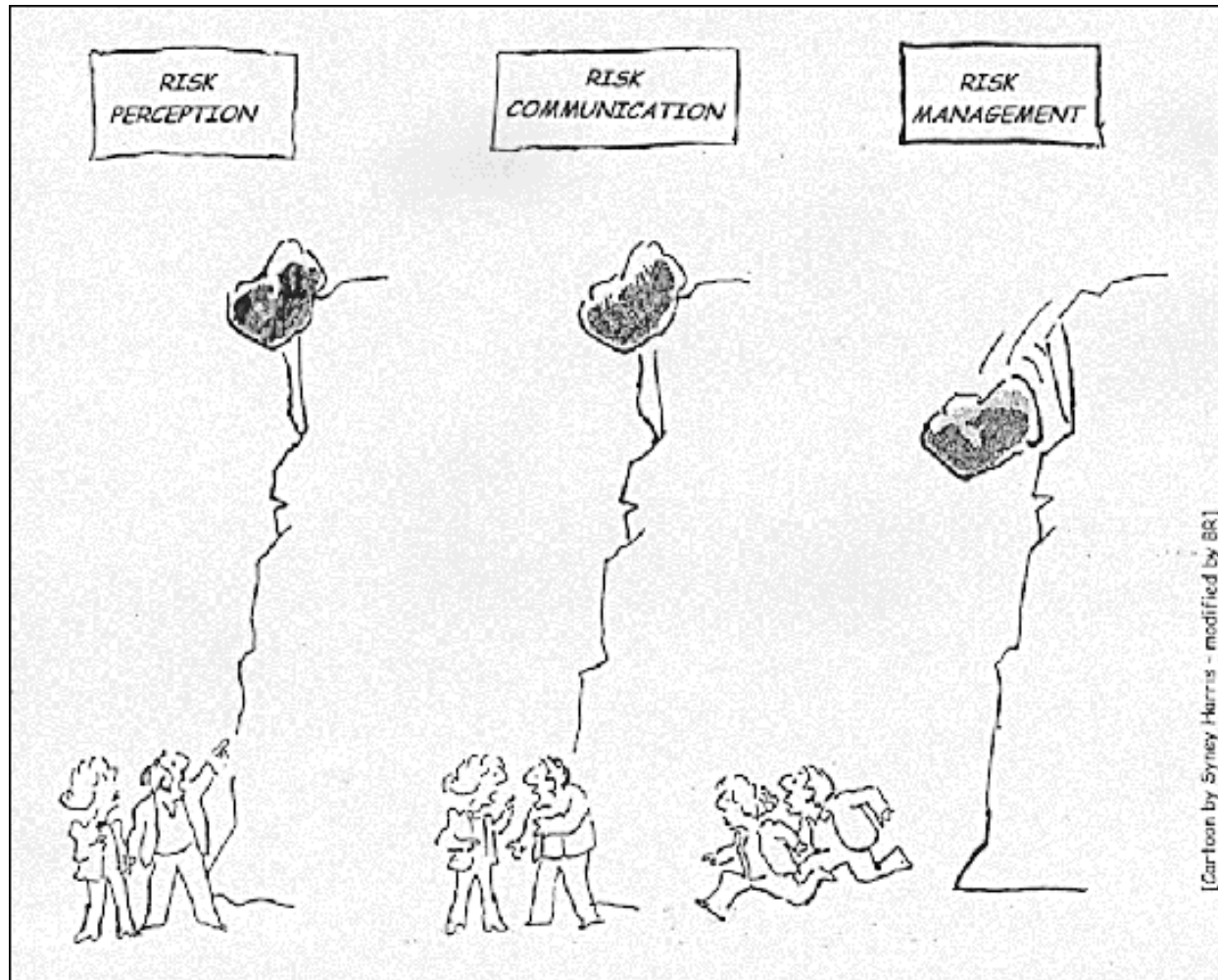


Uncertainty in Human Health Risk Assessment

OAIA 2013 - Toronto, ON



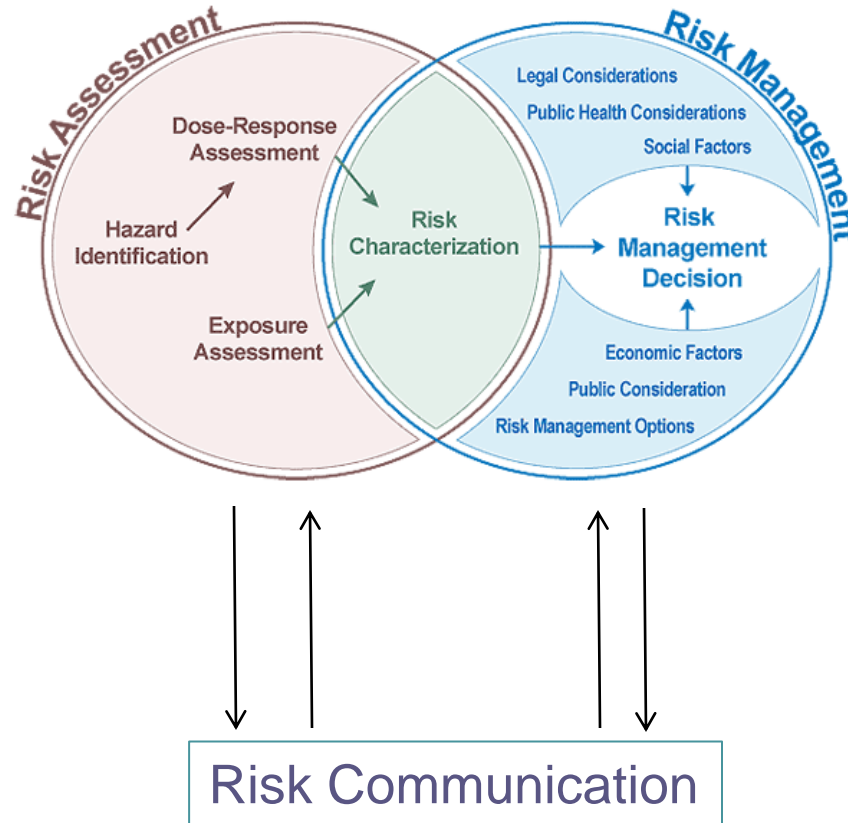
A primer on risk assessment....



- *Risk assessment is, to the highest extent possible, a scientific process. In general terms, risk depends on the following factors:*
 - *How much of a chemical is present in an environmental medium (e.g., soil, water, air),*
 - *How much contact (exposure) a person or ecological receptor has with the contaminated environmental medium, and*
 - *The inherent toxicity of the chemical.*

