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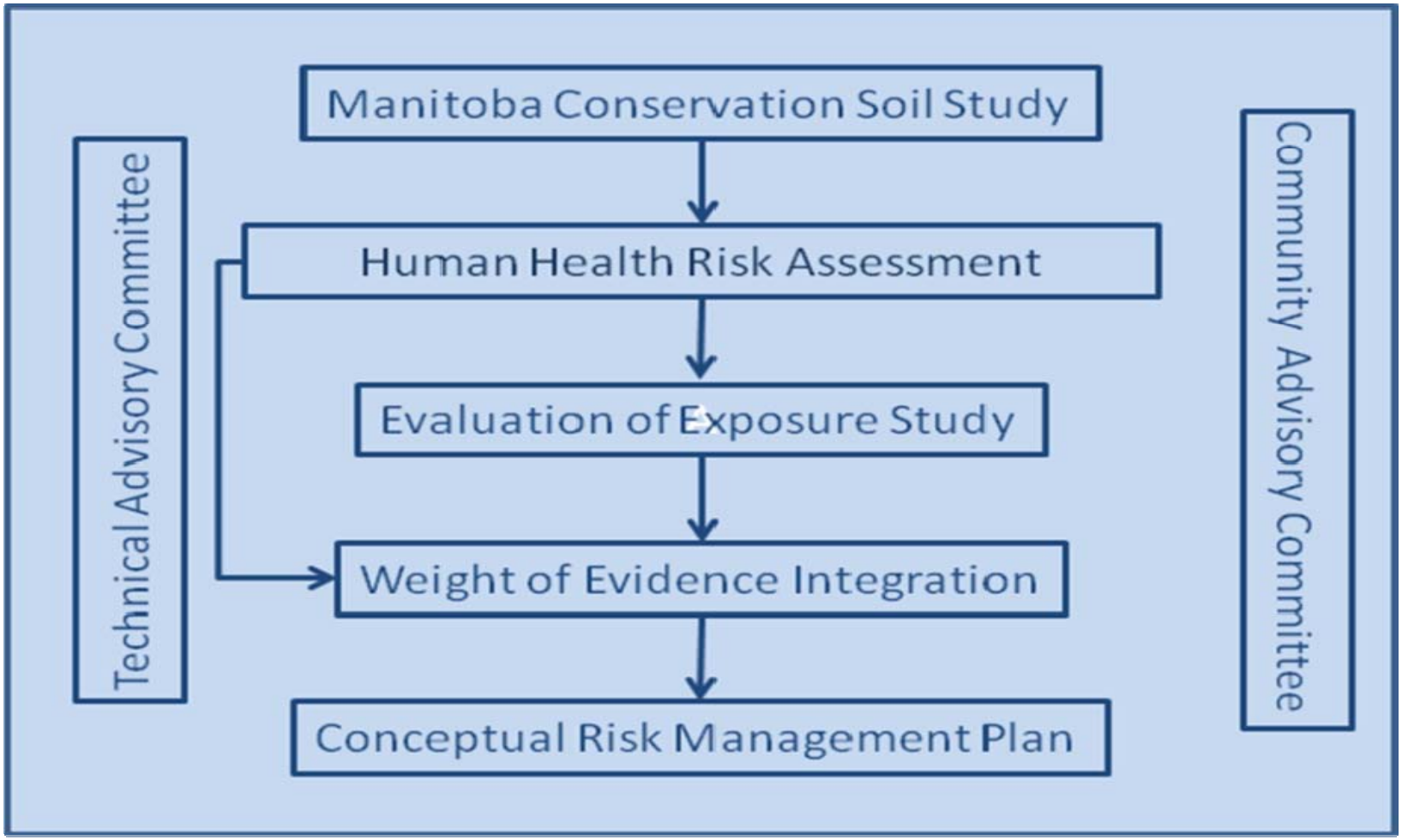
Human Health Risk Assessment Flin Flon, Manitoba and Creighton, Saskatchewan

Presentation of Results

Community Advisory Committee Meeting, Thursday March 25th, 2010

The Flin Flon Soils Study



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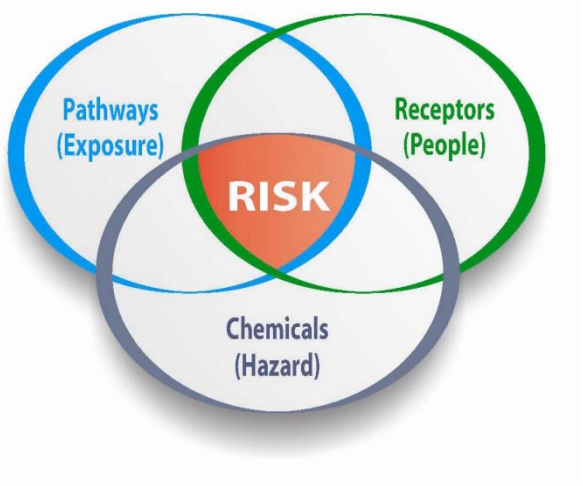
What Is A Risk Assessment?

