

Air Toxic Inhalation: Overview of Screening-Level Health Risk Assessment for Garfield County

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Outline

PART–I: Overview of Risk Assessment Process

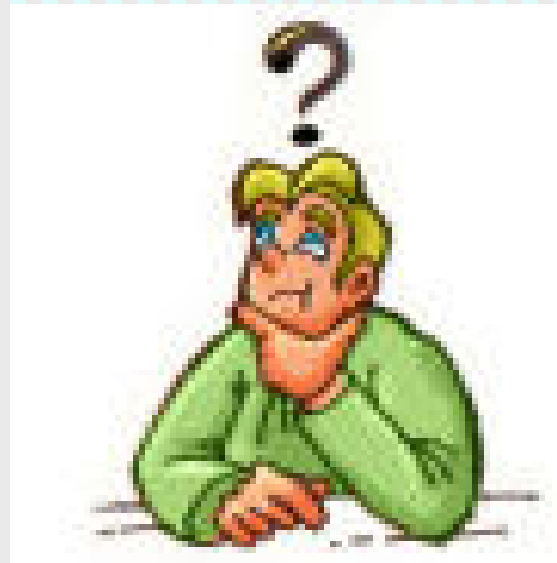
- What is risk assessment
- Benefits and limitations of risk assessment
- How to perform risk assessment
- EPA's Air Toxic Tiered Approach for Risk Assessment

PART–II: Screening-Level Risk Assessment for Garfield County

- Overview of monitoring/sampling
- Summary of Results
- Overview of Uncertainties
- Conclusions

PART-I

Risk Assessment Process



What Is Health Risk?

- A common definition of risk is the possibility of suffering harm or loss.
 - Health risk is the increased chance that an individual's health may be affected by exposure to a hazardous substance

Risk is estimated not measured

What Is Health Risk Assessment?

- A process to scientifically evaluate the increased chance (or likelihood) that adverse health effects will occur if people are exposed to toxics (or chemicals). It considers:
 - The exposure pathway(s)
 - The likelihood of adverse health effects
 - The expected types of health effects
 - The toxicity of individual chemicals

Risk assessment is not an exact science

What A Risk Assessment Cannot Do?

- It cannot determine whether adverse health effects have occurred or will occur as a result of site-specific chemicals.
- It cannot identify particular individuals likely to suffer health problems because of site contamination.

Risk assessment cannot predict an exact risk

What Do We Really Know About The Risks Related To Chemical Exposure?

- The precise health risk is not known.
- “Best Estimate” of the risk can be developed using:
 - Appropriate assumptions
 - Available data
 - Well established risk assessment methods

The risk estimate improves with more complete and reliable data

Why Can We Not Estimate An Individual's Risk?

- An individual's risk depends upon a number of factors:
 - The type of chemical
 - The amount of chemical (dose)
 - Duration of exposure to chemicals (e.g. in the air)
 - Other individual factors (e.g., age, gender, lifestyle, family traits, and state of health)

What Types Of Health Effects Are Estimated?

■ Cancer Effects

■ As risks

- Over a Lifetime

■ Non-Cancer or Systemic Effects

■ As hazards

- Chronic-Duration: 7 years to lifetime
- Subchronic –Duration: up to 7 years
- Intermediate-Duration: 15 to 364 days
- Acute-Duration: 1 to 14 days

Systemic effects involve the effects of chemicals on the nervous or reproductive systems or on organs (e.g., liver, kidney)

How Is Cancer Risk Estimated?

- **Excess Lifetime Cancer Risk** = The increased chance of getting cancer over a lifetime, from a chemical exposure.
 - Exposure conc. (Units of dose) x EPA's Air Unit Risk Factor (How much cancer per unit of dose) =
 - Increased probability of cancer = $1 \times 0.00001 = 0.00001$ or $1E-05$ or 1 in 100,000 (10 in a million)
- The level of cancer risk that is of concern is a matter of regulatory judgment:
 - Risk between 1 in a million ($1E-06$) and 100 in a million ($1E-04$) are considered to be acceptable by EPA.

Risk above 100 in a million is typically deemed large enough for intervention

How Are Non-Cancer Hazards Estimated?

