

---

# **Human health risk assessments – and beyond**

**Gordon L. Brown, Ph.D., QEP  
Intrinsic Environmental Sciences Inc.**

**John Dennis, Ph.D.  
SolAero Ltd.**

**CPANS Presentation  
February 11, 2008**

---

# Introduction

- When industrial projects are announced, there are legitimate public concerns about impacts on health and well-being of local residents.
- Widespread belief that industrial emissions substantially degrade the environment, in particular air, water and country food quality.
- Industrial projects must be properly assessed, addressed and mitigated through the EIA process.
- Human health risk assessments (HHRAs) are now required for most EIAs.

---

# Introduction (cont'd)

- HHRAs typically determine that risks associated with industrial emissions are low.
- Sincere communication with public stakeholders throughout the EIA and approval process is essential
- If overall community health and well being are to be considered, its likely that a “holistic health” approach would be beneficial

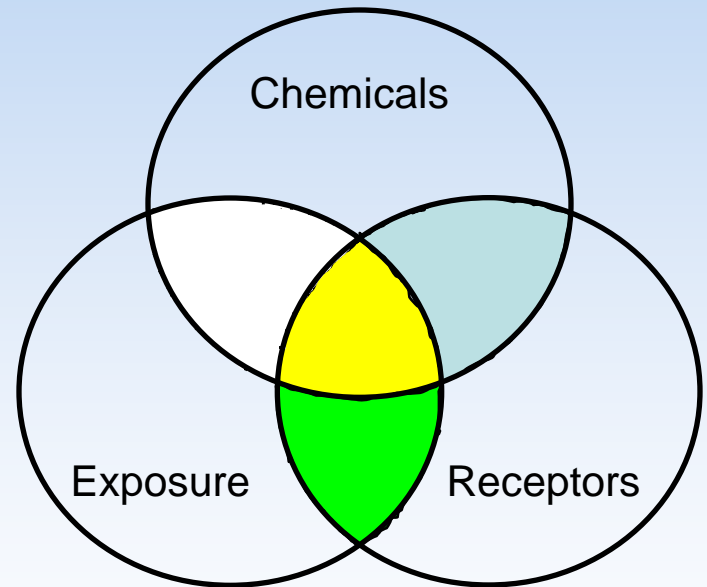
---

# Outline of Presentation

- Current Human Health Risk Assessment Paradigm
- Beyond Traditional Health Risk Assessment - the “Holistic Health” Approach

# What is Human Health Risk Assessment?

- Risk assessment is a scientific study which provides an evaluation of potential health risks to humans and the environment from exposure to chemical substances.