"A qualitative or quantitative evaluation of the environmental and/or health risk resulting from exposure to a chemical or physical agent (pollutant); combines exposure assessment results with toxicity assessment results to estimate risk."
[U.S. EPA]



- Risk is the chance of a health or environmental effect resulting from chemical exposure
- **Risk is dependent upon degree of exposure to a chemical as well as the toxicity of the chemical**

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Study Objectives

- **Objective 1:** To assess risks to human receptors residing in Flin Flon, Manitoba and Creighton, Saskatchewan as a result of exposure to metals in soil and other environmental media impacted by the activities of the HBMS complex. The HHRA will estimate the contribution from individual exposure pathways and environmental media to assist in the development of risk management objectives; and,
- **Objective 2:** Develop Provisional Trigger Concentrations (PTCs) for residential soil for each COC. PTCs can be applied on a property-by-property basis to determine which properties may have concentrations of COC in soil that may require risk management or further consideration such as biomonitoring of residents.

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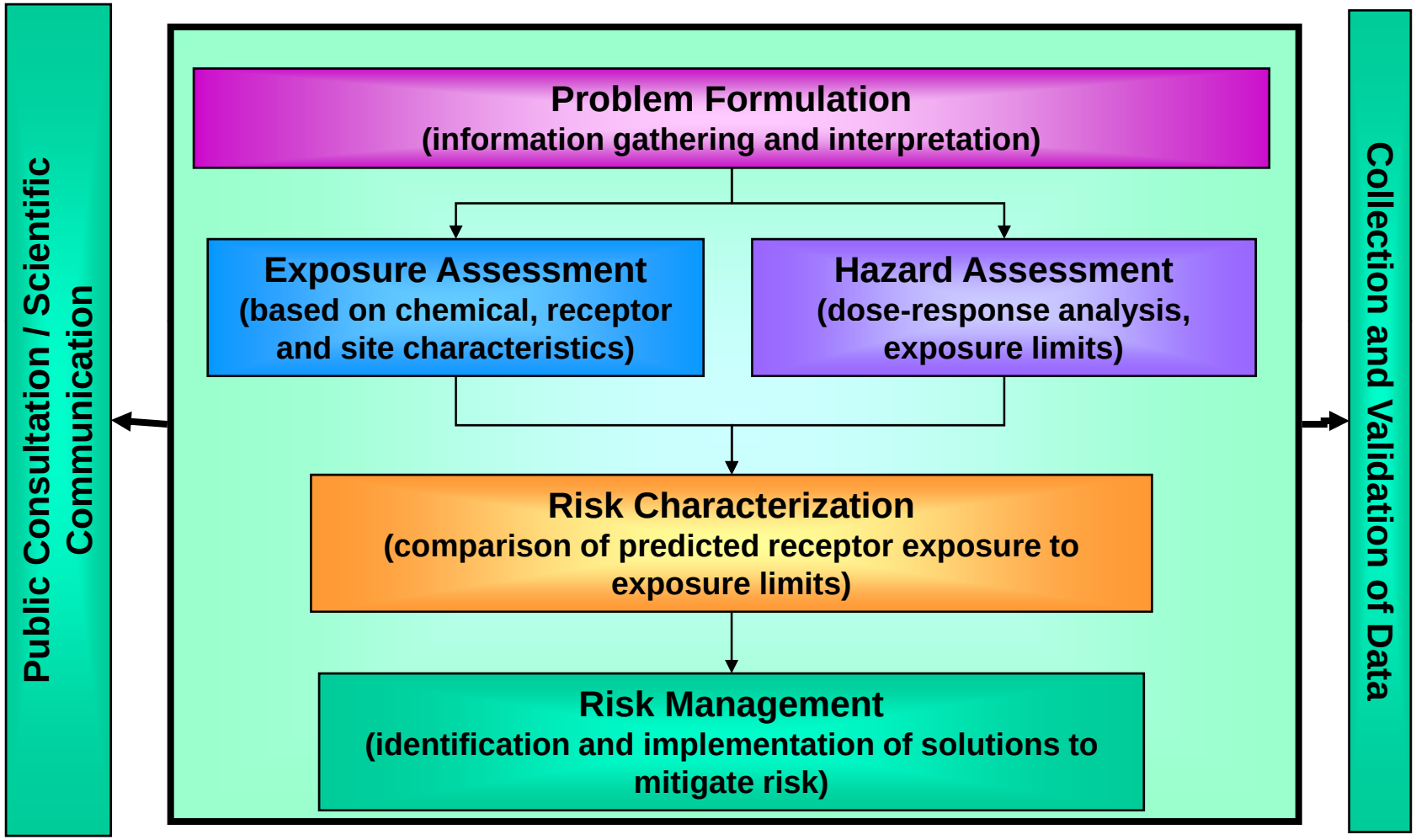
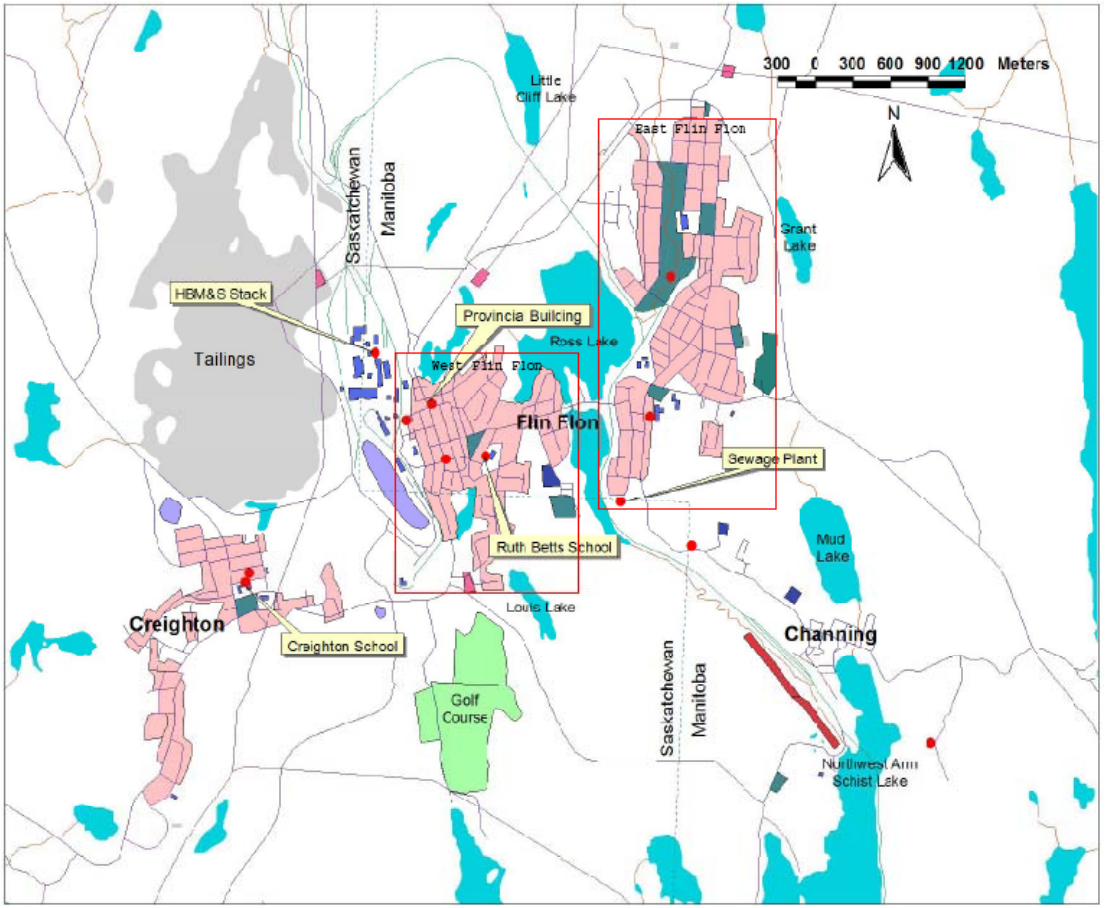
Human Health Risk Assessment



