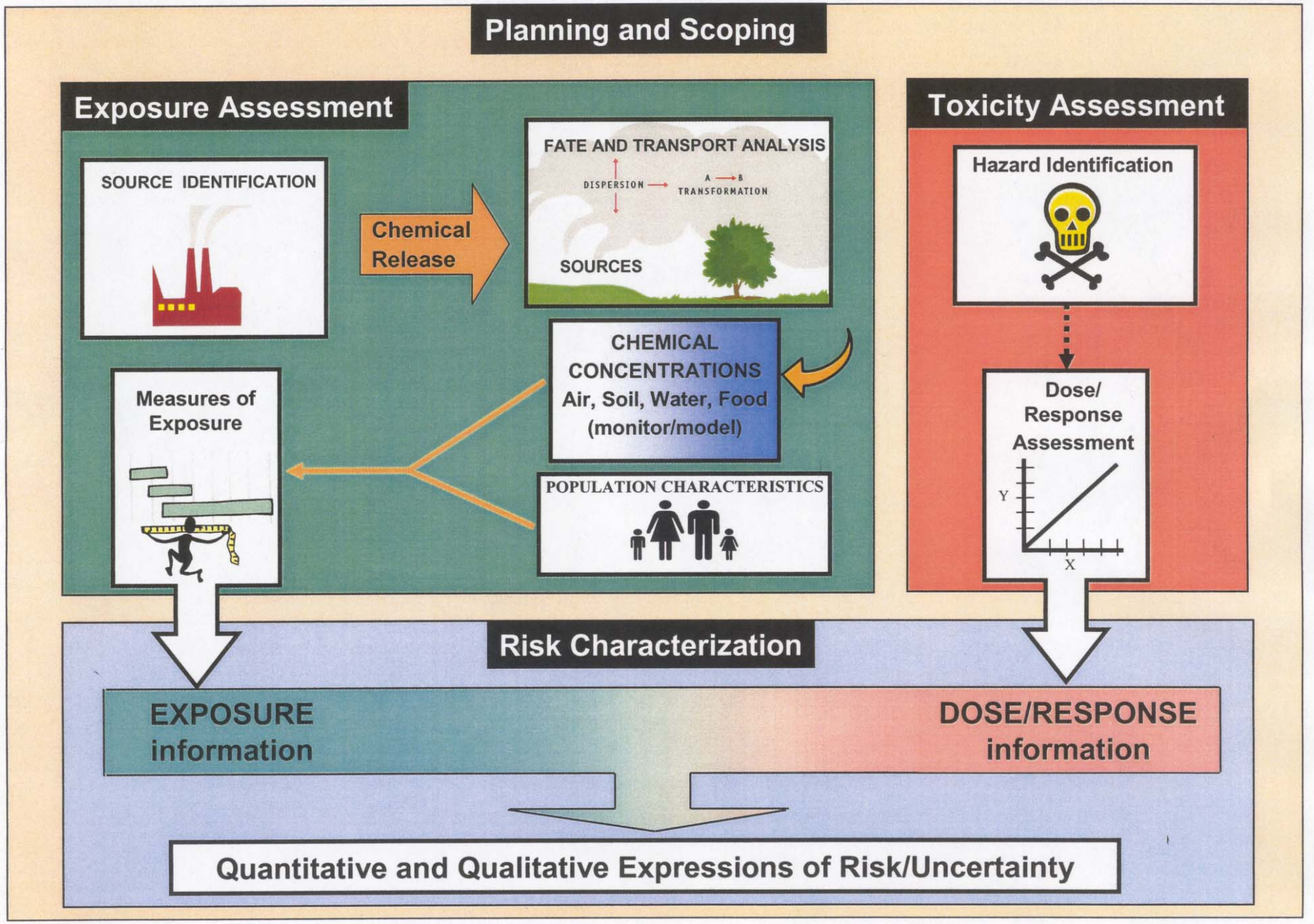

Greetings from
SUNNY, WARM,
MIAMI, FLORIDA !

Air Toxics Risk Assessments

Miami-Dade County Studies

Presented by Carl Pfaffenberger

The Detailed Air Toxics Risk Assessment Process



Work Plan

Using Stainless Steel Canisters, collect 24-hour ambient air samples every 6 days over a year's time from two Miami-Dade County locations situated about 20 miles apart. Have the samples analyzed by gas-chromatographic/mass spectrometric EPA Method TO-15NC; and then perform risk assessments using gc/ms analytical results.

