Integrated Environmental Risk Assessments of Two Crude Oil Train Derailments and Fires in Northern Ontario

Andrew Pawlisz, DABT ERT (UK)
Senior Toxicology/Risk Assessor

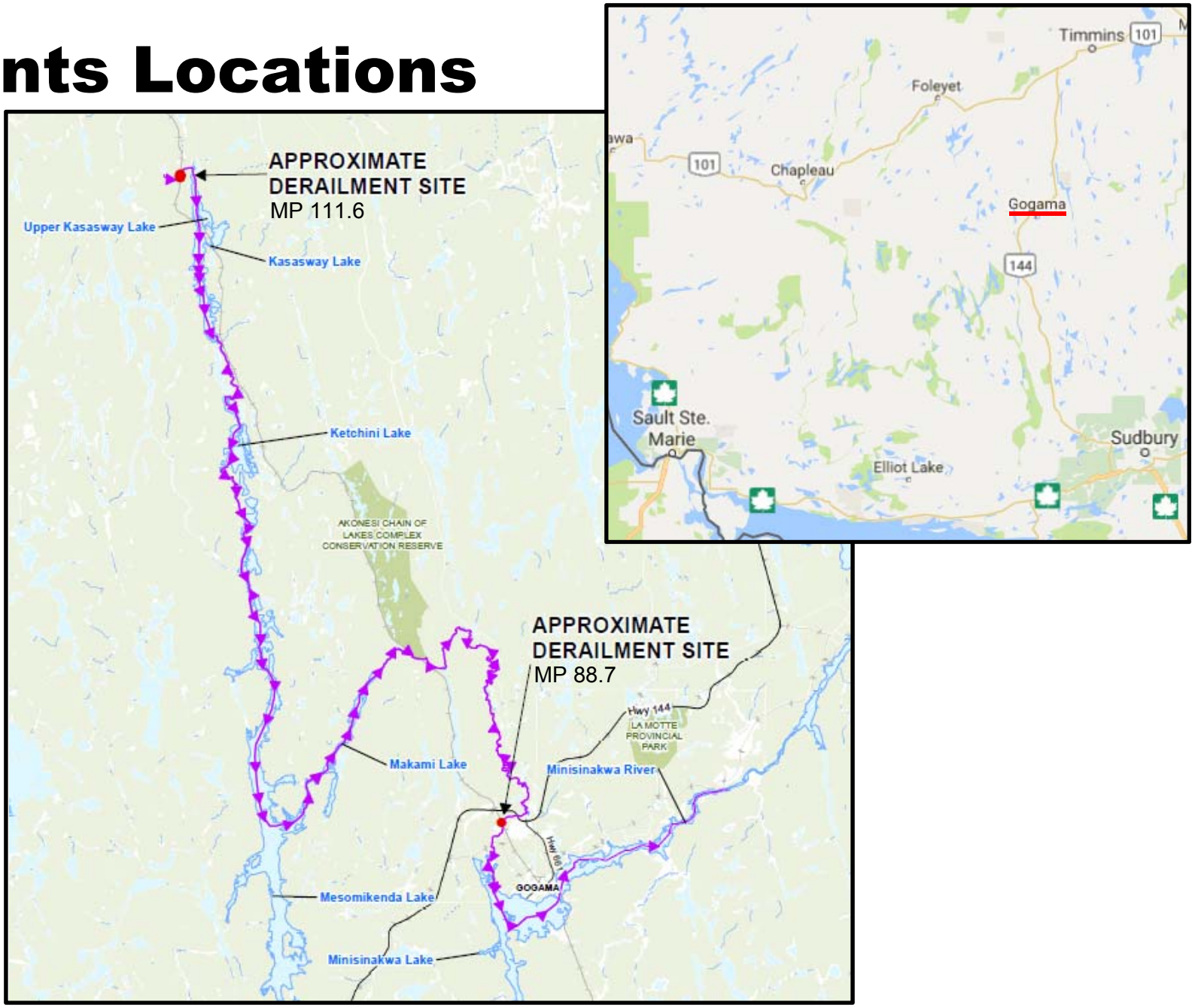
Laura Lawlor, MSc, C.E.
Senior Ecologist

