



SCIENCE ADVISORY BOARD

A Federal Advisory Committee to the U.S. Environmental Protection Agency

December 20, 2022

EPA-SAB-23-003

The Honorable Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Subject: Consultation on Environmental Justice Analysis for EPA's Lead and Copper Rule Improvements

Dear Administrator Regan,

EPA's Science Advisory Board held a public meeting on November 2 and 3, 2022, and conducted a consultation with EPA staff on environmental justice analysis for the Agency's Lead and Copper Rule Improvements. The Science Advisory Board Staff Office has developed the consultation as a mechanism to provide individual expert comments for the EPA's consideration early in the implementation of a project or action. A consultation is conducted under the normal requirements of the Federal Advisory Committee Act (FACA), as amended (5 U.S.C., App.), which include advance notice of the public meeting in the Federal Register.

No consensus report is provided to the EPA because no consensus advice is given. Individual written comments were requested from all members of the Science Advisory Board. The EPA's charge questions to the Board are provided in Enclosure A. The individual written comments received from EPA Science Advisory Board members are provided in Enclosure B.

We thank the EPA for the opportunity to provide early advice on environmental justice analysis for the Agency's Lead and Copper Rule Improvements.

Sincerely,

/s/

Alison C. Cullen, Sc.D.
Chair
EPA Science Advisory Board

Enclosures

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at <https://sab.epa.gov>.

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Enclosure A

The EPA's Charge Questions

Charge to the Science Advisory Board

Science Advisory Board (SAB) Consultation on the Lead and Copper Rule Improvements (LCRI)

Regulatory Background

On January 15, 2021, the U.S. Environmental Protection Agency (EPA) promulgated Lead and Copper Rule Revisions (LCRR). The LCRR strengthened requirements and improved implementation of the existing Lead and Copper Rule (LCR) in several areas, including lead tap sampling; corrosion control treatment; lead service line replacement; public notification; and public education. The LCRR also included new requirements for community water systems to create lead service line (LSL) inventories and to offer testing for lead in the drinking water of schools and childcare facilities.

EPA conducted a review of the LCRR to identify further opportunities to improve public health protection of the rule and announced the results of the review on December 16, 2021. That notice also announced EPA's intention to promulgate Lead and Copper Rule Improvements (LCRI) regulation prior to October 16, 2024, noting there are significant opportunities to improve the rule to support the overarching goal of proactively removing lead service lines and more equitably protecting public health. The EPA is considering requirements that, along with other actions, would result in the replacement of all lead service lines as quickly as is feasible. The EPA is also considering opportunities to strengthen tap sampling requirements and explore options to reduce the complexity associated with the action level and trigger level, with a focus on reducing health risks in more communities.

Issue Background

The EPA is in the initial stages of conducting Environmental Justice (EJ) analysis to inform the development of the proposed LCRI. There are three key questions recommended in EPA's Technical Guidance for Assessing Environmental Justice in Regulatory Analysis (USEPA, 2016):

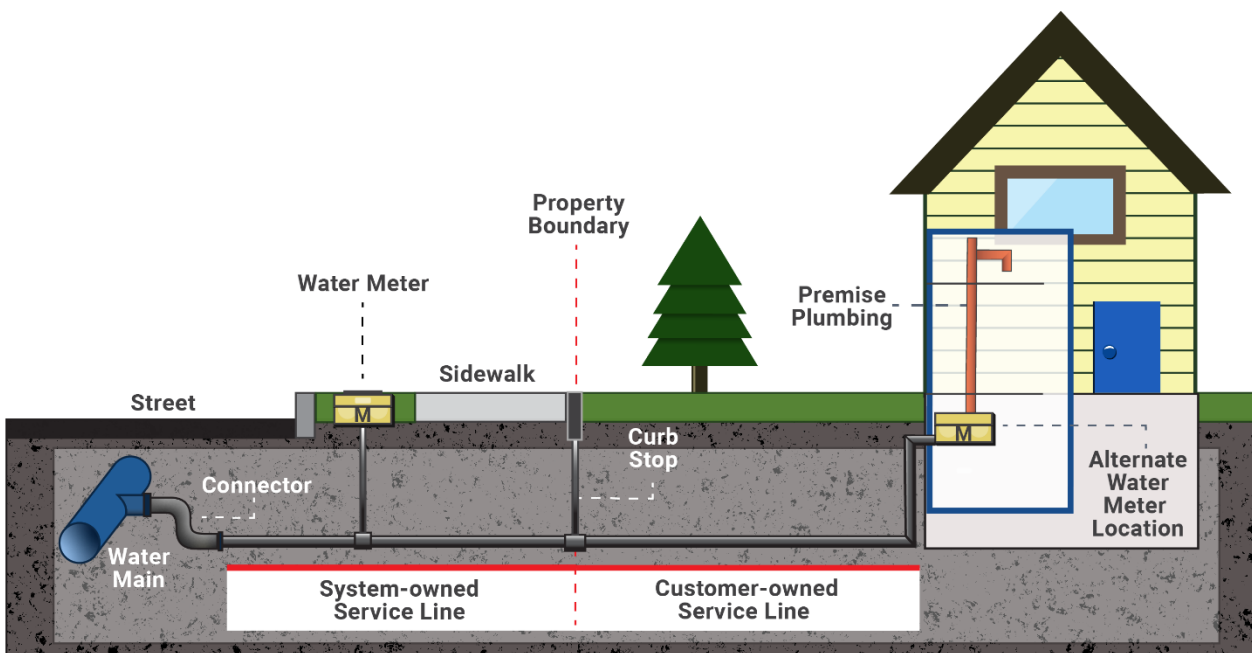
Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern in the baseline?

Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern for each regulatory option under consideration?

For each regulatory option under consideration, are potential EJ concerns created or mitigated compared to the baseline?

The key area of the rule EPA is evaluating for the LCRI EJ analyses focuses on the presence, prevalence, and replacement of lead service lines to advance the goal of prioritizing distributional impacts. Water service lines connect the service location to the water main. The 1986 Safe Drinking Water Act Amendments defined “lead-free” for pipes as being not more than 8% lead. Sites constructed prior to the lead ban could have lead service lines and EPA has estimated that there are between 6 to 10 million lead service lines remaining in the country. Ownership of the lead service line will vary from system to system. The diagram below is a fairly common division of ownership between the customer and water utility in which the system-owned portion of the service line is from the water main to the curb stop and the customer-owned portion is from the curb stop to the water meter. For some systems, the delineation may be different, (e.g., the ownership distinction is at the water meter or property line). In other instances, the water system may share ownership with customers, or the water system or customer may have sole ownership of the service line. Note that ownership of the property on which the service line is located does not always equate to ownership of the service line. Similarly, ownership of the service line does not necessarily equate to financial responsibility for the replacement. The determination of how a water system pays for lead service line replacement of the portion of the service line not owned by the water system is a matter of state or local law. Water systems are not required by EPA to bear the cost of replacement of the portion of the lead service line not owned by the system (40 CFR 141.84(d) and 141.84 (e)).

Example of Service Line Ownership Distinction between the Water System and Customer



In many water systems, the customer owns a portion or the entire service line that connects the water main to the residence. The cost of replacing the customer-portion of a lead service line (LSL) may leave the most vulnerable Americans disproportionately exposed to lead if they can't afford the expense of replacement.

The LCRR requires systems to create an inventory of LSLs, with a compliance deadline of October 16, 2024. LSL inventory data availability has improved as systems have been developing their inventories to comply with the LCRR requirement. For the LCRI, EPA identified several water systems willing to provide address-level LSL inventory data to facilitate environmental justice case study analysis within service areas.

EPA has developed three draft case studies of within-system LSL location patterns in relation to some of the environmental justice indicators summarized below. These case studies examine how the indicators characterize conditions within water systems with known LSL locations and areas without. EPA is asking for input on the methodologies for the initial three draft case studies so EPA can assure sound scientific data evaluation prior to conducting the EJ analysis. This examination will help EPA understand the available tools and indicators to support addressing the three key questions in EPA's Technical Guidance for Assessing Environmental Justice in Regulatory Analysis (as described above). SAB Input provided will inform EPA revisions to the initial three case studies as well as the development of additional case studies. EPA intends to use these case studies to support EPA's EJ analysis that will be considered in the development of the proposed LCRI.

EPA is aware of several environmental justice (EJ) tools that could be used to study the EJ impacts associated with the presence of LSLs in the EJ analysis for the LCRI. In the draft analyses EPA has incorporated EJScreen, Centers for Disease Control/Agency for Toxic Substances and Disease Registry's (CDC/ATSDR) Social Vulnerability Index, and the Area Deprivation Index. The EPA is aware of recent additional EJ tools that could be used to support analyses including CDC's Environmental Justice Index and the Council on Environmental Quality's Climate and Economic Justice Screening Tool. EPA has not yet applied these recent tools to the case study data on LSL locations. High level overviews of the tools are described below.

- EPA's [EJScreen](#) provides a nationally consistent dataset and approach for combining environmental and demographic indicators into EJ indexes and spatially analyzing them. The tool includes 7 demographic indicators (people of color, low-income, unemployment rate, linguistic isolation, less than high school education, under age 5, and over age 64) and 12 environmental indicators (particulate matter 2.5, ozone, diesel particulate matter, air toxics cancer risk, air toxics respiratory hazard index, traffic proximity and volume, lead paint, superfund proximity, risk management plan facility proximity, hazardous waste proximity, underground storage tanks and leaking underground storage tanks, and wastewater discharge). Data for all indicators are available at the level of Census block groups. EPA derives the demographic indicators from the U.S. Census Bureau's American Community Survey (ACS) 5-year data and the environmental exposure indicators from multiple data sources. To summarize how an environmental indicator and demographics come together in the same location, EJScreen uses an EJ Index. EJScreen also provides a demographic index based on the average of two demographic indicators: low-income and people of color.
- The CDC/ATSDR [Social Vulnerability Index](#) (CDC/ATSDR SVI) uses U.S. Census data to rank each census tract with respect to 15 social factors grouped under four themes: socioeconomic status (below poverty, unemployed, income, no high school diploma), household composition (aged 65 or older, aged 17 or younger, older than age 5 with a disability, single-parent households), race/ethnicity/language (minority, speak English "less than well"), and housing/transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters). ATSDR developed the SVI as a geospatial tool to help identify communities that would most likely need support before, during, and after a hazardous event.
- The [Area Deprivation Index \(ADI\)](#), originally developed by the Health Resources and Services Administration and updated by researchers at the University of Wisconsin, is a measure of socioeconomic disadvantage. The ADI includes 17 census variables related to education, occupation, income, and housing characteristics originally developed at the Census tract level but extended to the Census block group neighborhood level based on the Census and the ACS Five-Year Estimates.

