Evaluating Risk from Lead (Pb)

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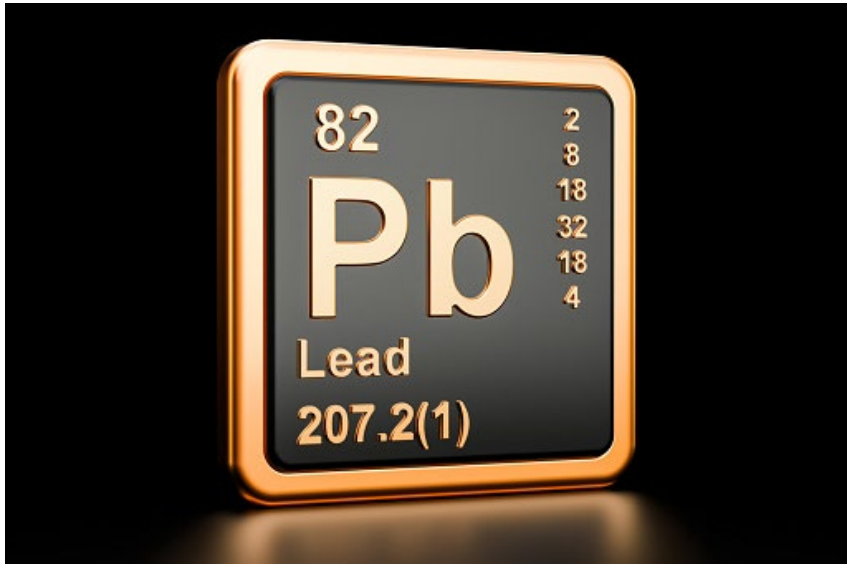
Objectives – why is this important?

- Improve understanding of models used to evaluate lead risk
- Strengthen risk communication practices for Sites involving lead contamination
- Promote collaboration between community involvement coordinators and technical support staff

Why is lead risk assessed differently?



- EPA has not yet found a concentration of lead that does not produce a biological effect

Lead risk assessment uses models

- **Environmental exposures to lead are modeled** to predict blood lead levels associated with site as well as non-site exposures
- **EPA currently uses two models:**
  - Integrated Exposure Uptake Biokinetic (IEUBK) Model – residential
  - Adult Lead Methodology (ALM) – non-residential

https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals

Why use models?

It’s difficult to get representative data and directly link blood-leads to a specific source.

With models we can estimate changes in blood-leads from potential changes in exposures.

