

October 19, 2012

RemTech Symposium 2012

# Non-Dissolved Extractable Hydrocarbons in Groundwater Samples



# Introduction

- The presence of non-dissolved extractable petroleum hydrocarbons (PHCs) in groundwater samples contaminated with mineral insulating oils (MIOs) was studied
- Non-dissolved extractable PHCs in groundwater samples can complicate the interpretation of laboratory data, comparison of results to regulatory standards, and site management

# Methodology

- Collected groundwater samples from five monitoring wells with varying levels of MIO contamination
- Two well purging methods:
  - Low flow purging
  - Rapidly purging multiple casing volumes
- Unfiltered and field filtered samples were collected for each purging method
- Samples were submitted for the laboratory analysis of PHC fractions F3 and F4 as defined under the Canada Wide Standard (CWS) published by the Canadian Council of the Ministers of the Environment (CCME)

# Extractable Hydrocarbon Analysis Components

- Components of an extractable PHC analysis (Lundegard and Sweeney, 2004)
  - Dissolved petroleum hydrocarbons
  - Hydrocarbons adsorbed to sediment
  - Droplets or micelles of phase separated hydrocarbons (NAPLs)
  - Biologically produced hydrocarbons
  - Dissolved polar organic hydrocarbons either naturally occurring or from the biodegradation of petroleum hydrocarbons
  - Hydrocarbons from contaminated field or laboratory equipment



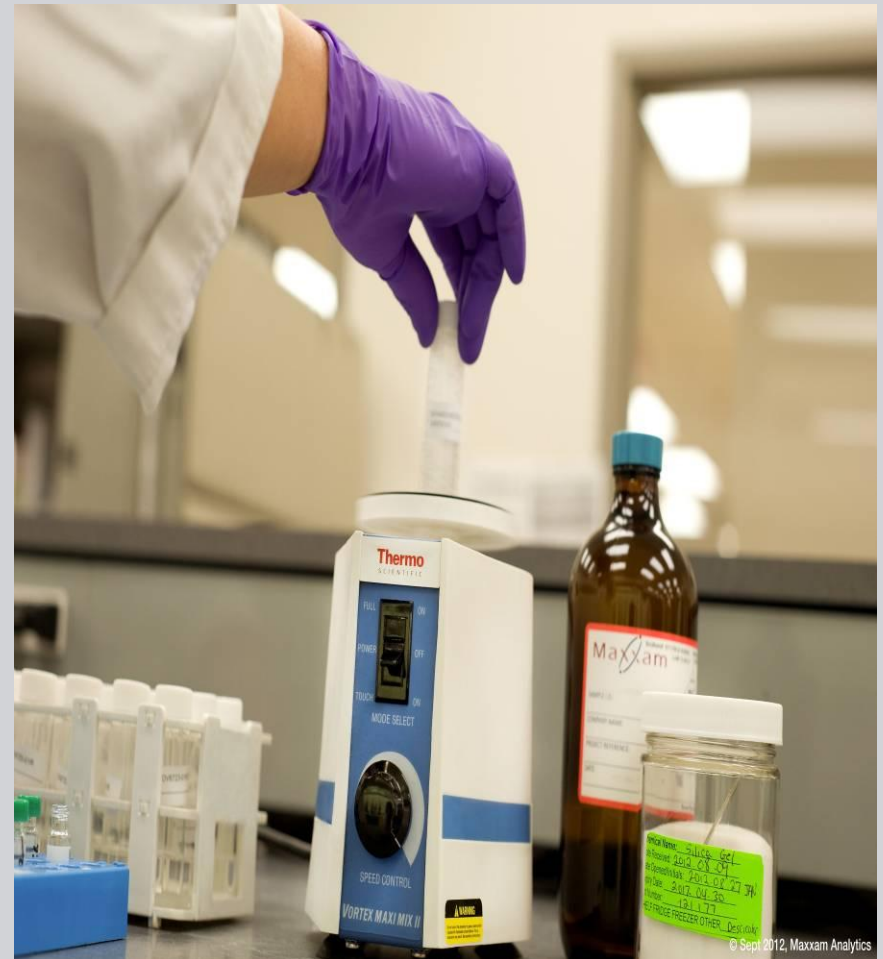
# Extractable Hydrocarbon Analysis



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# Extractable Hydrocarbon Analysis



- All non-polar hydrocarbons present in the groundwater sample are analyzed
- Dissolved, adsorbed to sediment, NAPLs!!!



