# Reducing the Health Risks from Industrial Lead Pollution: Case study-based recommendations

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**Natural Resources Defense Council**
**June 2011**

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The Natural Resources Defense Council, known as NRDC, is an international environmental organization. Established in 1970, NRDC uses law, science and the support of 1.2 million members and online activists to protect the planet and ensure a safe and healthy environment for all living things.

NRDC has offices in New York, Washington, Beijing, Chicago, Los Angeles and San Francisco.

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# Acknowledgement

Over the past three years, NRDC has collaborated with a variety of partners in China and the USA to conduct a cross-disciplinary, multi-party case study to evaluate and assess the mechanisms and approaches to handling risk to human health from industrial lead pollution. The research activities included site investigations, interviews, seminars, literature reviews and research, and a study tour to the USA. Findings from these research activities have been reported and analyzed comprehensively in a final project report. Based on the data and findings from the investigations and the final project report, NRDC prepared this policy brief to summarize the issues identified from the legal and regulatory perspective, integrate the experiences and lessons from the US study tour and site investigation, and suggest possible ways forward.

If it were not for the diligent efforts of all our partners, this policy brief would not be possible. We would like to take a moment to give recognition and thanks for the hard work of all our partners:

- Zhongnan University of Economics and Law
- Yunnan Provincial Environmental Protection Bureau
- Yunnan Provincial Center for Disease Control and Prevention
- Yunnan Provincial Environmental Monitoring Central Station
- Tongji School of Medicine at Huazhong University of Science and Technology
- Center for Legal Assistance to Pollution Victims at the China University of Political Science and Law (“CLAPV”)
- All other experts that provided comments and suggestions for the development of this project.

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# I. Introduction: Case study project profile

In February 2008, NRDC began a cross-disciplinary, multi-party research investigation to evaluate and assess the approaches to handling the risks to human health from industrial lead pollution.[1] Working with Zhongnan University of Economics and Law, and Tongji School of Medicine at Huazhong University of Science and Technology (Tongji), NRDC partnered with two local government agencies, the Yunnan Provincial Center for Disease Control and Prevention (Yunnan CDC) and the Yunnan Provincial Environmental Monitoring Central Station (Yunnan EMCS), to carry out investigations in a lead-zinc mining/smelting region of Yunnan Province. The site chosen was a county area in Yunnan Province. The investigations involved multiple site visits and a multifaceted analysis following Figure I below. In total, the field investigations lasted two and a half years and provided a substantial basis from which to analyze the gaps in China's regulatory framework for preventing the risks to human health from industrial lead pollution.

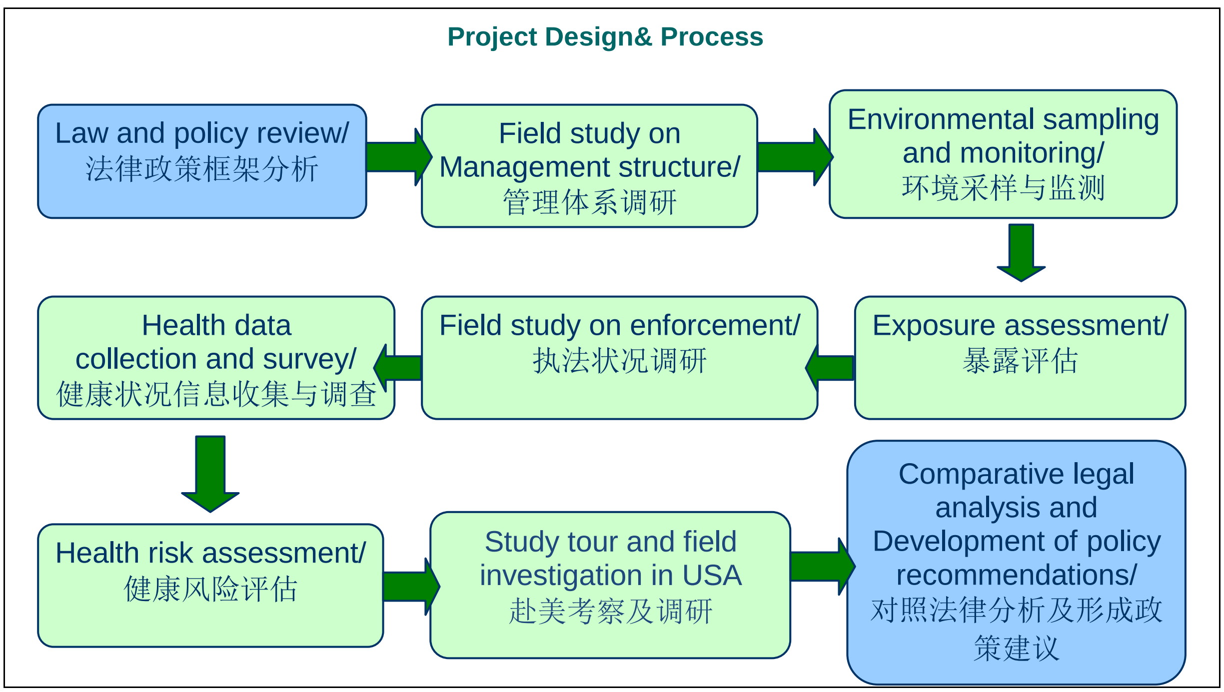


Figure I Lead Pollution Research Investigation Project Design and Process

Yunnan Province is the source of two-thirds of the mineral production in China, and holds the largest proven deposits of zinc, lead, tin, cadmium, indium, thallium, and crocidolite in China. The research team selected a mining area in Yunnan Province as the focal point for research in the hopes that lessons from this site will be applicable to other mining areas in the province (and

[1] For information on the health impacts of lead exposure, see "Toxicological Profile for Lead," U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry. Atlanta: Aug 2007. Available at http://www.atsdr.cdc.gov/toxprofiles/tp13.pdf.

across China). The largest single source of pollution in the area is a lead-zinc mine and smelter (*the Mine/Smelter*), which is also the only licensed lead industry source in that area. The *Mine/smelter* has mining operations and a large smelter in the study area, with an overall annual lead production capacity of 50,000 tons. A number of small villages are located relatively close to the *Mine/smelter*.

Our research project aimed to evaluate the approaches to health risk prevention against lead pollution in China, identify gaps in the regulatory framework and in practice, demonstrate the usefulness of health risk modeling techniques (such as the U.S. EPA IEUBK model), share findings and experiences from a study tour to the last primary lead smelter in the USA, located in Herculaneum, Missouri, and make preliminary recommendations and proposals - incorporating the international experience in a manner customized for China's unique circumstances. To meet these objectives, the team carried out exposure and risk assessment activities in the lead-zinc mining area. The Yunnan Provincial Environmental Monitoring Station sampled and tested the (i) crops, (ii) drinking water sources, (iii) soil, and (iv) dust, performed an exposure assessment on children in surrounding elementary schools to heavy metals (lead, cadmium, arsenic), and compared the exposure level to international and domestic standards. After the test and assessment, we found contaminated soil and the potential for high blood lead levels.

Based on the sampling results by the Yunnan Provincial Environmental Monitoring Station, the Yunnan Provincial Center for Disease Control and Prevention performed a child health impact survey of environmental pollution in this lead-zinc mining area in May 2009, aiming at understanding the level of children's exposure to the pollution, assessing the adverse effects and health risks caused by the pollutants, and providing the environmental protection and health agencies with the basis of any intervention strategies and measures, as well as relevant policies. The research team also examined the applicable laws and standards, and interviewed local environmental and public health officials of varying levels in Yunnan to learn about the gaps and problems with local environmental management and health risk prevention, as actually practiced in the field. Finally, we organized a study tour to the last primary lead smelter in the US.

The objective of this policy brief is to provide an independent, evidence-based analysis of the gaps in the local environmental and public health regulatory systems we found in the case study, and try to recommend what needs to be done to effectively reduce the health risks from lead pollution. This brief will:

- Articulate the specific gaps and deficiencies in the regulatory systems in practice that interfere with the protection of human health, based on our case study.
- Assess possible solutions drawn from experience with the Doe Run plant in the US.
- Provide a series of recommendations for how China can strengthen its lead management framework and reduce the health risks from lead pollution, including short-term responses for local affected areas, and medium- to long-term solutions of systemic public health and environmental regulatory deficiencies.

Our findings are based on investigations to the study area. However, we believe that our findings may not stand in isolation in the study area, and are indicative of problems with environmental health regulation and management of toxic metals in China generally.

# II. Key Findings in the Case Study: Gaps in the Environmental and Public Health Regulatory Systems

In order to understand the environmental health risks in the study area, we partnered with the Yunnan Environmental Monitoring Central Station (EMCS) to carry out sampling in the area from December 11, 2008 to January 7, 2009. Based on the local prevailing wind axis, Yunnan EMCS took samples at a total of nine locations, as displayed in Figure 2 below:

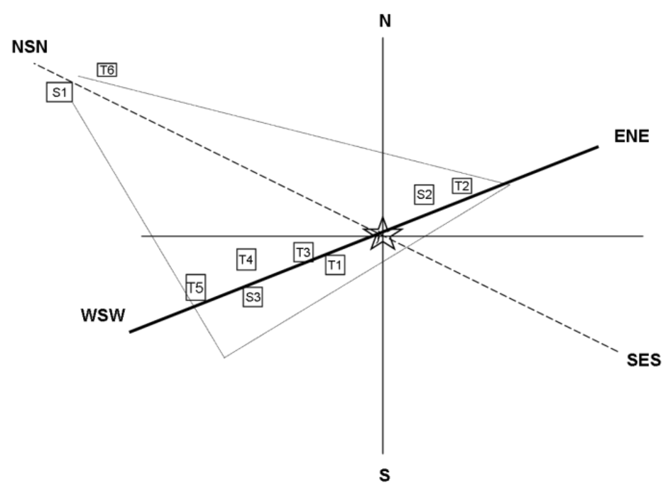


Figure 2 Sampling locations

In the graph above, the star in the center represents the primary source of pollution in the area, the *Mine/Smelter*. The thick line represents the primary and secondary prevailing wind directions. Among the nine sampling locations, six locations were village sites; five of these village locations were arrayed along the prevailing wind axis (T1, T2, T3, T4, and T5). T6, which was separated from *the Mine/Smelter* by a mountain range, was selected as a control site/background.[2] The other three locations were schools; two of the schools were located along the prevailing wind axis (S2, S3). School S1 was selected as a control site/background.[3]

Yunnan EMCS tested farmland soil and dust (in both schoolyards and classrooms), vegetables, and local tap water and underground (well) water. The results showed high levels of lead in vegetables, tap water, and well water, and particularly high lead levels in soil samples (farmland soil and schoolyard/classroom dust).