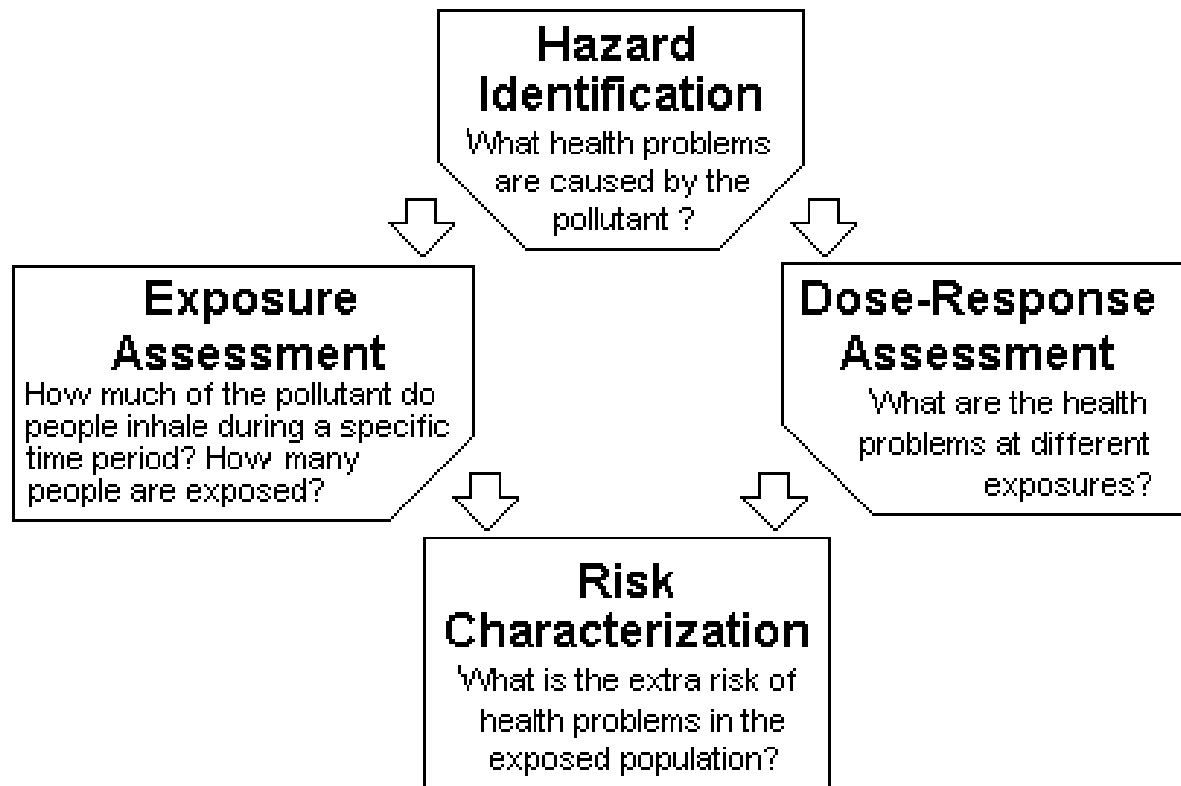
(United States Environmental Protection Agency)
- Applied to the Environmental Assessment process, risk assessments help identify quantify potential impacts associated with a project.
- RAs range from simple screening level exercises to multi-pathway, multi-receptor evaluations.

The process....



Adopted from: National Academy of Sciences (1983)