Hazardous Air Pollutants Detected

11 DiClEthane
11 DiClEthene
111 TriClEthane
112 TriClEthane
1122 TetClEthane
12 DiBrEthane
12 DiClBenzene
12 DiClEthane
12 DiClPropane
124 TriClBenzene
124 TriMetBenzene
13 Butadiene
13 DiClBenzene
135 TriMetBenzene
14 DiClBenzene
Acrylonitrile
Benzene
Bromomethane
Carbon Tetrachloride
Chlorobenzene

Hazardous Air Pollutants Detected (contd.)

Chloroethane	Chloroform
Chloromethane	*cis*12DiClEthene
*cis*13DiClPropene	DiClDiFlMethane
Ethylbenzene	Freon® 11
Freon® 113	Freon® 114
HexCl13Butadiene	meta+para Xylene
Methylene Chloride	ortho Xylene
Styrene	TetClEthene
Toluene	*trans*12DiClPropene
TriClEthene	Vinyl Chloride

Mean Levels differing by no more than 15%:

11 DiClEthane

x 111 TriClEthane

1122 TetClEthane

12 DiClBenzene

x 12 DiClPropane

124 TriMetBenzene

13 DiClBenzene

14 DiClBenzene

x Benzene

Carbon Tetrachloride

11 DiClEthene

x 112 TriClEthane

12 DiBrEthane

12 DiClEthane

124 TriClBenzene

13 Butadiene

x 135 TriMetBenzene

Acrylonitrile

Bromomethane

Chlorobenzene

Mean Levels differing by no more than 15%:

Chloroethane	x Chloroform
Chloromethane	*cis12DiClEthene*
cis13DiClPropene	*DiClDiFlMethane*
x Ethylbenzene	*Freon® 11*
x Freon® 113	x Freon® 114
HexCl13Butadiene	x meta+para Xylene
x Methylene Chloride	x ortho Xylene
x Styrene	*TetraClEthene*
x Toluene	*trans12DiClPropene*
x TriClEthene	*Vinyl Chloride*

Identification of COPCs

A Chemical of Potential Concern (a COPC) is one which is detected at a sampling site above its SQL* at least 10% of the time.

Thus the detection frequency at each of the sampling sites (Perdue and WASD) was determined for each of the 40 HAPS found.

*SQL = Standard Quantitation Limit

Chemicals of Potential Concern (COPCs)

- 11 DiClEthane
- 111 TriClEthane
- 1122 TetClEthane
- 12 DiClBenzene
- 12 DiClPropane
- *124 TriMetBenzene(W)*
- 13 DiClBenzene
- 14 DiClBenzene
- *Benzene(W&P)*
- Carbon Tetrachloride
- 11 DiClEthene
- 112 TriClEthane
- 12 DiBrEthane
- 12 DiClEthane
- 124 TriClBenzene
- 13 Butadiene
- 135 TriMetBenzene
- Acrylonitrile
- Bromomethane
- Chlorobenzene

Chemicals of Potential Concern (COPCs)

Chloroethane

- *Chloromethane(W&P)*

*cis*13DiClPropene

- *Ethylbenzene(W)*
- *Freon® 113(P)*

HexCl13Butadiene

- *Methylene Chloride(W&P)*
- *Styrene(W)*
- *Toluene(W&P)*

TriClEthene

Chloroform *(contd.)*

*cis*12DiClEthene

- *DiClDiFlMethane(W&P)*
- *Freon® 11(W&P)*
- *Freon® 114(W&P)*
- *meta+para Xylene(W)*
- *ortho Xylene(W&P)*

TetClEthene

*trans*12DiClPropene

Vinyl Chloride

Summary of Types of *COPCs* Found

5 Refrigerants producing no known direct human health consequence from chronic exposure – the *Freons® (11, 12, 113, and 114)* and *Chloromethane* refrigerant.

