

The Use of Ecological Risk Assessment for Regional Management of Aquatic Impacts



A Case Study



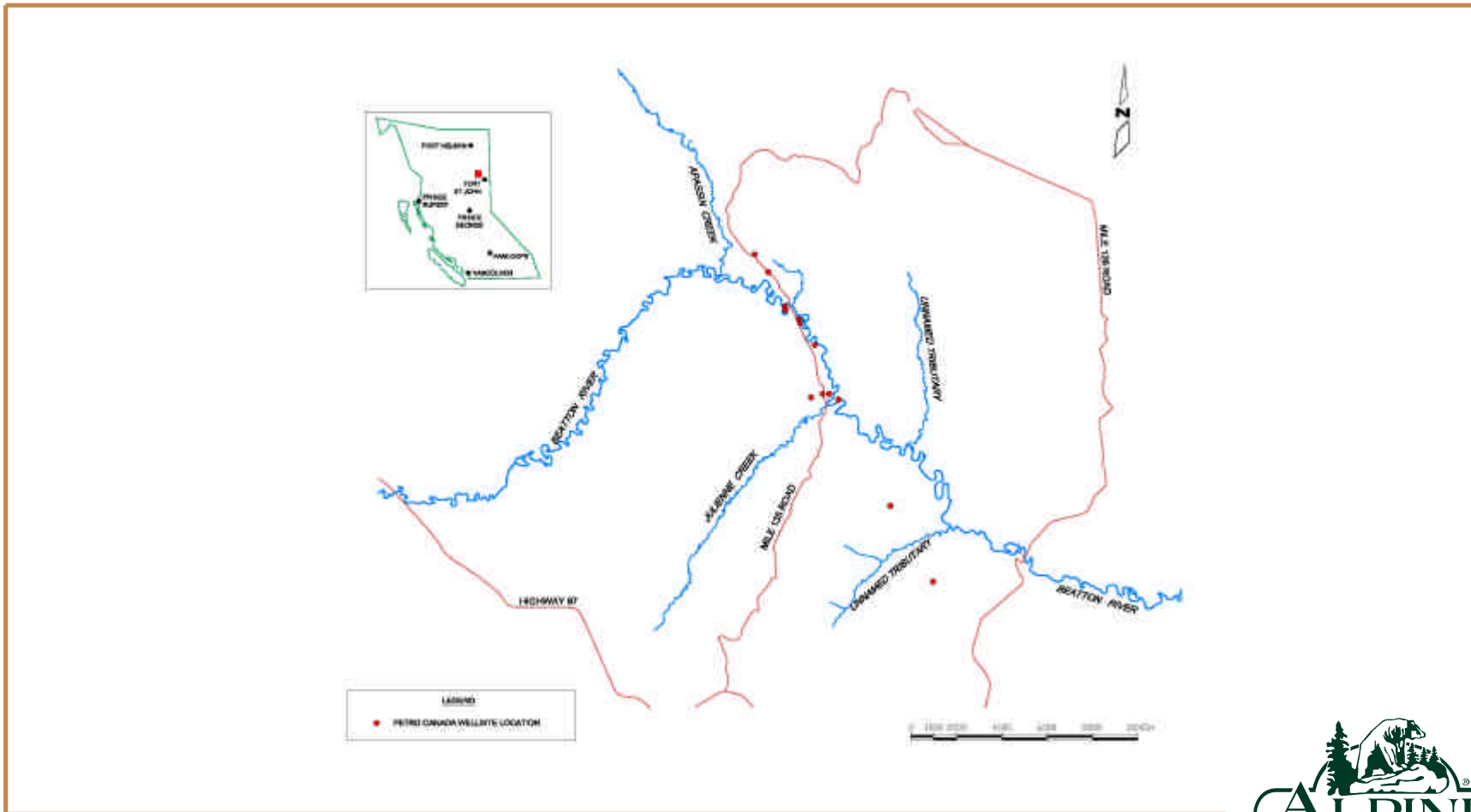
Background Information

- Development of area first started in 1961
- Petro-Canada acquired inactive properties along the Beaton River
- Historical on-site contamination, possibly migrating off-site





Study Area



Typical Lease on the Beattton River



Assessment Objectives

- Assess the impact, if any, the surrounding contaminated sites have had on the Beatton River
 - ✓ Water chemistry analysis
 - ✓ Sediment chemistry analysis
 - ✓ Benthic invertebrate community structure



