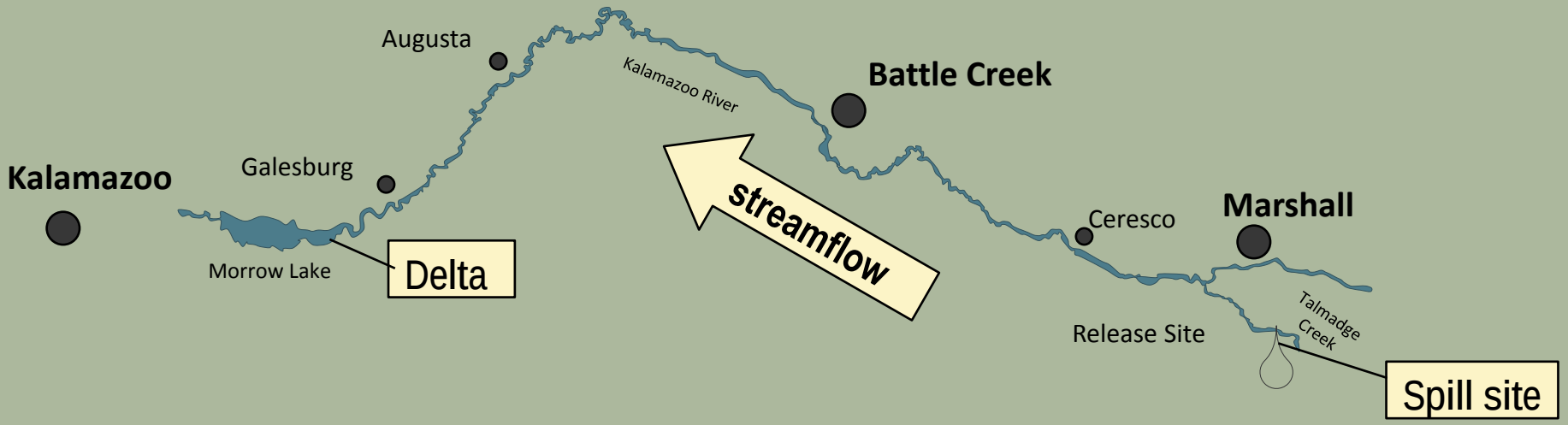
Overview of a Large Spill of Diluted Bitumen

July 2010 Enbridge Line 6B Diluted Bitumen Release



Presented by Faith A. Fitzpatrick (U.S. Geological Survey WI Water Science Center)

Large Spills of Diluted Bitumen in Rivers

- Heavy crude oil from Athabasca oil sands (bitumen)
  - becomes really sticky as it weathers,
  - easily mixes and adheres with river sediment and sinks
- Rivers can transport submerged oil and oiled sediment for many miles, especially during floods
- Submerged oil and oiled sediment can take a long time to clean up
- Special containment for flowing water is needed
- Ice and cold weather complicate recovery