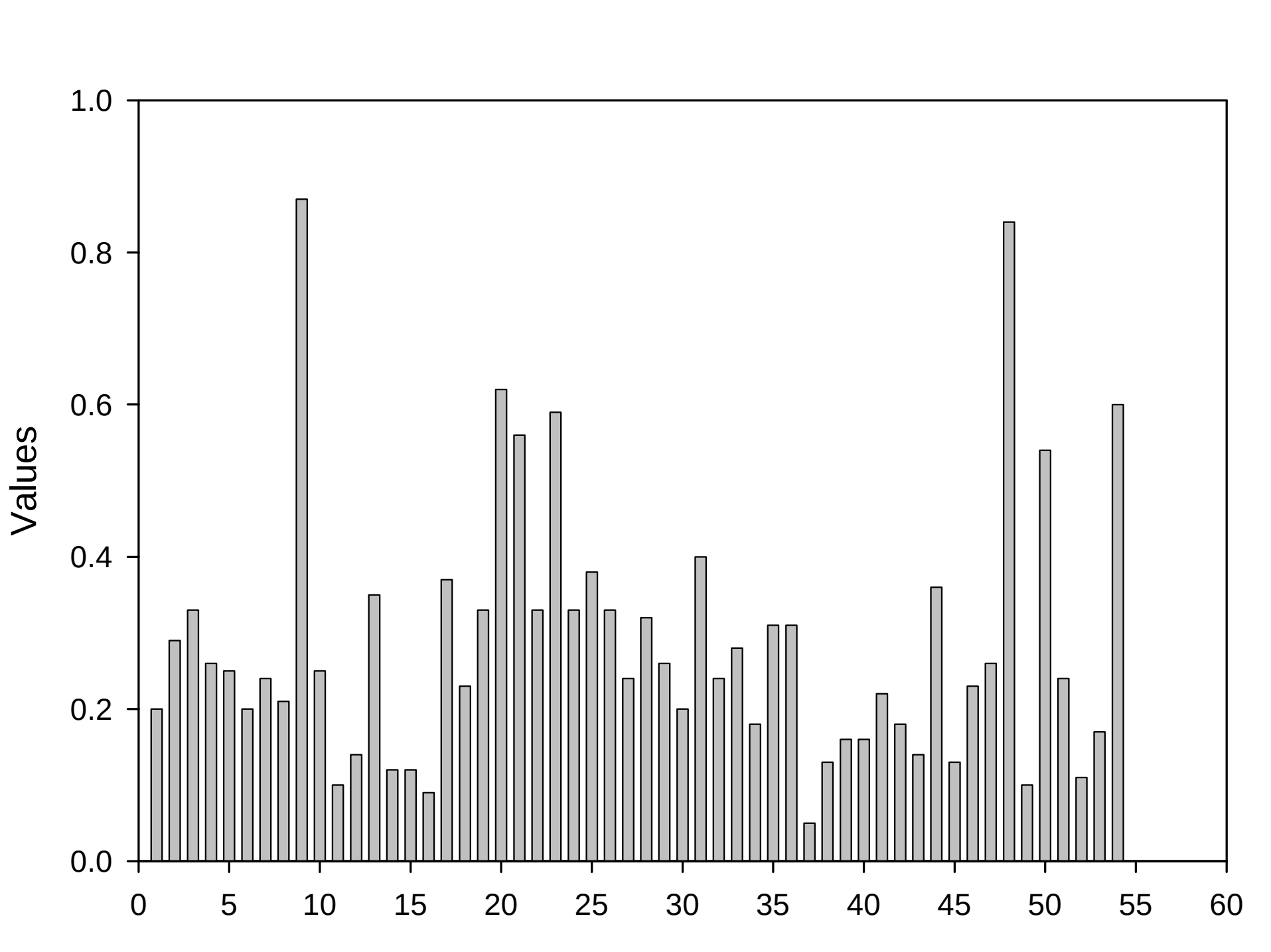
7 Common aromatic automobile fuel vapors – 3 *Xylenes, Toluene, Ethylbenzene, Benzene* and *1,2,4-Trimethylbenzene.*

2 Possible health hazards – *Styrene* & *Methylene Chloride.*

Benzene Statistics*	WASD	PERDUE
No. of Observations (No. of Detections)	63	54
Min. Value (ppbv)	0.06	0.05
Max. Value (ppbv)	0.97	0.87
Mean (ppbv)	0.4125	0.2861
Median (ppbv)	0.36	0.245
Std. Dev.	0.2097	0.1738
Coefficient of Variation	0.5085	0.6074
Skewness	1.044**	1.615**
Variance	0.044	0.0302

*"Normal" Calculations

**Suggests Non-Normality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0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60

Non-Parametric Data Sets

Use of computer software provided by the EPA, ***e.g.*, *ProUCL***, indicated that all data sets of the COPCs quantified in the Miami-Dade Air Toxics Monitoring Program were non-parametric and skewed in the positive (+) direction. Since this was the case, it was necessary to resort to alternative methods of arriving at an **U**pper **C**onfidence **L**evel of the population mean. Several options, while non-ideal, can be used to arrive at a reasonable approximation of this value, but the best was found to be Chebyshev (Mean, Std) Values.

