Project Completion Report

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"Kabwe pilot lead remediation project"

PROJECT SUMMARY

Site Description and Background

Kabwe is the second largest city in Zambia, with a population of more than 200,000 people and is located 130 km north of the nation's capital, Lusaka. It is situated adjacent to the "Copperbelt", which was once Zambia's thriving industrial base. Ore veins with lead concentrations as high as 20% have been mined at the site, and smelting operations were set up to process the ore. Today, high residual concentrations of lead dust remain, heavily polluting the site and adjacent communities. The contamination is not uniform, however, with certain neighborhoods significantly more contaminated than others – particularly neighborhoods close to or downwind of the mine and tailings piles area. It is proposed that a pilot remediation and community education project be carried out in the highly contaminated residential area of Chowa. The project will consist of capping residential yards and public areas, cleaning of homes interiors, a public education and awareness campaign, and monitoring and evaluation. The purpose of the project is to reduce exposures and therefore blood lead concentrations of Chowa residents. The concurrent goal of the project is to train local resources and government employees in implementing this type of project going forward.

Project Objectives

•To contribute to improving the environment and thereby improving the health of residents, especially children, in the Chowa neighborhood of Kabwe, Zambia

•To reduce lead exposures, especially of children, in the project area and leave the project area in a sustainable state such that exposures will continue to be reduced

Project Outputs

1. Complete a detailed assessment of lead exposure in Chowa
2. Educate the community on the health effects of lead and most effective ways to mitigate their risk of exposure
3. Mitigate the exposure to lead in all homes within the project area by capping yards and cleaning homes

Project Partners

Environment Africa (EA) is a non-profit organization established in 1990 in Zimbabwe and has since opened country offices in Malawi, Mozambique and Zambia. EA is currently working in

Kabwe, Chibombo, Lusaka, Kazungula, and Livingstone districts in Zambia. The organization has extensive experience in development projects relating to health, nutrition, and environmental education

Kabwe Municipal Council (KMC) is the local governmental organization with expertise in public health, urban planning, and engineering. KMC has partnered with Pure Earth and Environment Africa by providing access to local records and representatives and assisting in key portions of the remediation planning, outreach, and education.

Summary of Activities

This project involved six main components:

1. Detailed environmental assessment
2. Community health education
3. Improvement of drainage
4. Yard remediation and lead encapsulation
5. Home cleaning
6. Quality control and follow-up

The investigation and mitigation work completed in late 2015 was done in the Chowa neighborhood of Kabwe, as shown in the figure on page 5. The project area with approximately 250 homes was initially selected for a detailed environmental assessment based on its proximity to the mine and earlier lead testing results in soil and blood. The environmental assessment work indicated highly elevated and widespread lead contamination in the subject area in Chowa. A total of 180 homes were selected to be part of the education program, with 78 of those homes selected for encapsulation and cleaning in 2015 (Phase I). The remainder of homes are scheduled for encapsulation and cleaning in 2016 (Phase II).

Representatives from 180 homes within the overall project area and surrounding neighborhood attended one of three full day health education workshops. Individual remediation plans were then created for the yards of each home based on the layout of the yard, location of future gardens, outbuildings such as chicken coops and additional residences, and mature shrubs and trees. Each yard was encapsulated using a combination of barrier cloth and clean soil, freshly planted grass, gravel, and/or stone with homeowner's input and consent. Construction of adequate drainage ditches, cement pads, and vegetable gardens were also included in the

planning process. Homes were then cleaned with a shop vacuum containing a HEPA filter and soap and water. After all remediation and cleaning work was completed at each home, a follow-up team paid a final visit to spot check the yard to ensure quality control.