IEUBK Model

Purpose of the IEUBK Model

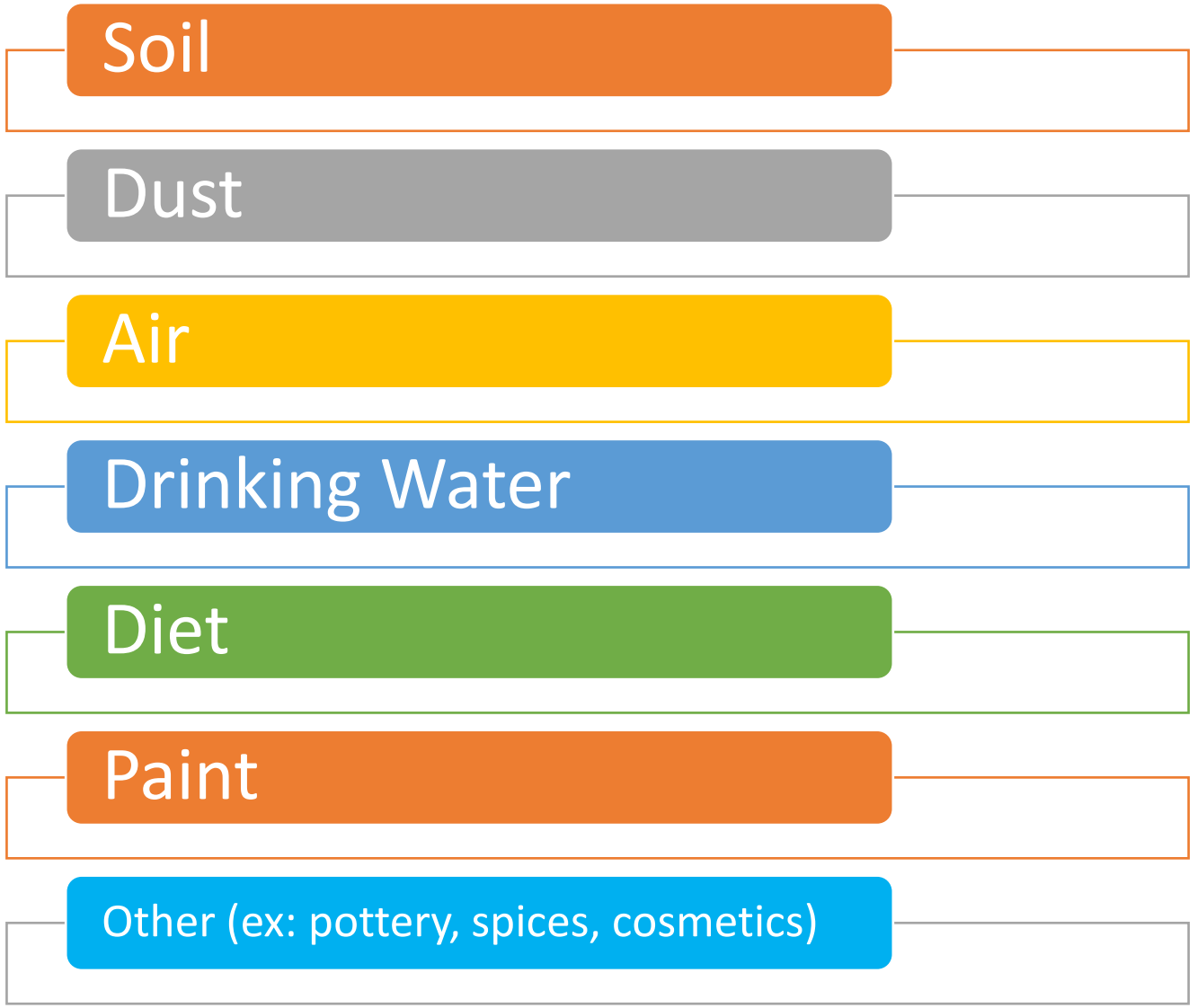
Predicts blood lead levels in young children who are exposed to environmental lead from multiple sources

Predicts risk (probability) that a hypothetical child (or group) will have a blood lead exceeding the target (for example: 5 µg/dL) due to environmental exposure

Can be used to calculate a risk-based Preliminary Remediation Goal (PRG) for soil for residential land use

IEUBK Parameters

Multi-media Pb Exposure



Model Parameters – Soil Lead Concentration

- Site-specific soil lead concentration should be used as the input.

Model Parameters – Indoor Dust Lead

- The model will calculate a value based on the soil concentration and outdoor air concentration.

