply for adults). Small contributions from total inhalation uptakes are included as part of the $PbB_{adult,0}$ term.

4.5.2 Parameter Selection

IEUBK Parameters

IEUBK requires a number of inputs aside from the air, soil, and dust lead concentrations. Table 17 shows the inputs and the proposed values for each. As a starting point, the values were set to those used in the exposure assessment supporting the current lead NAAQS level (U.S. EPA, 2007a) and in the exposure assessment supporting the Lead Renovation, Repair, and Painting rule, or "LRRP" rule (U.S. EPA, 2007b). Then, where possible, values were updated with data from more recently published literature. These included water lead concentration, lead absorption fractions, dietary lead intake, and the fraction of ingested soil and dust from soil.

In 2008, the U.S. EPA published a new edition of its Child-Specific Exposure Factors Handbook, from which updated mean values for total indoor/outdoor dust ingestion, water consumption, and ventilation rate were derived (U.S. EPA, 2008b). Where ages were expressed as a range in that report, rates for intermediate ages were interpolated using linear trendlines.

The IEUBK value for maternal blood lead level was updated using data from the most recent NHANES survey. These data from 2007 and 2008 reveal that the GM blood lead level among women aged 18 through 45 is 0.847 µg/dL. This was computed using the NHANES laboratory sample data and included nationally-representative sample weights (CDC, 2009). This value is somewhat lower than the adult predictions of blood lead for women living near the roadway presented in section 4.8. However, the maternal blood lead does not play a large role in estimating the child's lifetime-average blood lead in the IEUBK model. When the higher values presented in Table 23 are used for the maternal blood lead for each scenario, the lifetime average blood lead values only change by 2% or lower.

Table 17. IEUBK Blood Lead Model Input Values

Group	Parameter	Parameter Name	Parameter Value IEUBK Default Age Ranges (Years) 0.5 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	Basis/Derivation
Inhalation	Daily ventilation rate (cubic meters [m^3]/day)	Ventilation rate	5.4	8.0	9.5	10.9	10.9	10.9	12.4	U.S. EPA Child-Specific Exposure Factors Handbook (2008b) with interpolation for intermediate ages
Inhalation	Absolute inhalation absorption fraction (unitless)	Lung absorption	0.42							U.S. EPA (1989)
Inhalation	Indoor air Pb concentration	Indoor air Pb concentration (percentage of outdoor)	100%							These values are taken directly into account when developing the exposure concentrations
Inhalation	Time spent outdoors	Time spend outdoors (hours/day)	Not used							
Drinking Water Ingestion	Water consumption (L/day)	Water consumption (L/day)	0.36	0.271	0.317	0.349	0.380	0.397	0.414	U.S. EPA Child-Specific Exposure Factors Handbook (2008b) with interpolation for intermediate ages
Drinking Water Ingestion	Water Pb concentration (µg/L)	Lead concentration in drinking water (µg/L)	4.61							GM of values reported in studies of United States and Canadian populations (residential water) as cited in U.S. EPA (2006), section 3.3 Table 3-10), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)
Drinking Water Ingestion	Absolute absorption (unitless)	Total percent accessible (IEUBK)	50 % (Single value used across all age ranges)							Assumed similar to dietary absorption (see "Total percent accessible" under Diet below), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)

Table 17. IEUBK Blood Lead Model Input Values

Group	Parameter	Parameter Name	Parameter Value: IEUBK Default Age Ranges (Years) 0.5 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	Basis/Derivation
Diet	Dietary Pb intake (µg/day)	Dietary Pb intake (µg/day)	3.16	2.6	2.87	2.74	2.61	2.74	2.99	Estimates based on the following: (1) Pb food residue data from U.S. Food and Drug Administration (U.S. FDA) Total Diet Study (USFDA, 2001), and (2) food consumption data from NHANES III (CDC, 1997), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)
Diet	Absolute absorption (unitless)	Total percent accessible	50%							Alexander et al. (1974) and Ziegler et al. (1978) as cited in U.S. EPA (2006, section 4.2.1), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)
Outdoor Soil/Dust and Indoor Dust Ingestion	Outdoor soil/dust and indoor dust weighting factor (unitless)	Outdoor soil/dust and indoor dust ingestion weighting factor (percent outdoor soil/dust)	45%							This is the percent of total ingestion that is outdoor soil/dust. Value reflects best judgment and consideration (results published by van Wijnen et al. (1990), as cited in (U.S. EPA, 1989), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)
Outdoor Soil/Dust and Indoor Dust Ingestion	Total indoor dust + outdoor soil/dust ingestion (mg/day)	Amount of outdoor soil/dust and indoor dust ingested daily (mg)	60	110	110	110	110	110	110	U.S. EPA Child-Specific Exposure Factors Handbook (2008b), excluding cases of soil-pica and geophagy
Outdoor Soil/Dust and Indoor Dust Ingestion	Absolute gastrointestinal absorption (outdoor soil/dust and indoor dust) (unitless)	Total percent accessible (IEUBK)	0.30 for both outdoor soil/dust and indoor dust							Reflects evidence that Pb in indoor dust and outdoor soil/dust is as accessible as dietary Pb and that indoor dust and outdoor soil/dust ingestion may occur away from mealtimes (U.S. EPA 1989), as in the Lead NAAQS (U.S. EPA, 2007a) and Lead Renovation, Repair, and Painting Rule (U.S. EPA, 2007b)

Table 17. IEUBK Blood Lead Model Input Values

Group	Parameter	Parameter Name	Parameter Value: IEUBK Default Age Ranges (Years) 0.5 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	Basis/Derivation
Other	Maternal PbB (µg/dL)	Maternal PbB concentration at childbirth, µg/dL	0.847							NHANES 2007-2008, national weighted GM of all women aged 18-45 (CDC, 2009)

ALM Parameters

The parameters for the ALM were either set equal to the defaults or were set equal to the values in IEUBK. In particular, the background adult blood lead was set equal to the recommendation of U.S. EPA (2009g) following evaluation of the NHANES 1999-2004 survey data. The parameters are shown in Table 18. The background value may include exposure to indoor dust even though the ALM was adapted to directly apply the biokinetic slope factor to the dust ingestion. However, because the model is linear, the incremental blood lead arising from lead in wheel weights will be unaffected by the choice of the background value.

Table 18. Input Variables and Sources for the Adapted ALM Model

Definition	Variable	Value	Source
Soil + Dust Ingestion Rate, g/day	IR_{S+D}	0.05	U.S EPA (2003), ALM default
Weighting factor; proportion of IR_{S+D} which is soil	W_s	0.45	U.S EPA (1989), same as in IEUBK
Soil and Dust Lead Absorption Fraction	AF_{S+D}	0.12	U.S EPA (2003), ALM default
Biokinetic Slope Factor, µg/dL per µg/day	BKSF	0.4	U.S EPA (2003), ALM default
Background Adult Blood Lead, µg/dL	$PbB_{0,adult}$	1	U.S EPA (2009g), ALM default

4.6 Media Concentrations

First, the AERMOD model was used to estimate air concentrations at each modeled yard. Because these air concentrations are not affected by the soil concentrations (since resuspension is not included, see Section 4.3.1) or housing vintage, scenarios that differ only by these variable definitions will have the same air concentrations. In other words, the urban pre-1940 and post-1980 (Scenarios A and B) have the same air concentrations, as do the downtown rural pre-1940 and post-1980 (Scenarios C and D) scenarios.

Scenarios A and B – Urban pre-1940 (A) and post-1980 (B)

The concentrations in the receptor yards relative to the high and low volume streets for the urban scenario 3 km grid are shown in Figure 13. As discussed in Section 4.2.2, the AERMOD grid represents intersecting streets separated by the typical block length in the proxy city. This proxy city is a Northeastern city with multifamily homes and small yards. High traffic volume streets occur every kilometer with low traffic volume streets between them. In this figure, the light blue lines represent low volume streets, the dark blue lines represent high volume streets, and the colored dots each represent a single yard.

The highest annual-average concentration occurs just to the southeast of the central intersection of the high traffic volume streets and is indicated with a star. At this point, the concentration is 0.017 $\mu g/m^3$, and the total deposition (wet and dry) is 0.0011 g/m^2/year. The modeled concentration can be compared with the total concentration of 0.025 $\mu g/m^3$estimated from the AQS monitors (see section 4.4.2). In initial modeling efforts when street cleaning was not taken into account in the estimation of the lead emission rate, the modeled concentration was 0.054 μg/m^3, which is above the total concentration. However, the total concentration should include the contribution from wheel weights. This observation indicated the scenario was yielding unrealistically high air concentrations and the cleaning frequency calculation was included to ensure more reasonable modeling results were achieved.

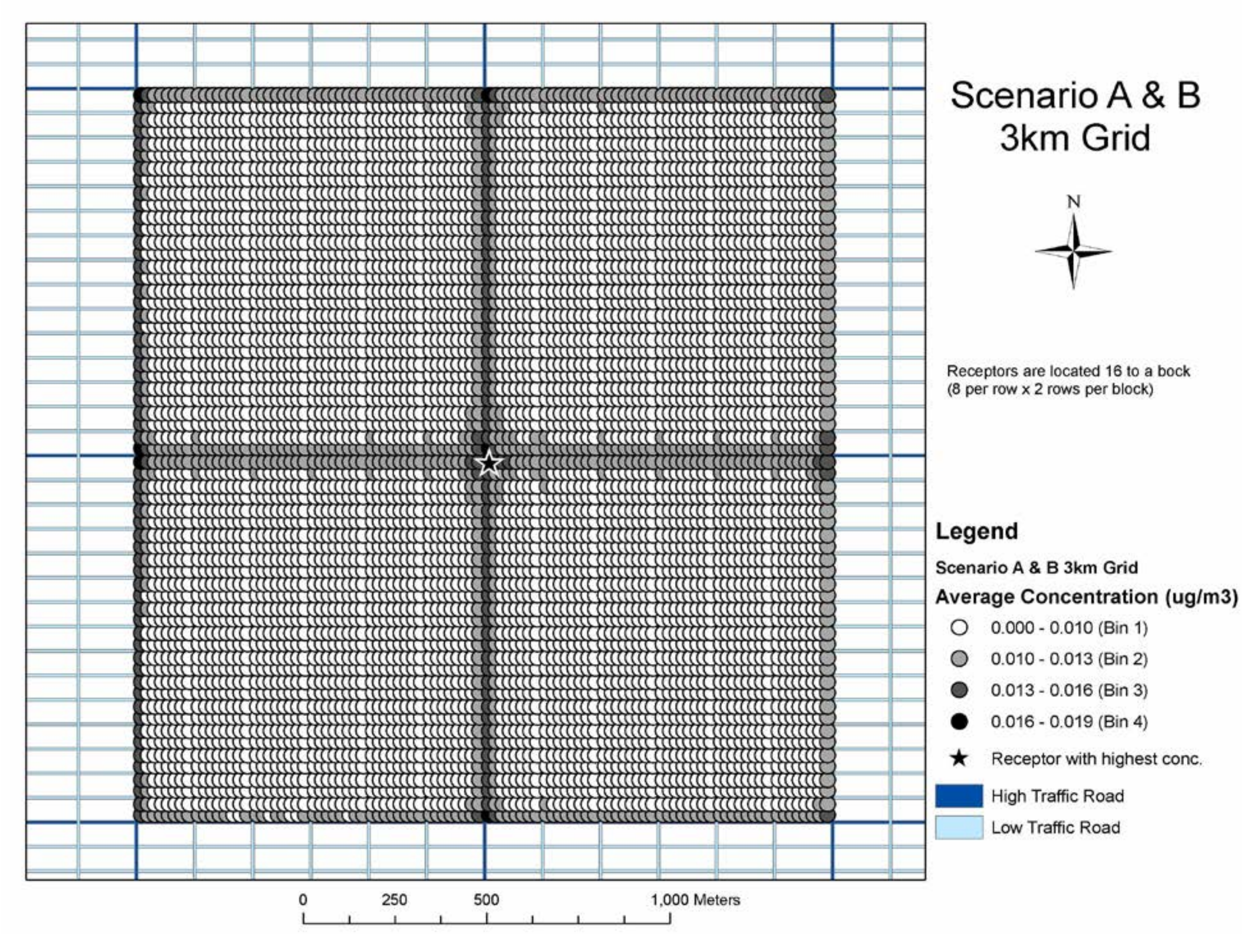

Figure 13. Modeled Concentrations in the Urban Scenario A and B, 3km Grid

Scenarios C and D – Downtown rural, pre-1940 (C) and post-1980 (D)

The concentrations in the receptor yards relative to the high and low volume streets for the rural scenario are shown in Figure 14. The highest annual-average concentration occurs just to the southeast of the central intersection of the high volume traffic. At this point, the concentration is 7.8E-4 μg/m^3, and the total deposition (wet and dry) is 5.3E-5 g/m^2/year. The modeled concentration can be compared with the total concentration of 0.010 μg/m^3.

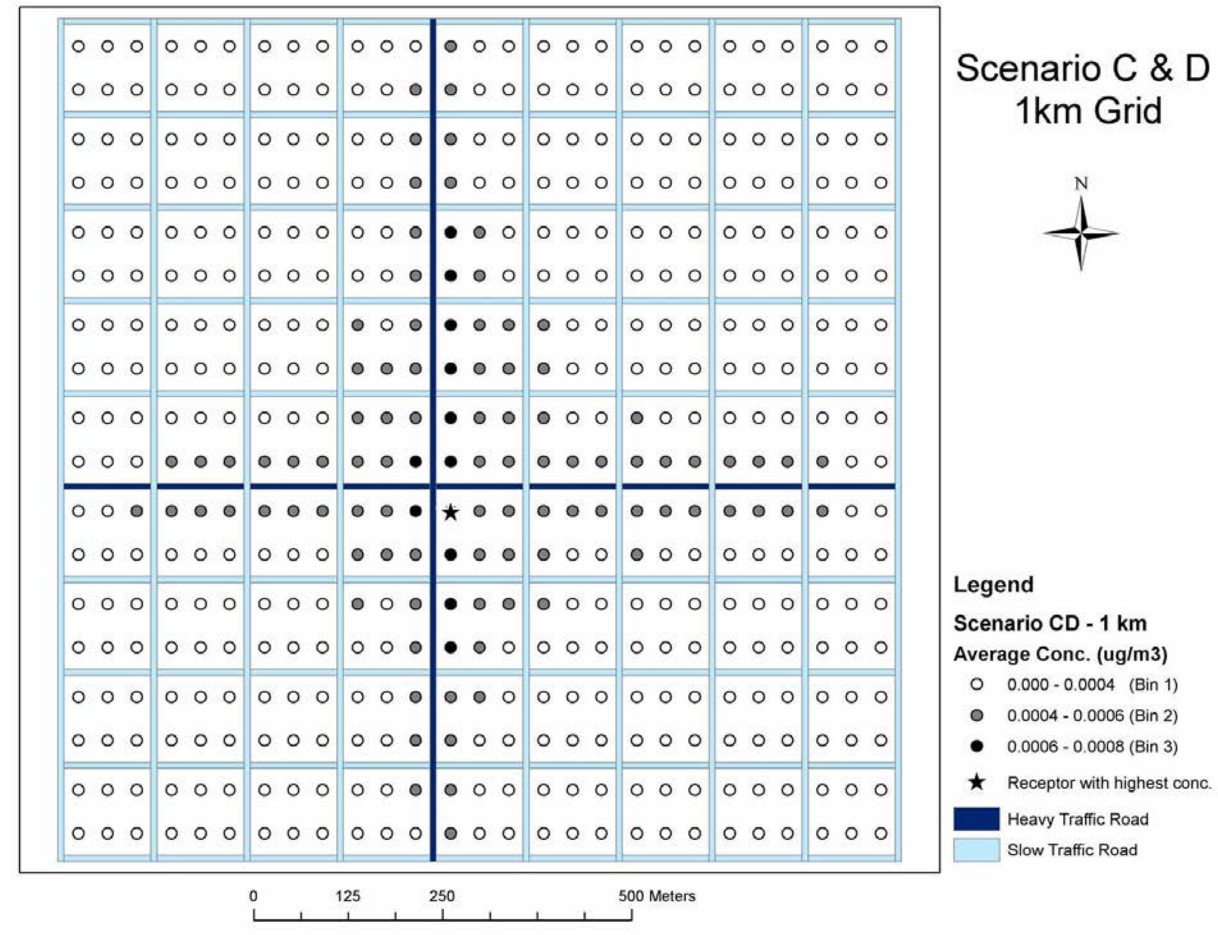

Figure 14. Modeled Concentrations in the Rural Scenario C and D, 1 km Grid

Scenario E – Suburban, post-1980

The concentrations in the receptor yards relative to the high and low volume streets for the suburban scenario 2 km grid are shown in Figure 15. The highest annual-average concentration occurs just to the southeast of the central intersection of the high volume traffic. At this point, the concentration is 2.1E-3 $\mu g/m^3$, and the total deposition (wet and dry) is 1.4E-4 g/m^2/year. The modeled concentration can be compared with the total concentration of 0.014 $\mu g/m^3$.

