



Exposure Assessment of Regional Communities Contaminated by Legacy Iron and Steel Industry (ISI) Waste and Sustainable End State Land Use Alternatives

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- Vikram Vyas, PhD – Environmental and Occupational Health Institute, Rutgers University and CRESP

The New Pittsburgh Region?

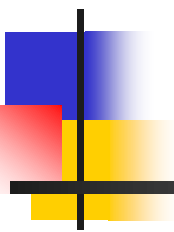


Fishing on the Mon



Homestead Works





Environmental Protection Agency (EPA) indicated in 1995 that the ISI was the largest industrial source of toxic environmental contamination in the United States. (*EPA 1995*)

This figure did not include industrial codes for foundries or machine tooling plants, which have historically been associated with the ISI in the Tri-State Area (TSA) and have waste streams associated with metals, organic solvents, cutting oils and isocyanates.



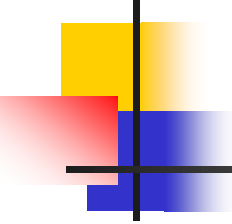
This Region Contains Three of the Most Polluted U.S. Rivers by ISI Prior to 1970's

- Monongahela River (Western Pennsylvania)
- Mahoning River (Warren and Youngstown)
- Ohio River (Weirton, WV and Steubenville, Ohio)



Daily Releases into the Mahoning River from Youngstown and Warren, Ohio ISI

- 400,000 pounds of suspended solids (many containing metals)
- 70,000 pounds of oil and grease
- 9,000 pounds of ammonia-nitrogen
- 800 pounds of zinc
- 600 pounds of phenolics and
- 500 pounds of cyanide were disposed of directly into the river (US Environmental Protection Agency Region V, 1977)



US Army Corps of Engineers Mahoning River Cleanup/Restoration Project

- Completion by 2017
- Will remove approximately 462,000 cubic yards of contaminated riverbed sediments
- 286,000 cubic yards of contaminated shore and bank sediment
- Along a 30 mile stretch of the river.

