A Tier 2 Approach to Address Trace PAH Soil Impacts

Craig Harris (AECOM)

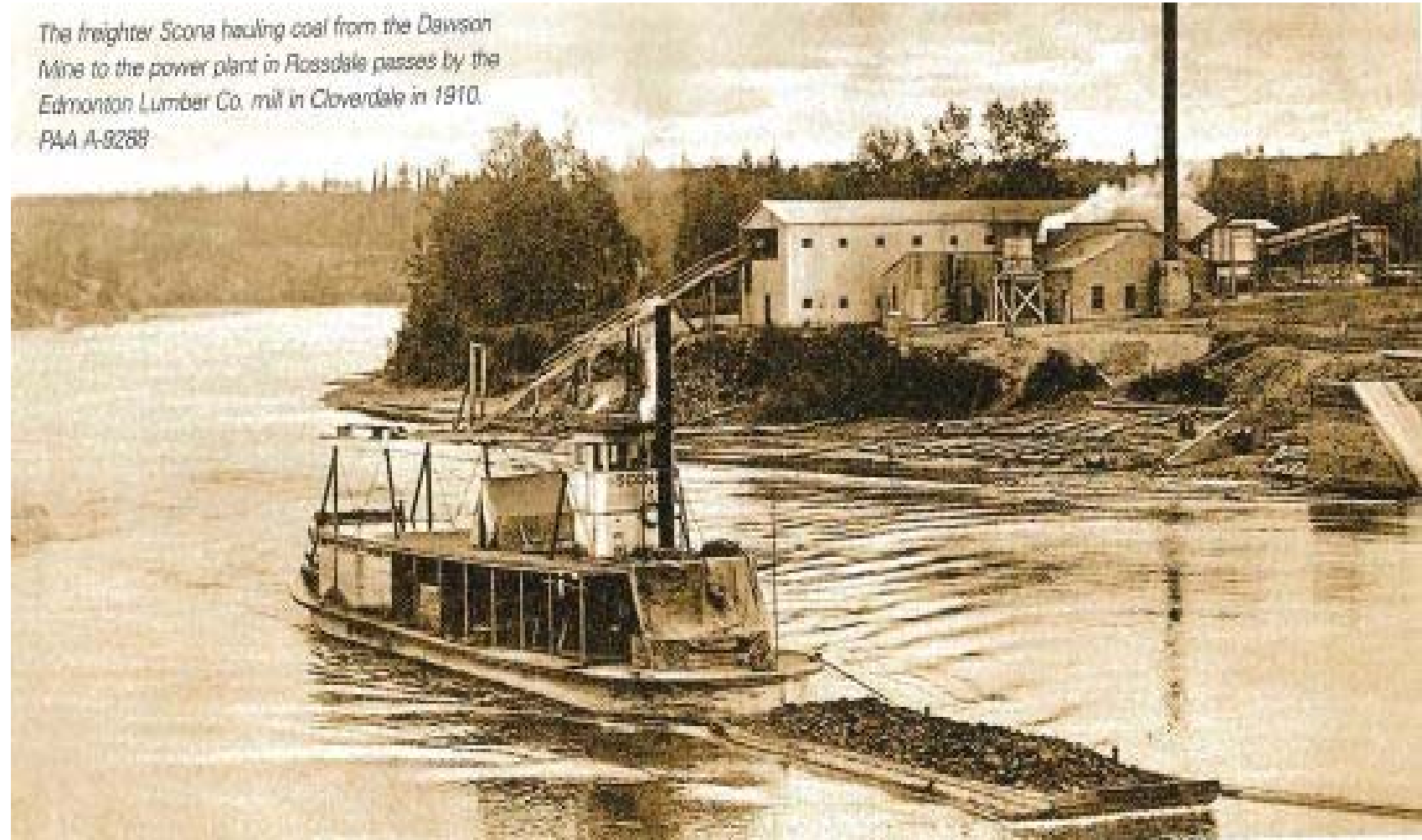Tami Dolen (City of Edmonton)

October16, 2015

Outline

- Historical Activities and Study Sites

- Municipal Driver & Regulatory Objectives

- Soil Characteristics

- CCME PAH Guidelines (FWAL)

- Results of Tier 2 Leachate Approach

- Optional Tier 2 Approaches for Impacted Groundwater

- Conclusions: Tier 2 Leachate Approach

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Historical Activities in North Saskatchewan River Valley

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The freighter Scona hauling coal from the Dawson Mine to the power plant in Rossdale passes by the Edmonton Lumber Co. mill in Cloverdale in 1910. PAA A-9288