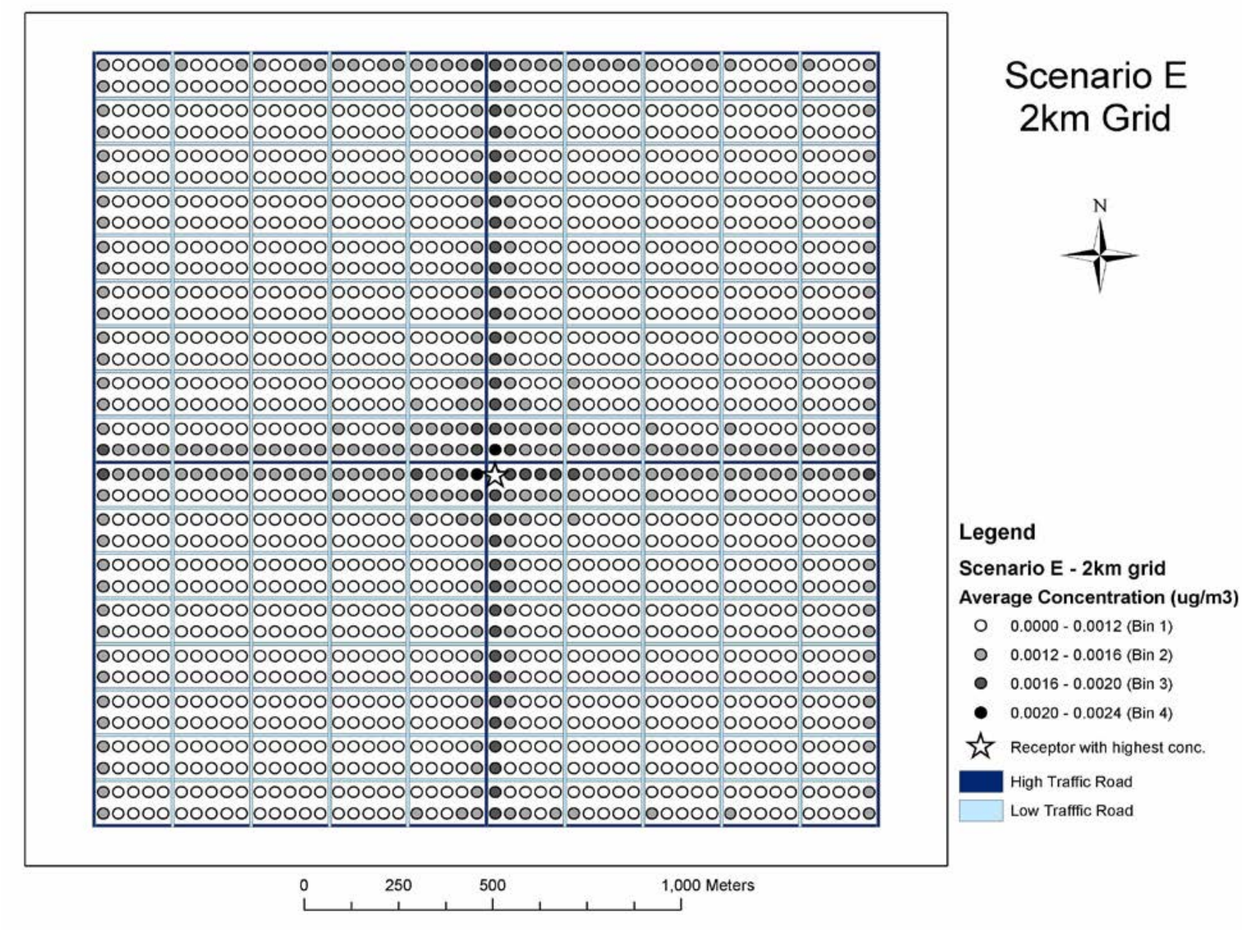

Figure 15. Modeled Concentrations in the Suburban Scenario E, 2 km Grid

Summary of Media Concentrations in the Modeled Scenarios

In each scenario, the modeled air concentrations were binned from lowest (Bin 1) to highest (Bin 3 or 4) concentration intervals that span the range of modeled concentrations in the domain. The bins were selected so that each scenario had three or four bins and the bin boundaries were equally-spaced. Then, the percentage of yards in each concentration bin was calculated using all the modeled yards on the eastern side of the grid. Because the wind is predominantly from the western direction, the eastern side of the grid has a larger contribution from upwind wheel weight emission and thus has a higher level of concentration precision than the western side of the grid. Table 19 shows the bin definitions and the percentage of eastern yards in each bin for the modeled scenarios.

Next, the mean air concentration and deposition was calculated in each bin for each scenario. These concentrations were then used to calculate both the soil and dust concentrations corresponding to these mean concentrations. In addition, the maximum air concentration and deposition in the domain were used to find the media concentrations at the maximally exposed home. Table 20 shows these media concentrations calculated from the AERMOD modeling, the yard soil module, and the indoor dust module. The total media concentration estimates are presumed to include both the wheel weight and other lead source contributions. The wheel weight contribution in Table 20 represents the portion of the total media concentration that is contributed by lead wheel weights. In the case of the dust concentration, this contribution is only approximate since the dust regression equation is nonlinear. The dust concentration was found using the 1) the total soil concentration and 2) the total soil concentration minus the wheel weight contribution and then subtracting 2) from 1). In general, the wheel weight contributions are a small percentage of the total soil and dust concentrations, particularly in the high soil concentration and earlier housing vintage cases. The air concentration contribution is larger, varying from 8% in the rural case up to 70% in the urban case. This large contribution in the urban case is surprising, since resuspended contaminated soil and industrial sources are expected to be the dominant sources in urban environments. However, the total air concentration value itself is highly uncertain, since it is calculated from a network of monitors placed in a variety of locations and which are not necessarily nationally representative. Efforts were made to filter out monitors whose modeling objective was to monitor industrial sources; thus, the total air concentration value may be low for a typical inner-city urban environment, and a true air concentration value is difficult to estimate. However, as will be discussed in the next section, the air concentration does not significantly impact the blood lead estimates; instead, soil and dust intakes are the dominant contributors.

Table 19. Modeled Air Concentration Bin Definitions

Model Scenario	Bin	Maximum Concentration in Bin ($\mu g/m^3$)	Number of Modeled Yards in Bin In Eastern Portion of Domain	Proportion of Modeled Yards in Bin in Eastern Portion of Domain
Scenario A and B Urban	Bin 1	0.0100	2543	85.9%
	Bin 2	0.0130	343	11.6%
	Bin 3	0.0160	70	2.4%
	Bin 4	0.0190	4	0.1%
Scenario C and D Rural	Bin 1	0.0004	207	76.7%
	Bin 2	0.0006	53	19.6%
	Bin 3	0.0008	10	3.7%
Scenario E Suburban	Bin 1	0.0012	674	79.3%
	Bin 2	0.0016	135	15.9%
	Bin 3	0.0020	39	4.6%
	Bin 4	0.0024	2	0.2%

Table 20. Media Concentrations in the Modeled Scenarios

Scenario	Bin	Concentrations					
		Total Air (µg/m^3)	Annually-Averaged Wheel Weight Contribution to Air (µg/m^3)	Total Soil (µg/g)	Wheel Weight Contribution to Soil (µg/g)	Total Dust (µg/g)	Approximate Wheel Weight Contribution to Dust (µg/g)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin 1 Mean	0.0250	0.0083	1463.0	25.0	658.5	3.7
	Bin 2 Mean		0.0112		35.0		5.3
	Bin 3 Mean		0.0142		44.8		6.7
	Bin 4 Mean		0.0169		54.7		8.3
	Max		0.0174		55.7		8.4
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin 1 Mean	0.0250	0.0083	1463.0	25.0	427.5	2.4
	Bin 2 Mean		0.0112		35.0		3.4
	Bin 3 Mean		0.0142		44.8		4.4
	Bin 4 Mean		0.0169		54.7		5.4
	Max		0.0174		55.7		5.5
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin 1 Mean	0.0100	0.0003	656.0	0.9	504.9	0.2
	Bin 2 Mean		0.0005		1.4		0.4
	Bin 3 Mean		0.0007		2.1		0.5
	Max		0.0008		2.5		0.6
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin 1 Mean	0.0100	0.0003	12.0	0.9	87.2	2.2
	Bin 2 Mean		0.0005		1.4		3.6
	Bin 3 Mean		0.0007		2.1		5.4
	Max		0.0008		2.5		6.6
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin 1 Mean	0.0140	0.0010	37.0	2.7	126.6	3.1
	Bin 2 Mean		0.0013		3.8		4.4
	Bin 3 Mean		0.0018		5.4		6.4
	Bin 4 Mean		0.0023		7.0		8.5
	Max		0.0023		7.1		8.7

4.7 Blood Lead Results for Children Age 0 to 7

The bin-mean media concentrations shown in Table 20 were input into the IEUBK blood lead model with the other inputs shown in Table 17. The childhood age 0 to 7 lifetime average blood lead level was calculated for the total exposure case first. Then, the blood lead level was calculated for each modeled scenario and bin by subtracting the wheel weight contribution to each media concentration from the total media concentration. In this way, the blood lead estimates represent situations where wheel weights are present and where wheel weights are not present, respectively.

The uptakes for each of the exposure media are shown in Table 21. Air, soil, and dust routes of exposure are assumed to include lead wheel weight contributions, while water and dietary routes of exposure do not include lead wheel weight contributions. In general, the soil and dust uptakes are the largest contributors to total lead uptake, with diet and water consumption routes playing an intermediate role. The inhalation uptake plays a relatively minor role in the total uptake. In addition, because the precision in IEUBK in the air concentration is 0.01 $\mu g/m^3$, the contribution by the wheel weights to the inhalation uptake is often not resolved in the different scenarios. Thus, the wheel weight contribution to the air concentration makes minimal difference in the blood lead of the child, but the ultimate deposition of this lead in the yard, the incorporation of the lead into yard soil and indoor dust, and the ingestion of this soil and dust by the child are predicted to result in small changes in the blood lead level.

Table 22 shows the blood lead levels for each scenario for the total exposure case and estimates of the contributions from lead wheel weights. In general, the contributions are on the order of 0.01 to 0.1 µg/dL, with the largest blood lead change in the urban high soil case with a value of 0.25 µg/dL. As stated in the introduction to Section 4, each scenario was constructed to represent specific exposure situations for the target populations in an urban, rural, and suburban environment. Thus, the magnitudes of the blood lead predictions should not be compared to national average values or values of a particular percentile in a nationwide survey. Instead, the incremental changes due to lead wheel weights are the key results from the analysis. The magnitude of these incremental changes will vary according to the total exposure media values selected, and the different scenarios were constructed to assist in determining the range of the variation.

Table 21. Uptake Estimates For Children in the Near-Roadway Scenario

Scenario	Bin	Lifetime Average Uptakes *							
		Total Air (µg/day)	Approx. Wheel Weights Air (µg/day)	Total Soil (µg/day)	Approx. Wheel Weights Soil (µg/day)	Total Dust (µg/day)	Approx. Wheel Weights Dust (µg/day)	Total Dietary (µg/day)	Total Water (µg/day)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin1 Mean	0.12	0.04	20.3	0.35	11.2	0.06	1.4	0.8
	Bin2 Mean		0.08		0.49		0.09		
	Bin3 Mean		0.08		0.62		0.12		
	Bin4 Mean		0.08		0.76		0.14		
	Max		0.08		0.77		0.14		
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin1 Mean	0.12	0.04	20.3	0.35	7.3	0.04	1.4	0.8
	Bin2 Mean		0.08		0.49		0.06		
	Bin3 Mean		0.08		0.62		0.07		
	Bin4 Mean		0.08		0.76		0.09		
	Max		0.08		0.77		0.09		
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin1 Mean	0.041	0.00	9.1	0.01	8.6	0.00	1.4	0.8
	Bin2 Mean		0.00		0.02		0.01		
	Bin3 Mean		0.00		0.03		0.01		
	Max		0.00		0.03		0.01		
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin1 Mean	0.041	0.00	0.2	0.01	1.5	0.04	1.4	0.8
	Bin2 Mean		0.00		0.02		0.06		
	Bin3 Mean		0.00		0.03		0.09		
	Max		0.00		0.03		0.11		
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin1 Mean	0.041	0.00	0.5	0.04	2.1	0.05	1.4	0.8
	Bin2 Mean		0.00		0.05		0.08		
	Bin3 Mean		0.00		0.07		0.11		
	Bin4 Mean		0.00		0.10		0.14		
	Max		0.00		0.10		0.15		

* Lifetime average indicates average between ages 0 and 7

Table 22. Blood Lead Estimates For Children in the Near-Roadway Scenario From IEUBK

Scenario	Bin	Lifetime Average Blood Lead *	
		Total (µg/dL)	Approx. Wheel Weights Contribution (µg/dL)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin1 Mean	9.79	0.11
	Bin2 Mean		0.16
	Bin3 Mean		0.20
	Bin4 Mean		0.24
	Max		0.25
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin1 Mean	8.86	0.11
	Bin2 Mean		0.16
	Bin3 Mean		0.20
	Bin4 Mean		0.24
	Max		0.24
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin1 Mean	6.28	<0.01
	Bin2 Mean		0.01
	Bin3 Mean		0.01
	Max		0.01
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin1 Mean	1.41	0.02
	Bin2 Mean		0.03
	Bin3 Mean		0.04
	Max		0.05
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin1 Mean	1.76	0.03
	Bin2 Mean		0.04
	Bin3 Mean		0.06
	Bin4 Mean		0.08
	Max		0.08

* Lifetime average indicates average between ages 0 and 7

4.8 Blood Lead Results for Adults

Table 23 shows the adult blood lead predictions for total exposure and for the approximate wheel weight contribution. The wheel weight contributions vary between less than 0.01 to 0.07 µg/dL.

Table 23. Blood Lead Estimates For Adults in the Near-Roadway Scenario From the ALM

Scenario	Bin	Total (µg/dL)	Approx. Wheel Weights Contribution (µg/dL)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin1 Mean	3.45	0.03
	Bin2 Mean		0.04
	Bin3 Mean		0.06
	Bin4 Mean		0.07
	Max		0.07
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin1 Mean	3.14	0.03
	Bin2 Mean		0.04
	Bin3 Mean		0.05
	Bin4 Mean		0.07
	Max		0.07
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin1 Mean	2.38	<0.01
	Bin2 Mean		<0.01
	Bin3 Mean		<0.01
	Max		<0.01
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin1 Mean	1.13	<0.01
	Bin2 Mean		0.01
	Bin3 Mean		0.01
	Max		0.01
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin1 Mean	1.21	0.01
	Bin2 Mean		0.01
	Bin3 Mean		0.01
	Bin4 Mean		0.02
	Max		0.02

4.9 Uncertainties in the Near-Roadway Exposure Scenario

The approach used to determine the effect of wheel weights on a hypothetical child or adult's blood lead level was designed to be systematic, to use peer-reviewed models and literature wherever possible, and to use approaches and input values similar to those used in other EPA lead analyses. However, the modeled scenarios are subject to numerous uncertainties. The following list highlights some of these uncertainties:

1. **The Root Study and Lead Emission Rates from Degraded Wheel Weights**. The Root (2000) study calculates the rate of lead wheel weight loss from cars and the fraction of roadway wheel weights degraded per day based on year-long sampling on a road in Albuquerque, NM. However, the methodology and conclusions in the study include many uncertainties such as:

    a. The study assumes that steady state conditions and loss rates can be ascertained by looking at the wheel weight stock on the curb only. However, it is likely that degradation mostly occurs on the roadway after the wheel weights fall off the vehicle and before they migrate to the curb. This omission may result in under-prediction of the degradation rates and the amount of lead mass emitted from the roadway.

b. The study assumes that all loss of wheel weights from the curb area occurs due to degradation. However, it is likely that other loss mechanisms are dominant in the curb area including street cleaning collection, collection by hobbyists, runoff into gutters from rain events, and ejection from the curb area into surrounding bushes or near-roadway areas. This assumption will tend to overestimate the amount of lead degradation and release to the air.

2. **The assumption that all degraded lead is emitted to the air**. The modeling approach assumes that all degraded wheel weight lead in the curb is emitted to the air. However, in reality runoff from rain events will remove some of the lead from the roadway before it is emitted. This assumption will tend to overestimate the lead emission rate from the roadway. This assumption is partially examined in the quantitative analysis below.

3. **The dust concentration in the home is not correlated with the ambient air concentration.** The indoor dust concentration in the home was estimated using a regression equation developed from the HUD survey data. However, ambient air measurements were not available in the survey, so indoor dust could not be correlated with the ambient air concentration. In actuality, penetration of ambient air particles into the home and the subsequent settling of particles onto the floor will affect the indoor dust concentration. It is unknown whether this limitation under- or over-predicts the indoor dust concentration.

4. **The use of proxy cities to represent urban, suburban, and rural communities.** Proxy cities were selected for each of the city types according to the availability of media concentrations and traffic data. These cities were used as the basis for the AERMOD grid. However, within these cities there is a wide variety of roadways with varying traffic volumes, and the grids are not uniform. Also, these cities may or may not be representative of the "average" urban, suburban, or rural community with respect to either media concentrations or traffic patterns. Thus, the use of these cities yields an illustrative hypothetical modeling scenario only.

5. **The exclusion of yard soil resuspension.** Resuspension of yard dust does not occur and deposition of roadway dust over the roadway does not occur. These assumptions are necessary to allow "decoupling" of the yard and air modeling compartments. To avoid this assumption, a full multimedia model would have to be used, but these models typically do not handle air dispersion as well as AERMOD.

6. **The application of the blood lead models.** The differences in media concentrations when the lead in wheel weights is excluded are small; the resulting differences in blood lead are also low, with blood lead changes on the order of 0.01 to 0.1 µg/dL. These predictions are close to the precision in the blood lead models and the predictive power of the models in this range is limited.

In addition to the issues noted above, some input variables had a wide range of possible values in the literature. In each case, the selected value was plausible, although no attempt was made to determine the overall probability that the combination of parameter values would exist in a single home or population. In order to determine the effect of these estimates, the child modeling was repeated using alternative values for the six variables deemed of lowest data quality. The six variables correspond to the bold variables in Figure 3.

The first four variables (the wheel weight loss rate, the wheel weight degradation rate, the roadway dust loss rate, and the additional roadway wheel weight removal rate) are all part of the roadway soil module and affect the lead emission rate. All four were either derived from the Root study or were assigned using professional judgment. Thus, the literature could not be used to inform the choice of the value that would be considered an alternative estimate for each variable. As a result, an illustrative case was selected to determine the extent to which the percent change in each variable carried through to the blood lead estimates. The wheel weight loss rate, which was calculated in the Root study, was decreased by a factor of two, resulting in an emission rate which is 50% of the base case emission rate. The loss rate of intact wheel weights due to hobbyist collection, removal into medians, or other processes, which was set at 0% in the base case based on professional judgment, was increased to 50. The loss rate of roadway dust to lateral runoff and other processes, which was set at 0% in the base case based on professional judgment, was increased to 50%. And the degradation rate, which was estimated in the Root study, was changed from 2.7% to 1. The effects of changing these variable values on the emission rate depends on the street cleaning frequency in each of the scenarios.

The other two variables, soil depth and the residence time of lead in soil, are parameters in the residential soil module and the published literature defines a range of values with wide uncertainty and/or variability. For these variables, values resulting in lower wheel weight lead concentrations were selected to explore the effects on the blood lead estimates. In the literature, the soil depth was expected to be between 1 cm and 20 cm, depending on the degree of tilling (yard aeration) and the soil content. For illustrative purposes, the soil depth was changed from the lower point in this range to near the midpoint (10 cm) to determine the effect on the blood lead estimates. The residence times had wide variation in the literature, and 1,000 years was selected for the base. The residence time will depend on the carbon content and other soil properties, and no data were collected in yards. However, many of the newer studies near roadways and in newer (lower carbon content) forests found residence times which had ranges which included 150 years. Thus, this value was selected for the illustrative uncertainty example.