USGS
ce for a changing world

July 2010 Enbridge Line 6B Crude Oil Release – Marshall, Michigan

Edmonton Control Center

Direction of flow

Lakehead System

Sarnia

Griffith

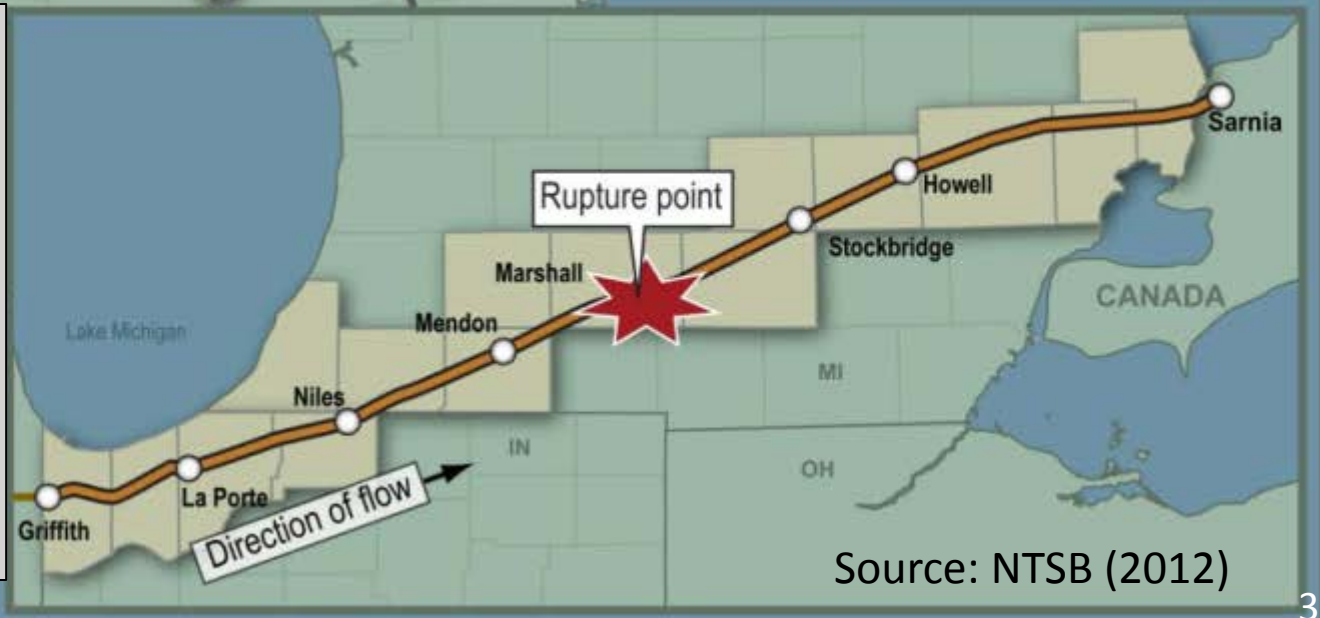
Line 6B

Enbridge Pipelines

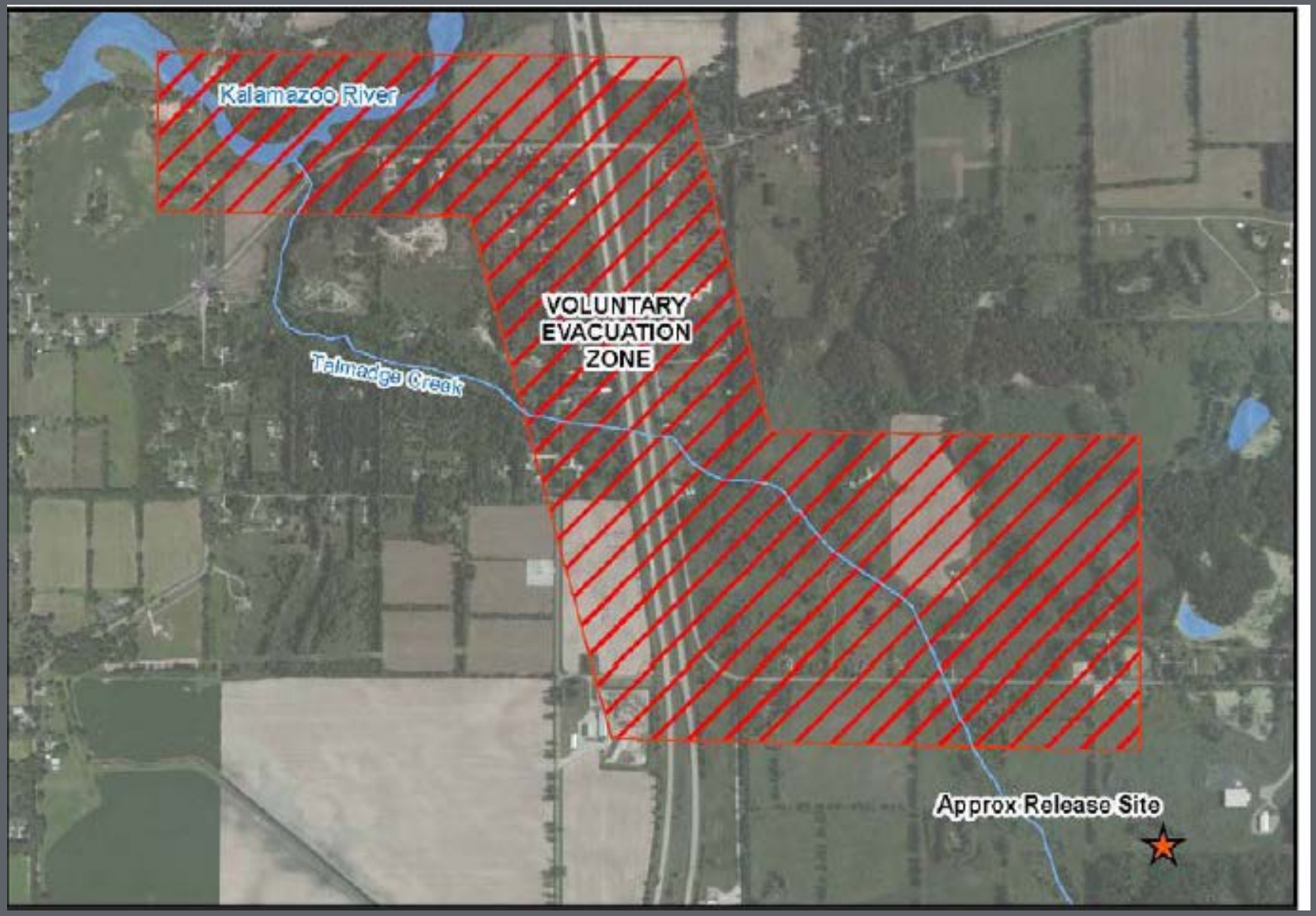
- Enbridge Liquids System
- Lakehead System
- Line 6B
- Edmonton Control Center
- Pump Station

Source NTSB (2012)

- July 25, 2010 pipeline rupture
- ~843,000 gallons of diluted bitumen (dilbit) released over 17 hours
- Wetland to Talmadge Creek to 38 miles Kalamazoo River
- 80 miles upstream from Lake Michigan



Source: NTSB (2012)



https://www.epa.gov/enbridge-spill-michigan/fosc-desk-report-enbridge-oil-spill

Kalamazoo River Spill

Photo credit: Enbridge

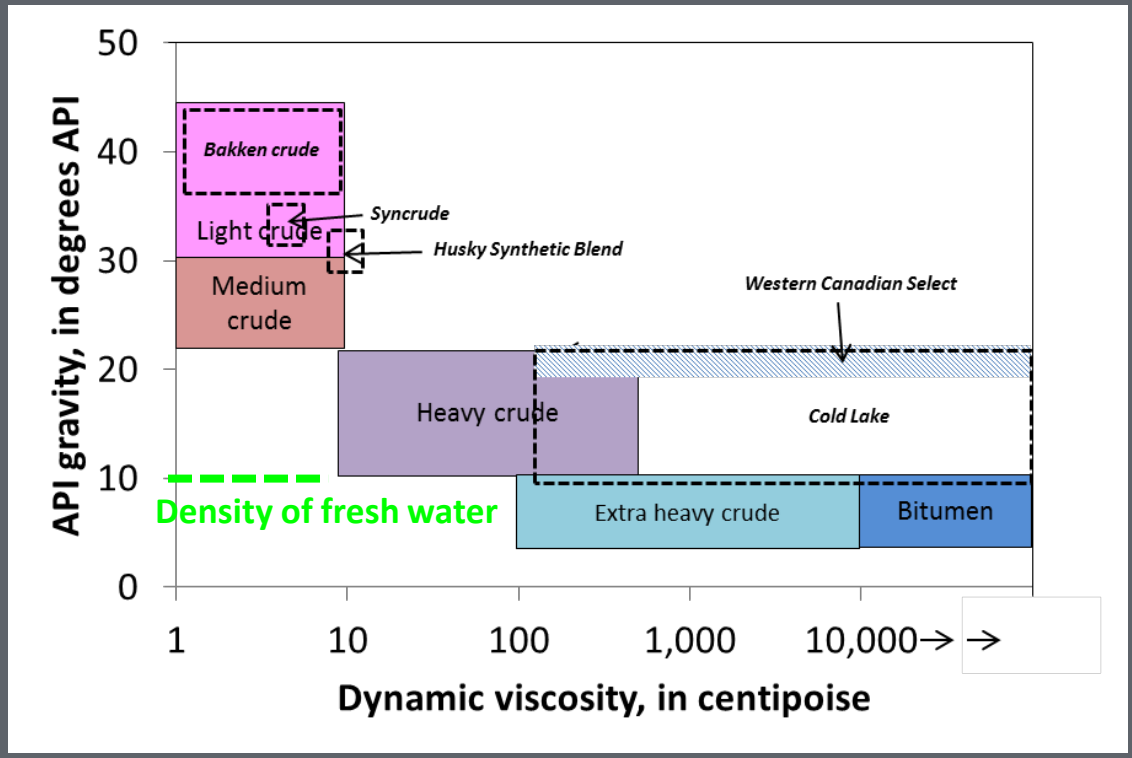
Photo credit: NASA/USGS

- First major spill of dilbit into a river/freshwater environment
- One of the most costly spills in U.S. history at >$1.2 billion
- Happened during a flood (4% probability of happening in any given year)