Historical Activities in North Saskatchewan River Valley

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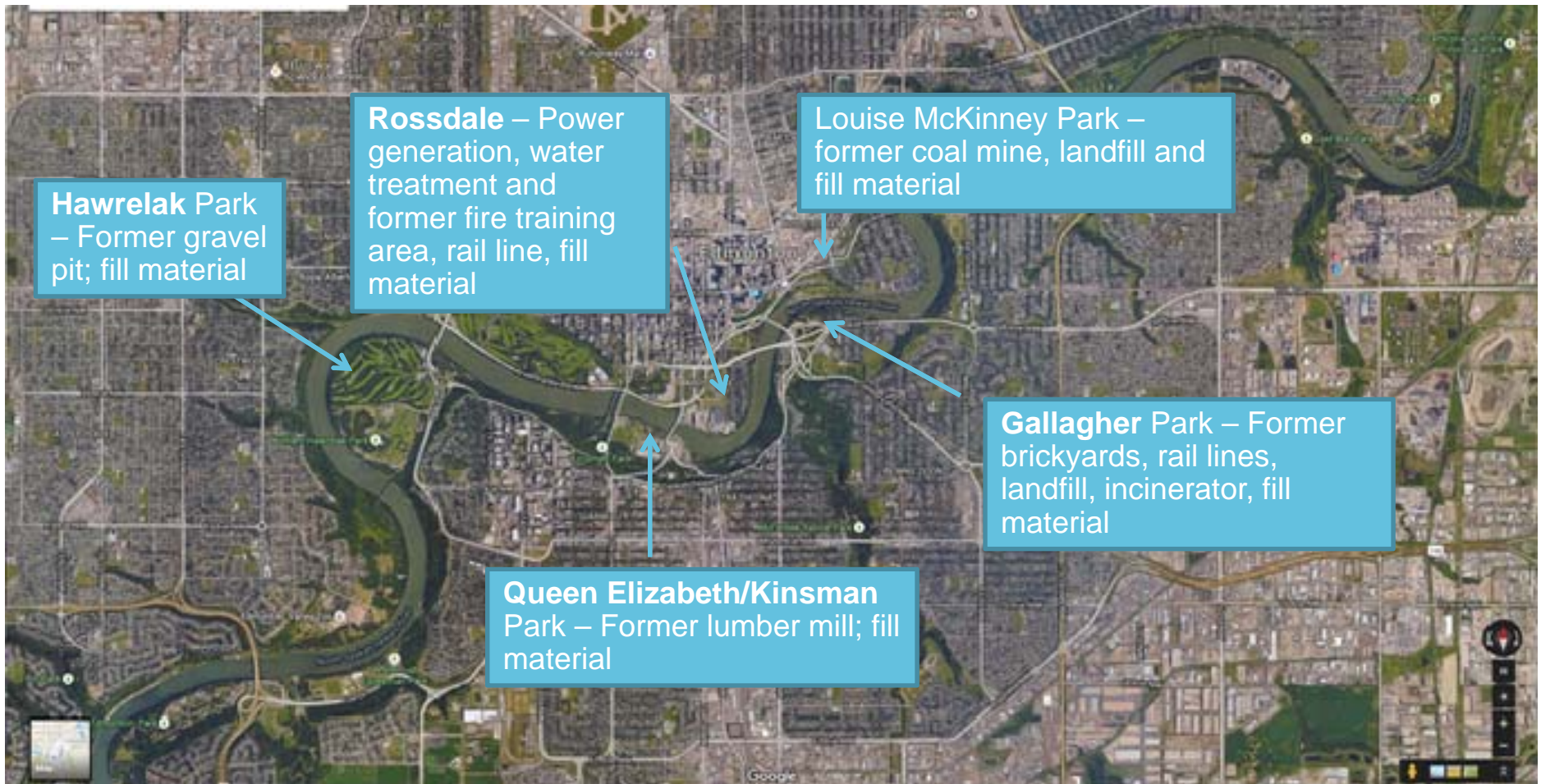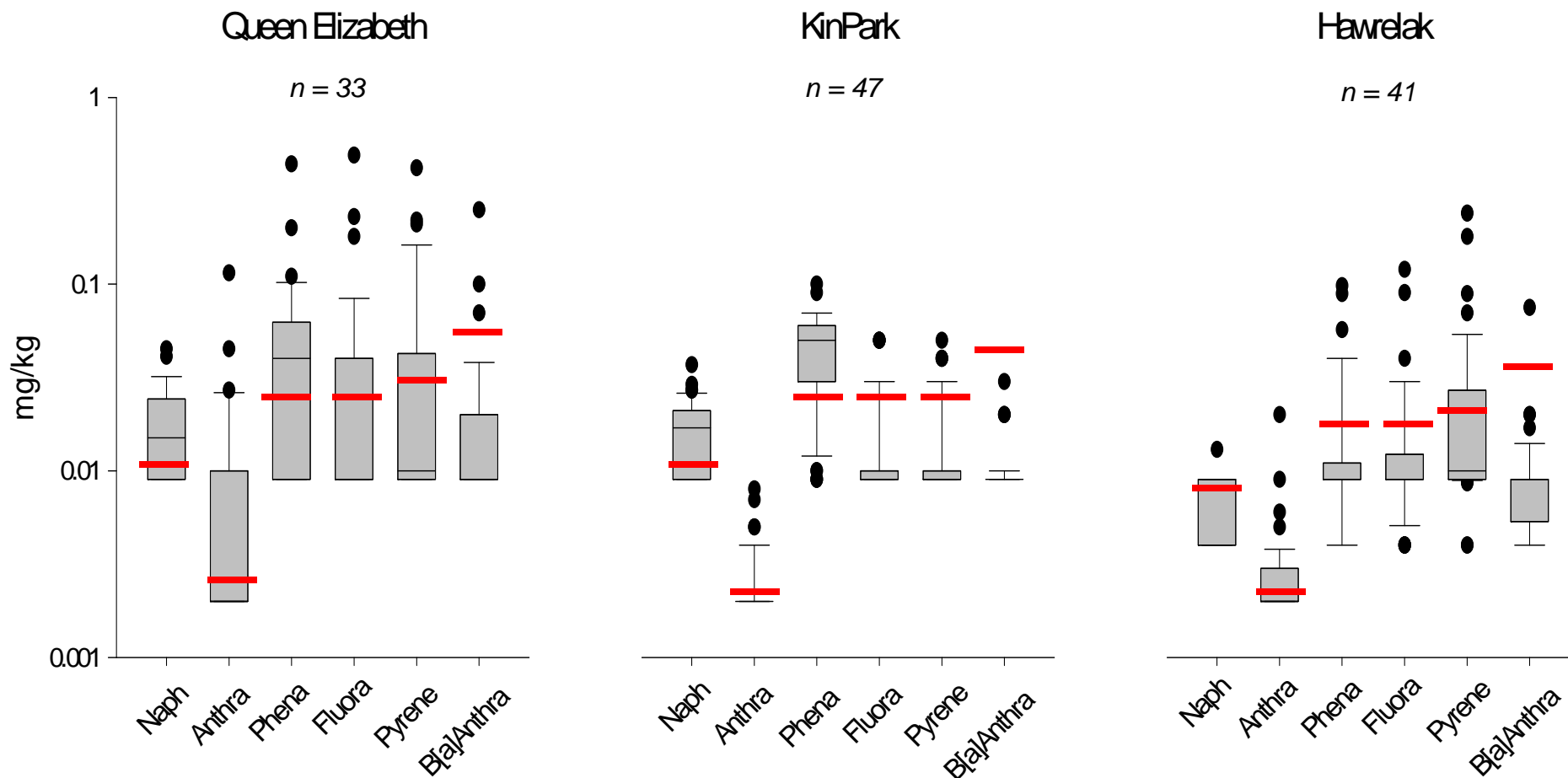# Historical Activities in North Saskatchewan River Valley

