Overview of Toxicology and CERCLA Baseline Risk Assessments

Former Wurtsmith Air Force Base
RAB Meeting

Janet K. Anderson, PhD, DABT
Principal Toxicologist
GSI Environmental Inc.

November 17, 2021

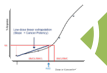
WHO WE ARE

GSI Environmental Inc. is an engineering and science consulting firm committed to investigating, analyzing, and solving complex environmental problems around the globe.

- Strong partnerships with universities/institutions and regulatory agencies
- **Primarily known for solving complex problems with cutting-edge science – PFAS, 1,4-dioxane, data visualization, vapor intrusion**

Toxicology and Risk Assessment Services

Baseline Risk Assessments



Chemical Toxicity Assessment

Risk Communication

OUTLINE

Toxicology / Exposure

- Key concepts
- Hazard identification
- Dose-response
- Exposure
- Guidance and resources

CERCLA Risk Assessment

- Baseline risk assessment
- Guidance
- Steps
- Human Health
- Ecological

Wurtsmith AFB

- Regulatory landscape
- PFAS
- Conceptual site model

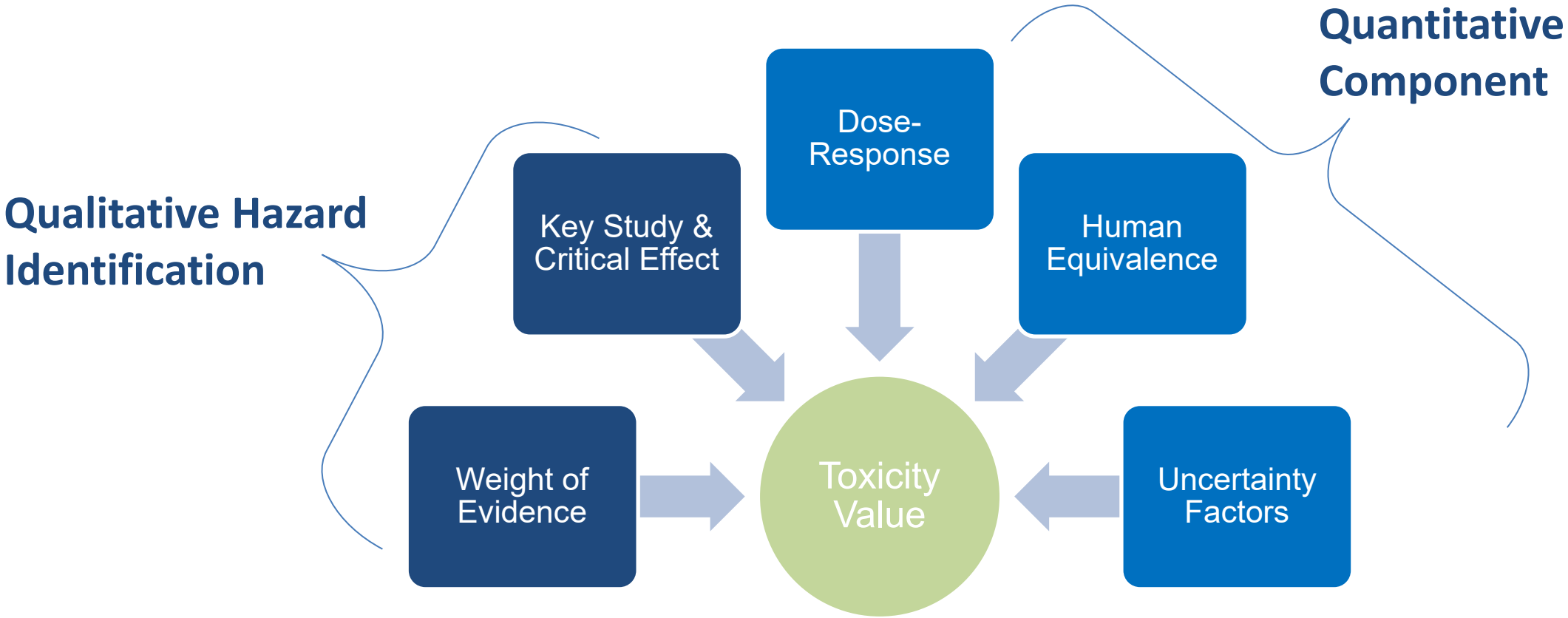
GSI ENVIRONMENTAL

KEY TAKE HOME POINTS

- Air Force must follow all applicable policies and guidance (EPA, DoD and CERCLA – Federal Law)
-  Human exposure may include consumption of fish and wildlife, backyard foods
-  Ecological receptors include fish and invertebrates, plants, mammals, and birds
- Science and regulatory landscape continues to change rapidly
-  Things to Watch: DoD policies, USEPA guidance, changing PFAS toxicity information

GSI ENVIRONMENTAL

Toxicology Is Not a Precise Science: Multiple Decision Points Impact Regulatory Values



THE PURPOSE OF BASELINE RISK ASSESSMENTS

What risk assessments DO:

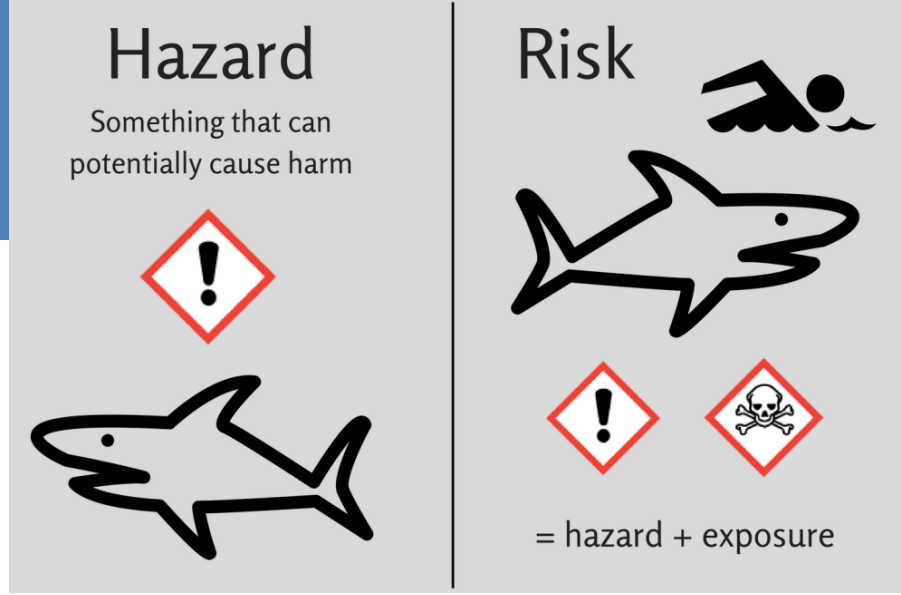
- Estimate site-specific exposures
- Characterize the probability of potential adverse effects
- Focus evaluation on key chemicals and receptor scenarios
- Guide risk management decisions

What risk assessments DON'T DO:

- Estimate risks to individuals
- Provide firm conclusions about disease, causation or health status

GSI ENVIRONMENTAL

WHAT IS RISK?



https://scimoms.com/hazard-risk/

Risk = Toxicity x Exposure

- What is the risk to human health / eco?
- What chemicals are driving the risk?
- How much risk is attributable to site (vs background)?

- What are the chemical's health effects?
- What is the relationship between exposure and health effects?

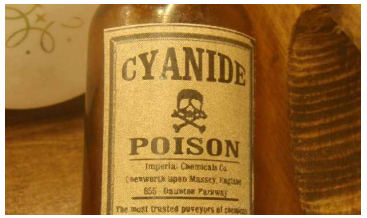
- How will receptors contact the chemical?
- What is the magnitude, frequency and duration of contact?
- Are exposures changing over time?

TOXICOLOGY KEY CONCEPTS

High Enough Levels of Any Chemical Can Cause Health Effects

"The Dose Makes the Poison"

Apple seeds contain ~0.6g/kg amygdalin



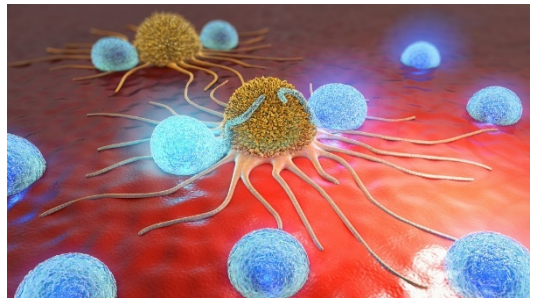
Amygdalin is converted to CYANIDE in our bodies

An average adult could die if they were to consume ~200 apple seeds

GSI ENVIRONMENTAL

TOXICOLOGY: Hazard Identification

- Weight-of-evidence evaluation of ALL relevant data
  - Human data (epidemiology)
  - Animal studies
- Identify adverse effects
  - Noncancer
  - Cancer