RemTech
October 12-14, 2016

Outline

- Introduction
- Risk Assessment Context
- Event 1 – February 14, 2015
- Event 2 – March 7, 2015
- Development of Multiple Lines of Evidence
- Conclusions
- Lessons Learned

Events Locations



Events Description

Event 1: February 14, 2015 MP 111.6 Ruel Subdivision 35 km of Gogama, ON

- 29 crude oil railcars affected
- Product released into ditch, creek, and lake
- Multiple stakeholder engagement (MOECC, MNRF, EC, First Nations, public)

Event 2: March 7, 2015 MP 88.7 Ruel Subdivision 3 km of Gogama, ON

- 37 crude oil railcars affected
- Product released into river and lake
- Multiple stakeholder engagement (MOECC, MNRF, EC, DFO, First Nations, public, HC, SDHU, GLSB)

Integrated ERA Process

Overview

- Environmental risk assessment (ERA) – risk assessment science
- ERA initiated with USEPA Superfund program (circa 1980)
- Traditionally Eco RA and HH RA separate
- Integrated ERA:
  - Remedial decisions
  - Regulatory compliance
  - Holistic risk management and risk communication

Event 1 - MP 111.6

RA CSM

- Areas beyond derailment and contamination containment zone (>300 m)
- No visible product in waterways
- Primary exposure media:
  - Air, Soil, Sediment, Surface Water, Groundwater
- Sensitive abiotic receptors:
  - Wetland
  - Pond
  - Creek
  - Upper Kasaway Lake
- Sensitive biotic receptors:
  - Residents and recreators (source of drinking water to seasonal residents)
  - Aquatic biota and wildlife

Event 1 - MP 111.6

Sampling

Air monitoring:

- Work, perimeter, and off-site areas

Surface water sampling:

- SW-0 through SW-19 (entire water column)

Sediment sampling:

- SW-0 through SW-15
- Background sampling
- MOECC sampling

Event 1 - MP 111.6

Analysis

Air monitoring:

- VOCs, H_2S, PM, benzene, O_2, explosive limits

Water and sediment:

- VOCs
- SVOCs (including 18 PAHs)
- PHCs
- Grain size (sediment)
- TOC (sediment)
- BC (sediment)

Soil:

- VOCs

Groundwater:

- VOCs

Event 1 - MP 111.6

Data Screening

Air:

- OSHA Occupational Exposure Limits (OELs)
- NIOSH guidelines
- Ambient Air Quality Criteria (AAQC) by MOECC

Water:

- Aquatic Protection Values (APVs) by MOECC
- Table 1 Standards by MOECC (Groundwater)
- Provincial Water Quality Objectives (PWQOs)
- Canadian Council of Ministers of the Environment (CCME) guidelines

Sediment:

- Sediment Quality Guidelines (SQGs) by MOECC
- Table 1 (Background soil) Standards by MOECC
- CCME Probable Effect Levels (PELs)

Groundwater:

- Table 9 Standards by MOECC

Soil:

- Table 3 and 9 Standards by MOECC

Event 1 - MP 111.6

Remediation and Restoration

- Comprehensive source control/ soil removal actions
- Topsoil and organic matter replenishment
- Reconstruction of wetland, creek, and terrestrial habitats 2015/2016
- Repurposing of cleared woody debris for habitat enhancement
- Permanent pool habitat element with cobblestone inlet/outlet
- Natural erosion/sedimentation controls
- Revegetation with native mix of plants and trees

Conclusions

Event 1 – MP 111.6

- Significant release, but relatively limited impacts (location and winter)
- Comprehensive remedial and restoration actions
- Leftover product under ballast managed by product containment system
- Groundwater monitoring program
- Little or no residual risk to human health and environment