Photo credit: David Kenyon MIDNRE

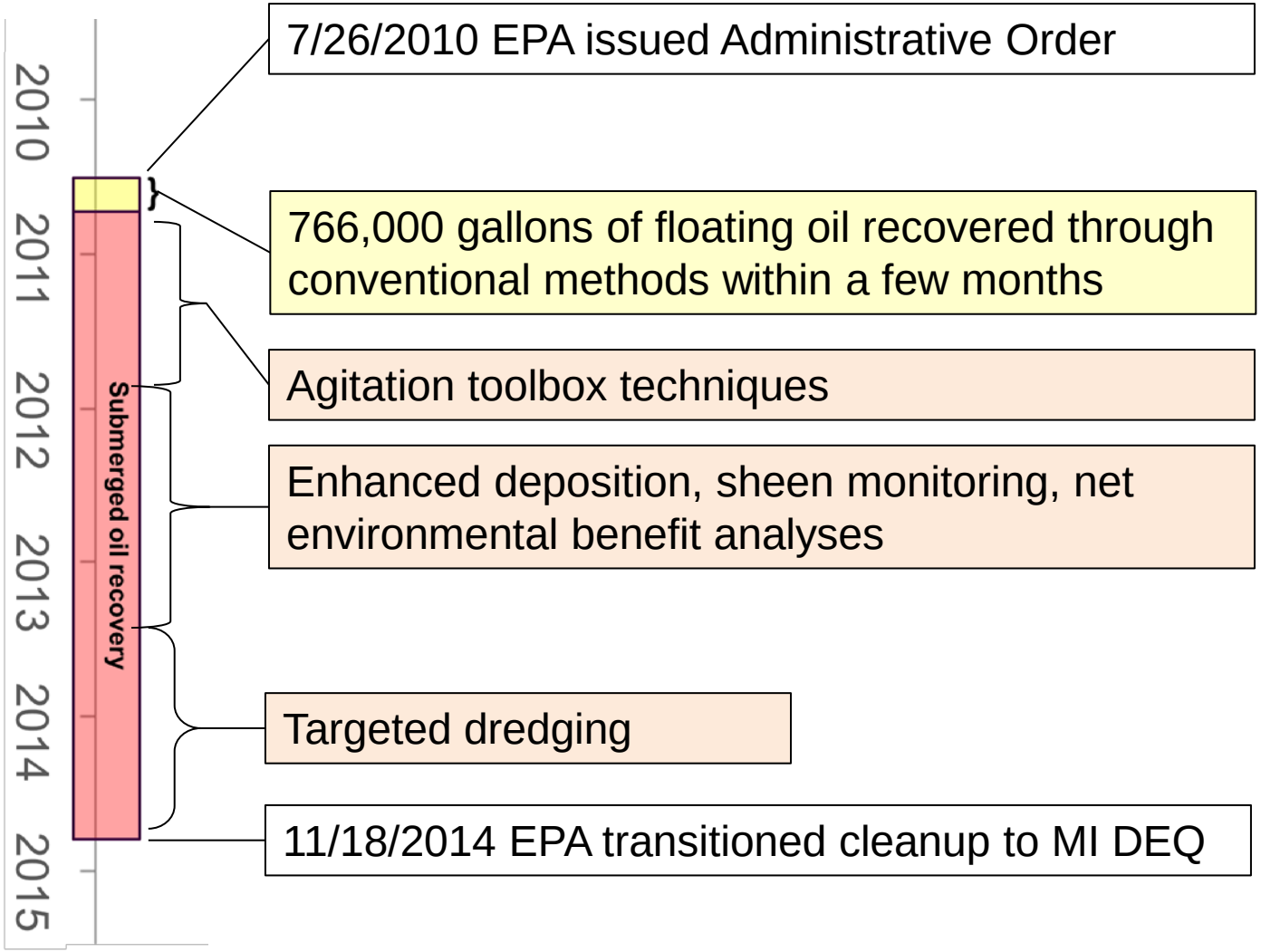
Line 6B Cold Lake Blend Properties

- Density close to water
- Viscosity high and temperature dependent
- High affinity to adhere to sediment and organic matter

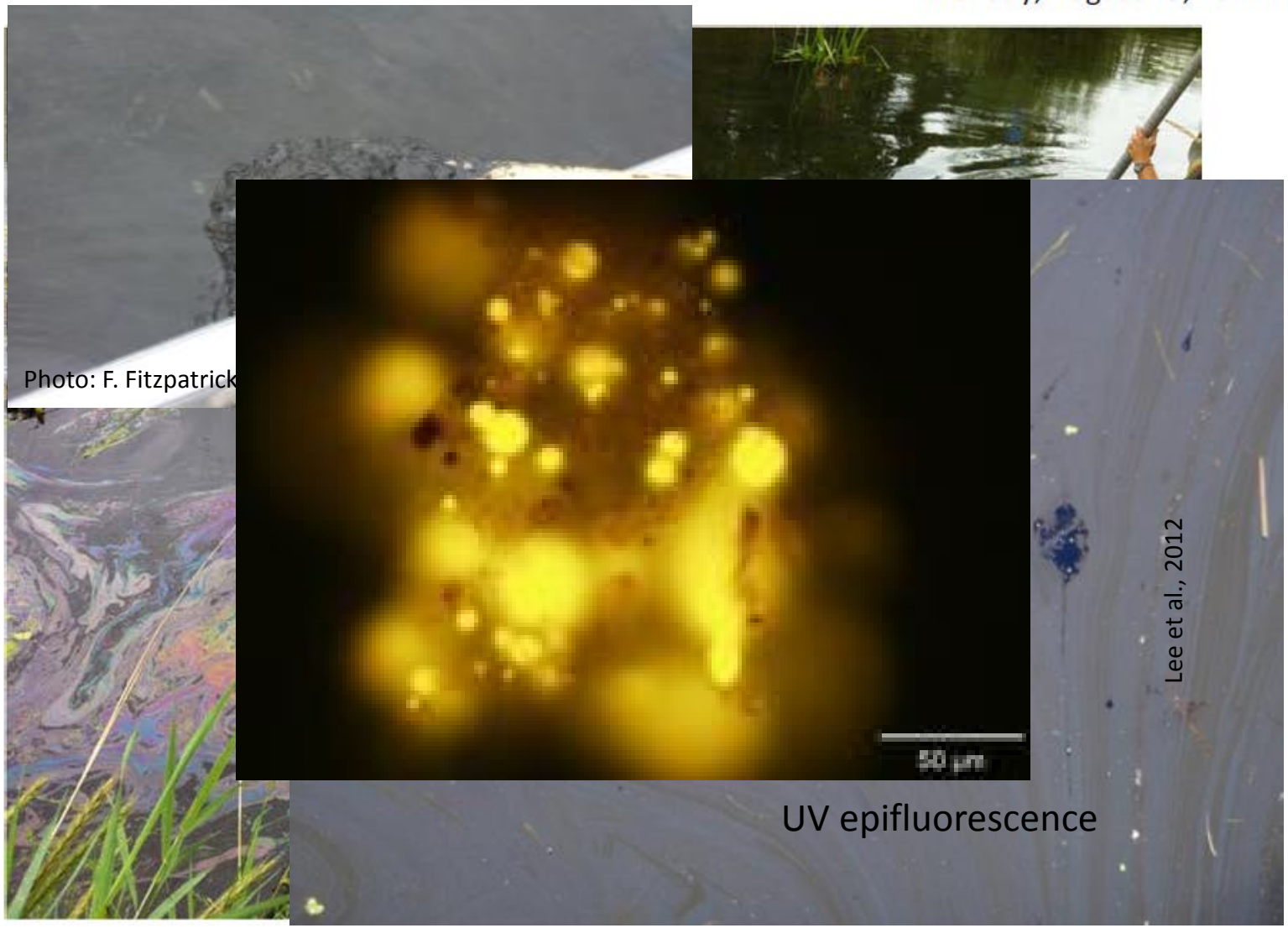


Graph from Fitzpatrick and others (2015)
Data summarized from Attanasi and Meyer (2007), American Petroleum Institute (2011), Sia Partners Energy Outlook (2011), Environment Canada's Oil Properties Web Site http://www.etc-cte.ec.gc.ca/databases/oilproperties/Default.aspx, Andrews (2014), Doelling and others (2014), Crude Quality, Inc. (2014); and Enbridge Energy Partners, L.P. (2013).