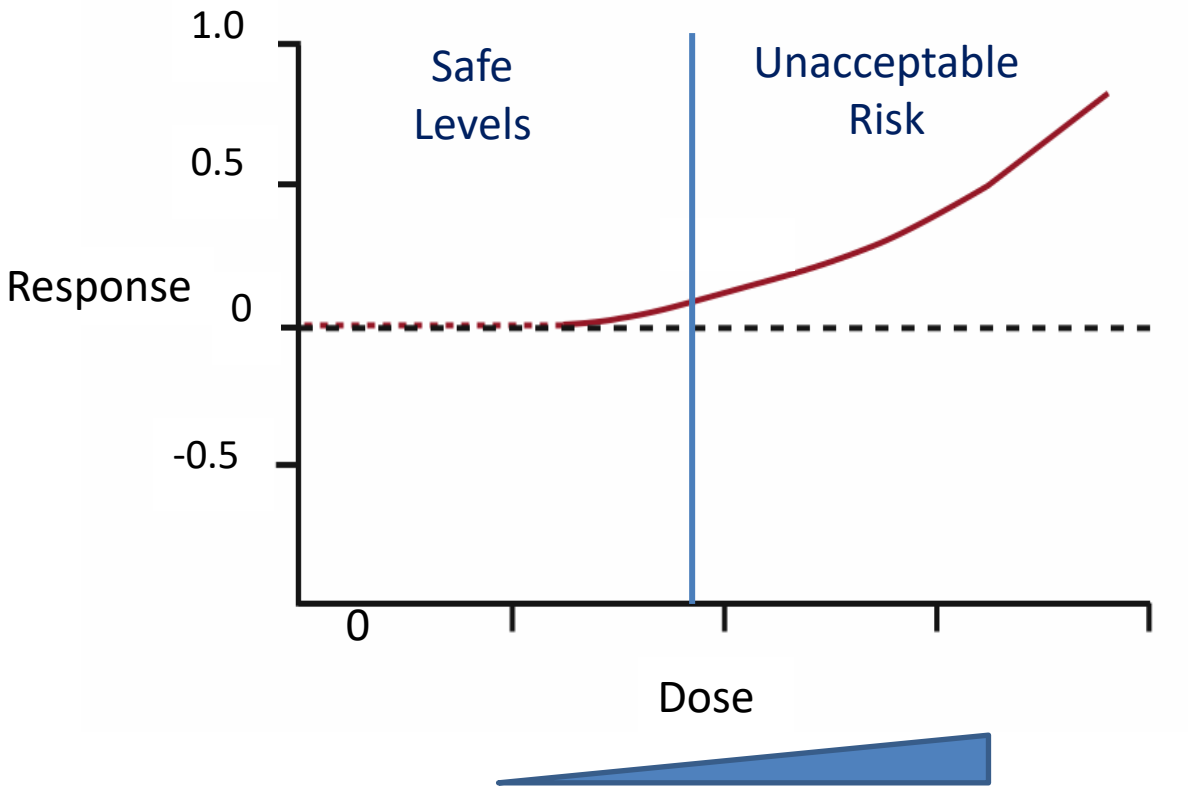


Chemicals may have different health effects based on different exposure scenarios

GSI ENVIRONMENTAL

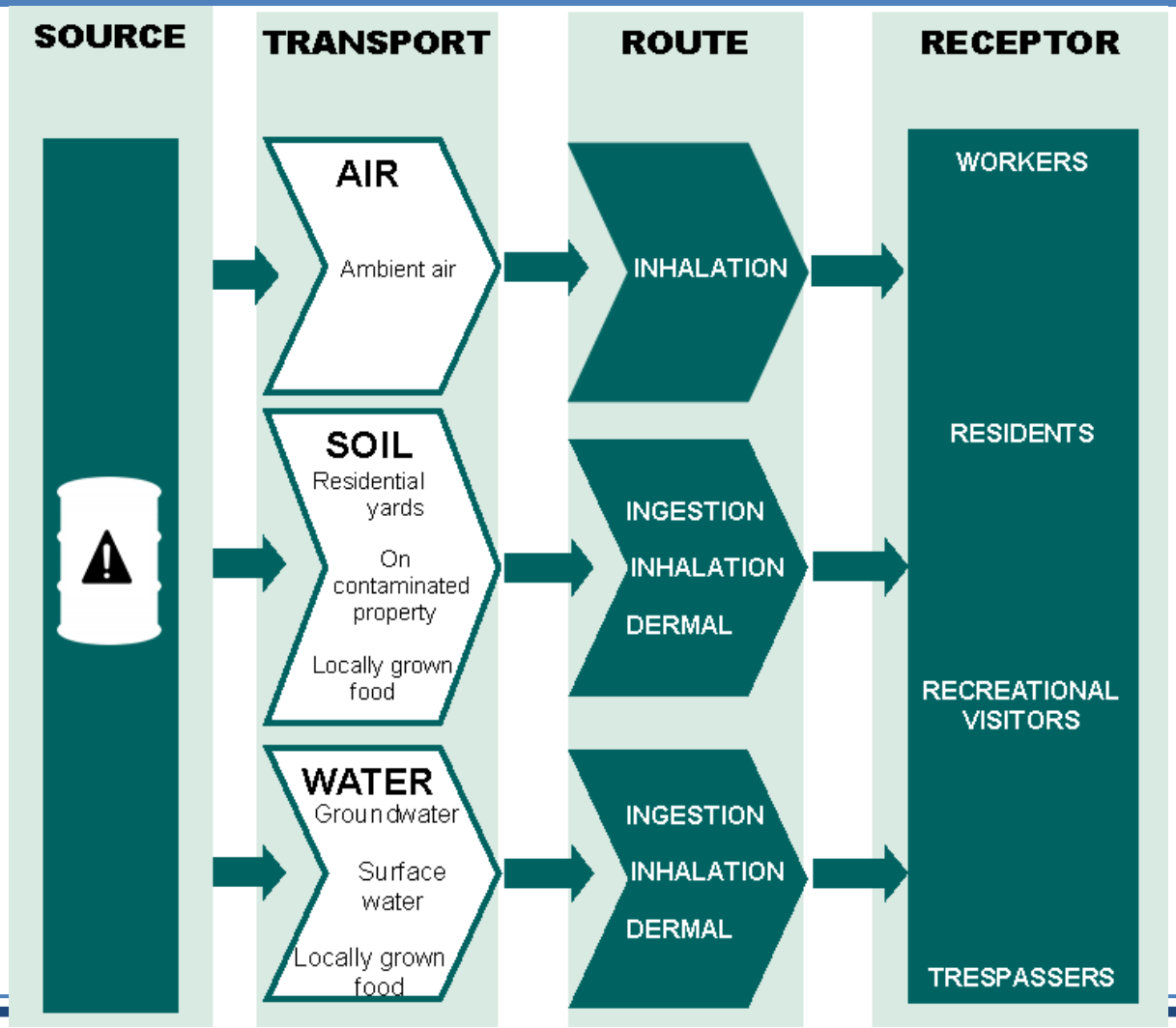
TOXICOLOGY: Dose-Response Assessment

- Relationship between exposure (dose) and health effects



There are levels of chemical exposure for which the risk of adverse health effects is zero or very low

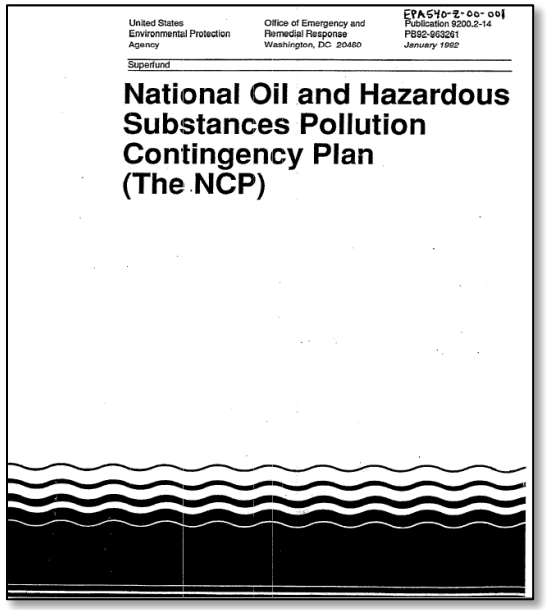
EXPOSURE CONSIDERATIONS



https://matracking.ehs.state.ma.us/Environmental-Data/exposures/index.html

GSI ENVIRONMENTAL

CERCLA BASELINE RISK ASSESSMENTS


United States Environmental Protection Agency | Office of Emergency and Remedial Response Washington, DC 20460 | EPA540-Z-00-001 Publication 9200.2-14 PB92-963261 January 1992

Superfund

National Oil and Hazardous Substances Pollution Contingency Plan (The NCP)

National Contingency Plan (NCP, 1990):

