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Supplemental Material

Estimating the Effects of Soil Remediation on Children's Blood Lead near a Former Lead Smelter in Omaha, Nebraska, USA

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Table S1. Residential soil lead levels (SLLs) at properties included in the focus area (N=28,422), greater Omaha Nebraska (1999-2016)

	21,212 Residences No Remediation		7,210 Residences Before Remediation		7,210 Residences After Remediation	
Average Yard SLL (ppm)[a]	N	% (N/21212)	N	% (N/7210)	N	% (N/7210)
not measured[b]	8588	40.5	10	0.1	10	0.1
0-200	9760	46.0	227	3.2	6226	86.4
200-400	2771	13.1	3409	47.3	974	13.5
400-800	90	0.4	2885	40.0	0	
800-1200	2	0.01	463	6.4	0	
>1200	1	<0.01	216	3.0	0	
median (min, max)		*132 (16, 1521)*		*398 (85, 5802)*		*131 (14, 336)*
Mean (std)		*144 (81)*		*484 (330)*		*129 (66)*
Geomean (geostd)		*123 (2)*		*423 (2)*		*102 (2)*
Maximum Yard SLL (ppm)[a]						
not measured	8588	40.5	10	0.1	10	0.1
0-200	6562	31.0	39	0.6	1874	26.0
200-400	5723	27.0	141	2.0	5326	73.9
400-800	299	1.4	4517	62.6	0	
800-1200	27	0.1	1398	19.4	0	
>1200	13	0.1	1105	15.3	0	
median (min, max)		*194 (20, 2080)*		*652 (116, 16499)*		*280 (14, 400)*
Mean (std)		*210 (126)*		*892 (882)*		*252 (113)*
Geomean (geostd)		*176 (2)*		*732 (2)*		*192 (2)*
Drip Zone SLL (ppm)						
not measured	9126	43.0	220	3.0	220	3.0
0-200	5852	27.6	525	7.3	6176	85.7
200-400	2381	11.2	814	11.3	814	11.3
400-800	2017	9.5	1770	24.5	0	
800-1200	868	4.1	1129	15.7	0	
>1200	968	4.6	2752	38.2	0	
median (min, max)		*212 (11, 54800)*		*916 (19, 54219)*		*14 (14, 400)*
Mean (std)		*458 (907)*		*1423 (1869)*		*56 (99)*
Geomean (geostd)		*226 (3)*		*883 (3)*		*23 (3)*
Maximum SLL of yard and drip zone (ppm)						
not measured	9160	43.2	222	3.1	222	3.1
0-200	4433	21.0	0	0	1598	22.2
>200-400	3683	17.4	16	0.2	5390	74.8
>400-800	2087	9.8	2347	32.5	0	
>800-1200	880	4.1	1448	20.1	0	
>1200	969	4.6	3177	44.1	0	
median (min, max)		*282 (20, 54800)*		*1105 (331, 54219)*		*292 (14, 400)*
Mean (std)		*493 (898)*		*1643 (1915)*		*262 (111)*
Geomean (geostd)		*289 (3)*		*1201 (2)*		*204 (3)*

Max=maximum; min=minimum; ppm=parts per million; SLL=soil lead level.

[b] The SLL metrics for average and maximum of the yard quadrants exclude the drip zone concentration.

[a]U.S. EPA conducted soil sampling with the intent of delineating a "focus area" where five percent of properties had soil lead concentrations above 400 ppm. Some SLLs at properties outside this focus area were also measured.

Table S2. Number of blood lead measurements comparing pre- and post-remediation capillary and venous blood lead levels (BLLs) among children in the remediation group, and pre-remediation BLLs capillary and venous BLLs in the comparison group.

Remediation Group (i.e., pre- and post BLLs)	Number of Measurements	Pre-remediation number of children (%)	Post-Remediation number of children (%)
Capillary Blood Samples	1	1455 (55.1)	1801 (62.4)
	2	720 (27.2)	675 (23.4)
	3	311 (11.8)	299 (10.4)
	4	113 (4.3)	79 (2.7)
	5	36 (1.4)	27 (0.9)
	>5	8 (0.3)	7 (0.2)
Venous Blood Samples	1	254 (63.9)	223 (70.1)
	2	83 (20.5)	54 (17.0)
	3	27 (6.7)	17 (5.4)
	4	14 (4.5)	7 (2.2)
	5	8 (2.0)	5 (1.6)
	>5	14 (3.5)	12 (2.2)
Comparison Group			
Capillary Blood Samples	1	21237 (54.9)	
	2	9032 (23.4)	
	3	4502 (11.6)	N/A
	4	2329 (6.0)	
	5	1130 (2.9)	
	>5	437 (1.1)	
Venous Blood Samples	1	7178 (77.9)	
	2	1381 (15.0)	
	3	365 (4.0)	N/A
	4	122 (1.3)	
	5	56 (0.6)	
	>5	108 (1.2)	

%=percent; BLL=blood lead level; N/A=not applicable

Table S3. Data corresponding to Figure 3.

	Yearly average of soil lead level (SLL) at residences (ppm) with measured SLL			
Date	Remediated houses within the focus area (n= 7200)	Non-remediated houses within the focus area (n= 12624)	Remediated houses outside the focus area (n= 187)	Non-remediated houses outside the focus area (n= 1352)
1/1/1999	892	210	665	145
1/1/2000	891	210	664	145
1/1/2001	877	210	661	145
1/1/2002	877	210	661	145
1/1/2003	851	210	651	145
1/1/2004	822	210	642	145
1/1/2005	753	210	625	145
1/1/2006	648	210	597	145
1/1/2007	539	210	581	145
1/1/2008	493	210	530	145
1/1/2009	442	210	527	145
1/1/2010	407	210	514	145
1/1/2011	349	210	457	145
1/1/2012	299	210	337	145
1/1/2013	282	210	297	145
1/1/2014	269	210	285	145
1/1/2015	262	210	263	145
1/1/2016	253	210	242	145

Note 1: Calculations for Figure 3 used values for individual properties. To honor privacy commitments, we provide here corresponding yearly averages that, when smoothed by LOESS, yield essentially the same curves.