The Anderson brickyard in 1914, the year it was shut down because the owner went off to war. The millions of red bricks that were cut and baked from the clay of the flat were used to build countless buildings in Alberta, B.C. and even Ontario. Mill Creek runs under the bridge in the foreground. NC-6-1015

River Valley Parks and Historical Activities

Hawrelak Park – Former gravel pit; fill material

Rossdale – Power generation, water treatment and former fire training area, rail line, fill material

Louise McKinney Park – former coal mine, landfill and fill material

Gallagher Park – Former brickyards, rail lines, landfill, incinerator, fill material

Queen Elizabeth/Kinsman Park – Former lumber mill; fill material
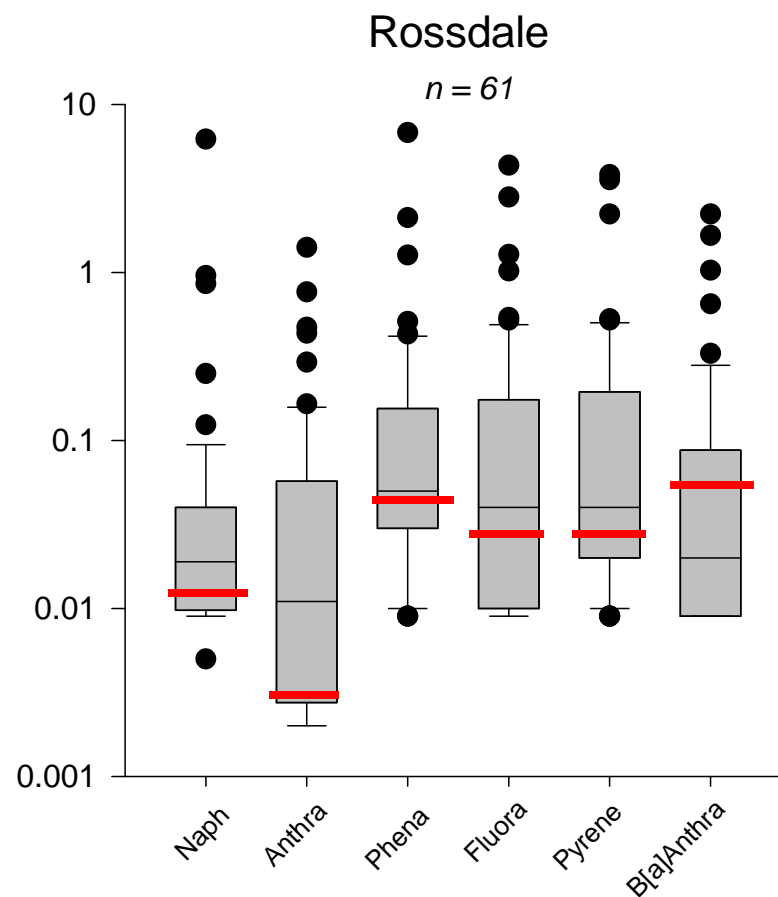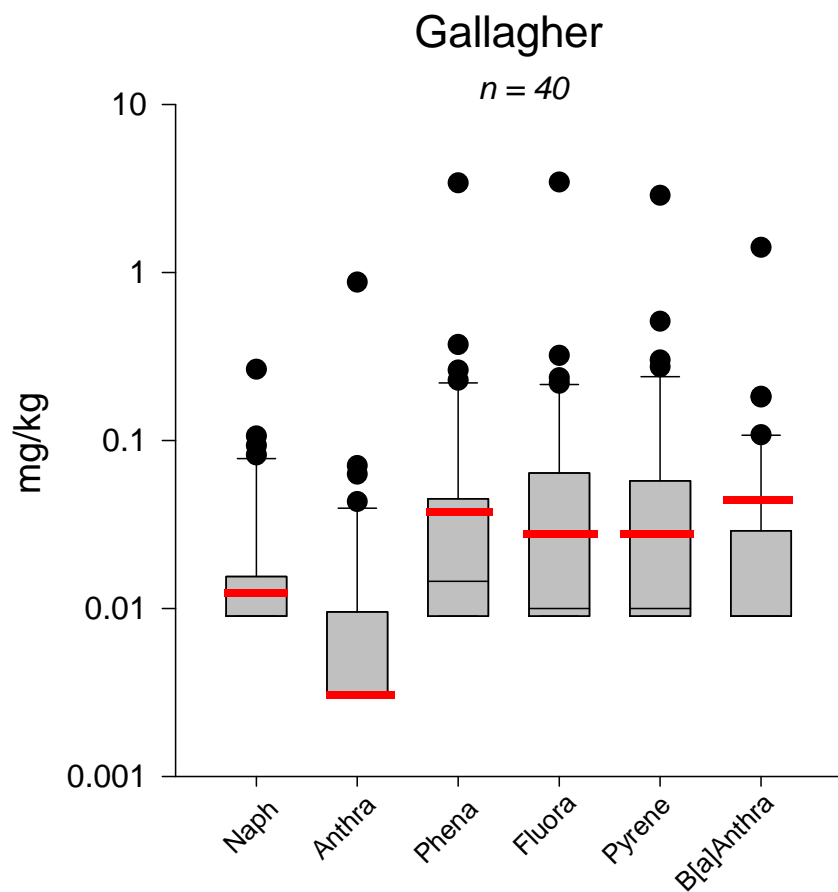
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Municipal Driver & Regulatory Objectives