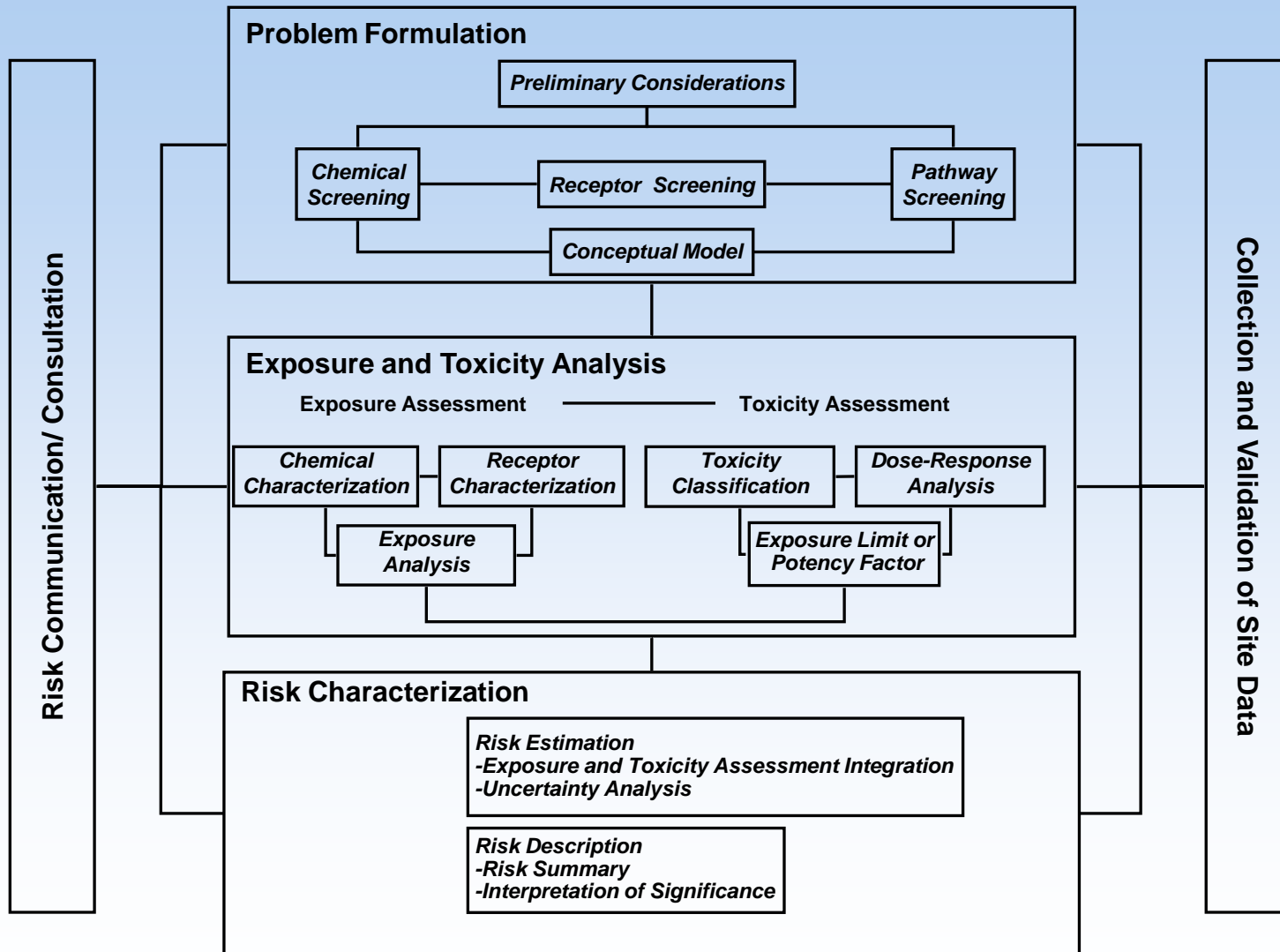


---

# Basis for Risk Assessment

- Risk is the chance of a health or environmental effect resulting from chemical exposure.
- Health risk is dependent upon toxicity of chemical(s) as well as degree and duration of exposure to those chemical(s).

# Human Health Risk Assessment Paradigm



---

# Why Do a Risk Assessment?

- To determine whether existing or future environmental conditions could result in adverse human health risks.
- To determine whether specific mitigation measures are needed, as well as follow-up monitoring to protect human health.
- To provide scientific information to the public regarding their concerns about potential health effects from industry.

---

# Main Features of a Health Risk Assessment

- Very comprehensive – considers all chemical constituents in air emissions - including those without air quality objectives
- Highly conservative approach - so risks are not underestimated
- Public consultation and input improve the product
- Based on current scientific (toxicology) knowledge
- Sources of uncertainty identified and addressed
- Transparent and scientifically defensible
- Can assess potential health effects related to chemical mixtures