Communities of Interest



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Manitoba Conservation surface soil study (2006)

- 93 sites in Flin Flon; 13 sites in Creighton (each site had 3 samples)
- Samples were collected from the top 2.5 cm and were a composite of 20 cores
- Publicly accessible lands such as parks, schoolyards, boulevards, vacant lots, undeveloped areas, etc.
- Results indicated that concentrations of 12 chemicals were elevated relative to a reference site
- Six chemicals exceeded health-based national guidelines
  - Arsenic, cadmium, copper, lead, mercury, and selenium
- Initiated the start of the HHRA

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Supplementary Site Characterization

- The literature review and data gap analysis identified the need for additional data collection which was completed in 2008
  - Residential soil
  - Drinking water
  - Supplementary air
  - Indoor dust
  - Bioaccessibility (outdoor soil)
  - Fish, surface water, sediment
  - Blueberries
  - Snow
  - Local food consumption survey

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Identification of Chemicals of Concern (COC)

- Identified based on concentrations in soil
- COC identification process included:
  - Comparison of maximum concentrations to human health-based soil guidelines
  - Consideration of the percentage of samples in excess of guideline
  - Consideration of regional background concentrations
  - Known association with smelter emissions
- Selection of maximum soil concentrations considered data from the Manitoba Conservation Study (2007) and the Residential Soil Study (2008)