Table 24 shows the change in the blood lead estimates for the different scenarios and compares the base case results with the uncertainty analysis results. For the parameters affecting the emission rate, in each case the change in emission rate carried through the analysis in a nearly linear fashion, such that a 50% decrease in the emission rate resulted in close to a 50% decrease in the blood lead estimates. For the soil variables, changes by a factor of nearly 10 resulted in changes in the blood lead estimates of less than a factor of 10.

Table 24. Estimates of the Blood Lead Changes Resulting from Lead Wheel Weights for the Uncertainty Analysis

Scenario	Bin	WW Blood Lead, Base Case (µg/dL)	WW Loss Rate Decrease by 50%		1% Degradation Rate		Roadway Dust Loss Rate of 50%		Additional Roadway Intact WW Removal Rate of 50%		Soil Depth 10 cm		Soil Residence Time 150 Years	
			WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case	WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case	WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case	WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case	WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case	WW Blood Lead (µg/dL)	Ratio of Unc. Case and Base Case
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	**Bin 1 Mean**	0.11	0.05	**0.5**	0.05	**0.4**	0.05	**0.5**	0.02	**0.2**	0.02	**0.2**	0.03	**0.2**
	Bin 2 Mean	0.16	0.07	**0.5**	0.06	**0.4**	0.07	**0.5**	0.02	**0.2**	0.03	**0.2**	0.03	**0.2**
	Bin 3 Mean	0.20	0.10	**0.5**	0.08	**0.4**	0.10	**0.5**	0.03	**0.2**	0.04	**0.2**	0.04	**0.2**
	Bin 4 Mean	0.24	0.12	**0.5**	0.10	**0.4**	0.12	**0.5**	0.04	**0.2**	0.04	**0.2**	0.05	**0.2**
	Maximum	0.25	0.12	**0.5**	0.10	**0.4**	0.12	**0.5**	0.04	**0.2**	0.04	**0.2**	0.06	**0.2**
Scenario B: Urban area, high soil lead concentration, post-1980 housing	**Bin 1 Mean**	0.11	0.05	**0.5**	0.05	**0.4**	0.05	**0.5**	0.02	**0.2**	0.02	**0.2**	0.03	**0.2**
	Bin 2 Mean	0.16	0.07	**0.5**	0.06	**0.4**	0.07	**0.5**	0.02	**0.2**	0.03	**0.2**	0.04	**0.2**
	Bin 3 Mean	0.20	0.09	**0.5**	0.08	**0.4**	0.09	**0.5**	0.03	**0.2**	0.04	**0.2**	0.04	**0.2**
	Bin 4 Mean	0.24	0.11	**0.5**	0.10	**0.4**	0.11	**0.5**	0.04	**0.2**	0.04	**0.2**	0.05	**0.2**
	Maximum	0.24	0.12	**0.5**	0.10	**0.4**	0.12	**0.5**	0.04	**0.2**	0.04	**0.2**	0.05	**0.2**
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	**Bin 1 Mean**	<0.1	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--
	Bin 2 Mean	0.01	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--
	Bin 3 Mean	0.01	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--
	Maximum	0.01	0.01	**0.5**	<0.1	--	0.01	**0.5**	<0.1	--	<0.1	--	<0.1	--
Scenario D: Rural area, low soil lead concentration, post-1980 housing	**Bin 1 Mean**	0.02	0.01	**0.5**	0.01	**0.6**	0.01	**0.5**	<0.1	--	<0.1	--	<0.1	--
	Bin 2 Mean	0.03	0.01	**0.5**	0.02	**0.6**	0.01	**0.5**	<0.1	--	<0.1	--	<0.1	--
	Bin 3 Mean	0.04	0.02	**0.5**	0.03	**0.6**	0.02	**0.5**	<0.1	--	0.01	**0.1**	0.01	**0.2**
	Maximum	0.05	0.02	**0.5**	0.03	**0.6**	0.02	**0.5**	<0.1	--	0.01	**0.1**	0.01	**0.2**
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	**Bin 1 Mean**	0.03	0.01	**0.5**	0.01	**0.5**	0.01	**0.5**	<0.1	--	0.00	**0.1**	0.01	**0.2**
	Bin 2 Mean	0.04	0.02	**0.5**	0.02	**0.5**	0.02	**0.5**	<0.1	--	0.01	**0.1**	0.01	**0.2**
	Bin 3 Mean	0.06	0.03	**0.5**	0.03	**0.5**	0.03	**0.5**	0.01	**0.1**	0.01	**0.1**	0.01	**0.2**
	Bin 4 Mean	0.08	0.04	**0.5**	0.04	**0.5**	0.04	**0.5**	0.01	**0.1**	0.01	**0.1**	0.01	**0.2**
	Maximum	0.08	0.04	**0.5**	0.04	**0.5**	0.04	**0.5**	0.01	**0.1**	0.01	**0.1**	0.01	**0.2**

Unc. = Uncertainty; WW = lead wheel weights; Ratios are not calculated for blood lead values below 0.01 µg/dL.

5. HOME MELTING EXPOSURE SCENARIO

In addition to the exposure pathway described previously, wheel weights that are lost from cars or removed by tire shop employees can also be collected by home hobbyists, who melt the wheel weights and produce a variety of hobby related items including lead fishing lures and sinkers, lead soldiers, and bullets. A case of acute lead poisoning was reported by the State of Alaska (State of Alaska Department of Health and Social Services, 2001) when a man turned his home hobby of fish sinker and ingot casting into a cottage industry and moved indoors into poorly ventilated space. This case indicates that exposure potential from inhalation of fumes and ingestion of indoor contaminated dust exists and can be quite high. Thus, this exposure scenario estimates the inhalation exposure concentration and garage dust loading for a child and adult present during a single melting event. Section 5.1 discusses the selected assessment method, Section 5.2 discusses the parameter selection, Section 5.3 presents the exposure concentrations and loadings, and Section 5.4 discusses the dominant uncertainties.

5. 1 Assessment Method Selected

Home melting of wheel weights can occur outside or inside the home. In this approach, the wheel weights are assumed to be melted in a garage, during a one hour session, with both an adult and child present. The child is included in the scenario to account for exposure to the more sensitive population, although the plausibility of a child being present during the event is unknown. Melting is usually achieved through the use of an electric pot, sold for this purpose, or with a propane burner. When either of these heating methods is employed, the lead, upon melting, will maintain equilibrium with the air above the pot. The air pressure will be equal to the saturation vapor pressure at the temperature of the interface of the lead and air. The heat generated will also cause a buoyant plume to form, as the heated air with lead vapor and combustion by-products directly above the pot will be less dense than the surrounding air. Agitation of the pot by stirring or mixing, which lowers the surface tension of the molten lead, will also release lead vapor. Modeling the processes of emission would be computationally rigorous, requiring computation fluid dynamic (CFD) modeling in connection with a mass balance model of the garage. However, this approach would involve numerous parameters and each would contribute to the overall uncertainty. Given the uncertainty in the emission rate from the pot, a simpler approach was selected.

Such a simpler, high-end method is the use of the saturation vapor pressure approach. The saturation vapor pressure approach assumes that the concentration of lead in indoor air throughout the room during the melting operation is equal to the equilibrium vapor pressure of lead at its melting temperature. This approach was recommended by Gurumurthy (2005) for modeling occupational exposures to chemicals when the data on workplace dimensions and practices are not available or are highly uncertain. Although this approach is high-end, it is likely to approximate the airborne lead concentration directly over the pot, which is where the home hobbyist would most likely be located during the melting event while stirring the metal and pouring it into casts.

The saturation vapor pressure approach assumes that the concentration of airborne lead is equal to the equilibrium vapor pressure at the temperature of melting for the entire duration of the melting event. In a closed system, lead vapor is formed above the surface of the molten lead and ultimately attains a thermodynamic equilibrium if the system is not perturbed. When such equilibrium is established, the concentration of lead expressed in pressure units is equal to the vapor pressure of lead at the temperature of the liquid. In reality, such equilibrium, if reached, will take time and will not be instantaneous. In addition, the concentration above the pot will be diluted in the remainder of the room and it will take time for the concentration in the whole garage to match the saturation vapor pressure (if it ever does). For this reason, the saturation vapor pressure represents an upper bound on the exposure air concentration and is appropriate for a high-end analysis. This approach does not rely on knowing the amount of lead in the pot or the size of the pot. Instead, by assuming the concentration in the garage instantaneously equals the saturation vapor pressure, only the chemical properties of lead, the temperature at which the lead is melted, and the duration of the melting event are needed. The two melting temperatures are related to their respective saturation vapor pressures by the Clausius-Clapeyron Equation (Schwarzenbach, 2003).

$$P_2 = P_1 \exp\left(\frac{-H_{vap}}{R}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

where:

P_2 = saturation vapor pressure at the temperature of melting (Pa)

P_1 = saturation vapor pressure at the reference temperature (Pa)

H_{vap} = enthalpy of vaporization of lead, 179 kJ/mol

R = Universal gas law constant (8.314 J K^{-1} mol^{-1})

T_2 = melting temperature (K)

T_1 = reference temperature (K)

The reference saturation vapor pressure and temperature, 1.33 kPa and 1433K, respectively were taken from the Toxnet Hazardous Substances Database information for lead (USNLM, 2010).

The calculated saturation vapor pressures associated with each melting temperature were converted to airborne concentrations by the ideal gas law, presented below.

$$Conc = \frac{P * MW}{RT}$$

where:

Conc = Concentration (μg/m^3)

P = pressure (Pa)

MW = molecular weight of lead (207.4 g/mol)

R = Universal gas law constant (8.314 m^3 Pa K^{-1} mol^{-1})

T = temperature (K)

The airborne concentrations were then related to the inhalation dose of lead for each scenario during the melting duration. The dose was estimated to be equal to the product of the airborne concentration of lead multiplied by the inhalation rate multiplied by the inhalation absorption fraction multiplied by the time of exposure.

During and following melting, the lead vapor in the air will cool and form particles that will settle and mix with the garage dust. By assigning a standard volume (both in height and area) to the garage and an appropriate particle deposition rate and air exchange rate for the garage, it is possible to estimate the floor lead dust loading in the garage. A simple mass-balance model was constructed to simulate the dust levels.

For the mass balance model, the changes in the airborne and deposited lead masses in the garage are related by the following two equations:

$$Mass_{air}(t=0) = Conc \times A \times h$$

$$Mass_{floor}(t=0) = D \times Mass_{air}(t=0)$$

$$\frac{dMass_{air}}{dt} = Mass_{air}(-\lambda - D)$$

and

$$\frac{dMass_{floor}}{dt} = Mass_{air} \times D$$

where:

$Mass_{air}$ = mass of lead deposited in the air of the garage, μg

$Mass_{floor}$ = mass of lead deposited on the floor of the garage, μg

$Mass_{air}(t=0)$ = the initial condition for the air mass just following the melting event

$Mass_{floor}(t=0)$ = the initial condition for the floor mass just following the melting event

t = time (hrs)

λ = typical garage air exchange rate

D = particle loss coefficient for deposition

A = the floor area of the garage

h = the height of the garage

This approach separates the exposure time into the time during the melting event and the time after the event. During the melting event, the air concentration is set equal to the saturation vapor pressure. The air exchange cannot be incorporated into this portion of the exposure event, since the vapor pressure model is a purely physicochemical model and does not allow for air exchange and other physical processes to mediate the concentration. Thus, it is assumed during this time that the floor loading at the end of the melting event is represented by the deposition rate multiplied by the total mass in the air and multiplied by the duration of the melting event (one hour).

After the melting event, the above equations are numerically integrated until the air concentrations reach only 0.1% of their during-melting levels. The resulting floor mass is divided by the floor area to estimate the floor lead loading at that time. It is worthwhile to note that because the concentration is assumed to be constant throughout the volume of the garage and the floor loading is normalized on an area basis, the floor loading for any size of garage would only vary with differences in ceiling height and would not change based on the footprint (square footage) of the garage.

Because this scenario represents high-end exposure to a single melting event, blood lead levels were not calculated. Blood lead is a long-term measure of exposure and the models are less suited to very short acute exposures, such as a single melting event. Combining melting events into a longer exposure profile would involve knowing the frequency of events and the cleaning frequency and efficiency in the garage, all of which are expected to be highly variable and are uncertain in the literature. Thus, the inhalation exposure concentrations and single-event dust loadings are the exposure metrics in this analysis, and blood lead levels were not estimated.

5.2 Parameter Selection

Representative Temperatures for Lead During Melting

Several sources provide recommendations to home bullet casters on the temperature ranges to maintain throughout the melting process. The how-to article "Bullet Casting for Beginners" (Boothroyd, undated) mentions that many casters melt lead at a temperature near 800°F (427°C). Because the wheel weights used in the melting contain a lead-antimony-tin alloy, the melting temperature is below the melting temperature of pure lead and is near 565°F (296°C, Boothroyd, undated). The author recommends keeping the temperature near this melting point at a temperature of 650°F (343°C). This will ensure the lead has melted but will not be hot enough to create "whiskers" as lead seeps through cracks in the mold when poured. Such whiskers will affect the performance of the bullet once used. In addition, keeping the temperature lower allows the caster to make many more bullets in a fixed amount of time because the cooling time is shorter. Thus, casters have an incentive to keep the melting temperature lower.

Because the performance of the bullet will be a priority of the caster, typical temperatures for bullet casting are likely between 650°F (343°C) and 800°F (427°C). Thus, these two temperatures are selected for the analysis. Although the pots can melt at temperatures up to 1000 °F (538°C, Boothroyd, undated), smoke would be created and would induce the caster to turn down the heat. In addition, casting at such a higher temperature will lead to impurities in the bullet. Thus, this temperature is included as an upper bound, but casters are not expected to maintain the pot at this temperature for long periods of time.

Duration of the Melting Event

The how-to article "Bullet Casting for Beginners" (Boothroyd, undated) mentions that casters can make up to 330 bullets in a single hour if the temperatures are kept near 650^{o}F (343^{o}C). Melting at higher temperatures yields approximately a 1/3 reduction in efficiency, resulting in approximately 100 bullets per hour. It is expected that this hour-long yield will be sufficient for a hobbyist, so a duration of one hour was selected as the melting duration.

Breathing Rates and Absorption Fractions

The average inhalation rate for children aged 2 to 16 during moderate activity is 1.37 m^3/hr (U.S. EPA, 2008b) and the adult inhalation rate during moderate activity is 1.6 m^3/hr (U.S. EPA, 1997). The absorption fraction was set equal to 0.42 as used in IEUBK (see Section 3.5.2).

Garage Height

The garage was assumed to have a height of 10 ft (or 3.0 m). This value is based on professional judgment.

Garage Air Exchange Rate

The air exchange rate (AER) for an attached residential garage was set at 1.24 hr^{-1} following EPA's exposure modeling guidance (Johnson, 2002.)

Particle Deposition Rate

The particle loss coefficient, D, is correlated with particle size. Nazaroff (2004) reports different deposition rates for different size particles, with deposition rates ranging from 0.1 to 2 hr^{-1}. A review of the literature suggests that a mass median aerodynamic particle diameter of 5 µm can be expected for lead melting operations (Donguk and Namwon, 2004). This size corresponds to a deposition rate of 2 hr^{-1}. Because the mass deposited on the floor is linearly correlated with the loss coefficient, alternative particle diameters of 0.01, 0.1, and 1 µm were also analyzed (corresponding to deposition rates of 1 hr^{-1}, 0.1 hr^{-1}, and 1 hr^{-1}, respectively).

5.3 Media concentration and inhalation results

The intermediaries and results of this approach are presented in Table 25 below, with inputs in normal font and results in bold font. As shown, the dose for both adults and children is much higher (nearly two orders of magnitude) at the middle temperature versus the lower temperature. Adult doses are slightly higher than child doses due to the higher inhalation rate of adults.

Table 25. Summary of Model Intermediaries and Results for the Home Melting Scenario

Variable Description	Units	Melting at 650°F	Melting at 800°F	Melting at 1000°F
Melting temperature	°C	343	427	538
Saturation vapor pressure	kPa	2.90E-09	1.87E-07	1.28E-05
Airborne Lead Concentration	**µg/m³**	**0.24**	**15.7**	**1070**
Adult Inhalation Exposure per hour	**µg/hour**	**0.163**	**10.5**	**719**
Child Inhalation Exposure per hour	**µg/hour**	**0.139**	**9.0**	**614**
Garage floor dust loading, d_p = 5 µm	**µg/ft²**	**0.177**	**11.4**	**781**
Garage floor dust loading, d_p = 0.01 µm or 1 µm	**µg/ft²**	**0.0978**	**6.31**	**431**
Garage floor dust loading, d_p = 0.1 µm	**µg/ft²**	**0.0118**	**0.76**	**52.1**

The results were compared to monitoring data collected by OSHA at facilities that manufactured sporting goods, such as fishing tackle and bullets and were likely to include casting of lead (OSHA, 2010). Data were available from a total of 62 facilities where 394 personal 8-hr samples were collected. It is assumed that personal samples, collected in the breathing zone of the worker most closely approximate the concentrations calculated with the saturation vapor pressure approach and the concentration to which the home hobbyist would be exposed. Of the samples collected, 297 were below the detection limit for lead. It was assumed that lead casting did not occur at these facilities. Of the personal samples that were above detection, the median lead concentration for personal samples was 32.4 µg/m³ and the mean lead concentration was 172 µg/m³, with a range from 3.3 to 4,800 µg/m³. Personal sampling concentrations can be affected by many things, including the size of the lead melting source, the proximity of the worker to the source, and building characteristics including the building ventilation system. The agreement between the OSHA collected personal sampling concentrations and the airborne lead concentrations calculated using the saturation vapor pressure approach suggests that the results are feasible and appropriate.

5.4 Uncertainties in the Home Melting Scenario

The modeling of the home melting scenario uses a highly simplified approach that is very sensitive to the melting temperature. The approach assumes the airborne lead concentration at the site of the melting (the garage) is equal to the saturation vapor pressure throughout the time spent melting lead and does not allow for any gradual achievement of steady state. In addition, this approach does not consider removal mechanisms, such as removal by deposition or ventilation.

6. IQ DECREMENTS FOR THE NEAR-ROADWAY SCENARIO

In order to facilitate the cost-benefit analysis in support of the wheel weights rule, IQ decrements were calculated for children exposed to lead wheel weights in the Near-Roadway Scenario. Section 6.1 presents the approach used for the modeling and Section 6.2 presents the results.

6.1 IQ Estimation Approach

For children, the human health endpoint selected was IQ decrement. The IQ module estimates the IQ decrement associated with the lifetime-average blood lead value between age zero and seven as depicted in Figure 16.