# Typical COPCs Assessed in Industry HHRAs

Metals	Polycyclic Aromatic Hydrocarbons (PAH)	Combustion Gases or Criteria Compounds
aluminum	1,2-benzanthracene	carbon monoxide (CO)
arsenic	1-chloronaphthalene	nitrogen dioxide (NO <sub>2</sub> )
barium	1-methylnaphthalene	PM <sub>10</sub>
cadmium	2-chloronaphthalene	PM <sub>2.5</sub>
chromium	2-methylnaphthalene	sulphur dioxide (SO <sub>2</sub> )
iron	acenaphthylene	ammonium sulphate
lead	anthracene	
manganese	benzo(a)pyrene	
mercury	benzo(b&j)fluoranthene	
nickel	benzo(g,h,i)perylene	
molybdenum	benzo(k)fluoranthene)	
selenium	chrysene	
silver	dibenzo(a,j)acridine	
titanium	dibenzo(a,h)anthracene	
vanadium	dibenzothiophene	
	fluoranthene	
	indeno(1,2,3-cd)pyrene	
	naphthalene	
	phenanthrene	
	pyrene	
	retene	

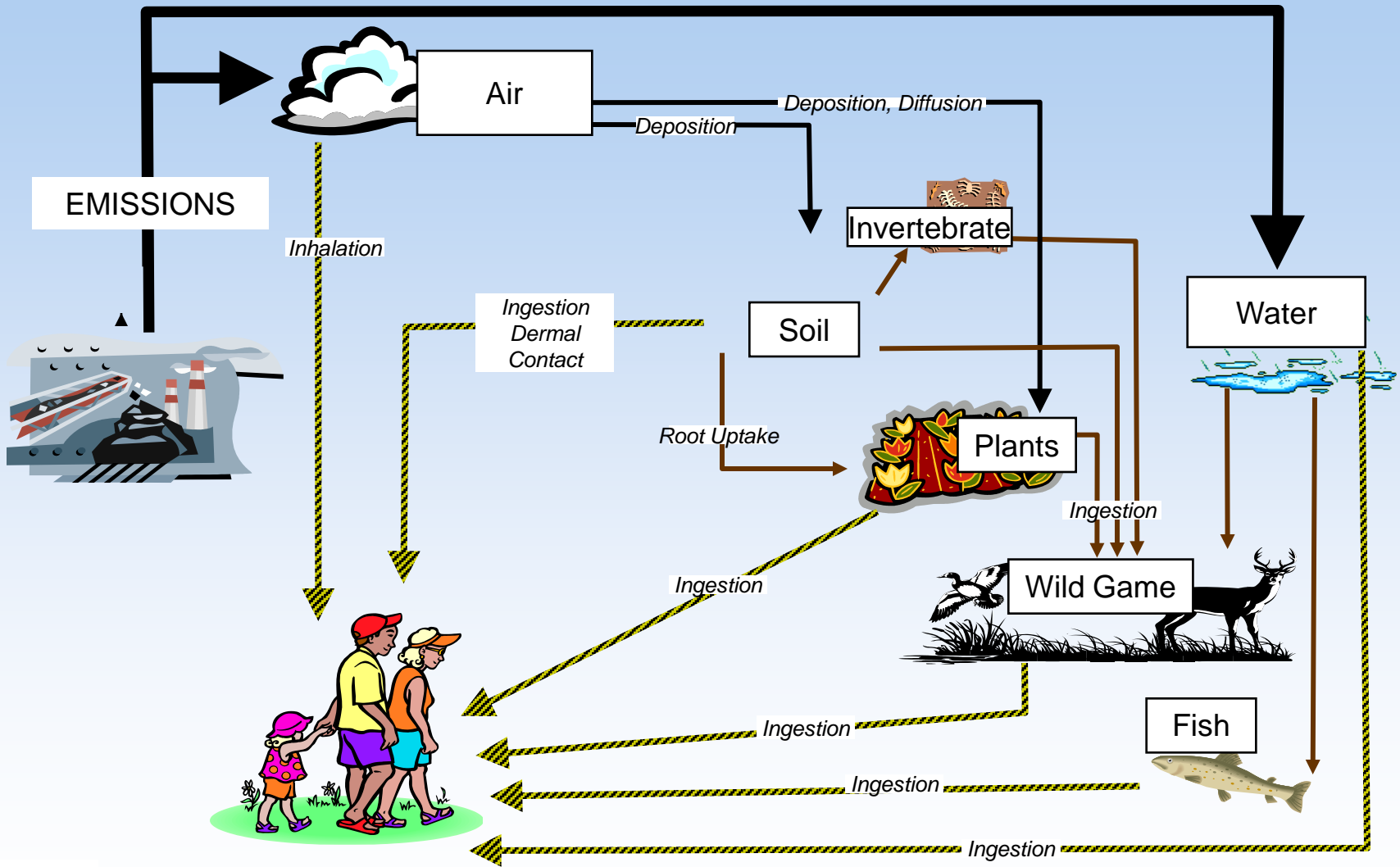
Note: COPC = chemical of potential concern