- **Arsenic, Cadmium, Copper, Lead, Mercury, Selenium**

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Receptor Identification

- To assess risks for non-carcinogenic endpoints, receptors within 5 age categories as recommended by Health Canada were considered:
  - Infant (0 to 6 months)
  - Toddler (7 months to 4 years)
  - Child (5 to 11 years)
  - Adolescent or teen (12 to 19 years)
  - Adult (20 to 80 years)
- To assess risks for carcinogenic endpoints, a lifetime composite receptor was considered

Identification of Exposure Pathways and Scenarios

Inhalation exposure pathways

- Direct inhalation of COC in outdoor air
- Direct inhalation of COC in indoor air

Dermal exposure pathways

- Dermal contact with COC in outdoor soil
- Dermal contact with COC in indoor dust
- Dermal contact with COC in surface water

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Identification of Exposure Pathways and Scenarios con't

Oral exposure pathways

- Ingestion of COC in outdoor soil
- Ingestion of COC in indoor dust
- Ingestion of COC *via* consumption of home garden vegetables
- Ingestion of COC *via* consumption of local wild blueberries
- Ingestion of COC *via* consumption of local fish and wild game
- Ingestion of COC *via* incidental surface water ingestion while swimming
- Ingestion of COC present in typical market basket items (*i.e.*, groceries)
- Ingestion of COC in drinking water derived from Flin Flon and Creighton area water resources
- Ingestion of COC in snow

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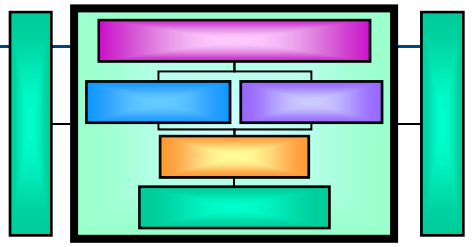
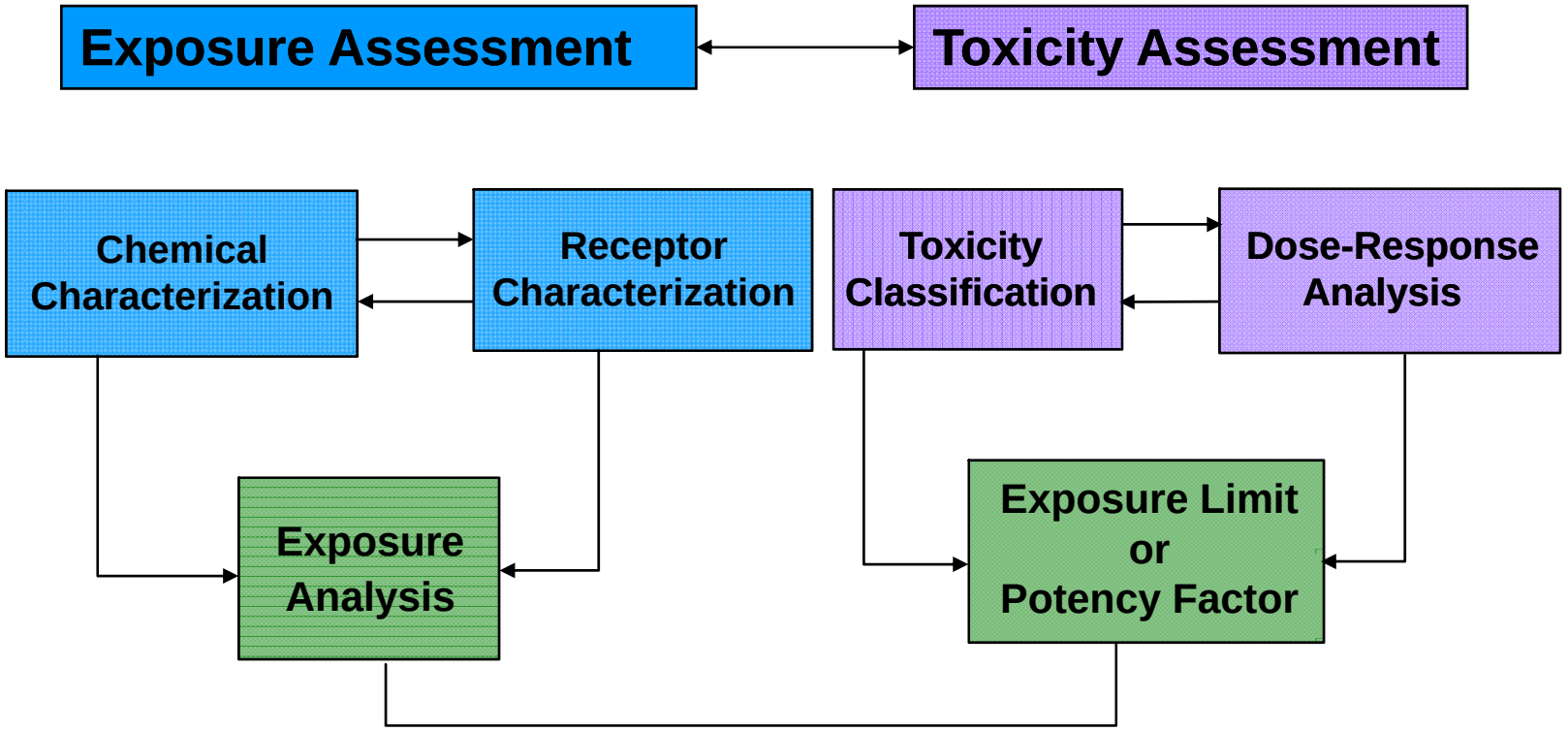
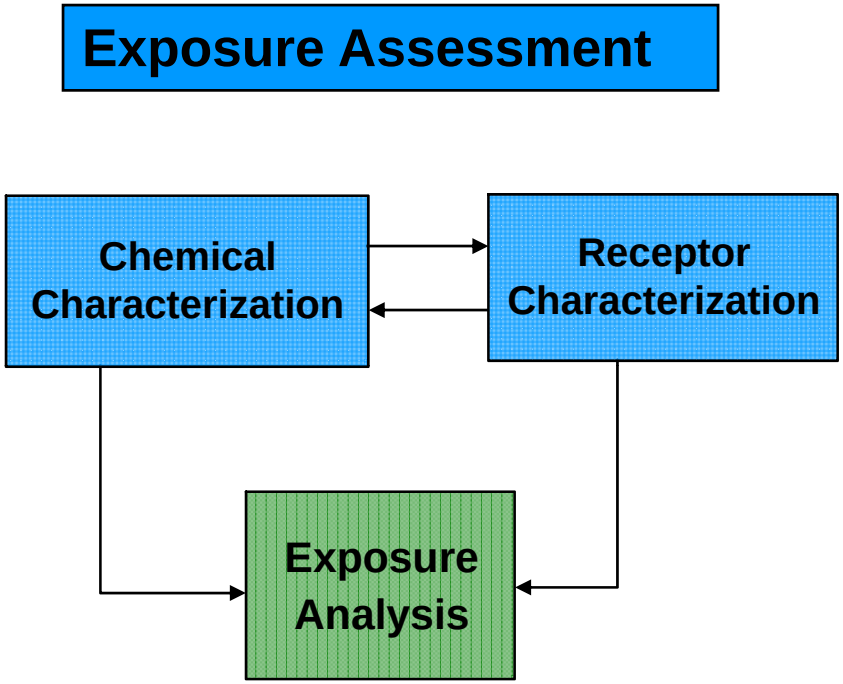
Exposure and Toxicity Analysis