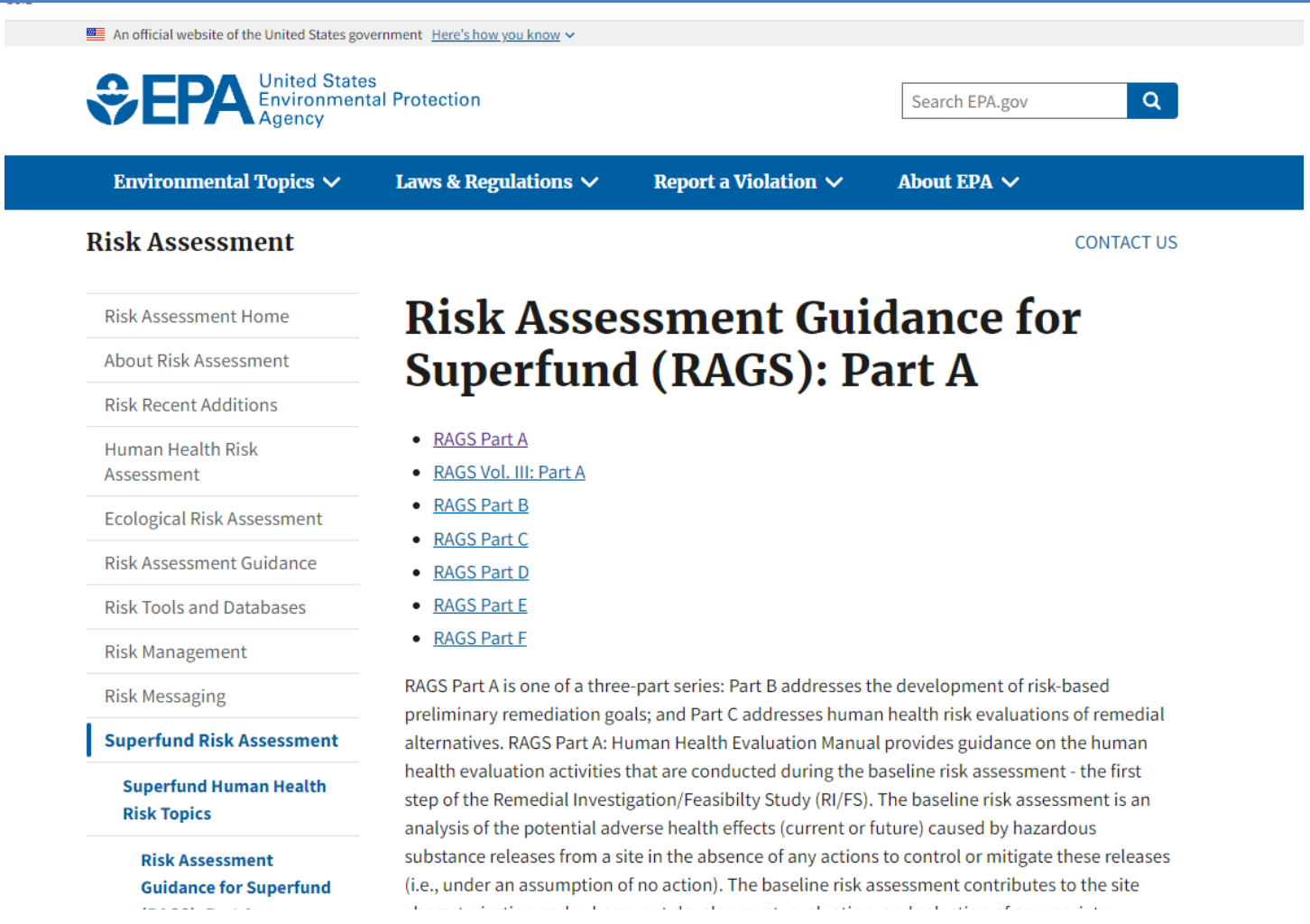
> "the lead agency shall conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment…"

** At non-NPL facilities, the AF must also comply with "nondiscriminatory" state laws

CERCLA Baseline Risk Assessments are RISK BASED to inform future remedial decisions

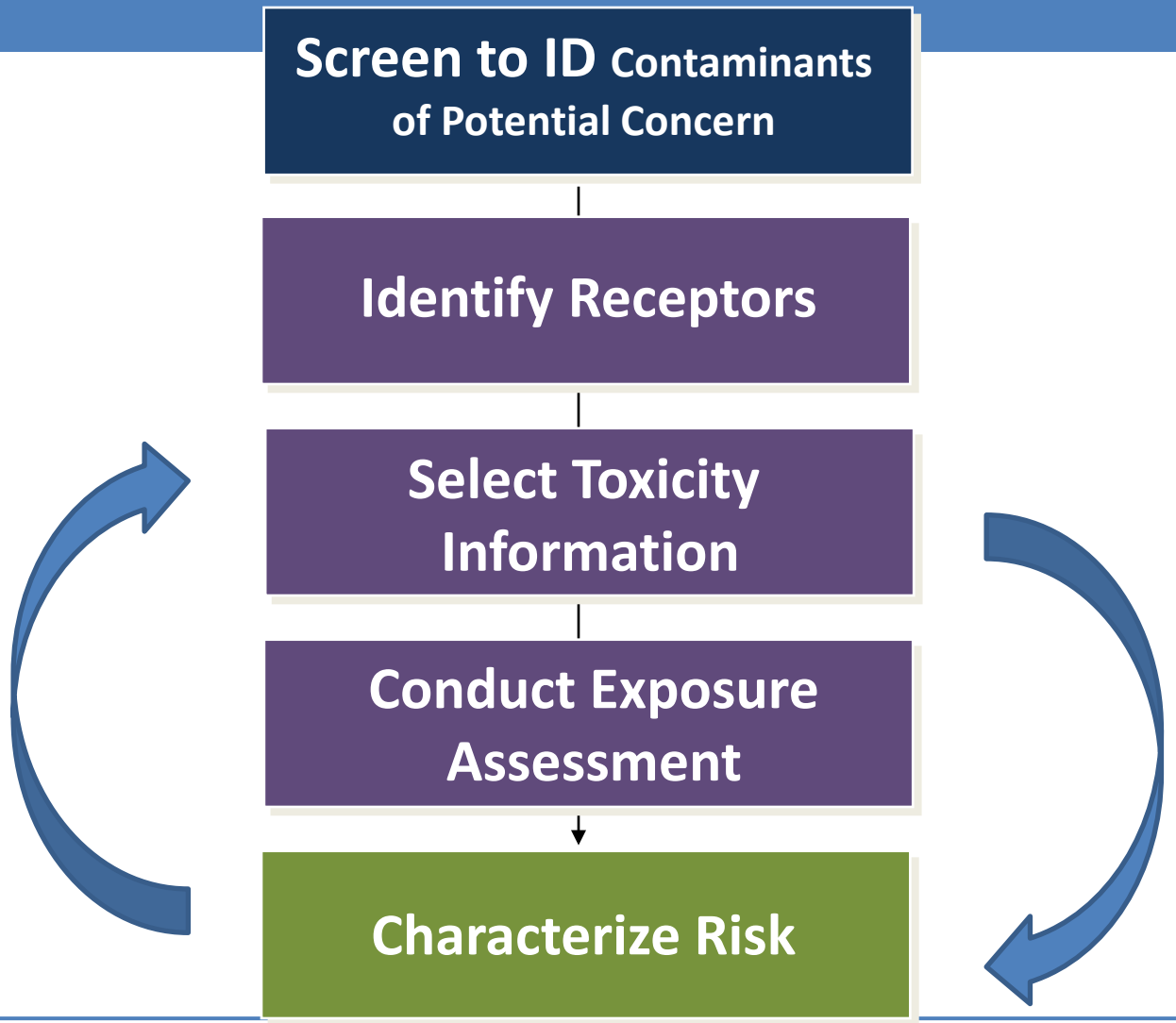
GSI ENVIRONMENTAL

GUIDANCE FOR RISK ASSESSMENT



GSI ENVIRONMENTAL

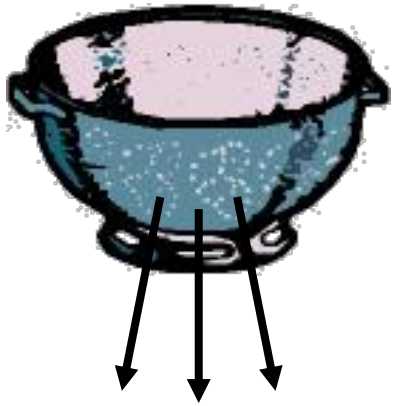
RISK ASSESSMENT COMPONENTS



GSI ENVIRONMENTAL

WHAT ARE HUMAN AND ECOLOGICAL SCREENING LEVELS?

