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Lead and Copper Rule Action Level Exceedances (1991-2021): Lead exposure has been associated with health effects including nervous system damage, cardiovascular disease, kidney damage, immune system disregulation, liver toxicity, reproductive harm, and various cancers (EPA, 2024d). Lead in drinking water is regulated according to the Lead and Copper Rule (LCR) of the Safe Drinking Water Act, which is relatively unique among National Primary Drinking Water Regulations in requiring systems to conduct a specific number of samples directly at consumer taps instead of at treatment plant or distribution network sampling locations. The Lead and Copper Rule also has an action level instead of a maximum contaminant level. A water system exceeds the action level for lead if the observed concentration in more than 10% of tap water samples collected is greater than 15 parts per billion (ppb) in a water system compliance monitoring period. Given the focus on the highest 10th percentile of sample concentrations, SDWIS includes a report for the 90th percentile lead concentration for each water system monitoring period (EPA, 2024e). These 90th percentile sample values are available for all medium and large systems in SDWIS, but they are not available for small water systems that do not have an action level exceedance (ALE). Due to the absence of 90th concentration observations for the smallest systems, we instead use an indicator for the number of lead action level exceedances. For this measure, we counted the number of times a water system was reported to exceed the lead action level over the period from 1991 to 2021. Our final sample included 20,688 lead action level exceedances across 45,934 unique public water systems. We note that a lead action level exceedance is only a proxy for lead concerns for any given drinking water system., In addition, given the nature of lead in drinking water resulting primarily from corrosion of lead-bearing plumbing in service lines and premise plumbing, there may exist substantial variation in lead concentrations at the tap across households within a drinking water even where an action level exceedance does not occur. See Stratton et al. (2022) for additional discussion of the limitations of lead action level exceedances in characterizing lead concerns for a particular system.

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Lead Action Level Exceedances (1991-2021): We summarize our measure of lead in drinking water, the count of lead action level exceedances (ALEs), according to each boundary in Table 1. The average count is similar at roughly 0.45 irrespective of the boundary representation employed, with 78% of all systems never experiencing a lead ALE from 1991 to 2021. As with the health-based violations, we observe that there is right skew to the the distribution of lead ALEs across systems, where the average number of ALEs for systems with at least one violation is over 2 according to all boundary types as shown in Appendix Table A5. We summarize the average population-weighted count of ALEs among systems serving each demographic group in Table 2, and we illustrate disparities across these groups in Figure 2(b). We find that Asian and Black populations experience more lead ALEs irrespective of the boundary representation employed. Asian populations have the greatest frequency of lead action level exceedances of any group with at least 1.5 times as many lead action level exceedances as non-Hispanic White populations according to all boundary types. Conversely, conclusions regarding the presence of a disparity in lead ALEs for Hispanic and low-income individuals depend on the service boundary representation employed, with EPIC boundaries suggesting the presence of a disparity and EPA ORD boundaries suggesting less risk. In contrast to the findings with respect to health-based violations, we do not observe an obvious pattern of greater disparities with increasing precision or completeness of boundaries, with county boundaries suggesting the greatest disparities for Asian populations. We map the count of action level exceedances in Figure 2(a). The map shows that water systems with more lead ALEs are concentrated in the northeastern US and the Midwest, which could be attributed to older infrastructure in these regions. Ohio has notably high levels of lead action level exceedances in comparison to other states, which we explore further in subsubsection 5.2.4. We also observe pockets of concern in Alaska and parts of California and the coastal Pacific Northwest. To explore the potential for environmental justice hotspots, we present bivariate plots of the number of lead ALEs alongside the percent People of Color in Figure 9(a) and the percent of individuals living below twice the federal poverty line in Figure 9(b). We observe that many areas with the greatest share of people of color and the highest number of lead ALEs are observed frequently in California, Alaska, and in some large cities such as Chicago. Clusters of elevated lead ALEs and low-income populations can also be observed in Alaska, California, Missouri, and parts of the Northeast.

Finally, we conclude with a statistical test of disparities in the number of lead ALEs across demographic groups conditional on other water system characteristics. These results are displayed in column (2) of Table 4. Water systems that serve a greater share of Asian, Black, and Pacific Islander individuals tend to have statistically significant higher counts of lead ALEs, whereas systems serving a greater share of Hispanic and low-income individuals tend to have fewer lead ALEs. A one unit increase in the share of a service population that is Black is associated with 25% more lead ALEs, or roughly 0.11 additional ALEs from the mean of 0.45 per system. While American Indian populations do not have statistically significantly elevated lead ALEs conditional on other controls, tribal utilities tend to have roughly 12% more ALEs conditional on other water system characteristics. Regarding the other system characteristics, large and very large systems have more lead ALEs than the omitted category of medium-sized systems, while small and very small systems have fewer lead action level exceedances. We note that certain point estimates may be unexpectedly large in magnitude because they represent inference from relatively small underlying populations or minimal shifts in the related independent variables. For example, one-unit increase in the share of a service population that is Pacific Islander is associated with 6-7 fold increase in the count of lead ALEs.