WASD Air Toxics Levels

Risk Assessed HAP	Mean Value – Norm. Stats. (in mg/cu.m)	Chebyshev (Mean Std) Value* (in mg/cu.m)
1,2,4-TrimethylBenzene	0.0010425	0.002175
Benzene	0.0013404	0.002523
Ethylbenzene	0.0008082	0.001645
meta+para Xylene	0.003307	0.005127
Methylene Chloride	0.003353	0.006831
Styrene	0.0005035	0.003896
Toluene	0.005574	0.011131
		*All Higher Values

Perdue Air Toxics Levels

Risk Assessed HAP	Mean Value – Norm. Stats. (in mg/cu.m)	Chebyshev (Mean Std) Value* (in mg/cu.m)*
1,2,4-TrimethylBenzene	0.0009105	0.001331
Benzene	0.0009297	0.001816
Ethylbenzene	0.000545	0.001084
meta+para Xylene	0.002016	0.002833
Methylene Chloride	0.004678	0.008478
Styrene	0.001444	0.015221
Toluene	0.002816	0.006073
		*All Higher Values

To Calculate Human Non-Cancer Risk from Chronic Inhalation of a HAP:

Use the equation EC (µg/cu.m) / R*f*C (µg/cu.m)*

For benzene at the Perdue Site, using Normal Mean Statistics:

0.9297 / 30 = 0.031 => no non-cancer risk

For benzene at the Perdue Site, using Chebyshev Statistics:

1.816 / 30 = 0.061 => no non-cancer risk

*EC = Exposure Concentration & R*f*C = Reference Concentration

To Calculate Human Cancer Risk from Chronic Inhalation of a HAP:

Use the equation EC (µg/cu.m) x IUR (risk/µg/cu.m)*

For benzene at the Perdue Site, using Normal Mean Statistics:

0.9297 x 7.8E-06 => cancer risk of 7E-6 or 7 in a million

For benzene at the Perdue Site, using Chebyshev Statistics:

1.816 x 7.8E-06 => cancer risk of 14E-6 or 14 in a million

*EC = Exposure Concentration & IUR = Inhalation Unit Risk

Air Toxics Risk Assessment Using OAQPS' Recommended Dose Response "Value Table" and WASD Sampling Site Concentrations

Miami-Dade COPC (**WASD** Site)	WOE for Cancer EPA	WOE for Cancer IARC	Non-Cancer (mg/cu.m)	Source	Cancer (1/µg/cu.m)	Source
Benzene	A	1	0.03	IRIS	7.8E-06	IRIS
Risk from Benzene:			0.045(0.084)**		10E-6(20E-6)** 10(20) in a million	
Ethylbenzene	D	--	1	IRIS	--	--
Risk from Ethylbenzene:			0.00081(0.0016)		0	
Methylene chloride	B2	2B	1	ATDSR	4.7E-07	IRIS
Risk from Methylene chloride:			0.0034(0.0068)		2E-6(3E-6) 2(3) in a million	
Styrene	--	2B	1	IRIS	--	--
Risk from Styrene:			0.00050(0.0039)		0	

Air Toxics Risk Assessment Using OAQPS' Recommended Dose Response "Value Table" and WASD Sampling Site Concentrations

Miami-Dade COPC (WASD Site)	WOE for Cancer EPA	WOE for Cancer IARC	Non-Cancer (mg/cu.m)	Source	Cancer (1/µg/cu.m)	Source
Toluene	D	3	0.4	IRIS	--	--
Risk from Toluene:			0.014(0.028)		0	
1,2,4-Trimethylbenzene (Cumene as surrogate)	D	--	0.4	IRIS	--	--
Risk from 1,2,4-Trimethylbenzene:			0.0026(0.0054)		0	
Xylenes	--	--	0.1	IRIS	--	--
Risk from the Xylenes:			0.033(0.051)		0	