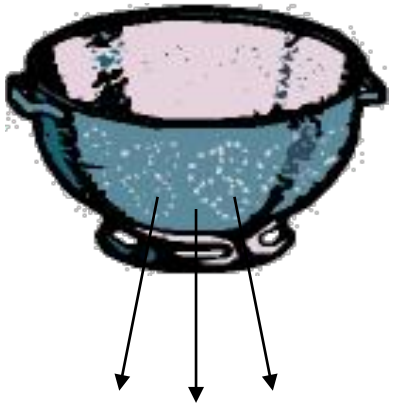
Strainer with large holes



Everything falls through

NO PROBLEM

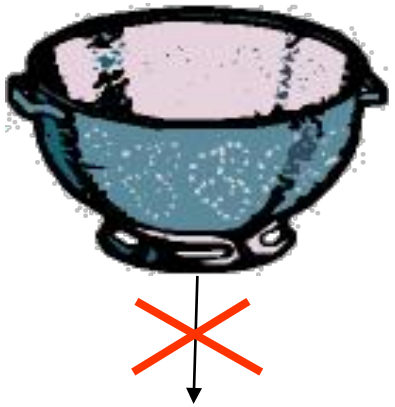
Strainer with medium holes



Some fall through

IDENTIFIES POTENTIAL CONCERNS

Strainer with small holes

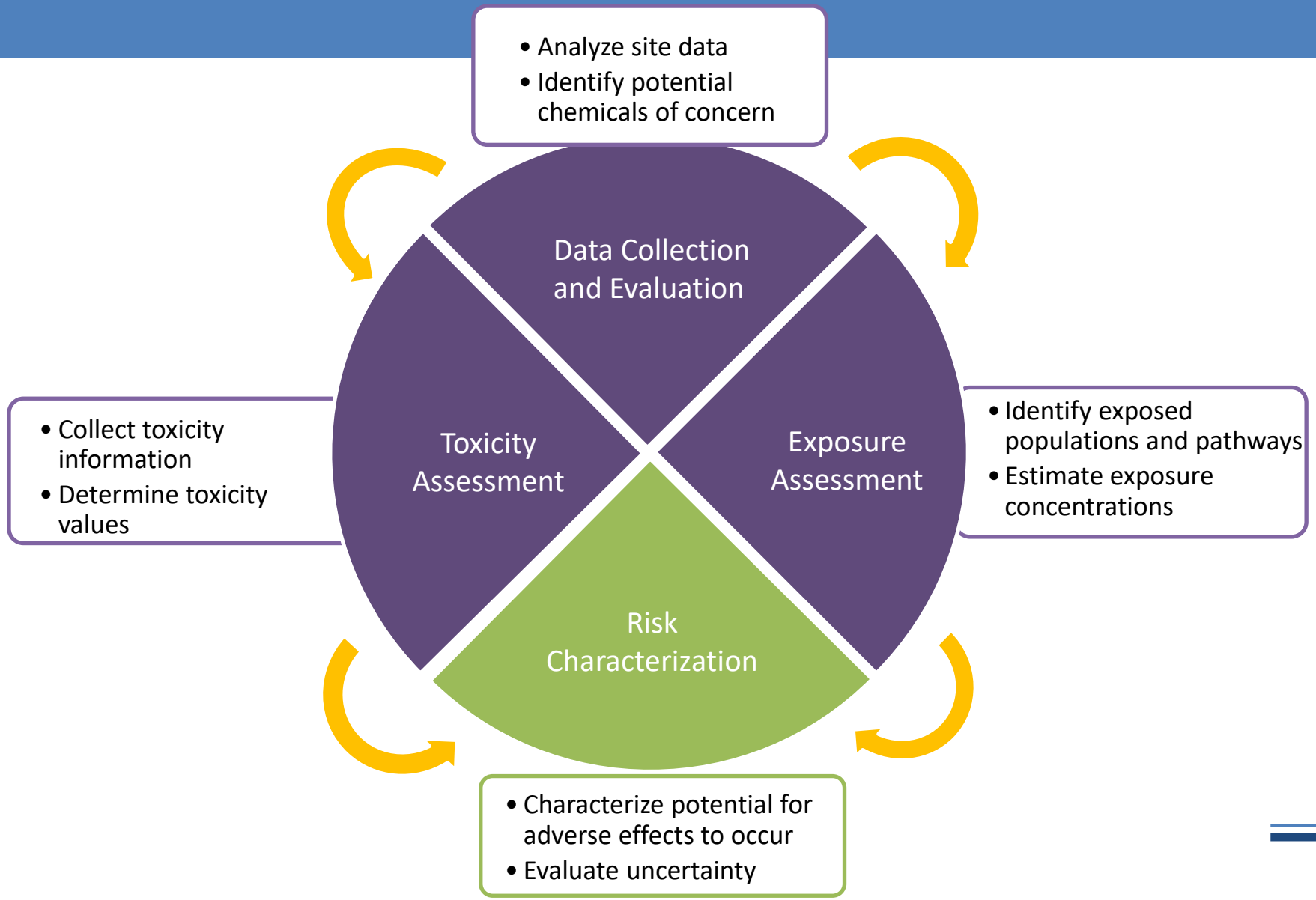


Nothing falls through

EVERYTHING IS A PROBLEM

GSI ENVIRONMENTAL

BASELINE RISK ASSESSMENT



Modified from USEPA RAGS Part A

COLLECT AND ANALYZE DATA

https://growers.ag/blog/4-soil-collection-methods-that-actually-work/

https://www.apacone.com/environmental-investigations.html

Data Collection and Evaluation

GSI ENVIRONMENTAL

SELECTION OF TOXICITY VALUES FOR RISK ASSESSMENT

Sources of Human Health Toxicity Values

Toxicity Assessment

Tier 1

EPA Integrated Risk Information System (IRIS)

Tier 2

EPA Peer-Reviewed Provisional Toxicity Values

Tier 3

- Agency for Toxic Substances and Disease Registry
- Other EPA offices (e.g., Office of Water)
- States, International Agencies

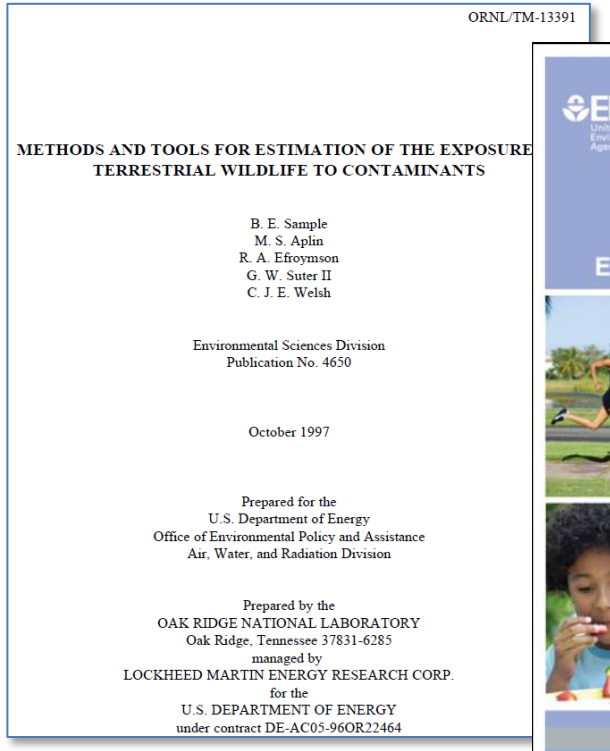
REQUIREMENTS

- ☑ State-of-science methods, consistent with EPA
- ☑ Transparent
- ☑ Most current science info.
- ☑ Peer-reviewed
- ☑ Finalized

GSI ENVIRONMENTAL

CHARACTERIZE EXPOSED POPULATIONS

Exposure Assessment


ORNL/TM-13391

METHODS AND TOOLS FOR ESTIMATION OF THE EXPOSURE
TERRESTRIAL WILDLIFE TO CONTAMINANTS

B. E. Sample
M. S. Aplin
R. A. Efroymson
G. W. Suter II
C. J. E. Welsh

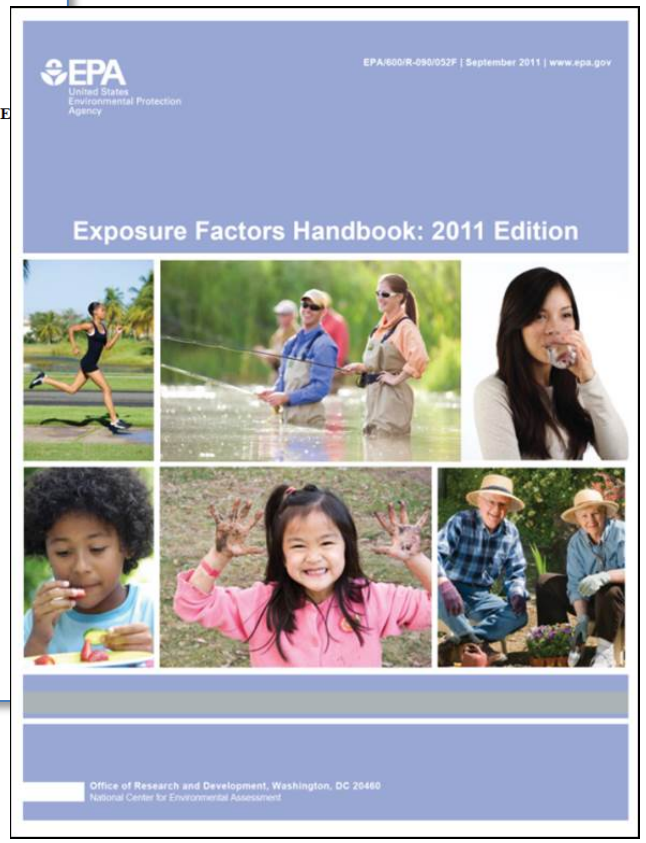
Environmental Sciences Division
Publication No. 4650

October 1997

Prepared for the
U.S. Department of Energy
Office of Environmental Policy and Assistance
Air, Water, and Radiation Division

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
LOCKHEED MARTIN ENERGY RESEARCH CORP.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

Oak Ridge National Laboratory 1997



USEPA 2011 (and updates)