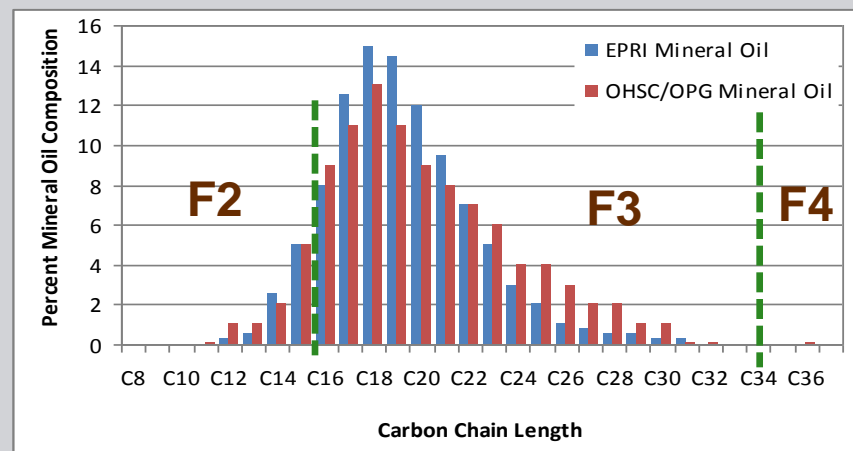
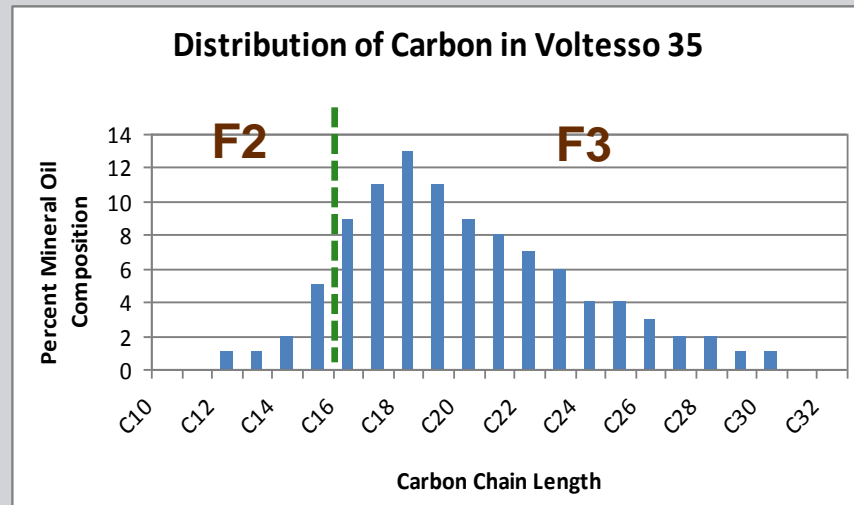
# Selection of Sampling Sites

- Five monitoring wells selected from three transformation stations
  - Varying levels of MIO contamination
  - PHC F3 and F4 data above expected solubility of MIOs