- CDC's [Environmental Justice Index \(EJI\)](#) measures the cumulative impacts of environmental injustice on health for each census tract using data from the CDC, EPA, U.S. Census Bureau, and U.S. Mine Safety and Health Administration.
- The [Climate and Economic Justice Screening Tool \(CJEST\)](#) was developed for the [Justice40 Initiative](#) and provides socioeconomic, environmental, and climate information on disadvantaged communities that are marginalized, underserved, and overburdened by pollution.

Charge Questions

- ***Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:***
 - a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.
 - b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.

- ***Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:***

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

- ***Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:***

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Enclosure B

Individual Comments from Members of the EPA Science Advisory Board on Environmental Justice Analysis for EPA's Lead and Copper Rule Improvements

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Comments from Dr. Marjorie Aelion

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

I agree with the approach EPA has taken in the Draft Case Studies document to compare results in detail of different utilities and different tools. An additional assessment of the impact of implementing different actions based on results of different tools on certain communities (including young children, lowest economic status individuals) might be valuable. For example, there may be differences related to the impact on young children of results of the environmental justice analysis because of different definitions of the variable “Population of children and adolescents” used in EJSCREEN, SVI and ADI. Based on Exhibit 2. Comparison of Variables in EJSCREEN, SVI, and ADI, EJSCREEN uses “Under the age of 5”; SVI uses “17 or younger”; and ADI has no indicator for the variable “Population of children and adolescents.” It appears that EJSCREEN may be more protective of children’s health than SVI or ADI.

Which tools/indicators/metrics EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis may depend on specific characteristics of the populations. Each tool/metric/indicator provides different information, and based on that information may have limitations for certain communities. An analysis of the basic demographics of individuals in the community could assist with selecting the tool/indicators/metrics most relevant to those individuals so that the environmental justice assessment is most protective. For example, in the case of Pb exposure, the enhanced susceptibility of young children to Pb exposure should be considered in Lead and Copper Rule Improvements, and the tool that is most protective of young children could be used.

- b. **Given the identified tools and indices (i.e., EJSCREEN, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Although there are health risks to adults from lead and copper exposure, I think children of young age should be given greater focus as an index. Children’s blood lead levels (BLLs) have been shown to increase significantly from birth to age 18-24 months, which also corresponds with the time of a child’s greatest neurological development. The current tools could be refined to include a greater number of children’s age intervals, particularly from age 0-6 months; 6 months to 1 year; 1-2 years, 2-5 years, and 6-17 years. It is acknowledged that data may not be readily available at this level of refinement. The U.S. Census includes data on children under 5 years, and from 5 to 17 years for total population numbers in the U.S. The U.S. Census also

contains data on children 3 years and over enrolled in preschool. These children are presumably aged between 3 and 5 years, and it may be possible to extract information from this dataset to refine the age categories.

Also noted is that the child poverty rate (for people under age 18) is greater than that for elderly populations. Child poverty was 16.9% in 2021, 4.2 percentage points higher than the national rate, while poverty for those ages 65 and over was 10.3%, 2.5 percentage points lower than the national rate. As economic status can negatively impact health status, the combination of lower economic capacity and greater vulnerability to health impacts of Pb exposure suggests that children are more vulnerable to Pb exposure than elderly populations in this specific case.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

I feel that combinations of indicators/metrics may be more suitable for studying the environmental justice impacts associated with lead service lines and their replacement than a single indicator. Child age and economic status are important metrics in this specific case because of the health impacts to children from Pb exposure, in addition to other critical indicators. Depending on what rules are being examined, a combination of critical indicators/measures could be extracted on a case-by-case basis.

Two economic indicators used in EJSCREEN, SVI and ADI are “Low-income population” and “Unemployment or employment.” How each defines economic status will affect the results and therefore the environmental justice analysis and its impact on certain populations. For example, one difference between EJSCREEN, SVI and ADI is the definition of “Low-income population” as is noted in the Draft Case Studies, Exhibit 2. EJSCREEN uses “Income \leq 200% national poverty threshold”; SVI uses “Income per capita” and “Persons below poverty level”; SVI uses “Median family income,” “Income disparity,” “Families below poverty level,” and “Population below 150% poverty threshold.”

The U.S. Poverty Guidelines in 2022 were \$13,590, \$18,301, \$23,030 and \$27,750 for 1, 2, 3 and 4 persons in a family/household, respectively. These dollar values are insufficient to support an individual or a family/household. People making 200% of this guideline would have difficulty finding affordable housing and supporting a family/household. For this reason, I feel that SVI would disadvantage communities in which a large percentage of the population lies just over the poverty guideline as defined above, regardless of the fact that income per capita is also included in the SVI analysis. EJSCREEN uses a greater poverty threshold (\leq 200% national poverty threshold) which includes more individuals than the SVI definition, but has no other income indicator. ADI is more thorough in its economic assessment of communities, and lies between the two other tools in its use of 150% below poverty threshold as its definition of “Low-income population.”

In terms of the variable “Employment or unemployment” which is an indirect metric of economic status, EJSCREEN and SVI both use “Unemployment rate.” ADI has a more thorough definition using not only “Unemployment rate,” but also “White-collar employment.” This is important because employment at minimum wage will not indicate that an individual has sufficient funds to fully participate in society (think of cost of owning an iPhone which is now required for access to many services like ride shares, communication, etc.). But, as noted in the response to Charge Question 1, ADI does not include a metric for children in the category “Population of children and adolescents” so it may not be the best tool in this specific case.

Finally, I would suggest that any financial requirement for individuals to replace lines is fraught in systemic injustice. Even if the program offers subsidies and grants to individuals who have fewer financial resources, invariably there is frustrating and time-consuming paperwork that individuals must complete to receive the funds. This in itself is problematic.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

A great deal of literature indicates that increasing home age and road coverage are associated with greater metal concentrations in residential soils and house dust. An international house dust study found associations between house age and house dust Pb and As concentrations (Isley et al., *Env Sci Technol* 2022). In addition, in a U.S. study in an urban area, home age and road coverage were associated with higher children’s blood lead levels (Aelion and Davis, *Sci Tot Environ* 2019).

Based on the Draft Case Studies Exhibit 2, under the variable “Housing characteristics”, EJSCREEN uses “Pre-1960 housing units”; SVI uses “Multi-family units,” “Mobile home units,” and “Group quarters”; and ADI uses “Median home value,” “Median gross rent,” “Median monthly mortgage,” “Owner-occupied housing units,” and “Incomplete plumbing.” Only EJSCREEN has an indicator of home age in the variable “Housing characteristics.” EJSCREEN also includes information on traffic proximity, suggesting it may be more useful for identifying possible Pb exposure through soil and house dust than SVI or ADI.

Road coverage reflects legacy Pb contamination over large geographic areas due to the use of leaded gasoline and home age may reflect legacy use of lead paints. In addition, point-source Pb contamination from industrial emitters including Pb mines and smelters, may be of interest in specific case studies. Broken Hill, New South Wales, Australia is an excellent example of legacy and on-going Pb contamination from a silver-zinc-lead mine and its impact on children’s blood lead levels (Liu et al., *Env. Sci. Technol.* 2021).

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Comments from Dr. Florence Anoruo

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Comments:

The consideration of tools, indicators, and metrics related to Environmental Justice (EJ) by EPA in the development of the Lead and Copper Rule Improvements environmental analysis is a step in the right direction. However, more emphasis should be concentrated on the those that address the subset of the population that are most vulnerable and overburdened by persistent exposure to lead and other pollutants, by virtue of their environmental and demographic disposition.

To arrive at a just and equitable development of the Lead and Copper Rule Improvements environmental justice analysis, a combination of the following tools, indicators, and metrics should be employed - EPA EJScreen, CDC/ATSDR SVI (Social Vulnerability Index), Area Deprivation Index (ADI), CDC's Environmental Justice Index (EJI). EJI particularly measures cumulative impact of environmental justice to health and would be instrumental in prioritization of the most vulnerable demographic group for the Lead Service Lines and their replacements.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Comments:

A subset of populations that meet the environmental and demographic indicator criteria delineated in the EJScreen, especially children under age 5, elderly, and those that live near other polluting facilities should be given higher weights and priority, since they are the most vulnerable to lead poisoning and suffer serious long term health impacts.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Comments:

The Environmental Justice Index (EJI) which measures the cumulative impacts of environmental injustice on health for each census tract will be most useful/suitable for studying the environmental impacts associated with Lead Service Line and their Replacement. Some of the environmental and demographic indicators in the EJScreen would be equally suitable.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Comments:

The EPA's EJSCREEN, Climate and Economic Justice Screening Tool (CJEST), CDC/ATSDR SVI (Social Vulnerability Index), Area Deprivation Index (ADI), and CDC's Environmental Justice Index (EJI) would be appropriate for assessment of lead impacts from other co-located exposure pathways. The EPA's EJScreen would be most helpful in the assessment.

