

Environmental Science for Environmental and Other Attorneys: Risk Assessment

January 27, 2016



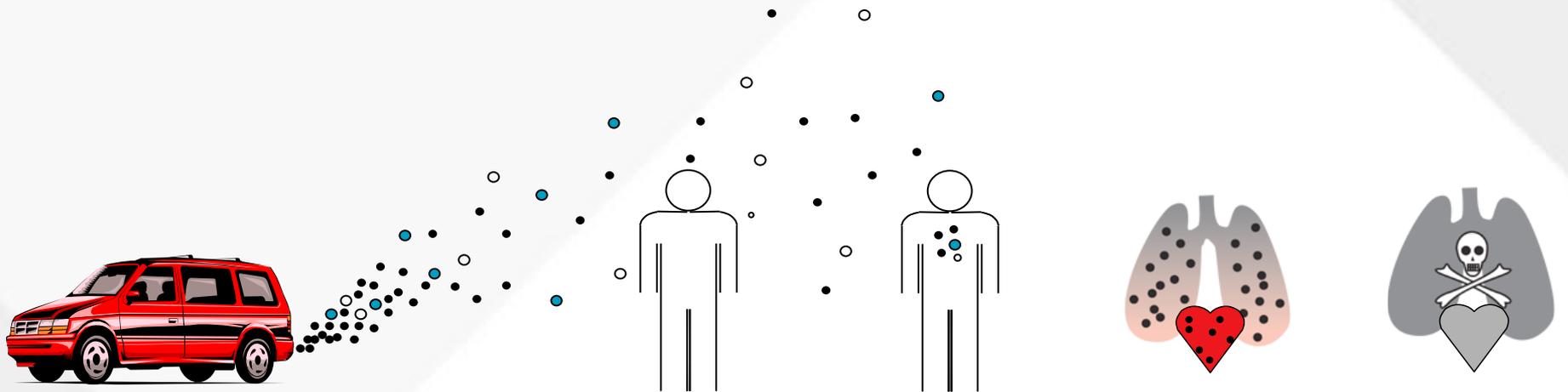
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Presented by
Katie Swor

Agenda

- ▲ Human Health Risk Assessment Paradigm
- ▲ Exposure Pathways
- ▲ Routes of Exposures
- ▲ Exposure Assumptions
- ▲ Toxicity Values
- ▲ Cancer Endpoints
- ▲ Non-cancer Endpoints

HHRA Paradigm



emissions → concentration → exposure → intake → dose → health effects

Diagram credit: Dr. Julian Marshall

MPCA's AERA Process

Air Emissions Risk Analysis

- ▲ Risk analysis for facilities and their emission sources

(Calculate emission rates!)

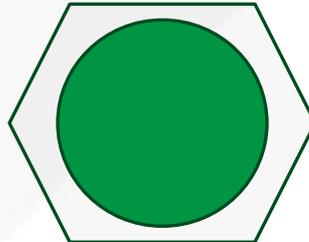
- ▲ Identify sources, source groups, chemicals, and exposure pathways that do NOT pose unacceptable risks or hazards to the public

(Calculate risks and hazards!)

- ▲ Identify those that MAY and therefore should be subjected to additional scrutiny and possible control

Definitions

RISK - the chance of exposure to an environmental stressor causing cancer (e.g., benzene exposure can cause leukemia)



HAZARD – the chance of exposure to an environmental stressor causing a harmful effect other than cancer (e.g., mercury exposure can cause hand tremors or decreased memory)



<http://www.periodictable.com/Elements/080/>



Exposure Pathways

- ▲ Ingestion
 - ▲ Soil
 - ▲ Water
 - ▲ Food
 - ▲ Breastmilk
- ▲ Inhalation: Ambient Air
- ▲ Inhalation: Indoor Air
- ▲ Dermal Exposure

Sources of Exposure

Many potential sources in daily life

- ▲ Eating contaminated soil
- ▲ Drinking contaminated water
- ▲ Eating contaminated food
- ▲ Infants ingesting contaminated breastmilk
- ▲ Breathing natural sources of pollution
- ▲ Breathing pollution from industrial sources
- ▲ Sources in your own home
- ▲ Contamination through skin