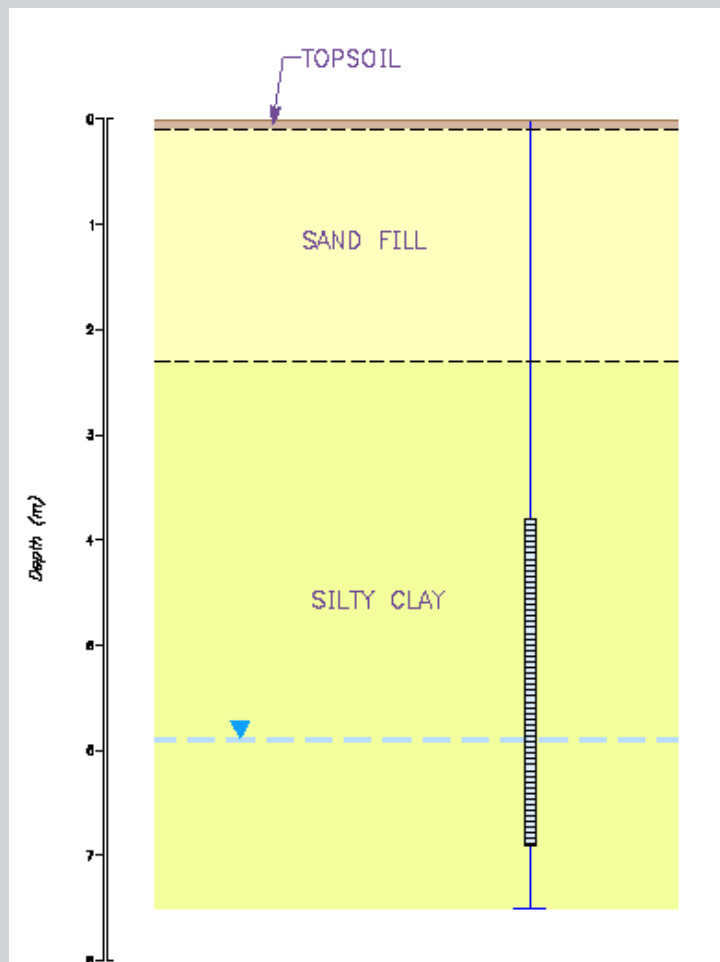


# Properties of Mineral Insulating Oils

- Highly refined crude oil
- Solubility in water <1 mg/L
- Specific gravity 0.755 to 0.895 gm/ml
- Low vapour pressure:  
0.0001 ml of Hg at 30°C
- Mostly PHC fraction F3,  
with minor PHC fraction F2



# Sampling Location Descriptions



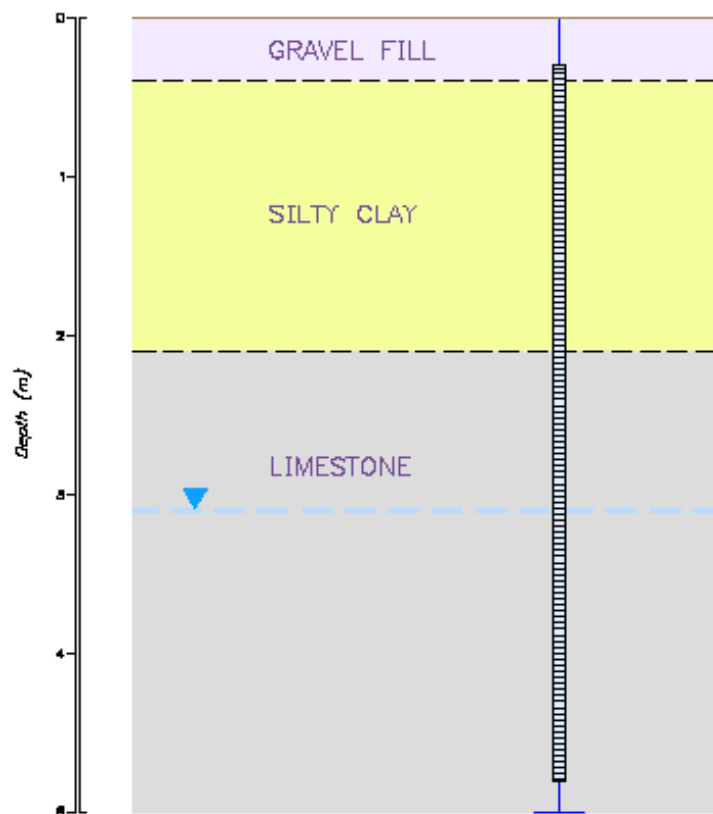
## Site 1

- Two sampling locations
- Water table approximately at 6 mbgs
- MIOs not observed during drilling
- LNAPL present in wells:
  - One location with sheens and measurable thicknesses
  - One location intermittent sheens
- PHC fraction F3 ranged from 18 mg/L to 350 mg/L