- **Hazard Quotient (HQ)** = A comparison of an exposure concentration (e.g., 2 ug/m³) to a Reference concentration (e.g., 1 ug/m³) that is assumed to be "safe"
 - $HQ = 2/1 = 2.0$
- If the HQ is equal or less than a value of 1,
 - it is believed that there is no appreciable risk that non-cancer effects will occur
- If an HQ exceeds 1,
 - there is possibility of non-cancer effects.

HQ above 1 does not indicate that an effect will definitely occur

What Happens When Two or More Chemicals Are Evaluated?

- Risks are assumed to be additive when two or more chemicals are present:
 - **Total cancer risk** = The sum of cancer risk for more than one chemical
 - $\text{Risk}_T = \text{Risk}_1 + \text{risk}_2 + \dots \text{Risk}_i$
 - **Total non-cancer hazard** = Hazard Index (HI)
HI = The sum of more than one HQ for multiple chemicals
 - $\text{HI}_T = \text{HQ}_1 + \text{HQ}_2 + \dots \text{HQ}_i$

HI's >1 are segregated based on the major effects of each chemical

EPA Air Toxic Tiered Approach (EPA, 2004)

- Iterative process for systematic progression from a relatively simple to more complex risk assessment
 - **Tier-1**
 - Screening-level analysis with health protective conservative assumptions ("*Generic*")
 - **Tier-2**
 - Intermediate level analysis using more realistic assumptions ("*Intermediate realistic*")
 - **Tier-3**
 - Advanced analysis using site-specific assumptions and probabilistic statistical techniques ("*site-specific*")

Only Tier-1 Screening-Analysis Performed for Garfield County

PART-II
Garfield County
Screening-Level Risk Assessment



What Was The Purpose Of Screening-Level Risk Assessment?

- To determine if residents are exposed to air toxics that may pose unacceptable risks to human health.
 - Via inhalation
 - Of volatile organic compounds (VOCs)

Semi-VOCs and metals not sampled e.g., formaldehyde, polycyclic aromatic hydrocarbons, and manganese

Monitoring sites

Oil & Gas Sites	Oil & Gas Sites	Urban Sites	Rural Background Sites
Bell (N=24)	Isley (N= 20)	Glenwood Springs (N= 8)	Cox (N=8)
Brock (N= 22)	Sebold (N=21)	New Castle (N=21)	Daley (N=8)
Butterfly (N=21)	Thompson (N= 3)	Parachute (N=8)	
Haire (N=22)	West Landfill (N=23)	Rifle (N=23)	

Chemicals of Potential Concern (COPCs)

- 43 chemicals Analyzed (June 2005 to May 2007):
 - At 24-hour fixed samples
 - 28 chemicals never detected
 - At 15-second grab samples
 - 31 chemicals never detected

15 detected chemicals evaluated as COPCs

28 Chemicals Never Detected

Bromomethane	Carbon disulfide	Cis-1,3-Dichloropropene	4-Methyl-2-pentanone
Bromoform	Carbon tetrachloride	Trans- 1,3-Dichloropropene	Methyl tert-Butyl Ether
Bromo dichloromethane	1,1-Dichloroethene	1,2-Dibromoethane	Trichloro fluoroethane
Chloroform	1,1-Dichloroethane	Dibromochloro methane	1,1,2-Trichloroethane
Chloromethane	Cis- 1,2-Dichloroethene	1,3-Dichlorobenezene	1,1,1-Trichloroethane
Chloroethane	Trans- 1,2-Dichloroethene	1,2-Dichlorobenezene	1,1,2,2-tetrachloroethane
Chlorobenzene	1,2-Dichloropropane	1,2-Dibromoethane	Vinyl chloride

List of 15 Detected COPCs

Acetone	2-Hexanone	Tetrachloroethylene
Benzene	Methylene chloride	Toluene
2-Butanone	Styrene	Vinyl acetate
Chloromethane	Trichlorofluoromethane	O-Xylene
Ethylbenzene	Trichloroethylene	m, p-Xylene

Most Commonly Detected COPCs

- Benzene
- Toluene
- Acetone
- Vinyl acetate
- 2-Butanone
- M,p-Xylene

Trends Across Three Areas

- Different COPCs are identified across the three areas.
 - Benzene across all sites except one rural site
 - Trichloroethylene only at one urban site
- Potential health impacts appear to be the lowest across the rural background area.
- Benzene is the largest contributor to non-cancer hazards across all three areas.