- North Saskatchewan River Valley Bylaw 7188 (adopted 1985)
  - Identifies boundaries for river valley and ravines;
  - Sets out policy and development approval procedures for lands within these boundaries;
  - Proposed developments require environmental sign-off (AEP); and
  - Past approach was to remediate only the footprint of the proposed development, ignoring broader contamination

- Tier 2 Risk Assessment and Risk Management
  - City seeks comprehensive park-wide approach addressing whole of the contamination
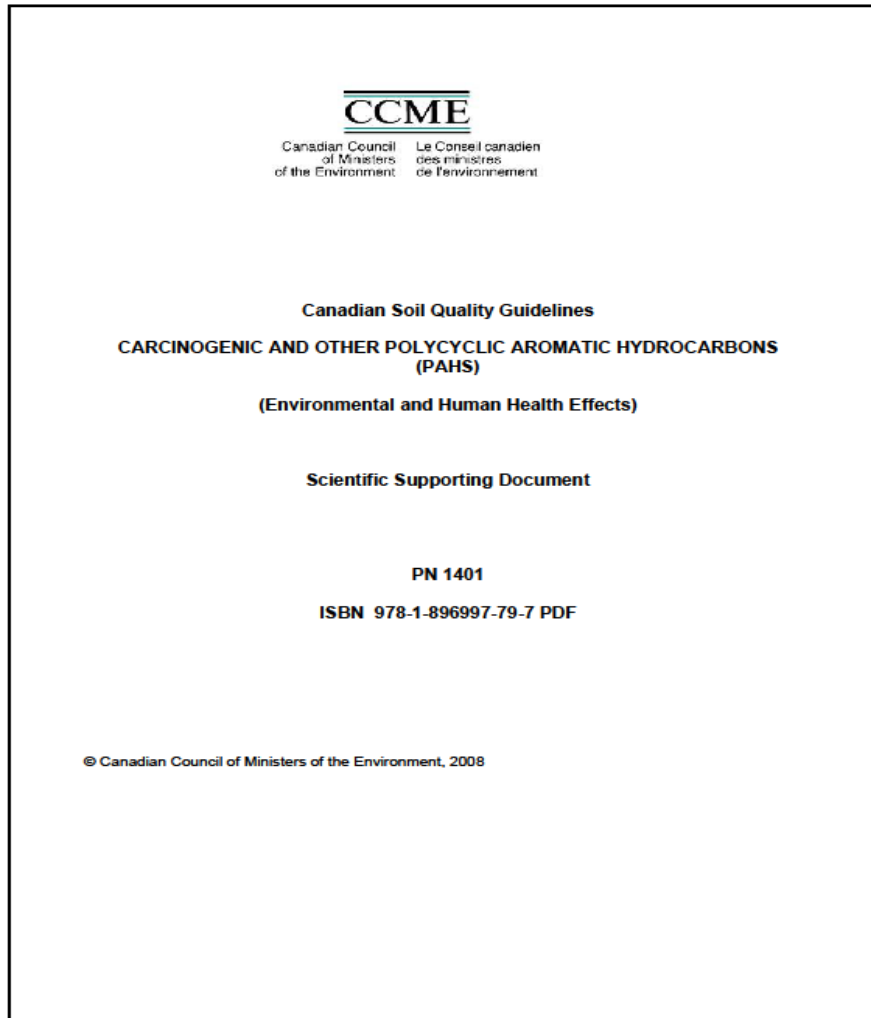 - Applicable for future developments without having to seek AEP sign-off