Note 2: A total 22,697 properties did not have soil lead level (SLL) measurements, i.e., 10 remediated properties within the focus area, 8,588 non-remediated houses within the focus area, 4 remediated properties outside the focus area, and 14,095 non-remediated properties outside the focus area.

Note 3: SLLs were constant for a residence unless it was changed through remediation.

Table S4. Data corresponding to Figure 4

	Yearly fraction of children with elevated blood lead level ≥ 5 μg/dL ($EBLL_5$)		
Date	Remediation group within focus area (n= 9050)	Comparison group within focus area (n= 70532)	Comparison group out of focus area (n= 39626)
1/1/1999	0.763	0.309	0.158
1/1/2000	0.660	0.277	0.140
1/1/2001	0.568	0.249	0.125
1/1/2002	0.488	0.225	0.113
1/1/2003	0.420	0.204	0.104
1/1/2004	0.366	0.190	0.099
1/1/2005	0.322	0.177	0.096
1/1/2006	0.286	0.155	0.091
1/1/2007	0.252	0.133	0.084
1/1/2008	0.208	0.109	0.073
1/1/2009	0.166	0.087	0.062
1/1/2010	0.123	0.068	0.050
1/1/2011	0.095	0.055	0.042
1/1/2012	0.074	0.046	0.036
1/1/2013	0.060	0.040	0.033
1/1/2014	0.053	0.037	0.031
1/1/2015	0.054	0.038	0.032
1/1/2016	0.061	0.043	0.034

Note: Calculations for Figure 4 used values for individual BLLs. To honor privacy commitments, we provide here corresponding yearly averages that, when smoothed by LOESS, yield essentially the same curves.

Table S5. Associations between categorical or continuous (log2-transformed) maximum soil lead levels (SLL) of yard quadrants and the drip zone[a] and children's $EBLL_5$; associations estimated separately using pre-remediation (N=115,405) and post-remediation (N=14,701) capillary BLLs of children residing at properties within the study area where SLL was measured, greater Omaha Nebraska, 1999-2016.

Exposure	Pre-remediation BLLs			Post-remediation[a] BLLs		
	N≥5 µg/dL/ N<5 µg/dL		OR (95% CI)	N≥5 µg/dL/ N<5 µg/dL		OR (95% CI)
	category	referent		category	referent	
Single-source models[b]						
Residential SLL (ppm)						
>200-400 vs. 0-200	1316/12755	1193/16299	1.36 (1.24, 1.49)	1207/9610	402/3041	1.08 (0.94, 1.25)
>400-800 vs. 0-200	1856/10356		2.00 (1.83, 2.18)	n/a	n/a	n/a
>800-1200 vs. 0-200	1022/4270		2.50 (2.26, 2.77)	n/a	n/a	n/a
1200+ vs. 0-200	1765/5983		2.71 (2.48, 2.97)	n/a	n/a	n/a
Continuous (log_2)	n/a	n/a	1.27 (1.25, 1.29)	n/a	n/a	1.02 (0.97, 1.06)
Neighborhood SLL (ppm)						
>200-400 vs. 0-200	5361/21640	5906/80379	1.59 (1.50, 1.68)	626/1758	999/11302	1.70 (1.42, 2.05)
>400-800 vs. 0-200	443/1010		1.85(1.62, 2.11)	8/12	999/11302	1.56 (0.58, 4.19)
Continuous (log_2)	n/a	n/a	1.41 (1.35, 1.47)	n/a	n/a	2.01 (1.47, 2.76)
Two-source model[c]						
Residential SLL (ppm)						
>200-400 vs. 0-200	1316/12755	1193/16299	1.35 (1.23, 1.48)	1207/9610	402/3041	1.10 (0.96, 1.27)
>400-800 vs. 0-200	1856/19356		1.95 (1.79, 2.13)	n/a	n/a	n/a
>800-1200 vs. 0-200	1022/4270		2.43 (2.19, 2.70)	n/a	n/a	n/a
1200+ vs. 0-200	1765/5983		2.62 (2.39, 2.87)	n/a	n/a	n/a
Neighborhood SLL (ppm)						
>200-400 vs. 0-200	3918/14828	2938/34280	1.21 (1.12, 1.30)	612/1692	989/10947	1.72 (1.43, 2.07)
>400-800 vs. 0-200	296/555		1.31 (1.10, 1.56)	8/12	989/10947	1.54 (0.57, 4.14)
Continuous (Log2)						
Residential yard SLL	n/a	n/a	1.26 (1.24, 1.28)	n/a	n/a	1.02 (0.98, 1.07)
Neighborhood SLL	n/a	n/a	1.11 (1.03, 1.20)	n/a	n/a	2.34 (1.68, 3.25)

BLL=blood lead level; CI=Confidence Interval; n/a=not applicable (i.e., average residential yard soil concentrations are not above 400 ppm following remediation actions); OR=Odds ratio; ppm=parts per million; SLL=soil lead level; vs.=versus; µg/dL=micrograms per deciliter

Note1: Measured SLLs were used to determine the pre-remediation residential SLL by taking the maximum of the SLL across yard quadrants and the drip zone. Neighborhood SLL was estimated by averaging the maximum SLLs of residences within the elementary catchment area on the day of the BLL measurement.

Note2: The total number of observations for each model are as follows: (1) Single source residential SLL, n=56,815 (pre-remediation BLLs) and n=14,260 (post-remediation BLLs); (2) single source neighborhood SLL, n=114,739 (pre-remediation BLLs) and n=14,705; (3) Two source residential SLL, n=56,815 (pre- remediation) and n=14,260 (post-remediation BLLs).