Model Parameters – Outdoor Air Lead Concentration

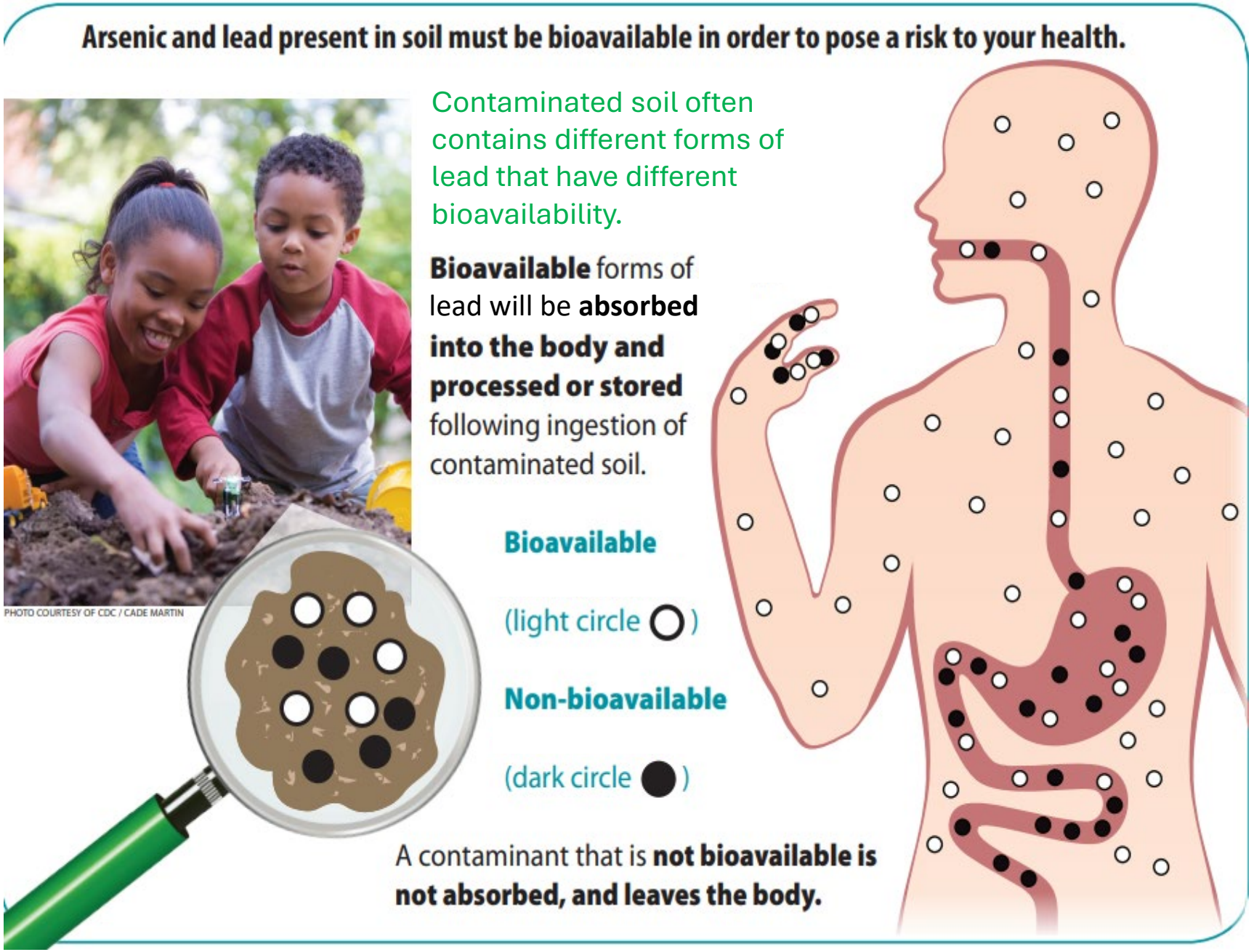
- The model has a default value of 0.1 µg/m³.
- Users can input site-specific data if available.

Model Parameters – Drinking water

- It is recommended to use a site-specific value if data available.
- The default value of 0.9 µg/L may be used if site-specific data is not available.

Media	Age-specific Intake Rates (years)							Comments
	0–1	1–2	2–3	3–4	4–5	5–6	6–7	
Soil/dust ingestion (mg/day)	86	94	67	63	67	52	55	Default values recommended. Intake is apportioned 55% dust & 45% soil.
Breathing rate (m^3/day)	3.22	4.97	6.09	6.95	7.68	8.32	8.89	Rate not accessible to users, but hours outside and absorption are adjustable.
Drinking water consumption (L/day)	0.40	0.43	0.51	0.54	0.57	0.60	0.63	Default values recommended.
Dietary lead intake (µg Pb/day)	2.66	5.03	5.21	5.38	5.64	6.04	5.95	Site-specific data may be used to assess exposure to fish, game, or home-grown produce.
Alternate source	Site-specific data may be used to account for intake of lead in other sources.							Refer to the IEUBK Model User's Guide for more information.

How does bioavailability play into risk assessment?