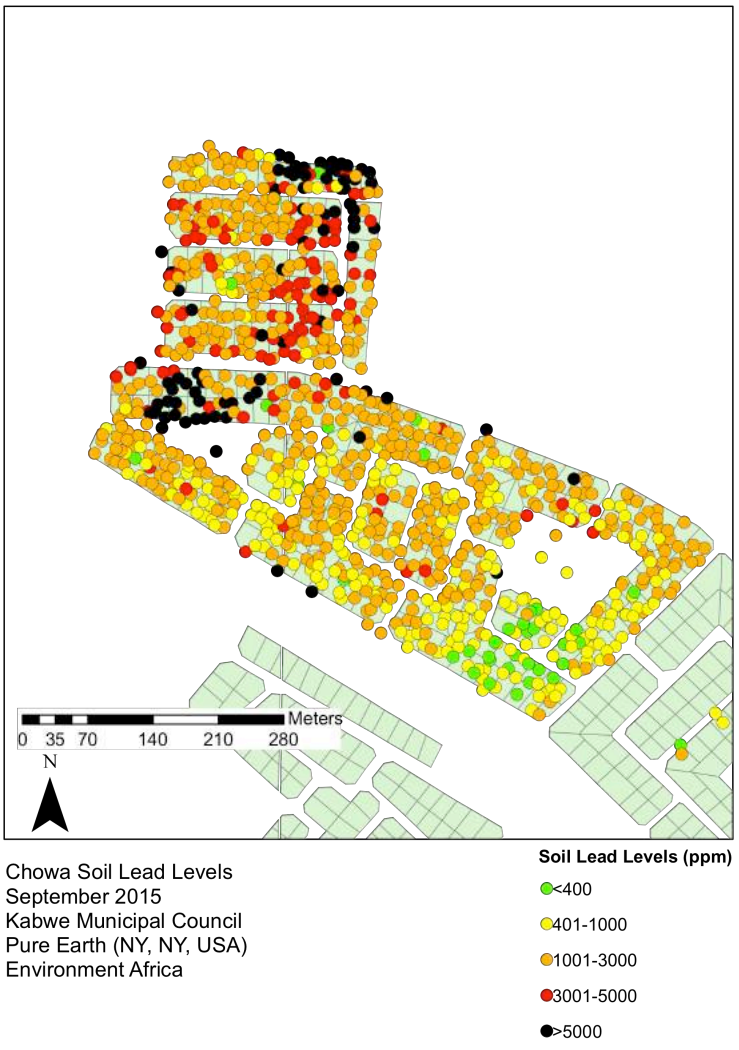
Summary of Results

Seventy-nine homes were in the designated project area and all but one home chose to participate in the project. Lead levels were measured as high as 24,000 parts per million (ppm) but were typically between 2,000 and 4,000 ppm; the USEPA standard for lead in residential soil is 400 ppm. All 78 homes within the designated project area had soil lead concentrations below the USEPA standard at the close of the project.

PROJECT COMPONENTS

Detailed Environmental Assessment

Approximately 1,000 soil samples were taken via XRF analyzer (Innov-X 4000 Alpha Series) throughout the Chowa neighborhood in early September 2015. Pure Earth partnered with Environment Africa and representatives from the Kabwe Municipal Council to take between two and six samples from each yard within a large mine-adjacent section of Chowa. Soil samples were also taken at several footpaths, churches, community gardens, football pitches, and playgrounds. Standard practices from Pure Earth's soil sampling protocol were followed throughout the assessment period.



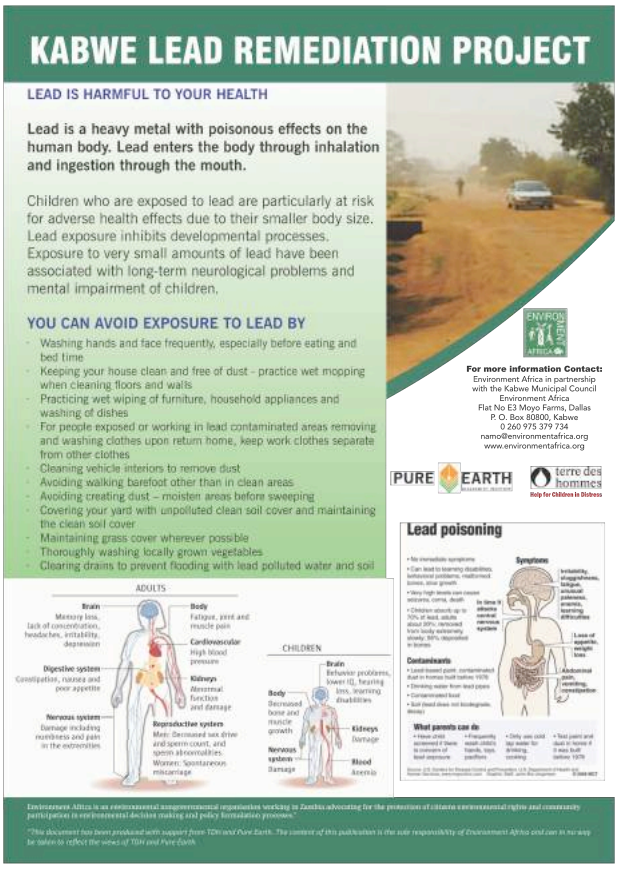
Above: A map of individual soil sample points created by Pure Earth staff, September 2015