EPA Emergency Response Submerged Oil Timeline



Monday, August 13, 2012 Photo Log



Photos: EPA/START

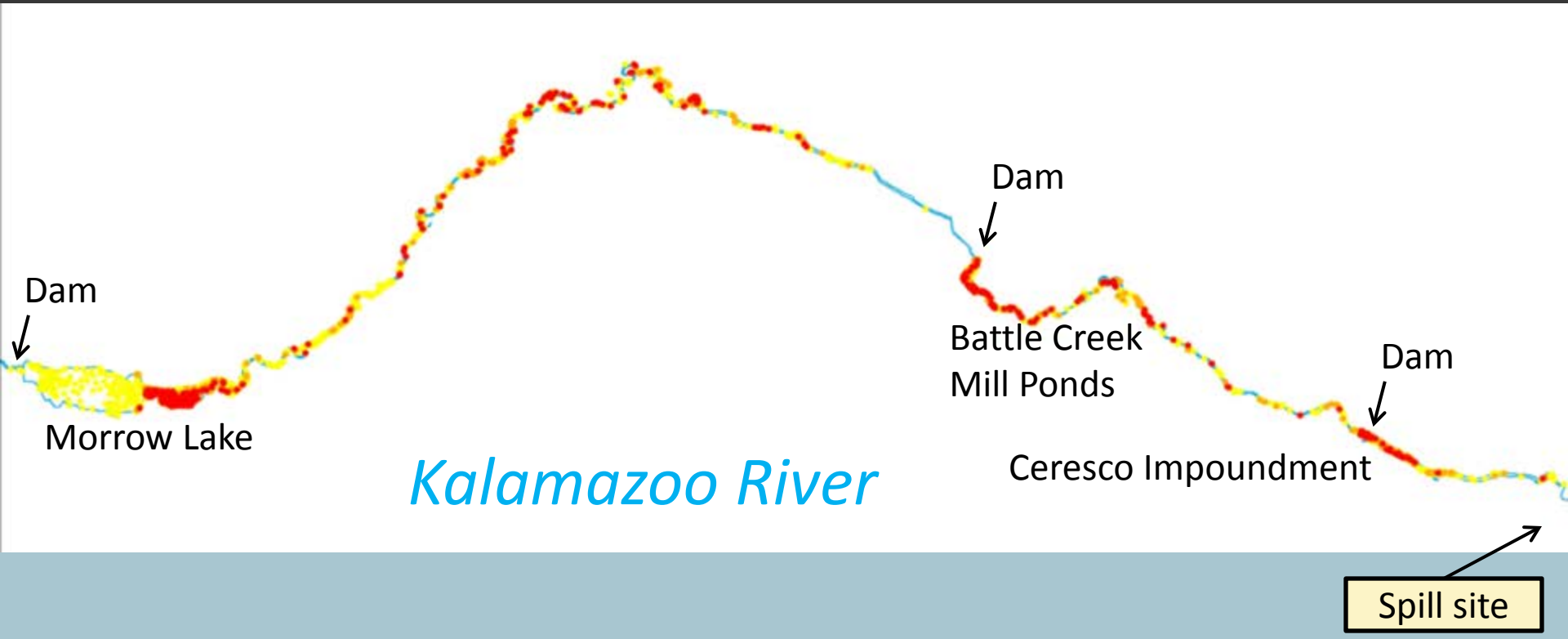
13. MP10.75 Area where heavy rainbow sheen was observed.

Lee, K., J. Bugden, S. Cobanli, T. King, C. Mcintyre, B. Robinson, S. Ryan, and G. Wohlgeschaffen (2012) UV-Epifluorescence microscopy analysis of sediments recovered from the Kalamazoo River: Center for Offshore Oil, Gas and Energy Research (COOGER), Fisheries and Oceans Canada, AR-1277.