[a]Remediated yard quadrants were assigned a SLL of 14 ppm and the SLL for the yard was determined by averaging across yard quadrants, including yard quadrants where soil was measured but never remediated because the quadrant had an average SLL <400 ppm.

[b]Generalized Estimating Equation (GEE) was used to account for various sources of correlation among samples and children. The single-source models were adjusted for characteristics of the child [sex (female or male), census tract level median income (≥40k per year or not), and census tract level percent house built before 1940 (≥50% or not)] and characteristics that varied within child depending on the observation [year (continuous), season (June-August or other), age (0-1, 2-3, or 4-7 years)]. Note that the single-source results for neighborhood SLL are identical to those reported in Table 3.

[c]The two-source model included both the residential yard SLL and the neighborhood SLL plus the covariates included in the single-source models.

Table S6. Associations between categorical or continuous (log2-transformed) average soil lead level (SLL) and children's $EBLL_5$, stratified by remediation status, i.e., associations estimated separately using pre-remediation (n=75,041) and post-remediation capillary blood lead levels (BLLs) (14,451) and restricted to the focus area[a], greater Omaha Nebraska, 1999-2016

Exposure	Pre-remediation BLLs			Post-remediation[a] BLLs		
	N≥5 µg/dL/ N<5 µg/dL		OR (95% CI)	N≥5 µg/dL/ N<5 µg/dL		OR (95% CI)
	category	referent		category	referent	
Single-source models[b]						
Residential SLL (ppm)						
>200-400 vs. 0-200	2576/13126	3056/31043	1.58 (1.48, 1.69)	200/1560	1409/11281	1.03 (0.86, 1.24)
>400-800 vs. 0-200	1062/3030		1.99 (1.81, 2.18)	n/a	n/a	n/a
>800-1200 vs. 0-200	163/318		2.23 (1.80, 2.77)	n/a	n/a	n/a
1200+ vs. 0-200	52/126		1.89 (1.32, 2.70)	n/a	n/a	n/a
Continuous (log_2)	n/a	n/a	1.36 (1.32, 1.40)	n/a	n/a	1.01 (0.96, 1.06)
Neighborhood SLL (ppm)						
>200-400 vs. 0-200	5194/20826	3468/44193	1.36 (1.28, 1.45)	625/1757	976/11073	1.71 (1.42, 2.06)
>400-800 vs. 0-200	427/933		1.51 (1.31, 1.74)	8/12	976/11073	1.56 (0.58, 4.20)
Continuous (log_2)	n/a	n/a	1.34 (1.25, 1.43)	n/a	n/a	2.35 (1.69, 3.25)
Two-source model[c]						
Residential SLL (ppm)						
>200-400 vs. 0-200	2576/13126	3056/31043	1.54 (1.44, 1.64)	200/1560	1409/11281	1.03 (0.86, 1.25)
>400-800 vs. 0-200	1062/3030		1.90 (1.73, 2.08)	n/a	n/a	n/a
>800-1200 vs. 0-200	163/318		2.12 (1.70, 2.63)	n/a	n/a	n/a
1200+ vs. 0-200	52/126		1.79 (1.25, 2.57)	n/a	n/a	n/a
Neighborhood SLL (ppm)						
>200-400 vs. 0-200	4024/15231	2579/31825	1.26 (1.17, 1.37)	625/1757	976/11072	1.71 (1.42, 2.06)
>400-800 vs. 0-200	306/587		1.31 (1.10, 1.56)	8/12	976/11072	1.57 (0.58, 4.22)
Continuous (Log2)						
Residential yard SLL	n/a	n/a	1.34 (1.30, 1.39)	n/a	n/a	1.02 (0.98, 1.08)
Neighborhood SLL	n/a	n/a	1.08 (0.99, 1.18)	n/a	n/a	2.38 (1.72, 3.30)

BLL=blood lead level; CI=Confidence Interval; n/a=not applicable (i.e., average residential yard soil concentrations are not above 400 ppm following remediation actions); OR=Odds ratio; ppm=parts per million; SLL=soil lead level; vs.=versus; µg/dL=micrograms per deciliter

Note1: Measured SLLs were used to determine the pre-remediation residential SLL by taking the average of the average SLL across yard quadrants. Neighborhood SLL was estimated by averaging the average SLLs of residences within the elementary catchment area on the day of the BLL measurement. [a]The focus area was delineated such that approximately 5% of the properties had SLLs greater than 400 ppm.

Note2: The total number of observations for each model are as follows: (1) Single source residential SLL, n=54,552 (pre-remediation BLLs) and n=14,450 (post-remediation BLLs); (2) single source neighborhood SLL, n=75,041 (pre-remediation BLLs) and n=14,451 (3) Two source residential SLL, n=54,552 (pre- remediation) and n=14,450 (post-remediation BLLs).

[a]Remediated yard quadrants were assigned a SLL of 14 ppm and the SLL for the yard was determined by averaging across yard quadrants, including yard quadrants where soil was measured but never remediated because the quadrant had an average SLL <400 ppm.

[b]Generalized Estimating Equation (GEE) was used to account for multiple samples per child. The single-source models were adjusted for characteristics of the child [sex (female or male), census tract level median income (≥40k per year or not), and census tract level percent house built before 1940 (≥50% or not)] and characteristics that varied within child depending on the observation [year (continuous), season (June-August or other), age (0-1, 2-3, or 4-7 years)].

[c]The two-source model included both the residential yard SLL and the neighborhood SLL plus the covariates included in the single-source models.

Table S7. Comparison of main results in Table 3 and 6 to results from sensitivity analyses using alternative specification for year and season.