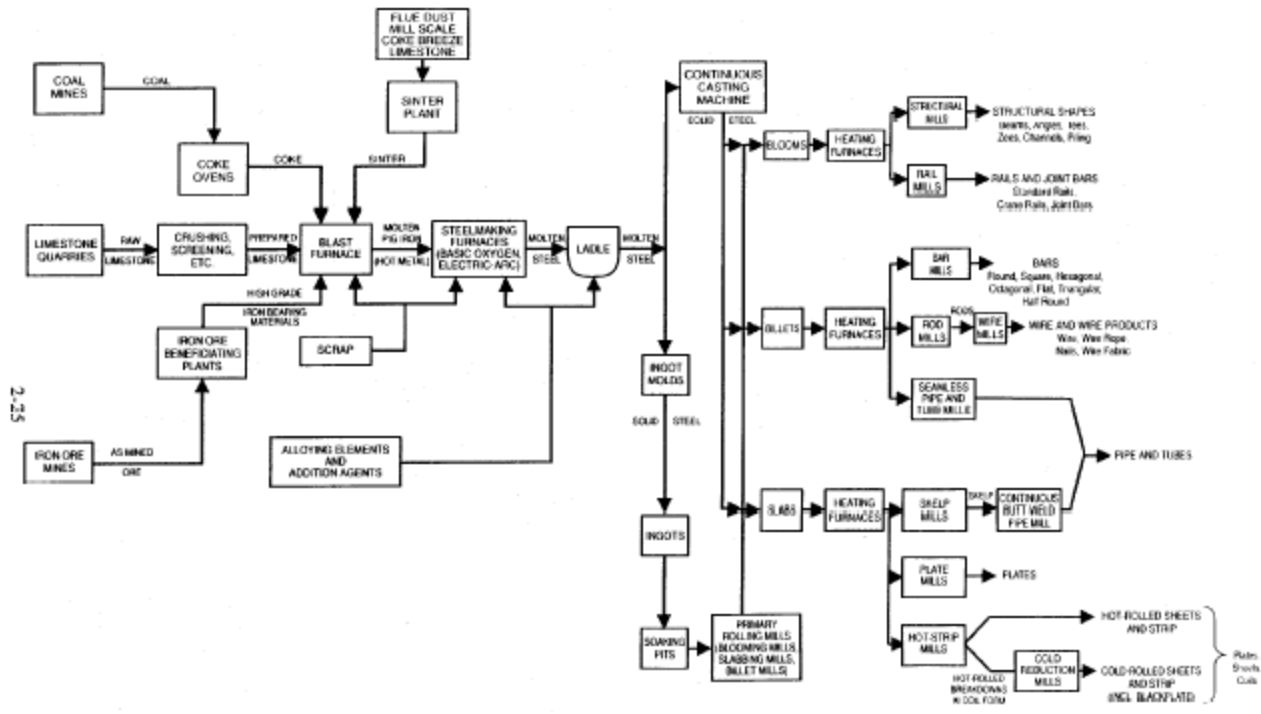


Figure 2-1. Steelmaking From Raw Materials to Finished Mill Products
(Coated Products Excluded)

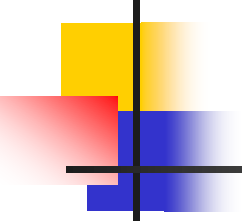
Legacy Contamination Mechanisms



- Air Emissions to Soil and Water -associated transport to subsoil, groundwater and river sediments.
- Leaking Pipes, Pits, Sumps to Soil and Water-associated transport to subsoil, groundwater and river sediments.
- Effluent Release to Streams and Rivers-associated transport to groundwater and river sediments.
- Waste depot transport to soil-subsoil-groundwater and surface water-sediments.

Composition of Exposure Pathways

- **Source (often multiple within one site)**
- **Magnitude and rate of environmental emissions**
- **The transport pathways through environmental media**
 - **Air**
 - **Surface Water**
 - **Soil**
 - **Subsoil**
 - **Groundwater**
 - **River Sediments**
- **The uptake pathways associated with exposure of different population and sub-population groups linked to specific activities**
 - **Inhalation**
 - **Ingestion**
 - **Dermal**
 - **Physical- radiation**
- **The dose that depends on the type, concentration and elimination rate of toxic substances to which these groups are exposed.**



ISI waste streams vary according to each plant's particular endpoints and levels of integration so the environmental fingerprint left in Tri-State Area communities with ISI facilities differ

Cokemaking





Cokemaking

- **Coal tar pitch volatiles- Polynuclear aromatic hydrocarbons**
- **Ammonia liquor and ammonia**
- **Phenol**
- **Cyanides and thiocyanides**
- **Large volumes of oils and grease**



Cokemaking continued

- **Hydrogen sulfide**
- **Lime sludge**
- **Benzene and other aromatic hydrocarbon releases/spills in coke by-product recovery operations**
- **naphthalene, creosote and tar residues and**
- **zinc from wastewater cleaning operations.**



Coke Storage- Clairton Coke Works





Sinter Plants

- **Oil and grease**
- **Phenolics**
- **Metals-including lead and zinc**
- **Aliphatic hydrocarbons**
- **Ammonia and associated compounds**
- **Suspended Solids**



Ironmaking

- Suspended Solids
- Ammonia
- Cyanides
- Phenols
- Heavy Metals including copper, lead and zinc
- Slag (contains mainly CaO , Fe_2O_3 and SiO_2)





Steelmaking

- Must consider waste streams from historic open hearth furnaces as well as basic oxygen and electric arc furnaces
- Metal dusts including lead and zinc
 - Fluorides



Forming, Cleaning and Descaling

- Spent pickle liquors including hydrochloric, sulfuric, nitric, and hydrofluoric acids
- Wastewater sludge containing manganese, iron, nickel, cobalt, copper, cadmium, chromium and lead
- Wastewater containing zinc, lead, cadmium and/or chromium
- Grindings containing chromium and zinc dross
- Oil and Grease



Hot-Coating

- Hot Dip Galvanizing- tin and zinc
- Terne Coating- lead and tin
- Galvalume coating- aluminum and zinc
- Wire Coating- cadmium
- Post Immersion- chromium



Electroplating

- Electro-galvanized (automobiles)—zinc, oil and grease
- Food and beverage electroplating- tin and chromium, oil and grease

(No time to cover foundry work or other industries associated with ISI production)

Basis for Sustainable Risk-Based End State Land Use Alternatives



- **Is there adequate characterization of site?**
- **Are the modes and routes of human exposure known?**
- **What will the site be used for?**
- **Are exposures blocked for the intended land use?**
- **Is there residual risk to human or ecological receptors?**
- **Is this risk adequately communicated to stakeholders and the public?**