Comments from Dr. Barbara Beck

General comments:

This project represents an important and challenging effort as U.S. EPA incorporates environment justice (EJ) issues into its regulatory agenda. Given the extensive information on sources of exposure to lead and potential health risks, a more focused effort is warranted than may be feasible for some other contaminants. Much may be learned with respect to lead that could, conceptually, be applicable to other agents.

It would be helpful for the agency to provide some upfront discussion as to how they see the case studies being used to inform the Lead and Copper Rule Improvements (LCRI). For example, the information gleaned from the case studies might be used to prioritize lead service line removal (LSLR), improve the agency's benefits analysis, or identify research priorities. Some context here would be useful.

Also, further discussion and some preliminary conclusions regarding the case studies would be beneficial, especially as to interpreting the results and informing future directions. For example, it is of interest that case study 3 from Utility C appears to be qualitatively different from Utility A and B in showing little, if any, correlation of LSLs with pre-1960 Housing. I would be interested in seeing if EPA has any proposals as to why this may be.

Charge Questions

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CEJST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**
- b. Given the identified tools and indices (i.e., Screen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

With respect to tools related to vulnerability, the agency should consider focusing on indicators that best reflect risk factors associated with neurocognitive and neurobehavioral effects in young children. These factors include (but are not limited to) socioeconomic status (SES), maternal education, birth weight, and quality of the home environment (as reflected in the HOME score). Vulnerability indicators in the Lead and Copper Rule Improvements Case Studies that map best to the lead-relevant factors should be given greater weight in scoring. For example, with respect to the EJSCREEN indicators for vulnerability, greater weight should be giving to indicators more relevant to lead vulnerability such as population < 5 years, minority, and low income.

While other indicators such as unemployment may be relevant, I am unaware that unemployment has been directly associated as a risk factor for neurocognitive and neurobehavioral effects.

Similarly, for EJSCREEN environmental indicators, indicators such as pre-1960 housing (a surrogate for use of lead paint an exposure to interior leaded dust and exterior leaded soils) and traffic proximity (a surrogate for historical releases of lead particulates from combustion of lead gasoline and release of lead tire weights to residential soils)¹ are more directly associated with lead exposure. While some SAB members suggested proximity to mining sites, I would like to note that in general lead derived from mining operations because of its larger size and tendency to be dominated by less soluble forms of lead (e.g., lead sulfide) may present a lesser risk than lead from certain other sources. In particular, weight should be given to residential areas near sites where there have been historical release of lead to air, such as lead and other smelter sites and battery recycling.² Such releases have the potential to contaminate surface soils in residential neighborhoods well beyond the source area where they can constitute an exposure pathway for young children. Thus, I recommend that EPA consider incorporating an indicator for residential areas near historical sources of lead to air.

Similarly with respect to the SVI overall Index, the indicators related to socioeconomic status should be given greater weight than several of those related to housing type (other than older housing which is not even specifically noted in the housing indicators).

I appreciate that the literature is voluminous and information on some of the factors for indicator use is not readily available. However, the U.S. EPA 2013 “Integrated Science Assessment for Lead” represents a good synthesis of the literature and would be a good place to start to identify most appropriate indicators for both vulnerability and exposure. This document can serve as documentation of the importance of maternal education and socioeconomic status as a risk factor that would merit greater weight than the population over 64 years old.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure

¹ With respect to traffic as an indicator of lead exposure, I note that such releases do not travel very far from the curb into residential yards where soil exposure may occur. To the extent possible, I suggest that housing density also be added as an indicator. Houses or apartment buildings with small yards are likely to have a higher percentage of contaminated soil in yards either from past release of leaded gasoline, homes being closer to the road) or from flaking of exterior leaded paint which tends to concentrate within a foot or so of the house perimeter.

² I emphasize historical releases because many of these operations are highly regulated today.

pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

I note that some of my comments here overlap with my comments on charge question 1. I retain them for completeness.

Pre-1960 housing, one of the existing metrics, is an important one in terms of other exposure pathways because of its strong correlation with lead paint. Interior house dust may contain lead from chalking or flaking interior lead paint and soils adjacent to the house may contain lead paint from exterior paint. In addition, proximity to traffic may be associated with elevated soil lead from historical releases of leaded gasoline into adjacent yards, although the magnitude of this impact is often less than that of release from exterior leaded paint. It is possible that data on housing density could improve the use of this metric. I recommend that EPA consider refining the traffic density indicator to include information correlated with distance to pavement.

Some of the other environmental indicators, e.g. major direct discharge indicator (to streams) seems to have little relevance to exposure to lead. EPA needs to justify (or eliminate) the use of these other indicators that have limited relevance to lead exposure.

Comments from Dr. Roland Benke

Charge Question 1.

Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

The charge question seems narrowly focused. In the spirit of the consultation, comments in this response are provided with a slightly broadened context. The Environmental Justice (EJ) analysis relies heavily on statistics for lead pipe presence and prevalence in characteristic categories but could be significantly improved by direct alignment to overarching statutory responsibilities and motivation for reducing lead-in-drinking-water concentrations. Among other local differences, water chemistry influences lead leaching rates into water, which final rule revisions address by corrosion control treatments and water quality parameters. Identifying areas most impacted is also highlighted in the revisions. Because lead concentrations in drinking water and drinking water consumption rates are principal to human health risk, service line replacement and EPA actions over the next decade should be prioritized to minimize human health risk. In doing so, human health risk becomes central to the EJ analysis. This necessarily extends the current body of work from a retrospective analysis with infrastructure updates to one with prospective assessment of averted lead consumption. On the basis of human health risk, historically overburdened communities naturally receive a higher priority for planned actions that yield greater EJ benefits from the subsequent lead consumption averted. These EJ recommendations seem to complement the risk communication improvements and lead-in-drinking-water testing requirements in the final rule revisions promulgated on January 15, 2021.

Case studies would also embrace this alignment. Establishing an EJ score based on the tools/indicators/metrics and applying it to lead concentration reductions in drinking water is one possible enhancement. EJ scoring would be useful during implementation planning to prioritize communities disproportionately impacted by lead contamination. The reduction of lead in drinking water coupled with its EJ score should be primary metrics because they simultaneously communicate the extent to which EJ communities benefit from EPA and stakeholder accomplishments on reducing lead in drinking water. If possible, a two-stage approach for implementing the case studies is recommended.

- (1) In the first stage, more in-depth information is gathered about the community, site and drinking water conditions. Compare tools/indicators/metrics based on existing data to those generated from in-depth information from the first stage. This is vitally important because analysts will be in a position to conclude the degree to which existing data (*ex ante*) are adequate for the EJ assessment. Pay particular attention to situations for which tools/indicators/metrics based on existing data differ significantly from those based on

in-depth information (*ex post*). Document similarities and differences. Only those tools/indicators/metrics demonstrated to be reliable should be included in the EJ analysis.

- (2) By maximizing achievable positive impacts, down selections would be made for advancing case studies to the second stage. The second stage includes implementing improvements and achieving reductions in lead in drinking water. Multiple case studies at the second stage would be highly advantageous.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

EJ assessment reaches its full potential when integrated with reductions in human health risk. This necessarily requires information about current, expected reductions, and actual reductions of lead levels in drinking water. Weight indices by the number of people positively affected by the improvement and by the magnitude of lead reduction in drinking water. EJ scoring justifies additional weighting for overburdened communities.

Charge Question 2.

Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Protecting public health and the environment from significant risks is central to the mission of EPA. In final rule revisions and the associated federal action plan, EPA makes a commitment to act to reduce lead in drinking water. The vision for 100% removal of lead service lines, with a focus on prioritizing communities that are disproportionately impacted by lead contamination, can be improved. Actions implementing both low-cost (e.g., filtration) and high-cost (e.g., lead service line removal) improvements to the water infrastructure could be more effective at reducing lead in drinking water over both short and long time periods, compared to primary reliance on high-cost improvements alone. However, it is unclear if programs enacted by new regulatory requirements are afforded this flexibility. As described in the response to Charge Question 1, the lead reduction in drinking water coupled with its EJ score should be primary metrics. Weighting for the number of people positively affected by the improvement, magnitude of lead reduction in drinking water, and EJ scoring seems appropriate.

Charge Question 3.

Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental

justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

No comments are provided in response to this charge question.

Comments from Dr. Sylvie Brouder

Prefacing comment: In reflecting on the charge questions and the text provided by EPA in the Charge and Draft Case Studies Statement, I am uncertain if we have sufficient information to really address the three charge questions. The three scenarios differ in terms of performance of the various indicators/variables for predicting LSL vs Never LSL and, without only minimal metadata for the case studies, no explanations for any differences can be discerned. For example, the EJSCREEN's environmental factors analysis show that pre-1960's housing is a fairly strong indicator of risk for Utility B, a moderate indicator for Utility A, and an indicator of little use for Utility C – metadata that seems missing is some attribute of pre-1960s housing that differentiates between houses that have benefited from full service line replace programs (or similar) and those that have not. Furthermore, in most cases, the distributions of block groups (both state and national census data) for indices and/or variables within an index are wide and overlapping. For example, the ADI seems useful in segregating Never LSL and LSL for Utility B but much less so for Utility A or C. Likewise, Socioeconomic variables in the SVI appear to have some abilities to differentiate Never LSL from LSL for Utility A and B but to offer little insight into Utility C. In many cases, while medians may differ, it is also clear that most demographic variables do not clearly resolve and segregate Never LSL from LSL and it is unclear who might be most harmed by that lack of resolution (i.e. is it an EJ issue that requires attention under EPA's technical guidance of 2016).

Charge Question 1a:

The tools, indicators and metrics track the vulnerability of people and seem appropriate to the goals of achieving environmental justice. Applying them to data characterizing the prevalence of LSL seems to be confounding independent and dependent variables – ultimately I understand the dependent variable to be risk to vulnerable populations versus all populations from exposure to LSLs. The analysis presented may be an important part of a case study but it seems more is needed to complete an effective case study. Also not clear to me is how variables within an index are integrated (e.g. are percent differences in the dependent variable (+/- LSL) just toted up with or without weighting?).