Study Design

- Design of the study based on ecological risk assessment conducted for Pembina following the Pine River spill
- Pine River Study clearly showed impacts to, and recovery of, the ecosystem as well as influence of other sources, unrelated to the spill

Methods

- **Water Quality**
 - ✓ Concentrations of hydrocarbons in surface water at selected sites (grab samples and semi-permeable membrane devices or SPMDs)
- **Sediment Monitoring**
 - ✓ Concentration of hydrocarbons in sediment core samples collected at selected sites
- **Benthic Invertebrate Community Diversity**
 - ✓ Measured diversity at selected sites using Hess Sampler

Modified Shelby sediment sampling tubes





Hess sampling unit



Methods Continued

- Semi-permeable Membrane Devices (SPMDs)
 - ✓ Lipid-filled membranes mimic fatty tissues
 - ✓ Allows for detection of ultra-trace concentrations of organic compounds
 - ✓ Time integrated sampling provides a cumulative concentration of PAHs over a 30-day period

SPMD in deployment canister



SPMD canister mounted on concrete pad before being deployed in the Beaton River



SMPD canisters and concrete pads are fully submersed in the Beaton River



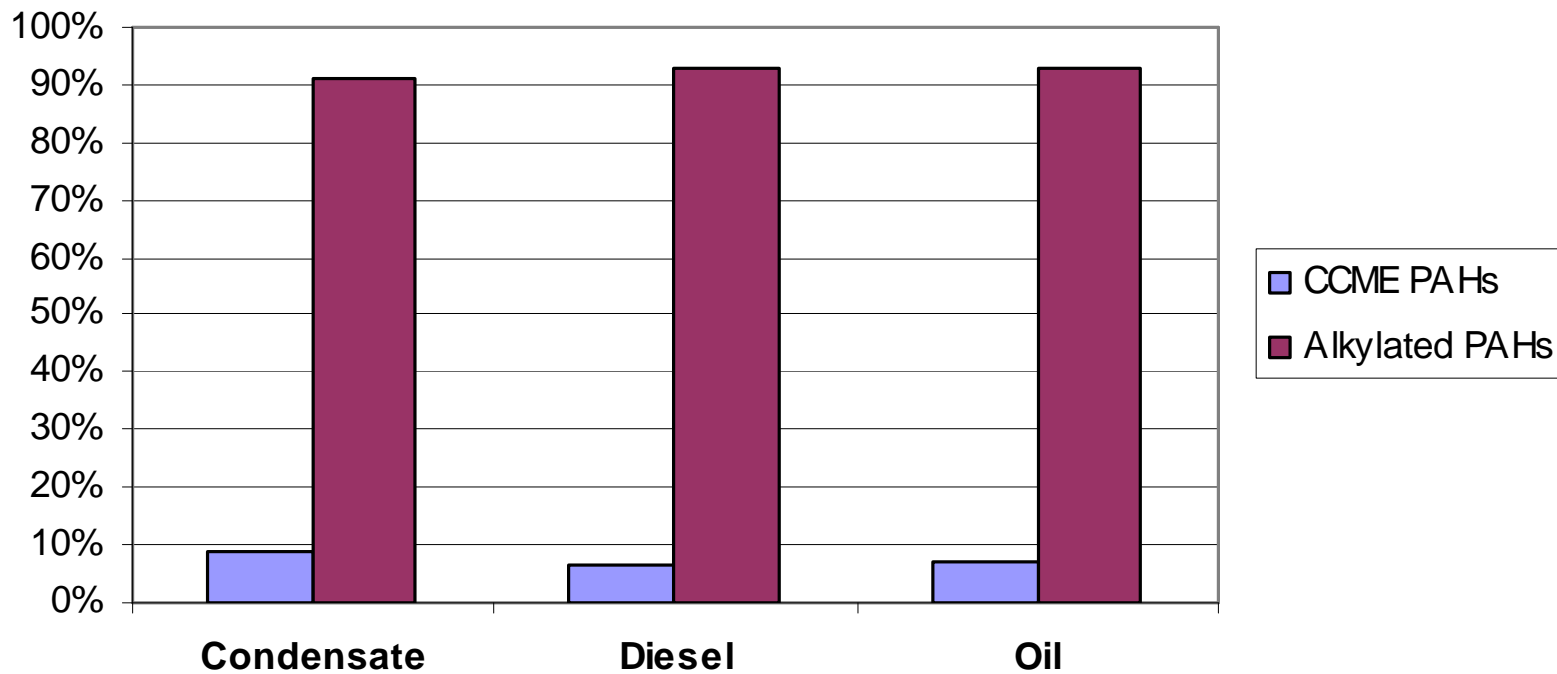
Analytical Program

- **Water:**
 - ✓ Benzene, toluene, ethylbenzene and xylenes (BTEX)
 - ✓ Light and Heavy Extractable Petroleum Hydrocarbons (LEPHs & HEPHs),
 - ✓ Polycyclic Aromatic Hydrocarbons (PAHs)
 - ✓ Dissolved Metals,
 - ✓ Routine Parameters
- **SPMDs:**
 - ✓ PAHs and Alkylated PAHs
- **Sediments:**
 - ✓ PAHs and Alkylated PAHs
 - ✓ Organic Content

Regulatory Framework

- CCME
 - ✓ Water: 11 PAH Compounds
 - ✓ Sediment: 13 PAH Compounds
- BC CSR
 - ✓ Water: 12 PAH Compounds
 - ✓ Sediment: 13 PAH Compounds
- BC AWQG
 - ✓ Water: 9 PAH Compounds
 - ✓ Sediment: 9 PAH Compounds

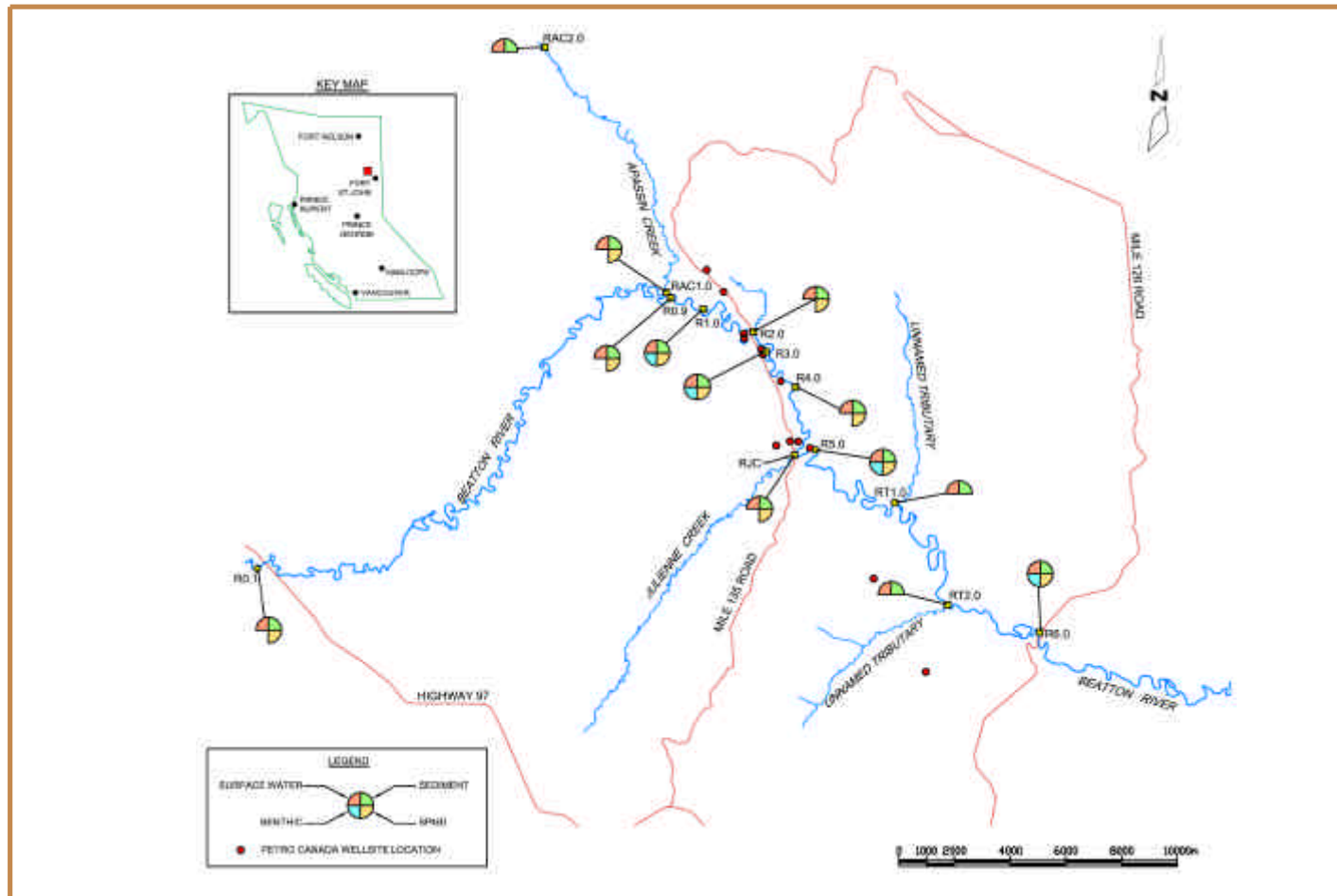
CCME PAHs vs. Alkylated PAHs in Petroleum Products