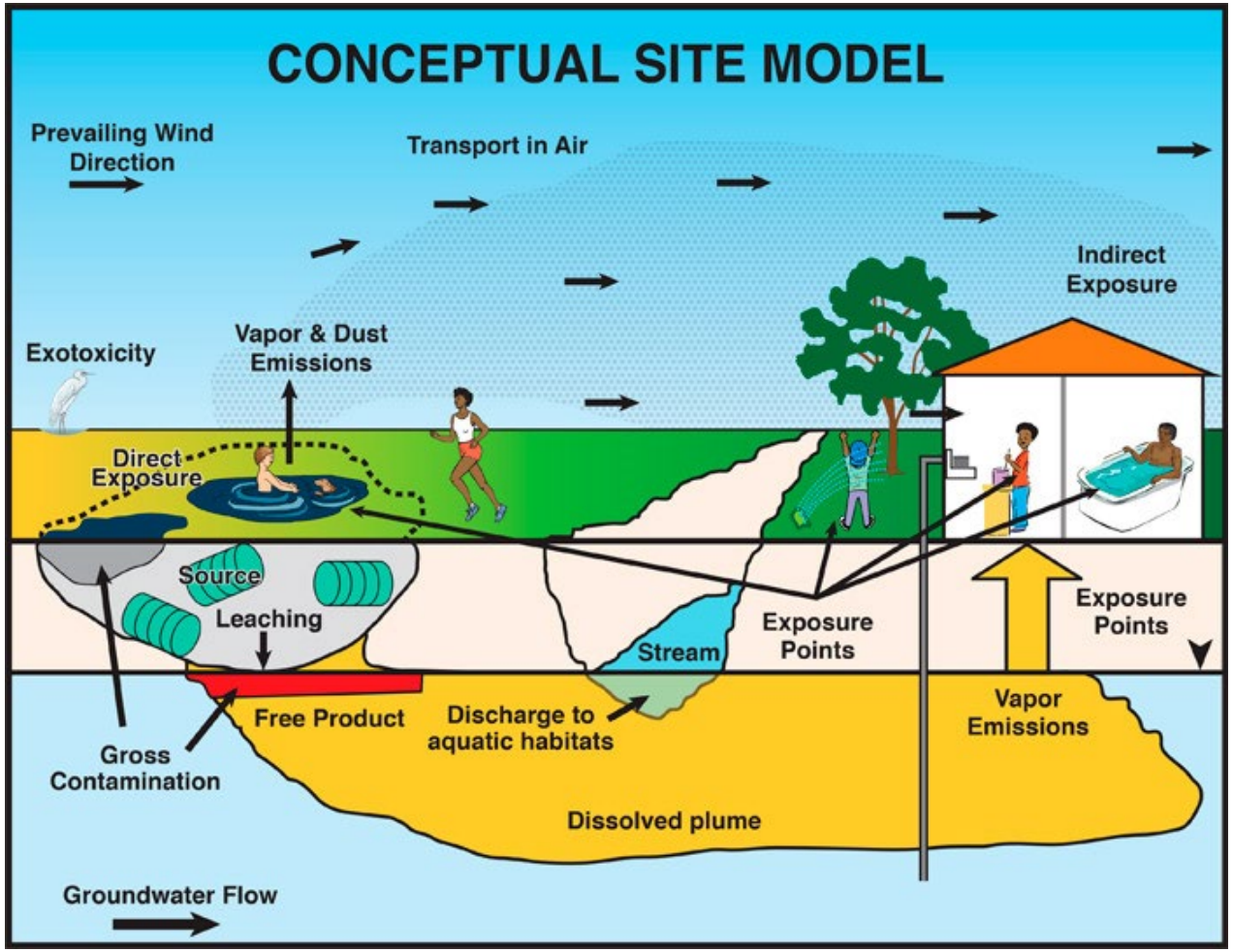
- Variability addressed by using mix of central and high-end exposure estimates (or probability distributions)
- Conservative to be protective

  2 L /day = 6.5 glasses of water …

  …everyday for 30 years

GSI ENVIRONMENTAL

CHARACTERIZE EXPOSURE PATHWAYS



Exposure Assessment

https://tphrisk-1.itrcweb.org/5-conceptual-site-models-and-investigative-strategies/

GSI ENVIRONMENTAL

QUANTIFY RISKS and IDENTIFY UNCERTAINTIES

Risk Characterization

$$\text{Average Daily Dose} = \frac{\text{Concentration} \times \text{Ingestion Rate} \times \text{Bioavailable Fraction} \times \text{Exposure Frequency} \times \text{Exposure Duration}}{\text{Body Weight} \times \text{Averaging Time}}$$

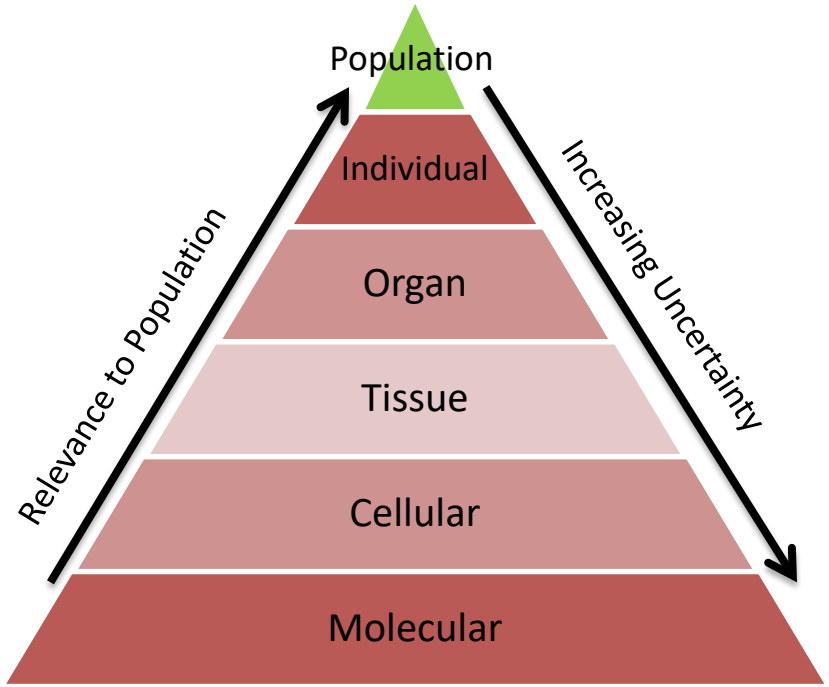
Taking into account:

- Chemical concentration
- Chemical characteristics (such as bioavailability: how much reaches the target organs)
- Exposure:
  - What pathways/routes?
  - How frequent? – Exposure frequency
  - How long? – Exposure duration

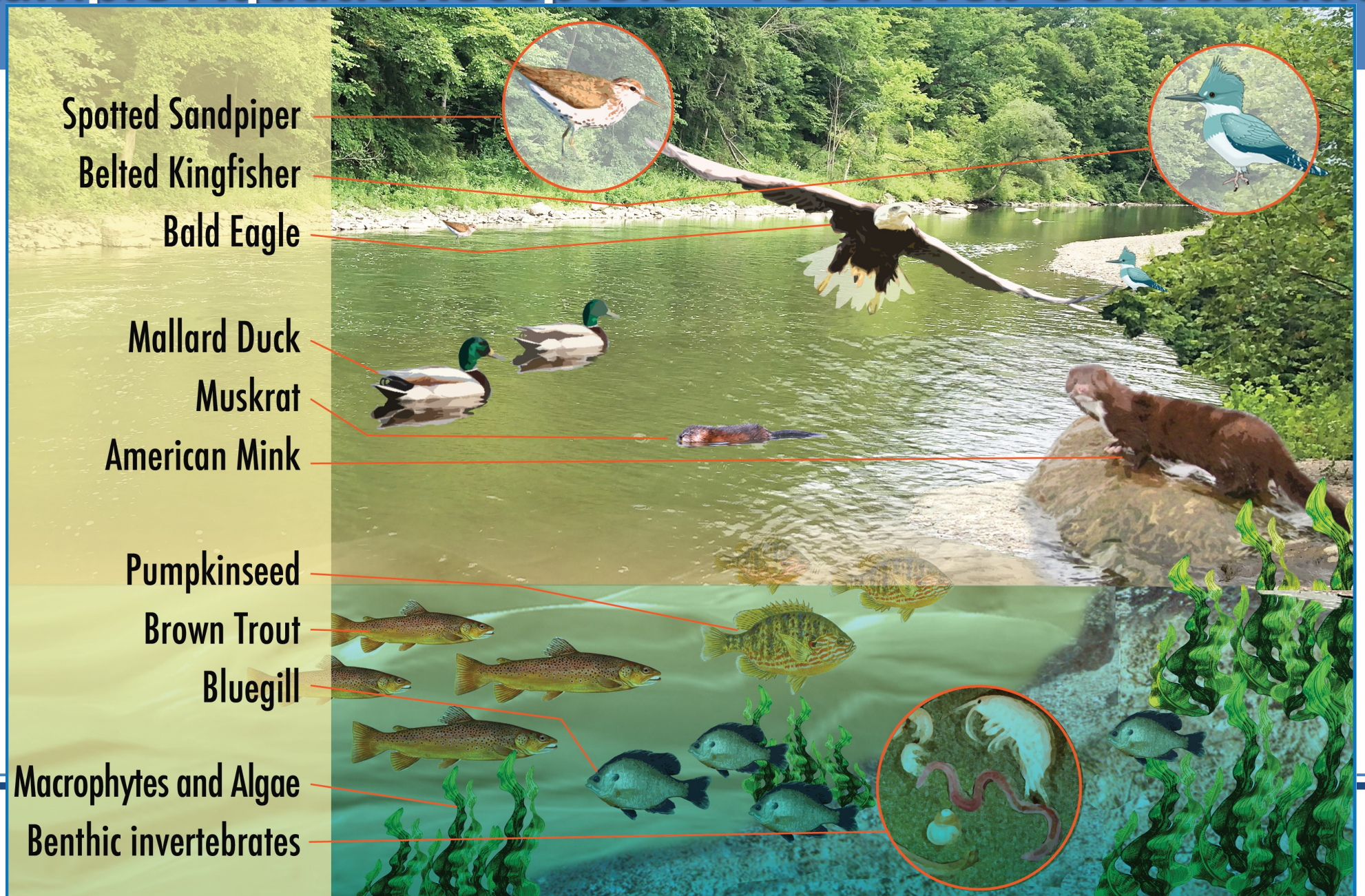
GSI ENVIRONMENTAL

ECOLOGICAL RISK ASSESSMENT (ERA) – KEY ELEMENTS

Site Investigation	Conceptual Site Model	Screening
• Target analytes • Paired abiotic/biotic • Spatial scales • Sufficient to address key questions	• Chemicals • Pathways • Receptors	• Eco screening levels • Background • **Bioaccumulation potential**