Exposure Assessment

- Derivation of Exposure Point Concentrations (EPCs)
- Multi-media exposure estimates
- Spreadsheet-based deterministic calculations
- Additional assessment using IEUBK model for lead



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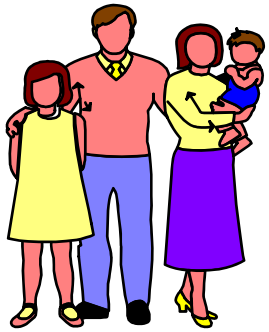
Modelling

- Involves the estimation of daily dose based on the concentrations of chemicals in environmental samples (e.g., soil, air, vegetables, etc.)

  Need to understand characteristics of who/what is being evaluated:

- Lifestyle and habits (e.g., what people or wildlife eat, how much time people spend indoors/outdoors, do species migrate)

- Physical characteristics (e.g., body weight, how much people or wildlife eat and drink)



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IEUBK Model for Lead in Children

- Computer simulation model derived by the U.S. EPA to predict childhood lead exposure and retention
- Has the ability to quantify the relationship between environmental lead concentrations in different media (*e.g.*, soil, water, air and food) to blood lead levels in children of different ages (0 to 84 months)
- Estimates of a likely distribution of blood lead concentrations are centered on the geometric mean concentration and can be used to calculate the probability that blood lead concentrations in children will exceed an acceptable level
- Standard tool for assessing lead in risk assessments