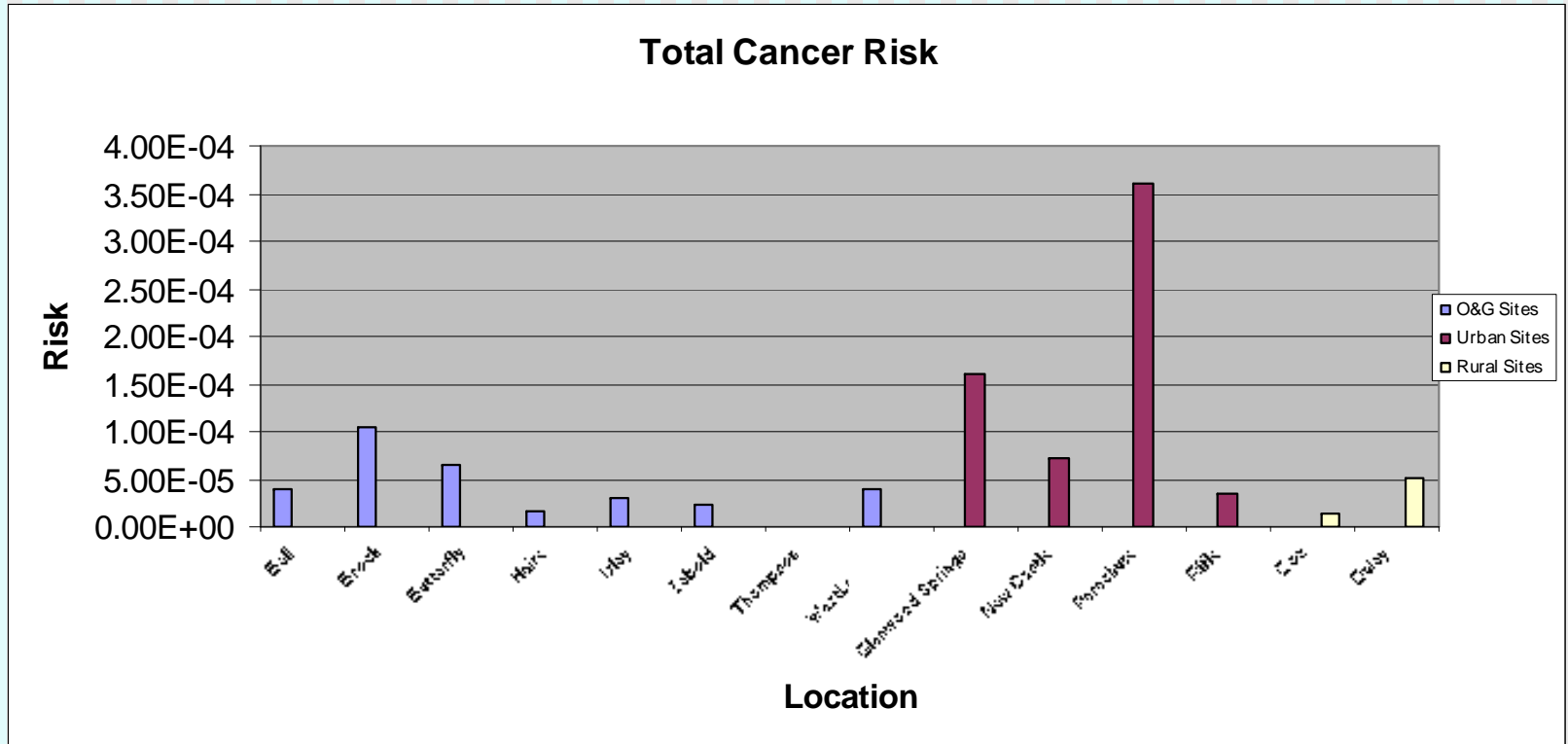
Estimates of cancer risk and non-cancer hazards for benzene are highest in the Oil & Gas area