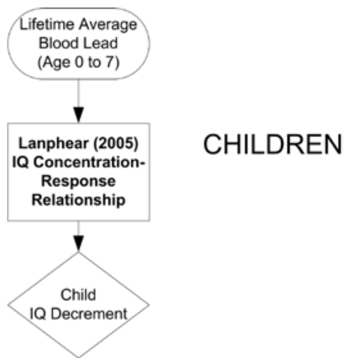

Figure 16. Flowchart Showing the Approach for the IQ Decrement Module

The Lanphear pooled analysis looked at the IQ decrements in children as a function of their lead exposure in the pooled data from seven studies and 1,333 children. The concentration-response functions from this paper were used in the exposure analysis for the review of the Lead NAAQS (U.S. EPA, 2007a) and for the LRRP rule (U.S. EPA, 2007b) and represent the functions based on the largest number of subjects and across the widest exposure range in the literature. Thus, these concentration-response functions were also selected for this analysis. For adults, the data in the literature remain inconclusive as to the most sensitive human health endpoint; thus, the adult exposure calculations estimate the blood lead levels only.

IQ decrements were estimated for children age 0 to 7. Lanphear et al. (2005) derived regression relationships between several blood lead metrics (lifetime averages and measurements made concurrently with the IQ test administration) and IQ test results based on linear, cubic spline, log-linear, and piecewise linear equations. The regression using piecewise linear equations and the lifetime blood lead average was selected to analyze the lead wheel weights IQ changes. The model has a blood lead "cutpoint" at 10 μg/dL where the slope of the concentration-response curve goes from a steeper slope at low blood lead levels to a less steep slope at higher blood lead levels. The equation relating blood lead to the change in IQ is then:

$PbB < 1 \quad IQ\ change = 0$

$PbB = 1 \text{ to } 10 \quad IQ\ change = PbB * -0.88$

$PbB > 10 \quad IQ\ change = -8.8 + (PbB - 10) * -0.10$

where:

PbB = Lifetime average of the blood lead level

As shown in the above equations, no IQ changes are predicted for blood lead concentrations less than 1.0 µg/dL. This assumption was made in recognition of the lack of data in this blood lead range in the Lanphear et al. (2005) study cohorts.

6.2 IQ Results

These lifetime blood lead estimates were then input into the IQ concentration-response function to estimate the IQ decrement for each near-roadway exposure scenario. Then, the change in IQ decrement caused by the presence of lead in wheel weights was estimated by subtracting the no wheel weights case from the total exposure case for each scenario and bin. The IQ decrements are shown in Table 26.

Table 26. IQ Decrements for Children in the Near-Roadway Scenario

Scenario	Bin	IQ Decrement	
		Total (IQ Points)	Approx. Wheel Weights Contribution (IQ Points)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin1 Mean	-8.62	-0.10
	Bin2 Mean		-0.14
	Bin3 Mean		-0.18
	Bin4 Mean		-0.21
	Max		-0.22
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin1 Mean	-7.79	-0.10
	Bin2 Mean		-0.14
	Bin3 Mean		-0.17
	Bin4 Mean		-0.21
	Max		-0.21
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin1 Mean	-5.53	> -0.01
	Bin2 Mean		-0.01
	Bin3 Mean		-0.01
	Max		-0.01
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin1 Mean	-1.24	-0.01
	Bin2 Mean		-0.02
	Bin3 Mean		-0.04
	Max		-0.04
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin1 Mean	-1.55	-0.03
	Bin2 Mean		-0.04
	Bin3 Mean		-0.05
	Bin4 Mean		-0.07
	Max		-0.07

The change in the IQ decrement due to the presence of the wheel weights is below one IQ point, with maximal changes varying between 0.01 IQ points in Scenario C to 0.2 IQ points in Scenario

A. In general, the wheel weights make a larger percent difference in the rural and suburban cases where exposures are lower and the relative contribution from wheel weights is larger. However, the absolute magnitude of the change in IQ in these scenarios is small. Wheel weights tend to have the largest percent difference in the inhalation exposure route, but because this route produces the smallest total uptakes, the overall contribution of wheel weights is lower than the air concentrations alone might suggest.

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APPENDIX. LEGGETT ADULT BLOOD LEAD PREDICTIONS FOR THE NEAR-ROADWAY SCENARIO

The ALM model was used as the primary method to estimate the adult blood lead contributions from lead wheel weights in the near roadway scenario. An alternative model, the Leggett model, can be applied to adults but tends to predict blood lead values which are higher than those observed in surveys such as the NHANES (U.S. EPA, 2007). However, for comparison purposes, blood lead values estimated from Leggett are included in this appendix.

Leggett Parameters

The Leggett blood lead model was used for the adult scenarios because the IEUBK model only models exposures up to age 7. The Leggett model was run beginning from birth and extending to age 75 with constant media concentrations throughout this lifetime. Unlike the IEUBK model, the Leggett model requires inputs of total inhalation intake and total ingestion intake over the age range modeled. These intakes were calculated the same way as in the IEUBK model in order to be consistent between the two methods. Thus, the total ingestion intake includes intakes from soil, dust, dietary, and water sources. Leggett intake parameters for the age range 0 to 7 years and for all parameters that do not vary by age were taken from the values used in the IEUBK model (see Table 17). Table A-1 shows the age-specific inputs for ages above age 7. This age range was split into two different segments: 7 to 18 (the remainder of childhood) and 18-75 (adulthood). Parameters were taken from the child-specific or general exposure factors handbook where available.

Table A-1. Leggett Blood Lead Model Input Values

Group	Parameter	Parameter Name	Parameter Value		Basis/Derivation
			7 to 18	18 - 75	
Inhalation	Daily ventilation rate (cubic meters [m^3]/day)	Ventilation rate	14.4	13.3	U.S. EPA Child-Specific Exposure Factors Handbook (2008b) with interpolation for intermediate ages; U.S. EPA Exposure Factors Handbook (1997), average of males and females
Drinking Water Ingestion	Water consumption (L/day)	Water consumption (L/day)	0.571	1.47	U.S. EPA Child-Specific Exposure Factors Handbook (2008b) with interpolation for intermediate ages; U.S. EPA Exposure Factors Handbook (1997), average of males and females
Diet	Dietary Pb intake (µg/day)	Dietary Pb intake (µg/day)	3.5	3.5	Based on dietary intake values from the Lead ISA
Outdoor Soil/Dust and Indoor Dust Ingestion	Total indoor dust + outdoor soil/dust ingestion (mg/day)	Amount of outdoor soil/dust and indoor dust ingested daily (mg)	110	50	Child Estimates based on U.S. EPA Child-Specific Exposure Factors Handbook (2008b), excluding cases of soil-pica and geophagy; Adult estimates from U.S. EPA Exposure Factors Handbook (1997).

Leggett Blood Lead Predictions

The adult blood lead concentrations were estimated using the same media concentrations presented in Table 20. These concentrations were input into the Leggett model, and the average blood lead levels during the child-bearing years (assumed to be age 18-45) and during the adult years (assumed to be age 18-75) were calculated. These values are presented in Table A-2.

Table A-2. Blood Lead Values for Adults in the Near-Roadway Scenario from the Leggett Model

Scenario	Bin	Child Bearing Years Average Blood Lead *		Age 18-75 Average Blood Lead	
		Total (µg/dL)	Approx. Wheel Weights Contribution (µg/dL)	Total (µg/dL)	Approx. Wheel Weights Contribution (µg/dL)
Scenario A: Urban area, high soil lead concentration, pre-1940 housing	Bin1 Mean	18.78	0.21	18.77	0.21
	Bin2 Mean		0.29		0.29
	Bin3 Mean		0.37		0.37
	Bin4 Mean		0.45		0.45
	Max		0.46		0.46
Scenario B: Urban area, high soil lead concentration, post-1980 housing	Bin1 Mean	16.28	0.19	16.28	0.19
	Bin2 Mean		0.27		0.27
	Bin3 Mean		0.35		0.35
	Bin4 Mean		0.42		0.42
	Max		0.43		0.43
Scenario C: Rural area, high soil lead concentration, pre-1940 housing	Bin1 Mean	12.74	0.01	12.78	0.01
	Bin2 Mean		0.01		0.01
	Bin3 Mean		0.02		0.02
	Max		0.02		0.02
Scenario D: Rural area, low soil lead concentration, post-1980 housing	Bin1 Mean	4.72	0.03	4.85	0.03
	Bin2 Mean		0.05		0.05
	Bin3 Mean		0.07		0.07
	Max		0.09		0.09
Scenario E: Suburban area, low soil lead concentration, post-1980 housing	Bin1 Mean	5.30	0.05	5.42	0.05
	Bin2 Mean		0.07		0.07
	Bin3 Mean		0.11		0.11
	Bin4 Mean		0.14		0.14
	Max		0.14		0.14

* Child bearing years indicates average between ages 18 and 45

Exhibit 3 to Declaration of Eve C. Gartner in Support of Petition for Writ of Mandamus

EARTHJUSTICE ECOLOGYCENTER Healthy People, Healthy Planet

June 15, 2016

Via E-mail and Mail

Mr. Jeffrey Morris, Deputy Director for Programs
Ms. Tala Henry, Director, Risk Assessment Division
Ms. Maria Doa, Director, Chemical Control Division
Office of Pollution Prevention and Toxics
United States Environmental Protection Agency
1201 Constitution Avenue, NW
Washington, DC 20460

Re: Regulation of lead wheel weights under the Toxic Substances Control Act

Dear Mr. Morris, Ms. Henry and Ms. Doa:

We write to thank you and the rest of your team for meeting with us and our NGO, state, and business colleagues on May 12.[1] We appreciate the opportunity to discuss our concerns about EPA's delay in proposing a rule to ban the manufacture, processing, distribution and use of lead wheel weights ("LWWs") under the Toxic Substances Control Act ("TSCA").[2] This letter outlines what we conveyed during our meeting and how a ban on LWWs would fit within the reformed TSCA statute.

Without doubt, banning LWWs will protect human health and the environment from lead toxicity and the costs are virtually non-existent. We say this with confidence because:

- the United States Geological Survey ("USGS") estimates that 4.4 million pounds per year of lead enter the environment due to lost LWWs;[3]

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[1] For the record, other than EPA staff, in-person participants in the meeting were: Eve Gartner, Earthjustice; Jeff Gearhart, Ecology Center; Tom Neltner, Environmental Defense Fund; and Tracy Kollan, Children's Environmental Health Network. In addition, the following people participated in the meeting by phone: Martin Lussier and Lynn Parker, Plombco (LWW manufacturer); Don Vanderheyden and Tim Presley, Bada Hennessy Industries (LWW manufacturer); Debra Hamlin, Bridgestone-Firestone Retail Operations (aftermarket tire retailer); John Gilkeson, Minnesota Pollution Control Agency; and Robert A. Root, Ph.D (LWW researcher).

[2] On August 26, 2009, EPA granted the TSCA Section 21 Petition submitted by Ecology Center and Sierra Club seeking a rule to prohibit the manufacture, processing, and distribution in commerce of LWWs, and committed to "promptly commence an appropriate proceeding under TSCA."

[3] Donald I. Bleiwas, USGS, *Stocks and Flows of Lead-Based Wheel Weights in the United States* (2006), https://pubs.usgs.gov/of/2006/1111/2006-1111.pdf

- based on the USGS loss rate, Dr. Robert Root estimates that some 60 million pounds of LWWs have been lost in this country since 2000, and at least half that amount has been abraded into small particles;[4]
- lead from these millions of pounds of lost and abraded wheel weights is inevitably contributing to the lead burden on United States residents, most significantly our children; [5]
- lead is a non-threshold chemical, meaning that *any* exposure poses hazards;
- lead exposure is associated with a variety of serious health harm including brain damage, nerve damage, cancer, kidney damage, and reduced fertility;
- given the harms of any lead exposure, all averted exposures carry health benefits;
- non-lead wheel weights have the same performance and are less expensive;
- wheel weights manufactured with lead alternatives now comprise more than half of the wheel weights sold in the United States;
- vehicle manufacturers equip all new passenger vehicles and light trucks sold in the US with non-lead wheel weights and have done so since at least 2010; and
- the shift to non-lead wheel weights has reached a status quo that will continue for years or even decades without federal action to ban or phase out lead. Based on longstanding buying habits, there continues to be significant demand for lead weights, and that will be met by imports if the North American manufacturers discontinue manufacturing LWWs in the absence of an EPA rule covering the entire U.S. market.

Given these facts, and the renewed national awareness of the devastating harm to children from early life lead exposure, it would be inappropriate for EPA to further postpone protective action on LWWs while it undertakes a lengthy, complex problem formulation and risk evaluation of *all* "TSCA uses" of lead.

Further delay is also concerning because it has resulted in a significant reduction in the market for recycling LWWs. The current stream of post-consumer wheel weights collected for recycling is a mixed stream of the metals now used for this purpose -- lead, zinc, and steel -- that cannot easily be sorted and recycled without contamination. As a result of EPA's delay in acting on LWWs, an increased amount of lead is being deposited in landfills.

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[4] Robert A. Root, *Lead Loading of Urban Streets by Motor Vehicle Wheel Weights*, Environmental Health Persp. Vol. 108, No. 10 (Oct. 2000), http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240125/pdf/ehp0108-000937.pdf

[5] As EPA wrote in its partial draft of a preamble for a rule banning lead wheel weights, which we obtained from the Agency in response to FOIA Request No. EPA-HQ-2015-008360:

> reducing the amount of lead entering the environment by any means will result in some level of human health benefits. Given that lead may remain in the environment for anywhere between two to 2,000 years, the continuing release of lead from wheel weights has the potential to adversely affect human health and the environment for many future generations.

Even if EPA's typical practice under TSCA will be to consider all uses of a chemical substance together in one risk evaluation, EPA should expedite action on LWWs before it addresses lead comprehensively because:

- lead is so potent and its dangers are so well-documented;
- the European Union, numerous countries in Asia, and several states have already banned lead wheel weights;
- all global automakers now supply lead-free weights on new vehicles;
- safer, cost effective alternatives are already well established in the U.S. and global market;
- the voluntary movement away from using lead in wheel weights in the U.S. has taken the market as far as it is likely to go absent federal action;
- EPA already agreed to ban LWWs; and
- this is one of those rare circumstances where the regulated community and the states (as well as environmental health NGOs) actively support regulation by EPA.

This last point is so critical that we have summarized below the reports from the industry and state representatives at our May 12 meeting:

> Industry: The wheel weight manufacturer Plombco reported that it started manufacturing lead-free wheel weights 15 years ago and now has the manufacturing capacity to meet all demand without lead. It reported that there is now a cost-saving in using lead alternatives because the price of lead is unstable while the price of steel is cheap and stable. The manufacturer Bada Hennessy Industries concurred. The wheel weight retailer Bridgestone-Firestone Retail Operations reported that they stopped selling LWWs in 2008 in both consumer retail and high performance racing applications.
>
> States: Seven states have banned the sale and installation of lead wheel weights within their borders. Most recently, Minnesota enacted legislation in 2014 that became effective January 1, 2016. In 2008, the Environmental Council of the States ("ECOS") developed and unanimously approved Resolution 08-9, entitled "Phasing Out Sale and Installation of Lead Wheel Weights." This resolution, which is the formal policy statement of the 50 state environmental agencies acting through ECOS, calls on EPA to adopt rules to phase out the manufacture, sale, and use of LWWs in the US, including proper management for lead weights at end of life. Underlying the ECOS resolution is the recognition that state by state regulation of LWWs is too fragmented to address the national market, including lead product imports, and the reality is that not every state can address this issue through legislation or other means. State by state efforts also create problems for companies in the distribution sector that operate across state lines.

Further delay in proposing a Section 6 rule banning LWWs is not warranted on the ground that EPA cannot quantify lead exposures from wheel weights. Neither the 1976 TSCA nor the reformed TSCA require a quantitative risk evaluation.[6] The TSCA reform legislation states that

[6] Even if quantification was required to comply with the "least burdensome" regulation requirement in the 1976 TSCA, that would no longer be a consideration under the reformed TSCA.

a risk evaluation must "integrate and assess *available* information" and "take into account, *where relevant*, the likely duration, intensity, frequency, and number of hours of exposure" to the substance.[7] Determining the precise extent of exposure is not "relevant" here, since without doubt use of LWWs is leading to *some* exposure, *any* human exposure to lead presents risks, and those risks are unreasonable given the availability of similar performing, cheaper alternatives.[8]

Please do not hesitate to contact us should you have any questions. We look forward to continuing our conversation about using TSCA to limit lead exposures as expeditiously as possible. If the Office of Pollution Prevention and Toxics decides to move forward with a Section 6 proceeding involving LWWs, we would appreciate your letting us know.

Sincerely,

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(212) 845-7381
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cc: Mr. Jim Jones
Ms. Wendy Cleland-Hamnett
Mr. John Gilkeson, Minnesota Pollution Control Agency
Mr. Tom Neltner, Environmental Defense Fund
Ms. Tracy Kolian, Children's Environmental Health Network
Dr. Robert A. Root
Ms. Deborah Hamlin, Bridgestone Firestone Retail & Commercial Operations
Mr. Martin Lussier, Plombco
Mr. Gregory Parker, Wegmann Automotive
Mr. Tim Presley, BADA-Hennessy Industries

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[7] Reformed TSCA § 6(b)(4)(F) (emphases added).

[8] *See* note 5, *supra*. Moreover, the TSCA reform legislation requires that when EPA conducts a risk evaluation of metals, it must use the Framework for Metals Risk Assessment of the Office of the Science Advisor (March 2007), which recognizes that a quantitative risk assessment may not always be possible and therefore that deference must be accorded to EPA's approach. Reformed TSCA § 6(b)(2)(E). *See* Framework for Metals Risk Assessment at 1-2, which states:

> While the science surrounding the metals risk assessment principles continues to be studied intensively and evolving rapidly, some areas still lack sufficient information for a quantitative assessment to be carried out. Thus, specific approaches may become outdated or may otherwise require modification to reflect the best available science and others may be addressed only qualitatively until additional information becomes available. Application of this Framework in future metals risk assessments will be based on EPA decisions that its approaches are suitable and appropriate.