	Main analysis: year as a continuous variable	Sensitivity analysis: year as categorical variable	Sensitivity analysis: year as cubic polynomial[a]	Sensitivity analysis: terms for each month
Association between soil lead level (SLL) and elevated pre-remediation blood lead level ($EBLL_5$)[b]:				
Single source model				
Residential SLL Continuous (log2)	1.36 (1.32, 1.40)	1.35 (1.32, 1.39)	1.36 (1.32, 1.39)	1.36 (1.32, 1.40)
Neighborhood SLL Continuous (log2)	1.41 (1.35, 1.48)	1.39 (1.33, 1.46)	1.40 (1.34, 1.46)	1.42 (1.36, 1.49)
Two source model				
Residential SLL Continuous (log2)	1.35 (1.31, 1.39)	1.35 (1.31, 1.39)[c]	1.35 (1.31, 1.39)[c]	1.35 (1.32, 1.39)
Neighborhood SLL Continuous (log2)	1.05 (0.97, 1.13)	1.02 (0.94, 1.10)	1.02 (0.95, 1.11)	1.05 (0.97, 1.14)
Association between soil lead level (SLL) and elevated post-remediation blood lead level ($EBLL_5$):				
Single source model				
Residential SLL Continuous (log2)	1.01 (0.96, 1.06)	1.02 (0.97, 1.07)[c,d]	1.02 (0.97, 1.07)[c]	1.01 (0.97, 1.06)
Neighborhood SLL Continuous (log2)	2.20 (1.60, 3.03)	1.90 (1.33, 2.72)[d]	1.90 (1.36, 2.65)	2.38 (1.71, 3.33)
Two source model				
Residential SLL Continuous (log2)	1.02 (0.97, 1.08)	1.03 (0.98, 1.08)[c,d]	1.03 (0.98, 1.08)[c]	1.03 (0.98, 1.08)
Neighborhood SLL Continuous (log2)	2.23 (1.61, 3.08)	1.93 (1.35, 2.76)[d]	1.93 (1.38, 2.69)	2.42 1.73, 3.37)
Estimated Odds Ratios (95% Confidence Interval) for elevated BLL using capillary (EBLL5)[e]				
Pre in the Remediation group vs. Post in the Remediation group	1.52(1.34, 1.72)	1.43 (1.26, 1.62)	1.47 (1.32, 1.69)	1.52 (1.35, 1.73)
Post in the Remediation group vs. Comparison group	1.12 (0.99, 1.27)	1.19 (1.05, 1.35)	1.15 (1.02, 1.30)	1.11 (0.98, 1.26)
Post-Only group vs. Post in the Remediation group	1.02 (0.90, 1.15)	1.01 (0.89, 1.15)	1.03 (0.90, 1.17)	1.02 (0.98, 1.26)
Post-Only group vs. Comparison group	1.14 (1.03, 1.27)	1.21 (1.09, 1.34)	1.18 (1.06, 1.32)	1.13 (1.02, 1.26)
Estimated Odds Ratios (95% Confidence Interval) for elevated BLL using venous (EBLL10)[f]				
Pre in the Remediation group vs. Post in the Remediation group	1.87 (1.27, 2.77)	1.87 (1.27, 2.74)	1.90 (1.30, 2.79)	1.86 (1.26, 2.75)
Post in the Remediation group vs. Comparison group	2.06 (1.38, 3.06)	2.14 (1.44, 3.17)	2.10 (1.42, 3. 10)	2.04 (1.37, 3.05)
Post-Only group vs. Post in the Remediation group	1.11 (0.65, 1.88)	0.97 (0.59, 1.58)	0.99 (0.61, 1.60)	1.10 (0.65, 1.88)
Post-Only group vs. Comparison group	2.28 (1.43, 3.64)	2.07 (1.32, 3.23)	2.07 (1.33, 3.23)	2.26 (1.41, 3.62)

[a]Linear, quadratic and cubic terms were transformed to improve numerical performance. Year was re-expressed as (year – 1999) before squaring or cubing to keep values smaller; and the resulting variables underwent Gram-Schmidt orthogonalization to reduce collinearity.
[b]A generalized Estimating Equation (GEE) was used to account for various sources of correlation among samples and children. The single-source models were adjusted for child [sex (female or male), census tract level median income (≥40k per year or not), and census tract level percent house built before 1940 (≥50% or not)] and characteristics that varied within child depending on the observation [year (continuous), season (June-August or other), age (0-1, 2-3, or 4-7 years)] (Table 3).
[c]Estimates differ between models with alternative specification or year at 3 significant digit.
[d]The years 1999-2004 were combined due to sparse data
[e]GEE models for capillary samples used exchangeable correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage housing built before 1940.
[f]GEE models for venous samples used the independent correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage of housing built before 1940.

Table S8. The association of soil lead level (SLL) with elevated blood lead level (BLL) ≥ 5 µg/dL: parameter estimates for the model of Table 3 with or without adjustment for race					
Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	250.7557	6.4712	238.0723	263.4390	<.0001
Log2 SLL	0.3128	0.0142	0.2849	0.3407	<.0001
Age (years)(categorical)					
0-1	0.3734	0.0338	0.3073	0.4396	<.0001
2-3	0.3481	0.0317	0.2861	0.4102	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	
Sex (categorical)					
Male	0.2183	0.0291	0.1612	0.2754	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	
Race (categorical)					
Black	0.3395	0.0430	0.2552	0.4237	<.0001
Unknown	-0.2305	0.0325	-0.2941	-0.1668	<.0001
White (referent)	0.0000	0.0000	0.0000	0.0000	
Sample Season	0.3086	0.0272	0.2553	0.3620	<.0001
Sample Year	-0.1272	0.0032	-0.1335	-0.1209	<.0001
Census tract level Income	-0.3461	0.0333	-0.4113	-0.2809	<.0001
Census tract level pre-1940 housing	0.0154	0.0315	-0.0464	0.0772	0.6249
Not Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	263.3373	6.3157	250.9589	275.7158	<.0001
Log2 SLL	0.3069	0.0142	0.2792	0.3347	<.0001
Age (years)(categorical)					
0-1	0.3734	0.0338	0.3073	0.4396	<.0001
2-3	0.3452	0.0317	0.2831	0.4072	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	
Sex					
Male	0.2183	0.0291	0.1612	0.2754	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	
Sample Season	0.3086	0.0272	0.2553	0.3620	<.0001
Sample Year	-0.1335	0.0031	-0.1396	-0.1273	<.0001
Census tract level Income	-0.4201	0.0326	-0.4841	0.3562	<.0001
Census tract level pre-1940 housing	-0.0116	0.0312	-0.0728	0.0495	0.6249

Table S9. Percentage of blood lead levels greater than 10 µg/dL (% EBLL) by children's characteristics for 9,050 capillary BLLs among 3,135 children in the remediation group (i.e., children who had both pre- and post-remediation blood lead measurements), 70,532 capillary BLLs from 38,667 children in the comparison group (i.e., children who had only pre-remediation blood lead measurements), and 9910 capillary BLL among 5774 children in the post-only group. All children reside within the focus area, greater Omaha Nebraska (1999-2016).