Basis for Sustainable Risk-Based End State Land Use Alternatives



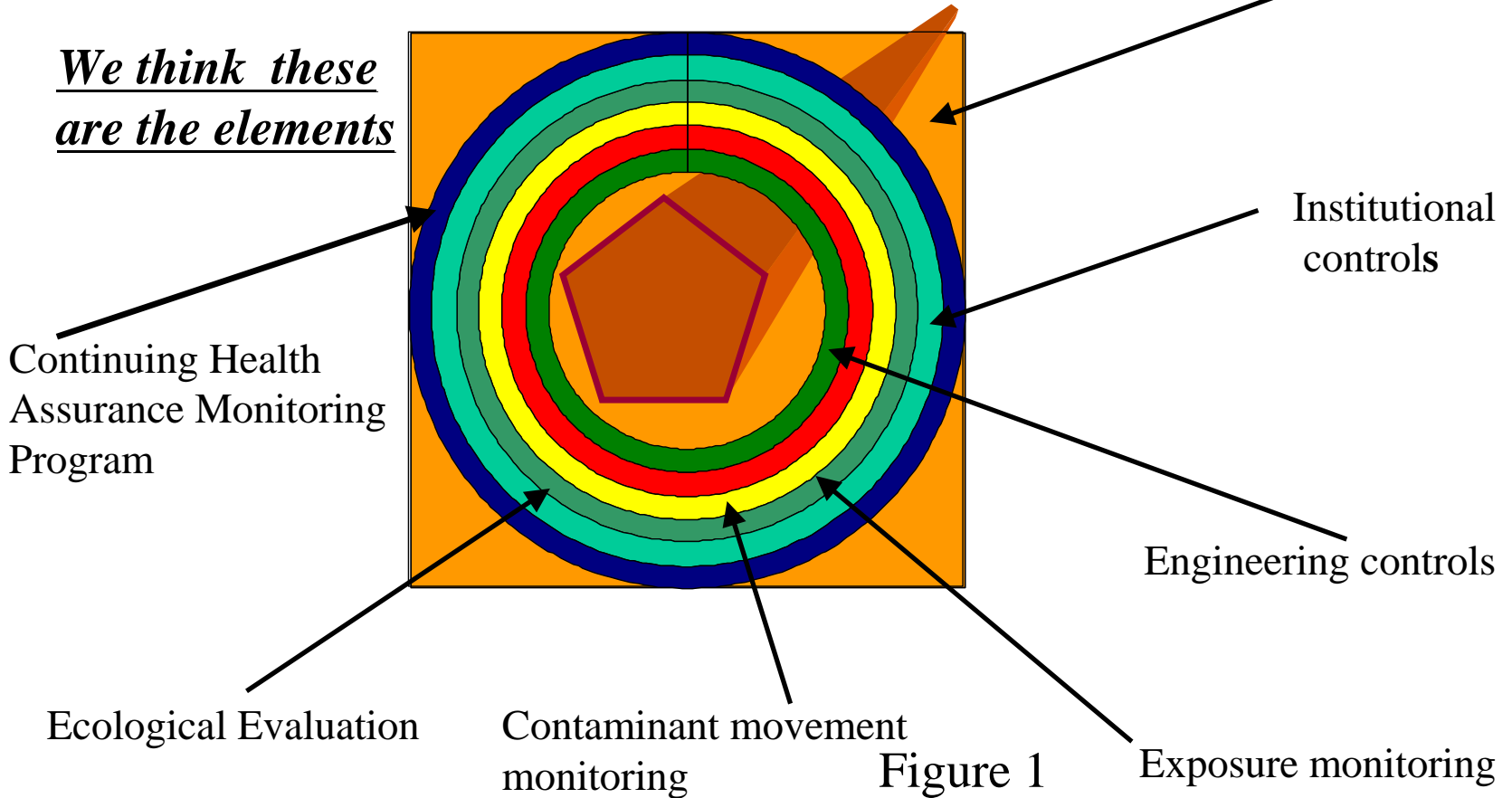
- **Are there engineering and/or institutional controls for residual hazards?**
- **Is there ongoing contaminant movement and exposure monitoring?**
- **Is there periodic ecological assessment?**
- **Is there a continuous health assurance monitoring program?**

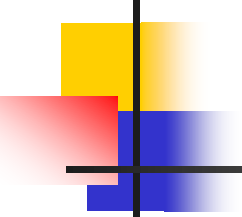
Sustainability: What Does it Mean?