Exhibit 4 to Declaration of Eve C. Gartner in Support of Petition for Writ of Mandamus

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 11 2016

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

Eve C. Gartner
Staff Attorney
Earthjustice
1625 Massachusetts Avenue NW
Washington, DC 20036

Dear Ms. Gartner:

Thank you for your letter of June 15, 2016, following our meeting in May concerning potential regulation of lead wheel weights under the Toxic Substances Control Act (TSCA). As I am sure you know, on June 22, 2016, President Obama signed the Frank R. Lautenberg Chemical Safety for the 21st Century Act, which amends TSCA significantly and establishes new requirements under section 6 for prioritizing existing chemicals for evaluation and taking action where risks are identified. The law contains many new requirements and imposes deadlines on the Agency for establishing priorities, conducting risk evaluations, and taking regulatory action to reduce risks, and the agency is currently evaluating how those requirements affect actions planned and underway at the time of passage.

Your letter raises important points for EPA to consider related to lead wheel weights. EPA is reviewing the new law to determine next steps, including, among other things, how potential risks from all ongoing TSCA-related lead uses, including lead wheel weights, could be evaluated and addressed. As we work to implement this law, we plan to involve key stakeholders and the public in our efforts as needed.

In addition, EPA, along with our many federal, state, and local partners, continues to work towards the goal of eliminating childhood lead poisoning through programs that focus on reducing exposures to lead from paint, dust and soil, and in the air and drinking water.

Again, thank you for your letter. I hope this information has been helpful to you. If you have further questions, please feel free to contact me or Joel Wolf, chief of the Existing Chemicals Branch at wolf.joel@epa.gov or (202) 564-0432.

Sincerely,

Jeffery T. Morris
Deputy Director
Office of Pollution Prevention and Toxics

cc: Jeff Gearhart, Ecology Center

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF JEFF GEARHART
ON BEHALF OF THE ECOLOGY CENTER, INC.

I, JEFF GEARHART, declare and state as follows:

1. I am the Research Director for the Ecology Center Inc. (the "Ecology Center"), where I have largely held the same position since 1996. I hold a Master of Environmental Advocacy and Environmental Science, and a Bachelor of Science in Natural Resource Ecology, both from the University of Michigan, and have worked in the environmental field for approximately thirty years. The information in this declaration is based on my personal knowledge and experience.

2. Through my role as Research Director for the Ecology Center, I am familiar with the Ecology Center's structure, mission, activities, and membership. The Ecology Center is a national 501(c)(3) nonprofit environmental health

organization, incorporated in Michigan with its headquarters located at 339 East Liberty Street, Suite 300, Ann Arbor, Michigan 48104. We also maintain an office in Detroit, Michigan located at 4750 Woodward Avenue, Detroit, Michigan 48201. The Ecology Center was founded after the Ann Arbor Teach-In on the Environment in 1970, the first and largest of hundreds of Earth Day events held across the United States.

3. The Ecology Center's mission is to create an environment that supports healthy people and a healthy planet. We believe that the central question of our time is how human beings are going to thrive in the world without destroying the earth's ability to sustain us. In the face of enormous environmental challenges, virtually all sectors of our society are now scrambling to create solutions, and the Ecology Center plays a critical role in advancing the best models. We are guided by three "North Star" principles: (1) a commitment to justice, (2) a focus on people's health, and (3) collaboration in all that we do.

4. The Ecology Center pursues its mission in five ways: (1) market transformation through direct corporate engagement; (2) policy and legislative action at local, state, and national levels; (3) education and generational transformation through investment in K-12 programming on environmental impacts; (4) place-based work in Southeast Michigan; and (5) direct green services and development of new institutional structures that advocate for a safe and

healthy environment.

5. We use these strategies to carry out the Ecology Center's programs, which include: (1) Ending Lead Poisoning; (2) Healthy Stuff Lab; (3) Climate Action & Energy Equity; (4) PFAS Action; (5) Health Leaders Fellowship; (6) Plastic Pollution and Zero Waste; (7) Purchasing for Safer Cities; (8) Environmental Education; (9) Air Quality; and (10) Community-Based Science. We also work with various coalitions and in partnership with hospitals, medical professionals, health care organizations, and public health agencies to advance our programs.

6. A substantial part of my work involves leading and conducting the Ecology Center's research on chemical hazards in consumer products and environmental media, with a focus on durable products like automobiles and consumer electronics, food and food packaging, and toys and children's products. I have co-authored dozens of peer-reviewed and self-published studies on toxic chemicals in consumer products, including heavy metals such as mercury and lead. I lead citizen science projects testing for toxic chemicals in products and work to maintain an internationally recognized product chemistry disclosure project, HealthyStuff.org, that I developed, which provides robust advocacy resources and product testing results for more than 100,000 products.

7. I also spearhead numerous chemicals policy market campaigns to directly engage with companies manufacturing products containing chemicals of concern. I work with these companies to help them transition to less toxic manufacturing practices.

8. The Ecology Center has a board of directors, which currently has twelve board members.

9. The Ecology Center is supported by approximately 6,400 members, located across the country, with the largest number of members located in Michigan. Members nominate and vote for the Ecology Center board of directors on an annual basis. They are also invited to an annual meeting of the members and special meetings called by the President. Members engage in work with Ecology Center programs, participate in email action campaigns, engage with our scientific studies, and participate in community-based science. Members are also encouraged to bring toxics-related concerns to staff members, and these concerns are considered and influence the projects we prioritize.

Ecology Center's Work to End Lead Poisoning

10. The Ecology Center has worked for years to end lead exposure and poisoning in Michigan, and across the United States, through advocacy, education, and policy development, and this work is central to our mission. Our work to reduce lead poisoning has included work on historical and ongoing sources of lead

exposure.

11. Following the Flint, Michigan water crisis in 2016, the Ecology Center and our allies formed the Childhood Lead Exposure Commission to urge statewide action to address lead contamination. The Commission issued a set of recommendations to end lead poisoning in Michigan and provided funding to local health departments to investigate lead risks. It also provided funding to twenty-four pilot projects across the state to stop lead poisoning before it starts.

12. In 2018, we founded the Great Lakes Lead Elimination Network ("GLLEN"), a coalition of nonprofit partners working together to eliminate and prevent lead poisoning in the Great Lakes region. GLLEN currently includes nonprofit partners from Michigan, Minnesota, New York, Ohio, Illinois, Wisconsin, Indiana, and Pennsylvania, and it works to eliminate lead hazards in homes, schools, workplaces, and other areas. We coordinate our efforts to engage with decision-makers regarding local- and state-level policy, and share resources including best practices and policies to educate the public and lawmakers about how to avoid lead. GLLEN also has a strong environmental justice and child-first focus. Childhood exposure is the most important place to intervene, so we put children first and foremost, and we also focus on communities of color where higher rates of lead poisoning are found.

13. In 2021, we launched the Lead Impacted Families Together ("LIFT")

program, which worked closely with over thirty lead-affected families in Michigan over an eight-month period to empower them with tools they could use to advocate for better lead policies at local, state, and national levels. Participants met with other families, health experts, environmental experts, and lawmakers throughout the training. LIFT materials are now available as a self-guided program that includes training materials and recorded webinars with nurses, lawmakers, health advocates, and impacted families.

14. In addition to our work through our commissions and campaigns, we hold educational sessions with state policymakers on childhood lead poisoning, advocate for the passage of state legislation that would eliminate sources of lead exposure and conduct educational sessions and webinars for the public on the sources and risks of lead.

The Ecology Center's Fight Against Lead Wheel Weights

15. Ecology Center has engaged in significant advocacy around lead wheel weights. In 2001, the Ecology Center surveyed two streets in Ann Arbor, Michigan—Division and Huron Streets—over the course of four weeks to determine how many lead wheel weights had fallen from vehicles (the "Ann Arbor Study"). Forty-seven wheel weights were recovered, weighing an average of around ¾ of an ounce. Nearly 98 percent of wheel weights were found within twenty-five miles of an intersection. The Ann Arbor Study concluded that the

number of wheel weights lost per vehicle mile per year was consistent nationwide.

16. The Ann Arbor Study was the impetus for Ecology Center's launch of the Lead-Free Wheels Program in 2003, a Midwest regional program focused on abating the problems caused by lead wheel weights deposits on urban streets. The Lead-Free Wheels Program intended to demonstrate the commercial viability of several safer substitutes for lead wheel weights, including tin, zinc, and steel external weights as well as lead-free internal balancing systems where glass beads are inserted into tires. The program has three goals: (1) directly reduce 6,000 to 7,500 kilograms of lead use on vehicles in Michigan and the Midwest; (2) demonstrate the viability of lead-free wheel weight installation at Michigan tire retailers, state and municipal fleets, and auto repair businesses; and (3) encourage domestic production of lead-free wheel weights and phaseout of lead use in wheel weights. The Lead-Free Wheels Program partners with full-service repair shops, service stations with repair facilities, tire retailers, and portions of publicly owned vehicle fleets to support a transition to lead-free wheel weights.

17. Through the Lead-Free Wheels Program, we also partnered with the city of Ann Arbor and the state of Minnesota, which became the first city and state respectively to begin replacing lead wheel weights with zinc and iron ones in their vehicle fleets.

18. Also in 2003, on behalf of Ecology Center, I co-authored the report

"Getting the Lead Out: Impacts of and Alternatives for Automotive Lead Uses" with the Environmental Defense Fund, which documents the release of lead into the environment resulting from automobile manufacturing, use, and disposal. The report specifically details the lead pollution from wheel weights in addition to other sources of lead exposure from vehicles. A true and accurate copy of this report is included as an attachment to the 2005 petition, which is included in the Appendix to the present Petition for Writ of Mandamus for which I am making this declaration.

19. In May 2005, the Ecology Center first petitioned EPA under section 21 of the Toxic Substances Control Act to establish regulations prohibiting the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel-balancing weights. A true and accurate copy of the 2005 petition is included in the Appendix to the present Petition for Writ of Mandamus for which I am making this declaration.

20. In August 2005, EPA denied the 2005 petition, asserting that it did not have enough information about human or environmental exposures to adequately assess the risks posed by lead wheel weights. A true and accurate copy of the 2005 response to the 2005 petition is included in the Appendix to the present Petition for Writ of Mandamus for which I am making this declaration.

21. In 2009, Ecology Center, along with other allies, again petitioned

EPA pursuant to section 21 of the Toxic Substances Control Act to establish regulations prohibiting the manufacture, processing, and distribution in commerce of lead wheel weights. This 2009 petition is the subject of the present Petition for Writ of Mandamus for which I am making this declaration. A true and accurate copy of the 2009 petition is included in the Appendix to the present Petition for Writ of Mandamus for which I am making this declaration.

22. In August 2009, Ecology Center received a response from EPA granting its 2009 petition. A true and accurate copy of the 2009 response to the 2009 petition is included in the Appendix to the present Petition for Writ of Mandamus for which I am making this declaration.

23. EPA's failure to regulate the manufacture, processing, and distribution of lead wheel weights has and continues to impair Ecology Center's ability to achieve its mission of eliminating sources of lead exposure and eliminating lead poisoning and securing a transition from lead wheel weights to a nontoxic alternative in Michigan and nationally.

Our Members Are Injured by Lead Wheel Weight Failure

24. EPA's failure to regulate lead wheel weights injures our members, like Melissa Cooper Sargent, by permitting the continued manufacture, processing, and use of toxic wheel weights where our members live, work, and recreate.

25. Lead wheel weight failure (i.e., when lead wheel weights fall off of

car tires) is an ongoing source of exposure to lead for our members. On average, 13 percent of wheel weights fall off of vehicles while driving, and about 50 percent of vehicles on the road may be missing one or more of their wheel weights. This equates to an estimated sixty-six tons of lead being deposited on roadways in Michigan each year, with the highest rate of lead deposition occurring in urban areas. Once these weights are deposited onto roadways, they are ground into lead dust particles that contaminate ground surfaces, storm water, harm the environment, and affect our water sheds. Scientific studies show that long-term exposure to even tiny amounts of lead can cause brain damage, kidney damage, hearing impairment, and learning and behavioral problems in children.

26. We have members who live and work near urban roadways where lead wheel weights fall off most frequently. They walk children to school on sidewalks near urban streets which are affected by lead dust from crushed wheel weights, and where wheel weights have fallen off and rest on the side of the road. I personally picked up lead wheel weights on the side of the road in June 2023 in Detroit, Michigan. There has been a massive amount of lead used on tires over the decades that has been deposited into these urban areas and onto roadways. This lead can affect the health of our members and their families.

27. As lead is a cumulative toxin, the harms from lead wheel weights contribute to Michiganders' risk of lead poisoning that is already elevated from

other sources of exposure to lead. For example, our members in Michigan struggle with exposure to lead in their drinking water and service lines, as seen very visibly in Flint, Michigan. The age of the housing stock in Michigan also means that we have historic lead paint issues, and addressing those issues is challenged by a lack of funding.

28. EPA's failure to regulate the manufacture, processing, and distribution in commerce of lead wheel weights, as it stated it would do, directly injures our members as it has resulted in the continuation of lead wheel weight use on vehicles that drive through Michigan, where these weights ultimately fall off and expose our members to lead. The only way to eliminate this ongoing hazard is for EPA to regulate the use of lead wheel weights. Our efforts to eliminate lead wheel weights locally cannot eliminate this problem as inter- and intrastate traffic means that vehicles from locations without regulations on lead wheel weights are permitted to travel where our members live and can then deposit toxic wheel weights in our neighborhoods. EPA has the authority to institute a national ban to eliminate this source of exposure, but it has failed to do so, causing harm to our members.

29. EPA regulating the manufacture, processing, and distribution in commerce of lead wheel weights would further the Ecology Center's mission to end lead poisoning and sources of lead exposure and would lead to the protection of our members from lead exposure stemming from lead wheel weight failure.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 17, 2023 in Ann Arbor, Michigan.

Jeff Gearhart

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF MELISSA COOPER SARGENT
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, MELISSA COOPER SARGENT, declare and state as follows:

1. I am a member of the Ecology Center. I am the Environmental Health Advocate for the Ecology Center, a role I have held for over ten years. Prior to my work at Ecology Center, I was the Education Director for LocalMotionGreen ("LMG"), a small nonprofit that merged with Ecology Center in 2013. I hold a Bachelor of Science in Resource Ecology Management from the University of Michigan's School of Natural Resources and Environment in Ann Arbor, Michigan.

2. I have been a member of Ecology Center for over a decade, and a supporter since 2013. I first became a supporter of Ecology Center through my

work with LMG. LMG partnered with Ecology Center on various projects, including fundraisers for sustainability projects at local schools, educating Michiganders about common toxic exposures in homes through our Home Safe Home workshops, and collaborating with other organizations to urge our legislators to take action on lead through Lansing Lead Day. I saw through my work with LMG that Ecology Center worked with grassroots organizations in Detroit in an intentional way, and I appreciated that it was thoughtful about what role it should play in Detroit.

3. I have donated financially to Ecology Center in the past.

4. Through my role as Environmental Health Advocate, I advocate for the regulation of toxic chemicals, including lead. I run campaigns advocating for the removal of toxic chemicals from different consumer products. For example, I organized our Receipt Deceit campaign, which advocates for the removal of bisphenol A and bisphenol S from store receipts, and our Children's Car Seat campaign which advocates for the removal of toxic flame retardants from children's car seats.

5. For the past year, I have done significant work advocating for the regulation of lead. I have lobbied in favor of two state lead bills: Universal Lead Testing and Filter First. The Universal Lead Testing bill, SB-0031, directs physicians to test the blood of children for lead at ages one and two. The hope is

that this bill will help detect and prevent lead exposure in children when they are particularly susceptible to harm. Filter First, SB-0088, would require all Michigan schools and childcare centers to introduce drinking water systems that filter water and to conduct regular testing. This bill similarly focuses on protecting children from lead exposure when they are still developing.

6. I am a resident of the city of Detroit, Michigan where I was born and raised. I have lived in Michigan my entire life and have always lived within five miles of Detroit. I plan to continue living in Michigan in the future.

7. I am a mother of four children—three sons aged seven, thirteen, and fifteen years old, and a twenty-year-old daughter. My sons all live with me full-time, and my home is the primary residence of my daughter, who stays at home when she is not at college. Many of my family members also live locally. My sister and her family live in Southfield, Michigan, and my husband lives across the street from me. My parents live half the year in Novi, Michigan, forty minutes from my home.

8. Ecology Center advocates for my personal interests as a resident of Detroit. Ecology Center was instrumental in getting the Detroit Renewable Power solid waste incinerator shut down, which was located less than two miles from my home. The incinerator caused serious air quality issues, and I feel that shutting the incinerator down created immediate benefits for me and my family. Ecology

Center continues to work to install and maintain air monitors across Detroit, hosts an air sensor collaborative, and makes the air monitoring data publicly accessible. Ecology Center also has continued to advocate on behalf of residents living near the Detroit Renewable Power incinerator by examining the site's soil test results conducted on behalf of the City of Detroit. The test results indicate widespread lead in the soil across the site. Ecology Center wrote a letter to the City requesting more thorough testing be done as well as remediation for lead and other toxics. These actions all benefit me personally as they have a positive impact on the health of me and my family.

9. I am very concerned about lead exposure. Because you cannot see lead dust, people often are unaware that they are exposed to this form of lead in particular. Lead exposure also has a broad impact on society and causes community harm. A lot of the behavior and attention issues we see in children at school I believe can be traced to lead exposure. I also worry about the lifelong impact lead poisoning can have on people's health.

10. I am also concerned about my and my family's exposure to lead from lead wheel weights specifically because of how easily wheel weights fall off of car wheels and how easily lead dust spreads. I know that if lead wheel weights are on the roadside degrading, the lead will spread into places like my yard, which is partially located on the side of the road. When our streets are cleaned, leaves from

the street are pushed into our yard and those leaves could be contaminated with lead. The wind could also blow lead dust into our yard. I am particularly concerned about this exposure because I live in a high-traffic urban area, which I understand is where most lead wheel weights fall off of vehicles and then get ground into dust by passing traffic.

11. I also know that because I live in an urban area, I have a higher likelihood of being exposed to lead from lead dust. I currently live in a single-family home located one block away from Mt. Elliot Street ("Mt. Elliot"), a heavily trafficked urban roadway. A Detroit Department of Transportation bus route runs along Mt. Elliot, both Northbound and Southbound, and it is also a City-of-Detroit-designated truck route. I frequently see stop-and-start traffic on these roads.

12. I drive almost every day. I drive to stores to shop. Also, for seven years, I commuted to the Ecology Center's Detroit office four days a week, which is located approximately three miles away from my home.

13. I drive my kids to and from school five days a week. Since my kids range in age, I drive to two different schools: Cass Technical High School ("Cass Tech") and Detroit Waldorf School. Both schools are located on main roads. Cass Tech is located on Second Avenue, and Detroit Waldorf School is located on

Charlevoix Street and Burns Street, and off Mack Avenue, a very busy road with stop-and-start traffic.