Charge Question 1b:

If the goal is to predict LSL vs Never LSL (vs vulnerable populations with LSL) weighting appears useful to focus data collection on most relevant variables and/or data anticipated to be most reliably robust. Rather than hypothesizing which data are most important, this could be quantitatively evaluated via a variety of approaches including machine learning (e.g., artificial neural networks). While some dislike such “black box” approaches, candidate weights can be generated for further evaluation.

Charge Question 2:

Based on the case studies provided, I am not sure if there is a clear indicator or measure that seems clearly useful across all 3 case studies. However, as mentioned in my response to Question 1.a, data are not presented in a way such that vulnerable populations and their risks are the dependent variable in some strategy or under some policy for LSL mitigation.

Charge Question 3:

Based on the information provided, I am challenged to provide useful advice on this question. As a non-expert in lead contamination and public health concerns, I need more information on our understanding to date of drivers of co-location. For example, I can easily imagine that pre-1960s houses with LSL still in place may also have unmitigated lead paint in both interiors and exteriors. However, as a non-expert, I'm not sure I can even imagine all potential co-located sources of lead in the full array of living arrangements for the U.S. population. It would have been useful to me if the question were accompanied by a list of the co-located sources to be considered and some summary of current knowledge on association between these sources and LSL.

Comments from Dr. Jayajit Chakraborty

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

There are a few limitations with the environmental justice (EJ) screening tools/indicators used in these Draft Public Water System Case Studies that reduce their usefulness for conducting rigorous EJ analysis of lead service lines (LSLs) and their replacement. These are summarized below:

While the ADI and CJEST do not include race/ethnicity, a single variable is used to represent minority status in EJSCREEN, SVI, and EJI. Aggregating all individuals who do not identify as non-Hispanic White into a single homogenous category for EJ analysis is somewhat problematic and assumes the EJ impacts to be identical for all racial and ethnic minority subgroups. Recent EJ studies have also shown that using a single ‘people of color’ indicator throughout the country fails to represent the distinctive identities of Indigenous communities and the ambiguity of racial/ethnic categories in specific places (e.g., Puerto Rico). It is thus important for future analyses to include separate race- and ethnicity-specific indicators that are currently unavailable in the aforementioned EJ screening tools/indicators/metrics.

Socio-demographic indicators in EJSCREEN, SVI, ADI, CJEST and EJI are derived from the American Community Survey (ACS) 5-year estimates, but these screening tools do not acknowledge or address any data quality issues. The unreliability of the ACS 5-year average estimates are well-documented, especially for smaller geographic units such as census tracts and block groups. Data on income and poverty are often missing for tracts or block groups with low population counts, or are highly unreliable with large margins of error in less populated areas (e.g., suburban or rural locations). While several techniques have been suggested to mitigate such errors and/or exclude census units with inaccurate estimates (higher margins of error), these are yet to be incorporated in the EJ mapping/screening tools or social vulnerability indicators that rely on ACS data. This could lead to inaccurate and unreliable results for EJ impacts, especially at the block group level.

For analyzing the EJ impacts of LCRIs, the EPA should consider the use of relevant socio-demographic variables from the 2020 U.S. Census, in conjunction with ACS data on socioeconomic characteristics. This would address some of the data quality problems associated with the ACS 5-year estimates, and also allow a more detailed exploration of racial/ethnic disparities (see comments above).

The screening tools used in Draft Public Water System Case Studies do not include any indicators/metrics for evaluating water-related vulnerabilities or water infrastructure. It is important to incorporate measures that focus on local water availability and quality, such as community water system (CWS) data on drinking water violations and/or ACS data on lack of residential plumbing that have been used in published EJ studies on water access. Additionally, several environmental indicators that primarily affect rural areas, including concentrated animal feeding operations (CAFOs), groundwater quality, pesticide use, and water infrastructure are not currently available in these national-level datasets or screening tools.

Finally, there are a couple of other screening tools/indicators that could be useful for this type of EJ analysis. It would be useful to consider the CDC's Minority Health–Social Vulnerability Index (MH-SVI); and the University of South Carolina Hazards and Vulnerability Research Institute's Social Vulnerability Index (SoVI). These could be more appropriate than the ADI or SVI for analyzing the EJ impacts of LSLs and their replacement.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Given the focus on lead pollution and related exposures, socio-demographic variables or indices focusing on children (i.e., those aged less than 5 and/or less than 18 years) should be given higher priority. It will be useful to have a subset of indicators that are children-specific and comprise relevant subgroups of persons under 5 years and/or 18 years. Examples include children belonging to minority racial/ethnic categories, children who are foreign-born, children with disability, children below poverty, and housing units with children (both owner and renter occupied).

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

In the Draft Public Water System Case Studies, only descriptive statistical measures are used for the *Baseline EJ Analysis*. The bivariate comparison of census block groups in two mutually exclusive categories based on LSL presence/absence (Exhibit A-9 & B-9) and high/low LSL proportions (Exhibit C-8) should be supported by appropriate two-sample statistical tests that indicate whether any of the observed differences in median percentile values are significantly different from zero.

Bivariate comparisons for the *Baseline EJ Analysis* are based on median percentiles that are calculated using EJSREEN demographic and environmental indicators, ADI values, and four SOVI theme indices. While these comparisons based on graphs and tables represent a useful first step, median percentiles may not be most effective approach for determining if specific socio-demographic groups are overrepresented in block groups with LSLs (Utility A and B) or a high proportion of LSLs (Utility C). Given that statistical overrepresentation of specific disadvantaged categories in adversely impacted areas has been a key focus of distributive EJ research, a more appropriate approach would be to directly compare the proportions of each socially disadvantaged group (e.g., percent minority, percent below poverty, percent unemployed, etc.) in LSL-impacted block groups to those in non-LSL-impacted block groups, using variables from the latest Census or ACS. This could be complemented by a statistical test (e.g., two-sample Z-tests of proportions) to evaluate if any of the observed percentage differences are significantly different from zero and determine which specific groups are disproportionately impacted by LSLs and their replacement.

The classification of block groups into two binary or dichotomous categories based on LSL presence/absence (Utility A and B) and high/low LSL proportions (Utility C) is a good starting point for understanding EJ impacts. But future analyses should also explore the use of continuous measures (e.g., percent of housing units in the block group with LSLs; percent of block group area covered by LSL-connected land parcels) and their statistical associations with socio-demographic variables relevant to EJ.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

I do not have any specific comments for Charge Question 3 at this stage, although some of my previous suggestions for Charge Questions 1 and 2 are also applicable here. I would like to mention, however, that the tools and indicators used in these case studies focus exclusively on distributional EJ, or documenting disparities associated with the spatial distribution of the impacts at the census tract/block group levels. However, the EPA's definition of EJ also emphasizes 'meaningful involvement of all people' and 'equal access to the decision-making process.' Future assessments of drinking water impacts thus need to consider participatory and procedural EJ issues, in addition to distributional EJ.

Comments from Dr. Aimin Chen

Tools, Indicators, and Metrics to be Considered for Developing the Lead and Copper Rule Improvements Case Studies

Charge Question 1a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CEJST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.

Comment: The EJSCREEN tool has more indicators about potential lead exposure, particularly pre-1960 housing units, proximity to Superfund sites, Risk Management Plan facility, hazardous waste site, and wastewater discharge. The Social Vulnerability Index (SVI) does provide two indicators that may be related to EJ: civilians with disability, and single-parent households. The Area Deprivation Index (ADI) has an indicator of incomplete plumbing, which may provide some additional information. The EJI provides two indicators that may be helpful to strengthen the estimation of EJ: lead mines and Houses built pre-1980 (for interior leaded paint). The Health Vulnerability in the EJI and Health Burden in the CEJST may have use secondary to the environmental exposures, but not as primary exposure indicators.

Charge Question 1b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.

Comment: The sub-set of variables that can be considered for LCRI may include Minority, Low Income Population, Linguistic Isolation, Population under age 5, Pre-1960 housing, Traffic proximity, NPL proximity, RMP proximity, TSDF proximity, PM2.5 from EJSCREEN, Civilians with disability and Single-parent households from SVI, Incomplete plumbing from ADI, and Lead mines and Houses built Pre-1980 from EJI.

Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Removal

Charge Question 2. Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Comment: The most suitable EJ indicators may include Minority, Low Income Population, The population under age 5, Pre-1960 housing from EJSCREEN, Civilians with disability and Single-parent households from SVI, Incomplete plumbing from ADI, and Lead mines and House built Pre-1980 from EJI. If further refinement of the indicators is needed, Pre-1960 housing and

House built Pre-1980 are two indicators to focus on. Still, there could be a combination of factors that may be more related to the lead service line EJ compared to the EJI where weights were pre-assigned and not specific to lead exposure, and EPA may need to do additional modeling to figure out the combined factors using more case studies.

Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways

Charge Question 3. Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Comment: The co-located exposure indicators may include Minority, Pre-1960 housing, Traffic proximity, PM2.5, lead mines, and Houses Built Pre-1980.

Comments from Dr. Weihsueh Chiu

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Many of the existing tools utilize overlapping data sources (e.g., Census ACS, EPA TRI, etc.). None of the aggregated indexes are directly applicable for LCRI, so none of them should be used “as is.” Instead, individual relevant indicators should be extracted for use in the EJ analyses.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

A subset of variables/indicators should be selected specifically for the issues relevant to the LCRI. See the answer to Charge Question 2.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

The case studies seem to be very narrowly focused descriptive/observational statistics on disparities in presence/absence of LSLs and in LSLR implementation. This is overly narrow focus, and there is a need for a systematic approach to addressing EJ in the LCRI. To that end, a conceptual framework would be useful for selection and weighting of indicators, and how they would inform the rulemaking. An example framework based on the source-to-outcome continuum is shown in Figure 1 below. It also includes specific mitigating interventions relevant to LCRI and where they fit along the source-to-outcome continuum.