Toxic Equivalency Factors of Alkylated PAHs

Compound	TEF
Naphthalene	0.001
C1-Naphthalene	0.001
C2-Naphthalene	0.01
C3-Naphthalene	0.1
C4-Naphthalene	0.1
Benzo(a)pyrene	1

Sampling Locations

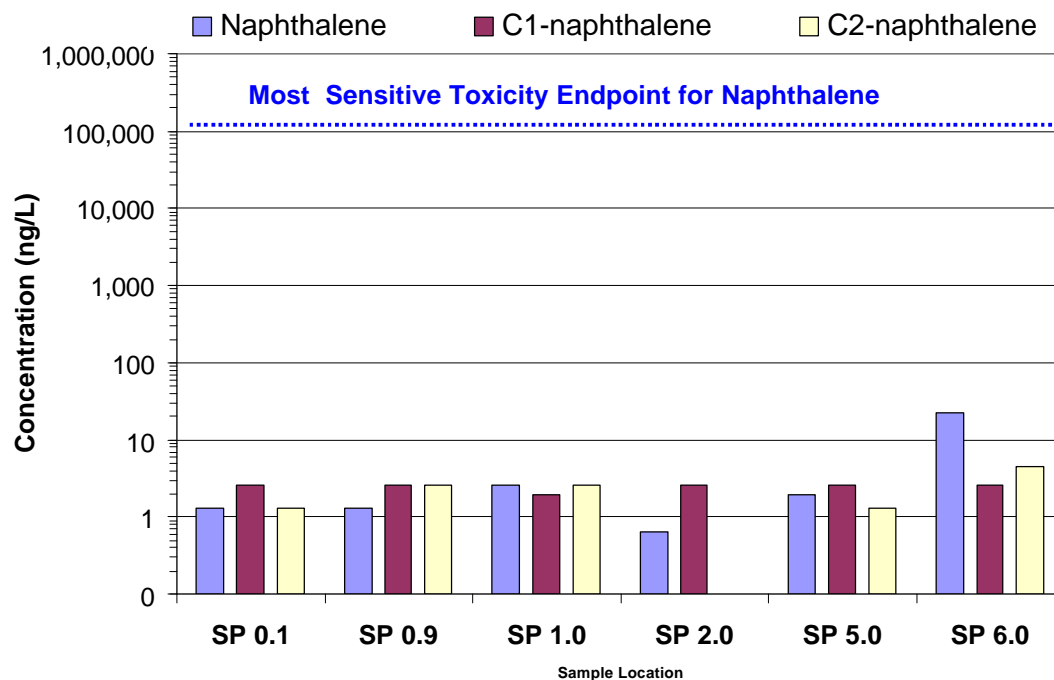




Results Water Quality

- 36 water samples collected at 16 sites along the Beaton River and its tributaries
- Concentrations of hydrocarbons were non-detectable or below applicable criteria at all sites
- Aluminum and iron concentrations exceeded applicable criteria at all sites
- No other parameters exceeded applicable criteria