To compare the lead contamination found in the soil against a relevant environmental standard, the research team cited Class II and Grade 2 criteria according to China's *Environmental Quality*

[2] T1 is located 0.5km southwest of the *Mine/smelter*; T2 is located 0.8km northeast of the *Mine/smelter*; T3 is located 0.6km southwest of the *Mine/smelter*; T4 is located 1.2km southwest of the *Mine/smelter*; T5 is located 2.8km southwest of the *Mine/smelter*; T6 (the background point) is located 10.0km northwest of the *Mine/smelter*.
[3] S1 (the background point) is located 10km northwest of the *Mine/smelter*; S2 is located 0.6km northeast of the *Mine/smelter;* S3 is located 1.2 km southwest of the *Mine/smelter*.

*Standards for Soil* (GB 15618-1995). The Class II, Grade 2 criteria mainly apply to soil in regular farmlands, vegetable fields, tea gardens, orchards and pasturelands, which stipulates that when the soil pH value is ＞7.5, the lead content should be ≤350mg/kg.

Figure 3 Assessment of Lead Contamination in Surveyed Area

Unit: mg/kg

| Site of Sampling | Lead Content | Contamination Index | Grade of Contamination |
|---|---|---|---|
| T2 village | 2014 | 5.7 | Heavy |
| T5 village | 1281 | 3.6 | Heavy |
| T3 village | 872 | 2.4 | Med |
| T1 village | 1097 | 3.1 | Heavy |
| T4 village | 659 | 1.8 | Light |
| T6 village (control site) | 188 | 0.5 | No contamination |
| Playground at S2 school | 2393 | 6.8 | Heavy |
| Inside classrooms at S2 school | 2351 | 6.7 | Heavy |
| Playground at S3 school | 2095 | 5.9 | Heavy |
| Inside classrooms at S3 school | 1574 | 4.4 | Heavy |
| Playground at S1 school (control site) | 1099 | 3.1 | Heavy |
| Inside classrooms at S1 school (control site) | 687 | 1.9 | Light |

Virtually all of the soil and dust samples (from farmland soil and schoolyard/classroom dust) violated *Environmental Quality Standards for Soil* (GB 15618-1995) for lead.[4] Only the three farmland soil samples from the control location at T6 Village did not exceed standards.

In addition, 36 vegetable samples were tested and found that 83% of the samples exceeded the national standard for lead as defined in *Maximum Levels of Contaminants in Food* (《食品中污染物限量》GB2762-2005). These vegetable samples were grown at the sampled sites, and testing indicated that the lead standard was surpassed by a significant margin, ranging from 5.8 to 15.4 times the level defined by law. Lead levels in tap water in three villages tested exceeded national standards by 1.9 to 3.9 times.

The environmental testing results showed that our case study site faces a serious lead pollution problem, particularly in schoolyard and classroom dust and locally grown vegetables. The elementary school dust, farmland soil, vegetables, and tap water are all potential pathways for lead and other heavy metals to enter the bodies of local residents, particularly local children, and the high levels of contamination indicate a very high likelihood of serious exposure to lead contamination and a high degree of health risk.

[4] GB 15618-1995 *Environmental Quality Standards for Soil*. These standards technically do not apply to schoolyard/classroom dust, but nonetheless give an indication of the severity of contamination.

In order to measure the degree of health risk, Tongji estimated the daily intake of dust, food, and water for elementary school-age children, utilizing the results of the environmental sampling and testing by Yunnan EMCS. NRDC introduced the U.S. EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) model for estimating exposure to lead in children as a potential method to identify health risk in China. The model allows for a reasonably accurate estimate of the probability of exceeding blood lead action levels (10 μg/dL) in the population studied by inputting the basic environmental monitoring data our partners were able to obtain in the case study. According to the IEUBK model's prediction of the blood-lead level of children at case study survey points, the children from all three elementary schools were predicted to be at risk for high blood-lead levels (>10 ug/dL). The hand-mouth pathway was identified as an important pathway for ingestion of lead among children at survey locations. Food was identified as the secondary pathway for the children to ingest lead. Among those pathways, 77 ~ 87% of lead came from dust, while 13 ~ 23% of lead came from vegetables.[5] In short, the environmental monitoring conducted at the case study site showed highly contaminated soil and dust, which presented a high degree of health risk.

The process and results obtained from identifying lead contamination levels and related health risks in the study area, in combination with extensive interviews with local officials, serve as the foundation of this brief's gap analysis for the environmental and public health regulatory systems for industrial lead pollution management.

### *Guiding Framework for the Gap Analysis*

Environmental health risk control must integrate both environmental management and public health management; hence, it cannot be carried out through a freestanding regulatory system or one singular agency. It is by nature a multi-faceted process. To conceptualize our approach to control environmental health risks and to link these two arms of environmental health risk governance, we have introduced a four-step risk control framework displayed in the figure below:

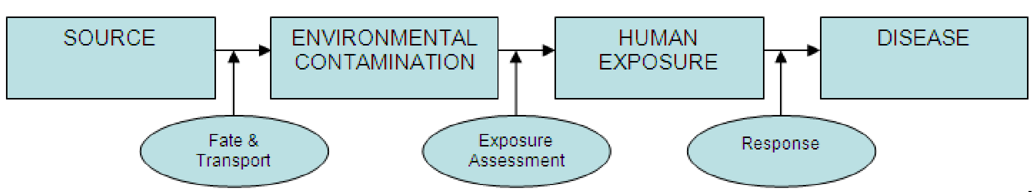


Figure 4 Four-Step Risk Control Framework

This figure shows the causal chain between the source of pollution and human disease, distilled into four steps. Below we describe the process of risk measurement at each step for purpose of assessing health risks, as well as regulatory approaches that could be performed to control risk.

1) **Pollution source.**
   - **Measurement**: The amount of pollution emitted can be ascertained either through monitoring of actual emissions/discharge data, or estimation of emission based on "emissions factors" and known data, or estimates based on production levels.

[5] Although these preliminary results contain a number of uncertain factors, the predictive power of the model indicates blood-lead testing should be performed for local children to make sure that there is no ongoing lead poisoning.

- **Regulatory approaches**: The pollution from industrial sources can be reduced through emission standards, permitting, and incentives such as requiring polluters to pay. China also requires industrial pollution sources to fulfill "three simultaneous" requirements (“三同时”), which require installation of pollution control facilities to reduce pollution before initiating industrial operation. [6]

2) **Environmental contamination.**
   - **Measurement:** Environmental contamination caused by pollution sources can be determined through actual measurement of pollution in the ambient environment, or through modeling based upon data of local wind patterns, weather, etc.
   - **Regulatory approaches:** Environmental contamination can be controlled through ambient environmental quality standards and accompanying implementation schemes such as monitoring; planning; contamination cleanup and site remediation; imposition of additional pollution controls or shutdown of the pollution source; and environmental impact assessment. In addition, China has a unique "total emission control" (“总量控制”) approach to set a ceiling of total emissions from all pollution sources in an area over a certain period. However, the total emission control has not been applied to lead or any other heavy metal pollutants yet. [7]

3) **Human exposure.**
   - **Measurement:** Human exposure to environmental contamination can be measured through biological monitoring (e.g., hair, urine, blood), or through modeling exposure estimation based upon knowledge or assumptions regarding food, air and water intake.
   - **Regulatory approaches:** Tools to reduce and control human exposure to pollution include, but are not limited to, exposure assessments; public health interventions (such as public education to provide practicable self interventions to reduce exposure); providing public sanitary equipment as needed; medical intervention; and other tools to reduce human exposure such as site remediation and controlling pollution at its source.

4) **Disease assessment.** Once human exposure is known, an assessment of health risk can be made based on existing standards and data, or a full-blown epidemiological study can be conducted to determine the impact of certain levels of pollutants on human health.

The purpose of our study is to identify the gaps and loopholes in the environmental and public health management systems that prevent an effective reduction in health risks resulting from industrial lead pollution through the case study. Our study focuses on programs and regulatory tools that can be utilized to reduce risk, pollution, and exposure during the first three steps: (i) the pollution source; (ii) contamination of the environment; and (iii) human exposure. We did not address the fourth stage because it was beyond the scope of the project. Although risk assessment tools are crucial for health risk control, these tools will not be a principal focus in this report. Our objective was to focus on the regulatory and management tools to prevent or minimize human exposure to toxic chemicals.

[6] "Three simultaneous" requirements (“三同时”) is a unique tool utilized in Chinese law. It applies to all new construction projects, and the modification or expansion of existing construction projects. It requires the pollution control facilities and other environmental protection facilities to be designed and constructed in concert with the remainder of the facility.

[7] The pollutants subject to total emission control during the 11th Five-Year Period were COD and $SO_2$, and the pollutants for the 12th Five-Year Period are COD, $SO_2$, NOx, and ammonia nitrogen.

The results of the site investigation in the study area indicate a range of gaps in the health risk identification system and environmental regulation system in each key area of the causal chain. We also found that China currently has a number of environment regulatory tools in existence that have been, or could be, employed to address lead health risk more effectively; the gaps, however, mostly remain in the implementation and enforcement of existing laws, regulations, and standards.

**Our primary findings in the study area are:**

- **In general, an overarching mechanism for identifying or controlling environmental health risk is yet to be firmly established**. **Pollution source controls are insufficient for health risk prevention or not enforced.** The mere existence of industrial emission standards does not guarantee elimination of health risks; even if standards were effective in this regard, loose enforcement renders them weak.
- **Ambient environmental quality control is inadequate for propose of preventing health risks.** We found no systematic approach to health-oriented environmental quality control. Even in a lead smelting region, there was no systematic attempt to assess and meet ambient air quality standards for lead by environmental agencies.
- **National pollution reduction targets have a great impact on the local authorities in prioritizing regulatory actions.** The enforcement of environmental laws and standards targets the main pollutants, especially $SO_2$ and COD, subject to total emission control. This influenced industrial emission standard enforcement, pollution fee collection, air quality monitoring and evaluation, and permitting, with lead and other heavy metals overlooked to some extent in regulatory actions and enforcement.
- **The process for siting new smelters does not yet ensure a sufficient buffer between the facility and the affected public.** Controlling fugitive emissions from sources such as smelters can be very challenging, thus the first line of protection is to avoid human exposure in the first place by isolating the pollution source as much as reasonably possible. However, the planning processes in place do not appear sufficient to keep vulnerable populations out of harm's way.
- **Monitoring is sporadic and not comprehensive**. Both ambient and facility-level monitoring is sporadic and not generally carried out for heavy metals, nor was regular monitoring of soil and crop pollution implemented.
- **Soil Pollution is severe but untreated.** Although our research in the study area showed very high pollution (exceeding national standards), environmental officials did not regularly monitor soil for lead pollution, nor was there any history of taking action for soil pollution**.**
- **Systematic health risk assessment and intervention systems barely exist.** There was no systematic public health education or approach to assessing lead poisoning risks for vulnerable populations (e.g., children).

These gaps will be discussed below from each area of the four-step framework.