	Remediation Group						Comparison Group			Post-Only Group		
	Pre-remediation EBLL			Post-remediation EBLL								
	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%
Overall	339	4509	7.5	104	4541	2.3	1780	70532	2.5	245	9910	2.5
By age (years)												
0-1	181	2204	8.2	7	128	5.5	623	22022	2.8	130	3924	3.3
2-3	134	1841	7.3	57	1703	3.3	709	25420	2.8	80	3479	2.3
4-7	24	464	5.2	40	2710	1.5	448	23090	1.9	35	2507	1.4
By sex												
Female	156	2185	7.1	39	2203	1.8	806	34594	2.3	108	4850	2.2
Male	183	2324	7.9	65	2338	2.8	974	35938	2.7	137	5060	2.7
By race												
Black	76	538	14.1	27	525	5.1	420	9743	4.3	62	733	8.5
White	222	2160	10.3	59	2003	2.9	925	24405	3.8	117	3077	3.8
Other	10	101	9.9	6	89	6.7	109	2624	4.2	22	221	10.0
Unknown	31	1710	1.8	12	1924	0.6	326	33760	1.0	44	5879	0.7
By season												
June-August	126	1180	10.7	40	1389	2.9	710	20165	3.5	91	26`0	3.5
Other months	213	3329	6.4	64	3152	2.0	1070	50367	2.1	154	7300	2.1
By remediation phase[b] of the property where the blood lead sample was collected												
1999-2004 (≥ 1200 ppm)	64	158	40.5	43	521	8.3	100	482	20.7	68	1423	4.8
2005-2009 (≥ 800 ppm)	128	787	16.3	48	2222	2.2	275	3536	7.8	123	5165	2.4
2010-2017 (≥ 400 ppm)	30	1019	2.9	13	1798	0.7	115	5169	2.2	54	3322	4.8
Never eligible (< 400 ppm)	117	2545	4.6	n/a	n/a	n/a	1290	61345	2.1	n/a	n/a	n/a
By census tract level median income												
0-40 K	287	3421	8.4	95	3656	2.6	1443	48783	3.0	222	7846	2.8
≥40 K	52	1088	4.8	9	885	1.0	337	21749	1.5	23	2064	1.1
By census tract level percent house built before 1940												
0-50%	83	1239	6.7	21	951	2.2	558	28695	1.9	60	2182	2.7
≥50%	256	3270	7.8	83	3590	2.3	1222	41837	2.9	185	7728	2.4

%EBLL= percentage of capillary blood lead levels greater than 10 µg/dL; SLL = soil lead level.

[a] The focus area boundary delineates the area where 1 in 20 properties are expected to have soil lead levels that exceed 400 ppm.

[b] "Remediation phase" refers to time periods associated with a particular soil lead level (SLL) required for a property to be eligible for remediation.

Table S10. Percentage of blood lead levels (BLLs) greater than 5 or equal to µg/dL by children's characteristics for 1255 venous BLLs among 551 children in the remediation group (i.e., children who had both pre- and post-remediation blood lead measurements), 12685 venous BLLs among 9211 children in the comparison group (i.e., children who had only pre-remediation blood lead measurements), and 960 venous BLL among 593 children in the post-only group. All children reside within the focus area, greater Omaha Nebraska (1999-2016).

	Remediation Group						Comparison Group			Post-Only Group		
	EBLL Pre-remediation			EBLL Post-Remediation								
	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%
Overall	481	725	66.3	308	530	58.1	3,828	12,685	30.2	428	960	44.6
By age (years)												
0-1	220	357	61.6	25	43	58.1	1121	4577	24.5	152	358	42.5
2-3	215	308	69.8	175	257	68.1	1599	4352	36.7	178	345	51.6
4-7	46	60	76.7	108	230	47.0	1108	3756	29.5	98	257	38.1
By sex												
Female	217	358	60.6	109	215	50.7	1778	5986	29.7	226	483	46.8
Male	264	367	71.9	199	315	63.2	2050	6699	30.6	202	477	42.3
By race												
Black	143	192	74.5	110	152	72.4	1075	2735	39.3	130	195	66.7
White	301	405	74.3	160	262	61.1	1601	3992	40.1	162	288	56.3
Other	19	37	51.4	29	46	63.0	331	972	34.0	94	145	64.8
Unknown	18	91	19.8	9	70	12.9	821	4986	16.5	42	332	12.7
By season												
June-August	151	220	68.6	89	153	58.2	1227	3856	31.8	132	307	43.0
Other months	330	505	65.3	219	377	58.1	2601	8829	29.5	296	653	45.3
By remediation phase[b] of the property where the blood lead sample was collected												
1999-2004 (≥ 1200 ppm)	188	208	90.4	141	205	68.8	325	476	68.3	79	202	39.1
2005-2009 (≥ 800 ppm)	142	199	71.4	133	229	58.1	558	1339	41.7	239	504	47.4
2010-2017 (≥ 400 ppm)	46	90	51.1	34	96	35.4	362	1256	28.8	110	254	43.3
Never eligible (< 400 ppm)	105	228	46.1	n/a	n/a	n/a	2583	9614	26.9	n/a	n/a	n/a
By census tract level median income												
0-40 K	440	641	68.6	291	484	60.1	3218	9979	32.2	393	862	45.6
≥40 K	41	84	48.8	17	46	37.0	610	2706	22.5	35	98	35.7
By census tract level percent house built before 1940												
0-50%	109	192	56.8	80	125	64.0	1149	4447	25.8	91	213	42.7
≥50%	372	533	69.8	228	405	56.3	2679	8238	32.5	337	747	45.1

%EBLL= percentage elevated blood lead level greater than 5 µg/dL; SLL = soil lead level.