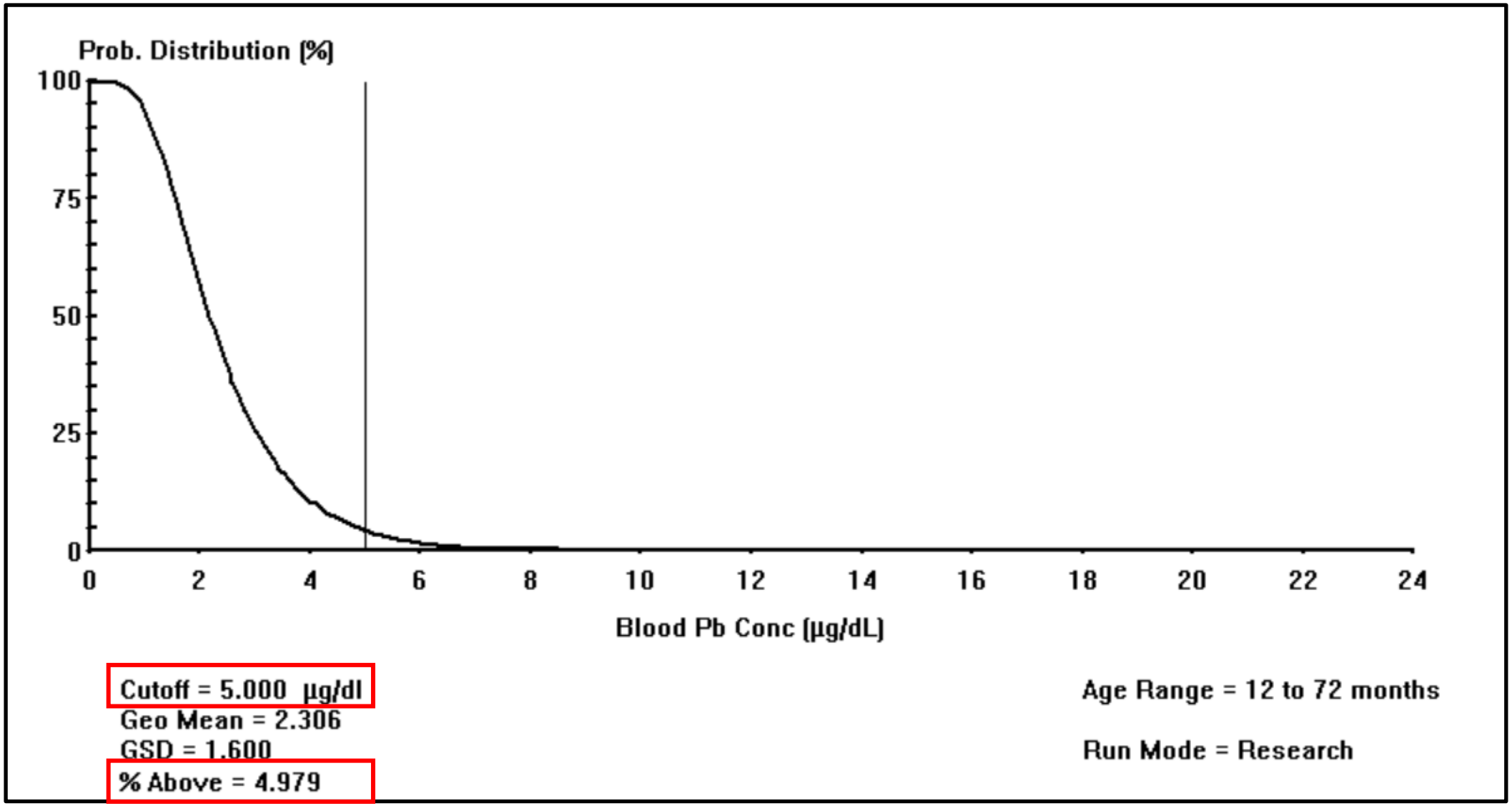
Bioavailability in the IEUBK

- The IEUBK has default bioavailability parameters for soil, dust, water and diet.
- A bioavailability study measures absorption of lead (relative to soluble lead in water).
- We can use results of the bioavailability study to adjust the bioavailability parameters for soil and dust.