***Gaps in Environmental and Public Health Regulatory Systems in the Case Study***

**a. Pollution source: the industrial air emission standard and its enforcement have not been adequate to prevent health risks posed by lead smelters.**

Lead air emissions from the *Mine/Smelter* in the study area were identified as the primary cause of lead pollution in that area.[8] The primary approach to reduce the pollution from industrial sources is to control emissions at a certain level. However, we saw from the site investigation that the current industrial air emission standard—the *Emission Standard of Air Pollutants for Industrial Kiln and Furnace* (《工业炉窑大气污染物排放标准》GB9078-1996) - did not seem to provide satisfactory lead emission control. We found at the study area that ambient soil quality standards were not met, even though the *Mine/smelter*, the only licensed lead facility in the study area, was consistently meeting industrial emission standards. Below are some factors we identified as potential reasons that this continues to occur. These factors, together or alone, contributed to lead pollution in the study area.

First, monitoring of industrial lead emission compliance was inadequate. Based on our interviews, lead in industrial air emissions were not regularly monitored, and routine monitoring was typically limited to sulfur dioxide, suspended particulates, and large particulates (PM10). Sulfur dioxide was part of a national reduction target, and our interviews corroborated that this was a focus of enforcement activity, whereas lead and other heavy metals were not. To local officials, a claim of industry's compliance with an air emission standard could vaguely imply meeting the limit for $SO_2$, but not for heavy metals.[9] Industrial lead air emissions might be tested during the "three simultaneous" verification processes and/or during environmental impact assessment reviewing processes before the industrial facility begins operation. However, it was unclear whether such emissions were then monitored on an ongoing basis after the verification and EIA approval.

Second, permits did not play an effective role in decreasing lead pollution. Permitting should be a crucial tool to enforce standards and reduce emissions. However, China has yet to develop a comprehensive permitting program. Permits are currently used as a tool for total emission control. Generally, there are two requirements in a permit, in the form of two figures: the pollutant emission allowance under total emission control; and the pollutant concentration limit which is the same as in the emission standard. Yunnan province has promulgated provincial permitting regulations that set forth requirements for nonferrous-metal smelting[10]; namely, lead, arsenic, and cadmium are characteristic pollutants and should be included in a permit.[11] However, in practice, lead and other heavy metals have only been included in water permits in the study area. Although air emissions are the primary source of lead pollution, air permits only list $SO_2$, smoke, and dust. Accordingly, enforcement action for air permit compliance, such as routine inspections and annual permit review, did not cover lead at all, and no other mechanism

[8] The *Mine/smelter* recycled waste water generated from operation. The waste residue from the smelter has been gathered in the slag pile. Therefore, NRDC and our partners focused on air emissions.
[9] It is important to note that lead, arsenic, copper, cadmium, and chromium were monitored in water.
[10] See Yunnan Sheng Pai Fang Wu Ran Wu Xu Ke Zheng Guan Li Ban Fa (Shi Xing) 《云南省排放污染物许可证管理办法（试行）》, Yunnan Provincial Administrative Measures on Pollutant Discharge Permit (trial); Yunnan Sheng Shi Shi Pai Wu Xu Ke Zheng Zhi Du Ji Shu Zhi Nan《云南省实施排污许可证制度技术指南》, Yunnan Provincial Technical Guidance on Implementing Pollutant Discharge Permit.
[11] Ibid, Yunnan Sheng Shi Shi Pai Wu Xu Ke Zheng Zhi Du Ji Shu Zhi Nan《云南省实施排污许可证制度技术指南》, section four.

was utilized for enforcing lead ambient air quality standards. Moreover, regulation of small illegal smelters in the area was apparently even more problematic.

Third, fugitive emissions in industrial smelter areas are essentially ignored. Fugitive emissions can be a substantial source of lead contamination at smelter sites. The *Emission Standard of Air Pollutants for Industrial Kiln and Furnace* (《工业炉窑大气污染物排放标准》GB9078-1996) has stipulated a ceiling for lead concentration in fugitive emissions.[12] However, control of fugitive emissions appeared to be ignored in the study area. For example, we saw vehicles transporting minerals in and out the *Mine/Smelter* area, but no measures were taken to prevent transportation-related fugitive emissions from contaminating the environment.

Lastly, Yunnan province has not developed local industrial emission standards that take into consideration the higher risks prevalent in lead-zinc mining areas as opposed to other areas. The effective national industrial air emission standard during our investigation, *Emission Standard of Air Pollutants for Industrial Kiln and Furnace* (GB9078-1996), only limits pollutant (including lead) concentration in emissions but does not limit total loading to the environment.[13] This pollutant concentration-based standard was not enough to force industrial sources to reduce lead emissions to the maximum degree. Nor did it consider accumulated pollution in concentrated industrial areas. Lead emissions in the air easily deposit and accumulate in nearby soil; this transfer of lead from air emissions to soil has not been addressed, in industrial air emission standards or in soil quality standards. Though industrial sources may be in compliance with air emission stack limits, the attainment of ambient standards for air or other media still cannot be ensured, in the case of pollutant transfer.

**b. Environmental contamination: a health-oriented environmental quality and health risk control has not been firmly established**

***i. Environmental contamination: environmental health risks from lead pollution are only addressed in part, if at all, during planning.***

Government planning is a crucial stage for prevention of health risk prior to the operation of polluting sources. Zoning, siting, and environmental impact assessments (EIA) are useful tools that could be used during planning to prevent and control pollution and reduce human health risks. Sound planning requires reasonable and careful site selection, a safe distance between lead smelters and nearby communities, particularly sensitive areas such as villages and schools, and effective lead emission control measures when necessary. The State Council promulgated *Regulations on Environmental Impact Assessment on Planning* (规划环境影响评价条例) (the Regulations) in late 2009, which requires land use planning, regional (watershed) development planning, and other sector development planning such as industrial planning, agricultural planning, and natural resources development planning to prepare environmental impact assessments.[14] Since the Regulations are in place for less than two years, the local

[12] GB9078-1996, 4.4.

[13] For the lead-zinc industry, this standard has since been replaced by the newly promulgated *Emission Standard of Pollutants for Lead and Zinc Industry* (GB 25466-2010) as of October 1, 2010. .

[14] The State Council *Regulations on Environmental Impact Assessment on Planning* (规划环境影响评价条例), became effective on October 1, 2009.

environmental officials from the study area were facing technical challenges to produce adequate environmental impact assessments for this kind of planning. Most difficult is to define the overall environmental capacity. In addition to a local planning EIA, China requires individual construction projects (建设项目) to conduct an EIA. The environmental protection agency should review and decide whether to approve the EIA prepared by the developers. However, due to the long timeframe for review and approval of EIAs for construction projects—sometimes as long as two years, a number of construction projects would start illegally, before the approval of an EIA, which poses potential risks to the environment.

Because the planning and EIA reports from local smelters are not disclosed to the public, we are unable to prove whether environmental factors were specifically considered during the planning stage in the study area. Moreover, given the age of the smelter, many of the planning authorities may not have existed at the time. Still, we note the mere layout and minimal distance between the villages, elementary schools, and lead smelters serve to reinforce the importance of the planning process.[15] At the time of this report publication, the *Mine/smelter* is considering moving to a nearby township. However, the abbreviated version of the EIA for the new siting remains a concern, since it reveals insufficient consideration of environmental health impact during the planning phase. Lead and arsenic are the primary characteristic pollutants of a lead-zinc smelter, but the EIA report overlooked the examination of lead in the air background, causing difficulties in assessing the air emission impact resulting from operation of the proposed smelter. At least two villages are located downwind from the *Mine/smelter*'s proposed new location; the new proposed siting is not consistent with the safe protective distance requirement between industrial facilities and communities as specified in *Sanitary Standards for Industrial Enterprise Design* (《工业企业设计卫生标准》GBZ 1-2002)—though even these standards are not enough to prevent health risks. Given the difficulty in controlling stack and fugitive emissions from smelters, siting standards are the initial and perhaps most fundamental regulatory tool for protecting public health, particularly for new sources. The EIA process for the new smelter, at least the version of the EIA we reviewed, did not meet this health protection objective.

***ii. Environmental contamination: absence of health-based soil and dust standards applying to schoolyards***

A health-based or harm-based ambient quality standard for a pollutant is a standard set at a level sufficient to avoid health effects from exposures to the pollutant. Lead contaminated soil can pose risks through direct ingestion, uptake in vegetable fields, or entering homes. Currently relevant soil quality standards are *Environmental Quality Standards for Soils* (《土壤环境质量标准》GB15618-1995), and *Farmland Environmental Quality Evaluation Standards for Edible Agricultural Products* (《食用农产品产地环境质量评价标准》HJ 332-2006). GB15618-1995 was promulgated in 1995; at that time, the primary goal for setting the environmental soil quality standard was to protect agriculture. The standard consists of three levels of pollutant accumulation limits for three type of soil. Level I applies to nature reserves, drinking water sources and other protected soil, aiming at preserving the soil at its natural status; Level II is for regular farmland, vegetable fields, tea plantation, fruit orchards and pastures, to prevent pollution to the environment and plants; Level III is for forest land and other soil of greater pollution

[15] See Figure 2 at page 5.

capacity.[16] For regular farming land, the Level II standard applies, and the limit for lead accumulation is set at 250-350mg/kg based on different pH levels of the soil. Considering that vegetable fields are vulnerable to heavy metal pollution, the former State Environmental Protection Agency (SEPA) formulated the *Farmland Environmental Quality Evaluation Standards for Edible Agricultural Products* (HJ 332-2006) in 2006, which is more stringent than GB15618-1995. The ceiling for lead accumulation in vegetable fields is set at 50mg/kg, and 80mg/kg for other types of farmlands.

However, the scope of both of the two standards is very limited, and some locations frequented by vulnerable groups lack any applicable standards. In the study area, for instance, we found no soil standards applying to residential areas or elementary school playgrounds; none of the three types of soil regulated in *Environmental Quality Standards for Soils* (GB15618-1995) included residential areas or schoolyards, meaning that soil in residential areas or elementary schools was left completely unregulated. This poses multiple dangers to the health of children, who could easily ingest or inhale lead dust in these settings.

***iii. Environmental contamination: non-point monitoring for lead is weak.***

Routine ambient environmental monitoring is indispensable for identifying health risk in the environment to keep lead accumulation in the environment at a safe level. However, there was no routine ambient environmental quality monitoring for lead in the study area. As discussed above**,** while there are lead limits in the ambient air standard (1.5 μg/$m^3$ quarterly average, and 1.0 μg/$m^3$ annually average),[17] there was no routine monitoring performed to check for lead in the ambient air in the study area. No ambient air monitoring stations for lead were found in the area during site visits. Without such monitoring data, the ambient air quality standard for lead is unlikely to be enforced. The emphasis of environmental monitoring up to this point has been COD and $SO_2$, as these pollutants are subject to national targets for pollution reduction. Lead is not included as an indicator for the regular air pollution index (API). The indicators for current air quality index include $SO_2$, NO2, and PM10. Additionally, routine soil quality monitoring is almost entirely lacking. Moreover, it is very important to note non-attainment of ambient lead standards does not trigger any enforcement process to bring the ambient environment into compliance.