EJ factors can be broadly categorized in two groups:

- Disparities in implementing mitigating interventions, including
 - Barriers to implementation
 - Secondary effects of implementation
- Disparities in baseline cumulative burdens

Within each group, factors can be identified that can cause/exacerbate these disparities, and then indicators/data/metrics for each of those factors can be identified to create a customized EJ index specific for this regulatory context.

Within such a framework, a factor or indicator might have greater weight if it affects more than one point along the source-to-outcome continuum, so that its impact is magnified, or if there is stronger evidence/greater potency of the impact of that factor or indicator. These are evidence-based judgment calls that require transparency in their justification.

Ultimately, these factors should inform the design of the regulation and how it is operationalized so as to maximize both impact and equity in light of the challenges posed by these EJ factors.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

This is a specific issue that falls under the category of “factors related to disparities in baseline cumulative burdens” under the factor “other sources of lead exposure” in Figure 1 below. Other SAB members have commented on specific indicators and their utility of characterizing co-exposure to lead.

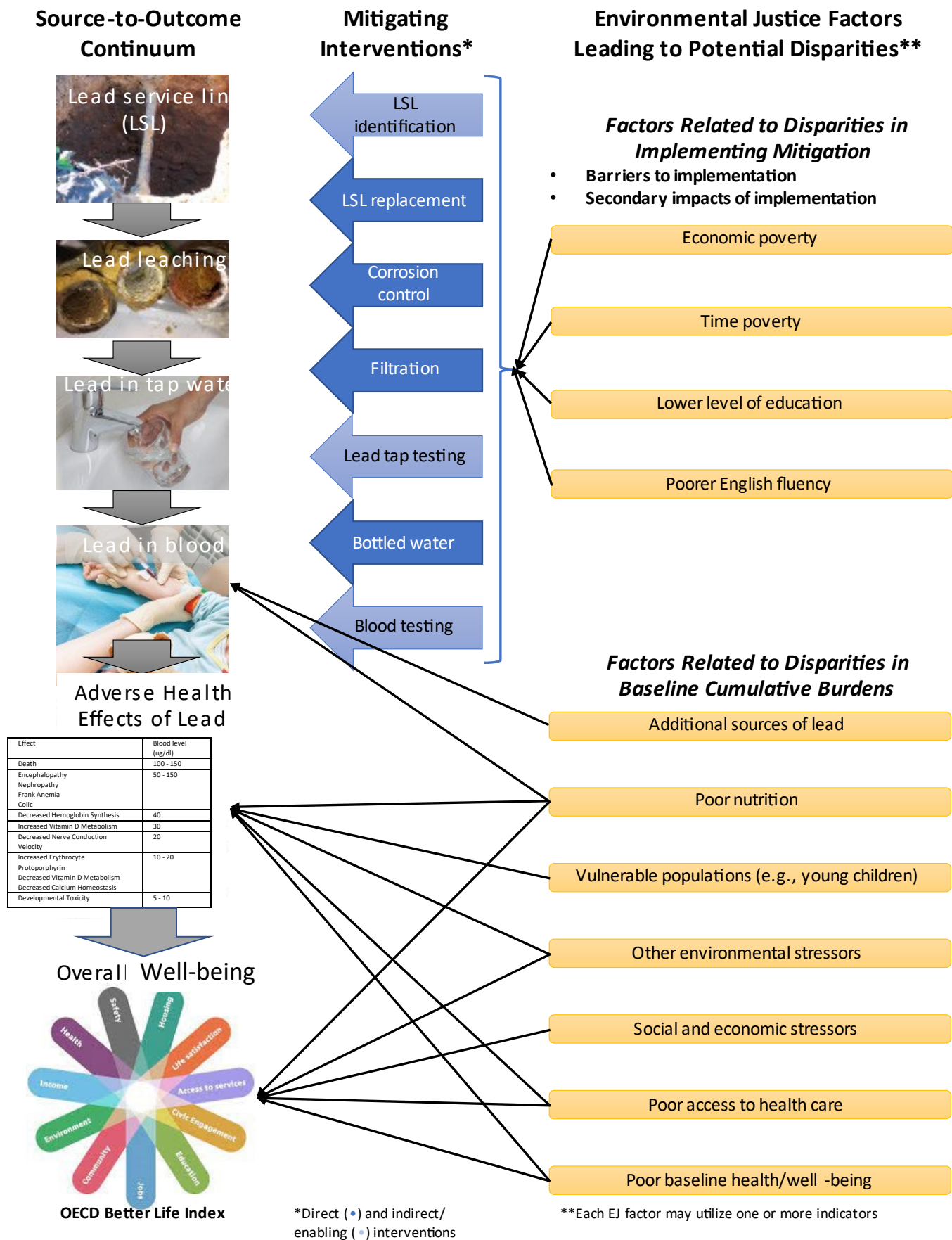


Figure 1. Conceptual framework for selection and weighting of indicators.
Sources of information in Figure 1:

Lead service line photo CC BY 2.0

(https://en.wikipedia.org/wiki/Lead_service_line#/media/File:DC_WASA_lead_water_main_-_cropped.jpg)

Lead leaching photo from <http://flintwaterstudy.org/2015/08/the-unintended-consequences-of-migrating-to-flint-river-water/>

Lead in tap water photo from CDC <https://www.cdc.gov/nceh/lead/prevention/sources/water.htm>

Blood lead testing photo from CDC <https://www.cdc.gov/nceh/lead/news/blood-lead-safety-alert.htm>

Overall well-being from OECD document

<https://www.oecdregionalwellbeing.org/assets/downloads/Regional-Well-Being-User-Guide.pdf>

Comments from Dr. John Guckenheimer

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

I have no professional expertise relevant to these questions. It is apparent that there is a large overlap in the tools/indicators/metrics used to develop EJI and CJEST, so I expect that they will produce similar results. My presumption is that it is almost inevitable that there will be legal challenges to any environmental justice analysis produced by EPA. A joint analysis with other governmental agencies that solicits public input and seeks to merge existing tools/indicators/metrics into a single comprehensive and definitive source of information about past and current environmental issues in communities across the country would be very useful. An analogy can be made with the Census Bureau and the National Center for Health Statistics whose missions are to collect and curate data within the domains in which each has primary responsibility. With regard to environmental justice, a single agency should be given responsibility for collecting and curating relevant data that is not the responsibility of other agencies, and there should be an agency charged with determining which communities have suffered environmental justice harms. EPA would be a logical choice to be the designated agency.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

To the extent that environmental justice assessment will be used to prioritize replacement of lead pipes, the variables that should be given higher weight are ones that reflect housing and population characteristics. Public comments suggest a consensus that the population of young children should be given high weight because they suffer from disproportional adverse effects from lead compared to older individuals. Even today, news reports describe discrimination in real estate property valuations based on race that affect the ability of impacted communities with a large proportion of low income residents and people of color to obtain financing for improvements. These factors should be quantified and given substantial weight in the environmental justice assessments.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Adverse health effects of lead exposure are associated with lead service lines. Their environmental justice impacts might be inferred from correlation of the health effects caused by lead exposure with environmental justice indices. Modern tools from machine learning and artificial intelligence can be used in investigating these correlations.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

Previous SAB consideration of limits to lead concentration in drinking water examined modeling and analysis of lead levels in different organs of the body. In contrast to the thousands of studies of correlations between health disorders and lead concentrations in blood, there is much less data on the transport of lead within the body. The LCRI assessment may be a good opportunity to initiate new experimental studies that would improve our understanding of the impacts of lead from all exposure pathways. I again remark that the EPA has been slow to adopt advances in data science that have the potential to improve our understanding of the health effects of lead exposure from all sources.

Comments from Dr. Selene Hernandez-Ruiz

I commend the U.S. Government and the EPA for recognizing and acting on environmental stressors affecting disadvantaged communities.

I find the Draft Public Water Case Study Analyses to be a sound start to assess the location patterns in relation to environmental justice indicators. It is recognized that the lead sampling protocol issued for the LCR of 1991 has limitations, for instance multifamily units (Tier 2) in which a significant portion of disadvantaged communities live are not usually tested and even when sampling is accomplished the results can be confounded by the distance water travels to each unit as well as the coordination of the stagnation period. Nonetheless, one of the indicators used in this draft is “Pre-1960 housing” and although LSL were officially phased out, lead soldering continued for years after this period. My recommendation is to evaluate the scientific literature of lead concentrations in facilities built after the 1960s.

In terms of the comparison variables presented, “school education” was used for the EJSSCREEN and SVI and ADI block groups. However, data for lead concentrations from schools are missing as a criterion for this analysis. Since children are a vulnerable population and spend a significant portion of their day at school and often participate in after school programs on site, I would recommend these data be gathered as part of the evaluation process.

Many thanks your consideration.

Comments from Dr. David Keiser

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

The tools and indicators discussed by EPA seem appropriate for use in the environmental justice analysis. I am not familiar enough with each individual tool to have a strong impression of which tool would be best to use. However, some tools have some disadvantages and advantages that should be considered. For example, according to Exhibit 2, ADI does not have information on Minority Status, which would be important to consider. SVI is at the larger census tract, rather than the census block. The more granular level would seem to be better. EJ Screen has information on young children, whereas the other tools do not (per Exhibit 2).

My initial impression is that the analysis using these tools could be improved. It is unclear why EPA highlights indicator variables when median values for Lead Service Lines are 10 and 20 percentile points higher than Non Lead Service Lines. It seems that it would be more standard to compare whether the mean values are statistically different from each other.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

I would encourage EPA to discuss internally whether there are advantages of using weights tailored to the Lead and Copper Rule versus other rules. I think this fits more broadly into a suggestion for EPA to consider whether it might be appropriate to reassess current guidelines for EJ analyses to see if there are some consistent practices that can be applied across analyses of major rules. My initial impression is that there could be a strong argument for not weighting variables differently for different analyses, because it could give rise to different answers related to environmental justice depending on which weights someone chooses. This opens the door to a slippery slope where an analyst could get the result that they are expecting by changing the weights. At the same time, there could be an argument for weighting variables that reflect the most sensitive populations to lead (particularly infants and young children) and individuals least likely to have the means or ability to replace lead lines (i.e., low income population, renters).