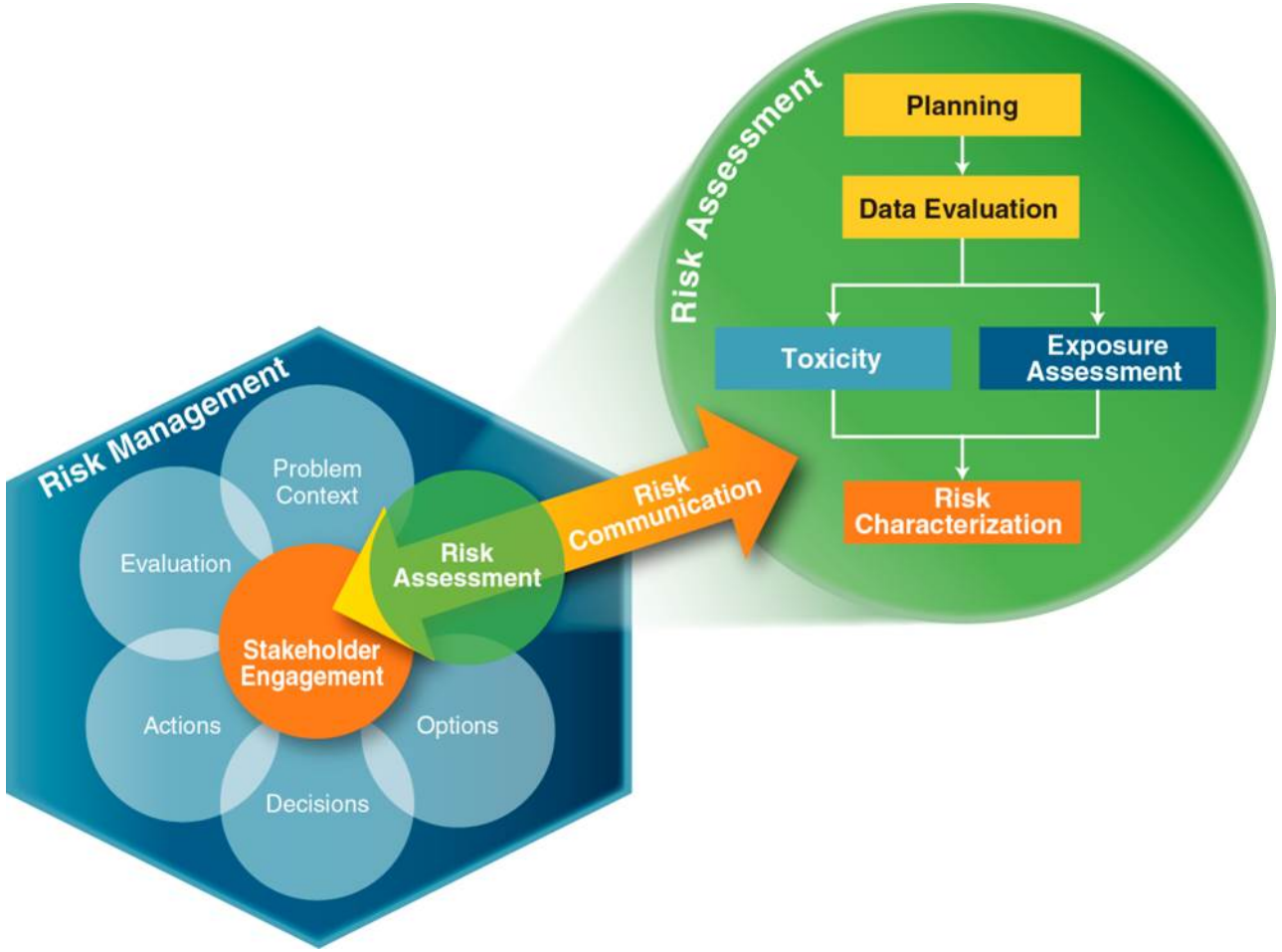


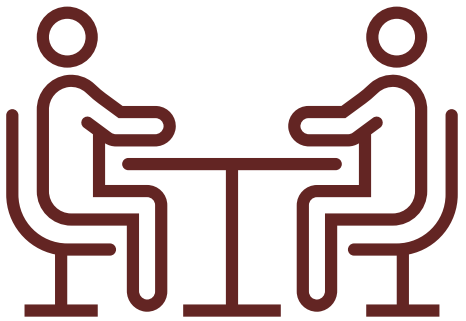
ERA – Example Aquatic Receptors – Food Web Considerations



GSI ENVIRONMENTAL

FORMER WURTSMITH AFB RISK ASSESSMENT PLANNING AND STAKEHOLDER ENGAGMENT

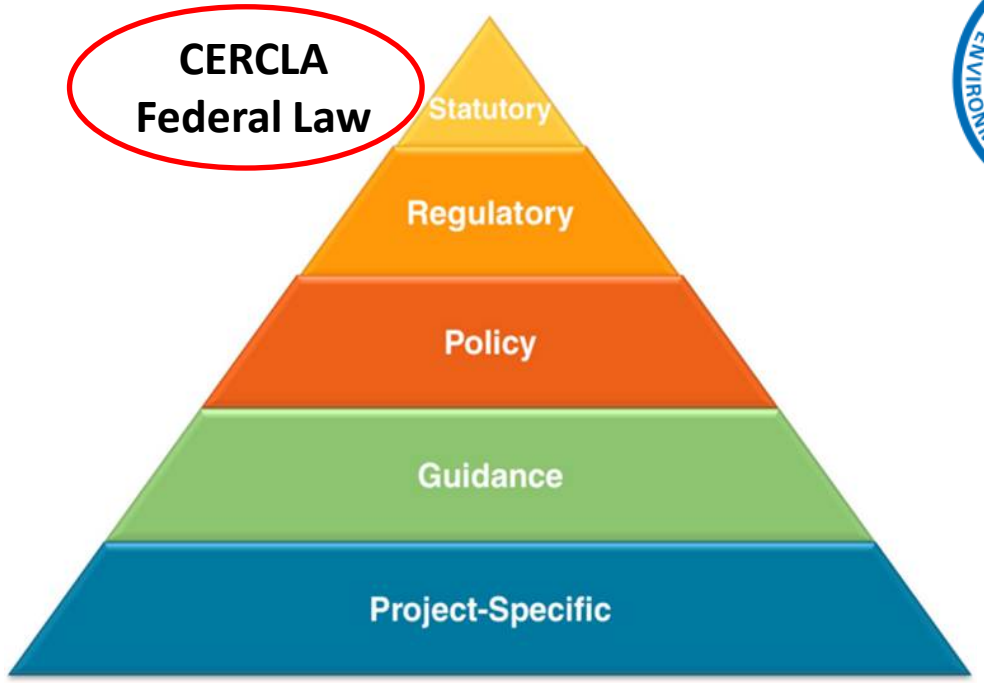




GSI ENVIRONMENTAL

REGULATORY LANDSCAPE

Regulatory context hierarchy



Source: ITRC RISK-3 Section 3.1.3

- CERCLA
- DoD policies/guidance
- EPA guidance for PFAS

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

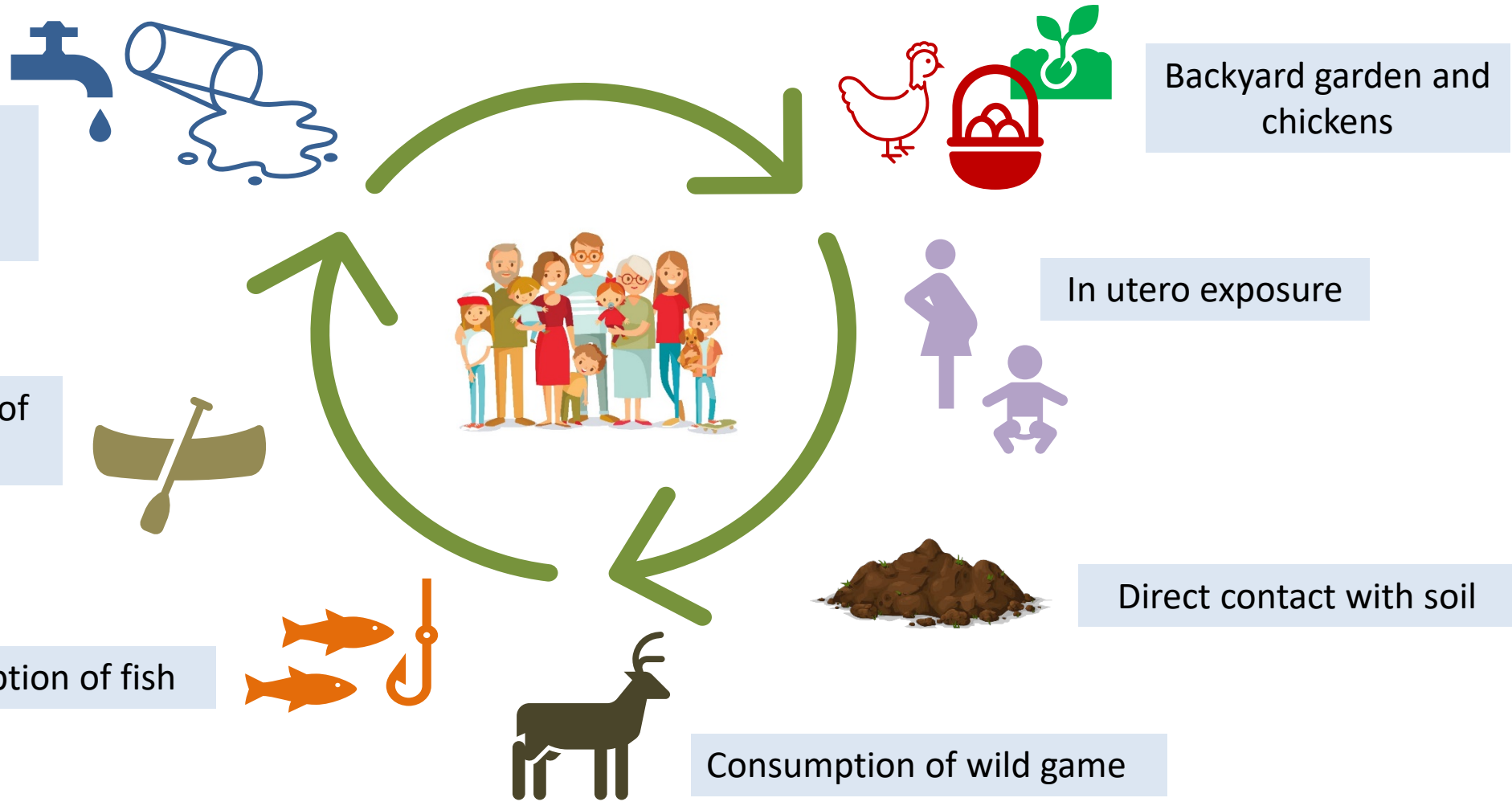
State Information:

- MCLs
- SW quality criteria (HH)
- GW to SW Interface
- Soil guidance
- SW for eco values
- Sediment
- Tissue

WURTSMITH PROJECT AREA – AREA DETERMINED BY RI NATURE AND EXTENT

GSI ENVIRONMENTAL

HHRA – EXPOSURE ASSESSMENT CONSIDERATIONS FOR PFAS



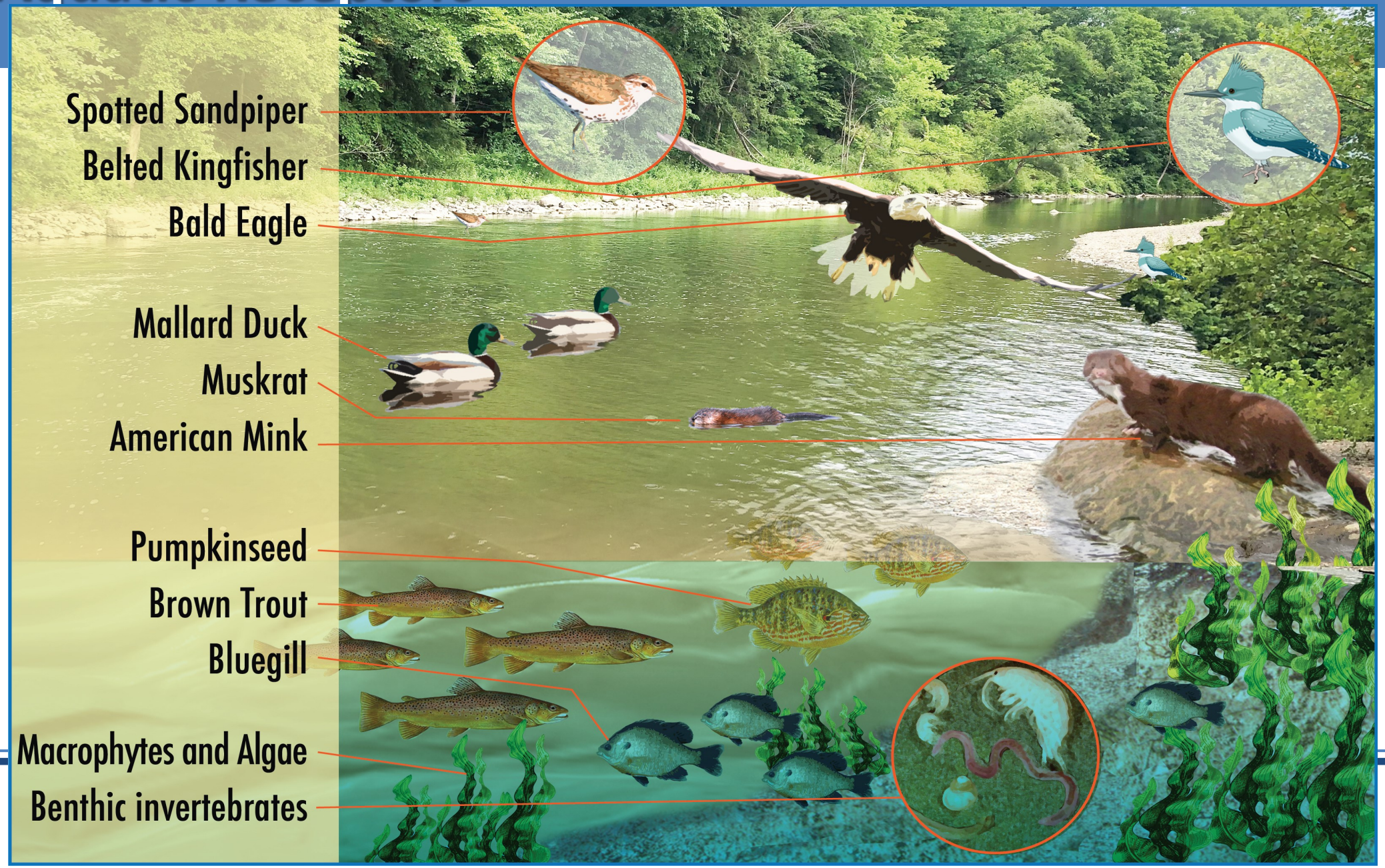
CONCEPTUAL SITE MODEL – HUMAN HEALTH

Contaminant Source	Environmental Media	Exposure Routes	Human Health Receptors
Project area: PFAS releases	Groundwater Surface water Soil Plants and Wildlife	Ingestion	• Commercial/industrial workers • Construction workers • Trespasser/visitor • Resident • Hunter • Angler • Recreator

CONCEPTUAL SITE MODEL – ECOLOGICAL RECEPTORS

Contaminant Source	Environmental Media	Exposure Routes	Representative Ecological Receptors
Project area: PFAS releases	Surface water	Ingestion (direct and food web)	• Plants and invertebrates • Fish (small, medium, large) • Aquatic birds • Terrestrial birds • Small mammals • Large mammals (eating small mammals)
	Soil		
	Food Web		

ERA – Aquatic Receptors

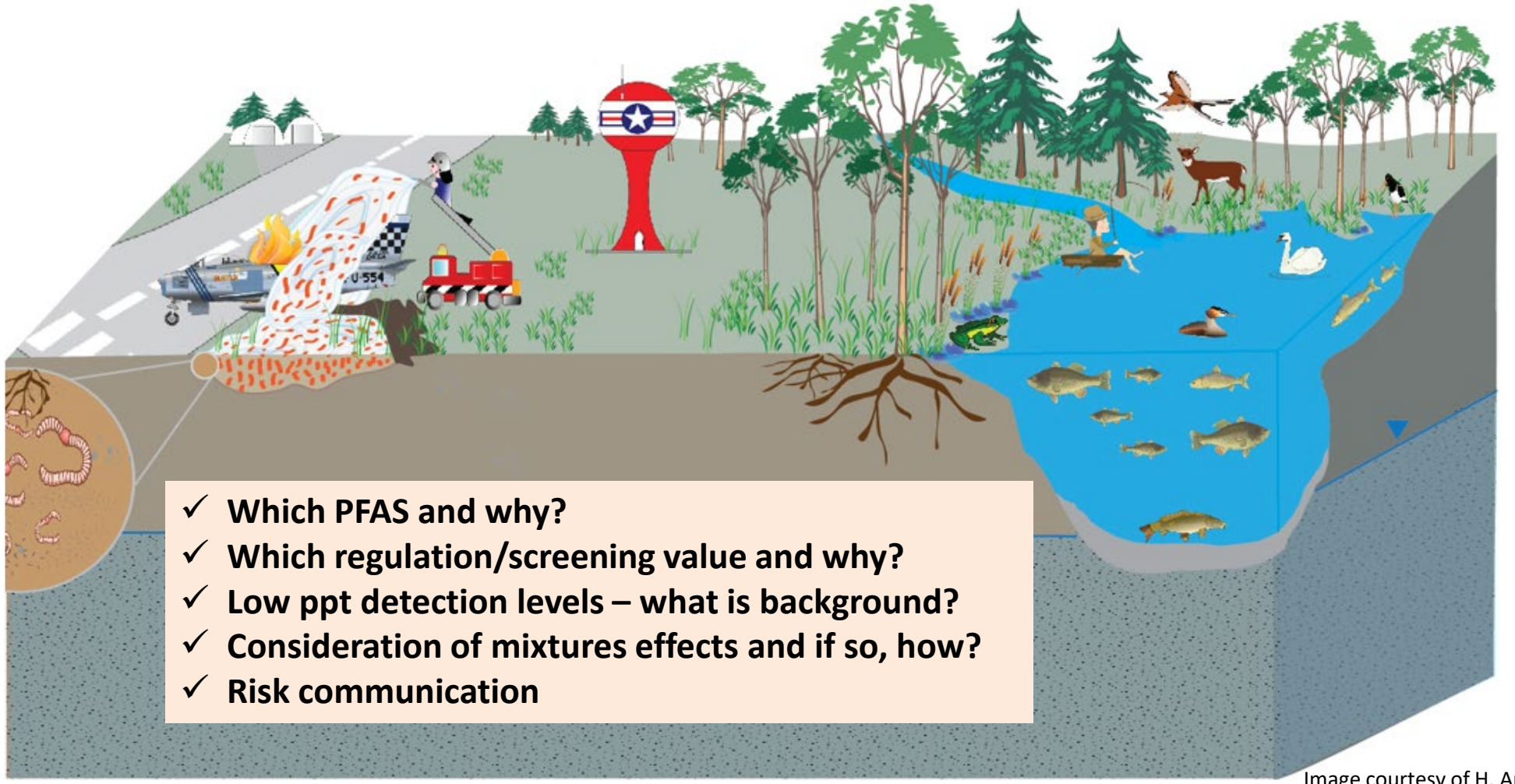


GSI ENVIRONMENTAL

ERA –Terrestrial Receptors

GSI ENVIRONMENTAL

CHALLENGES WITH PFAS RISK ASSESSMENTS



- ✓ Which PFAS and why?
- ✓ Which regulation/screening value and why?
- ✓ Low ppt detection levels – what is background?
- ✓ Consideration of mixtures effects and if so, how?
- ✓ Risk communication