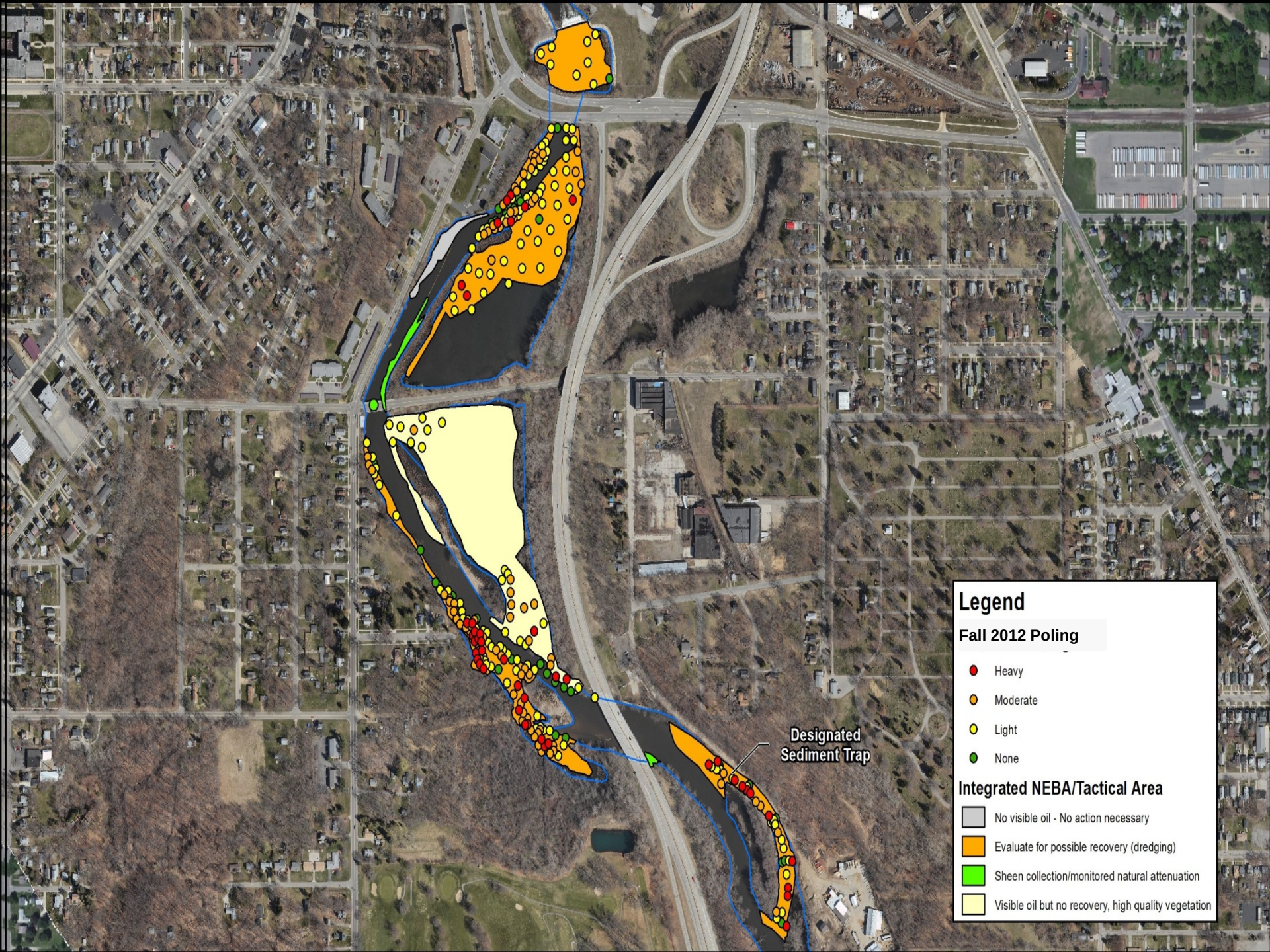
Poling Technique

Video: USEPA

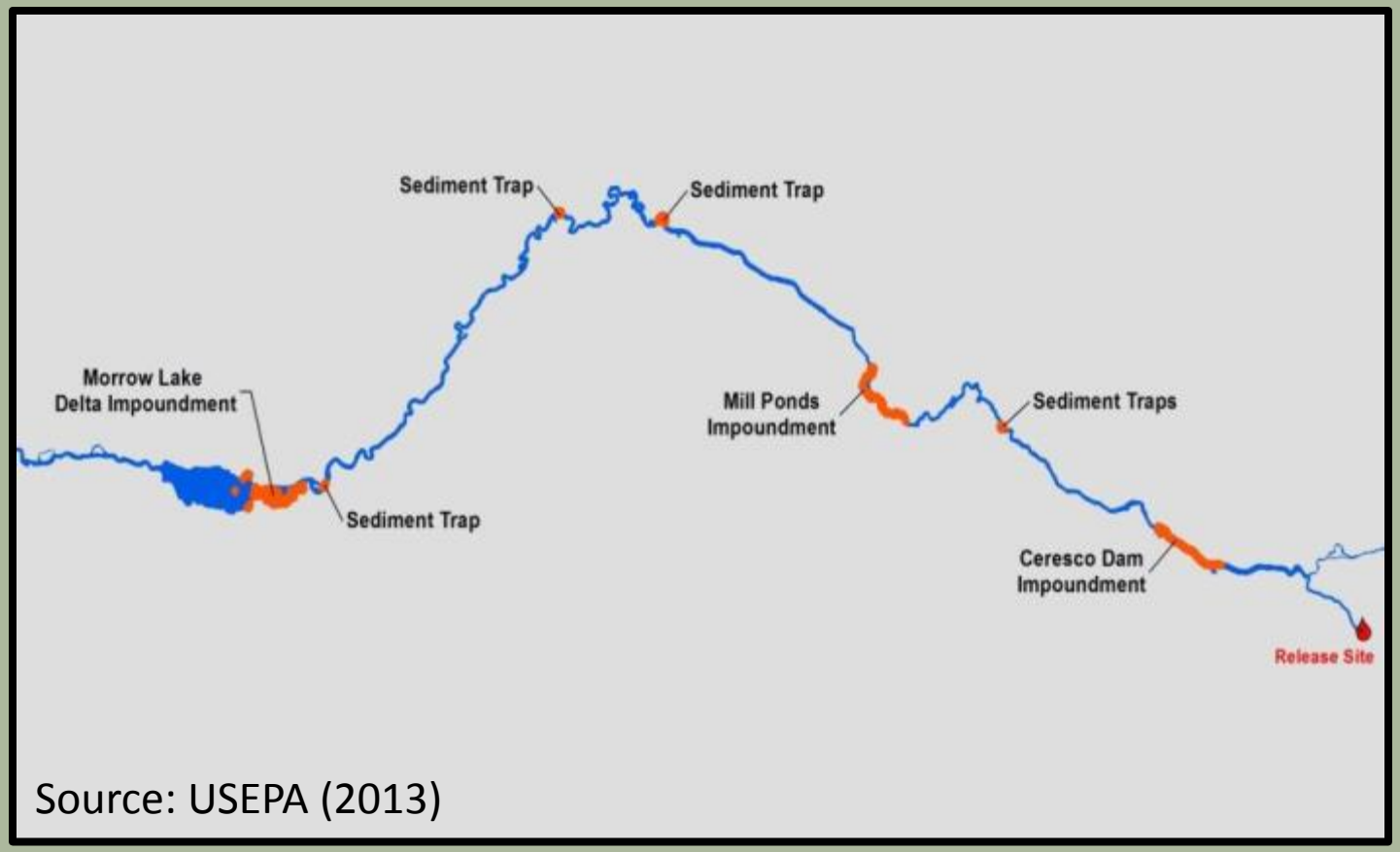
2012 Spring Reassessment



Moderate and heavy oiled sediment along entire Kalamazoo River 38-mi spill zone – 200 + targeted areas


Designated
Sediment Trap
Legend
Fall 2012 Poling
Heavy
Moderate
Light
None
Integrated NEBA/Tactical Area
No visible oil - No action necessary
Evaluate for possible recovery (dredging)
Sheen collection/monitored natural attenuation
Visible oil but no recovery, high quality vegetation

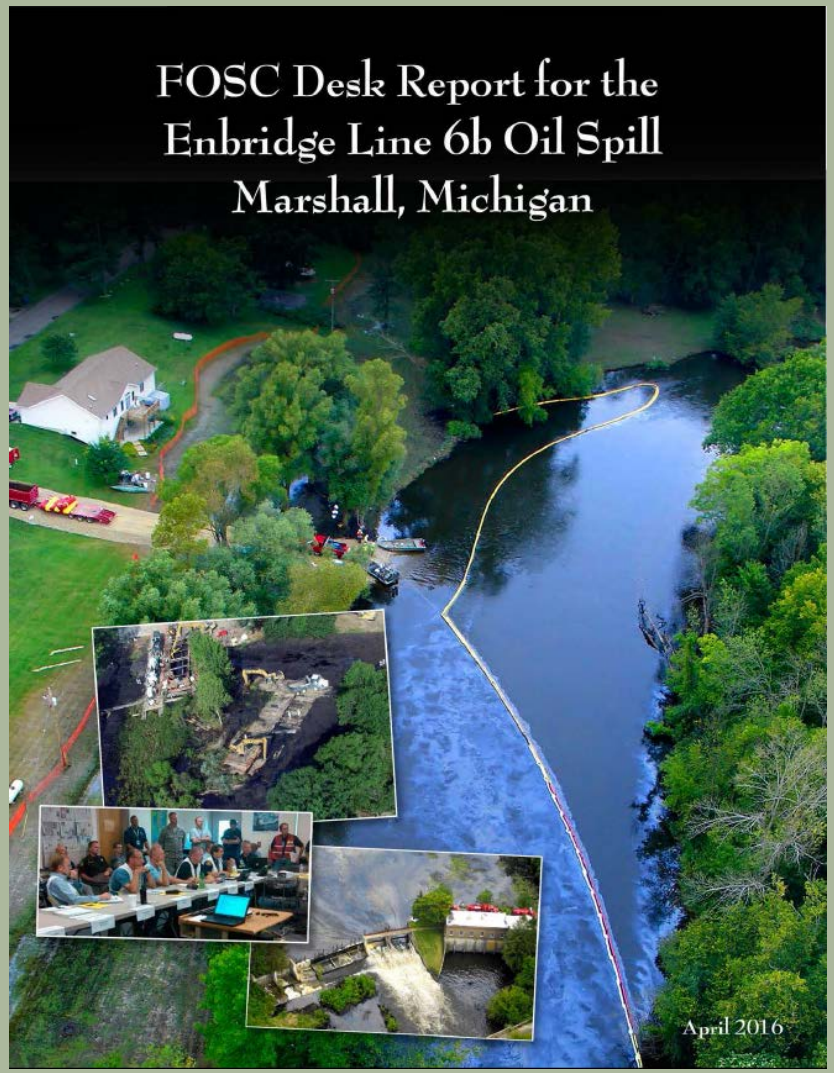
Targeted Dredging 2013-14



Source: USEPA (2013)

Balance of final recovery effectiveness with a need to do no additional harm to the environment