The 4-Step Risk Assessment Process

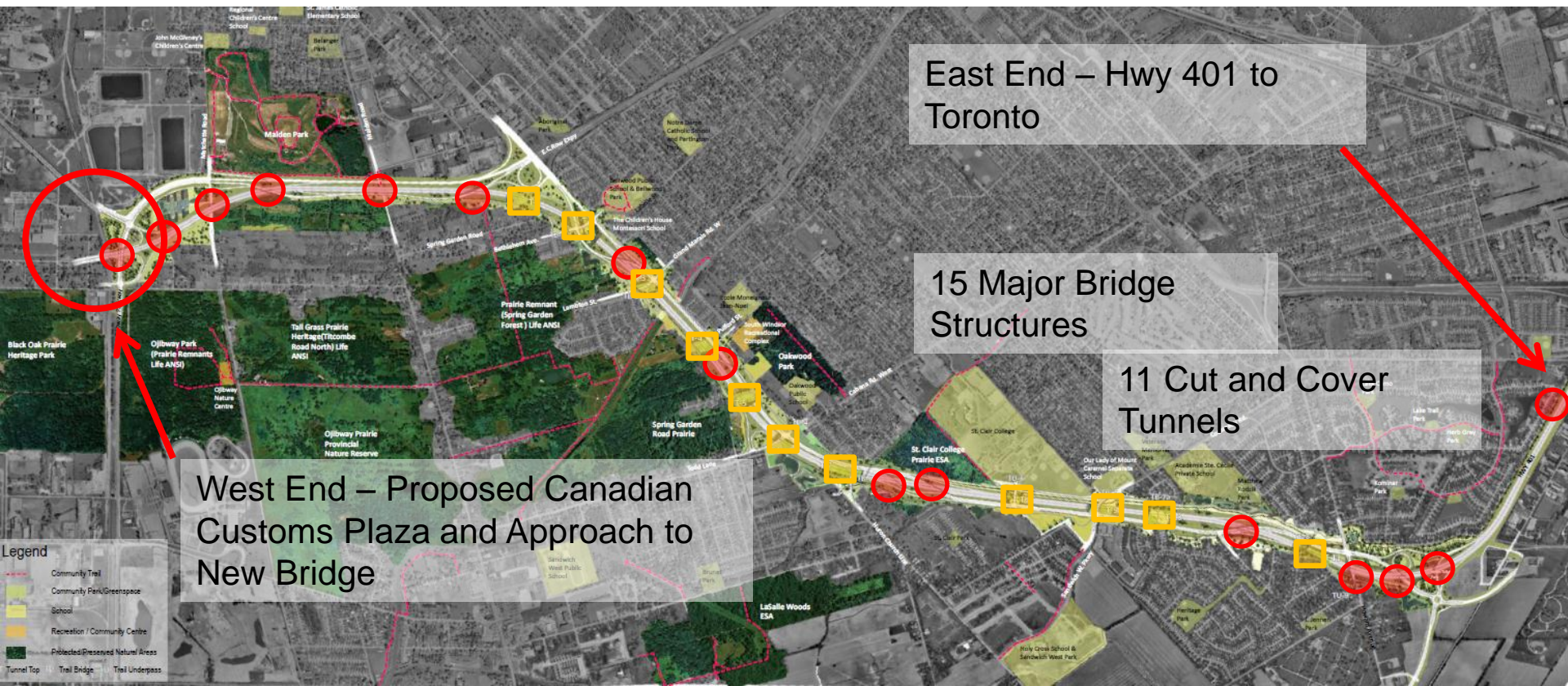


- Uncertainty is a fact of life when completing risk assessments
 - Guidance suggests that all uncertainties be identified and their consequence taken into consideration in any recommendations made
- Risk assessors typically rely on “conservative” assumptions to deal with uncertainty (i.e. “worst case”)
- When unacceptable risk is identified it can mean one of two things
 - A threat to human health or the environment; or
 - An erosion of the margin of safety between the calculated level of exposure and that known to cause adverse effects (i.e. *we were too conservative!*)
- Understanding the difference is critical to making effective management decisions

Case Study 1: Human Health Risk Assessment for the Windsor Essex Parkway



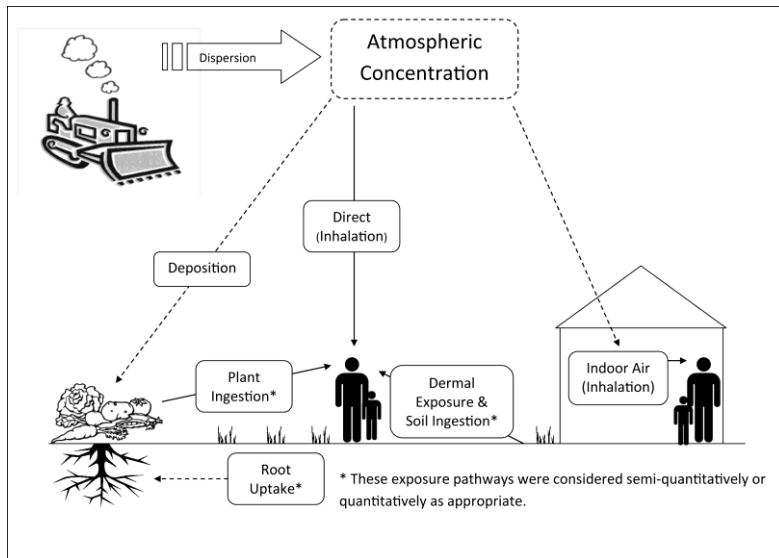
- The Windsor-Essex Parkway is a below grade, six-lane highway, 11.2 kilometers long with a four-lane service road, 300 acres of green space and 20 km of trails
- First piece of the new Detroit International Crossing



Human Health Risk Assessment - Windsor Essex Parkway



- Approved under OEAA in 2009
 - Study reports included comprehensive air quality study and human health risk assessment
- As a condition of approval, proponent was required to complete a focused assessment of risk to human health associated with the construction phase of the project