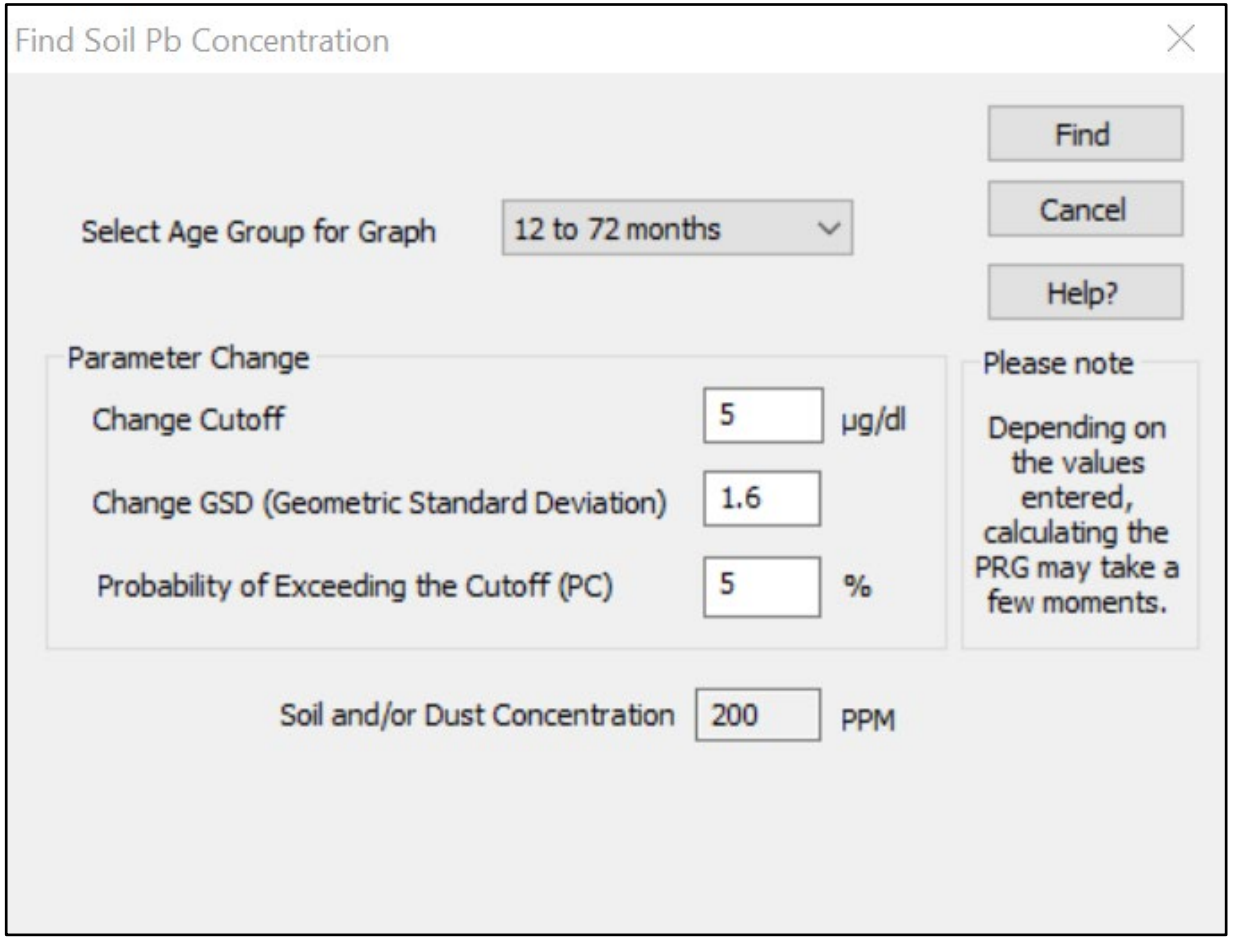
How does a bioavailability study affect site cleanups?

- If lead is more bioavailable, the risk will be greater (lower PRG).
- If lead is less bioavailable, the risk will be lower (higher PRG).
- EPA strongly encourages IEUBK model users to obtain representative site-specific in-vitro bioaccessibility data to estimate bioavailability in soil