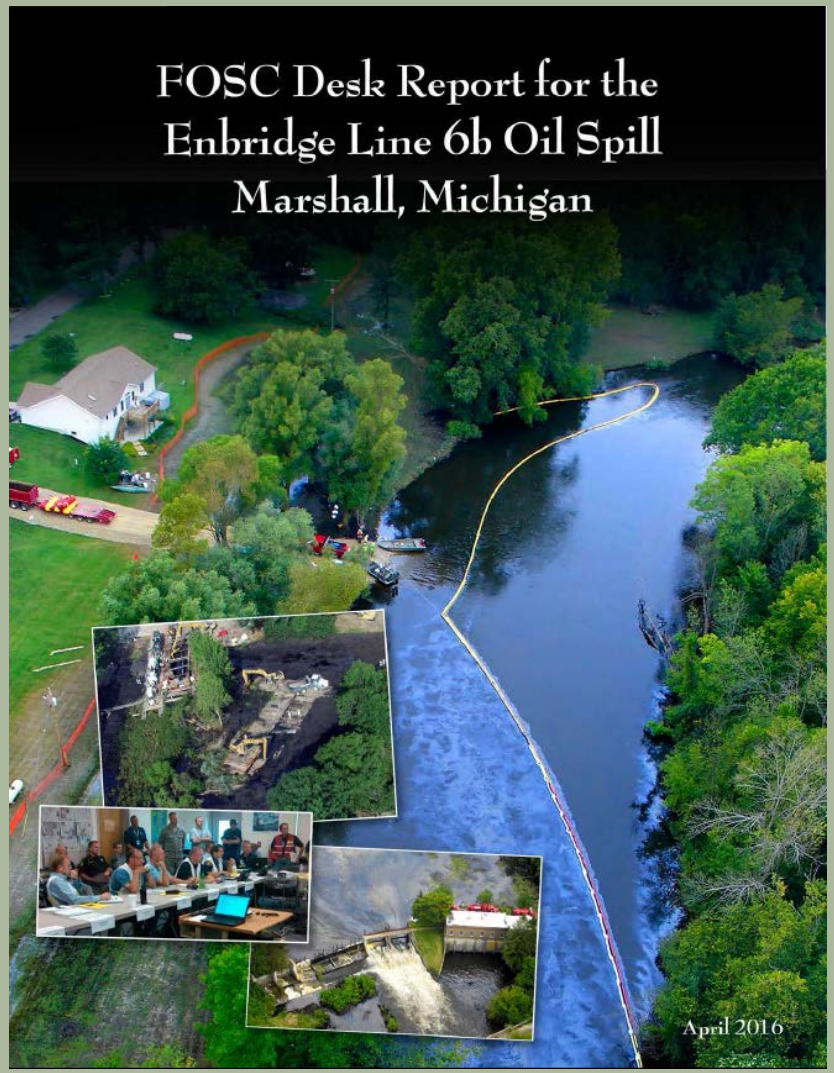
Federal On Scene Coordinator Recommendations Enbridge Line 6B Oil Spill



- Use conventional techniques for containment and recovery before weathering window closes and oil sinks
- Put submerged oil containment systems in place robustly and early
- Be prepared to conduct aggressive air monitoring and sampling to protect public health and worker safety.
- Practice strong area planning to optimize strong response organization early on.
- Initiate science aspects of response support early to support the ultimate cleanup goals.

https://www.epa.gov/enbridge-spill-michigan/fosc-desk-report-enbridge-oil-spill

Science Support for Operations
Fate and Transport of Submerged Oil



- Fluvial geomorphology understanding
- Effects of temperature on resuspension
- Biodegradation rates
- Submerged oil assessment and mapping
- Comprehensive sheen mapping
- Modeling simulations of river flows and containment techniques
- Line 6B oil fingerprinting
- Quantification of submerged oil
- Net environmental benefit analyses

https://www.epa.gov/enbridge-spill-michigan/fosc-desk-report-enbridge-oil-spill

North American Crude Oil Pipelines

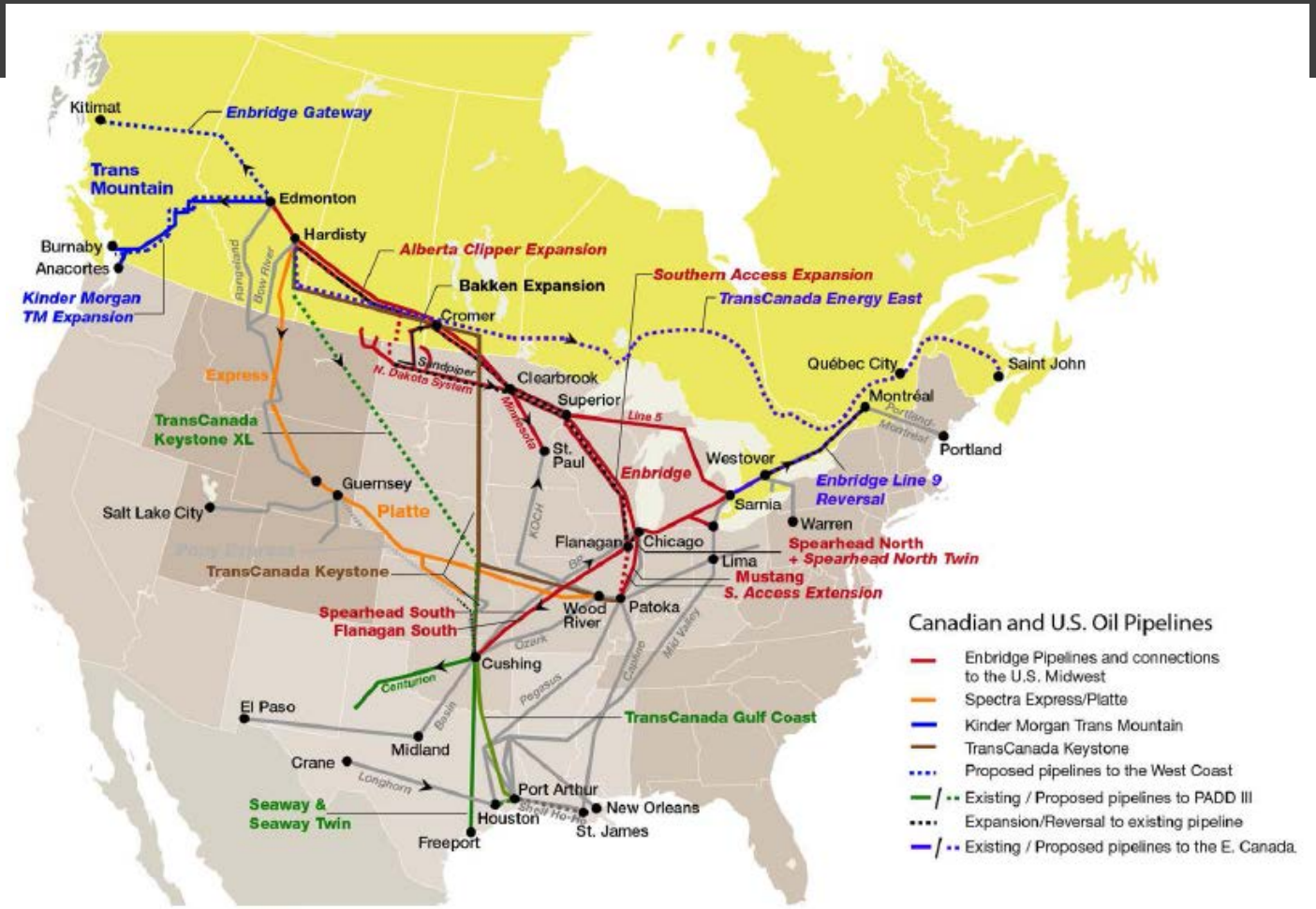


Figure 1-1 Existing and proposed Canadian and U.S. crude oil pipelines.