Total Risks: HI: 0.099(0.18) or 0 Total CA: 12(23) million

Air Toxics Risk Assessment Using OAQPS' Recommended Dose Response "Value Table" and Perdue Sampling Site Concentrations

Miami-Dade COPC (Perdue Site)	WOE for Cancer EPA	WOE for Cancer IARC	Non-Cancer (mg/cu.m)	Source	Cancer (1/µg/cu.m)	Source
Benzene	A	1	0.03	IRIS	7.8E-06	IRIS
Risk from Benzene:			0.031(0.061)**		7E-6(14E-6)** 7(14) in a million	
Ethylbenzene	D	--	1	IRIS	--	--
Risk from Ethylbenzene:			0.00055(0.0011)		0	
Methylene chloride	B2	2B	1	ATDSR	4.7E-07	IRIS
Risk from Methylene chloride:			0.0047(0.0085)		2E-6(4E-6) 2(4) in a million	
Styrene	--	2B	1	IRIS	--	--
Risk from Styrene:			0.0014(0.015)		0	

Air Toxics Risk Assessment Using OAQPS' Recommended Dose Response "Value Table" and Perdue Sampling Site Concentrations

Miami-Dade COPC (Perdue Site)	WOE for Cancer EPA	WOE for Cancer IARC	Non-Cancer (mg/cu.m)	Non-Cancer Source	Cancer (1/µg/cu.m)	Cancer Source
Toluene	D	3	0.4	IRIS	--	--
Risk from Toluene:			0.0070(0.015)		0	
1,2,4-Trimethylbenzene (Cumene as surrogate)	D	--	0.4	IRIS	--	--
Risk from 1,2,4-Trimethylbenzene:			0.0023(0.0033)		0	
Xylenes	--	--	0.1	IRIS	--	--
Risk from the Xylenes:			0.020(0.028)		0	
Total Risks:			HI: 0.067(0.13) or 0		Total CA: 9(18) / million	

Ideally experimental exposure should be made to take place over the entire lifetime of the organism for which adverse effects are predicted. Inasmuch as the adult laboratory rat lives about two years, and human exposure can be for as much as 70 years or more, safety factors must be introduced into any final assessment. Additional safety factors used to protect developing embryos, fetuses, newborn infants, the immunity compromised, and the aged can skew the assessment far into the ultra conservative arena. Moreover, since human activity and highly probable mobility allow for periods during which "decontamination" can occur, an assumption that an exposed individual constantly remains at the point of maximum exposure for his lifetime tends to greatly over-estimate the deleterious effects expected from the exposure. Then there is the problem of biochemical variability among humans, high and low sensitivity to chemical insults (exposures) & the like.

Seven COPCs were identified, and as discussed in this report, only benzene and methylene chloride appeared of real concern. Methylene chloride results may be inaccurate due to the (often) confounding variable of laboratory use of it as a solvent from time to time. However, inasmuch as dichloromethane has been classified as a B2 carcinogen by the EPA and as a 2B carcinogen by the IARC, it was included in the risk analyses. Benzene is an A[EPA] or 1[IARC] carcinogen.

For both sampling locations, HIs (Hazard Indices) of 0 were determined, even when Chebyshev statistics were used to calculate the chemical's mean values.

Both sampling stations suggested increased cancer risk from lifetime human exposures. Use of Normal Mean Values in the calculations led to increased risk of cancer (all types) of 9 in a million around the Perdue site and 12 in a million around the WASD site. When Chebyshev Statistics were used in the calculations, an increase to 18 in a million was predicted around the Perdue site and 23 in a million around the WASD site. These possible increases are well within those currently allowed by the EPA as predictions even as high as one in ten thousand are sometimes allowed.

As a final note, ultimate human cancer morbidity to all causes of the disease is 1 in 3 in America, 1 in 4 Americans of which will suffer cancer mortality.

Recognition of Collaborators

Dr. Ken Mitchell ☺ Dr. Ken Mitchell ☺ Dr. Mitchell

☺ Patrick Wong ☺ Patrick Wong ☺ Patrick Wong ☺

☺ Debbie Griner ☺ Debbie Griner ☺ Debbie Griner ☺

☺ Broward County Environmental Laboratory ☺