Soil lead concentrations tended to be highest along the northern border of the neighborhood that is defined by a large drainage canal. Residents said this canal occasionally floods during heavy rains when it has not been

adequately maintained, which has been a problem in the past. The lowest concentrations were found in the southeast section of the neighborhood that was furthest from the canal and the mine. In general, soil lead levels were between 2,000 and 4,000 ppm within the project area and between 1,000 and 3,000 ppm in the remainder of the neighborhood. Soil samples were confirmed with a laboratory analysis. Additionally, three municipal water samples were collected and analyzed within the project area to determine if water was a significant pathway. Lead was not detectable in all water samples analyzed, which is consistent with historical analyses.

Community Health Education

At the beginning of the project, all staff from EA and KMC to be involved in the project were trained by Pure Earth regarding the health effects of lead and appropriate exposure mitigation techniques. Pure Earth's project partner Environment Africa undertook the health education and community awareness portion of the project. Information, education, and communication (IEC) materials were developed jointly with Pure Earth and Environment Africa staff, based on materials Pure Earth helped develop for similar projects. Posters about the project, the effects of lead, and exposure mitigation were placed throughout the community. Additionally, pamphlets were distributed at the full day workshops held in October 2015.



Above: One of several IEC materials developed jointly by Environment Africa and Pure Earth

The health education team conducted 3 workshops with attendance from a total of 180 households from the project area and surrounding community. In addition Environment Africa held a workshop for school leaders, which was attended by principals and other leaders from almost all primary and secondary schools in Kabwe. In addition to workshops, a door-to-door campaign was also undertaken to follow up with homeowners in the project area to answer their questions about the project in a

more private setting and have them sign consent forms. The Kabwe Municipal Council also indentified two staff members to assist the team from Environment Africa in this work.

Improvement of Drainage

The first work step in the project was to assure that drainage systems in the project area work. This was essential to assuring the sustainability of remediation measures, notably to prevent erosion and re-contamination of remediated areas due to flooding. The KMC Engineering department conducted work in September and October to clean drainage canals in the roads in the project area, as requested and directed by Pure Earth. Laborers hired by the Kabwe Municipal Council performed all drainage clearance activities. The KMC Engineering Department also cleared the main drainage canal adjacent to and downstream of the project area to assure that storm runoff would flow and prevent flooding of the neighborhood from a backed-up canal, which would re-contaminate yards remediated.

Yard Remediation and Lead Encapsulation

A total of 78 homes were selected for encapsulation during the initial Phase I remediation work completed in late 2015. These homes were located in a roughly rectangular area comprising four roads, namely Sturgeon, Moskwa, Kasaba, and the adjoining portion of Chowa Road.

Above: One of several remediation teams prepares a yard for encapsulation with a barrier cloth

These homes were selected based primarily on lead levels in surficial soil. Remediation work began at the end of October 2015 once adjacent drains and canals had been cleared tomitigate the potential for future flooding. A remediation team of approximately 25 people was hired locally and provided proper personal protective equipment (PPE) and training. PPE included uniforms, gloves, boots and N95 particulate respirators. Uniforms were washed daily and left at the project area to prevent spread of lead dust. Workers training included information about the hazards of lead

and methods to be used to prevent exposure, as well as work methods and objectives. Workers were also provided with lunches, ample water, and a place to wash before eating and at the end of the workday.

In September and October 2015, the teams leveled the yards of all 78 homes and also removed vegetation and obstructions (e.g. debris) that would interfere with the encapsulation process. It took approximately ten days to prepare each yard for the barrier cloth utilized in the encapsulation process. Once yards had been adequately leveled and cleared, cement pads were added to the entryway of approximately two thirds of the homes within the project area. The pads were installed to prevent erosion of clean soil outside the home as most homeowners sweep their doorsteps daily.