SOURCE: Canadian Association of Petroleum Producers[5a]

From Committee on the Effects of Diluted Bitumen in the Environment "Spills of diluted bitumen from pipelines…" (2015)

Thank you:

U.S. EPA Federal On-Scene Coordinators, U.S. EPA, MDEQ and Enbridge Operations and Environmental Sections, Incident Command Structure

FOSC's Science Support and Coordination Group

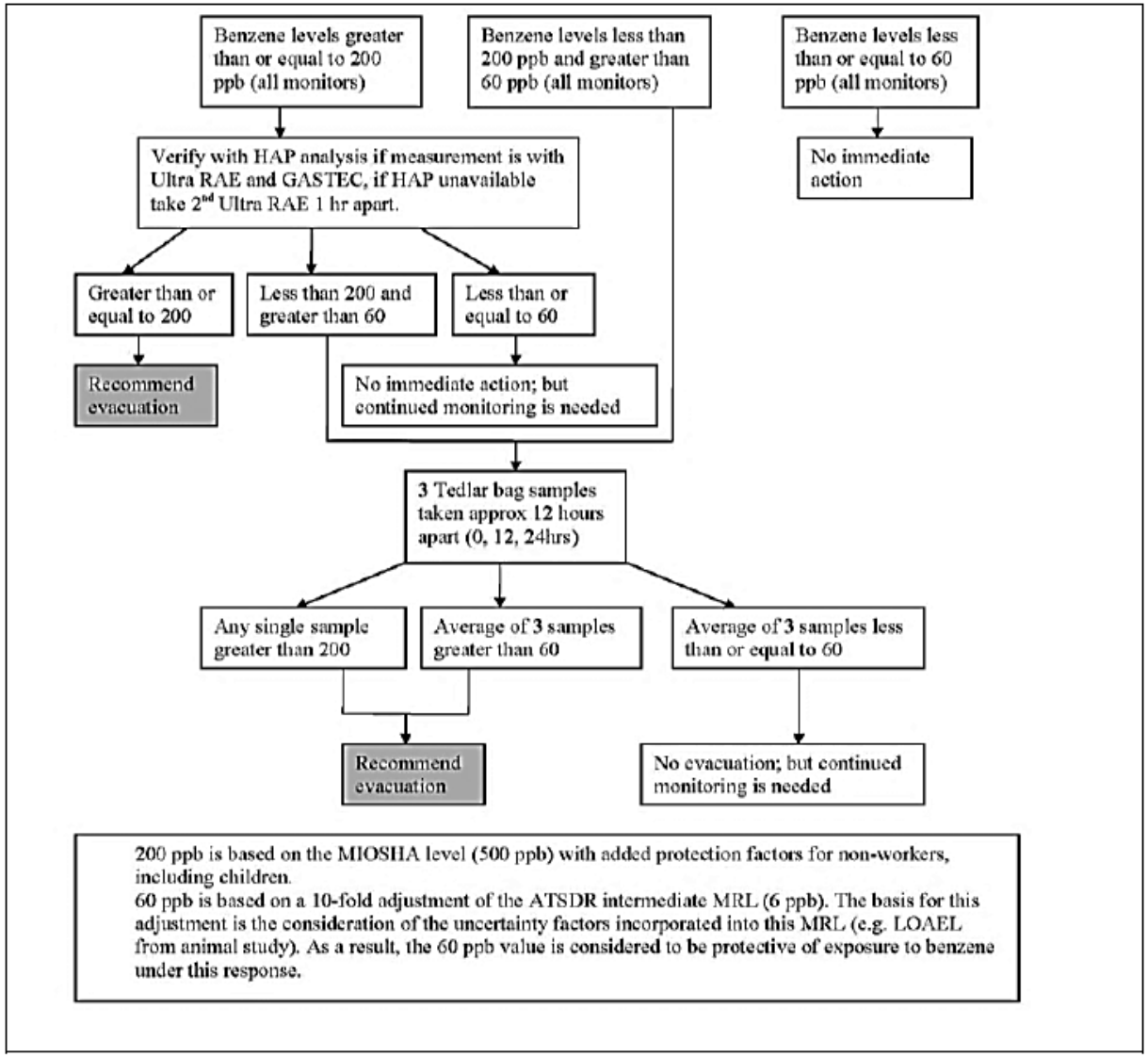
For more information:

U.S. EPA web site for EPA's Response to Line 6B Spill: http://www.epa.gov/enbridgespill/

Documents, data, photos, and the Administrative Record are posted for public access. http://www3.epa.gov/region5/enbridgespill/documents.html

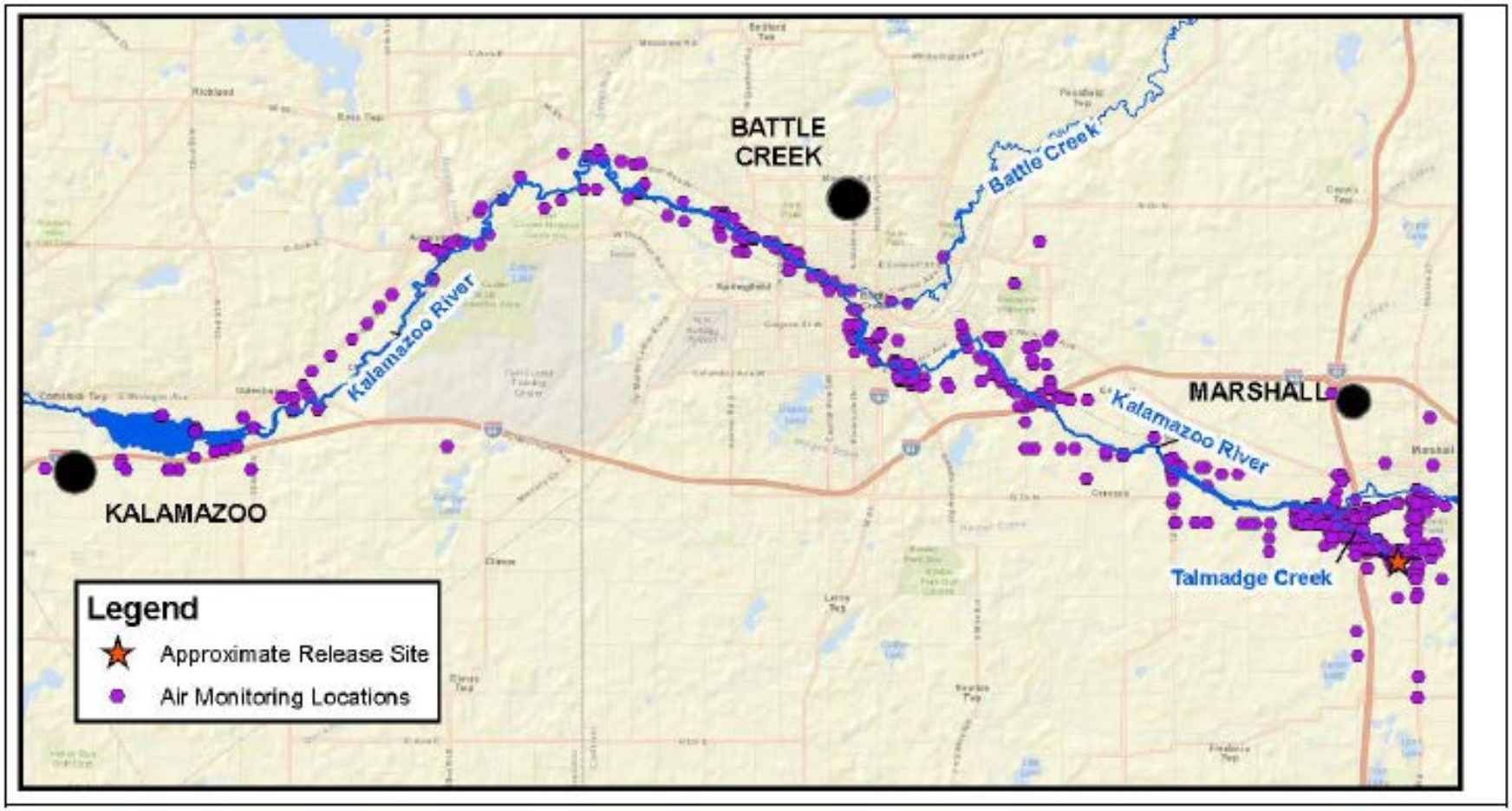
Extra Slides

Figure 93 – Evacuation Decision Tree (Based on Benzene Concentrations), July 2010