[a] The focus area boundary delineates the area where 1 in 20 properties are expected to have soil lead levels that exceed 400 ppm.

[b] Remediation phase refers to time periods associated with a particular soil lead level (SLL) required for a property to be eligible for remediation.

Table S11. Estimated Odds Ratios (95% Confidence Interval) for elevated blood lead levels (EBLLs) using capillary ($EBLL_{10}$) and venous ($EBLL_5$) measurements separately from children in the remediation group within the focus area, Omaha Nebraska (1999-2016).

Sample type	Contrast: First category vs. Second category	N ≥ threshold / N < threshold		OR (95% CI)
		First category	Second category	
Capillary[a] Threshold = 10 µg/dL N=89,492	Pre in the Remediation group vs. Post in the Remediation group	339/4170	104/4437	2.68 (2.14, 3.37)
	Post in the Remediation group vs. Comparison group	104/4437	1780/68752	1.10 (0.87, 1.40)
	Post-Only group vs. Post in the Remediation group	245/9886	104/4437	1.01 (0.79, 1.30)
	Post-Only group vs. Comparison group	245/9886	1780/68752	1.12 (0.91, 1.37)
Venous[b] Threshold = 5 µg/dL N=14,900	Pre in the Remediation group vs. Post in the Remediation group	481/244	308/222	1.66 (1.23, 2.24)
	Post in the Remediation group vs. Comparison group	308/222	3828/8857	2.20 (1.65, 2.94)
	Post-Only group vs. Post in the Remediation group	428/532	308/222	0.90 (0.61, 1.33)
	Post-Only group vs. Comparison group	428/532	3828/8857	1.99 (1.42, 2.78)

BLL=blood lead level; $EBLL_5$: BLL ≥ 5 µg/dL; $EBLL_{10}$: BLL ≥ 10 µg/dL; OR=odds ratio; CI=confidence interval; dL=deciliter; µg/dL=micrograms per deciliter; GEE = generalized estimating equation.

[a]GEE models for capillary samples used exchangeable correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage housing built before 1940.

[b]GEE models for venous samples used the independent correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage of housing built before 1940.

Table S12. Percentage of elevated blood lead levels (EBLLs) by children's characteristics in the comparison group (i.e., children who had only pre-remediation blood lead measurements) before and after 6/29/2009[a]. All children reside within the focus area[b], greater Omaha Nebraska (1999-2016).

	Comparison Group - Capillary $EBLL_{10}$						Comparison Group - Venous $EBLL_5$					
	before 6/29/2009			after 6/29/2009			before 6/29/2009			after 6/29/2009		
	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%	EBLL(n)	BLL(N)	%
Overall	1496	36095	4.1	284	34437	0.8	3460	10687	32.3	368	1998	18.4
By age (years)												
0-1	517	12058	4.3	106	9965	1.1	1014	3955	25.6	107	622	17.2
2-3	593	12844	4.6	116	12576	0.9	1446	36336	39.8	153	716	21.4
4-7	386	11193	3.4	62	11897	0.5	1000	3096	32.3	108	660	16.4
By sex												
Female	676	17745	3.8	130	16849	0.8	1602	5070	31.6	176	916	19.2
Male	820	18350	4.5	154	17588	0.9	1858	5617	33.1	192	1082	17.7
By race												
Black	370	6005	6.2	50	3738	1.3	1011	2527	40.0	64	208	30.8
White	812	15860	5.1	113	8545	1.3	1483	3715	39.9	118	277	42.6
Other	79	1388	5.7	30	1236	2.4	246	536	45.9	85	436	19.5
Unknown	235	12842	1.8	91	20918	0.4	720	3909	18.4	101	1077	9.4
By season												
June-August	609	10635	5.7	101	9530	1.1	1096	3236	33.9	131	620	21.1
Other months	887	25460	3.5	183	24907	0.7	2364	7451	31.7	237	1378	17.2
By remediation phase[c] of the property where the blood lead sample was collected												
1999-2004 (≥ 1200 ppm)	100	482	20.7	0	0	n/a	325	476	68.3	0	0	n/a
2005-2009 (≥ 800 ppm)	275	3506	7.8	0	0	n/a	558	1337	41.7	0	0	n/a
2010-2017 (≥ 400 ppm)	98	4026	2.4	17	1142	1.5	355	1211	29.3	7	45	15.6
Never eligible (< 400 ppm)	1023	28081	3.6	267	33264	0.8	2222	7663	29.0	361	1951	18.5
By census tract level median income												
0-40 K	1221	25537	4.8	222	23246	1.0	2938	8493	34.5	280	1486	18.8
≥40 K	275	10558	2.6	62	11191	0.6	522	2194	23.8	88	512	17.2
By census tract level percent house built before 1940												
0-50%	456	13234	3.4	102	15461	0.6	1037	3818	27.2	112	629	17.8
≥50%	1040	22861	4.5	182	18976	1.0	2423	6869	35.3	256	1369	18.7

$EBLL_5$: elevated blood lead level greater than 5 µg/dL; $EBLL_{10}$: elevated blood lead level greater than 10 µg/dL; µg/dL=micrograms per deciliter; SLL = soil lead level.

[a] The median date for properties that underwent remediation

[b] The focus area boundary delineates the area where 1 in 20 properties are expected to have soil lead levels (SLLs) that exceed 400 ppm

[c] Remediation phase refers to time periods associated with a particular SLL required for a property to be eligible for remediation.