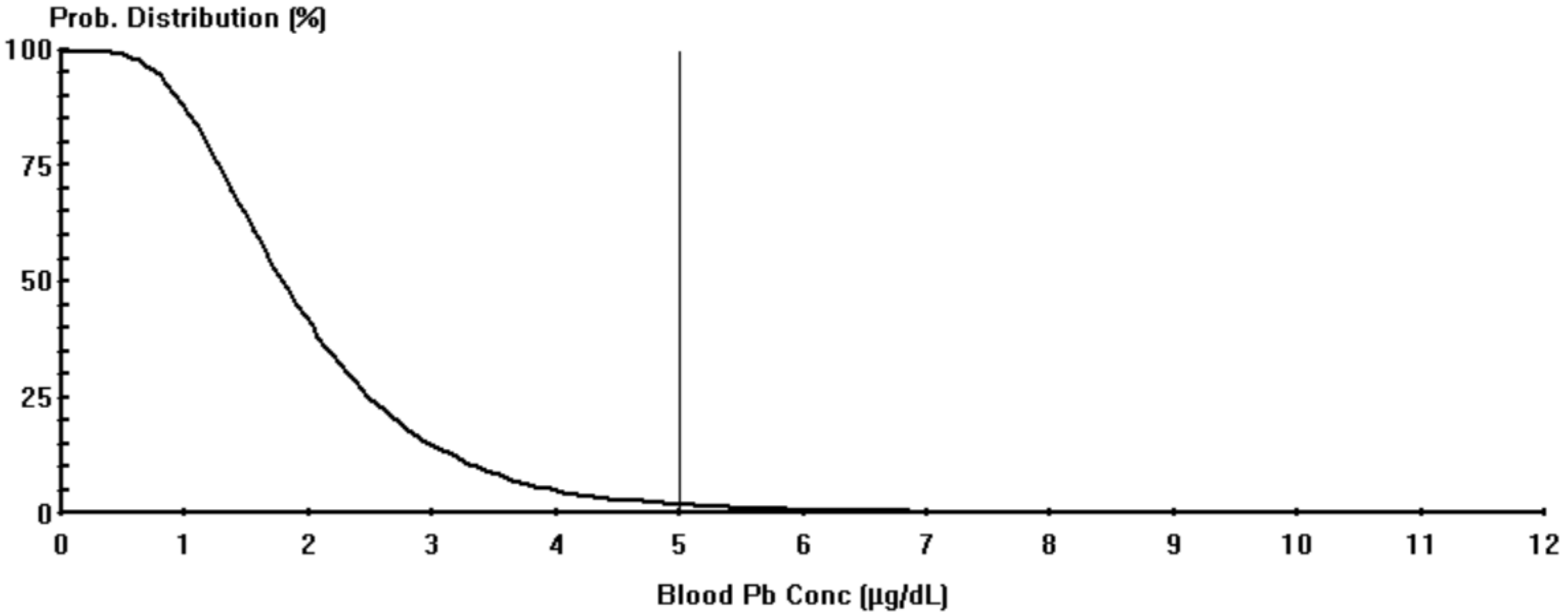
Predicted blood lead in a population of children exposed to 200 ppm lead in soil



Calculating PRGs: given a certain target blood lead level, what lead concentration in soil would be protective?