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

I don't have a strong opinion on which indicator is best. However, given the sensitivity of infants and young children to lead exposure, EJ Screen has an advantage over the other indicators in that it captures information on this demographic, while the others don't. My suggestion would be to use multiple indicators as a way to gauge the sensitivity of the results.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

No comments.

Comments from Dr. Mark LeChevallier

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

It is surprising that data on children's blood lead levels is not included in any of the tools – especially if they are going to be used to evaluate lead service line replacement and exposure scenarios. Blood lead levels would be the most direct indicator of the impacts of the rule and its environmental justice analysis. Other variables already included in the indices are lead paint and proximity to highways – as these are known indicators for lead exposure and would be important co-variables in evaluating the impact of lead service line replacements. Housing stock – particularly prior to 1950 for most areas of the country, but prior to 1980 for some select areas (like Chicago) are also known important predictors of the presence of lead service lines.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

As outlined above, blood lead levels, lead paint, proximity to highways, and housing stock age are key variables defining exposure. Income, race and education can be linked to the quality of the housing stock. There is a concern that the use of the large number of variables in the EJI can create the likelihood of confounding co-variables that are unrelated to lead service line replacement but are co-correlated to other variables. Therefore, attention to variables that can be linked to causality for lead service line exposure is an important concern when a large number of variables are "thrown against the wall to see what sticks!"

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

- a. Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.**

With the caveat outlined above, the EPA EJScreen and the CDC Environmental Justice Index appear to contain variables most likely to be related to lead service lines.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

- a. Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources**

Children's blood lead level data should also be included. Industrial pollution and mining are other routes of exposure that are included in some of the EJL.

Comments from Dr. Angela Leung

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

This topic is not my trained area of expertise, but I have reviewed the five proposed tools/indicators/metrics (EJScreen, CDC/ATSDR SVI, ADI, CDC's EJI, and CJEST) in detail toward consideration of the EPA's development of lead service line replacement case studies. Both the EJScreen and the CDC's EJI appear to be most relevant to this charge question, as they are the two that combine environmental and demographic data, while the CDC/ATSDR SVI and the ADI primarily focus on socioeconomic and demographic indicators. Note that the CDC's EJI Explorer was offline, and the "view the resource" page link of the CJEST was unavailable, on 10/27/22 and thus these could not be evaluated.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

All of the socioeconomic and demographic variables in the CDC/ATSDR SVI and the ADI would be relevant toward the Lead and Copper Rule Improvements environmental justice assessment. Additionally, in the EJScreen, the most relevant variables appear to be all seven demographic indicators (people of color, low income, unemployment rate, limited English speaking, less than high school education, under age 5, over age 64) and the following environmental indicators: lead paint exposure, Superfund proximity, risk management plan facility proximity, hazardous waste proximity, underground storage tanks (UST) and leaking USTs, and wastewater discharge. All of the Environmental Burden Modules in the CDC's EJI may be helpful, particularly all four air pollution indicators; the toxic release inventory sites; treatment, storage, disposal facilities; risk management plan sites; lead mines; and housing built pre-1980 indicators.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

For the reasons delineated in Charge Question 1 above, I believe the EPA's EJScreen would be most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

The EJScreen tool also captures lead paint exposure, which may be a useful indicator to complement drinking water as a source. As lead may also be emitted into the air, the six variables in EJScreen related to air (particulate matter 2.5, ozone, diesel particulate matter, air toxics cancer risk, air toxics respiratory hazard index, and traffic proximity and volume) can also be investigated. All of the demographic variables in EJScreen would continue to be relevant for this Charge Question as well.

Comments from Dr. Lala Ma

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

The tools do not break down people of color (e.g., Non-Hispanic Black, Non-Hispanic Asian, and Hispanic). While the breakdown may not be directly available from the tools, they are available from Census data. Further racial/ethnic group breakdowns may impart additional insight on the EJ impacts of the rule.

This comment is about the comparison used in the EJ analysis rather than the tool or indicator used. Service lines with “Unknown materials” are grouped with non-LSL block groups. The draft case studies state that it does not affect the value for LSL block groups. However, this does affect the comparison between LSL and non-LSL groups, and the case study makes that comparison in addition to comparisons with state and national percentile distributions. While the number with unknown materials may account for a small share in the case studies (the largest share is in Case C, which represents about 3%), this may not extend to other areas. Of particular concern is if whether the material is unknown is correlated with the socioeconomic status of an area.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

It is unclear to me how one would choose the weights if the EPA were to assign different weights to certain variables.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

For Exhibit A-4 (and the corresponding figures in the other case studies), people of color (POC) and low income are grouped together. I suggest breaking this apart.

In addition to the measures already used, voter participation may be a useful measure to explain why certain census blocks see more replacement.

Replacement of lead service lines may increase housing or rental prices and have a welfare impact. This is a benefit for homeowners but a cost for renters (who are also more likely to be of low socioeconomic status). The current indices used are cross-sectional, but price measures over time may be useful to understand some of these indirect EJ impacts.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Many of the environmental indicators in EJSCREEN are likely to be sources of non-drinking water lead exposure. Age of the housing stock from Census data could indicate chance of exposure through lead paint.

Comments from Dr. John Morris

Question 1- Comments on tools/indicators/metrics

The EPA is to be commended for initiating the task of implementing scientifically sound approaches to evaluate environmental justice relative to environmental health issues. This is no easy task. Potential evaluation techniques for environmental justice issues related to lead pipes are presented to the SAB for comment. Providing input relative to which tools/indicators/metrics such as the EJSCREEN, SVI or ADI is quite difficult because it isn't clear to me precisely how the case studies would be used to guide the LCRI rule development or implementation. More importantly, it is difficult for me to provide specific recommendations without knowledge of how the derived data are to be analyzed and interpreted. The analysis/evaluation that is presented in the case studies document, in my view, is better characterized as a subjective description of the results rather than a scientifically rigorous analysis and interpretation. This makes it difficult to evaluate if the described EJ process will assure sound science-based decision making.

With respect to relying on pre-existing screens (EJSCREEN, ADI, SVI), a concern of mine deals with multiple measures within a screen that overlap and undoubtedly are correlated and co-vary with each other. I provide the following two examples. The EJSCREEN includes diesel PM, PM_{2.5} and proximity to traffic. Are all three needed, and given the strong interrelationships among these measures, how precisely will such data be rigorously evaluated? Moreover, are these parameters directly related to lead vulnerability? The EJSCREEN includes many social determinants of health (low income, low education, unemployment, etc.) as well as race/ethnicity. If one views race/ethnicity-based health disparities as reflective of the concomitant social determinants of health, then this could be considered to be redundant. Again, left undescribed is how closely interrelated, correlated, and co-varying data will be rigorously analyzed.

In making a recommendation relative to metrics, I would suggest applying Occam's razor, picking a few indices that are critical for this issue of concern (lead exposure/effects). Such indicators should be directly (rather than peripherally) related to concerns about lead-induced health effects. So doing would facilitate a rigorous scientifically-based analysis. Importantly, the analytical approaches to be used should be outlined *a priori* to maximize the science-based value of any decision making based on the EJ analysis.

I also provide a few technical comments relative to the specific metrics in the EJSCREEN. I recognize that the EJSCREEN is an EPA tool available on the web, but I am not aware of documentation of its scientific validation of its metrics or of data interpretation methodologies (nor did I have time to search for such documentation). Perhaps there exists documentation of which I am unaware that focusses on these issues in which case these concerns are moot. These concerns are as follows. Is the "Respiratory hazard" based simply on the airborne lead concentration relative to the RfC, if so, it could be indicated. If it reflects all airborne hazards in general, then I don't see how it could be calculated. Many of the proximity measures are

calculated by dividing the specific metric by distance away. This implies that there is a linear relationship between distance and risk, particularly with respect to lead in soil. Is this valid? At first glance one might suspect a distance-squared or -cubed relationship. With respect to PM2.5, the metric is annual average rather than days above the short-term limit. What is the basis for this decision? Finally, it is curious that the screen does not incorporate some measure of pre-existing disease. Perhaps such data aren't available.

If weighting of variables is to be done I would recommend that greater weight be given to factor(s) that are directly related to the potential for that variable to result in increased blood lead levels or are directly related to toxicological sensitivity (e.g., age).

Question 2 – Most suitable measure

If forced to select a single metric I would recommend pre-1960 housing as the most suitable measure. If allowed to pick one more metric I would recommend children under 5 years of age.

Question 3- Colocalized exposure

The existence of lead contaminated dust derived from lead paint in older homes immediately comes to mind relative to other potential exposures. Proximity to historic or ongoing mining/smelting operations or smelters is another potential source. If lead remains in soil for long periods of time then historic rather than current data on mining/smelting is needed. Is there sufficient lead in cigarette smoke to predict that parental smoking rates might be a vulnerability factor? Does lead remain in the soil for decades? If so, then historic data on traffic density (e.g., when leaded gasoline was still in use) might be a predictor of lead levels in soil, particularly within high density urban areas.

Comments from Dr. Sheila Olmstead

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Response: Given my expertise, I have no comments on the specific EJ tools/indicators/metrics used by the EPA for this purpose. However, I suggest that when indicators' median values are compared between the lead service line (LSL) and never-LSL groups in the case study document, the results of tests for statistical significance of any differences should be reported. The summary tables (Exhibits A-9, B-9, and C-8) would be a useful place to present that information in a compact way. Significant differences using both the national and the state data could be marked for each indicator with an asterisk to the right of the "LSL" or "High LSL" value in each cell.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Response: I have two suggestions here. First, given the large literature on the impacts of early-childhood exposure to lead, the Agency should consider giving high weight to "% under age 5." Second, because avoidance behaviors (e.g., purchase of water filters) and mitigating behaviors (e.g., provision of a nutritious diet) may be less likely to occur in lower-income settings, given their expense, EPA could consider giving greater weight to "% low income."