A Stewardship Safety Net with Appropriate
Multiple Rings to Assure Sustainability
While Hazards Pose a Possible Risk

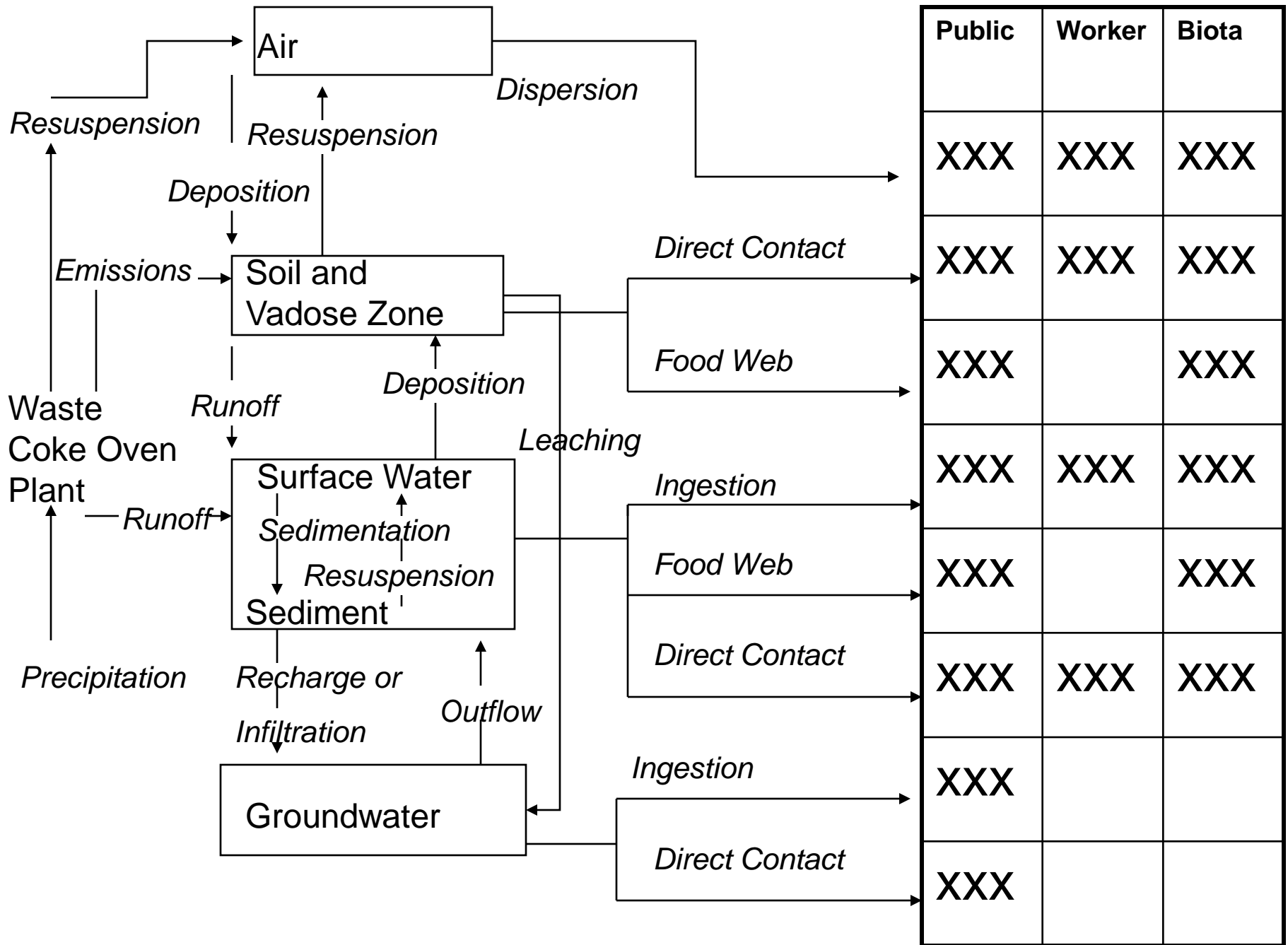
A sustainable
management
of the “net”

*We think these
are the elements*





“Everyday people make choices based on their understanding of the likely consequences, sometimes accepting uncertainty, sometimes taking known risk, and sometimes facing hazards deemed acceptable while avoiding others deemed unacceptable... One of the greatest difficulties in making decisions regarding risk is the absence of factual information. This leads to uncertainty as to the consequences of a particular event... Another difficulty in risk decision making is the complexity of the information. This can confuse issues and lead to a lack of acceptance of decisions.” (MacKenzie 1994,)



Are the Exposures Gone?