14. I also drive my sons to baseball practice at various fields across the city. All three of my sons play baseball. I also take my kids to Perrien Park, located on East Warren Street, to play. After practice and games, my sons regularly keep their cleats on and walk around the house in them. We also walk around the house with our everyday shoes on, as we are not a "shoes off" household. I understand that this could track lead dust into our house.

15. I drive a 2009 Saturn. I conduct simple maintenance on my car including putting air in the tires.

16. Every day, my kids play on the sidewalk in front of my home, as well as in the side yard, which is located next to the road. When my kids were younger, they regularly biked through Detroit with their father, who was a bike messenger. We now bike to go to the farmers market or to the Detroit River.

17. I walk regularly in my neighborhood. I walk my dog multiple times a week. It is common to walk in the street in my neighborhood because the sidewalks are regularly unwalkable, and I have walked in the street as a result. I do not wipe my dog's paws when we return home from a walk, and, like my children, I wear my shoes around the house after my walks.

18. In addition to being exposed to lead dust from driving, walking, and

my children's activities, I am also concerned about being exposed to lead from lead wheel weights because other lead exposures I have experienced increase the lead burden in my body. My home was built in 1907, well before lead paint was banned. My son was two years old when we moved into our home, which I know is a sensitive age for lead exposure. The house needed a lot of renovations, which my husband and I did ourselves. We scraped paint off of walls, and repainted. We also removed walls and cut holes in the walls to make space for new windows, which I believe created lead dust. Also, there was another old home next door that was demolished around the same time, so I am concerned that lead could have gotten into the soil from that demolition.

19. My oldest son struggles with attention issues in school. He has been put on an Individualized Education Plan as a result. I know that attention issues can be linked to lead exposure. I have also had my children's blood lead levels tested. My thirteen-year-old had a blood lead level of approximately five parts per billion when tested, which was high enough to necessitate a follow up appointment with the doctor. My younger son had a blood lead level of three parts per billion. While his level was not extremely high, I know that there is no safe level of lead in the blood.

20. The U.S. Environmental Protection Agency's ("EPA's") failure to

regulate lead wheel weights harms me because it means that I face another source of lead exposure from lead dust created by lead wheel weights falling off of cars. Because I live in an urban, high-traffic area I understand I am at greater risk of inhaling or ingesting lead dust from lead wheel weights, and I am concerned that this exposure can harm the health of myself and my children—some of whom I know already have lead in their blood and struggle with attention issues.

21. If EPA were to regulate lead wheel weights, I would feel safer because it would eliminate one more exposure source to lead. Every route of exposure matters, and if we can eliminate this route, that would be fabulous.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August, 17, 2023 in Detroit, Michigan

Melissa Cooper Sargent

Melissa Cooper Sargent

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF KAYA ALLAN SUGERMAN
ON BEHALF OF CENTER FOR ENVIRONMENTAL HEALTH

I, KAYA ALLAN SUGERMAN, declare and state as follows:

1. I am the Director of the Illegal Toxic Threats Program ("ITT Program") for the Center for Environmental Health ("CEH"), a position I have held since January 2020. I have been with CEH since September 2016, when I joined as a Litigation Program Assistant. From July 2017 until January 2020, I served CEH as the Community Partnerships and Litigation Coordinator for the ITT Program. I have worked on issues related to toxic threats for approximately ten years. I hold a Bachelor of Arts in Peace and Conflict Studies with a minor in Global Poverty and Practice from the University of California, Berkeley. The information in this declaration is based on my personal knowledge and experience.

2. Through my role as the Director of the ITT Program at CEH, I am familiar with the structure and mission of CEH. CEH's mission is to protect our supporters and the public from exposure to toxic chemicals in the air, food, water, and consumer products by working with communities, consumers, workers, government, and the private sector to demand and support business practices that are safe for public health and the environment. We work towards this protection through policy advocacy, institutional and corporate engagement, legal action, and community partnerships.

3. CEH was founded in 1996 and is a 501(c)(3) nonprofit organization incorporated and headquartered in Oakland, California. CEH also has satellite offices located in Los Angeles, California, North Carolina, Washington D.C., Virginia, Indiana, Washington, and Illinois where staff work and engage in local place-based work.

4. We have a number of programs, each led by a program director. These programs include: (1) Illegal Toxic Threats; (2) Petrochemicals, Plastics, and Climate; (3) Food; (4) Built Environment; (5) Community Partnership; and (6) Policy. Scientists support all programs, and root CEH's work in credible data collection. Communications staff support all programs and amplify calls to action for supporters.

5. CEH actively partners with many environmental justice organizations, environmental and public health groups, conservation groups, allies, and residents' groups who often inform which projects our programs prioritize. Formal partnerships, network collaborations, and coalition-led projects create a network where CEH receives regular technical assistance and research requests from partner supporters, and its goals and activities are informed and influenced by these supporters.

6. CEH is governed by a board of directors, which has thirteen members. CEH's board members are influential environmental health and justice experts and advocates who are often also financial supporters of CEH. CEH's Leadership Team—made up of its CEO, senior staff members, and science director—assist with the recruitment and selection of our board members. The board nomination committee, composed of board members, has conversations with prospective candidates and confirms their appointment by vote.

7. CEH is funded in part through supporter contributions. CEH relies significantly on contributions from its supporters, both big and small.

8. CEH has 30,000 supporters and 100,000 followers across social media channels. Supporters help to determine CEH's priorities through participation in public events, surveys, and webinars. Supporters actively engage in CEH's work through internships and virtual town halls. CEH also hosts conversations with the

CEO where supporters can submit questions and follow up before, during, and after with feedback.

9. In my current position, I oversee public interest litigation—past, present, and future. I also coordinate with allies and community organizations, supervise teams including the ITT Program's staff, and prioritize toxics litigation across the organization. I work closely with stakeholders to accomplish this, and I am the primary decision-maker for our litigation work on toxic threats.

CEH's Commitment to Fighting Toxic Threats and Our Work on Lead

10. CEH's ITT Program uses public interest litigation, as well as state and federal legislation, to work toward the elimination of toxic threats, and to protect people and communities.

11. Our supporters are particularly concerned about lead and very frequently come to us with concerns. Many are concerned about exposure from ambient and indoor air, drinking water, food, and products widely used by consumers. We receive continuous inquiries about leaded aviation gasoline, concerns about exposure to leaded paints in homes, concerns about exposure to lead in drinking water, and concerns about lead in consumer products, including but not limited to jewelry, household appliances, and fashion accessories.

12. We often partner with other nonprofits and coalitions, communities of color, low-income communities, and national environmental justice organizations to protect communities from lead exposure.

13. We are currently working to remove lead from a variety of sources, including consumer products such as fashion accessories like handbags and wallets, as well as air emissions from a California lead-acid battery recycler. In the past, we have worked to remove lead from other sources including children's toys, lunchboxes, baby bibs, and candy.

14. In 2004, we filed a lawsuit with other public health advocates against more than thirty candy makers for selling candies containing lead in violation of California law. Our settlement was the basis of California Assembly Bill No. 121 to ban the sale of candies containing lead, now codified in the California Health and Safety Code.[1] In 2023, we tested eleven Urban Outfitters accessory items and found that over half of the products were composed of up to 64 percent lead.[2] Our findings led to a communications campaign and sign-on letter which pressured Urban Outfitters to remove these contaminated products from shelves and online sales.

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[1] Cal. Health & Safety Code § 110552 (West, Westlaw through 2023 Legis. Sess.).
[2] Matt Nevins, *Testing Finds High Levels of Lead in Urban Outfitters Jewelry,* CEH: Press Releases https://ceh.org/latest/press-releases/testing-finds-high-levels-of-lead-and-cadmium-in-urban-outfitters-jewelry/ (last updated Apr. 20, 2023).

15. CEH has had a focus for a long time on children's health, and supporters often come to CEH with concerns about children's lead exposure. We co-sponsored the Safe Jewelry Act in 2019, which included updates to California's 2006 Metal-Containing Jewelry Law and provides additional protection to youth under sixteen.[3]

16. We are also working to remove lead from aviation gasoline. In 2021, we, along with community partners, petitioned the Environmental Protection Agency ("EPA") to compel the agency to make an endangerment finding that leaded aviation gasoline contributes to air pollution that harms public health and welfare.

CEH's Work on Lead Wheel Weights

17. In 2007, CEH filed a complaint under California's Safe Drinking Water and Toxic Enforcement Act of 1986 against leading makers of lead wheel weights because they continued to sell lead wheel weights despite knowing the dangers of lead exposure and having knowledge of viable, safer alternatives.

18. In 2008, we settled our case. Our settlement agreement barred Chrysler and three leading makers of auto wheel weights from selling lead wheel weights in California. In August 2008, we published a report called "Clean

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[3] Cal. Health & Safety Code § 25214.2–25214.4.1 (West, Westlaw through 2023 Legis. Sess.).

Highways and Water!" announcing our settlement agreement, detailing the dangers of lead wheel weights, and informing the public about steps they could take to reduce the use of lead wheel weights.[4]

19. However, CEH was still concerned that international and domestic producers could bring lead wheel weights into California, so we co-sponsored bill SB 757 to ban lead wheel weights in California. Our participation in this case, reflects our long-standing priorities to eliminate lead exposure from wheel weights.

20. In 2009, we, along with other nonprofit groups, petitioned EPA under section 21 of the Toxic Substances Control Act ("TSCA") to regulate the manufacturing, processing, and distribution of lead wheel weights. The 2009 petition is the subject of the Petition for Writ of Mandamus for which I am submitting this declaration.

21. We continue to advocate for policy change by sharing information about toxic exposure from lead wheel weights with our supporters and by partnering with public health advocates to pursue a federal ban of lead wheel weights.

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[4] Caroline Cox, CEH, *Clean Highways and Water! An End to Lead Wheel Balancing Weights in California* (2008), https://ceh.org/wp-content/uploads/2020/01/wheel_weight_settlement.pdf.

Lead Wheel Weights Injure CEH Supporters

22. CEH has many supporters, like Andrea Braswell and Gabriel Cardenas, who live, work, and recreate in close proximity to locations contaminated by lead from lead wheel weights.

23. Our supporters are injured by exposure to lead wheel weights. Many of our supporters currently live, walk, and/or work near urban roadways, and many work on their own cars or around auto shops. These activities all take place in locations where lead wheel weights frequently fall off vehicles and are then ground into lead dust, which our supporters then are exposed to, creating the potential for health harms. We also have supporters who are pregnant or have children who live, work, and play near locations where lead wheel weights are lost, and these two groups are highly susceptible to health harms stemming from lead exposure. This lead exposure from lead wheel weights threatens the health of our supporters.

24. EPA's failure to regulate lead wheel weights is causing injury to our supporters. Our supporters are still exposed to lead from lead wheel weights because EPA has failed to regulate them.

25. Because of the interconnected highway system and the nature of travel in the United States, our supporters' exposure to lead wheel weights cannot be fully remedied by state laws and must instead be remedied by federal regulation. If EPA were to regulate lead wheel weights, our supporters could rest assured that

there is one less source of exposure to lead, a neurotoxin with drastic health effects including harm to the developing brains of children.

26. CEH plans to continue advocating for the regulation of lead wheel weights and working to inform our supporters and the public about ways to protect themselves and their families from lead exposure.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 21, 2023 in New York City, New York.

Kaya

Kaya Allan Sugerman

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF GABRIEL CARDENAS
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, GABRIEL CARDENAS, declare and state as follows:

1. I am a supporter of the Center for Environmental Health ("CEH"). I am the Institutional Giving Coordinator for CEH, a role I have held since March 2022. I hold a Bachelor of Science degree in Political Science with a concentration in Economics from Ball State University ("Ball State") in Muncie, Indiana.

2. I have been a supporter of CEH for approximately one and a half years. I first learned about CEH's advocacy related to toxic chemicals in an Environmental Law and Policy class I took at Ball State where we discussed nongovernmental organizations that advocated for environmental health. Learning

about how CEH advocated for environmental health and justice made me interested in supporting the organization.

3. I financially donate to CEH on a monthly basis, and I have done so since April 2022.

4. I support CEH's work outside of my role as the Institutional Giving Coordinator. I have signed on to support several campaigns to remove toxic chemicals from consumer products. For example, I signed on to a CEH campaign urging companies to remove Bisphenol A from socks made for babies, children, and adults. I often post and share resources related to CEH campaigns and fundraisers on my personal Instagram account.

5. I am a resident of Indianapolis, Indiana where I was born and raised. I have lived in Indianapolis my entire life, except for three years when I lived in Muncie, Indiana while I attended Ball State.

6. I am twenty-four years old. I currently live in a condominium with my mother and nineteen-year-old sister. I live close to many family members including my father, who lives approximately ten minutes away, and my grandmother, aunts, uncles, and cousins. I intend to live in a city, close to urban roads, for the foreseeable future.

7. CEH advocates for my interests as an individual, outside of my role as an employee. I believe that CEH does good work to protect myself and my family

from toxic chemicals, which continue to be released in Indianapolis, a heavily polluted city.

8. I have learned through my role at CEH about exposures to various toxic chemicals. Part of my role at CEH involves drafting grant proposals, and a large part of my drafting process involves researching the work that CEH does, including our work on toxic chemicals. This has helped me learn more about the dangers posed by exposure to lead.

9. I am concerned about me, and my family, being exposed to lead from lead wheel weights, as I know lead can cause serious health effects, and wheel weights can easily fall off of car tires and then contaminate the environment. I first learned about wheel weights when I worked in my uncle's autobody repair shop. I worked in my uncle's shop during the summers of my sophomore and junior years of high school, when I was sixteen and seventeen years old, respectively. I worked full-time each summer. I did a significant amount of work on vehicle wheels, which I sanded down to prepare for painting. I learned about wheel weights while working at the shop because I knocked a wheel weight off by accident. I learned from that experience that wheel weights can easily fall off cars. I had to be careful not to knock them off when I was sanding and painting wheels. At the time, I was also unaware that wheel weights were often made of toxic metal, so I did not take

as many precautions as I would now, with my current knowledge that many wheel weights are made of lead and are highly toxic.

10. I am concerned about my exposure to lead from lead wheel weights because I live near urban roadways, and I understand that wheel weights fall off of tires and then get ground into lead dust most frequently on urban roadways.

11. I live one block from West Eighty Sixth Street, a heavily trafficked street in Indianapolis. I also live approximately two miles from the intersection between West Eighty Sixth Street and Interstate 465, a heavily traffic highway. I live approximately two miles from a hotel with frequent guests, and a large shopping center with several restaurants. My condominium complex is also approximately one mile from Kenneth Edmons Highway, another major highway in Indianapolis. There is frequent stop-and-start traffic on all the roadways close to my home. I have seen people accelerate and decelerate quickly and hit curbs while driving in my area.

12. There are also several potholes in neighborhoods close to me where I regularly drive. I have hit potholes many times while driving.

13. I drive every day. I drive to my father's house, located on Michigan Road, a major urban road and one of Indianapolis' first highways, almost every day. I also regularly drive to my grandma's house, which is fifteen minutes away.

14. I run approximately four times a week, for about two to three miles each time. I run on city streets, sidewalks, and in local parks. I have also run organized races. I ran the Indianapolis 5K & Monumental Mile race in June 2023 which took place on a course that involved running in the following streets: Pennsylvania Street, North Meridian Street, East Saint Clair Street, East Saint Joseph Street, and East Washington Street. All these streets are urban roadways in downtown Indianapolis.

15. I work out at two gyms, which I drive to, approximately four times a week. Each gym is approximately ten to fifteen minutes away from my home. I drive on highly trafficked roads to get to the gym including Interstate 465 and Lafayette Road. Part of my routine at the gym includes mat exercises, and I do not take off my shoes when doing these exercises. My gym shoes are the same shoes I run in, so I understand that I could be exposed to lead dust on my shoes while I work out.

16. I also play several sports including basketball, soccer, tennis, and golf. I play sports about two times a week. I play basketball outside at neighborhood basketball courts, and at a local high school basketball court, which is located on West Seventy-First Street, a major urban roadway. I play soccer at a field located outside near Castleton Square Mall, where there is frequent traffic. When I play

soccer and basketball, I walk through the parking lot to get to the court and field, respectively.

17. I drive a 2018 Toyota Tacoma, which I bought pre-owned. Prior to owning my Tacoma, I owned a 2014 Toyota RAV4. I have always conducted light maintenance on my car including filling my tires with air.

18. I understand that all of my commuting, running, and sport activities increase my likelihood of being exposed to lead dust from lead wheel weights, and I am concerned about this exposure.

19. Another reason I am concerned about exposure to lead from lead wheel weights is because I have been exposed to lead from other sources. When I was a teenager, I worked with my father to help renovate houses. I would help by hauling trash out of the homes, landscaping, taking out walls, and painting. Many of the homes were older, and they likely had lead paint in them. I did this work about two days a week and on weekends every year from most of my teenage years until I was about twenty years old.

20. As I already mentioned, I also worked at my uncle's autobody shop in high school where I worked on tires. When I used a machine to sand the tires, I sanded around wheel weights, which I understand could have created lead dust. I had a mask available for use, but I did not regularly wear the mask when working on car tires. I also did not wear gloves when I was working on cars.

21. I am concerned that the U.S. Environmental Protection Agency's ("EPA's") failure to regulate lead wheel weights could harm my health and the health of my family members.

22. I have suffered from respiratory illnesses in the past. When I was younger, from middle school to early high school, I suffered from asthma. I had to use an inhaler to manage my asthma and took steroids treatments through a nebulizer at night. I have also always suffered from allergies. My sister also has attention deficit disorder, which she was diagnosed with as a teenager. I understand that respiratory illnesses and attention deficit disorder are both linked to lead exposure.

23. EPA's failure to regulate lead wheel weights harms me because I could be exposed to lead dust created by lead wheel weights falling off of cars. I understand I am at greater risk of inhaling or ingesting lead dust from lead wheel weights because I live in an urban, high-traffic area, and I am concerned that this exposure can harm the health of myself and my family members.

24. If EPA regulated these wheel weights, I would not be exposed to this source of lead, and my health would be less threatened. I believe that if EPA has banned lead from other products, like paint, it doesn't make sense to continue to use lead in wheel weights.

25. Lead is a soft metal, can leach into everything, and lead from lead wheel weights can be ground into dust and get into the air and water. This exposure will harm people and affect animals and plants. Indiana is already polluted, and does not have the best environmental policies, so I am concerned that lead wheel weights are just one more source of exposure to lead. EPA should act to eliminate this source of exposure.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August, 12, 2023 in Indianapolis, Indiana.