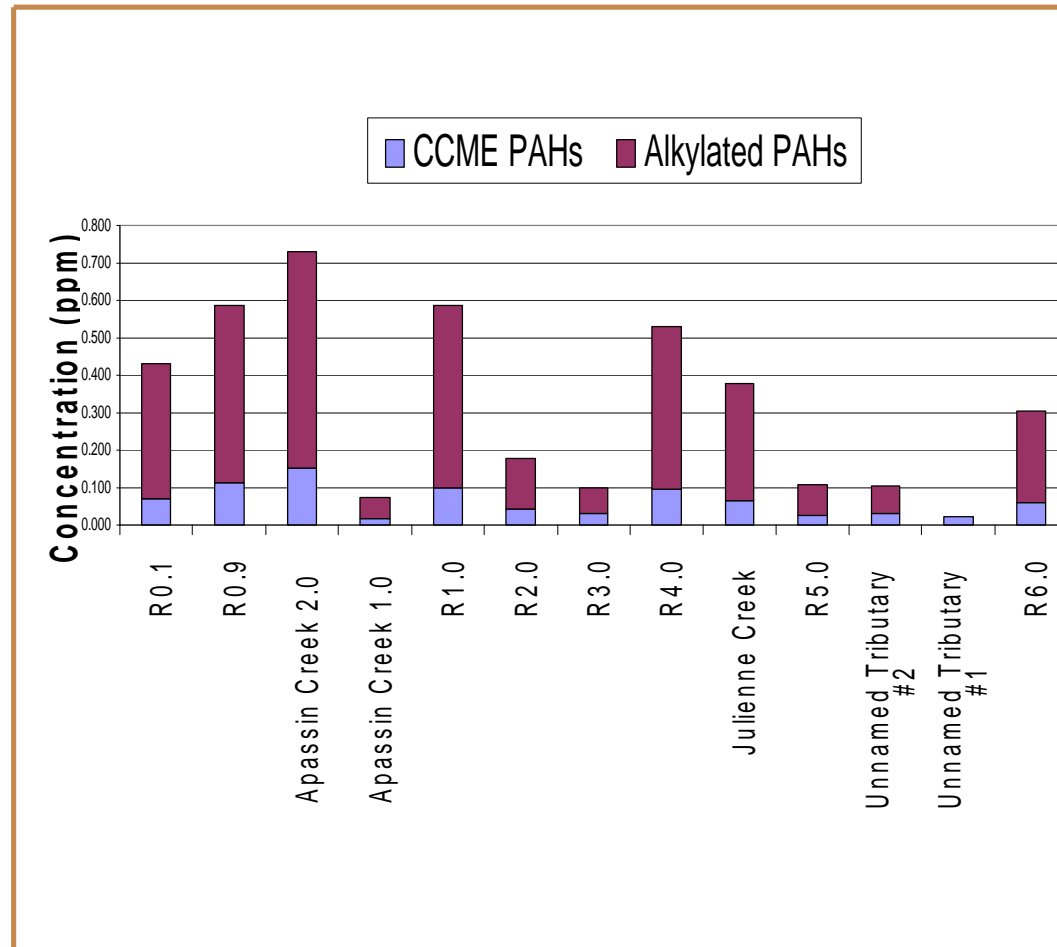
Results SPMDs



Naphthalenes present at very low concentrations in Beaton River.

Orders of magnitude below documented toxicity and probable effects levels.