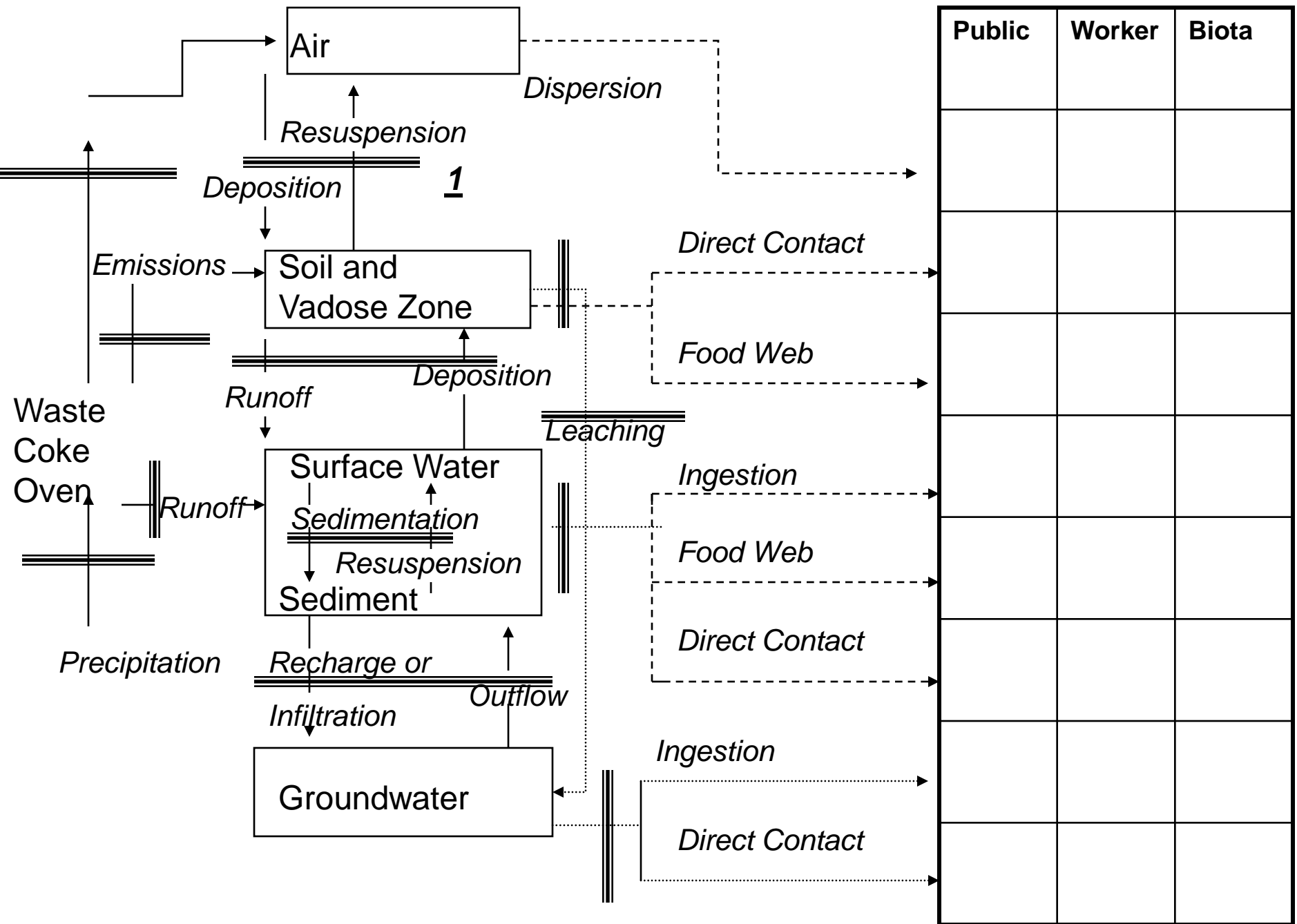
Who might be exposed?