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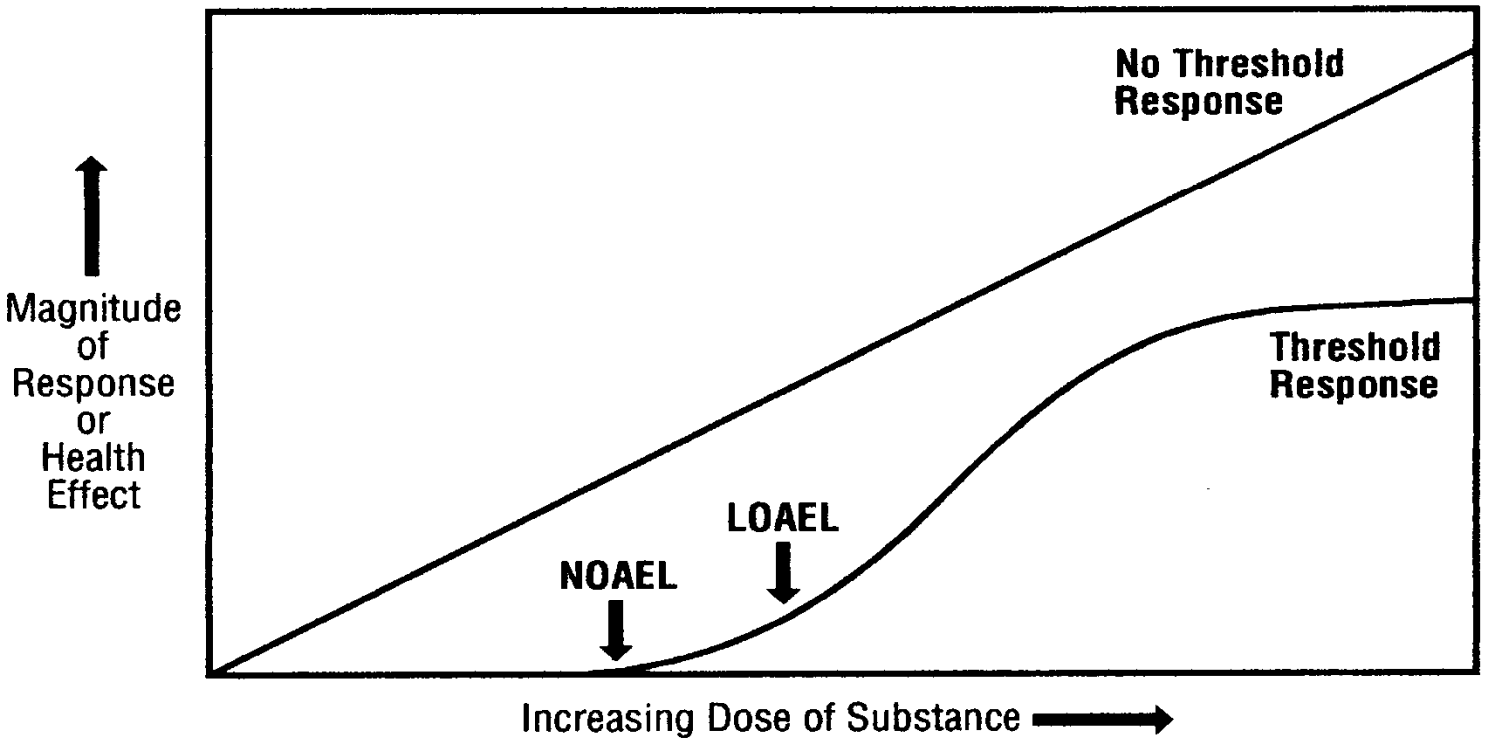
Toxicity Assessment



NOAEL - No Observed Adverse Effect Level - The level of exposure to a chemical at which no adverse effects are observed during studies with laboratory animals or in human epidemiological studies.

LOAEL - Lowest Observed Adverse Effect Level - The lowest level of exposure to a chemical at which adverse effects are observed during studies with laboratory animals or in human epidemiological studies.

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Development of Toxicity Reference Values (TRVs)

- TRVs were obtained from regulatory agencies including the Health Canada, U.S. EPA, U.S. Agency for Toxic Substances and Disease Registry (ATSDR), California Environmental Protection Agency Office of Environmental Health Hazard Assessment (Cal EPA OEHHA), the Ontario Ministry of the Environment (MOE), U.S. Centers for Disease Control (CDC), the European Union (EU), and the World Health Organization (WHO)
- A detailed toxicological assessment was conducted for each COC, involving identification of mechanism of action and relevant toxic endpoints, and determination of receptor- and route-specific toxicological criteria

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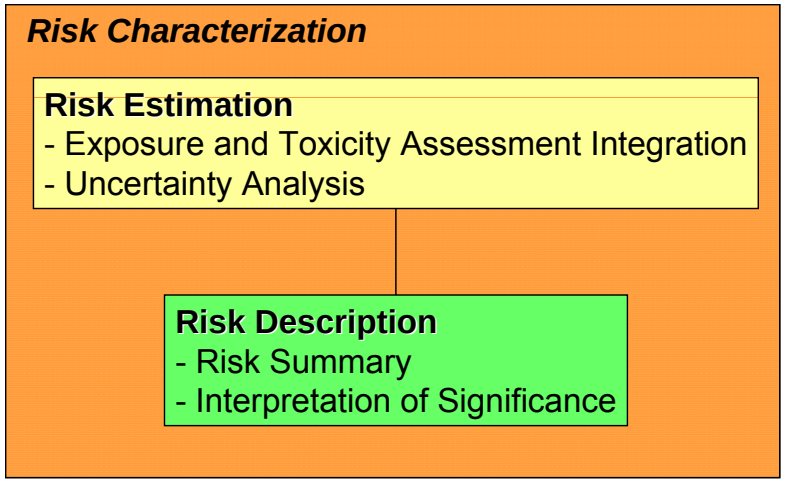
Risk Characterization