Event 2 - MP 88.7

Event 2 - MP 88.7

RA CSM

Site divided into 8 operational Divisions over 8 km Assessment Area

Primary exposure media:

- Air, Sediment, Surface Water

Sensitive abiotic receptors:

- Makami River, wetlands and riparian habitat
- Minisinakwa Lake (4 km downstream)

Sensitive biotic receptors:

- Residents and recreators (drinking water supply and recreational uses)
- Sport, subsistence, and commercial fish species
- Aquatic biota and wildlife

Event 2 - MP 88.7

Sampling

Air monitoring:

- Work, perimeter, and off-site areas

Surface water:

- ~100 samples
- Background sampling

Sediment:

- +200 samples and on-going
- Background sampling
- MOECC sampling

Fish tissue:

- ~20 samples of sport/commercial
- 11 samples of prey fish

Benthic surveys:

- Community structure as additional line of evidence

Groundwater:

- +100 samples and on-going
- Background sampling

Event 2 - MP 88.7

Analysis

Air monitoring:

- VOCs, H2S, PM, benzene, O2, explosive limits

Water and sediment:

- BTEX
- SVOCs (18 parent and 16 alkylated PAHs)
- PHCs
- DOC (water)
- Grain size (sediment)
- TOC (sediment)
- BC (sediment)

Fish:

- SVOCs (18 parent and 16 alkylated PAHs)

Benthos:

- Benthos Community Metrics (density, richness, species, diversity index)

Food chain modeling:

- Wildlife

Event 1 - MP 88.7

Data Screening

Air:

- OSHA Occupational Exposure Limits (OELs)
- NIOSH guidelines
- Ambient Air Quality Criteria (AAQC) by MOECC

Sediment:

- Sediment Quality Guidelines (SQGs) by MOECC
- Table 1 (Background soil) Standards by MOECC
- CCME Probable Effect Levels (PELs)

Water:

- Aquatic Protection Values (APVs) by MOECC
- Table 1 Standards by MOECC (Groundwater)
- Provincial Water Quality Objectives (PWQOs)
- Canadian Council of Ministers of the Environment (CCME) guidelines

Fish:

- FDA/food chain modeling

Groundwater:

- Table 9 MOECC standards

Event 2 - MP 88.7

Results: Surface Water

PAHs > SLs:

PAHs
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Chrysene
Indeno(1,2,3-cd)pyrene
Pyrene

Detected, but no SLs:

- Alkylated PAHs
- benzo(b)fluoranthene
- PHC fraction F2 (C10-C16)
- PHC fraction F3 (C16-C34)

Event 2 - MP 88.7

Results: Sediment

PAHs > SLs:

PAHs
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Phenanthrene
Pyrene

Detected, but no SLs:

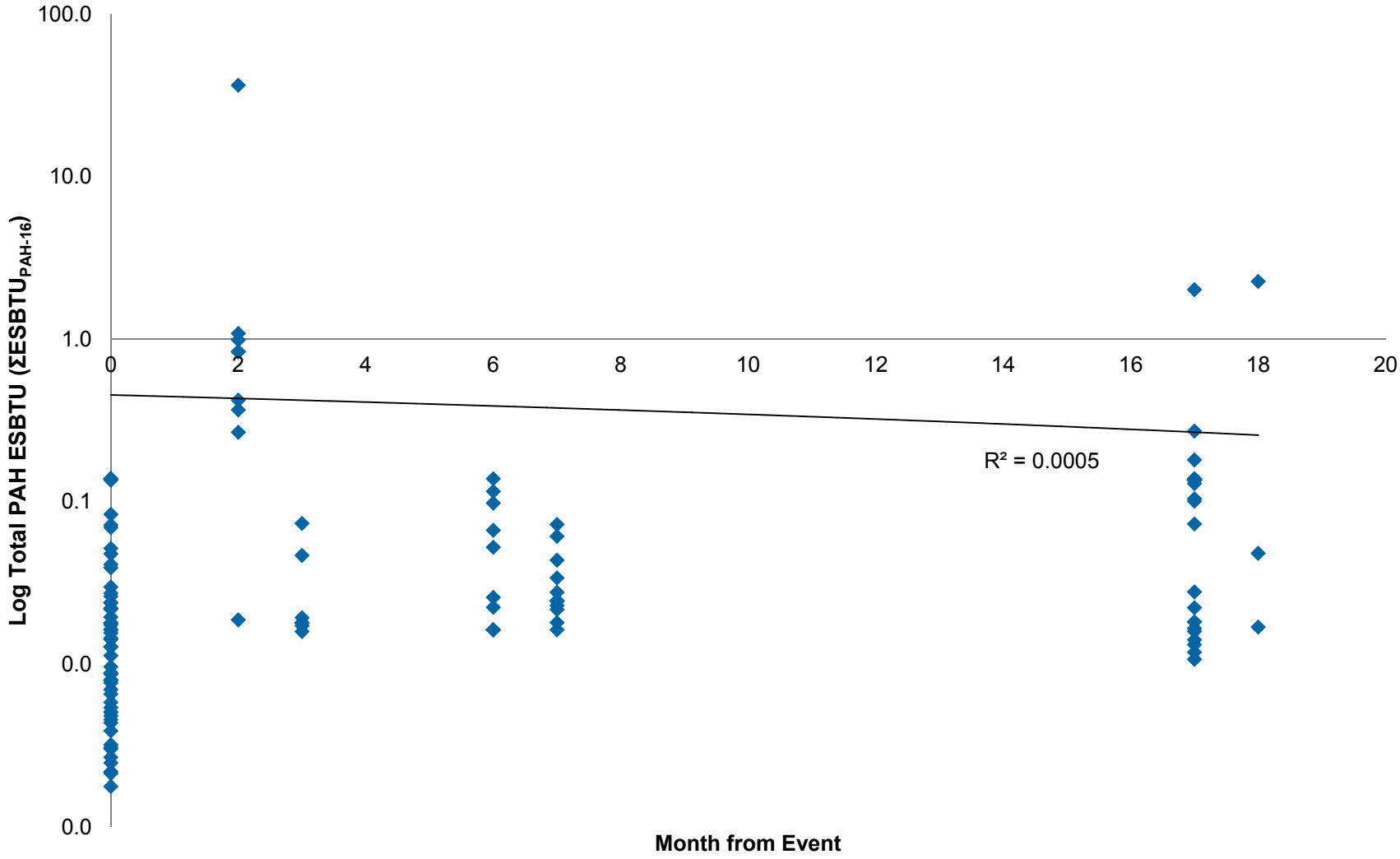
- Acenaphthene, acenaphthylene, acridine, benzo(b)fluoranthene, benzo(b)pyridine, benzo(c)phenanthrene, benzo(e)pyrene, 1,1-Biphenyl, dibenzothiopene, naphthalene, and perylene
- BTEX
- PHCs F1 (C6-C10), F2 (C10-C16), F3 (C16-C34) and F4 (C34-C50)