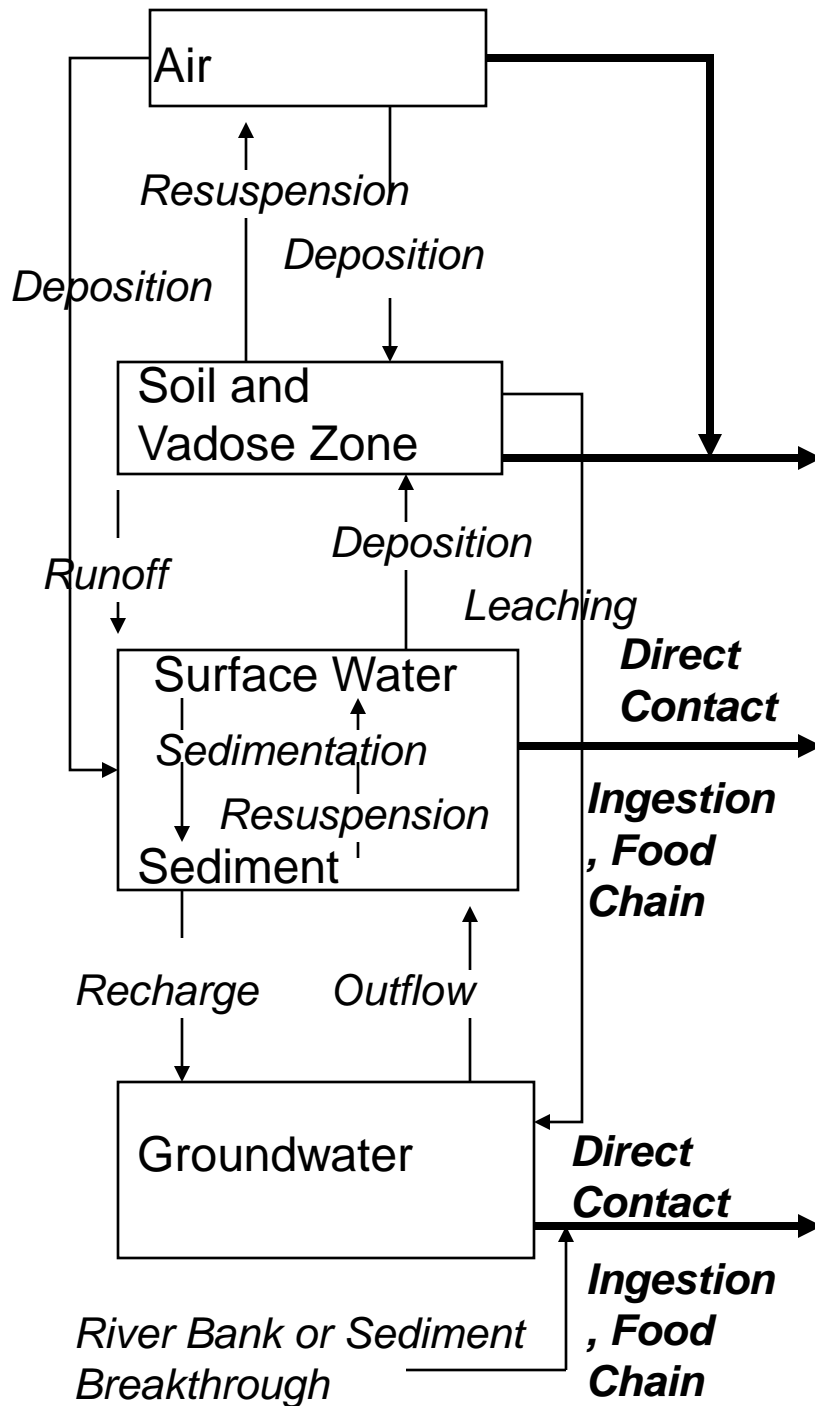


What is Missing?









| Aquatic Ecological Receptors | Terrestrial Ecological Receptor | Public and Fisherman | Consumers of River Caught Fish |
|------------------------------|---------------------------------|-------------------------------|--------------------------------|
| N/A | Inhalation, Dermal, Ingestion | Inhalation, Dermal, Ingestion | N/A |
| Gills, Dermal, Ingestion | Dermal, Ingestion | Dermal, Ingestion | Dermal, Ingestion |
| Gills, Dermal, Ingestion | Dermal, Ingestion | Dermal, Ingestion | Dermal, Ingestion |

River Bank or Sediment Breakthrough → **Ingestion, Food Chain**