Cancer Risk Estimates And Drivers

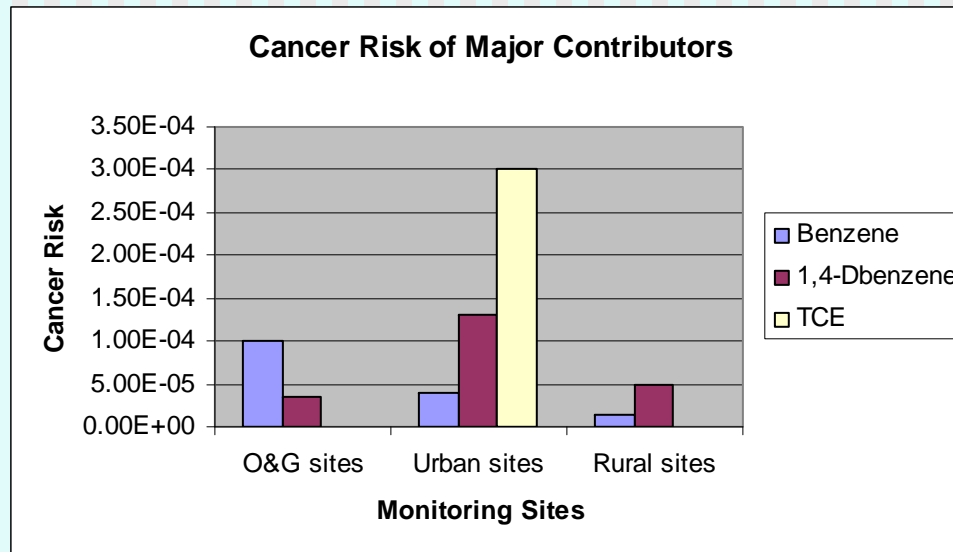
- Highest risk estimates are at, or slightly above, the upper-end of EPA acceptable range (1 to 100 excess cancers per million)
- The largest contributors to cancer risk are:
 - Benzene – Oil & Gas area (104 in a million)
 - Trichloroethylene – Urban area (300 in a million)
 - 1,4-dichlorobenzene – Rural Background area (50 in a million).

Benzene cancer risks (Proven human carcinogen) are somewhat higher in the O&G area than those across urban and rural areas

Comparison Of Total Cancer Risk Across Three Areas



Comparison Of Cancer Risk Drivers Across Three Areas



Estimates Of Chronic Non-Cancer Hazards

- Acceptable for all chemicals across the three areas.
 - $HI = 0.006$ to 0.6 (below the acceptable level of 1.0).
 - Benzene $HQ = 0.4$ (Oil & Gas area)

$HI < 1$ indicates that adverse non-cancer effects are not likely to occur under chronic exposures (7 years to lifetime)

Short-Term Non-Cancer Hazards (Average)

- A plausible range of hazards estimated (average to high-end).
- Across the three areas, the **average** exposures **acceptable** for for all chemicals :
 - Acute HIs = 0.001 to 0.5
 - Benzene Acute HQ=0.4 (Oil & Gas area)
 - Intermediate HIs = 0.0 to 0.8
 - Benzene Intermediate HQ=0.7 (Oil & Gas area)