Table S13. Estimated Interaction Odds Ratios (95% Confidence Intervals) for elevated blood lead levels (EBLLs) using capillary ($EBLL_{10}$) and venous ($EBLL_5$) measurements separately for children withing the focus area, Omaha, Nebraska (1999-2016).

Sample type	Contrast	N ≥ threshold /N< threshold		OR (95% CI)
		Pre	Post	
Capillary[a] **Threshold =** 10 µg/dL N=79,582	Interaction[c]	n/a	n/a	2.18 (1.65, 2.90)
	Pre vs. Post in the Remediation group	339/4170	104/4437	2.99 (2.37, 3.78)
	Pre vs. Post in the Comparison group	1496/34599	284/34153	1.37 (1.12, 1.67)
Venous[b] **Threshold =** 5 µg/dL N=13,940	Interaction[c]	n/a	n/a	2.26 (1.51, 3.38)
	Pre vs. Post in the Remediation group	481/244	308/222	1.60 (1.16, 2.20)
	Pre vs. Post in the Comparison group	3460/7227	368/1630	0.71 (0.53, 0.95)

BLL=blood lead level; $EBLL_5$ is BLL ≥ 5 µg/dL; $EBLL_{10}$ is BLL ≥ 10 µg/dL; OR=odds ratio; CI=confidence interval; dL=deciliter; µg/dL=micrograms per deciliter; GEE = generalized estimating equation.

[a]GEE models for capillary samples used exchangeable correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage housing built before 1940.

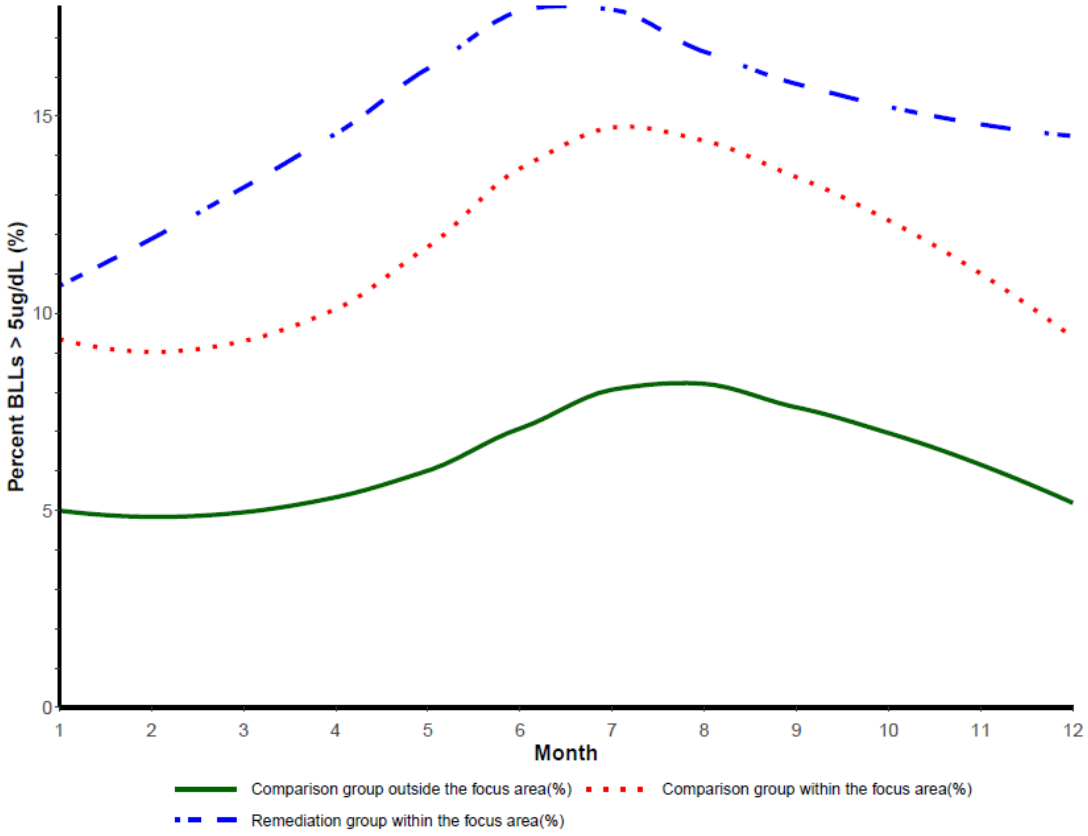
[b]GEE models for venous samples used the independent correlation structure adjusted for year, season, age, sex, remediation phase, census tract level median income, census tract level percentage of housing built before 1940.

[c]Interaction OR may be regarded as assessing the association of EBLL with remediation after adjusting for temporal trend; interaction ORs>1 imply pre-remediation proportion of EBLL is greater than the post-remediation proportion.