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Soil Characteristics – Random Fill
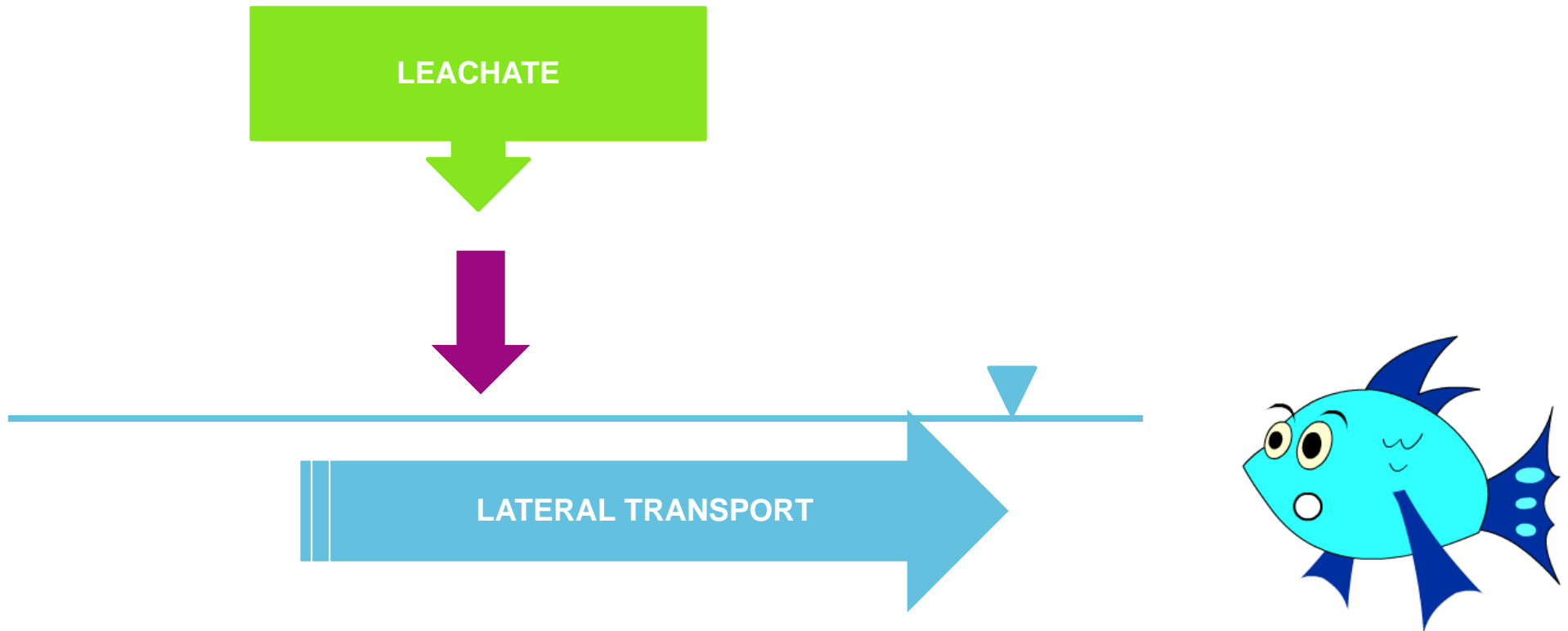
Soil Characteristics – Industrial Point Sources

Gallagher

n = 40

Rossdale

n = 61

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CCME PAH Soil Quality Guidelines (FWAL)

CCME
Canadian Council   Le Conseil canadien
of Ministers   des ministres
of the Environment   de l'environnement

Canadian Soil Quality Guidelines

CARCINOGENIC AND OTHER POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

(Environmental and Human Health Effects)

Scientific Supporting Document

PN 1401

ISBN 978-1-896997-79-7 PDF

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SQG_{FWAL} back calculated from ambient water quality guidelines

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CCME PAH SQG $_{FWAL}$ – Finite Source

LEACHATE

LATERAL TRANSPORT

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CCME PAH SQG $_{FWAL}$ — Random Fill/ Native