Challenges

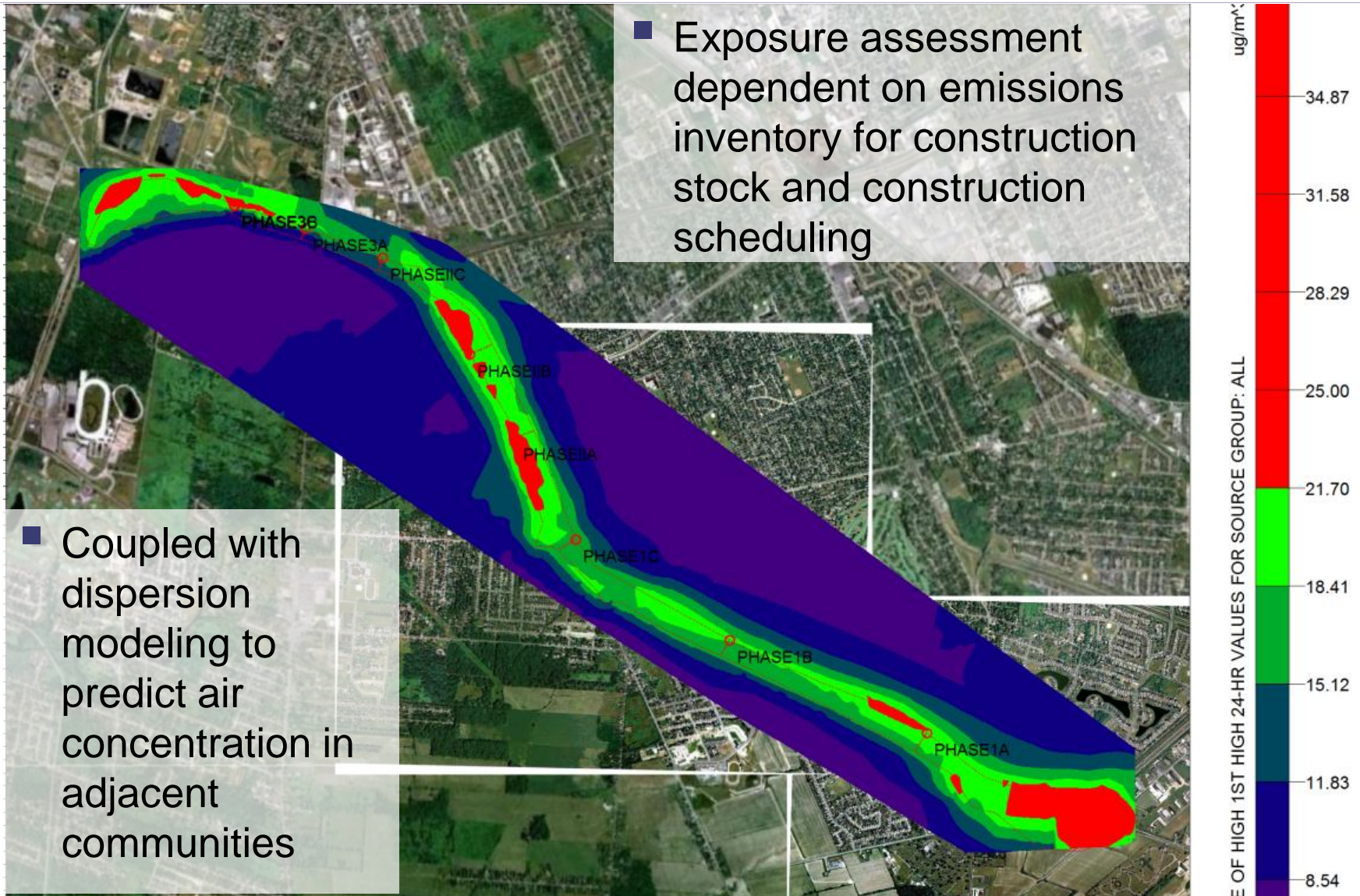
- Scope and intensity of construction
- Proximity to sensitive receptors (residential homes, parks, schools etc)
- The number of contaminants to be assessed
- Timing
- Uncertainty