---

# Human Receptors

- Urban community residents
- Rural non-farming residents
- Rural farming residents
- Potentially highly-exposed groups such as First Nation and Hutterite communities
- All age groups from infant to adult
- Lifetime exposures estimated

# Potential COPC Exposure Pathways



---

# Exposure Assessment

- Predicted maximum air concentrations are assumed:
  - 1-hour average contaminant concentrations (acute effects)
  - 24-hour average contaminant concentrations (acute effects)
  - Annual average contaminant concentrations (chronic effects)

---

# Assessment Cases

- The assessment scenarios for the EIA and risk assessment include:
  - **Baseline case**, includes existing air quality based on monitored results
  - **Project Alone case**, includes the proposed project by itself
  - **Application case**, includes the Baseline case plus the Project Alone case
  - **CEA (future) case**, includes predicted air quality based on all announced projects

---

# COPC Exposure Limits

- Exposure limits have been established by reputable scientific or regulatory agencies such as Health Canada and the US EPA
- Exposure limits include safety factors to protect the general public and sensitive individuals

---

# COPC Mixture Toxicity

- Potential health effects are considered resulting from exposure to chemical mixtures including compounds that:
  - are structurally similar
  - act toxicologically via similar mechanisms, or
  - affect the same target tissue in the body

---

# Hazard Quotient (HQ) Values

$$\text{HQ} = \frac{\text{Exposure Estimate}}{\text{Exposure Limit}}$$

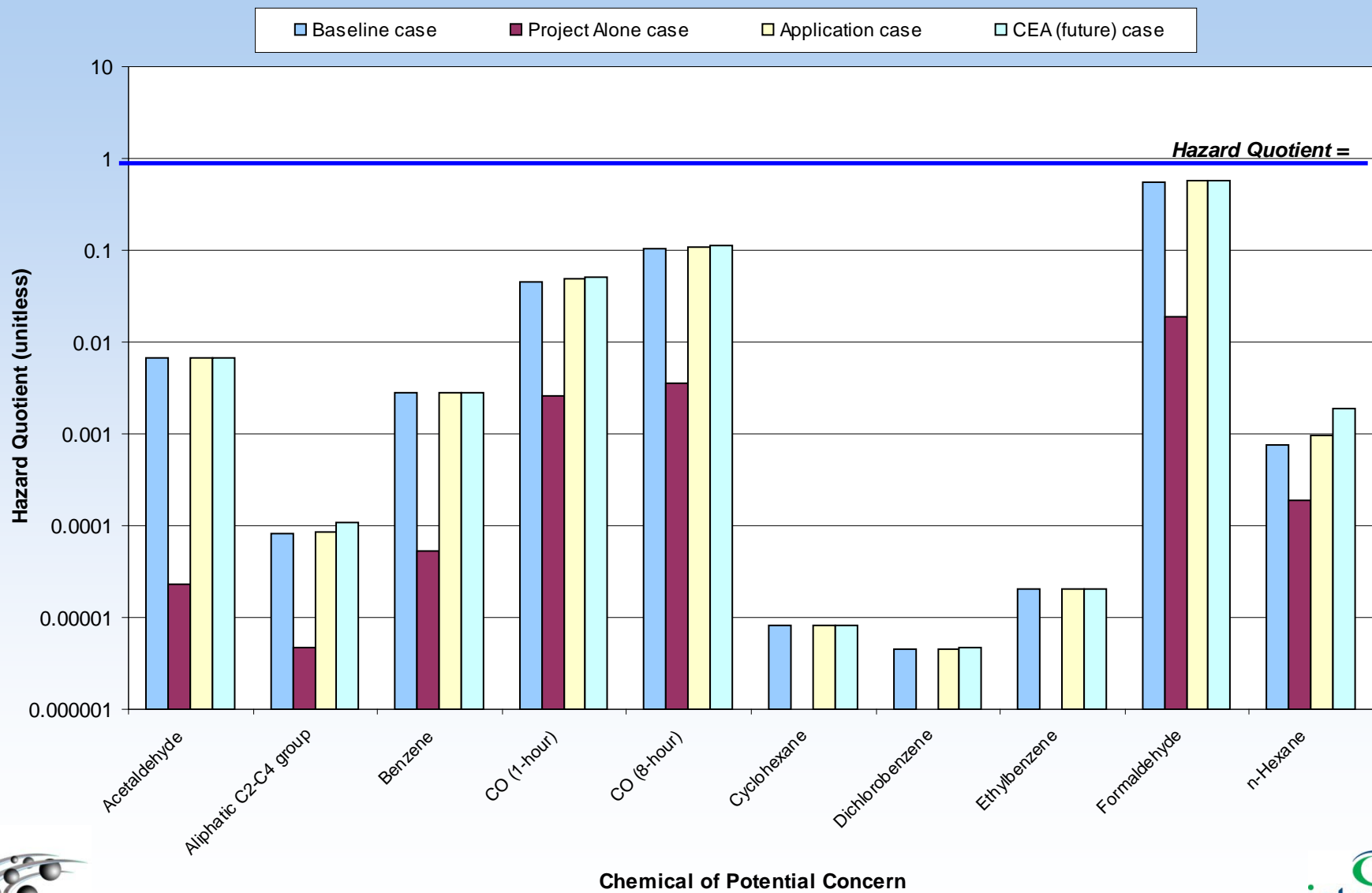
HQ < 1

- ✓ no health risks predicted
- ✓ no further analysis required

HQ > 1

- ✓ possible health risks predicted
- ✓ further analysis needed

# Predicted Health Risks



---

# Conservative Assumptions

- Maximum predicted air concentrations and deposition rates
- Upper chemical concentrations in country foods
