

# Effects of Diluted Bitumen in the Environment

## *Introductory Remarks*

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# The Role of the USGS in Oil Spills

## Scientific Support

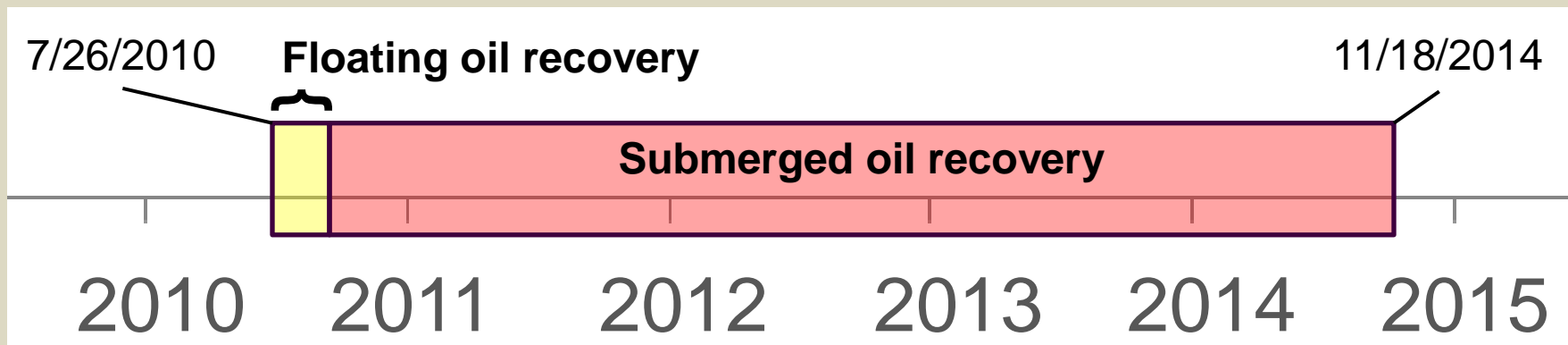
- Rapid response for assisting emergency operations
- Rivers, lakes, groundwater, wetlands, shorelines, ocean
- Field, laboratory, data collection, research, decision support tools, modeling/simulations
- Hydraulics, hydrology, chemistry, ecological impacts, mapping, water and sediment toxicity, degradation
- Fate, transport, and effects
- Natural Resource Damage Assessments



Weston/START photo

## Diluted Bitumen and the Kalamazoo River

- Released into a wetland adjacent to the Kalamazoo River, Michigan
- Most of the oil was recovered quickly using conventional techniques for floating oil
- Some of the oil mixed with river sediment, submerged, and resuspended
- New techniques were needed to contain and recover submerged oil
- New science was needed to understand fate and transport of submerged oil



## July 2010 Enbridge Line 6B Pipeline Release

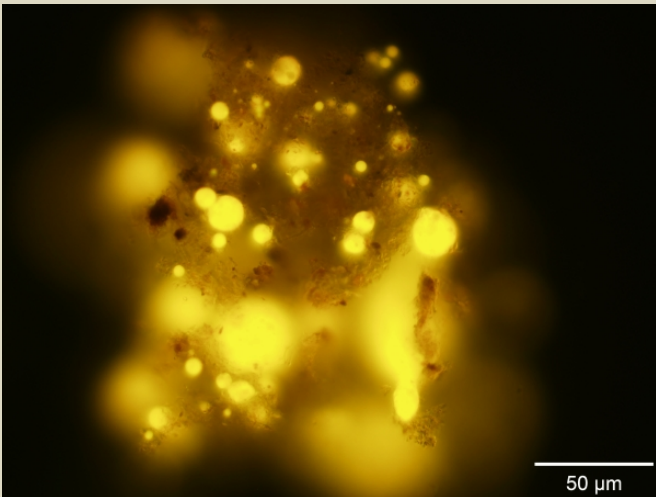
Weston/START photo

# The Spilled Oil



Weathered Cold Lake Blend, D. Waterman, Ven Te Chow Hydrosystems Lab

- Bitumen diluted with natural gas condensate (Western Canadian Select to Cold Lake Blend)
- 843,000 gallons discharged over 17 hrs (reported by Enbridge)
- Weathered oil = positively buoyant (density of 0.983-0.993 g/cm<sup>3</sup> at room temperature)
- Submerges when mixed with river sediment under natural turbulent river conditions
- Submerged oil causes persistent globule and sheen releases



Lee, et al. 2012, Kalamazoo River sediment spiked with weathered source oil after 48 hrs, under UV-epifluorescence microscopy at 320x magnification