LEACH

LEACH

LEACH

LATERAL TRANSPORT

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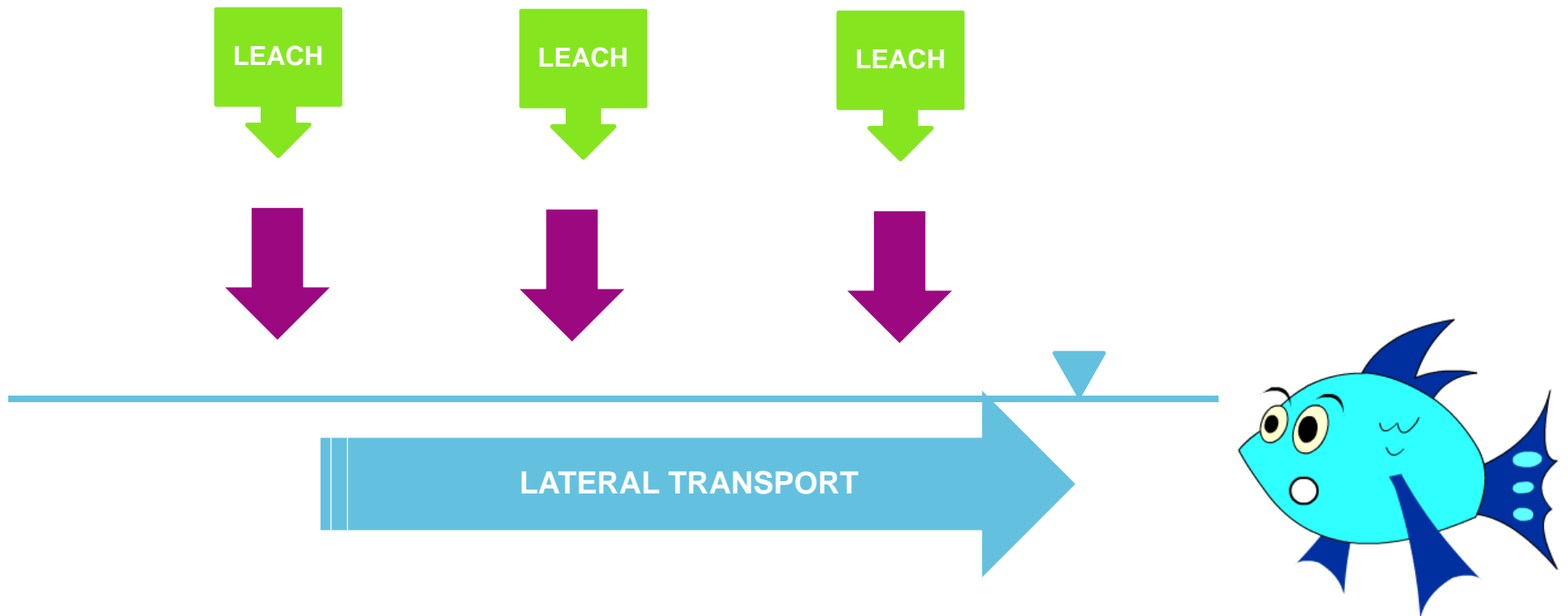
Are Back Calculated SQG$_{FWAL}$ To Conservative?

$$C_l = \frac{C_s}{K_{oc}f_{oc} + \theta_w/\rho_b + H'\theta_a/\rho_b} \; x \; 1000$$

Where

C_l	= chemical concentration in leachate
C_s	= chemical concentration in soil
K_{oc}	= organic carbon partition coefficient (chemical specific)
f_{oc}	=fraction organic carbon (soil matrix)
θ_a	= air filled porosity (soil matrix)
θ_w	= water filled porosity (soil matrix)
P_b	= bulk density (soil matrix)
H'	= Henry Law Constant, dimensionless and chemical - specific

The equation is simply a re-arrangement of the Tier 1 Dilution Factor #1.

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Methods and Field Program

- Drill, soil sampling, Shelby tubes and monitoring well installation

- Test fill and native material for PAH, metals & TOC

- Bulk density, porosity, moisture from Shelby tubes

- SPLP PAH leachate on selected soil samples above SQG_{FWAL}

- Groundwater analysis for PAHs in all wells

- Calculate theoretical PAH leachate concentrations based on site-specific matrix parameters

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SPLP Leachate

- Synthetic precipitation leaching procedure (US EPA Method 1312);

- Designed for semi volatiles and imitates rain water leachate in soil matrix either rich in organic carbon, or poor in organic carbon; and

- 18 hour duration standardized test that most laboratories will be capable of running.

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Results (Hawrelak and Queen Elizabeth Parks)

PAH Compound	Soil Input (mg/kg)	Predicted Leachate (µg/L)	SPLP Leachate (µg/L)	Measured Groundwater (µg/L)
Anthracene	0.003	0.004 – 0.003	< 0.005	< 0.005
	0.024	0.11 – 0.07	< 0.005	< 0.005
Phenanthrene	0.01	0.117 – 0.035	< 0.1	< 0.1
	0.06	0.83 -0.24	< 0.1	< 0.1
Fluoranthene	0.03	0.213 – 0.231	< 0.01	< 0.01
	0.04*	0.28 – 0.53	< 0.01	0.01
Pyrene	**0.07***	0.233 – 0.224	0.03	< 0.01
	0.14*	0.37 – 0.31	< 0.01	0.020
Benzo[a]anthracene	**0.03***	0.20 – 0.20	< 0.01	<0.01

BOLD* - value exceeds Tier 1

Site-specific f_{oc} ranged 0.039 to 0.011
Site-specific bulk density 1.6 g/cm3
Site-specific moisture filled porosity 0.34 to 0.31
Site-specific air filled porosity 0.05 to 0.07