- Upper food consumption rates
- Exposure limits with safety factors to protect sensitive individuals
- The intention of these conservative assumptions is to “overestimate” potential exposures and therefore health risks.

---

# Beyond Health Risk Assessment

- Health risk assessment provides critical information required to ensure project emissions are safe
- If broader issues of community health and well-being are to be addressed, a “holistic health” approach should be considered

---

# Human Health

Not merely the absence of disease or infirmity ...

... A state of complete physical, mental and social well-being.



---

# Health Determinants

- Income and social status
- Social support services
- Education and literacy
- Employment and working conditions
- Physical environments
- Personal health practices and coping skills
- Health child development
- Biology and genetic endowment
- Health services
- Gender
- Culture
- Diet
- Stress



---

# Expanded Human Health Risk Impact Assessment

## CURRENT PARADIGM

- Pollutant exposure modeling in air, water, foods
- Adopt safety margins and model health impact
- Conclude low risk

## EXPANDED PARADIGM

- Includes current plus impacts to ...
  - Socio-economic
  - Culture
  - Diet
  - Stress
- Adopt safety margins
- Conclude significant risk
- Risk perception
- Risk communication



---

# Risk perception

- Fear
- Fear influences behaviour
- Creates stress – individual, family and community
- Stress vs. Strain
- Influence on diet? alcohol? drugs?
- Impact on Health !

---

Reduce/control impact through  
*effective* risk communication

Explore off-sets

BATEA

Keeping Clean Areas Clean

---

# Conclusion

## CURRENT PARADIGM

- Emissions
- Exposure assessment/modeling
- Comparison to Acceptable Standards

... leads to conventional human health risk assessment

## EXPANDED HOLISTIC PARADIGM

- Current HHRA plus indirect health impacts
- Prudent risk assessment errs on the side of safety