## July 2010 Enbridge Line 6B Pipeline Release

Weston/START photo

# The Lowland River Environment

- **Flows** – Variable, quiescent to turbulent (0 to >2 m/s)
- **Water** – Freshwater, seasonally variable temperatures (0 to 28° C)
- **Suspended sediment** – Silt and organic matter (D50 of ~30  $\mu\text{m}$ ), low concentrations (~25 mg/L)
- **Channel** – Wide (50 m) and shallow (1 m), sinuous, gentle slope (0.06 percent), energy dissipation associated with bottom and banks
- **Three impoundments** – Punctuated depositional setting and turbulence of dams

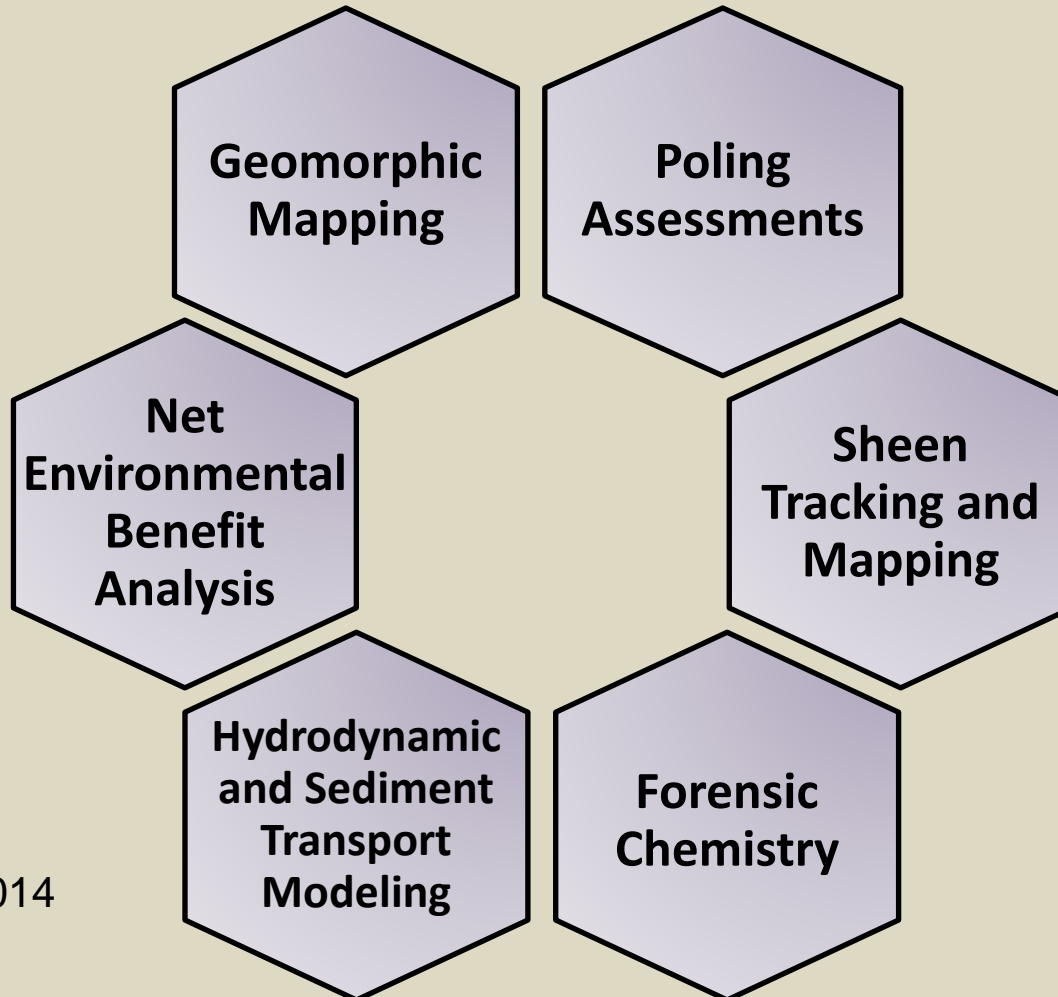
## Kalamazoo River Oil Spill Reach



Weston/START photo

# The Cleanup of Submerged Oil

## Multiple Lines of Evidence



# The Science Issues for Submerged Oil INLAND SPILLS



Kalamazoo River, Ceresco Impoundment, Summer 2011

- Formation, resuspension, settling, and breakup of oil-particle aggregates
- Containment and recovery (including active role in oil-particle interactions)
- Near-real-time mapping of spilled oil
- Oil fingerprinting and tracking
- Biodegradation and weathering
- Ecological effects related to sediment toxicity and habitat degradation

**Where is the [spilled oil + environment] along a weathering continuum?**

# Selected References

Contact: [fafitzpa@usgs.gov](mailto:fafitzpa@usgs.gov)

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**U.S. EPA web site for EPA's Response to Line 6B Spill**

<http://www.epa.gov/enbridgespill/>