Gabriel Cardenas

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF ANDREA BRASWELL
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, ANDREA BRASWELL, declare and state as follows:

1. I am a supporter of the Center for Environmental Health ("CEH"). I am the former Program Manager for CEH's Petrochemicals, Plastics & Climate Program, a role I held from November 2021 to August 2023. I also worked at CEH as the Program Manager for the Policy Program and as an Executive Assistant. I hold a Bachelor of Arts degree in Environmental Sustainability from Meredith College in Raleigh, North Carolina.

2. I have been a supporter of CEH for a little over four years. I chose to support CEH in part because I appreciate the work CEH does to increase

transparency around the use of toxic chemicals and to explain the danger of toxic chemicals in a way that everyday people can understand.

3. When I had just had a baby, I saw a report written by the alliance of nonprofit organizations, Healthy Babies, Bright Futures, that was being promoted by CEH. The report was entitled "What's in my baby food?" and described a study where neurotoxic chemicals were found in 95 percent of tested baby foods. That report led me to look for other reports and studies that CEH helped draft and/or promote that could help me learn how to feed my young daughter food that contains fewer toxic chemicals.

4. Having access to reporting on toxic chemicals was really helpful as a new mom. Also, as a single mom, I have to rely on easy-to-use products because I have limited time to meet all my obligations, but as an environmentalist I feel bad about using products like single-use plastics or buying disposable products, which make life easier but which I know are not sustainable. CEH reports provide me with ways to make safer choices that are not as bad for the environment.

5. I am a resident of the city of Roxboro, North Carolina, where I grew up. I previously lived in Raleigh, North Carolina for a little over a year as a professional, and for four years as a student at Meredith College. My family, including my twin brother, little brother, and parents also live in North Carolina,

either in Raleigh or Roxboro. I, as well as my family, intend to remain living in North Carolina.

6. I am a thirty-one-year-old mother of two young daughters, aged two and four years old. I gave birth to both my daughters while living in North Carolina.

7. I live with my two daughters. We are temporarily staying with my parents in Roxboro, but are moving to our own home in Roxboro, which we are renting, in August 2023. I hope to purchase property in Roxboro in the future.

8. I am very concerned about me, and my family, being exposed to lead from lead wheel weights, as I know lead can cause serious health effects. I first learned about lead wheel weights and the health harms they can cause when I helped to design CEH's website and read about our organization's work advocating against the use of lead wheel weights through our Illegal Toxic Threats Program. After reading about lead wheel weights on our website, I discussed the health harms stemming from lead wheel weights with CEH's since-retired Research Director to increase my understanding.

9. I am concerned about exposure to lead from lead wheel weights because I currently live in and am moving to a high-traffic urban area, which I understand is where most lead wheel weights fall off of vehicles and then get ground into dust by passing traffic.

10. My daughters and I lived in a rented apartment in the Brier Creek area of Raleigh, North Carolina for a little over a year. Our apartment complex was less than one mile from Glenwood Avenue, a major thoroughfare connecting downtown Raleigh to the suburbs in the northwest and the city of Durham. Our apartment was under one mile away from a car-towing business, a shopping center, two car dealerships, and a number of restaurants—all of which are highly trafficked businesses.

11. The home we will move into shortly is located in Roxboro, a heavily trafficked and highly populated city adjacent to Raleigh, the state capital. Our new house is located less than one mile away from a number of high-traffic businesses including: two hotels, a large shopping center with a superstore, a car dealership, several fast-food restaurants with drive-throughs, and a truck rental agency.

12. The new Roxboro home is also less than one mile away from the intersection of two highways: Durham Road and Oxford Road. There is also a stoplight right across from my house where vehicles frequently stop.

13. Many people who work in Raleigh or Durham choose to live in Roxboro because the cost of living is lower, and there is a significant amount of commuter traffic close to my new home.

14. My children both attend a daycare in Durham, North Carolina located on Wake Forest Highway, a highway that leads to the Raleigh-Durham

International Airport. I am my daughters' primary caretaker and drop off and pick up the girls every weekday. Getting to my daughters' daycare is terrible because it is right on the highway, and the highway goes to the airport, so it is heavily trafficked. A drive that should take fifteen minutes can take up to thirty-five minutes. I understand that my daughters and I have an increased likelihood of being exposed to lead dust created by lead wheel weights because we live near major urban roadways and because the girls attend a daycare located on a major urban roadway.

15. I am also concerned about exposures to lead from lead wheel weights that my daughters could experience through play and their age-appropriate behavior. My two-year-old daughter mouths toys and puts her hands in her mouth as a form of self-soothing. Both my daughters play around on the ground doing gymnastics, particularly inside our home. I also take the girls for a walk at least once a day in our area, and we walk to local shops. We are a mostly shoes-off household, but my children frequently forget to take off their shoes when they get home, so I am concerned that they could track in dust containing lead from the streets into the home and then my youngest daughter might ingest it when she is soothing herself or when the girls are playing.

16. My daughters and I all have reactive airways disease, a respiratory illness similar to asthma. When I experience reactive airways symptoms, I have to

receive steroids through nebulizer treatments and use an inhaler for a few weeks. My eldest daughter receives similar treatments.

17. My youngest daughter has more severe reactive airways disease, and I worry she will develop asthma. She developed reactive airways disease at just nine months old. She experiences several symptoms including persistent coughing and wheezing. She is frequently sick and has already suffered one asthma attack which led her to be taken to the Emergency Room. She must undergo daily steroid treatments through a nebulizer. She also now needs to visit a pulmonologist to address her respiratory illnesses. I am concerned that exposure to lead dust created by lead wheel weights falling off of cars could exacerbate her health issues.

18. EPA's failure to regulate lead wheel weights harms me because I could be exposed to lead dust created by lead wheel weights falling off of cars. Because I live in an urban, high-traffic area, I understand I am at greater risk of inhaling or ingesting lead dust from lead wheel weights, and I am concerned that this exposure can harm the health of myself and my daughters who all have respiratory illnesses.

19. If EPA regulated these wheel weights, my daughters and I would not be exposed to this source of lead and our health would be less threatened. I am frustrated, disheartened, and confused about how EPA has so much power and fails to utilize it.

20. If EPA regulated lead wheel weights, that would address my concerns about exposure to this source of lead, and I believe my daughters and I would be safer.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August, 15, 2023 in Roxboro, North Carolina.

Andrea Braswell

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF ZAKIA RAFIQA SHABAZZ ON BEHALF OF UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS

I, ZAKIA RAFIQA SHABAZZ, declare and state as follows:

1. I am the National Director of United Parents Against Lead & Other Environmental Hazards f/k/a United Parents Against Lead National, Inc.—referred to as UPAL for short—and founder of the Virginia chapter. I founded the Virginia chapter of UPAL after my son was diagnosed with lead poisoning in early 1996 and have headed it ever since. In 2001, I became the National Director of UPAL. I hold a bachelor's degree in Business Administration and a paralegal certificate specializing in real estate and civil litigation. I am also a 2019 graduate of the Environmental Protection Agency's ("EPA") Environmental Justice Academy. The information in this declaration is based on my personal knowledge and experience.

2. UPAL was formed in 1996 by parents of lead-poisoned children. It is a national networking organization of and for parents of lead-poisoned children dedicated to ending the continuing threat of lead poisoning and other environmental hazards through education, advocacy, awareness, intervention, and resource referral. UPAL's mission is to ensure the fundamental right of all children to live in a safe and healthy environment. Our work focuses on reducing exposure to lead—a dangerous toxin that can have lifelong health harms and for which there is no safe level—and supporting parents and families with lead-poisoned children.

3. As UPAL's National Director, I am familiar with UPAL's organization, policies, membership, and practices.

4. UPAL is a 501(c)(3) nonprofit membership organization incorporated and based in Virginia. It has chapters in New Jersey, Maryland, Michigan, and Washington, D.C.

5. UPAL has over fifty members. Members of UPAL have children who have been poisoned by lead, and UPAL organizes events for its members, including health fairs and lead testing.

6. UPAL has nine board members, and multiple board members are parents of lead-poisoned children.

UPAL's Commitment to Addressing Childhood Lead Exposure, Including Exposure from Lead Wheel Weights

7. UPAL promotes taking proactive steps to prevent children's exposure to lead. UPAL connects with parents of children who have been, or could potentially be, exposed to lead and provides them with resources and information that will empower them to make informed health decisions. We also connect parents of lead-poisoned children with other lead-poisoning prevention advocacy groups. UPAL advocates for families with lead-poisoned children by sharing their stories with the media and assists families facing lead exposure by providing grants to remediate homes contaminated with lead and providing relocation support.

8. UPAL is involved in a number of projects to eliminate sources of lead exposure. Since 2016, UPAL has been part of the Lead Service Line Replacement Collaborative, a joint effort of twenty-eight organizations to accelerate full removal of lead pipes that bring drinking water to millions of homes across the country. UPAL has worked with a Virginia state senator to advocate for required testing for lead in drinking water in schools. UPAL also recently launched a campaign to test water in higher-risk areas of Richmond, Virginia and then send those results to the city of Richmond 's Department of Public Utilities. Families will then be able to get support with having their water lines fully replaced utilizing federal funding that has been allocated to states. UPAL operates with an equity lens, making sure

that communities who have not historically been given adequate attention are prioritized.

9. In 2009, UPAL and others petitioned EPA to establish regulations prohibiting the manufacture, processing, and distribution in commerce of lead wheel weights. This 2009 petition is the subject of the Petition for Writ of Mandamus for which I am submitting this declaration. Even though EPA granted that petition in August of 2009, EPA has never taken the step of actually regulating lead wheel weights. As a result, UPAL's members and their children remain at risk of lead exposure from this source.

Unregulated Sources of Lead, Including Lead Wheel Weights, Harm UPAL's Members

10. UPAL's members are parents of lead-poisoned children, and they experience firsthand the devastating effects of lead poisoning and the irreparable damage and suffering it causes.

11. UPAL's members are concerned about their family members' exposures to lead and try to minimize exposure to as many sources of lead as possible. For example, one of UPAL's members, Charlotte Scott, is very concerned about her great-granddaughter being exposed to lead dust, including lead dust that is created from lead wheel weights. This concern is so significant that her great-

granddaughter is not allowed to play in dirt and grass in her yard as it could be contaminated with lead.

12. UPAL's members and their children are harmed by ongoing exposures to lead from lead wheel weights. UPAL has members who live in communities with highways running through their neighborhoods and who walk along busy roadways. Lead wheel weights often fall off of tires during normal driving, and children may pick up and play with these weights when they find them on the side of the road. Lead wheel weights can also be ground down into dust, contaminating the soil around roadways, where individuals walk to work and school and where children play. UPAL's members and their children who live and walk along these busy roads where lead wheel weights fall off are exposed to this lead dust.

13. Any additional source of lead exposure is harmful and concerning to UPAL's members and their children. Children of UPAL members are exposed to lead from multiple sources, such as lead paint, lead wheel weights, water delivered in lead pipes, leaded aviation gasoline, lead dust, and lead-contaminated soil. As the level of lead in a child's blood increases, the negative health effects can increase. Exposure to lead from wheel weights increases the amount of lead in a child's body and increases the harm that child faces, and UPAL's members are concerned about this increase.

14. If EPA regulated this source of lead, it would decrease the chances of the children of UPAL members and children nationwide being poisoned by lead and it would help get rid of a significant source of lead. It would also help UPAL achieve its mission of eliminating sources of lead pollution and protecting children from this dangerous and cumulative toxic substance, and it would help UPAL's members feel safer in their neighborhoods.

15. EPA needs to make good on its promise to regulate lead wheel weights so that children do not continue to be detrimentally exposed.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 16th day of August 2023, in Richmond, Virginia.

Zakia Rafiqa Shabazz

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF CHARLOTTE SCOTT
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, CHARLOTTE SCOTT, declare and state as follows:

1. I am a member of United Parents Against Lead & Other Environmental Hazards ("UPAL"). I also am a member of the Virginia Environmental Justice Collaborative, the Portsmouth Virginia NAACP, the African American Historic Society, and I began establishing two additional groups—the People for Environmental Justice and the People Against Environmental Racism. I have been a member of UPAL for more than five years. I joined UPAL because I am very concerned about exposures to lead and other toxic chemicals like mercury, chromium, and arsenic; the environmentally unsafe business profiteers that are located in the 23704 residential community, an area of

Portsmouth; and chemical exposures from the Norfolk Naval Shipyard in Portsmouth. I am deeply passionate about environmental protection, as it has impacted myself, my family, many friends, and neighbors. I believe we all have an inalienable right to be free from toxic chemical exposures.

2. I was born and raised in Portsmouth, Virginia. I lived in California for a few years while working at the Teratogen Registry at the University of California in San Diego, which worked to establish how newborns develop cancer. There I learned that when lead and other toxic chemicals are breathed in by their future parents, they cause birth defects and cancer and changing genes. I moved back to Virginia with my family in 1982 and have lived in Virginia ever since. I have four sons, eight grandchildren, and four great-grandchildren. I live in Chesapeake, Virginia, but right now I am staying with my son and granddaughter in Suffolk, Virginia while I recover from a car accident. I intend to remain in Virginia.

3. I grew up in Portsmouth, which is a community with significant lead contamination. From the 1920s until the late 1970s, there was an active brass and bronze foundry in Portsmouth that recycled lead-containing railway bearings, and it was adjacent to a low-income apartment complex called Washington Park. I used to live down the street from Washington Park. The operators of the foundry used to dump waste sand containing lead filtered sand in the ditches outside of the foundry

building. The sand was also used to fill in deep trenches at the corner curbs where there were bus stops. This is where the transit buses pulled up to the curbs and the big tires cut deep into the soil, creating ruts. That filled with water when it rained, causing ponding, flooding, and spreading of the contamination through the soil.

4. The Norfolk Naval Shipyard in Portsmouth also releases toxins into the atmosphere and surrounding soil and water from sandblasting lead-based paint from ships contaminated with many heavy metals and other toxic chemicals. As a child, I remember getting ugly rashes, coughs, and colds with thick mucus in my eyes from playing in soil that was contaminated by lead, and the mucus had to be washed out in order to open my eyes. I also began coughing up thick green mucus. As a community, we also planted fruits and vegetables in our family gardens, which was a part of the community culture. When I was growing up, we ate the foods grown in the gardens, which contained lead-contaminated soil, which I believe was another form of contamination and caused death by colon cancer.

5. Children living in the area suffered from lead poisoning even after the foundry shut down because the area was still contaminated by lead. In fact, people in the area are still concerned about the lead contamination in that soil. In the early 1990s, the Washington Park Lead Committee was formed to advocate for the rights of nearby residents to be free from lead exposure. In 1991, I started speaking up and out at Portsmouth City Council meetings about the lead exposure that our

communities were facing. I was worried about the lead and soil contamination in the Washington Park area, and I told the City Council so. I was worried that children suffering from lead poisoning were returned to school to receive transfers to alternative schools, and they were suspended and expelled because of symptoms of attention-deficit/hyperactivity disorder ("ADHD"). Many of the children at the neighborhood school had symptoms of ADHD.

6. I continued to speak out at government meetings about my concerns regarding environmental issues and toxic exposures that the communities are facing. In 1992, I moved across the river to Norfolk, Virginia in the Berkley community, which was right near the Colonna's Shipyard, and I spoke out about my concerns with that shipyard's unsafe environmental practices. Children in this community were tested for lead in their blood and multiple children had very high levels.

7. In May 2020, I told the Virginia Council on Environmental Justice that I was concerned about contamination in the Newtown neighborhood of Portsmouth, where I grew up. I also told the Council that contamination was affecting African American communities and causing disproportionately high levels of adverse health effects.

8. I am extremely worried about the health harms stemming from exposure to lead. I know that lead is a teratogen, meaning that it can interfere with

fetal development, and an epigenetic modifier, meaning that it can alter DNA. It also is a carcinogen, affects the immune and reproductive systems, and can cause other health harms like bronchial disorders and ADHD. I also know that lead is a cumulative toxic chemical, so that more lead exposure can lead to more adverse health effects.

9. My family and I have experienced many of the health harms associated with lead exposure. When we moved back to Virginia from California, my kids developed bronchial disorders. In 1992, my sons and I got our blood lead levels tested, and my level was nine micrograms of lead per deciliter of blood, which is much higher than average. My sons also had detectable levels of lead in our blood. My sons and I have ADHD, my granddaughter has immune disorders, and my two-year-old great-granddaughter was born prematurely and had disorders as an infant.

10. I worry about my family and me being exposed to lead. I know that lead can end up in the air we breathe, the water we drink, and the soil we plant our gardens in, and that any level of lead is dangerous. I try to protect my family and even keep my great-granddaughter from playing in the yard to minimize her exposure to lead in soil, but it is difficult to protect them when the government is still allowing lead to be used.

11. I am concerned about lead exposures from lead wheel weights because lead wheel weights can fall off of cars. I have seen clip-on wheel weights attached to the rims of my own tires, and there are many potholes in Portsmouth, so I can see how they can fall off easily. When they fall off, children can get to them easily, and lead is especially dangerous to children. My home in Chesapeake is near major roadways with a lot of traffic, including Interstate 664 and U.S. Route 17, and near Taylor Road, which has a lot of stop-and-go traffic, and I understand that lead wheel weights can fall off in these circumstances. I like to walk around my neighborhood for exercise, and it is concerning that the lead from wheel weights can contaminate my neighborhood and expose me to this dangerous chemical.

12. Because EPA has not regulated and banned the use of lead in any products, lead wheel weights can still be used and fall off of cars in Virginia. This contaminates areas near roads with a lot of traffic, like my neighborhood in Chesapeake and where I grew up in Portsmouth, and it creates another source of exposure to this dangerous chemical.

13. I would feel safer if EPA would ban the use of lead for any purpose and in all products, including wheel weights, because it is such as toxic chemical. In fact, I think EPA should ban all sources of lead because it is such a toxic chemical. Children deserve to live in an environment that is free from toxic

chemicals like lead. For that reason, I offer no apology for my loud and bold expression in contempt for lead contamination and its effect on the health and well-being of the people living in Newtown, Portsmouth, Virginia and its surrounding area.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on August, 21, 2023 in Suffolk, Virginia.