***iv. Environmental contamination: the work of health bureaus is almost disconnected from the pollution control work of environmental bureaus.***

Public health agencies focus their work on monitoring epidemics and infectious diseases; they do not have an active monitoring system for environmental risks to human health. Our interview with local health officials revealed that public health agencies take actions only when real health damage occurred and was reported. The only mandatory monitoring that health agencies complete is drinking water monitoring, which is primarily performed by CDC. No public health interventions will be triggered when environmental monitoring exposes cause for concern or abnormality. Since no information is shared routinely among various agencies, nor is reporting required among various agencies, the CDC and other health agencies are unaware of the

[16] *Environmental Quality Standards for Soils* (GB15618-1995), 3.1.
[17] *Ambient Air Quality Standard* (环境空气质量标准 GB 3095 – 1996).

occurrence of health risks outside its direct supervision (which only includes drinking water monitoring). Even when abnormal blood-lead levels in children are found, the CDC lacks a unified approach such as exposure assessment, public education and other exposure intervention to control the health risk other than medical treatment.

***v. Environmental contamination: contaminated sites are left untreated, responsibilities and standard for soil remediation are lacking.***

Heavy metals and other chemicals can stay in soil for a very long time. Soil contamination could transfer into the groundwater, or crops growing in contaminated soil, and further infect the entire eco-system. In addition, soil contamination directly exposes children to health risk through hand-to-mouth contact. Our interviews with environmental protection officials revealed that soil remediation might be conducted when sudden environmental accidents occur; however, minimal to no action had been taken on large-scale sites with historically accumulated contamination. Rules and programs governing contaminated soil do not currently exist, and laws or regulations to define the responsibilities to clean and remediate the contaminated soil, or even standards for soil remediation, have not been formulated. While there are limited standards governing soil quality (such as GB 15618-1995 mentioned above), there does not appear to be a clear authority to trigger remediation or clean-up of soil that exceeds those standards. Our research found highly contaminated farmland soil, but no enforcement action mechanism to clean-up the soil or even identify the sources of pollution so that regulatory action could be taken at those sources. Moreover, no measures are presently taken to reduce lead laden dust or to remove contaminated vegetables from market circulation.

These gaps in soil remediation strategy do not imply that the local government in the study area is not concerned. In fact, to address concerns about contaminated water, the local township government established a water station that ostensibly pumps water from mountain areas that are removed from suspected contaminated areas. We have been told this is a common remedy in rural areas of China: provision of deeper wells or access to mountain springs to provide clean water to polluted villages. Unfortunately, as discussed above, water ingestion is unlikely to be the primary route of lead exposure from industrial sources such as smelters, particularly exposure to children.

**c. Human exposure: exposure control and other public health interventions for contaminated sites are not well developed.**

Public education about hygiene and cleanliness in areas affected by industrial pollution is not developed yet. Health authorities lack programs and resources to carry out basic public education and interventions to reduce health risks from heavy metals. Local technical capacity to identify exposure to pollutants and evaluate health risk is low. In the study area, schoolyard and classroom dust appears to be a major pathway for lead ingestion. We saw no measures taken to address this. No program of dust minimization/control was in place (for example to wash hands and clothes more frequently, to clean indoor dust, to seal classrooms and homes, etc.), and we observed children spending time after school playing in schoolyard dust we knew to be severely polluted with lead.

As mentioned above, one aspect of our case study was to introduce the IEUBK risk assessment model to local partners and experts.  While no such risk assessment modeling tools are currently being used in China, development of a similar risk assessment tool in China would be beneficial over the long-term.

**d. Underlying general governance issues**

Throughout the discussion of the afore-mentioned gaps, there are several underlying issues in general governance that have contributed to or exacerbated the difficulties and gaps in protecting human health from lead pollution.

***An overarching mechanism for environmental health risk control is lacking.*** An overarching environmental health risk control mechanism has not been fully established to integrate environmental and health risk management.  There is little to no coordination between health and environmental regulatory bureaus.  Response to environmental health risk is largely ad-hoc and reactive to accidents or incidents of "social unrest."  In fact, two departments only collaborate together *after* pollution accidents occur: our interviews with Yunnan public health agencies showed that public health agencies only get involved with environmental and health issues in response to an environmental incident.  This kind of reactive action is usually led by the environmental protection agencies, and implemented in coordination with public health agencies, and other agencies if needed.  In the course of these actions, the environmental protection agencies are responsible for treating the environment, and the public health agencies are in charge of medical treatment to pollution victims.

The health agencies abide by the procedures stipulated in *Contingency Plan in Response to Sudden Public Health Incidents* (the "contingency plan") (《突发公共卫生事件应急预案》). The contingency plan applies to sudden outbreak of major infectious diseases, unknown epidemic diseases, major food and occupational poisoning, and public health incidents resulting from natural disasters, accidents or social security incidents.[18] The main objective of the contingency plan appears to be controlling the spread of disease and treating casualties and patients—not targeting the health risks in the environment.  The contingency plan focuses on public medical treatment, and does not specifically include discussion of health risks in the environment.  Preventive pollution monitoring and health evaluations are not implemented.  No actions are explicitly required in the contingency plan to identify the sources or measure risk in the environment.

The lack of an overall approach to addressing environmental health risk undoubtedly contributes to the above discussed gaps in the environmental and public health regulatory framework.  This is seen in the failure of ambient soil standards to be health-based, nonexistence of environmental quality monitoring for lead, absence of health risk interventions by pubic health authorities, and inadequate information sharing between government agencies.

***County level environmental enforcement suffers from extremely limited capacity.***
Environmental enforcement is weak both in terms of local capacity (staffing, education-level,

[18] Effective as of February 26, 2006.

financial resources, and basic equipment) and legal authority. Our investigation in the study area revealed that local environmental agencies greatly lack funding, personnel, and expertise; this contributes to weak environmental monitoring and loose enforcement of environmental laws. Local monitoring and enforcement officials in the township of our study area did not even have regular access to a car with which to do inspections. A big portion of staff for environmental monitoring in the study area are demobilized soldiers, and lack professionalism. The county monitoring was extremely limited in technical and equipment capacity.

***Information disclosure is low.*** Little information was disclosed to the public about lead and heavy metal emissions in the EIA, emissions monitoring in general, and other relevant information. Basic data, such as health outcomes, factory emissions, and environmental quality, were difficult for our research group to obtain. Government officials similarly expressed concern about their own difficulties in obtaining information from other bureaus. As mentioned above, there is no routine mechanism for inter-agency information sharing either. There is essentially no way for the health agencies to be aware of health risks in the environment due to lack of environmental data.

***Environmental law enforcement remains weak.*** Compliance and enforcement problems in China are well-known, including, insufficient capacity (discussed above), insufficient legal authorities, low fine limits, and lack of information. Lead risk governance is not immune from weak environmental law enforcement in the study area.

# III. Take Actions Immediately to Reduce Lead Health Risk

### *Lead industry trends would worsen the lead pollution problem if unattended*

The lead pollution problem will only get worse if left unattended. China has been the world's top producer of lead since 2003.[19][20] At the annual China International Lead and Zinc Conference hosted in Shenzhen in November 2010, representatives from Antaike, the leading information provider for the mining and metals industries in China, predicted that lead production in China will reach five million metric tons by 2012, an average yearly rate of increase of about 12% from 2009 levels.

Following only Australia, China has the world's second largest natural reserve of lead, totaling 11 million tons.[21] And China is capitalizing on this: China's mining ore output for lead increased from 0.58 to 1.52 million tons from 1998 to 2008—an average growth rate of 10.1%.[22]

[19] Chen, X and Peng R. "Lead-Zinc Metal Resources Condition and Strategy for Lead-Zinc Metals Industry Sustainable Development in China." *Nonferrous Metals*, 2008, 60 (3): 129 – 133.
[20] http://web.archive.org/web/20070827030846/http://www.ldaint.org/information.htm
[21] USGS, Mineral Commodity summaries 2009, http://minerals.usgs.gov/minerals/pubs/mcs/2009/mcs2009.pdf, 91.
[22] Xi S. Current Situation of Exploitation and Utilization of Lead/Zinc Mineral Resources in the World, China Metal Bulletin, 2009, 37.

China's smelting capacity has grown even faster than mine production capacity for the past several decades. But China's demand for lead far surpasses its resources, as domestic mines only meet half of domestic demand. China has been a net importer of lead since 2001, and production of lead acid batteries continues to grow rapidly.[23] Due to growing domestic demand for lead-acid battery powered cars, motorcycles, and electric bikes, current projections for 2015 include a doubling in production of lead-acid batteries from 2009 levels.[24]

While these forecasts may at first carry positive implications for China's growing economy, the potential health, economic, and environmental costs could be overwhelming if immediate action is not taken to establish efficient controls and regulations to safeguard human health. For example, a 1997 study of economic costs associated with pediatric lead poisoning in the United States estimated losses of $43.2 billion USD:

Figure 5: Estimated Costs of Pediatric Lead Poisoning, United States, 1997.[25]

**Table 1. Estimated costs of pediatric lead poisoning, United States, 1997.**

| | | |
|---|---|---|
| EAF | = | 100% |
| Main consequence | = | Loss of IQ over lifetime |
| Mean blood lead level in 1997 among 5-year-old children | = | 2.7 µg/dL |
| A blood lead level of 1 µg/dL | = | Mean loss of 0.25 IQ points per child |
| Therefore, 2.7 µg/dL | = | Mean loss of 0.675 IQ points per child |
| Loss of 1 IQ point | = | Loss of lifetime earnings of 2.39% |
| Therefore, loss of 0.675 IQ points | = | Loss of 1.61% of lifetime earnings |
| Economic consequences | | |
| For boys: loss of 1.61% × $881,027 (lifetime earnings) × 1,960,200 | = | $27.8 billion |
| For girls: loss of 1.61% × $519,631 (lifetime earnings) × 1,869,800 | = | $15.6 billion |
| Total costs of pediatric lead poisoning | = | $43.4 billion |

Experts estimate that 20 million hectares, or nearly 20%, of China's arable soil are already polluted;[26] China's Ministry of Land Resources recently acknowledged the contamination of 12 million tons of grain by heavy metal pollutants, leading to direct economic losses surpassing 20 billion RMB.[27] Though current statistics do not exist on China's economic costs associated with soil remediation for lead pollution and/or the health consequences of lead poisoning, we can imagine they are sizeable—and they will only increase if measures are not taken immediately.

***China's efforts to reduce industrial lead pollution***

[23] "China 2010 lead demand seen up 20 pct on battery." *Reuters*. March 26, 2010 (http://www.reuters.com/article/idUSBJI00227020100326).

[24] According to presentation by CAO Guoqing, officer at the China Battery Industry Association, made at the China International Lead and Zinc Conference in Shenzhen, November 2010.