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Response: I do not have any comments related to this charge question.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

Response: “Pre-1960 housing” could be a useful indicator for the presence of lead paint. “Traffic proximity” could be a useful indicator for the presence of lead in soil, particularly in areas near roadways that pre-date the phaseout of lead in gasoline. That said, it would seem preferable to obtain more direct data on lead exposure via these alternative pathways if they are available, given that the EJ screening tools were not designed for this specific purpose.

Comments from Dr. Gloria Post

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Both of the tools mentioned above are intended to identify disadvantaged/overburdened communities. Specific indicators included in these tool that are related to lead exposure from non-water sources are older (pre-1980 or pre-1960) housing as an indicator for lead paint and proximity and volume of traffic nearby, which is related to lead in soil.

The developing fetus, infants, and young children are the most sensitive subpopulations for the adverse neurodevelopmental effects of lead, and infants and young children also drink more water on a body weight basis than older individuals. For these reasons, replacement of lead service lines could be prioritized in residential areas with a higher percentage of pregnant women and young children and areas where facilities for infants and young children (e.g., preschools, elementary schools, childcare facilities, camps) are located.

- b. **Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Important variables related to consider for addressing lead in drinking water in the EJScreen include:

- Population under age 5, since infants and young children are a vulnerable population for the adverse effects of lead and also drink more water on a body weight basis than older individuals. In general, areas with a large number of pregnant women, infants and/or young children could be prioritized for lead service line replacement.

In case studies A and C, the indicator for children under age 5 was much higher in areas with lead service lines, but this was not true for case study B.

- Pre-1960 housing. The EJScreen indicator pre-1960 housing is an indicator for exposure to lead paint. When lead paint is present, there is a potential for higher exposure to lead from this non-drinking water source, and it would be prudent to prioritize prevention of additional exposure to lead from drinking water.

In case studies A and B, but not case study C, pre-1960 housing appeared to be highly associated with lead service lines.

- **Traffic proximity.** This EJScreen indicator is relevant to lead exposure from soil. The level of lead in soil is related to the volume and proximity of traffic nearby because lead-contaminated soil can result from the release of lead into the air from automobiles that use leaded gasoline. When lead paint is present, there is a potential for higher exposure to lead from this non-drinking water source, and it would be prudent to prioritize prevention of additional exposure to lead from drinking water.

In case studies A and B, but not case study C, higher traffic proximity appears to be associated with the presence of lead service lines.

If tools other than EJScreen are used, variables related to exposure to children should be considered, such as population age 17 or younger from the SVI (although younger age groups, such as less than age 5 are most relevant). If housing characteristics indicators included in the SVI or ADI such as multifamily housing are known to be associated with lead paint, these indicators should also be considered.

Additionally, although not included in the environmental justice tools or discussed in the EPA documents that the SAB was asked to review, lead service lines that provide drinking water to facilities for infants or young children such as preschools, elementary schools, camps, and childcare facilities could be prioritized for replacement.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

As stated in my response to Charge Question 1, part b. above, the indicators included in the environmental justice tools mentioned in the charge questions that appear to be most relevant to lead in drinking water are number of young children, pre-1960 housing which is an indicator for lead paint, and traffic proximity which is a source of lead in soil. As stated above, lead service lines that serve facilities for infants or young children (preschools, elementary schools, camps, childcare facilities) could be prioritized for replacement.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

As mentioned above, pre-1960 housing is intended as indicator of lead paint, and higher traffic proximity is associated with higher levels of lead in soil. These two indicators are therefore relevant to non-drinking water sources of lead exposure.

Comments from Dr. Kristi Pullen-Fedinick

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CEJST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**
- General comments:
 - i. No matter the tools the Agency uses, either individually or in combination, the goal of the analysis should be to capture as much of the population that is disproportionately burdened as possible. The agency should not limit itself to using the tools individually, e.g., EJ Screen alone, but should consider utilizing indicators from multiple tools in combination in order to more effectively identify communities that are disproportionately burdened by lead exposures.
 - ii. If/When using race as a variable, it was unclear to me that the relatively coarse race indicators in EJScreen and the SVI (i.e., people of color) is fine enough to determine within group variability within this indicator. The agency should look to the published literature about ways to take a finer approach to using race variables.
 - iii. No tool should be used discount or discredit communities that are impacted by lead service lines.
- CEJST - earlier this year, CEQ requested comments/information from the public about the CEJST tool (CEQ-2022-0002). If the Agency has not done so already, it should review the submitted comments. Many commenters discuss the lack of inclusion of race as an indicator, and the scientific and technical limitations of the tool due to the lack of inclusion of this variable. Other comments highlight the limitations of the threshold mechanisms for triggering classification as a “disadvantaged community,” the lack of nuance in the lead paint indicator (i.e., pre versus post 1960), and the implications of using a standard income threshold that do not take local cost of living indicators into account. While the CEJST tool does provide useful information, if utilized by the Agency in their LCRR EJ assessment, developing alternative methods of utilizing the information - akin to the EPA EJScreen - would be advised.
- EJI - this tool seems to be somewhat limited by a lack of community driven purpose. It is unclear what the goals are of the tool and how it should be applied. The use of a national percentile ranking may not be particularly useful for the local implementation of the LCRR. That said, there are indices within the EJI that could be useful to the identification

of Census blocks that are more vulnerable to the impacts of lead service line replacements, including - pre1980 housing and the pre-existing chronic disease information. The agency should open its aperture in thinking about the types of disease indicators that are critical to look at in addition to neurodevelopment - e.g., immune system impacts, including asthma outcomes - that can also be impacted by exposure to lead. While I appreciate the inclusion of lead and copper mines in this tool, it would be helpful to include historic and present mines within this variable, if possible.

- **Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**
 - In reviewing the case study information, it was difficult to determine if there were specific factors that should be weighted, given the heterogeneity of the case study locations. It was also difficult to calibrate the results of the analysis without more details about the cities in question. For example, demographic information about the cities themselves.
 - While the agency didn't find race/language to be as strong an indicator for lead service lines in their case studies, a 2019 report by NRDC ([Watered Down Justice](#)), found that for all violations to the SDWA, the minority status and language indicators had the strongest association with both violations and enforcement. Socioeconomic status and living conditions also had significant associations. It was useful in that analysis to look at both the themes variables and the subvariables making up the theme.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

- Bringing in additional information to look at lead exposures - e.g., blood lead levels, proximity to roadways, data on NPL or other sites with lead measurements could be helpful.
- Looking at indicators that allow for more nuanced assessments of age of property could also be helpful - for example, homes built before or after 1980.
- The Agency should also look at lead levels in drinking water samples that fall below 15 ppb within the SDWIS. 90th percentile samples that are exceed action levels set by sister agencies (e.g., 5 ppb lead for bottled water - FDA) and other organizations (e.g., 1 ppb - American Academy of Pediatrics) could also be useful information to explore. You can find an example of this type of analysis at [Millions Served by Water Systems Detecting Lead | NRDC](#)

- Renter information will also be an important indicator - renters are less likely to have the power to change service line materials.
- Looking at within city variation would also be helpful to look at from a demographic perspective - e.g., identifying areas that have experience historic redlining, lack of economic investment, etc. could help to identify areas within a city that might be more likely to experience deteriorating and/or older infrastructure.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

- Though there are other indicators that could be used to help with this effort, the Agency should not get too bogged down in creating the perfect indicator. The Agency should make sure that it is designing a tool that fits the purpose of identifying communities that should be prioritized for lead service line removal. This is not an academic exercise that is focused on absolute precision, but one that is meant to quickly and efficiently serve the public.
- In developing a tool, particularly one that does not rely on highly detailed information, it will be critical for the Agency to assess which populations are missed by the tool and why they are missed. Sensitivity analysis to determine the best fit between different analytical options will also be critical.
- Finally, the Agency should not limit itself to using either one tool, e.g., EJ Screen, versus another, e.g., SVI. The agency should avail itself to using the most appropriate indicators from all available tools to most rapidly and effectively identify communities most vulnerable to the impacts of lead service lines.
- The Agency should also look at a report from the Pew Charitable Trust report to identify the cross-pollination that happens within cities. This could help to refine the ways that different exposures to lead happen in populations - [10 Policies to Prevent and Respond to Childhood Lead Exposure | The Pew Charitable Trusts \(pewtrusts.org\)](https://www.pewtrusts.org/en/research-and-analysis/issue-brief/2019/10/policies-to-prevent-and-respond-to-childhood-lead-exposure)

Comments from Dr. Amanda Rodewald

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

While each tool contains useful and relevant information, it seems preferable to rely most heavily upon tools that have finer resolution and use geographic units at levels of census block groups (EJScreen & Area Deprivation Index (ADI)) as they would presumably improve the precision of prioritizations.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

The following demographic factors are especially important based on our understanding of the health effects of lead, known differences between high & low LSL blocks (based on case studies), and important indicators of vulnerable communities:

- Under Age 5
- Low income
- People of Color
- Non-vacant Housing Units Occupied by Renters OR Total Occupied Units within vulnerable communities

The case studies also indicated that census block groups with high proportions of low income and POC residents had lower proportions of LSL's replaced.

Although not included within any of the tools, is it possible to identify schools (if not already prioritized as part of the Infrastructure Bill), public libraries or other community buildings, and park/athletic facilities that provide drinking water within vulnerable communities?

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

The best indicator of the high risk of adverse health impacts would seem to be census block groups within vulnerable communities (as identified by the EJScreen tool) that also have relatively greater populations of children under age 5.