Bioavailability decrease from 60% to 40%

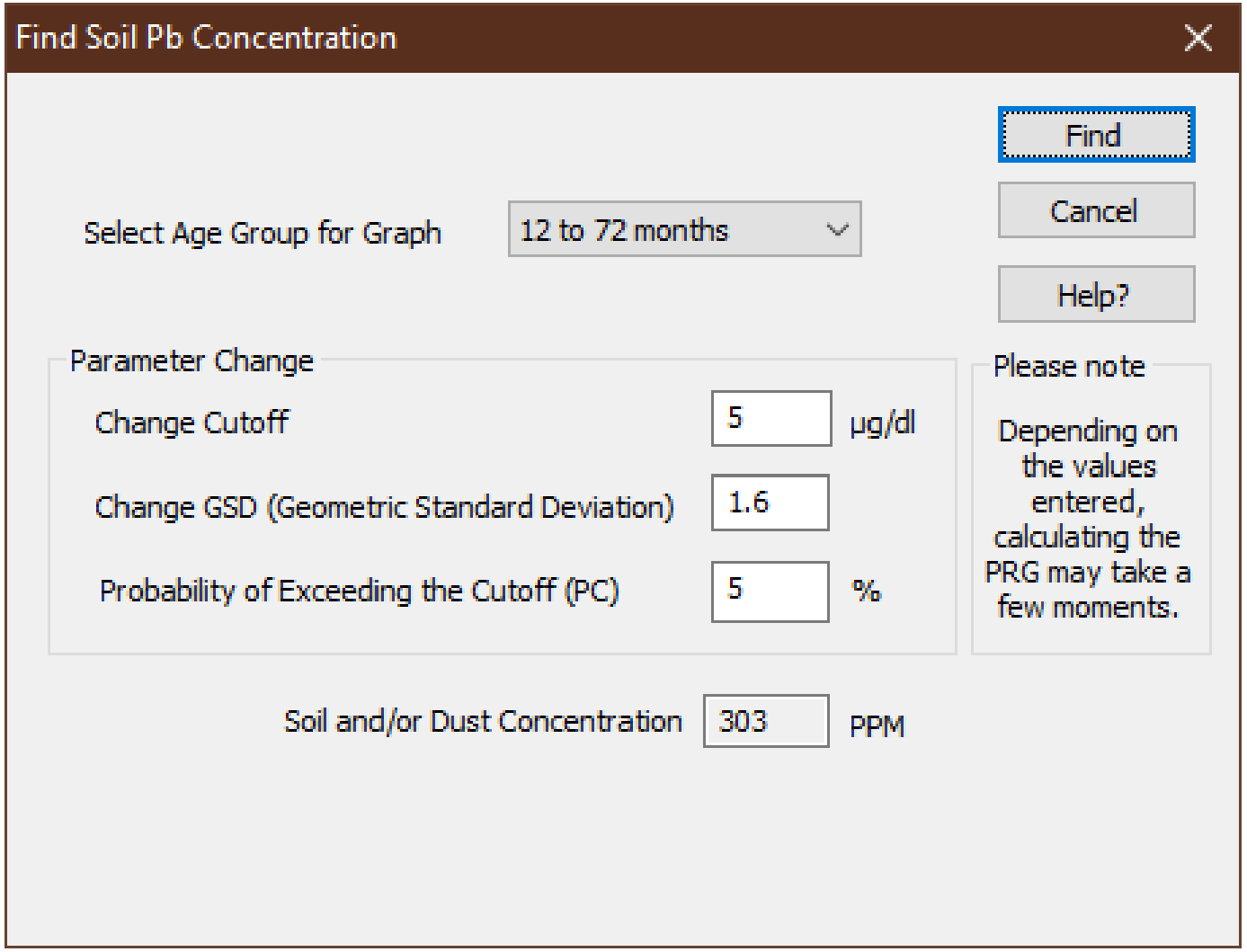


Cutoff = 5.000 µg/dl
Geo Mean = 1.893
GSD = 1.600
% Above = 1.938

Age Range = 12 to 72 months

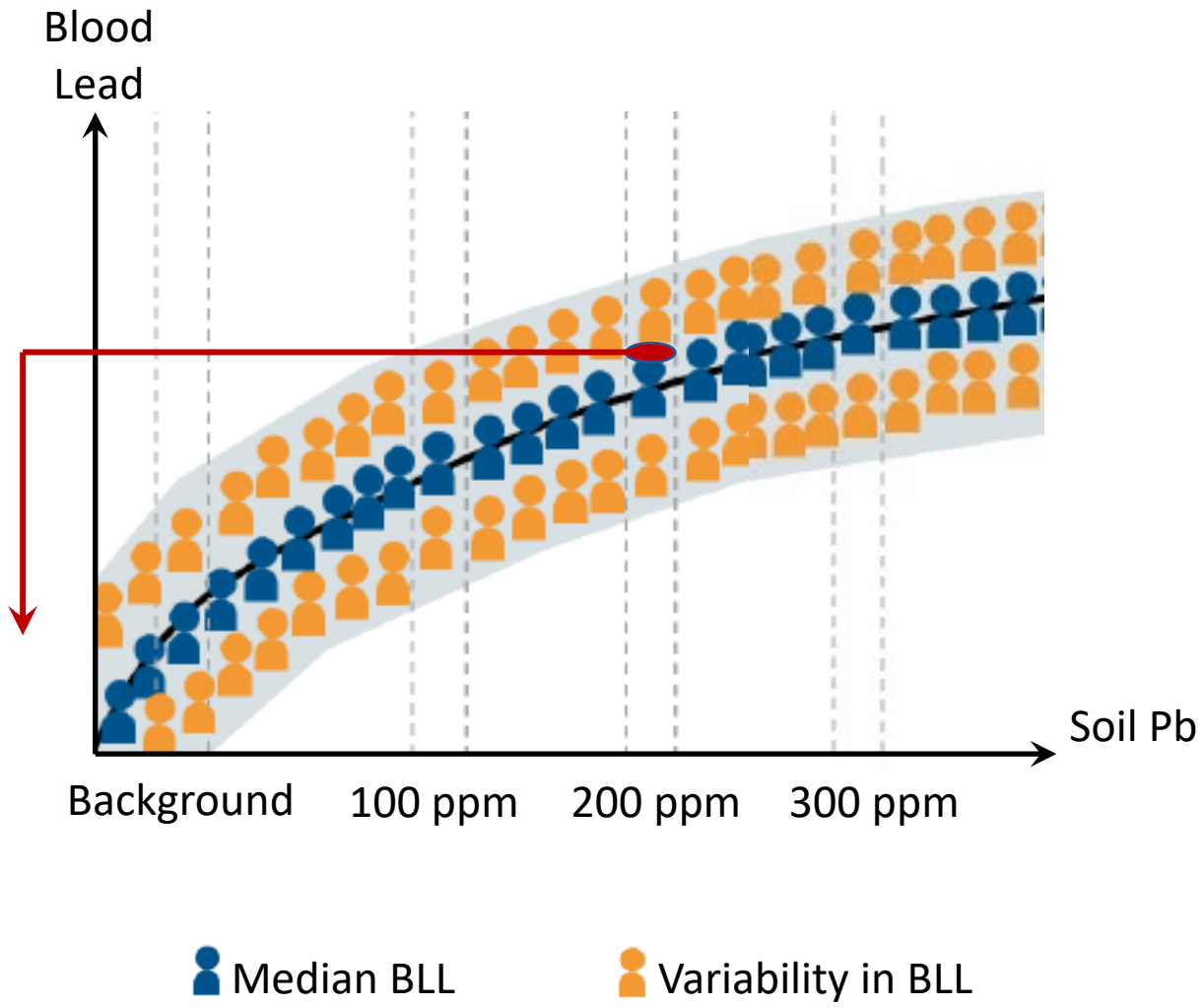
Run Mode = Research

Example PRG results with site specific bioavailability information



Modeling Blood Lead Levels to Inform Decisions

Reduce the probability of exceeding a target blood lead



Adult Lead Methodology (ALM)

Purpose of Adult Lead Model (ALM)

- Predicts the risk of elevated blood lead levels in commercial/industrial settings
- Used for populations other than children
- Calculates PRG (cleanup levels) for soil in non-residential land use

Features of the ALM

- The methodology predicts the risk to women of childbearing age based on exposure to soil lead.
- The goal is to limit exposure to the fetus of the pregnant woman because this is the most sensitive receptor.
- Protecting the fetus will protect other receptors.

Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas

U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	1054
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	2.1
$PbB_{fetal,0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	5.0
PbB_t	Target PbB level of concern (e.g., 2-8 ug/dL)	µg/dL	**5.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB exceeds target PbB, assuming lognormal distribution**	**%**	**5.0%**

B	C	D	E
Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas			
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee			
Version date 06/14/2017			
Variable	**Description of Variable**	**Units**	**GSDi and PbBo from Analysis of NHANES 2009-2014**
$PbB_{fetal,\ 0.95}$	Target PbB in fetus (e.g., 2-8 µg/dL)	µg/dL	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
$AF_{S,\ D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,\ D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S,\ D}$	Averaging time (same for soil and dust)	days/yr	365
PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB		**ppm**	**1,050**

Let’s summarize:

- Lead models were developed to evaluate risk from lead and to support risk management decisions.
- The Integrated Exposure Uptake Biokinetic (IEUBK) model combines exposure across media and is used for a residential setting.
- The Adult Lead Methodology (ALM) is used to predict elevated blood leads from exposure to lead in soil in a commercial/industrial setting.

Why should CICs understand lead models?

- Understanding how we use lead models gives a basis to understand how we set screening levels and cleanup levels and will better enable us to build our risk communication strategies for lead
- Going forward there will be a more urgent need for coordinated risk communication efforts between CICs and risk assessors
- Work with your regional risk assessors on messaging involving lead

A note on lead messaging

- Moving away from saying “no safe level”
- Reducing exposure to lead reduces risk and improves health outcomes

Questions?