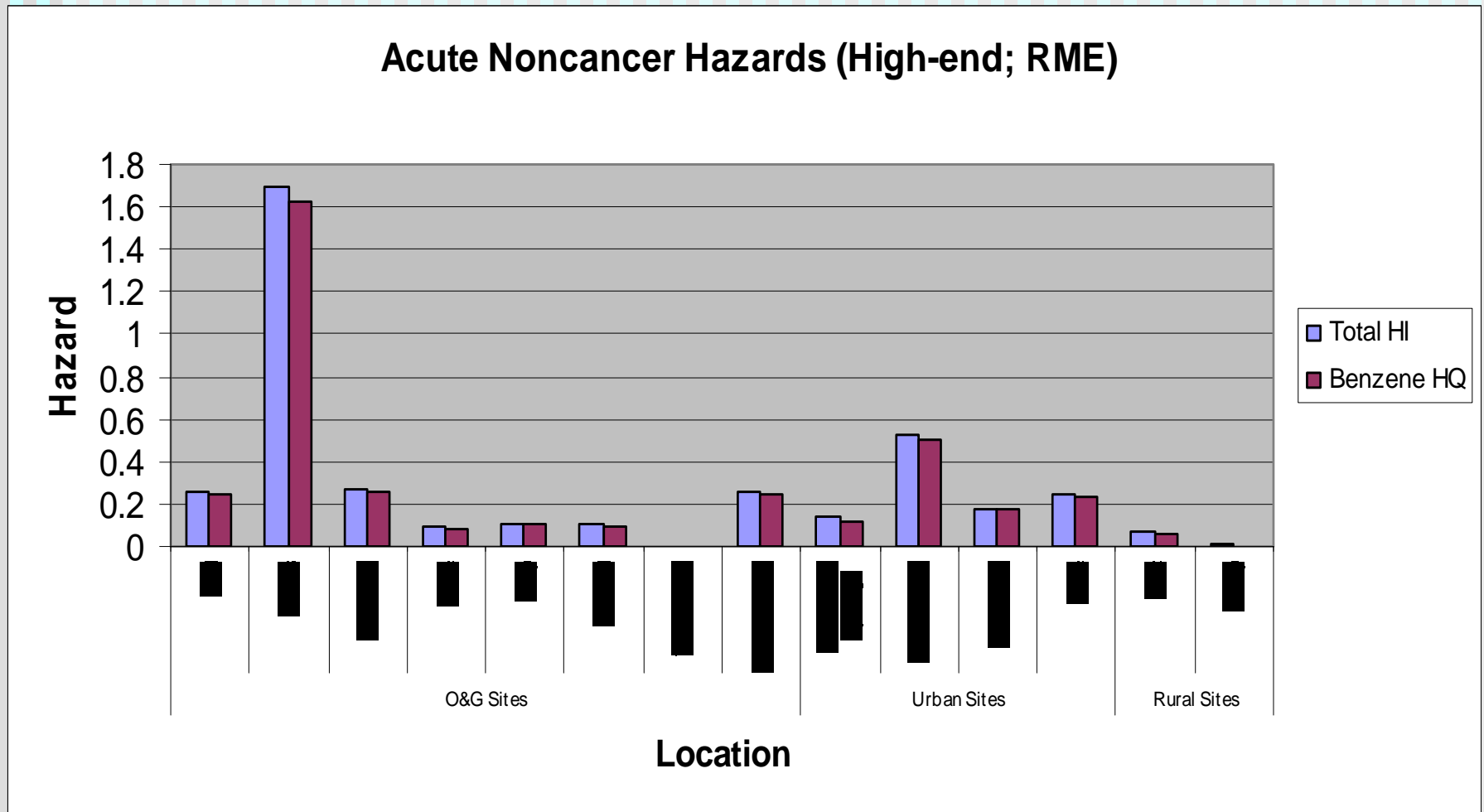
HI < 1 indicates that adverse non-cancer effects are not likely to occur under average short-term exposures (1-364 days)

Short-Term Non-Cancer Hazards (High-End)