[25] Landrigan PJ, Schechter CB, Lipton JM, Fahs MC, Schwartz J. "Environmental Pollutants and Disease in American Children: Estimates of Morbidity, Mortality, and Costs for Lead Poisoning, Asthma, Cancer, and Developmental Disabilities." Environmental Health Perspectives. 2002;110(7):721-8. Accessed online 28 Feb 2011 <http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ehp.02110721>.

[26] Xinhua. "Farmers pin hope on 'soil doctors' to cure polluted land." 26 May 2009. Accessed 28 Feb 2011 <http://www.china.org.cn/environment/news/2009-05/26/content_17836421_2.htm>.

[27] "Heavy Metal Pollution: Need for Comprehensive Prevention." ["重金属污染：必须防治相结合".] China Economic Times. 2 Mar 2011. Accessed 7 Mar 2011 < http://www.cet.com.cn/20110302/f1.htm>.

The challenges ahead for China are formidable, and China has just started the difficult path to addressing these lead risks. A series of government whitepapers and official announcements have highlighted heavy metal pollution issues. As aforementioned, China launched a "National Action Plan on Environment and Health (2007-2015)" on November 21, 2007. The Action Plan calls for a comprehensive assessment of current laws, rules, regulations an standards concerning the environment and public health to be conducted, and enactment of laws, rules, regulations and standards on environment and health.

In response to the Fengxiang and Wugang incidents, China's Ministry of Environmental Protection (MEP) approved in principle a draft "Implementation Plan for the Comprehensive Handling of Heavy Metal Pollution" (《重金属污染综合整治实施方案》) on August 28, 2009. MEP has stated that this plan will include strengthening reform of industrial structure, raising the environmental criteria as a threshold of market access, strengthening regulation of industrial pollution, rapidly establishing a regulatory system for managing heavy metal pollutant emissions, and a complete inspection and supervision system for prevention and control of such pollution.[28]

On September 29, 2009, MEP released the *Notice on Thoroughly Carrying Out Special Inspections of Heavy Metal Polluting Enterprises* (《关于深入开展重金属污染企业专项检查的通知》), which states that MEP would—along with eight (8) other ministries or offices[29] —commence a three-month nation-wide investigation initiative to examine enterprises that involve significant amounts of heavy metals (lead, cadmium, mercury, chromium and arsenic) in production, storage or transport processes. MEP called to tighten the monitoring over heavy metals in "2010 Environmental Monitoring Working Focuses" issued in January 2010, which set monitoring of heavy metal pollution from major emitters in China as one of MEP's areas of focus in 2010.[30]

In February 2011, the first special 12$^{th}$ Five Year Plan (FYP) approved by the State Council is the 12$^{th}$ FYP on comprehensive prevention and control of heavy metal pollution, which calls for the emission of heavy metal pollutants to be reduced by 15% from 2007 level in key control areas, and to establish a heavy metal pollution prevention and control system, emergency response system, and environment and health risk assessment system by 2015, among others.[31]

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[28] "MEP: Heavy Metal Pollution has Already Received Appropriate Resolution 环保部：重金属污染事件均已经得到妥善处置," Sep. 27, 2009 (http://www.23xw.com/23xw/xinwen/guonaxinwen/2009/0927/5835.html).

[29] In addition to MEP, the other ministries or offices involved in this campaign are: the National Development and Reform Commission (NDRC; 国家发展和改革委员会; http://www.ndrc.gov.cn); Ministry of Industry and Information Technology (MIIT; 工业和信息化部; http://www.miit.gov.cn); Ministry of Supervision (MOS; 监察部; http://www.mos.gov.cn); Ministry of Justice (MOJ; 司法部; http://www.moj.gov.cn); Ministry of Housing and Urban-Rural Development (MOHURD; 住房和城乡建设部; http://www.cin.gov.cn); State Administration for Industry & Commerce (SAIC; 国家工商行政管理总局; http://www.saic.gov.cn); State Administration of Work Safety (国家安全生产监督管理总局; http://www.chinasafety.gov.cn); State Electricity Regulatory Commission (SERC; 国家电力监管委员会; http://www.serc.gov.cn). The document setting forth the inspection campaign can be found at http://www.mep.gov.cn/gkml/hbb/bgt/200910/t20091022_174813.htm.

[30] 环保部今年将加大重金属监测工作的力度, http://www.chinanews.com/cj/cj-hbht/news/2010/01-25/2090639.shtml; 关于印发《2010 年全国环境监测工作要点》的通知, http://www.zhb.gov.cn/gkml/hbb/bgt/201001/t20100121_184736.htm

[31] 周生贤在重金属污染综合防治"十二五"规划视频工作会议上强调坚决打好重金属污染防治攻坚战切实维护人民群众利益和社会稳定, http://www.mep.gov.cn/zhxx/hjyw/201102/t20110221_200992.htm.
The text of the 12$^{th}$ FYP on comprehensive heavy metal pollution prevention and control has not been released yet as of this writing.

These initiatives and announcements reveal China's determination to tackle the lead pollution health risk. However, implementation of these policies will prove very challenging if they rely on problematic regulatory tools and institutional approaches, especially at the local level where implementation and enforcement take place. China will need to institute a wide-ranging set of laws, policies, and planning to address environmental health risks in a meaningful and effective way.

The following section of the report will describe the results of the field study trip to the USA, and provide a description of comparable USA legal and policy mechanisms for addressing lead pollution. In Section V of the Report, NRDC will provide recommendations and suggested directions for concrete approaches to reducing China's health risks from lead pollution.

# IV. US Experience In Regulating Lead Smelters to Reduce Health Risks

In November 2009, NRDC organized a one-week study tour to the US to study approaches to reducing the health risks from lead pollution. We took a cross-disciplinary group—consisting of central and provincial government officials from environment and health bureaus, leading environmental law and public health experts, and an NGO activist—to investigate the multi-faceted and multi-stakeholder lead management program in the States. Over the one-week investigation, we visited:

- U.S. Environmental Protection Agency and other environmental regulators in the State of Missouri who monitor and manage emissions sources, as well as handle soil remediation;
- Public health experts at Johns Hopkins University and the Baltimore City Health Department, which has battled childhood lead poisoning from residential paint in Baltimore for the past three decades;
- Doe Run Lead Smelter facilities, the last primary lead smelter in operation in the United States; and,
- Citizen groups that monitor pollution and participate in the civilian governance of environmental and public health management systems, including the local couple in Missouri who started the efforts to address the Doe Run Smelter pollution, and the NGO law clinic at Washington University in St. Louis that supported them.

The centerpiece of the trip was the site visit of the Doe Run Lead Smelter in Herculaneum, Missouri, to learn its story and see the measures that have been taken there over the years. Many of our findings below are outcomes from our meetings during the course of the study tour.

Control of lead health risk in the US relies upon an extensive regulatory program made up of several federal statutes: the Clean Air Act (CAA), Clean Water Act (CWA), Resource

Conservation and Recovery Act (RCRA), the Safe Drinking Water Act, , and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), among others. Our priorities in this paper are CAA emission control measures and contaminated site remediation under CERCLA.

***CAA Approach to Lead Emissions***

Under the Clean Air Act (CAA), two separate but related regulatory approaches govern lead emissions. The first approach relies upon health-based standards, while the second approach relies upon technology-based standards.

**a. NAAQS: health-based standards for ambient air quality.**

The Clean Air Act requires EPA to identify and list each air pollutant the emissions of which "cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare". For each of the pollutants listed, EPA must then issue primary and secondary national ambient air quality standards (NAAQS).

The primary NAAQS is the health-based standard, and must be at a level "the attainment and maintenance of which …allowing for an adequate margin of safety, are requisite to protect the public health." EPA interprets this to mean that the NAAQS must be at the maximum level that will protect the health of representative persons within a sensitive group of the population (i.e., small children), but not necessarily each and every person within that population. The "adequate margin of safety" clause is intended to address technical and scientific uncertainties inherent in NAAQS development, and provide some protection against hazards not yet identified. Significantly, EPA cannot consider costs in setting the health-based NAAQS.

The secondary standard must "protect the public welfare from any known or adverse effects associated with the presence of such pollution in the ambient air". Welfare effects include impacts on soils, water, crops, vegetation, weather, climate, property, and personal comfort and well-being.

On October 5, 1978, EPA promulgated the initial lead primary and secondary NAAQS. Both standards were set at 1.5 µg/cubic meter measured as lead in total suspended particulate matter (Pb-TSP). In setting this initial standard, EPA determined at that time the blood lead level for an individual should be no higher than 30 µg/dL, and the maximum safe mean blood lead population of young children is 15 µg/dL.

On November 12, 2008, EPA revised the primary and secondary lead NAAQS, **lowering the standard tenfold** to 0.15 µg/cubic meter. EPA lowered the standard primarily to protect children from the impacts of exposure to lead at lower concentrations than previously addressed by the 1978 standard. EPA determined evidence gathered since 1978 demonstrated lower blood levels than 15 µg/dL produced slowed childhood development and lower IQ, and thus the 1978 standard no longer met the statutory standard of protecting public health with an adequate margin of safety. The new standard is intended to protect against an air-related loss of IQ of two or more points.

The new NAAQS is accompanied by the required monitoring of industrial sources emitting more than 0.5 ton or more of lead per year, based upon the likelihood of these sources to cause or contribute to NAAQS violations.[32] EPA anticipates 96 industrial facilities will be monitored nationwide. In addition to industrial sources, monitoring is required at (general aviation) airports emitting greater than 1.0 ton or more of lead annually, and at a set of monitoring stations deployed in urban areas throughout the country. The monitoring data from these stations will be routinely reported to EPA.

**b. SIPs: state implementation plans to enforce NAAQS.**

Within three years of NAAQS promulgation, states must develop and then demonstrate to EPA their air pollution control regulations and strategies will ensure areas not currently in compliance with the NAAQS can achieve compliance within five years. This collective body of regulations and strategies is called a State Implementation Plan, or SIP. These SIPs can be huge, incorporating many regulations, enforceable documents, and supporting information as discussed below.

The Clean Air Act requires that SIPs contain:

- An ambient air monitoring and data management system
- Air quality modeling to predict effects on air quality of particular sources
- A program for enforcing control measures
- A stationary source monitoring program
- Adequate authorities to impose contingency measures if the NAAQS is not achieved or maintained
- Provisions for SIP revisions in response to a revised NAAQS or a finding that the SIP is inadequate
- A system for public notification of NAAQS exceedences
- Permitting fees for each major stationary source to cover the cost of processing and enforcing the facility permit

There are ample opportunities for public participation during SIP development and approval. Once federally approved, the state is the primary enforcement agency, but the SIP provisions may also be enforced by EPA, or the public through the Clean Air Act citizen suit provisions.

In response to NAAQS violations occurring after initial SIP approval, EPA can find the existing SIP "substantially inadequate", and require revisions to the SIP as necessary to correct such inadequacies. A state's failure to comply with revising a SIP as needed or implementing the SIP as approved, can result in EPA imposed sanctions upon the state. The principal sanction is a loss of federal highway approvals or construction funds for the non-attainment area. EPA may also impose a federal SIP upon a state following SIP disapproval, if the state fails to correct SIP deficiencies.