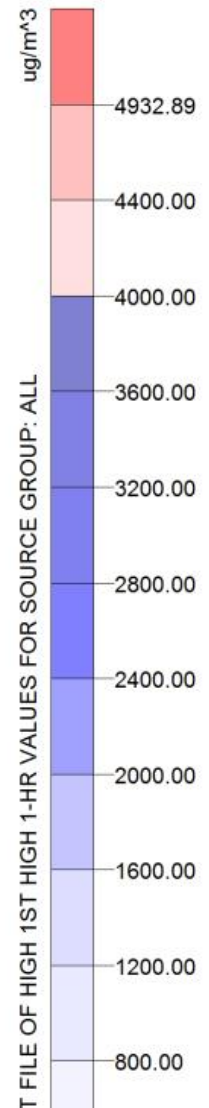
Approach

- Exposure assessment dependent on emissions inventory for construction stock and construction scheduling

- Coupled with dispersion modeling to predict air concentration in adjacent communities

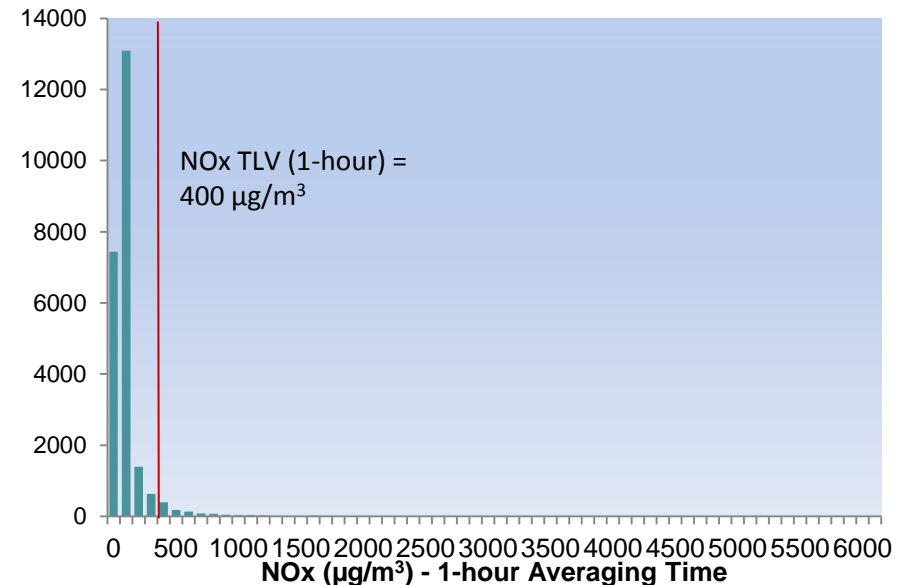


- Using conservative exposure assumptions only particulate matter ($PM_{2.5}$ and PM_{10}) and oxides of nitrogen (NO_x) had the potential to exceed air quality limits
 - HQs >17 for 1-hr exposure and >5 for 24-hr exposure
 - Acceptable air quality limits predicted to be exceeded 2-5% of the time
- As initial results were based on aggressive construction schedule, examined implications of alternate construction schedule on air quality impacts
- Additional modeling indicated that concentration of key pollutants decreased by 40% through changes to the construction schedule & an additional 45% by reducing the number of machines operating at any one time



Uncertainty and how it was addressed...

- Principal sources of uncertainty were exposure assessment and dose response assessment.
- In typical manner addressed uncertainty using conservative assumptions
 - Highest emissions coupled with poorest dispersion in 5-year meteorological dataset
- Evident by examining frequency and intensity of exposure – *exposure below criteria 95-98% of the time*



Accounting for uncertainty....

- Recognizing the potential for unacceptable health risks, choices were to refine exposure estimates (e.g. monitoring) or manage the risk accordingly.
- Chose the later – *used the results of the risk assessment to manage construction*
 - Developed alternate construction scheduling to avoid heavy concentration of activity in any one area
 - Accelerated the Phase in of Tier IV emission standards for off-road diesel engines
 - Adopted best management practices for dust control
 - Used on-road trucks for materials haulage
 - Idling policy
- *While uncertainty was recognized in the process, consequences could easily be addressed as part of the risk management recommendations.*

