Zamfara State Lead Poisoning Epidemic
Environmental Remediation

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ZAMFARA MINISTRY OF ENVIRONMENT

TerraGraphics
Environmental Engineering, Inc.

CDC
World Health Organization
Blacksmith Institute
UNICEF
Where the Story Starts

- **May 2010 – CDC & World Health Organization Investigation.**
  - 163 deaths in two villages
  - About 33% of children < 5 years old died of lead poisoning
  - Emergency Response Begins
Where is Zamfara State, Nigeria?
Zamfara State – Cultural & Economic Context

- **Socio-economic**: extremely poor
- **Religious**: traditional Muslim/Sharia
- **Family Structure**: polygamous extended family
- **Political/Governmental**: intense/challenged

- **Geographic**: remote, unreliable power and water
- **Climatic**: hot and extreme wet or dry, harmattan
- **Security**: travel restrictions
- **Health and Environment**: several endemic diseases, limited medical facilities
Zamfara State Culture – Hausa

- Agrarian (Farmers)
- Villagers
Zamfara State Culture – The Fulani

- Herders
- Nomadic
- Indigenous group
Project Background

- The worst lead poisoning in history
- 400 to 500 children have died
- 30 to 43% of all children under the age of 5
- 45% of cases presented to clinics died in early stages
- 17,000 villagers lead poisoned
- Long-term irreversible health effects
Agriculture to Artisanal Mining
Agriculture to Artisanal Mining
Agriculturally, a family typically makes/lives on ≈ 700 NGN/day (5 USD)
Processing the gold ore, they can make > than 2,000 NGN/day (13 USD)
In the Villages: From Ore to Gold

- Breaking
- Grinding
- Washing
- Drying
- Cooking
NW Nigeria Ore - Gold occurs in quartz veins within hydrothermally altered schist.
Washing
The Final Product
Lead levels as high as 9 percent (90,000 ppm) in soils and 18 percent (180,000 ppm) in sweep samples
Lead Exposure Routes

- Children eat soil! Most at risk
- High ingestion rates
Discoveries During Phase I

- **Much worse** than initially conceived
  - Price of Gold highly favorable
  - Ore Processed in the Villages and in Compounds
  - Ore with High Lead Content Produced Lead Dust
  - Lead Dust Contaminated Soil, Food, and Water
  - Villagers Consumed Lead by Eating / Breathing Dust
  - Nearly Every Villager was Poisoned and Damaged
  - Killing and Disabling the most vulnerable Villagers – Pregnant Women and Small Children
Response Plan
Integrated Response

Remediation

Medical Intervention

Institutional Controls & Safe Mining Practices

Kids stop dying
Remediation – Work Summary

- **General Process**
  1. Characterize Lead Contamination (Mapping)
  2. Excavation
  3. Disposal
  4. Clean Soil/Capping
Remediation – Characterization

- **Characterization Elements**
  - Map each compound – plan view
  - Interview household members

- XRF Sampling
  - Grid Pattern
  - Biased Sampling

- Define action areas
- Wipe samples – mortars & concrete
Initial Mapping
Remediation – Excavation

- Excavation Work
  - Performed by excavation crews
  - Scrape/dig using hoes & picks
  - Bag up contaminated soil
  - Verification XRF sampling
Disposal

- **Disposal Work**
  - Performed by disposal crews
    - Managers & supervisors
    - 7 villagers per crew
  - Collect sacks with excavated soil
  - Load onto cantors
  - Haul to landfill
  - Unload and slash sacks
  - Compact sacks w/equipment
Seven Landfills Closed with Monuments
Remediation – Clean Soil/Capping

- Performed by clean soil crews
  - Managers & supervisors
  - 5 villagers per crew
- Clean soil staging – pay loader
- Haul into compounds with wheel barrows
- Spread clean soil over designated areas (including any excavated area)
- Thickness \( \approx 3 \) inches
- Verification XRF sampling
- Concrete capping as necessary
Nigeria ... Other Areas of Interest
On the Road
Various Other Obstacles ....
Hope for the Future

- 8 Villages Remediated
- Lead Exposure Relief to Thousands
- Thousands of Children Treated
- 300 Community Members Trained
- Villagers Amiable to Safer Mining Practices
Questions?