# Sampling Location Descriptions

## Site 2

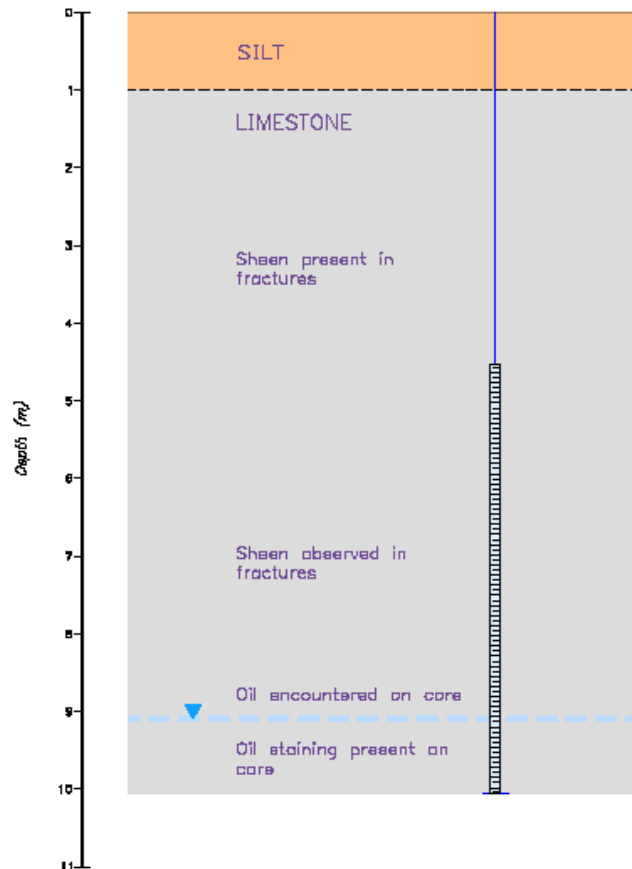


- One Sampling Location
- Water table at approximately 3 mbgs
- MIO odours in clay
- LNAPL present in well:
  - Intermittent sheens
- PHC fraction F3 ranged from 19 mg/L to 360 mg/L

# Sampling Location Descriptions

## Site 3

- Two sampling locations
- Water table at approximately 8 mbgs
- MIOs observed at one location during drilling
- LNAPL present in one well:
  - Sheens and measurable thicknesses
- PHC fraction F3 ranged from 37 mg/L to 200 mg/L, or <1mg/L



# Sampling Methodology



- Collected filtered and unfiltered samples by low flow purging using a peristaltic pump and flow through cell
- Monitored Temp, pH, DO, EC, ORP, turbidity, and water level



# Sampling Methodology



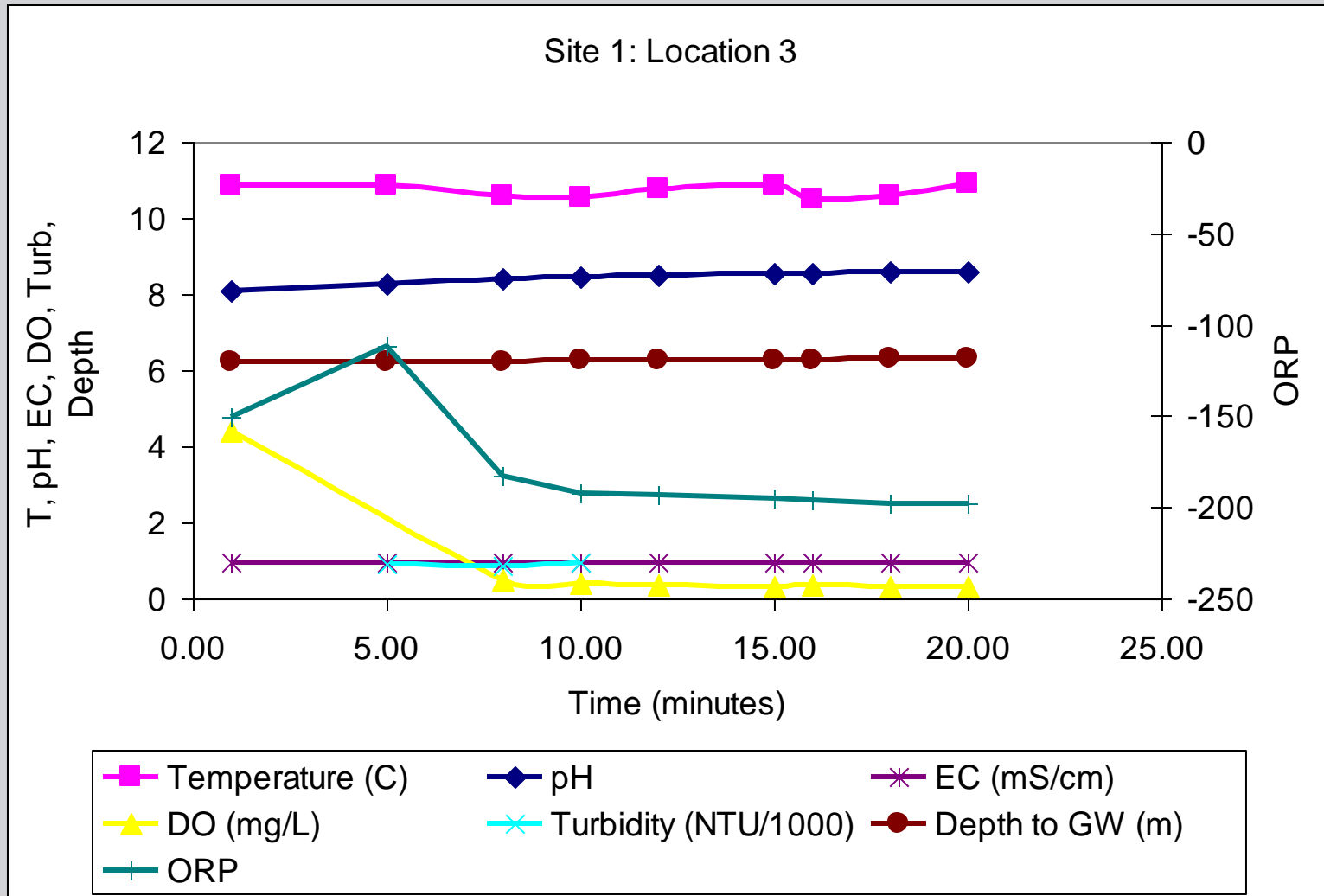
- After low flow sampling, unfiltered and filtered samples were collected by rapidly purging multiple casing volumes
- Bailers or foot valves were used to purge the wells