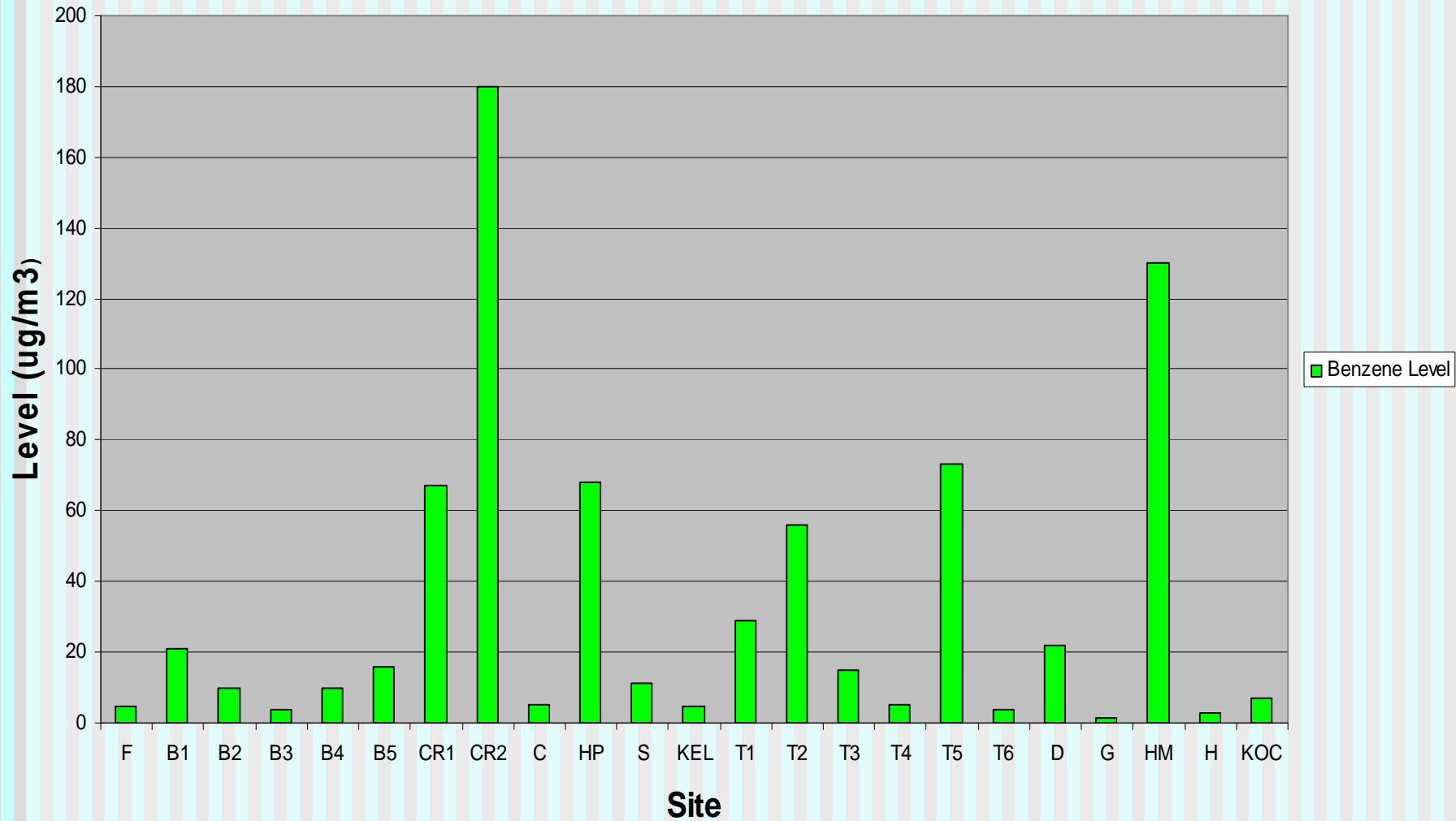
- Across Oil & Gas area, the **high-end** exposures **exceeded** acceptable level of 1.0 for benzene.
 - Benzene Acute /Intermediate HQ = 2 to 3 (Oil & Gas area)
 - Benzene Acute HQ = 2 to 6 (at six grab locations)

Elevated HQ for benzene indicates increased potential for immune system effects under high-end exposures of 1-364 days