[32] See 75 FR 81126 (December 27, 2010).

### c. Maximum Available Control Technologies (MACT): technology-based standards required for HAPs.

Separately from the NAAQS program, the Clean Air Act also requires EPA to regulate the emissions of hazardous air pollutants (HAPs) from major sources, including lead. The standards must reflect Maximum Available Control Technologies, or MACT. For new sources, the standard (or MACT floor) cannot be less stringent than the emission control achieved by the best controlled similar source. For existing sources, the MACT floor cannot be less stringent than the average emission limit achieved by the best performing 12% of existing sources. EPA may set a standard above the MACT floor based upon a consideration of the cost of achieving additional emission reduction, any non-air quality health and environmental impacts, and energy requirements. The MACT program was created in large part because EPA only issued a NAAQS for a small number of chemicals, thus a technology-based program was viewed as a quicker way to achieve emission controls of toxic chemical pollutants. Thus, in the USA, lead is somewhat unique since it is governed by both a NAAQS and technology-based regulations.

EPA issued its MACT rules governing primary lead smelters on June 4, 1999. The same standards apply to both new and existing facilities. A ``plant wide'' emission limit of 500 g/Mg of lead produced (1.0 lb/ton of lead produced) for lead compounds was established. The limit applies to (1) process sources, (2) process fugitive sources, and (3) fugitive dust sources. Process sources that are regulated include sinter machines, blast furnaces, and dross furnaces, and typically involve stack releases. Process fugitive emission sources that are regulated include sinter machine charging and discharging, sinter crushing and sizing, blast furnace tapping, and dross furnace charging and tapping. Fugitive dust sources that are regulated include plant yards and roadways subject to wind and vehicle traffic, process areas, and materials handling and storage areas.

Recognizing that technology-based standards may not adequately protect public health, particularly for toxic pollutants lacking an NAAQS, the Clean Air Act requires EPA to review and revise the MACT standards where necessary "to provide an ample margin of safety to protect human health". EPA has started issuing these so-called "residual risk" MACT revisions, and proposed revisions for primary lead smelters (see discussion below).

### d. Permits: tool of NAAQS and MACT implementation at the source.

The Clean Air Act establishes a permit program where the various substantive requirements in the Act are integrated into the operating authorization for a facility, including SIP requirements and MACT controls. The CAA specifies that each permit must contain enforceable emission limits and monitoring requirements; and conditions regarding inspections, access to the facility, compliance certifications and other measures to assure compliance. EPA's regulations include signature requirements by a senior official of the company for submissions of certifications and other compliance related submissions, allowing regulatory official access to the facility to conduct inspections and review/copy records, and schedules of compliance where applicable. Permits cannot be issued for more than five years.

There are minimum pubic participation requirements for issuance of permits; this typically consists of a public notice, comment period, the opportunity to obtain a public hearing, and preparation of a comment response document.

The Clean Air Act also specifies minimum requirements for a state permitting program, including monitoring and reporting requirements, fees to cover the cost of developing and administering the program, adequate personnel and funding, adequate permitting and enforcement authority, etc. States must submit extensive documentation and apply to EPA for approval to administer the permit program. After a state is approved, EPA still retains enforcement authority, and EPA may object to the issuance of an individual permit under Section 505 of the Act. Citizen suits under the Act are available as well.

***US Emergency Response and Remediation Program***

The principal federal statute governing federal remediation of contaminated sites is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), more commonly known as Superfund. This summary targets those authorities and policies applicable to Superfund remediation of lead in residential settings, based upon EPA memoranda and guidance currently available.[33]

**a. The Superfund Law Generally**

Superfund provides EPA with the authority to spend its own money and respond to a release or threatened release of a "hazardous substance" "into the environment" which "may present an imminent and substantial danger to the public health or welfare". Such EPA responses take two forms: removals and remedial actions. Removals are response actions limited in time duration and cost. As a general matter, removals are limited to one year and $2,000,000, but exceptions can be made. Remedial actions constitute the more permanent response actions, and are subject to detailed decision-making criteria.

The procedures and standards governing Superfund remedial actions are contained in the National Contingency Plan (NCP). Under the NCP, remedial selection follows a Remedial Investigation (RI) and Feasibility Study (FS), which evaluate the nature and extent of contamination, and potential cleanup options respectively. Under the NCP, there are nine criteria for evaluating potential cleanup options and selecting a remedy:

- Overall protection of human health and the environment during both the short and long-term
- The extent to which they achieve compliance with federal or state requirements (i.e., media protection standards)
- Long-term effectiveness and permanence[34]
- Reduction of toxicity. mobility, or volume through treatment

[33] For the purposes of this paper, residential settings include those places accessible to small children such as homes, schools, day care facilities, playgrounds and parks.
[34] If contamination is left onsite, the remedial actions are subject to reviews every 5 years, pursuant to Section 121(c) of Superfund.

- Short term effectiveness (i.e., potential risks to workers or the community while the remediation is conducted)
- Implementability (i.e., technical and administrative feasibility)
- Cost
- State acceptance
- Community acceptance

As these criteria suggest, remedial selection is a data rich, site-specific, lengthy process which often takes years and millions of dollars to complete. Where EPA chooses to undertake the response action itself, it can seek reimbursement of the cleanup costs from one or more responsible parties.[35] Responsible parties include both past and present owners of the release source(s).

Instead of undertaking the removal or remediation itself, EPA can compel the entity responsible for the release to undertake the removal or remedial action, by filing suit or issuing an administrative order. Persons found in violation of these orders can be fined up to $25,000/day.

**b. Superfund Policies for Addressing Lead Contaminated Soils**

It has been EPA policy for at least 15 years that the risk reduction goal for Superfund response actions is to reduce soil lead levels to the concentration which corresponds to no more than a 5% probability that a typical child or group of children exposed to that soil will have a blood level exceeding 10 µg/dl. This 10 µg/dl blood lead level and higher correspond to the concentrations EPA and the Centers for Disease Control (CDC) believe are associated with health effects in children, and thus warrant medical intervention.

EPA used the Integrated Exposure Uptake Biokinetic Model (IEUBK) to set a nationwide screening or no-action level to determine if a response action may be warranted at contaminated sites, and then uses IEUBK to help determine an appropriate response action at individual sites where lead soil concentrations are above the screening levels.

IEUBK predicts the blood lead levels in children exposed to lead from various sources, and the probability that a child will have a blood lead level above the 10 µg/dl level of concern. To set the nationwide screening or no-action level, EPA used the default parameters in the model for the various lead exposures (i.e., air, drinking water, diet), and then ran the model to obtain the soil concentration that would achieve the above-stated risk reduction goal. Based upon the default parameters for other sources of lead exposure, EPA derived a no-action level of 400 ppm in residential setting soils. Therefore, soils containing lead below 400 ppm do not typically receive further attention, while those above 400 ppm could warrant a response action.

In this regard, it is important to recognize the difference between the soil screening level and a cleanup standard. The cleanup standard will be derived on a site-specific basis, and not rely on the default parameters in the IEUBK for at least dust and soil. Therefore, there is no national

[35] Liability may also extend to natural resource damages under Section 107(f) of Superfund. There are regulations and case law governing how natural resource damages can be calculated and imposed, but since the focus of this paper is on responding to public health concerns, further details on natural resources damages are not provided.

cleanup standard for lead in residential soil, and the soil concentration at a given site which achieves the risk reduction goal can differ from the 400 ppm no action level. Moreover, as noted above, for remedial actions at large sites particularly, the model alone does not dictate the final remedy, since a complex balancing of factors is required which could affect the final remedy selected.

Still, EPA regards IEUBK as the "primary tool" for generating risk-based soil cleanup levels (sometimes called Preliminary Response Goals or PRGs) at current or future residential sites. Cleanup decisions can be based solely upon the model's blood level predictions, so blood lead studies are not required. In fact, EPA discourages blood testing for the purpose of remedy selection. EPA believes blood testing results can change over time due to the behavior of the population (i.e., less washing of hands or dust collection), and thus may be unreliable for predicting long term consequences of current soil conditions.

Significantly, EPA and CDC do believe there is a potential role for blood testing at contaminated sites. They believe blood measurements are useful for identifying the most important exposure pathways, directing the medical community to those children needing medical intervention, and evaluating the impact of health education activities (see also CDC discussion below). Such education activities and regular house cleaning have produced significant short-term reductions in blood lead levels at some sites. Thus, EPA encourages health education activities, and blood lead screening as appropriate, as early as possible once elevated soil lead levels are detected. However, EPA does not regard health education activities by themselves as a permanent remedy, again because of the difficulty in sustaining this behavior over time.

Site sampling and characterization are performed to estimate an average soil lead concentration (for modeling purposes), and to scale the size of the response action. Following site sampling, EPA officials need to determine the urgency of the situation, including whether removal actions are warranted in advance (or at small sites in lieu of) of remedy selection. For this purpose, EPA guidance categorizes lead contaminated sites into three tiers as follows:

1. Tier 1 – pregnant women or children under 7 are present, and either surface soil concentrations are 1,200 ppm lead or higher or children blood levels exceed 10 µg/dl
2. Tier 2 – No sensitive populations are present and surface soil concentrations above 1,200 ppm, or sensitive populations are present and surface soil concentrations are between 400-1,200 ppm
3. Tier 3 – No sensitive populations present and soil concentrations between 400-1,200 ppm.

Tier 1 sites are eligible for immediate removal actions without relying upon IEUBK modeling if the site manager believes the site poses an urgent threat. Tier 2 sites can be addressed through immediate or longer term removal actions, or long term remedial actions. Tier 3 sites are not a priority for immediate action.

Significantly, EPA "strongly prefers" a response action consisting of soil excavation followed by placement of cover soil, particularly for sites with shallow soil contamination, such as smelting sites. Where excavation is not feasible due to the size of the site, EPA prefers placement of a soil cover for the remedial option. EPA prefers these options because no effective soil treatment technologies have been identified to date. A minimum of 12 inches of clean soil cover thickness is recommended for direct human contact, and 24 inches where gardening is conducted.

**c. CDC Guidance for Medical Interventions**

CDC believes coordinating, providing, and overseeing care giver services is appropriate for any child with a blood level above 10 µg/dl. The time frames for initiating case management activities depend on the blood levels observed, as illustrated in the following table.

**Time Frames for Initiating Case Management Activities According to a Child's Blood Lead Level**

| Blood lead level µg/dL) | Actions | Time frame for beginning intervention |
|---|---|---|
| 10-14 | Provide caregiver lead education. Provide follow-up testing. Refer the child for social services if necessary. | Within 30 days |
| 15-19 | Above actions, plus:<br>If BLLs persist (i.e., 2 venous BLLs in this range at least 3 months apart) or increase, proceed according to actions for BLLs 20-44. | Within 2 weeks |
| 20-44 | Above actions, plus:<br>Provide coordination of care (case management).<br>Provide clinical evaluation and care.[c]<br>Provide environmental investigation and control current lead hazards. | Within 1 week |
| 45-70 | Above actions. | Within 48 hours |
| 70 or higher | Above actions, plus hospitalize child for chelation therapy immediately. | Within 24 hours |

The table below summarizes the range of medical interventions recommended for various observed blood levels. As both these tables indicate, measurement of blood lead levels is used to determine the extent of lead adsorption in the body, how urgent intervention is needed, and how successful case management has been.