# Sampling Methodology



- Filtering was completed with 0.45 micron Teflon filters that required pre-conditioning with methanol

# Results

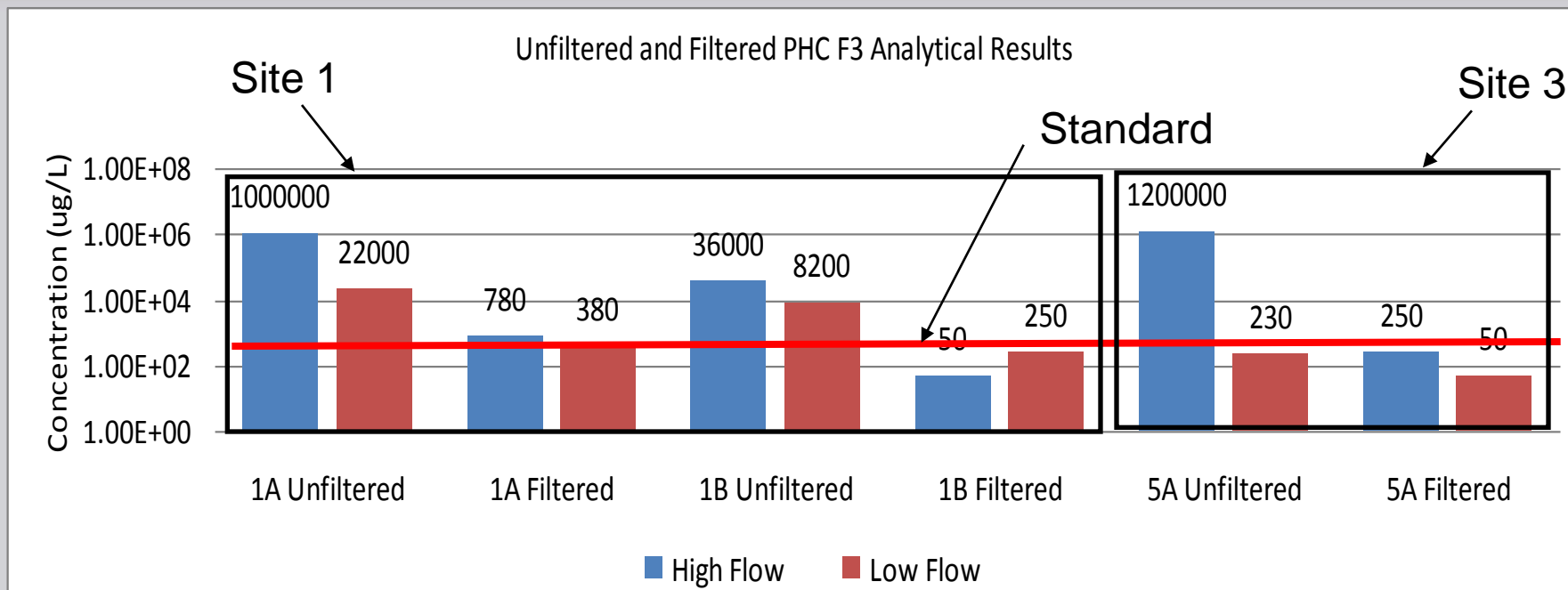




# Results

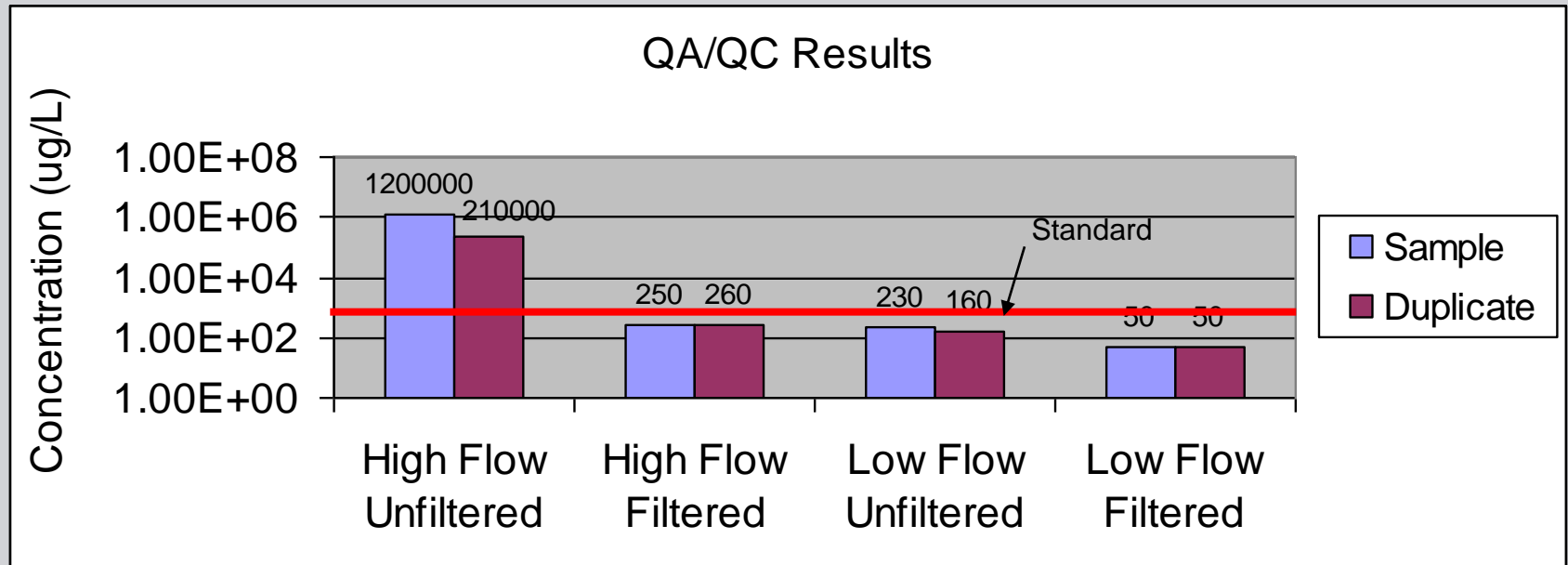
Well	Casing Volume (L)	Total Volume Purged and Sampled (L)	Observations of MIO Contamination
1A	2.0	8.0	Oily film on bailer
1B	3.0	10.6	Sheen on purge water
2	3.2	5.2	None
3A	2.4	21	None during low flow sampling Oily film on bailer
3B	4.0	4.0	None

# Results



- MIOs were observed at all of the above sampling locations
- Unfiltered samples collected by purging multiple casing volumes can produce analytical results orders of magnitude greater than samples collected by low flow purging or that were field filtered
- Low flow purging and filtering resulted in lower PHC F3 concentrations

# Results



- Very poor agreement between unfiltered samples collected by purging multiple casing volumes
- Better agreement between unfiltered low flow samples and filtered samples, but all results  $< 5 \times \text{MDL}$

# Discussions

- The selected purging method can affect extractable hydrocarbon analytical results
- Aggressive versus Passive
- Filtering





# Conclusions

- The presence of MIO as NAPLs in monitoring wells affected PHC fraction F3 analytical results
  - Results can be orders of magnitude above the expected solubility
  - Poor reproducibility between primary samples and duplicates for unfiltered samples
  - More aggressive purging methods resulted in higher PHC F3 analytical results
  - Passive purging methods resulted in lower PHC F3 analytical results
  - Filtering effectively removed MIO from the groundwater samples for a better estimate of dissolved PHCs

# MESSAGE

- **EXTRACTABLE HYDROCARBON ANALYTICAL RESULTS:**
  - NO RIGHT ANSWERS
  - JUST DIFFERENT ANSWERS
  - PERHAPS BETTER ANSWERS
    - PURPOSE!!!!!!

# Acknowledgements

Maxxam

hydro<sup>one</sup>