Image courtesy of H. Anderson, AFCEC

GSI ENVIRONMENTAL

THINGS WE ARE WATCHING

SCIENCE

- Research findings
  - DoD: Department of Defense
  - SERDP: Strategic Environmental Research and Development Program
- Conference venues and publications
- Estimation methods and tools
- Site risk assessments (e.g., Minnesota)

REGULATORY POLICIES AND GUIDANCE

- USEPA
- EGLE
- Other states

Archives of Environmental Contamination and Toxicology (2019) 77:1–13
https://doi.org/10.1007/s00244-019-00620-1

Perfluoroalkyl Contaminant Exposure and Effects in Tree Swallows Nesting at Clarks Marsh, Oscoda, Michigan, USA

Christine M. Custer[1] · Thomas W. Custer[1] · Robert Delaney[2] · Paul M. Dummer[1] · Sandra Schultz[3] · Natalie Karouna-Renier[3]

Received: 30 November 2018 / Accepted: 22 March 2019 / Published online: 6 April 2019

Abstract
A site in northeastern Michigan, Oscoda Township, has some of the highest recorded exposure in birds to perfluorinated substances (PFASs) in the United States. Some egg and plasma concentrations at that location exceeded the lowest reproductive effect threshold established for two avian laboratory species. The objectives of this study were to determine whether there were reproductive effects or physiological responses in a model bird species, the tree swallow (*Tachycineta bicolor*), associated with this extremely high exposure to PFASs. The lack of exposure above background to other contaminants at this site allowed for an assessment of PFAS effects without the complication that responses may be caused by other contaminants. A secondary objective was to determine the distribution of PFASs in multiple tissue types to better understand and interpret residues in different tissues. This can best be done at highly exposed locations where tissue concentrations would be expected to be above detectable levels if they are present in that tissue. There were no demonstrable effects of PFAS exposure on reproduction nor on most physiological responses.

Perfluoroalkyl substances (PFASs) are manmade fluorinated compounds that have high thermal, chemical, and biological inertness. They have been used in a wide variety of applications including stain-, oil-, and water-resistant coatings for fabric and papers, as well as, for many industrial applications including as fire-fighting foams (European Food Safety Authority 2008). Contamination by PFASs in the vicinity of fire suppression training facilities is now a well-known problem (Place and Field 2012), but effects on birds have not been studied. The contaminants of concern at fire suppression training facilities are the film-forming firefighting foams that often contain fluorinated surfactants. These chemicals reduce surface-tension and offer superior capabilities compared with other formulations of fire extinguishing chemicals.

Clarks Marsh (44°26′39.14″N, 83°23′35.66″W), which is on the south side of the former Wurtsmith Air Force Base in Oscoda, Michigan (MI), is known for extensive PFAS contamination in ground and nearby surface waters (Bermejo et al. 1997; Moody et al. 2003). These PFASs originated from firefighting foams that were used during a 25-year period for training purposes. While the groundwater plume has been characterized, and a "do not eat" advisory for all fish caught in Clarks Marsh was issued in 2012, this is the first information published on exposure in birds from that area, as well as, the first characterization of PFASs in birds from firefighting foam sources. There have been publications on exposure and effects of PFASs at other types of point sources including manufacturing plants (Custer et al. 2013, 2014; Dauwe et al. 2007; Groffen et al. 2017, 2019; Lopez-Antia et al. 2017), as well as numerous publications on the worldwide distribution of PFASs in avian tissues (including Butt et al. 2010; Giesy and Kannan 2001).

The objectives of this study were to quantify exposure to, and possible effects of PFASs in tree swallows (*Tachycineta bicolor*) nesting at Clarks Marsh. Tree swallows are a model avian species, which have been used extensively

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00244-019-00620-1) contains supplementary material, which is available to authorized users.

✉ Christine M. Custer
ccuster@usgs.gov

[1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Rd., La Crosse, WI 54603, USA

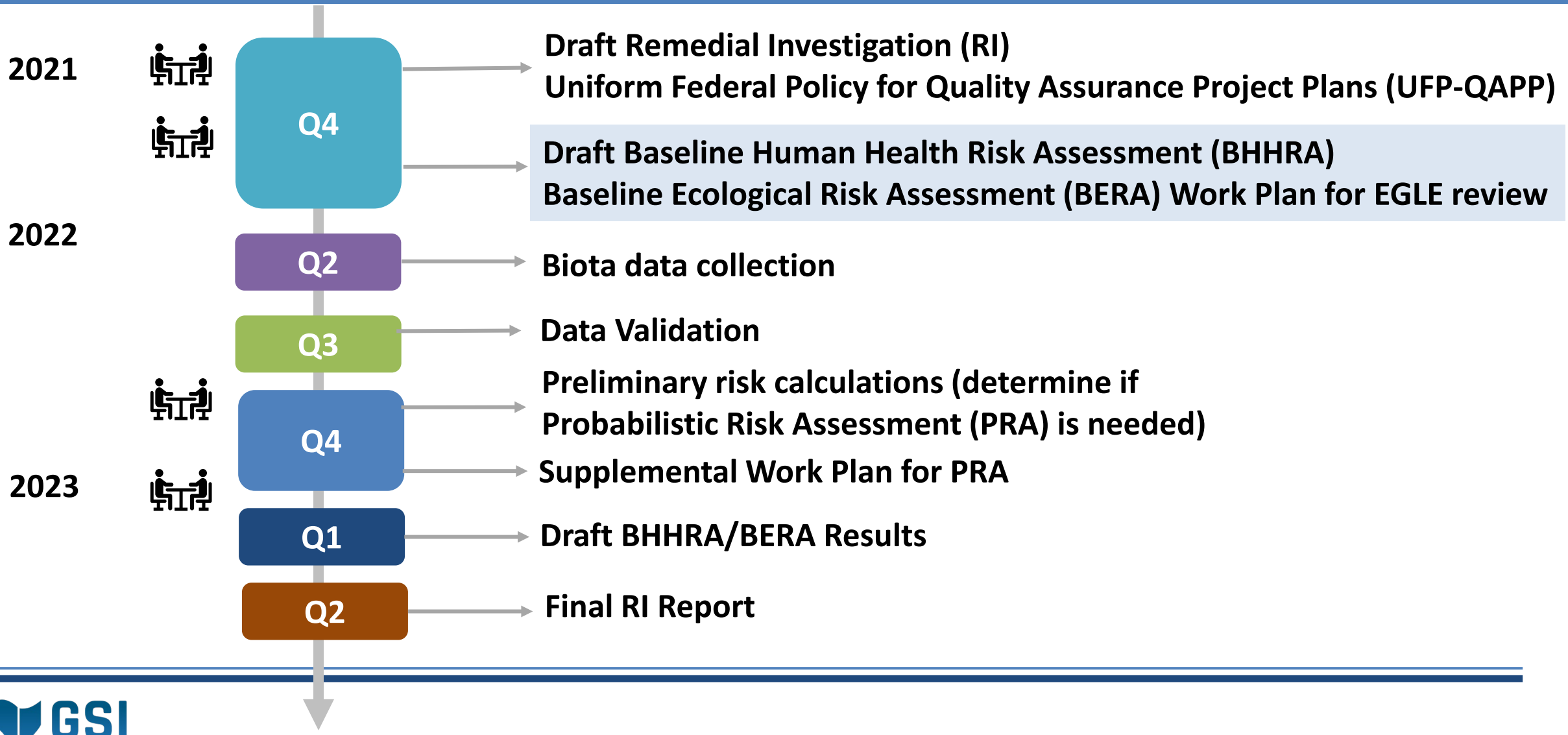
[2] Michigan Department of Environmental Quality, P.O. Box 30473, Lansing, MI 48909-7973, USA

[3] U.S. Geological Survey, Patuxent Wildlife Research Center, 10300 Baltimore Avenue, Beltsville, MD 20705, USA

GSI ENVIRONMENTAL

BASELINE RISK ASSESSMENT

Schedule and Deliverables for EGLE



GSI ENVIRONMENTAL

Image: Mobile plasma reactor that destroys PFAS

GSI ENVIRONMENTAL

Janet Anderson, Ph.D., DABT

Principal Toxicologist

jkanderson@gsi-net.com

Phil Goodrum, Ph.D., DABT

Principal Toxicologist

pegoodrum@gsi-net.com