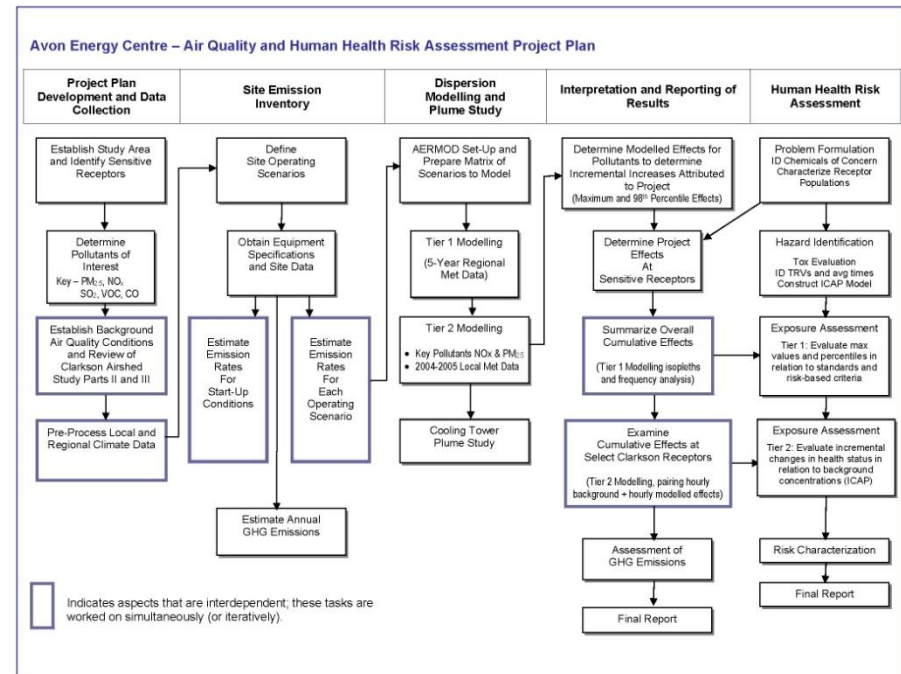
Case Study 2: Human Health Risk Assessment for a Natural Gas-Fired Generating Station

- HHRA completed in support of an EA for the permitting & construction of a natural gas-fired power generation facility
- Facility was to be located in “stressed” air shed with well organized and active community
- Key issue was regional air quality and the issue of cumulative effects



Approach

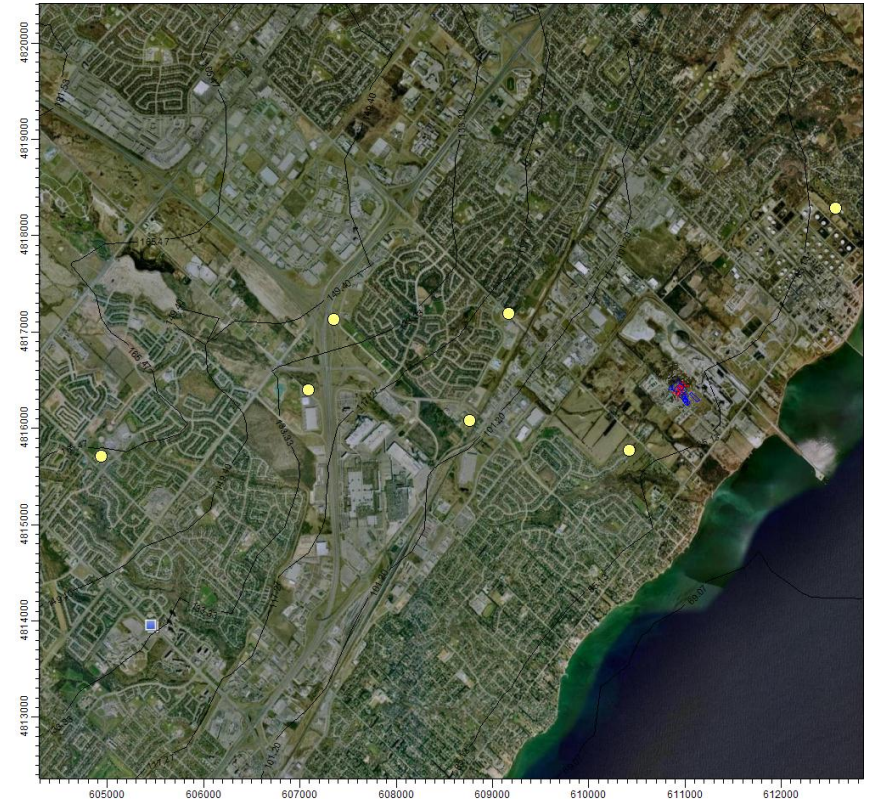
- Combination of emissions inventory and dispersion modeling to predict effects in neighbouring communities
 - Assessed exposure via direct inhalation and indirectly via soil deposition with subsequent uptake in garden vegetables
- Cumulative effects assessed using the *Illness Cost of Air Pollution* (ICAP) model.
 - Evaluates air quality on a regional scale against changes in health indicators measured on a population basis