Event 1 - MP 88.7

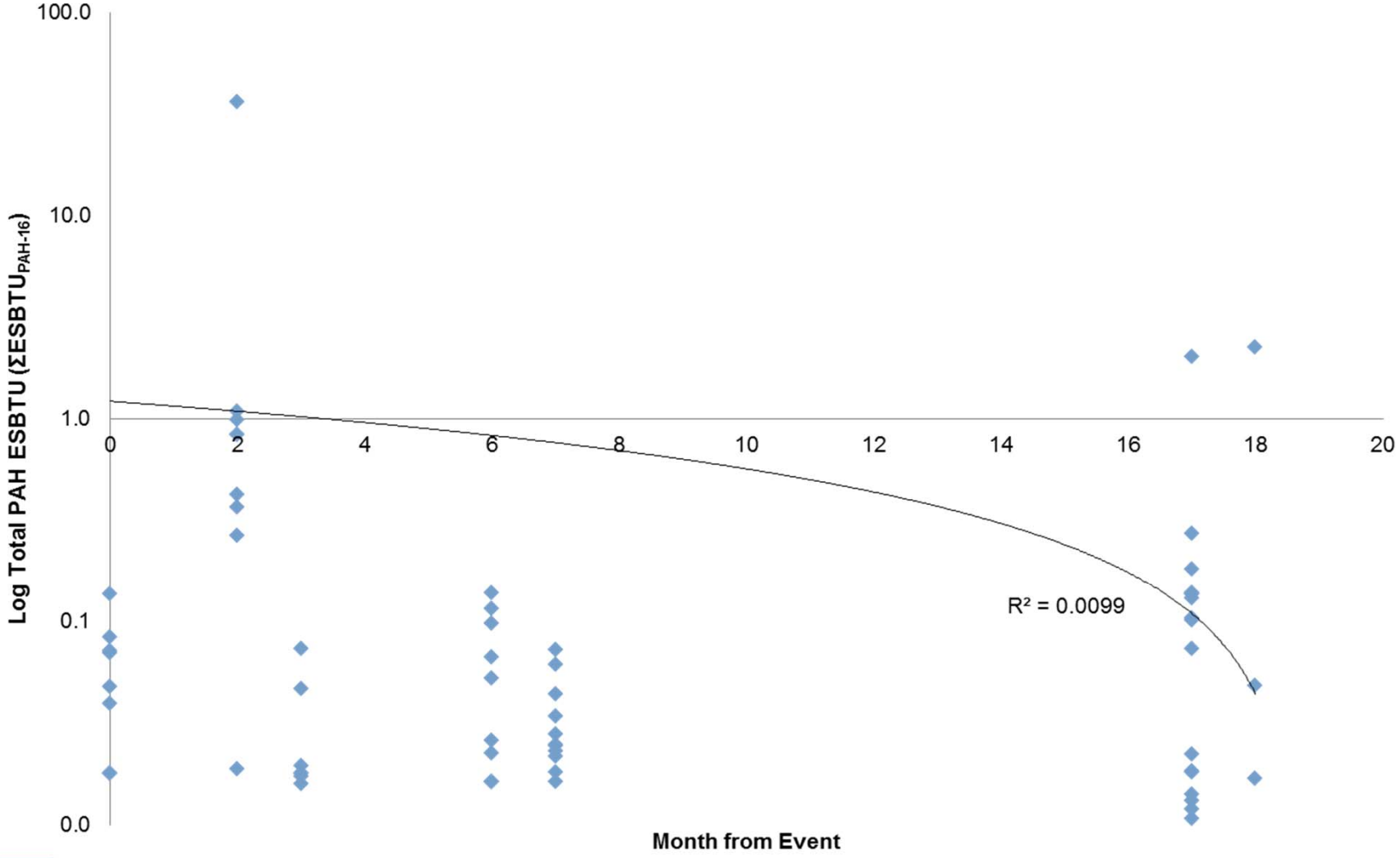
Results: Benthos-Chemical Line of Evidence

- FOC≥0.2%: Equilibrium Partitioning Benchmarks – sediment pore water toxicity predicted from bulk sediment concentrations
- FOC<0.2%: MOECC SQGs
- Toxic Unit approach – additive toxicity of individual PAHs (∑ESBTU)
- 16:34 PAH conversion factors calculated
- ∑ESBTUs > 1 in Divisions A and C
- Largest TU contributors:
  - C2/3-fluorenes (as high as 40%)
  - C2/3/4-phenanthrene/anthracenes
  - C1/2/4-naphthalenes
  - Naphthalene
- Additional (on-going) hot spot risk management actions to reach ∑ESBTUs ≤ 1
- Overall, no impacts on benthic community area expected in the rest of the Assessment Area