In addition, the following variables are suitable indicators of risk: Low income, People of Color, and Non-vacant Housing Units Occupied by Renters (or Total Occupied Units (nonvacant) within vulnerable communities that was used to supplement the EJScreen.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA’s understanding of lead exposures from non-drinking water sources.

The case studies showed that high LSL blocks were closer to facilities with Risk Management Plans (RMP), Hazardous waste treatment, storage, and disposal facilities (TSDF). Major direct discharger, and areas high traffic volume; had more Underground Storage Tanks; and higher levels of Diesel Particulate Matter. As such, they may be important co-located exposure pathways of lead.

Comments from Dr. Emma Rosi

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Response: I was not familiar with these tools prior to reading this document as it is out of my area of expertise. That said, I defer to other experts on how effective these indices are and whether the data collected that go into these indices are sufficient to adequately address EJ concerns. Based on the fruitful discussions at the SAB Meeting on Nov 3, there is reason to consider using a subset of variables that are related to risk associated with lead exposure. I concur with these recommendations by other members of the EPA SAB and the suggestions of paring down the EJ screening tools to the most appropriate variables makes a great deal of sense.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Response: This is out of my area of expertise, but it seems like variables that address the most vulnerable populations to lead exposure could be given higher weights, e.g., young children, who are especially vulnerable to lead exposure during childhood development. Again, see comment above about the suggestions by a number of experts in EJ and lead exposure on the SAB who recommended considering variables such as blood lead levels among others to narrow down the set of variables to consider in these analyses.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Response: I do not have a good answer to this question, as I was a bit unclear what is being asked. I defer to other experts in this area on the EPA SAB that provided useful suggestions at the EPA SAB meeting on Nov 3.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental

justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Response: Again, this is out of my area of expertise and I am not aware of other tools or indicators that can be used for non-drinking water exposure. However, I believe a great deal of research investigates the risks to young children based on housing stock age (a proxy for lead in homes) and location of roadways where lead deposition from leaded gasoline vehicles may present risks to exposure. As was raised at the EPA SAB meeting on Nov 3, the blood levels of children should be considered as an important dataset that is currently collected. However, as was raised at the meeting, exposure during the first 6 months of life for formula fed infants would not be captured well in blood lead levels as these are not measured so early on in life. I recommend the EPA consider the comments made by experts in the field at the EPA SAB meeting as there were numerous insightful comments about this question.

Comments from Dr. Jonathan Samet

Charge Questions 1 and 2

As defined by the EPA, “Environmental justice is 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.” How do analyses, such as those in the case studies provided related to the LCRI, help to achieve that goal? First, by documenting the existence of environmental injustice and, second, by providing data-driven guidance towards implementing interventions that will achieve the goal of providing equal protection against environmental threats for all.

The analyses presented in the three case studies are descriptive and related to the first purpose of describing environmental injustice. They contrast levels of the various indicators in block groups with and without the problem of lead-containing pipes that is the focus of the LCRI. The contrast for the environmental justice indicators considered is either for block groups with/without lead service lines or for block groups with a higher versus a lower proportion of lead service lines.

These analyses, as presented, are not informative on the question of what subsets of variables may be most useful and how they should be weighted. The aggregate indexes used mask the informativeness of individual variables and have intrinsic weighting. The three case studies could be used for analyses that would be informative. Some potential approaches are listed below:

- Examine the correlations at the block group level among the EJScreen indicators and percentiles with values for the alternate indicators. There are shared measures among the indexes and their values are likely to be correlated to a degree.
- Compare rankings of census block groups on the EJScreen indicator values (using percentile?) and rankings assigned based on the alternative indexes. This should be done for each of the case study locations.
- Examine clustering of the components of the EJScreen at the census block level. Presumably such an exercise was done when the index was developed. The three case studies could be informative as to how the correlation structure differs by location.
- If one purpose of using EJScreen is to identify those geographic areas that should receive the greatest effort in screening for lead-containing pipes and remediation resources, then analyses could be carried out for that purpose. Typically, a prediction model would be developed using a data set with known values for the outcome of interest. Once developed, the model would then be applied to a separate data set to gauge how well it predicts the outcome of interest. For the case studies, there are two outcomes of interest at the block group level: 1) whether the block group has lead service lines; and whether the percentage of homes in the block group with lead service lines exceeds some cut-off level. Straight-forward multiple logistic models might be developed to predict the outcome categories for the block groups. The individual variables included in the EJScreen and the alternative indexes could be used. Models could be built with a priori selection of some key variables and then the gain in informativeness examined by adding additional variable, one at a time, with consideration of the change in log likelihood.

- Could similar analyses be carried out with the household as the unit of analysis?

Charge Question 3

Given the multiple ways that lead exposure can occur, it is useful for EPA to consider pathways for exposure other than through drinking water. In urban areas, exposure to lead paint remains common and measures might be developed, based on housing age, as an indicator of the potential for ingestion of lead from lead paint or for inhalation of lead-contaminated dust. The EJScreen includes the percentage of homes built prior to 1960. An additional variable that might be considered would be the percentage of homes built prior to 1978 when lead paint was banned. Finally, are data available on the numbers/percentages of homes that have been remediated for lead paint by block group?

General Comments

For the SAB, it would be useful to have an overview of the process by which the environmental justice case studies were generated. Are there protocols? Models? Is there an internal review of these analyses within EPA?

Comments from Dr. Daniel Stram

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

It seems certain that environmental injustice plays a role in the current geographic distribution of lead service lines. However, I have nothing to say specific to the charge question regarding tools, indicators, and metrics, since I don't specialize in this area.

- b. Given the identified tools and indices (i.e., EJSCREEN, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Certainly, benefits to the most vulnerable populations should be addressed with high priority, but I am not familiar with the indices and can't make a sensible comment about the variables that comprise the indices

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement

It is important to quantify the actual health benefits that are achieved by replacement of lead service lines, so that costs and benefits associated with replacement can be balanced equitably both within the community and in relation to mitigation of other exposure pathways

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

I assume that if the exposures from other pathways are correlated with exposures from lead service lines that this implies that exposure tools and indicators will be similar too. Unfortunately I'm not familiar enough with the field to be more specific than this

Comments from Dr. Godfrey Uzochukwu

Charge Question 1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Comments: EPA focused primarily on evaluating whether and how EPA's EJSCREEN indicators varied across the block groups categories. EPA evaluated whether alternative index values provided additional information on indicators to characterize baseline environmental justice conditions. EPA used EJSCREEN Demographic Indicators to Characterize Vulnerability. The Climate and Economic Justice Screening Tool (CJEST) developed for the Justice40 Initiative provides socioeconomic, environmental, and climate information on disadvantaged communities that are marginalized, underserved, and overburdened by pollution. The EJI and CJEST tools, indicators and metrics seem appropriate for the time being.

- b. Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Comments: The sub-set of variables identified within the indices should be updated regularly due demographic shifts and emerging EJ issues.

Charge Question 2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Comments: Social Vulnerability Index (SVI), Area Deprivation Index (ADI), Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CJEST) are suitable for studying EJ impacts associated with LSL. The indicator/measure should be updated regularly.

Charge Question 3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water source

Comments: The tools and indicators under consideration for use to assess LCRI of drinking water EJ impacts can inform EPA's understanding of lead exposures from non-drinking water sources. The tools and indicators require updates from time to time.

Comments from Dr. Wei-Hsung Wang

1. Tools, indicators, and Metrics for the Lead and Copper Rule Improvements Case Studies:

- a. **Please comment on the tools/indicators/metrics, such as the recently released Environmental Justice Index (EJI) and Climate and Economic Justice Screening Tool (CEJST), that EPA should consider using when developing lead service line replacement case studies to support the development of the Lead and Copper Rule Improvements environmental justice analysis.**

Response

Since the purpose of the Lead and Copper Rule is to protect public health by minimizing lead and copper levels in drinking water from plumbing materials, it seems prudent to include the routine monitoring results of lead and copper from the tap water samples in these case studies. If data are available, toxics in soil and water may be used as an additional environmental indicator.

- b. **Given the identified tools and indices (i.e., EJScreen, SVI, ADI) please comment on whether there is there a sub-set of variables within the indices which should be given higher weights in the Lead and Copper Rule Improvements environmental justice assessment.**

Response

I suggest the following indices be given higher weights:

- Environmental variables reflecting the housing quality- because these relevant characteristics can be used to describe the synergistic impacts quantitatively.
- Young (age 17 and less) and older (age 65 and over) population- because they are more vulnerable to the adverse health effects from exposure to lead and copper.
- Low income population- because they are more likely to consume greater quantities of tap water than bottled water.

2. Indicator/Measure Most Suitable for Studying Environmental Justice Impacts Associated with Lead Service Lines and their Replacement:

Please comment on the indicator/measure that is most suitable for studying the environmental justice impacts associated with lead service lines and their replacement.

Response

I think that the most suitable indicator/measure for studying environmental justice impacts with respect to the lead service line replacement is “early childhood”. It has been well established that younger children are especially vulnerable to lead poisoning which can cause severe detrimental effects on mental and physical development. Also, this demographic indicator is likely to be most objective and acceptable to the general public as well as least controversial and politically incorrect.

3. Tools or Indicators to Assess Lead Impacts from Other Co-Located Exposure Pathways:

Please comment on whether any of the tools or indicators under consideration for use in the Lead and Copper Rule Improvements assessment of the drinking water environmental justice impacts can help to better assess lead impacts from other co-located exposure pathways (e.g., lead paint, soil, and dust) to inform EPA's understanding of lead exposures from non-drinking water sources.

Response

Because the human body accumulates lead over a lifetime and releases it very slowly, it is vital to include the following indicators to evaluate the potential lead impacts from the non-drinking pathway:

- traffic proximity,
- lead paint,
- hazardous waste proximity,
- Superfund proximity, and
- soil.

If feasible, community health will also be a useful factor to help optimize the return of the lead service line replacement efforts.