SOURCES OF LEAD AND SELECTED OTHER HEAVY METALS IN WILLIAMSBURG SOILS, BROOKLYN, NEW YORK

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Concern exists that soil in the Wiliamsburg section of Brooklyn, New York, because of restorative repairs to the Williamsburg Bridge, is being extensively contaminated with lead. Even with the protective draping of successive areas that underwent recent sand blasting, the paint litter that results from the present program of structural maintenance, and the planned use of leaded paint in repainting the bridge has the potential to contaminate Williamsburg houses, stores, playgrounds, school yards and parks with leaded dust and paint chips. Flame atomic absorption spectrophotometric (AAS) analysis of Williamsburg soil for lead and other toxic heavy metals indicates that although the Williamsburg Bridge is a source of soil–Pb, soil–Cu, and soil–Zn, it is not the only source of those metals, nor is it the major source for soil–Pb in the Williamsburg section of Brooklyn. Instead, the principal source of lead, and possibly also of copper and zinc contamination in Williamsburg soils is the Broadway elevated rapid transit line (ERTL).

Sinelnikov (1993) ascribed high soil–Pb concentrations under Brooklyn's McDonald Avenue ERTL to viscous leaded paint and primers routinely used to provide maximum protection against corrosion in the maintenance of this steel structure. Because of similar construction and maintenance histories and other maintenance conditions (Cunningham and DeHart, 1977), Sinelnikov (1993) suggested that other elevated train line structures, and perhaps even elevated highways are previously unrecognized significant sources of environmental lead contamination (Harris *et al.*, in preparation).

Twenty-seven soil samples were collected from relatively undisturbed sites at considerable distance from elevated steel structures, and from under and next to such structures in the Williamsburg section of Brooklyn, New York. Soil–Pb, –Cu, and –Zn show similar distribution patterns. Up to 77 x more lead, 13 x more copper, and 4 x more zinc were found in soil under and next to the Broadway ERTL, the Williamsburg Bridge and the Brooklyn–Queens Expressway (BQE) viaducts when compared to lead (0.36 mg Pb/g soil), copper (0.078 mg Cu/g soil) and zinc (0.54 mg Zn/g soil) background levels characteristic of undisturbed sites in the eastern part of the sampling area. Mechanical disturbance, recent sand blasting, and painting of some portions of Williamsburg elevated steel structures have dispersed leaded paint dust and residue chips to soil under and next to such structures. This is documented by the greater concentrations of lead in soils collected from beneath recently sand blasted or painted sections of the Broadway ERTL (28 mg Pb/g soil), as compared to smaller concentrations of lead in soil from under portions of this ERTL that had not recently been painted (1.6 mg Pb/g soil), or in soil to either side of the ERTL. Copper may be formulated as a fungicide in the leaded paint used on these elevated structures.

The Broadway ERTL is a major linear source of lead, copper and zinc contamination, whereas the Williamsburg Bridge and the BQE are important, but secondary sources of lead, copper and zinc in Williamsburg soil. Galvanized fences and other Zn–coated metal structures locally contribute considerable zinc to Williamsburg soil. In contrast to the considerable variation in soil–Pb, –Cu, and –Zn concentrations from one site to another, soil–Cd concentration is uniformly low (0.002 – 0.01 mg Cd/g soil) throughout the sampling area. Thus, Cd as a pigment was not used in the paint for the maintenance of the elevated steel structures. Some of the cadmium in Williamsburg soil is possibly related to the presence of cadmium in zinc-metal coatings. Most, however probably is the result of atmospheric fallout of airborne particulates derived from areas west of Williamsburg.

Lead and copper in most of the Williamsburg soil sampled is at dangerously high concentrations concerning human health. Twenty-three of the soil samples exceeded the soil–Pb screening level (0.4 mg Pb/g soil) (USEPA, 1989), and all the samples exceeded the soil–Cu preliminary remediation goal (0.039 mg Cu/g soil) (USEPA, 1991). Williamsburg soils contain up to 69 times more Pb and up to 26 times more Cu than these U. S. E. P. A. regulatory levels. Zn and Cd concentrations were smaller than U. S. E. P. A. preliminary remediation goals for these metals (USEPA, 1991). The screening level for Pb is designed for residential land use to protect children from soil-Pb ingestion and translates to 10 μg Pb/dl blood. A child would need to eat 100 mg soil/day for 6 years to achieve that blood concentration. Preliminary remediation goals are based on ingestion of 200 mg soil/day for 6 years. This quantity is equivalent to the toxicity of reference doses used in epidemiological studies on lab animals extrapolated to humans for non-carcinogens and then back-calculated to concentration in soil.

Adults typically retain less than 10% of the lead that they ingest, whereas children absorb 50% (Nadakavokaren, 1984). Lead paint is most hazardous to children of ages 1–7 years as they are more prone to ingest soil particles than are adults (Binder and Falk, 1991). A child can become severely poisoned (60–80 μg Pb/dl blood) by ingesting 1 mg of lead-paint dust/day, equivalent in size to about three granules of sugar. Lead is initially absorbed in the blood and is then slowly redistributed and accumulated in bone. For the maximum lead concentration in Williamsburg soil, a child would need to eat only 1.4 mg soil/day (the size equivalent of about three granules of sugar) for 6 years to exceed the 10 μg Pb/dl blood level that would result at the U. S. E. P. A. screening level of 0.4 mg Pb/g soil.

Soil-Pb probably is not the only lead source to which Williamsburg children are exposed. Lead might be present in the air that they breathe, the food that they eat, and the tap water that they drink. Ingestion of Williamsburg soil also could lead to a dietary intake of too much copper as compared to zinc. A high tissue copper level in conjunction with a copper/zinc tissue imbalance could adversely affect the child's normal biological functions and metabolic activity.

Binder, S. and Falk, H. (1991) Strategic Plan for the Elimination of Childhood Lead Poisoning, Centers for Disease Control, DHHS/PHC, Atlanta, GA.

Cunninghamn and DeHart (1977) A History of the New York City Subway System. Part 3, The Independent Subway and City Ownership, New York.

Harris, W.H., Amaach, N.H., Sinelnikov, A. Kramer, C., Kaye, S., and Seidemann, D. S. (in preparation) Elevated steel viaduct and rapid transit structures: Potential sources of soil lead, copper, tin and zinc contamination.

Nadakavokaren, A. (1984) Man and the Environment: A Health Perspective, 2nd ed. Illinois State University.

Sinelnikov, A. (1993) Elevated rapid transit structures: Potential sources of soil lead contamination, Science and Technology Entry Program, Brooklyn College.

U. S. E. P. A. (1989) Risk Assessment Guidance for Superfund, Complimentary v. 1, Part A, Human Health Evaluation Manual, EPA/540/1-89/002.

U. S. E. P. A. (1991) Risk Assessment Guidance for Superfund, Complimentary v. 1, Part B, Development of Risk-Based Preliminary Remediation Goals, Office of Research and Development, EPA/540/R-92/003.