Makami River and Minisinakwa Lake Total PAH ESBTU ($\Sigma ESBTU_{PAH-16}$)



Divisions A and C PAH ESBTU (ΣESBTUPAH-16)



Event 2 - MP 88.7

Results: Food Chain Modeling

- Surrogate Valued Ecosystem Components:
  - Chimney swift (SAR small avian invertivore)
  - Lesser scaup (small avian invertivore)
  - Belted kingfisher (small avian piscivore)
  - Common merganser (large avian piscivore)
  - River otter (large mammalian piscivore)
- PAHs, BTEX, and PHC intake via food, sediment, and water
- Exposure media EPCs calculated to account for receptor mobility
- All ecological screening quotients (ESQs) ≤ 1

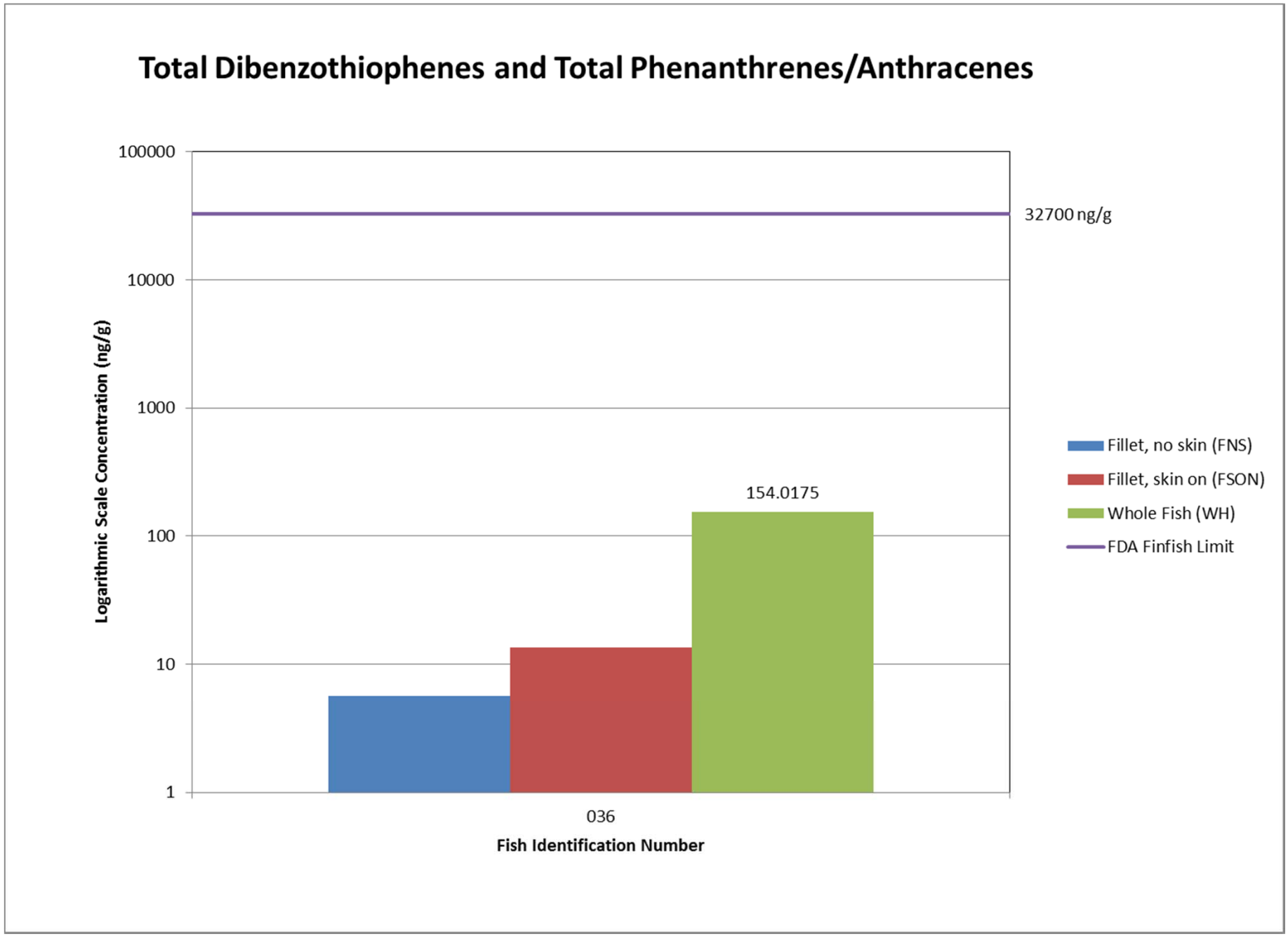
Event 2 - MP 88.7

Results: Fish

March 15, 2015 – April 29, 2015

- Northern pike, whitefish, walleye, cisco, common ling, yellow perch
- No odor or tainting reported
- Whole fish, fillet (w/o skin)
- Majority PAHs ND
- Highest detected 125 ng/g in whole yellow perch
- FDA limit 32,700 ng/g
- No impacts anticipated on human health

"Following review of the fish sample results, and in consultation with Public Health Ontario, the Sudbury & District Health Unit has found no increased health risk associated with consumption of fish from Minisinakwa Lake as a result of the derailment." https://www.sdhu.com/news


Total Dibenzothiophenes and Total Phenanthrenes/Anthracenes
100000
10000
1000
100
10
1
Logarithmic Scale Concentration (ng/g)
32700 ng/g
154.0175
036
Fish Identification Number
Fillet, no skin (FNS)
Fillet, skin on (FSON)
Whole Fish (WH)
FDA Finfish Limit

Event 2 - MP 88.7

Results: Risk Lines of Evidence

- **Air monitoring:** no impacts off-site
- **Water quality monitoring (including residential sampling):** no impacts
- **Sediment quality monitoring:** hot spots near derailment site (being addressed)
- **Soil removal:** in the immediate area of the derailment
- **Fish sampling:** no impacts