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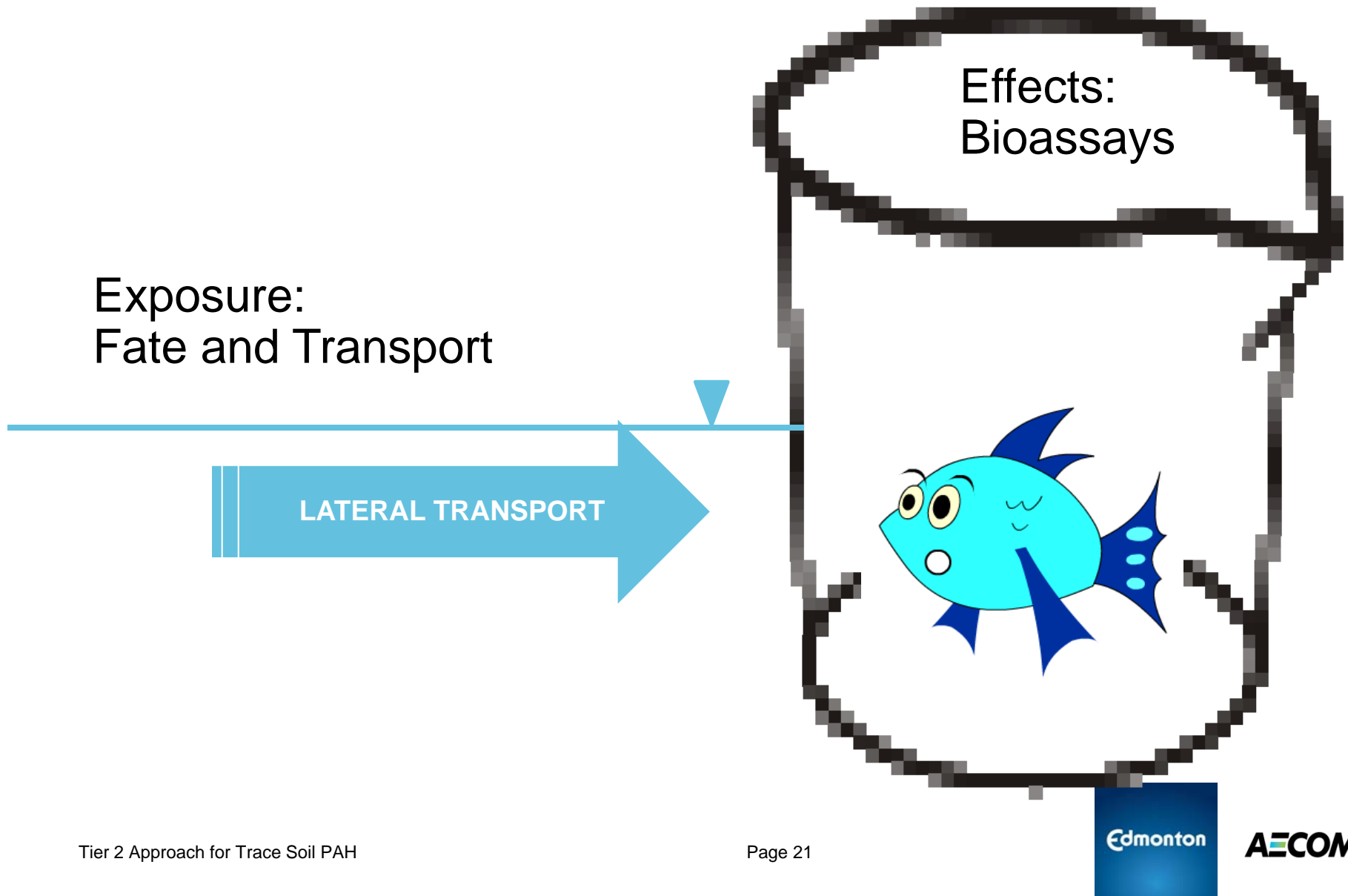
Results – (Rossdale Power Plant Flyash)

PAH Compound	Soil Input (mg/kg)	Predicted Leachate (µg/L)	SPLP Leachate (µg/L)	Measured Groundwater (µg/L)
Naphthalene	**0.034***	--	< 0.1	< 0.1
Anthracene	**0.153***	--	< 0.005	**0.035***
Phenanthrene	**0.39***	--	< 0.1	< 0.1
Fluoranthene	**0.52***	--	< 0.01	**0.09***
Pyrene	**0.52***	--	< 0.01	**0.10***
B[a]anthracene	**0.26***	--	< 0.01	**0.06***