Determine Emission Sources

Air Example: Industrial Waste-to-Energy Facility

- ▲ Municipal Waste Combustors
- ▲ Auxiliary Boiler
- ▲ Truck Traffic

Vapor Intrusion Example: Former Manufacturing Plant

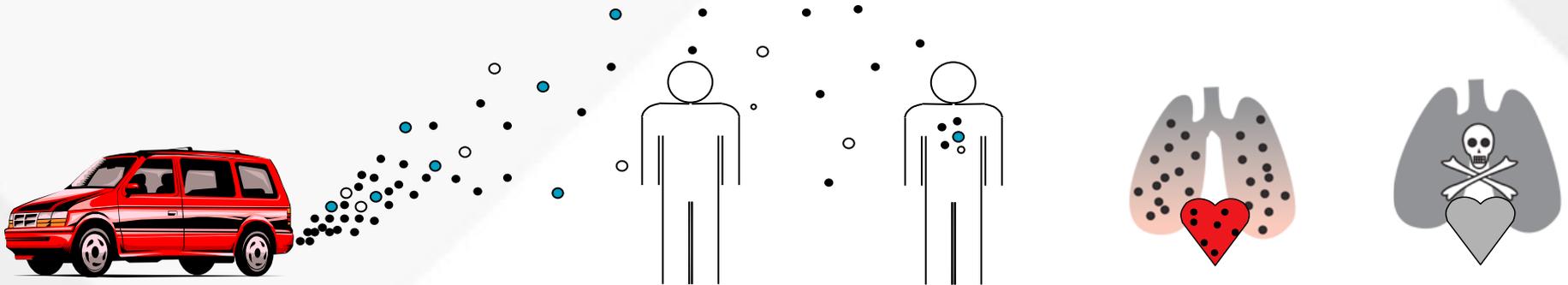
- ▲ Groundwater Plume
- ▲ Soil Plume

Exposure Assumptions

How much is emitted?

How much is someone exposed to?

How much does someone take in?



emissions → concentration → exposure → intake → dose → health effects

Default Exposure Factors Excerpt

Definition (units)	Previous Default Value	Currently Recommended Value	Source of current recommendation
Ingestion and Dermal Contact Rates			
Resident Drinking Water Ingestion Rate - Child (L/day)	1	0.78	U.S. EPA 2011a, Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years)
Resident Drinking Water Ingestion Rate - Adult (L/day)	2	2.5	U.S. EPA 2011a, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (≥ 21 years)
Resident Soil Ingestion Rate - Child (mg/day)	200	200	U.S. EPA 2011a (Table 5-1); "upper-bound values" accounting for both soil and dust ingestion
Resident Soil Ingestion Rate - Adult (mg/day)	100	100	U.S. EPA 1991a (pp. 6 and 15); EFH 2011 only provides a central tendency value
Indoor Worker Soil Ingestion Rate (mg/day)	50	50	U.S. EPA 1991a (pp. 9-10, 15); EFH 2011 values not provided
Outdoor Worker Soil Ingestion Rate (mg/day)	100	100	U.S. EPA 1991a (pg. 15), same as adult resident; EFH 2011 value not provided
Resident skin surface area - child (cm ²)	2,800	2,690	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere (per EPA 2011b))

Toxicity Values: Hierarchy

- ▲ EPA's Integrated Risk Information System (IRIS)
 - ▲ Slope Factor for cancer
 - ▲ Cancer Weight-of-Evidence
 - ▲ Reference Dose for non-cancer effects

- ▲ Other Sources:
 - ▲ Minnesota Department of Health HRV (Health Risk Value)
 - ▲ California EPA
 - ▲ PPRTV (Provisional Peer Reviewed Toxicity Values)

Cancer Endpoints

Slope Factor (SF): Risk per milligram of chemical per kilogram of body weight per day (mg/kg/day)⁻¹

Excess Lifetime Cancer Risk:

$$Risk = C * \frac{IR \times EF \times ED}{BW \times AT} \times SF$$

C: Concentration in media

EF: Exposure frequency

ED: Exposure Duration

IR: Ingestion Rate

BW: Body Weight

AT: Averaging Time

Non-Cancer Endpoints

Each chemical's non-cancer effects are summarized in a hazard quotient

Reference dose (RfD) or Reference Concentration (RfC): intake which poses no appreciable risk of adverse health effects, even to sensitive populations

$$HQ = \frac{ADD}{RfD} \text{ or } HQ = \frac{EC}{RfC}$$

ADD: Average Daily Dose (mg/kg/day)

EC: Exposure Concentration (mg/m³)

Risk Assessment Applications

Environmental Assessment Worksheets (EAW)

Environmental Impact Statement (EIS)

Prevention of Significant Determination (PSD) projects

Soil remediation

Groundwater remediation

Permit conditions

Facility changes: fences, property transfer, etc.

Thank you!

Questions?

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