Table S14. The effect of remediation (pre- versus post comparison): parameter estimates for the model of Table 6 with or without adjustment for race.					
Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	273.4271	5.7787	262.1011	284.7530	<.0001
Pre in the remediation group vs. post in the remediation group	0.4969	0.0488	0.4013	0.5926	<.0001
Post in the remediation group vs. comparison group	0.0726	0.0632	-0.0513	0.1966	0.2507
Post-only group versus post in the remediation group	0.1392	0.0535	0.0342	0.2441	0.0093
Age (years) (categorical)					
0-1	0.2903	0.0289	0.2338	0.3469	<.0001
2-3	0.3163	0.0259	0.2656	0.3670	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	.
Sex (categorical)					
Male	0.1815	0.0245	0.1336	0.2295	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	.
Race (categorical)					
Black	0.2799	0.0365	0.2083	0.3514	<.0001
Unknown or other	-0.2492	0.0274	-0.3029	-0.1955	<.0001
White (referent)	0.0000	0.0000	0.0000	0.0000	.
Sample Year	-0.1374	0.0029	-0.1431	-0.1318	<.0001
Sample Season	0.3032	0.0225	0.2591	0.3473	<.0001
Remediation phase (categorical)					
1999-2004	0.5202	0.0389	0.4440	0.5963	<.0001
2005-2009	0.1899	0.0379	0.1157	0.2641	<.0001
2010-2017	0.8739	0.0626	0.7513	0.9965	<.0001
Never eligible for remediation (referent)	0.0000	0.0000	0.0000	0.0000	.
Not Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	286.9470	5.6408	275.8914	298.0027	<.0001
Pre in the remediation group vs. post in the remediation group	0.5336	0.0489	0.4378	0.6294	<.0001
Post in the remediation group vs. comparison group	0.1147	0.0631	-0.0089	0.2383	0.0689
Post-only group versus post in the remediation group	0.1311	0.0536	0.0260	0.2362	0.0145
Age (years) (categorical)					
0-1	0.2621	0.0288	0.2057	0.3185	<.0001
2-3	0.3152	0.0259	0.2644	0.3659	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	.
Sex (categorical)					
Male	0.1804	0.0244	0.1325	0.2283	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	.
Sample Year	-0.1442	0.0028	-0.1497	-0.1387	<.0001
Sample Season	0.3077	0.0225	0.2636	0.3519	<.0001
Remediation phase (categorical)					
1999-2004	0.5120	0.0389	0.4358	0.5882	<.0001
2005-2009	0.1764	0.0379	0.1022	0.2506	<.0001
2010-2017	0.8707	0.0625	0.7482	0.9932	<.0001
Never eligible for remediation (referent)	0.0000	0.0000	0.0000	0.0000	.
Census tract level Income	0.1112	0.0259	0.0605	0.1619	<.0001
Census tract level pre-1940 housing	-0.4575	0.0290	-0.5144	-0.4007	<.0001

Table S15. Time by intervention interaction analysis: parameter estimates for the model of Table 8 with or without adjustment for race					
Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	228.7396	8.8043	211.4836	245.9957	<.0001
Pre-versus post in the comparison	0.3179	0.0466	0.2266	0.4091	<.0001
Pre-versus post in the remediation group	0.1718	0.0669	0.0407	0.3030	0.0102
Interaction	0.2041	0.0747	0.0576	0.3506	0.0063
Age (years) (categorical)					
0-1	0.2591	0.0306	0.1991	0.3192	<.0001
2-3	0.3080	0.0271	0.2548	0.3612	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	.
Race (categorical)					
Black	0.2290	0.0382	0.1541	0.3038	<.0001
Unknown or other	-0.2173	0.0292	-0.2744	-0.1601	<.0001
White (referent)	0.0000	0.0000	0.0000	0.0000	.
Sex (categorical)					
Male	0.1871	0.0259	0.1363	0.2379	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	.
Sample Year	-0.1153	0.0044	-0.1238	-0.1067	<.0001
Sample Season	0.3135	0.0237	0.2670	0.3600	<.0001
Remediation phase (categorical)					
1999-2004	0.5438	0.0401	0.4651	0.6225	<.0001
2005-2009	0.1048	0.0404	0.0256	0.1840	0.0095
2010-2017	1.0448	0.0776	0.8927	1.1970	<.0001
Never eligible for remediation (referent)	0.0000	0.0000	0.0000	0.0000	.
Not Controlling for Race					
Parameter	**Estimate**	**Standard Error**	**Lower 95% CI**	**Upper 95% CI**	**Probability > |Z|**
Intercept	234.1830	8.7884	216.9581	251.4079	<.0001
Pre-versus post in the comparison	0.3617	0.0465	0.2705	0.4528	<.0001
Pre-versus post in the remediation group	0.2251	0.0667	0.0944	0.3558	0.0007
Interaction	0.1653	0.0746	0.0190	0.3115	0.0268
Age (years) (categorical)					
0-1	0.2338	0.0305	0.1740	0.2937	<.0001
2-3	0.3070	0.0272	0.2537	0.3603	<.0001
4-7 (referent)	0.0000	0.0000	0.0000	0.0000	.
Sex (categorical)					
Male	0.1858	0.0259	0.1350	0.2365	<.0001
Female (referent)	0.0000	0.0000	0.0000	0.0000	.
Sample Year	-0.1180	0.0044	-0.1266	-0.1094	<.0001
Sample Season	0.3186	0.0237	0.2721	0.3651	<.0001
Remediation phase (categorical)					
1999-2004	0.5386	0.0401	0.4600	0.6172	<.0001
2005-2009	0.0891	0.0404	0.0099	0.1683	0.0274
2010-2017	1.0498	0.0778	0.8973	1.2022	<.0001
Never eligible for remediation (referent)	0.0000	0.0000	0.0000	0.0000	.
Census tract level Income	0.1401	0.0270	0.0872	0.1931	<.0001
Census tract level pre-1940 housing	-0.4528	0.0301	-0.5118	-0.3938	<.0001

Figure S1. Monthly average percentage of capillary blood lead measurements that equal or exceed 5 µg/dL (%EBLL$_5$) (averaged over years) for children in the remediation group within in the focus area (blue, dotted and dashed), in comparison group within in the focus area (red, dotted), and in the comparison group outside the focus area (green, solid) in Omaha NE, 1999-2016.



	Monthly estimated percentage of children with elevated blood lead level of 5 μg/dL		
Month	Remediation group within focus area (n= 9050)	Comparison group within focus area (n= 70532)	Comparison group out of focus area (n= 39626)
January	10.8	9.4	5.0
February	11.9	9.1	4.8
March	13.2	9.3	5.0
April	14.5	10.1	5.3
May	16.1	11.7	6.0
June	17.6	13.6	7.1
July	17.7	14.6	8.0
August	16.7	14.3	8.2
September	15.9	13.4	7.5
October	15.3	12.3	6.9
November	14.8	11.0	6.2
December	14.3	9.5	5.3