BOLD* - value exceeds Tier 1

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Groundwater Results: Gallagher Park and Rossdale
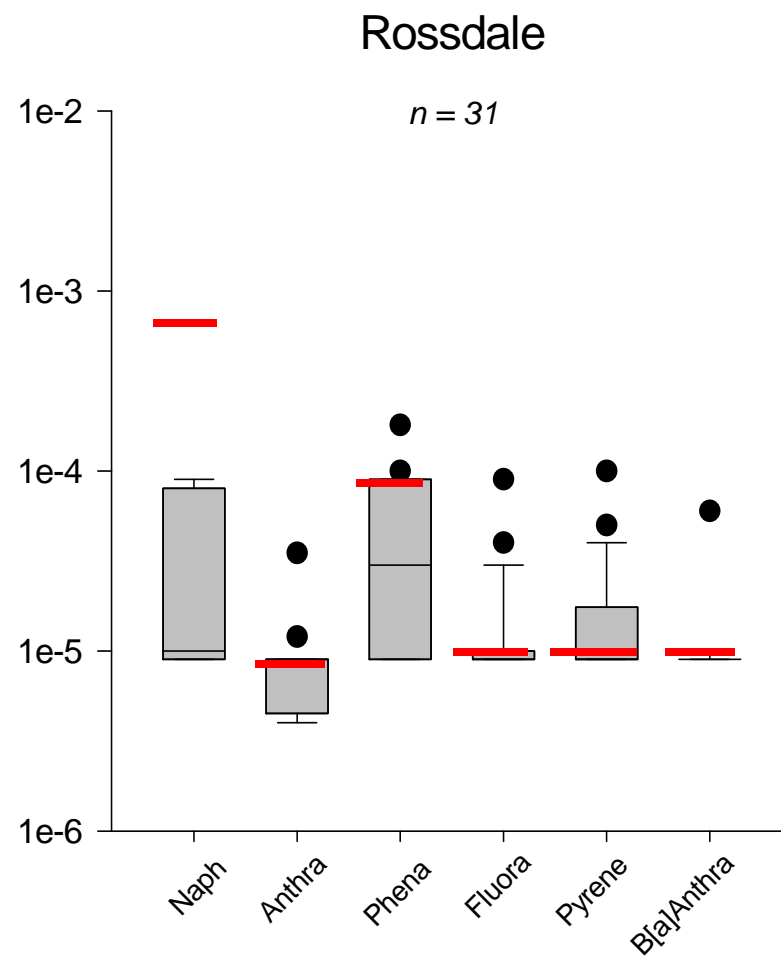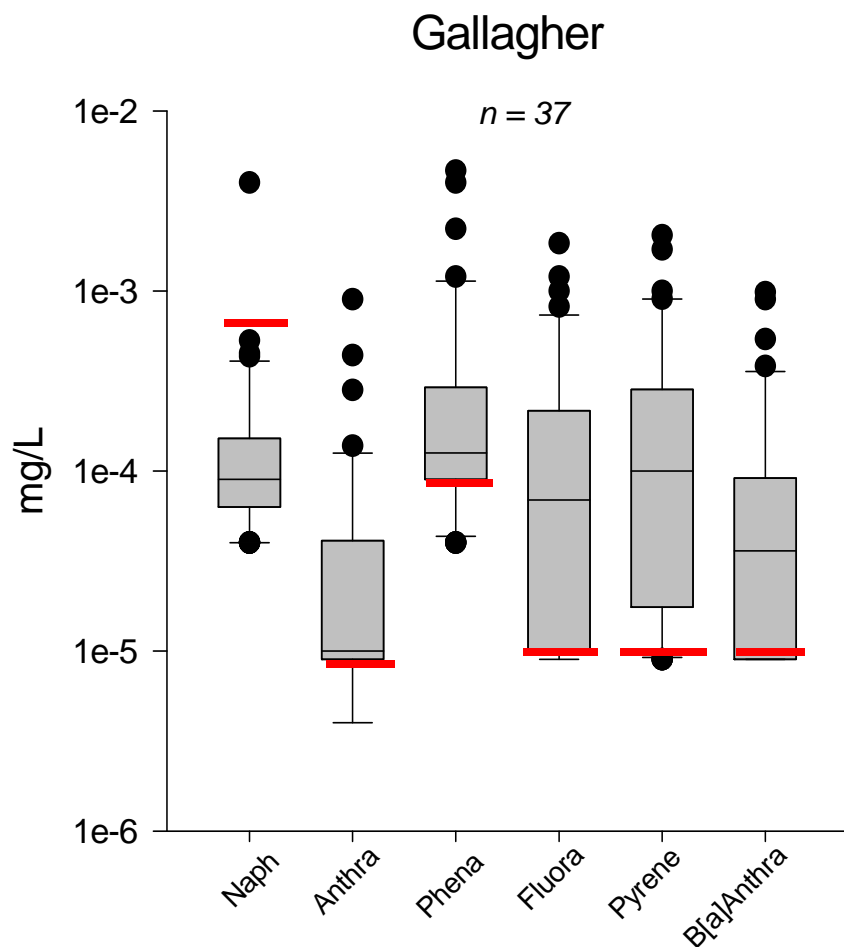
Optional Tier 2 Approach for Groundwater Contamination

Effects:
Bioassays

Exposure:
Fate and Transport

LATERAL TRANSPORT

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Conclusions for SPLP Leachate Tier 2 Approach

- The approach appears to predict an accurate outcome under the following conditions:
  - PAH contamination is present in random fill and native material and concentrations are <u>within</u> the same order of magnitude as Tier 1

- The approach does not necessarily predict an accurate outcome when:
  - PAH contamination is present as a finite source and concentrations are 1 and 2 orders of magnitude above Tier 1

Thank You

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