**Summary of Recommendations for Children With Confirmed Elevated Blood Lead Levels**

| 10 - 14 | 15 - 19 | 20 - 44 | 45 - 69 | >70 |
|---|---|---|---|---|
| Lead education<br>-Dietary<br>-Environmental<br><br>Follow-up blood lead monitoring | Lead education<br>-Dietary<br>-Environmental<br><br>Follow-up blood lead monitoring<br><br>Proceed according to actions for 20-44 µg/dL if: | Lead education<br>-Dietary<br>-Environmental<br><br>Follow-up blood lead monitoring<br><br>Complete history and physical exam | Lead education<br>-Dietary<br>-Environmental<br><br>Follow-up blood lead monitoring<br><br>Complete history and physical exam | Hospitalize and commence chelation therapy<br><br>Proceed according to actions for 45-69 µg/dL |

| | | | | |
|---|---|---|---|---|
| | -A follow-up BLL is in this range at least 3 months after initial venous test<br>**or**<br>-BLLs increase | Lab work:<br>-Hemoglobin or hematocrit<br>-Iron status<br><br>Environmental investigation<br><br>Lead hazard reduction<br><br>Neurodevelopmental monitoring<br><br>Abdominal X-ray (if particulate lead ingestion is suspected) with bowel decontamination if indicated | Lab work:<br>-Hemoglobin or hematocrit<br>-Iron status<br>-FEP or ZPP<br><br>Environmental investigation<br><br>Lead hazard reduction<br><br>Neurodevelopmental monitoring<br><br>Abdominal X-ray with bowel decontamination if indicated<br><br>Chelation therapy | |
| ***The following actions are NOT recommended at any blood lead level:*** | | | | |
| Searching for gingival lead lines<br><br>Testing of neurophysiologic function<br><br>Evaluation of renal function (except during chelation with EDTA) | | Testing of hair, teeth, or fingernails for lead<br><br>Radiographic imaging of long bones<br><br>X-ray fluorescence of long bones | | |

***The US Lead Regulatory Framework in Action: Case Study of Doe Run Primary Lead Smelter.***

The Doe Run Smelter in Herculaneum, Missouri is the only primary lead smelter still operating in the US. The smelter began operation in 1892, and currently has a production capacity of 250,000 tons/yr. The facilities occupy approximately 52 acres. Herculaneum was a town of 2,555 people before relocation activities began in 2002. At that time, 67 people resided with ¼ mile of the facility, 369 people within the next quarter mile, and 2,055 people within the next half mile. Three schools were located within one mile of the facility.

**Doe Run remediation activities.** Doe Run was required to take specific remedial measures by means of a Superfund Order and subsequent modifications. The company was required to investigate and then remove surface soil contamination at residential yards, day care facilities, schoolyards, parks, and other high use areas frequented by children. Soil removal was required to a depth of at least one foot. Replacement soil could not exceed 240 ppm lead. To date, soil replacement has been performed at about 565 residences and a half dozen sensitive areas (parks, schools), and 125 house interiors were cleaned.

Separately, the State of Missouri and Doe Run entered into a Settlement Agreement in 2002 requiring Doe Run to offer to purchase (at fair market value based upon three appraisals) about

160 homes closest to the smelter and provide relocation expenses, prior to the end of 2004. As of 2006, all but 26 homeowners took advantage of this offer and relocated. Doe Run was also required to develop a plan for screening children's blood-lead levels and organize associated education/outreach in coordination with the state health department. Parents were invited to participate in the program every August free of charge.

EPA also used its Superfund authorities to obtain additional fugitive emission controls because of the connection between the fugitive emissions and high lead soil concentrations in the area. Moreover, if two NAAQS violations were detected after the AOC, Doe Run was required to reduce production to 50,000 short tons per quarter or take comparable measures (this approach was subsequently incorporated into SIP revisions and production limits were reduced further, as discussed below).

EPA also used its Superfund authorities to address releases from the slag pile at the facility. Over time, EPA required enhanced groundwater monitoring; and construction of a flood protection berm, a storm water retention pond, a pumping system to route storm water to an onsite wastewater treatment facility, an engineered cover for the pile (i.e., grading, soil, vegetation); and wetlands mitigation.

In 2010, EPA and Doe Run agreed on additional remedial measures in response to recontamination detected in the community near the plant. Of 372 residential properties sampled by Doe Run, 129 had lead contamination in excess of 400 ppm, and 104 of the 129 had already been cleaned up at least one time. Moreover, road edge sampling continued to indicate very high lead levels, indicating fugitive emissions from ore transportation remained a significant contamination source. Therefore, the company was required once again to initiate property sampling up to 1.5 miles from the smelter, and soil remediation using 400 ppm lead as the trigger for initiating remediation.

**Lead air emission control at Doe Run.** The history of lead air regulation at Doe Run reveals that the regulatory framework is more effective in detecting NAAQS violations, rather than remedying them. However, as seen in the table below, significant emissions reductions have been achieved since 2000, largely by newly enclosing areas or tightening existing structure enclosures, improving ventilation and air flow within the structures to direct emissions toward outlets equipped with baghouses, installing new and improved baghouses, and reducing fugitive emissions from transport and conveyance vehicles.

| Calendar Year | Lead Emissions (Tons/Yr) |
|---|---|
| 2000 | 139.80 |
| 2001 | 113.54 |
| 2002 | 58.81 |
| 2003 | 25.13 |
| 2004 | 25.95 |
| 2005 | 28.09 |
| 2006 | 28.42 |
| 2007 | 21.81 |
| 2008 | 20.00 |

Much of this progress involved a repeated process of detected NAAQS violations and SIP revisions directed at different sources of lead emissions from the facility. Many of the control measures imposed on the smelter are not related to the stack, but rather fugitive emissions sources - that is, air and dust coming off large areas of the site, including emissions related to the storage and handling of ore at the facility. Current ore-related transportation and handling control measures include street sweeping, tarping, enclosing buildings, watering ore, and required production decreases.

Indeed, at the 2008 lead production rate of 149,500 tons, the lead emission rate was approximately 0.2 lb/ton, or only about 20% of the current MACT limit. Yet risk modeling conducted by EPA in support its residual risk MACT review indicated that lead air concentrations near the plant could exceed the new NAAQS for lead by as much as 50 times, resulting from just the 2.85 tons/yr of fugitive emissions still coming from the facility. Even though the stack emissions were greater (13.31 tons/yr), the height of the stack dispersed the lead emissions so that lead levels would be below the NAAQS in the surrounding community. Consequently, in its proposed MACT rule revision issued on February 17, 2011, EPA proposed lowering the MACT emission limit from 1.0 lb/ton of production to 0.22 lb/ton of production, almost an 80% reduction deemed necessary to ensure compliance with the new NAAQS would be achieved. EPA also proposed to require compliance with the new NAAQS standard as an additional fugitive dust standard.

Even before the revised MACT standards were proposed, recognizing the challenges presented by the new and more stringent NAAQS for lead, the Company recently consented to closing the existing Herculaneum smelter by early 2014. The Company is developing a new technology for producing lead which it claims will reduce emissions by over 99% over the current technology.[36] Until closure of the facility, production is now limited to 130,000 tons annually, or about 50% of plant capacity.

The NAAQS monitoring network around the smelter consists of 9 monitoring stations, five of which have co-located monitors operated separately by Doe Run and the State. Two monitors are sampled every day; the others every third day (note the federal minimum is every sixth day).

***What Can Be Learned From the US Framework*?**

***1. Both health-based standards and technology-based standards work in combination to regulate lead emissions.*** Technology-based standards by themselves would have allowed substantially greater lead emissions, resulting in community exposures posing significant health risks. This is especially the case with lead sources where fugitive emissions can contribute substantially to community exposures which may not be adequately addressed by technology-based standards focused at stack controls or other point sources.

***2. Monitoring the source well is critical in understanding its impacts and whether pollution control strategies are working.*** It was the repeated process of detecting and responding to NAAQS violations which triggered substantial emission reductions at the facility. If the facility was not routinely and adequately monitored, the violations may not have been detected.

[36] See http://doerun.com/NewLeadProcessingTechnologyAnnouncement/tabid/168/language/en-US/Default.aspx.

***3. Because of the potential risks to children and how children are exposed, dust control and soil remediation are a core aspect of responding to lead contamination.*** The EPA has established a robust system for soil remediation, including the following measures:

- Tier 1 soil action levels which authorize immediate response action without the need for lengthy studies or analysis;
- Tools for site characterization (evaluation of the nature and severity of the problem);
- Surface soil replacement;
- Cleaning of home interiors; and
- Cleaning streets

***4. Since lead is a well studied pollutant, EPA can utilize tools such as modeling to justify actions where site-specific information is not yet available or expensive to obtain.*** Use of models such as IEUBK expedites EPA's response capability, particularly where a rapid response is required. USA law does not require actual proof of individual harm before an agency can take response action to site contamination.

***5. EPA and health agencies can employ a range of public health interventions to reduce health risk.*** Since environmental cleanup can take time, environmental and public health agencies have a variety of tools to reduce health risks before and during cleanup. These range from blood testing all the way to relocation.

***6. EPA can spend its own money and/or order the polluter to respond to site contamination, and both capabilities are required.*** It is not unusual for EPA to spend its own money to investigate and perhaps even undertake removal activities, and then use its Superfund authorities to negotiate a longer-term remedy for the site (and receive reimbursement for money spent).

***7. At active facilities, coordination between remediation and regulatory programs, and between EPA and public health authorities, are essential.*** Site remediation authorities can dictate air emission controls, and public health interventions.

***8. We learned from our study tour the important role the community played in shaping cleanup and regulatory decisions at the site.*** The affected community, assisted by an NGO at a nearby law school, took advantage of the information disclosure and public participation opportunities provided under USA law, both formal and informal, to engage policymakers and push stricter controls. NGOs also forced changes to the NAAQS requirements through lawsuits against EPA, including development of the new standard and stricter monitoring requirements.

***9. We also learned from the study tour that the company credits improved worker protection practices with some emissions reduction.*** Educating workers about the importance of dust control produced both onsite and offsite benefits. Because fugitive emissions are a substantial cause of community exposures, better onsite dust control limiting exposure to workers also lowered emissions offsite. Exposures inside worker homes were similarly reduced simply through better hygiene and washing practices, both of clothing and bodies.

***10. Ongoing soil sampling is required, even after site remediation, due to possible recontamination from fugitive and other sources of emissions.*** Many of the properties at Doe Run will need to be cleaned up multiple times because of transportation-related and other dust sources at the facility.