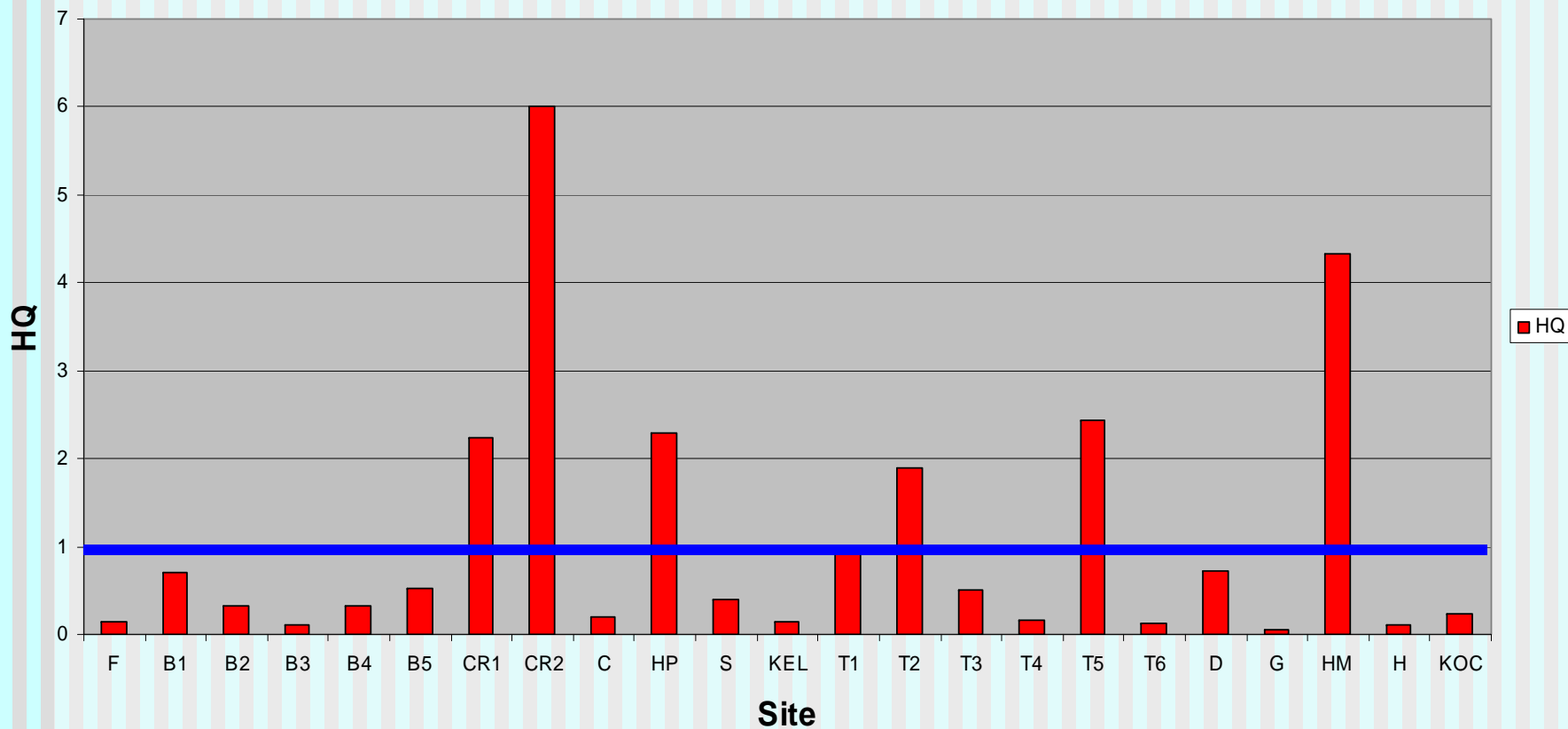
Comparison of Acute Non-Cancer Hazards Across Three Areas



Benzene Level in Grab Samples (at 25 sites)



Benzene Hazard (Acute High-End) in Grab Samples (at 25 sites)



Major Sources Of Uncertainty

■ Monitoring data

- Some assumptions may lead to over or under-estimation of potential risks.
 - location of monitors
 - Frequency of data collection- once a month or once a quarter
- Some assumptions may lead to underestimation of potential risks.
 - Limited number of chemicals monitored

Major Sources Of Uncertainty

Monitoring data (cont.)

- Some assumptions may over-estimate the high-end non-cancer hazards for acute and intermediate exposures
 - Use of the 24-hour maximum concentration to estimate 1-14 days acute exposures and 15-364 days intermediate exposures.
 - Use of the 15-second maximum concentration (grab samples) to estimate 1-14 days acute exposures.

Overall uncertainty errs on the side of health protection due to exposure assumptions

Conclusions

- The limited available data are somewhat indicative of potential for benzene impacts across the Oil & Gas area, based on the results at the Brock site and at grab sampling locations.
 - The highest estimated benzene cancer risk is at the high-end of EPA's acceptable range (cancer risk at Brock=104 in a million).
 - The high-end short-term non-cancer hazards for benzene are above acceptable level of 1.0 (HQs at Brock and six grab locations=2 to 6).

**More data are needed for the
"Best Reasonable Estimate" of risk**

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