- Interpretation of health risks
  - Quantitative
  - Qualitative



- Acute inhalation (24 hour durations);
- Acute oral (short-term soil and snow exposure events);
- Residential chronic multiple pathways (*i.e.*, inhalation, oral and dermal exposures); and,
- Commercial/industrial (outdoor worker) chronic multiple pathways (*i.e.*, inhalation, oral and dermal exposures).

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Acute (short-term) Risks

- Short-term or acute risks were evaluated for air, soil and snow related exposures
- Slightly elevated risks were predicted for some COCs
- By definition, acute exposure are short-term and transient in nature, typically occurring as a result of a unique or extreme situation or facility anomaly
- The results of this evaluation indicated that some people may experience short-term and reversible health effects on rare occasions
- The magnitude of exceedances were less than an order of magnitude and the margins of safety inherent in the acute TRVs are large, indicating that the occurrence of acute health effects is unlikely.

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Chronic (long-term/lifetime) Risks

Arsenic

- Both non-cancer and cancer numerical risk estimates for arsenic exceeded standard acceptable benchmarks for both oral/dermal and inhalation exposures
  - Market basket foods were the main contributor to non-cancer arsenic-related risks
  - For carcinogenic risks, the inhalation of ambient air was the most significant source of risk
  - The consumption of drinking water and exposure to soil/dust also contributed significantly to both cancer and non-cancer risk estimates

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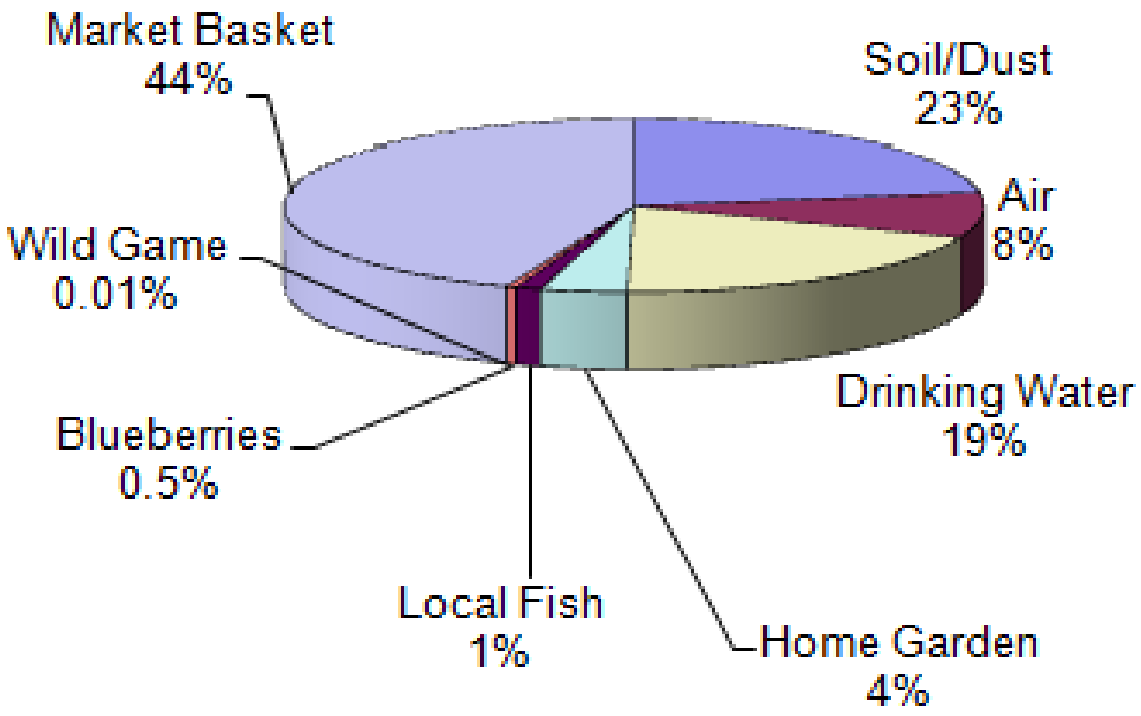
Arsenic Exposure to a West Flin Flon Toddler



Arsenic Weight of Evidence

- The most powerful and persuasive piece of evidence in other weight-of-evidence evaluations was the urinary arsenic study results
- These provide a comparison urinary arsenic levels of an impacted community with those of a control community
- It is recommended that a Urinary Arsenic study be undertaken for the Flin Flon area, focusing on homes in West Flin Flon and Creighton in which a significant number of homes included within the residential soil sampling program contained concentrations of arsenic in excess of the PTC