- **Food chain modeling:** no impacts
- **Visual surveys:** no impacts (few fish entrained in sediment dredging)
- **Sheen:** aesthetic, but an important community risk perception aspect

Conclusions

Event 2 – MP 88.7

- Significant release; more notable impacts due to aquatic release
- Hot spots in Division A (derailment site)
- Pathways/receptors in other Divisions not associated with unacceptable risks
- Comprehensive remedial and risk management actions
- Little or no residual risk to human health and environment
- Leftover product under ballast managed by product containment system
- Groundwater monitoring program
- Habitat restoration and enhancement
- Sheen – lingering risk perception

Lessons Learned

Events 1&2 - MP 88.7&111.6

Lessons Learned

Location of release has significant impact on magnitude of risk and response

Seasonality provided opportunity and challenges

Air was not a prolonged media of interest

Water and fish tissue did not show prolonged exposure, but remain in question by the public and First Nations

Sediment and soil represent significant exposure media

PAHs, particularly Alkylated PAH, are important risk drivers

Events 1&2 - MP 88.7&111.6

Lessons Learned

Concurrent RA's within the watershed required additional management based on mixed review teams

Engagement of agencies from outset and throughout was key to the successes thus far

Agencies will still collect primary data for their analyses and consideration

Timelines are relative

Events 1&2 - MP 88.7&111.6

Lessons Learned

Net environmental benefit can be a difficult concept to grasp

‘Perception is reality’; perception of risk can drive site activities at any stage

- FWIN and fish tissue
- Surface and groundwater
- Benthos and wildlife
- Sediment and soil

Appropriate communication is an ever evolving complexity

www.ghd.com