- As before, principal areas of uncertainty are exposure assessment and toxicity
- Addressed through a series of conservative assumptions:
 - Person exposed to maximum ground level concentration continuously for a lifetime
 - For contaminants that partition from air to soil, deposition occurs at the maximal point of impingement for the lifetime of the project
 - Receptor is exposed simultaneously to maximal concentration in ambient air, soil, dust derived from soil and home grown produce.
- Uncertainties with ICAP include:
 - Relationships between air quality indicators and health outcomes not fully understood (i.e. relative contribution of various pollutants & modes of action)
 - Relies on annual average concentrations so does not account for short-term changes in air quality

Findings

- Exposure to at the *maximum point of impingement* was not predicted to result in unacceptable health risks (i.e. an $HQ > 1.0$ or 0.2 or and $ILCR > 10^{-6}$) via direct and indirect exposure pathways.
- ICAP Model predicts slight increase in hospital admissions and emergency department visits attributable to emissions from the facility (e.g. 2-3 additional visits or 0.5-2%).

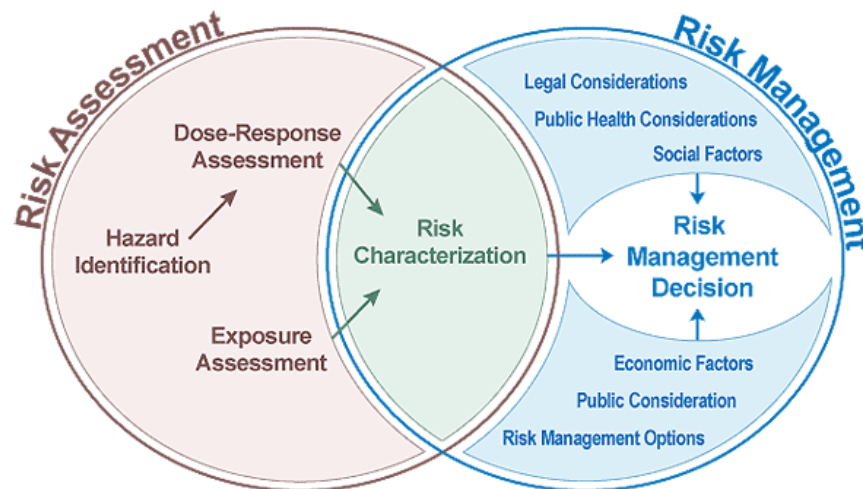


- Findings did not result in a need for risk management
 - No unacceptable risk associated with direct or indirect exposure
 - Incremental effects predicted by ICAP were deemed not significant in light of the uncertainties inherent in the model

- While uncertainties were as great or greater than with Windsor Essex parkway example, outcome in this example was different
 - Level of uncertainty acceptable in present case as significant risks not identified (or within acceptable margin of error) – *therefore conservative assumptions have no consequence*
 - With WEP, conservative assumptions identified significant incremental risks - *while the risk estimates could be refined, a simpler solution was to implement risk management based on the findings of the RA.*

Summary

- Risk assessment is a rigorous evaluation of the potential impacts to human and/or ecological receptors.
- Risk assessment helps identify the nature, source(s) and magnitude of risk associated with an undertaking
- Like any scientific exercise there is uncertainty in all aspects of the evaluation
- Uncertainty needs to be acknowledged, evaluated and adequately addressed as a critical component of the overall assessment



Thank You

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Stuart Bailey, PhD
Principal, Risk Assessment
Mississauga, ON
stuart.bailey@amec.com
T: 905.568.2929
C: 416.434.6916