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Cadmium

- Oral/dermal and non-cancer inhalation exposures were within acceptable levels
- Concentrations of cadmium in ambient air may have the potential to result in an unacceptable increase in the risk of developing lung cancer
- ILCR for Cadmium are quite elevated and consideration should be given to future reductions in smelter-related emissions, which would have a direct and immediate effect on reducing inhalation-related exposure and risks

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Copper

- The estimated HQ values associated with copper exposures were less than 1.0 under all exposure and receptor scenarios
- Overall, the health risks to Flin Flon-area residents associated with exposure to copper are within risk levels deemed to be acceptable by Health Canada and the CCME
- Risk management measure or soil remediation are not considered to be necessary to prevent or reduce human health risks associated with exposure to copper in residential soils

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Lead

- Both the HHRA model and the IEUBK model predicted average lead related exposure within acceptable levels
- A significant number of residential properties in West Flin Flon, as well as a few in East Flin Flon and Creighton, contain concentrations of lead in outdoor soil that are above the residential PTC protective of a 5% probability of exceeding a BLL of 10 µg/dL
- The health benchmarks for lead (10 µg/dL and 3.6 ug/kg/day) are currently under review by regulatory agencies such as Health Canada, and it is anticipated that these benchmarks will be reduced in the near future

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Lead Follow-up

- Since a significant percentage of homes in the Flin Flon area contain soil concentrations in excess of those predicted to be protective of a 5% probability of exceeding a BLL of 10 µg/dL, the completion of a blood lead survey would be an appropriate method of reducing uncertainty in the exposure assessment and provide a more accurate measure of the levels occurring in young children in these communities
- The blood lead survey should primarily focus on children up to the age of 7 years as they are the most sensitive to the impaired neurobehavioral development associated with elevated BLLs

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Mercury-Inorganic

- With the exception of toddlers in West Flin Flon, all exposures were below the acceptable levels indicating that adverse effects associated with elevated exposure to inorganic mercury are not anticipated
- Exposure of the toddler to inorganic mercury, and subsequent risk levels, are dominated by contributions from soil
- Biomonitoring would be an appropriate option to more accurately assess inorganic mercury exposure to individuals in West Flin Flon
- For long-term, low level exposures to inorganic mercury, measurement through urine samples is the preferred medium

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Mercury-Methyl

- Exposure to methyl mercury was assumed to occur *via* the consumption of fish from market basket foods, consumption of local fish, consumption of drinking water, and inhalation of ambient air
- the primary route of exposure for all receptors other than the infant was the consumption of local fish
- Based on the assessment results, it is recommended that fish consumption advisories be considered, particularly for sensitive receptors

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Selenium

- The estimated HQ values associated with selenium exposures were less than 1.0 under all exposure and receptor scenarios
- Overall, the health risks to Flin Flon-area residents associated with exposure to selenium are expected to be similar to those observed in other parts of Canada and are within risk levels deemed to be acceptable by Health Canada and the CCME.

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Number of Properties with Concentrations of Arsenic in Outdoor Soil in Excess of the PTC of 74 µg/g					
	West Flin Flon	***East Flin Flon***	***Creighton***	***Channing***	***Total***
# of Properties Sampled	77	66	30	10	183
# of Properties >74 µg/g	30 (39%)	0	10 (33%)	0	40 (22%)

Number of Properties with Concentrations of Mercury in Outdoor Soil in Excess of the Residential PTC of 64 µg/g					
	West Flin Flon	***East Flin Flon***	***Creighton***	***Channing***	***Total***
# of Properties Sampled	77	66	30	10	183
# of Properties >64 µg/g	40 (52%)	0	0	0	40 (22%)

Number of Properties with Concentrations of Lead in Outdoor Soil that Exceed a Residential PTC of 370 µg/g					
	West Flin Flon	***East Flin Flon***	***Creighton***	***Channing***	***Total***
# of Properties Sampled	77	66	30	10	183
# of Properties >370 µg/g	32 (42%)	2 (3%)	4 (13%)	0	38 (21%)

Development of Provisional Trigger Concentrations (PTC)

- PTCs were developed for all COCs
- PTCs are effectively area specific trigger levels prompting the requirement for further action
- A significant number of properties in West Flin Flon and to a lesser extent in Creighton exceeded the PTC for lead, arsenic and mercury

Recommendations

- The HHRA provides a recommendation for a comprehensive biomonitoring program to evaluate environmental contaminant exposure in children (under 16) in Flin Flon, Manitoba and Creighton, Saskatchewan
- The study will examine urinary arsenic; blood lead; and, urinary inorganic mercury levels.
- A study of this nature was conducted in the fall of 2009.

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