Charlotte Scott

Charlotte Scott

**UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT**

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

**DECLARATION OF SONYA LUNDER
ON BEHALF OF SIERRA CLUB**

I, SONYA LUNDER, declare and state as follows:

1. I am the Senior Toxics Policy Advisor for the State Lobby and Advocacy program at Sierra Club. I have held the Senior Toxics Policy Advisor position since 2018, first in the Policy, Advocacy, and Legal department and since July 2023 in the State Lobby and Advocacy program. I have been working in toxics advocacy for approximately twenty years. I hold a Master of Public Health, with a focus on environmental health and toxicology, from the University of California, Berkeley, and a Bachelor of Arts in Environmental Studies from the University of California, Santa Cruz. The information in this declaration is based on my personal knowledge and experience.

2. Through my role as Senior Toxics Policy Advisor for Sierra Club, I am familiar with Sierra Club's structure, mission, activities, and membership. Sierra Club is a national 501(c)(4) environmental nonprofit, organized and existing under the laws of the state of California, with its headquarters located in Oakland, California. The Club was founded in 1892, has sixty-three chapters, and has approximately 800,000 members across all fifty states and the District of Columbia and Puerto Rico, including approximately 169,000 members located within California.

3. Sierra Club's mission is to preserve and protect the places where people live, work, and play. Our members are dedicated to exploring, enjoying, and protecting the wild places of the earth; to practicing and promoting responsible use of the earth's ecosystems and resources; to educating and enlisting humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives, nationwide.

4. Sierra Club has dedicated itself to protecting public health and its members from toxic chemicals, including lead. The Sierra Club's mission includes protecting its members' health and their ability to enjoy being outdoors and to engage in recreational activities and the use of public lands, parks, green space, and outdoor spaces without experiencing exposure to lead. Sierra Club works to

address widespread exposure to toxic chemicals, such as lead, that jeopardize the health of communities across the country.

5. Our organization is made up of paid staffers, members, and supporters. Sierra Club members advance our mission by advocating for locally identified campaign priorities, attending public meetings with local representatives, volunteering for leadership positions to help develop priorities and strategies, and generally working to implement goals developed by the organization. Members can provide input on Sierra Club priorities in various ways. On a national level, members volunteer to co-lead campaigns and are responsible for building national strategies and can volunteer to supervise state-based staff. On the local level, members meet and democratically determine the priorities of their chapter.

6. Sierra Club members pay dues that help to finance the programs and activities of the organization.

7. Members have voting rights to elect Sierra Club's board of directors, which consists of fifteen directors. Members can also vote for leadership at the local and state level.

8. In my role as Senior Toxics Policy Advisor, I work as a national staffer who supports local, state, and national staff and members with issues related to toxic chemicals and exposure. A substantial part of my work involves advising and supporting our volunteer-led teams on toxics issues. One such volunteer-led

team is our National Toxics Team, which works to educate the public about dangerous chemicals and advocates for regulations that adequately protect the public, wildlife, and environment from exposure to toxic chemicals.

Sierra Club's Lead Work

9. Sierra Club strives to reduce lead exposures by advocating for stronger policies on a national and local level. We have launched multiple campaigns and initiatives to address different sources of lead exposure.

10. Sierra Club is particularly concerned about lead exposures and adverse health outcomes for children. Many children are exposed to lead by living in houses contaminated by lead paint. Sierra Club, alongside other environmental health advocacy groups, brought forth a lawsuit challenging the U.S. Environmental Protection Agency's ("EPA's") failure to strengthen its rules regarding the regulation of lead in paint and dust, specifically highlighting the failure of the rules to sufficiently protect children. *In re A Cmty. Voice,* 878 F.3d 779 (9th Cir. 2017).

11. Sierra Club is also concerned about lead in municipal drinking water. We have worked to reduce this exposure through legislative advocacy, including staff testimonies to national and state legislative bodies, litigation to reform regulations, and public education on hazards posed by lead in drinking water. Specifically, we have advocated for the replacement of lead service lines and

robust testing of lead in water supplies. In 2021, Sierra Club and other environmental groups filed suit challenging EPA's revisions to its lead and copper rule, a set of regulations intended to protect the public from exposures to lead in drinking water under the Safe Drinking Water Act. Petition for Review, *Newburgh Clean Water Project v. EPA*, No. 21-1019 (D.C. Cir. Jan. 15, 2021).

12. Sierra Club has also worked to curb lead contamination at acid battery disposal facilities, also known as secondary smelters. Local chapters have opposed expansions of lead-acid battery recycling plants through regulatory comments and attending public meetings with representatives. Nationally, Sierra Club has sued EPA on more than one occasion regarding its regulations for the secondary lead smelting sector.

13. The National Toxics Team also monitors developments related to lead and policies that impact lead emissions and exposures, such as reviewing human exposure data and thinking about ways that policy impacts ongoing uses of lead.

Sierra Club Members Are Concerned About and Injured by Lead Wheel Weights

14. As lead has negative health outcomes at all stages of life, Sierra Club members who range from youth to elders are concerned about protecting themselves, their communities, and their environment from lead exposure and lead wheel weights specifically.

15. Sierra Club has advocated for regulation of lead wheel weights in the past. In 2009, Sierra Club petitioned EPA, alongside other environmental and health advocacy groups, requesting EPA ban the manufacture, processing, and distribution in commerce of lead wheel weights. This 2009 petition is the subject of the Petition for Writ of Mandamus for which I am submitting this declaration.

16. The Sierra Club has many members, like Doris Cellarius and Christy McGillivray, who live, work, and recreate in close proximity to locations contaminated by lead from lead wheel weights.

17. Sierra Club members live in every major city in the United States, and many of these members live close to urban roadways where lead wheel weights frequently fall off of vehicles. This can expose our members to lead since lead wheel weights fall off of cars and are ground into lead dust particles, and this dust can also become re-suspended in the air when cars drive by roadways. I expect many of our members drive, walk, and live near places where they are exposed to lead from lead wheel weights.

18. We also have members who are pregnant or already have children and are concerned about their children's exposures to lead, which is a neurotoxin, and other toxic chemicals. Our members have children who play near places where they have access to lead wheel weights that they could pick up or can be exposed to lead dust from ground up lead wheel weights.

19. I have personally spoken to members who are concerned about exposure to lead wheel weights and how this exposure can contribute to their cumulative exposure to lead. Many of the states where our members live also have disproportionately high levels of existing lead sources, increasing their cumulative exposure.

20. EPA's failure to regulate lead wheel weights injures our members by allowing another source of lead exposure to persist, contributing to our members cumulative lead exposure.

21. EPA regulating the manufacture, processing, and distribution in commerce of lead wheel weights would redress Sierra Club's injury, as it would reduce the amount of lead in the environment, ultimately making our members feel safer and furthering Sierra Club's mission of reducing lead exposure to its members and communities. The most effective action to reduce lead exposure is through national regulation.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 18, 2023 in Boulder, Colorado.

Sonya Lunder

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

DECLARATION OF DORIS CELLARIUS
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS

I, DORIS CELLARIUS, declare and state as follows:

1. I have been a member of Sierra Club for about sixty years. I joined because I was inspired by how Sierra Club was led in part by volunteers and gave them opportunities to be leaders.

2. I am a retired textbook editor and educator residing in Portland, Oregon, where I have lived for the past three years. I retired in 2000 to raise my family and I spend a lot of my time volunteering with Sierra Club.

3. I live with my husband in a home where I intend to live for the foreseeable future. I have two adult daughters and one grandson. One of my

daughters lives a mile away from me with my grandson who is seventeen years old.

Involvement in Environmental Advocacy and Sierra Club

4. I am an active member of the Sierra Club and support the Club in many ways.

5. About sixty years ago, my husband purchased me a lifetime membership for Sierra Club.

6. I have served in many leadership roles with the Club. I am currently the acting volunteer leader of Sierra Club's National Toxics Team and active in Sierra Club's local Oregon chapter. I work with the Senior Toxics Advisor at Sierra Club to build and launch new initiatives related to toxic chemicals, including lead.

7. The mission of the National Toxics Team is to work nationally to address toxic exposures. I work on many toxics issues such as exposure to lead and pesticides, Superfund site remediation, and safe drinking water. I write fact sheets and advise local Sierra Club members about how to address toxic exposure problems. I have written fact sheets about lead exposure, including a fact sheet about lead in faucets.

8. I have chaired other national Sierra Club committees in the past, including Sierra Club's Hazardous Materials Committee. Now, I am actively

working on toxics issues as well as other environmental issues such as forestry protection and the dangers of radiation from nuclear weapons development and existing nuclear power plants.

9. Through my local Oregon chapter, I have sent comments to Oregon legislative committees on bills regarding toxics issues such as toxic chemicals in children's products, pesticides, and incinerators. I have helped write testimony on those issues.

10. In the 1990s, I gave testimony to the Washington State Legislature on behalf of a painters' union to advocate for better regulations on lead.

11. In 1979, I helped to launch a lead education project in Seattle, Washington with the Washington Toxics Coalition, which is now known as Toxics Free Future. At the time, we educated mothers about protecting their children from lead.

Concerns About Lead and Lead Wheel Weights

12. I am concerned about lead exposure as I know lead is a hazard to older people, like myself, as well as children, like my grandson.

13. I have filtered my drinking water ever since I moved into my house in Portland, Oregon three years ago because my tap water is high in lead. I believe that it has not been safe to drink the water or cook with it.

14. Because of my concern that my water will harm my health because of its lead levels, I have been sending in samples of my drinking water for over a year to help the local government try to determine if the new treatment system they built is working. For several months, the lead levels in my drinking water were over twenty parts-per-billion, which is over the advisory level for lead in water. Recently, it has gone down and while I am happy we are drinking water that is cleaner, I am still concerned that the lead levels of my water are too high.

Exposure to Lead Wheel Weights

15. I have been aware of and concerned about exposure to lead from lead wheel weights for over three decades. About thirty years ago, the local Sierra Club in Olympia, Washington conducted an educational awareness project about lead wheel weights. It was a project of the Thurston County Hazardous Materials Program led by a person who was also the chair of the local Sierra Club in Olympia at that time. They had people pick lead wheel weights up and show them to others so that people could see what they look like so they could advise children to stop picking them up and putting them in their mouths. As a local volunteer interested in toxics, I learned about the health harms stemming from lead wheel weights at that time, volunteered with the initiative, and picked up lead wheel weights along the side of the road.

16. I am worried about exposure to lead from lead wheel weights as I know that any exposure to lead would be harmful to my health. When lead wheel weights fall off of cars and are ground into lead dust, I could be exposed without knowing it. I also understand that lead wheel weights fall off of cars most frequently in areas with start-and-stop traffic. I currently live close to high traffic roads where I have found and picked up lead wheel weights.

17. I live about one block away from a state highway: Oregon Route 99E, also called McLoughlin Boulevard. Close to my house is an intersection of four city streets that get moderate start-and-stop traffic with stop signs at the corner. I have observed cars rapidly accelerating or decelerating at this intersection.

18. I drive approximately four times a week to go buy groceries two miles away from my house and attend medical appointments four miles away. I drive on roads with moderate to heavy traffic to complete these tasks.

19. I drive a Toyota Prius plug in. I replaced my four tires at a Toyota facility about a month ago after I hit a huge pothole by my house and ripped a hole in my tire.

20. It is my understanding that potholes on roads increase the likelihood that wheel weights will fall off. The streets by my house, which I regularly drive, have a lot of potholes as the pavement buckles from the tree roots planted on my block. When I am driving, I encounter rough pavement.

21. I take walks several times a day around my neighborhood, including walking my dog and going to the post office. I walk about one to two miles total every day. I have also walked alongside Oregon Route 99E by my house. On one recent occasion, I picked up two wheel weights while walking along Oregon Route 99E—one was intact and the other had been flattened. After I return home from walking, I do not take my shoes off. I walk in my house in those same shoes which I understand could mean that I am tracking lead dust into my home.

22. I spend an hour each day gardening and working in the soil in my backyard. When I am done gardening and go back inside, I do not take my shoes off and wear the same shoes around the house.

23. I plan to continue living in my current home, driving, walking, and gardening on a regular basis in the future.

EPA's Failure to Regulate Lead Wheel Weights

24. EPA's failure to regulate lead wheel weights has a direct impact on me as I am potentially being exposed to lead dust created by lead wheel weights falling off into the streets by my house. I am concerned about the negative health effects from being exposed to lead dust from these lead wheel weights. Since I am eighty-five years old, I am concerned that exposure to lead could significantly affect my health.

25. I believe that EPA should address all sources of exposure to lead, including exposures to lead wheel weights. If EPA had regulated lead wheel weights years ago, my potential exposures to lead would be lower and my health would be less threatened by lead.

26. If EPA were to regulate lead wheels, I would feel safer knowing that a source of lead exposure is being eliminated. Knowing that a few states have already banned lead wheel weights, EPA should definitely follow through and make it a national ban.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 9, 2023 in Portland, Oregon.

Doris Cellarius

Doris Cellarius

**UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT**

IN RE ECOLOGY CENTER, INC., CENTER FOR ENVIRONMENTAL HEALTH, UNITED PARENTS AGAINST LEAD & OTHER ENVIRONMENTAL HAZARDS, and SIERRA CLUB, *Petitioners*	Case No.

**DECLARATION OF CHRISTY MCGILLIVRAY
IN SUPPORT OF PETITION FOR WRIT OF MANDAMUS**

I, CHRISTY MCGILLIVRAY, declare and state as follows:

1. I am a member of Sierra Club. I have been a member intermittently since 2006, with continuous membership since 2020. I originally joined Sierra Club because I was already working in environmental advocacy in Michigan and believed it would be good to support Sierra Club's grassroots advocacy, particularly its work on clean energy and toxics which is important to me. Most recently, I renewed my membership to stay current on the communications that Sierra Club sends to its members.

2. I live in Grosse Pointe Woods, Michigan with my partner, Shawn, and my daughter, Edith. Edith is eleven years old. We have lived at the same address since 2017. We intend to remain at this address for the foreseeable future.

Involvement in Environmental Advocacy and Sierra Club

3. I have worked as the Legislative and Political Director of the Michigan Chapter of Sierra Club since 2020. In this role, I oversee state legislative advocacy, the political program, and work related to elections in the state legislature. Before working as the Legislative and Political Director, I was hired as the Great Lakes Organizer and worked primarily on advocacy related to PFAS and the Line 5 pipeline.

4. Prior to being employed by Sierra Club, I worked in a coalition with the organization (when I worked at Clean Water Action) on the Great Lakes Compact of 2008, an agreement between the eight states bordering the Great Lakes and the U.S. Congress to protect the Great Lakes' fresh surface water.

Concerns About Lead and Lead Wheel Weights

5. I am concerned about lead exposure generally because I know lead is a health hazard to all people, and especially to children like my daughter, Edith.

6. I live in a community with detectable levels of lead in our drinking water. In a report we received from the city, the range of lead in the samples was between two parts per billion and fourteen parts per billion.

7. Michigan, like many other states, does not properly track a huge inventory of lead service lines. I have closely followed initiatives to remove lead service lines in my community, but that effort is slow moving. I also worked on the initiative to get mandatory blood lead level screenings for children in Michigan.

8. Throughout my career, I have worked on advocacy surrounding the health hazards of lead through my involvement with water policy in Michigan. Lead exposure is a personal and professional concern of mine.

9. I am aware that lead is used to make wheel weights for cars. I am also aware that these wheel weights frequently fall off cars, are ground to dust, and can be a source of lead exposure through inhalation or ingestion. I am concerned that my family and I are exposed to lead dust from abraded lead wheel weights because of where we live and our lifestyle. We have no control over this exposure and no ability to avoid it.

<u>Exposure to Lead Wheel Weights</u>

10. Our home is located in close proximity to multiple urban roadways. We live less than half a mile away from I-94, a heavily trafficked interstate highway which serves as a trucking route to Canada. We also live within half a mile of Vernier Road (also called “8 Mile”), a state highway, and Mack Avenue, a busy roadway with cars frequently starting and stopping. The intersections

surrounding our home have stop signs and traffic lights, so there is stop-and-go traffic around our home.

11. Before moving to our current house, we lived within one mile of the intersection between I-696 and I-75, two major highways.

12. On average, I drive at least fifteen miles per day on these heavily trafficked roadways, including driving to my Sierra Club office in Detroit and around the state for work. My car is a 2015 Ford C-Max. My partner, Shawn, drives a 2017 Kia Niro. Occasionally, I perform basic maintenance tasks on my car, which include checking the air pressure in the tires and filling them.

13. Around my house and throughout Michigan, I frequently observe cars hitting curbs or potholes, rapidly accelerating and decelerating, and making sharp turns. I understand that these are ways in which wheel weights can fall off cars. Michigan has many potholes, including one on the entrance to I-94 near my home.

14. In addition to driving on these urban roadways, my family and I frequently walk along or near them. On average, we walk at least thirty minutes per day, and often more. We walk our dogs every day and walk to the grocery store, to friends' houses, and to nearby parks. When we return home, we wear the shoes that we walked in into the house, which I understand could track lead dust into our home.

15. Edith walks to her school, Parcells Middle School, every day. The school is located in Gross Pointe Woods, Michigan at the intersection of Vernier Road and Mack Avenue. Edith crosses both roads to get to school. Before Edith began at Parcells Middle School, she attended Mason Elementary School, which is on Vernier Road as well. Edith also walks to friends' houses. One of Edith's friends lives across I-94 and Edith will walk to the other side of the highway. Another of Edith's friends lives one block closer to I-94 than our house is, and she walks towards the highway to get to that friend's house.

16. In my free time, I take Edith to parks and the local pool to play. Edith plays in the grass, dirt, and woodchips in our yard, at the park, and at her school playground, which is along Vernier Road.

17. In Detroit, I observe road debris and scrap metal in the streets everywhere.

18. My family and I plan to continue living in our current home, driving, walking throughout our neighborhood, and playing in parks and our yard on a regular basis in the future.

EPA's Failure to Regulate Lead Wheel Weights

19. I am directly impacted by EPA's failure to regulate lead wheel weights because my family and I could be exposed to lead dust from lead wheel weights on a regular basis.

20. I am worried about the health harms associated with lead exposure, and I am concerned with EPA's failure to adequately assess the risks of lead wheel weights. I feel that EPA should address all sources of exposure to lead and am concerned that it does not.

21. I am especially concerned about lead exposure from lead wheel weights because my family and I are exposed to lead through other pathways as well. We live in a community with detectable levels of lead in our drinking water.

22. I would feel safer for myself and my family if EPA were to address all sources of exposure to lead, including exposure from lead wheel weights. Because we cannot avoid potential exposure from lead wheel weights given where we live, work, and play, we would benefit if EPA were to issue a rule to regulate lead wheel weights.

I declare under penalty of perjury that the foregoing is true and correct.

Executed August 15, 2023 in Grosse pointe woods, Michigan.

Christy McGillivray