# V. Recommendations

Relying again on the environmental health risk control framework outlined in chapter two, we are reminded that a comprehensive and systematic lead risk control requires a three-pillar system including:[37] a) **Environment controls**: industrial emissions control; ambient environmental monitoring and controls; contamination clean-up and remediation, b) **Public health management**: exposure prevention and reduction; health risk monitoring; public health intervention, and c) **Interagency cooperation:** information sharing, and cooperation between environmental and public health authorities. Based on the gaps identified in our case study, experience and lessons from US practice, our research concluded with a number of possible responses, varying from immediate actions, to long-term system development.

<u>Short-Term (0-3 years)</u>

- Undertake soil sampling in residential areas and common areas where children congregate (i.e., schools, playgrounds, day care centers) near active and closed priority industrial sources for the purpose of determining the need for immediate response actions to protect public health.

    This is the logical first step toward identifying those active and historic sites posing an immediate health risk to children. Results from this sampling should be used to prioritize sites for subsequent response actions.

- Issue soil action levels, and short-term guidance, for undertaking emergency response actions at residential settings and locations where children congregate.

    These action levels will provide a basis for local agencies to make consistent decisions in the short-term regarding whether and how to respond to detected levels of lead soil contamination. The emphasis should be placed on taking quick action to reduce childhood lead exposure where lead levels are high enough to justify action under any reasonable set of assumptions regarding residential exposure. Accordingly, the action levels will enable immediate remediation and

[37] The establishment of a systematic lead health risk prevention approach will require institutional reform as well, in addition to building a regulatory framework. Our recommendations focus on the regulatory approaches. Within the regulatory framework, the focus is on air and site remediation activities, based upon the findings of the case study. We recognize other actions may be needed to address issue of waste management and water discharges, for example.

other exposure reduction activities at the worst contaminated sites, while models and other risk assessment techniques are further refined for future use to assist decision-making at more moderately contaminated sites.

- Establish public health and medical intervention guidance as needed for areas where soils exceed lead action levels, or other data (i.e., elevated blood levels) indicate substantial ongoing lead exposures to children.

  Begin coordination with public health agencies through adoption of agreed upon guidance in response to detected levels of contamination and/or blood lead levels. These procedures should complement and take into account the procedures for remediating soil contamination.

- Take interim and immediate medical, public health and environmental response actions as needed to address children exposures.

  At priority sites, begin taking action to mitigate significant public health risks. These actions can be viewed as short-term measures to immediately reduce substantial exposures, while longer term remediation options are investigated.[38]

- Identify the priority industrial sectors responsible for lead pollution in China, and establish source-specific lead air monitoring programs to ensure compliance with lead limits in the national Ambient Air Quality Standard. The inclusion of both facility-run and government-run monitors as needed should be part of this monitoring program. When non-attainment of national Ambient Air Quality Standard is detected, there should be a process for identifying the source(s) contributing to the violation(s).

  This is the logical first step toward identifying those lead pollution sources in China contributing to a significant public health risk.

- Modify the permitting and enforcement processes for such sectors such that the permit must: (1) include all relevant lead standards and controls; (2) require the company to demonstrate the lead standards and controls will be met; and (3) require corrective action where violations of either permit conditions or the national Ambient Air Quality Standard are detected.

  In anticipation of identifying substantial lead pollution sources, the licensing framework should be revised to enable regulatory agencies to effectively respond to public health risks by taking immediate steps to reduce lead emissions at such facilities.

[38] Examples of such response actions can be found at http://www.epa.gov/emergencies/content/hazsubs/ractions.htm.

- Enact emission control standards for the priority industrial sectors applicable to new and existing facilities which reflect Best Available Technology (BAT), cover fugitive emissions, incorporate national Ambient Air Quality Standard compliance (and associated monitoring) as an enforceable standard, and require corrective action where emission standards or national Ambient Air Quality Standard are exceeded.

  Begin controlling fugitive emissions through best practices, and ensure stack controls meet appropriate international standards for these facilities.

- Issue and enforce siting standards for new facilities, on the basis of the current *Sanitary Standards for Industrial Enterprise Design* and other requirements as needed, and ensure the EIA process is consistent with such standards. Encourage the creation of industrial parks and other settings where significant sources of lead pollution are isolated from the general public, particularly children.

  Due to the difficulty of completely controlling fugitive emissions and the highly toxic nature of lead, it may be challenging in some settings to protect human health using emission controls alone. An additional way to avoid health impacts is to prevent human (childhood) exposure, and the best way to prevent exposure is to avoid placing children in harm's way. The siting standards should place a buffer zone between the facility (and associated transportation routes), and places where children will stay for long periods of time such as residences, schools, playgrounds, and day care centers. Multiple lead pollution sources can be combined into industrial parks, sized large enough to provide the necessary buffer zone, with ambient air monitors located at the boundary to protect the general population.

- Conduct capacity assessment to monetize needs of regulatory and public health agencies at all levels to improve governing and response structure at all levels of government.

  Local environmental and public health agencies will require additional resources to undertake the monitoring, emissions control, site remediation, and public health interventions anticipated under this enhanced program. Based upon the number and location of the priority sources identified, a capacity needs assessment should be performed to identify and quantify capacity needs.

- Evaluate possible approaches to funding the capacity needs identified, including fee(s) on lead ore produced or imported, and/or lead produced or imported.

  In conjunction with the capacity needs analysis immediately above, options for providing sufficient and stable funding should be evaluated, including fees derived from the relevant industrial sources.

- Conduct pilots at various sites where environmental response and/or public health interventions are warranted to test mechanisms for public disclosure and participation in the planning and implementation processes.

  Use this period of time to test various models for information sharing and coordination between agencies and involving the public, to inform policymakers charged with developing future guidance governing the site remediation process discussed below.

Medium-Term (3-5 years)

- Complete national lead air monitoring system through the installation of non-source urban air quality monitoring stations.

  Select urban locations for non-source component of national lead air monitoring system, and begin collecting data to determine general population exposure to lead, determine overall trends, and help understand relationship between population blood lead levels and lead concentrations in air. The data collected should be evaluated periodically to determine if current and anticipated lead actions are sufficient to protect public health, and if they are not, gaps in coverage should be identified and plans initiated to address them.

- Enact comprehensive site remediation legislation imposing liability for cleanup on the polluting source(s), and authorizing and providing resources for a government response where polluters are unwilling or unable to respond.

  Develop the critical legal authorities necessary to respond to environmental contamination on a routine and sustained basis, and ensure the authorities and mechanisms extend down to the local levels where many will be applied.

- Establish mechanisms for interagency coordination, sharing of information, and lines of authority for responding to lead pollution incidents, which may include an electronic platform for data sharing among agencies on permit conditions, compliance, emissions data, environmental sampling, health effects info (e.g. blood monitoring programs), etc.

  As part of this process, use the opportunity to evaluate electronic platforms and mechanisms for interagency team building in an effort to encourage long lasting changes in regulatory agency practices regarding information sharing and disclosure.

- Establish or revise as needed soil standards to protect exposed children and food tolerance levels to protect the public food supply from lead contamination.

  Based on the principal lead exposure routes to children (i.e., soil ingestion, dust inhalation), modify the soil standards as needed to include standards governing these exposure pathways, particularly for residential areas and other locations where children congregate. Adapt internationally available exposure and risk assessment tools to China situation as needed.

- Modify the permitting and enforcement processes for priority industrial sources such that the permit must: (1) require periodic soil sampling in residential areas and common areas where children congregate, and agricultural areas near the facility, and require site remediation where detected levels pose a public health risk; (2) be subject to modification to reflect new requirements; and (3) allow environmental regulators access to the permitted facility and its records without prior notice.

  Include soil sampling and remediation (as needed to protect public health) as standard conditions for operating licenses at priority lead sources, and make other revisions to such license conditions necessary to optimize use of the licenses as a principal enforcement tool. Authorize inspections and sampling without warning through these license conditions as a basic tool of regulatory agencies to enter the property and inspect equipment and/or records, and take samples whenever deemed necessary by the regulatory agencies.

- Review implementation of public disclosure law as applied to priority industrial sector sources, particularly the disclosure of emission data, and initiate recommendations for addressing discovered shortcomings.

  Use the priority lead industrial sectors as case studies for evaluating and improving implementation of the public disclosure law.

- Investigate clean production methods for the priority industrial sectors, and develop recommendations for transitioning the priority sectors into such methods.

  Develop partnerships in academia, trade associations, and the public and private sectors to investigate opportunities for advancement into next generation technologies which minimize or eliminate significant lead emissions, including the phase-out of lead for current uses where superior alternatives are available. Develop sector specific transition plans for achieving next generation technologies.

- Initiate annual reports on lead air emissions nationally, provincially and by sector, including detected ambient air quality standard violations.

  Improve and standardize reporting of lead emissions into the environment, and ambient lead monitoring data, so that current status and trend information can be readily ascertained.

- Establish lead website at MEP, where information on lead pollution and sources is consolidated and maintained.

    Use lead and other toxic metals as pilots for constructing MEP websites where source-specific and national data are consolidated, and laws/regulations/policies are provided. The website should be maintained and kept up-to-date as the first location of choice for agencies, policymakers, and the public for information on lead pollution in China.

<u>Long-Term (more than 5 years)</u>

- Modify lead limits in the national Ambient Air Quality Standard to reflect newest information on health effects from lower dose exposures and to incorporate consideration of inter-media transfers from air to other media.

    China's current standard should be lowered to reflect current information on the toxicity of lead to children at low concentrations, and then permitting and monitoring requirements should be revised as needed to implement the new standard.

- Based upon the new site remediation legislative authorities, establish final technical guidance for responding to lead contaminated sites, including how to determine when a response is needed (including emergency actions), the menu of response actions available and how they should be conducted if chosen, and how to identify the appropriate response action at a particular site (such response actions should include both site remediation and public health interventions).

    Using the new legislative authorities, issue legal and technical guidance on how lead contaminated sites should be remediated. Update this guidance as needed to reflect new information and program improvements.

- Establish guidance for public disclosure and outreach in site response and remediation activities.

    Informed by the pilot case studies discussed above, develop guidance for local agencies on how to best involve the public in site remediation activities.

- Support transitioning the priority industrial sectors into best environmental performers internationally.

    Based upon the next generation technology transition plans developed above, begin implementing the plan so that China's priority industrial sectors largely reflect the latest and cleanest international developments by 2020.

China already has a number of regulatory tools in place. Our recommendations can build upon the existing programs, and enhance licensing and enforcement capacities. We believe our proposals are feasible for China, in part because the improvements would be made in strategic and logical steps as presented above. China has already shown the willingness and determination to tackle industrial lead pollution in the next five years. We hope our suggestions can be helpful by providing some direction for concrete approaches to establish a long-term systematic approach to reduce health risk from lead pollution in the 12th Five-Year Plan period, and beyond. We share the same objective - to protect people's health adequately and comprehensively against pollution.