Results Sediment

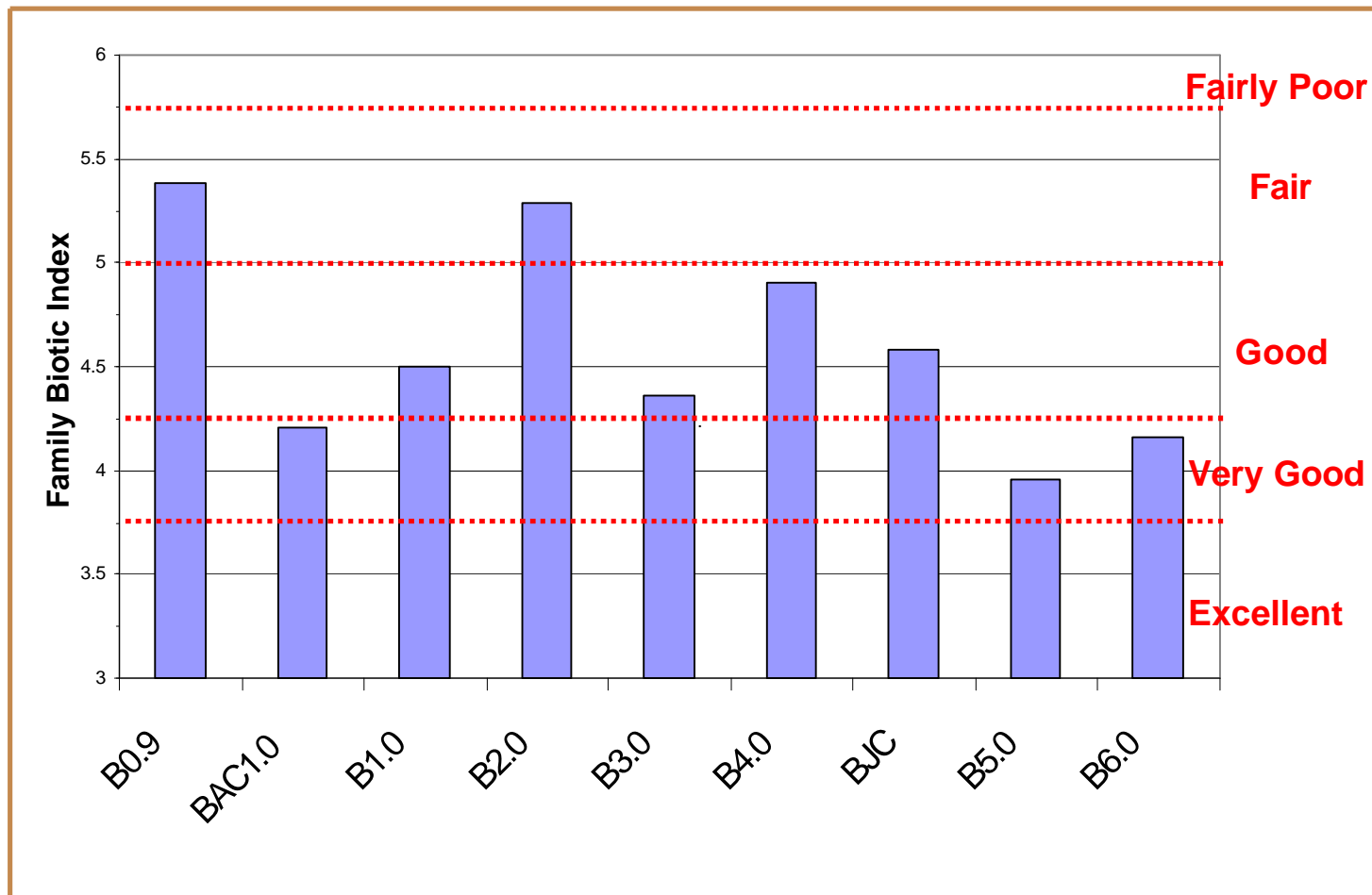


PAHs ubiquitous in Upper Beaton watershed

Some PAHs above CCME and/or BC CSR criteria

Great variations in PAHs concentrations

Results Benthic Invertebrates



Conclusions

- Water
 - ✓ No hydrocarbons were found above criteria
 - ✓ High levels of iron and aluminum likely a local phenomena
 - ✓ hydrocarbon concentrations found in the SPMDs were several orders of magnitude below toxicity levels

Conclusions Continued

- **Sediment**
 - ✓ Some PAHs found above criteria
 - ✓ Possible widespread historical impact and/or natural causes
- **Benthic Invertebrates**
 - ✓ Overall poor diversity and species richness
 - ✓ Relationship between benthic community and sediment quality under investigation



Summary

- Sediments appear to be impacted, but PAHs are likely not transferable to fish
- Water quality shows no impact from hydrocarbons

On-going and future work

- Focus on areas where sediments showed hydrocarbon impacts
- Establish sediment toxicity to benthic invertebrates as per BC CSR
- Expand the program to additional tributaries that might contribute hydrocarbon loading to the Beatton River

Aknowledgments

- Petro Canada
 - ✓ Tim Taylor
 - ✓ Mike Morden
- Pembina Pipeline Corporation
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 - ✓ Roy Crowther