In November 2015, remediation teams then consisting of 30-40 people completed the encapsulation process at all 78 homes. The teams first laid a geotextile barrier cloth (Fibertex F25) at each home where appropriate, avoiding areas where lead is already encapsulated (i.e. paved or gravel driveways, stone walkways, densely packed grass areas, etc.). This geotextile was then covered with approximately 10-15 cm of clean laterite soil. In addition to the yards, a frequently used and highly contaminated pathway between the project area and nearby roads, schools, and churches was covered with clean soil. Clean laterite soil was sourced locally from Mpima borrow pit just outside of Kabwe and was tested via XRF analysis to ensure it was below the USEPA standard of 400 ppm lead. The laterite soil brought into the project area had a lead concentration of less than 25 ppm, which was confirmed by laboratory testing. For vegetable gardens and newly

Above: A remediation team carries a rolled up barrier cloth, also called a geotextile layer, into the yard of a home to prepare it for encapsulation

grassed areas, soil with a higher organic content known locally as “black soil” was used. The black soil was also sources locally from the Matondo borrow pit. This soil had a lead content of less than 125 ppm, which was also confirmed by laboratory testing. Compaction to prevent erosion was considered but found to be unnecessary based on the generally flat terrain and observations of the soil being naturally compacted following rain to form an erosion resistant surface. Pure Earth maintains maps showing each of the 78 house lots, the location of outbuildings, portions covered by barrier cloth, gravel, laterite soil, and black soil.

Where necessary, drainage in the yards was improved to decrease the likelihood of flooding in the rainy season. Drainage channels were enhanced with stone and large gravel to cover underlying contaminated soils while also allowing drainage or infiltration (similar to a French drain). Grass seed was planted in pre-determined areas designated by the homeowners for lawns. Adequate cement blocks, usually 50 per household desiring them, were left once the remediation was completed so that homeowners could cordon off a section of their yard and construct a raised bed for growing vegetables. In these areas, black soil with a higher organic content was provided to homeowners to facilitate growth of the garden as well as to cover the underlying soil to a depth of 20 cm or more, thus allowing growth of the vegetables in clean soil. It is estimated that a total of 200 truckloads of laterite soil (4,000 cubic meters) and 125 truckloads of black soil (2,500 cubic meters) were delivered to the 78 homes in the project area (Phase I).

House Cleaning

Once a yard remediation was completed, two ‘house cleaning’ teams of four people each entered each home and cleaned it with the assistance of a HEPA filter and soap and water to mitigate lead exposure via dust inhalation and ingestion. The insides of houses were found to be highly contaminated through XRF testing. This is believed to be a major risk as young children spend much of their time inside houses (as well as in yards). Cleaning could only be done after the yard remediation so that lead dust is not re-introduced into homes after cleaning.

Cleaning teams followed a house cleaning protocol created by Pure Earth with the assistance of several technical advisors. The protocol was given out by Environment Africa staff as part of the IEC materials developed for the health education sessions. Additionally, homeowners were educated in proper cleaning techniques when available. First, the house cleaning involved washing the surfaces with soap and water. Surfaces were then rinsed and vacuumed with the HEPA filter. The same worker exposure training and protection measures were used for the cleaning crews as the remediation workers.

Above: One of the home cleaning teams with community outreach staff from Environment Africa

Final Inspection and Quality Control

Members of the Kabwe Municipal Council checked all homes after the remediation to ensure quality control. The follow up included spot-checking via XRF to confirm soil lead levels were below the USEPA standard of 400 ppm. Home cleaning, drainage, adequate encapsulation, and homeowner satisfaction were also gauged during the follow up.

Though blood lead testing is the standard biological marker to measure a decrease in exposure to lead, it was deemed unnecessarily invasive as part of this project as the Japanese International Cooperation Agency (JICA) recently took baseline measurements. Follow-up measurements are planned for summer 2016. It is expected that blood lead levels in children residing in the project area in Chowa will decrease significantly relative to areas of similar contamination in the rest of the city.

Stakeholder Development

The project was implemented with strong support from the Kabwe Municipal Council. Regular meetings were held and updates were given to all relevant stakeholders, notably including the KMC housing and engineering department directors, Environment Africa staff and local volunteers and remediation laborers. Key involvement and support was obtained from the local

elected council members from the Chowa neighborhood. As stated above, the homeowners in the project area were engaged and educated through workshops and door-to-door outreach. All homeowners whose homes were involved in the project signed consent forms for the work done in their homes and yards, and were consulted regarding matters of drainage, lawns, cement placement, driveways, and garden construction. Staff members from the Kabwe Municipal Council and Environment Africa were trained in the health effects and appropriate exposure mitigation techniques of lead. Additionally, several key staff members were also trained in proper soil sampling techniques via XRF analysis.

Funding

Funding for the project came from several key sources. These are listed below.

Donor	USD
terre des hommes	42,400
Marilyn S. Broad	12,500
Foundation Beyond Belief	10,000
International Foundation	15,000
Other Private Donations	35,100
Project Total	**115,000**