https://www.epa.gov/enbridge-spill-michigan/fosc-desk-report-enbridge-oil-spill

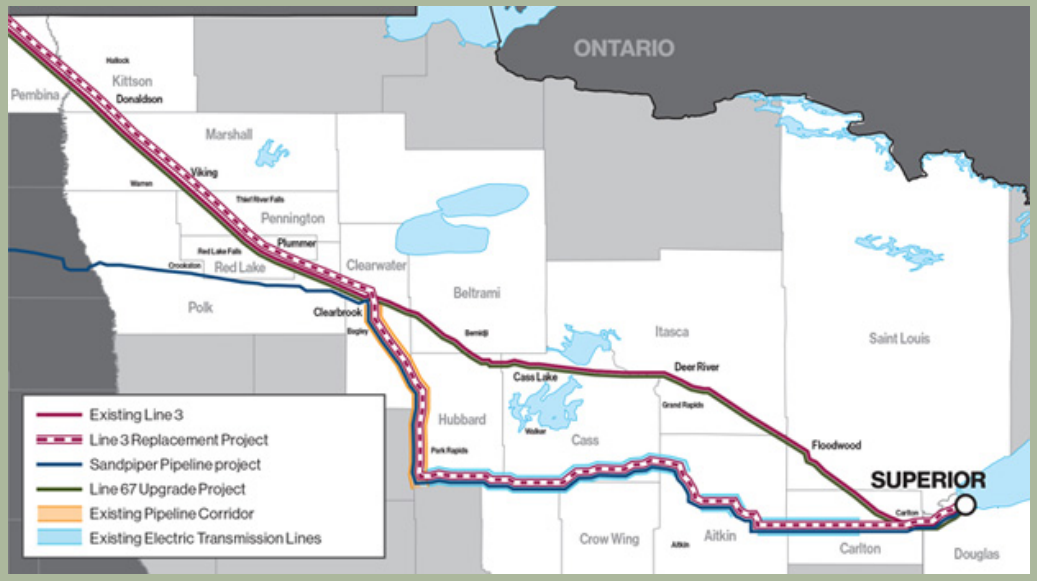
Figure 91 – Air Monitoring Locations Along Affected Waterway



https://www.epa.gov/enbridge-spill-michigan/fosc-desk-report-enbridge-oil-spill

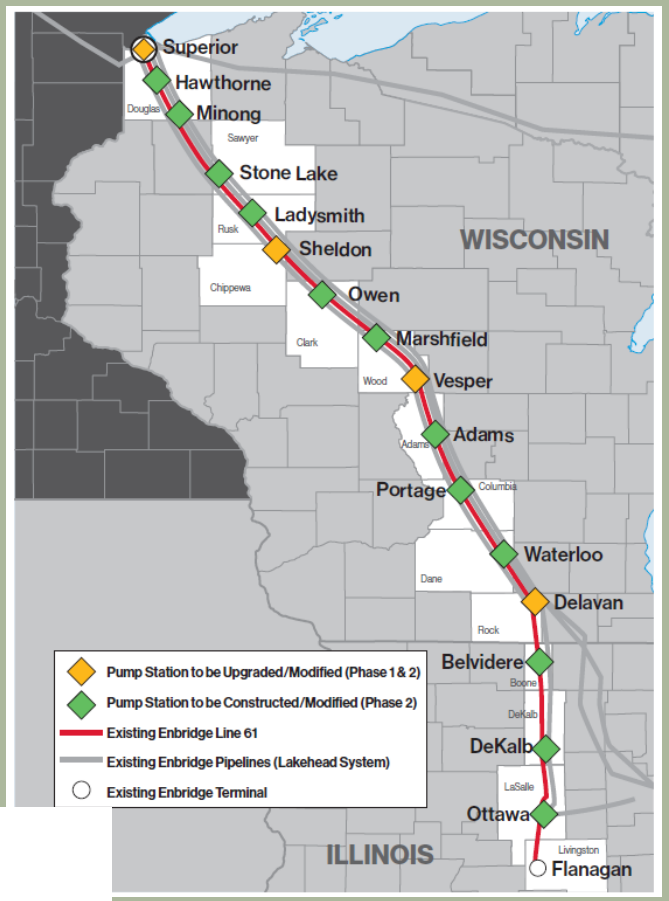
Pipeline Expansions in Minnesota and Wisconsin

Lines 3 and 67



http://www.enbridge.com/~/media/Rebrand/Documents/Projects/US/ENBLine61UpgradeHandoutMAY2015L03.pdf?la=en

Line 61



http://www.enbridge.com/~/media/Rebrand/Documents/Projects/US/ENBLine61UpgradeHandoutMAY2015L03.pdf?la=en

Capacity: Expand average annual capacity of Line 61 from:

Phase 1: 400,000 bpd to 560,000 bpd

Phase 2: 560,000 bpd to 1.2 million bpd

National Academy of Sciences 2015 Study on Dilbit

	Property	Potential Outcomes	Level of Concern Relative to Commonly Transported Crude Oils: Diluted Bitumen	Level of Concern Relative to Commonly Transported Crude Oils: Weathered Diluted Bitumen
Fate	Density	• Sinking • Burial	SAME	MORE
	Adhesion	• Sinking after sediment interaction • Surface coating	SAME	MORE
	Viscosity	• Penetration	LESS	LESS
	Percentage of light fraction	• Air emissions	SAME	LESS
	Flammability	• Fire or explosion risk	SAME	LESS
	Biodegradability	• Persistence	MORE	MORE
	Burn residue	• Quantity of residue • Residue sinking	MORE	MORE

http://www.nap.edu/catalog/21834/spills-of-diluted-bitumen-from-pipelines-a-comparative-study-of

National Academy of Sciences 2015 Study on Dilbit

Effects

Property	Potential Outcomes	Level of Concern Relative to Commonly Transported Crude Oils	
		Diluted Bitumen	Weathered Diluted Bitumen
Density	• Impaired water quality from oil in the water column and sheening	SAME	MORE
Adhesion	• Fouling and coating	MORE	MORE
BTEX components	• Contaminated drinking water • Respiratory problems/disease	SAME	LESS
HMW components	• Trophic transfer/food web • Aquatic toxicity	UNKNOWN	
LMW components	• Aquatic toxicity • Taste/odor concerns in drinking water	UNKNOWN	
		SAME	LESS

http://www.nap.edu/catalog/21834/spills-of-diluted-bitumen-from-pipelines-a-comparative-study-of

High Priority Research Needs (Data Gaps)

- Baseline data from high-risk areas
- National data base for risk assessment information
- Shoreline sensitivity mapping in the Arctic
- Sensitivity mapping in inland freshwater habitats
- Experiments for efficacy of current and new oil-spill response techniques
- Comparison of risks of cleanup methods under Arctic conditions
- Focused risk assessments as a follow-up to recent assessments (short term)
- Take advantage of spills of opportunity (fate, behavior, effects)