LNAPL Conceptual Site Models: A Case Study

MWCC 2017

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The Issue

- Numerous older LUST sites with LNAPL detections
- Often "nuisance quantities" (few inches or less in 1-2 wells)
- New developments in science & technology over to course of a project result in a "moving target"
- Large volumes of older data not collected in accordance with current standards
- No process to achieve "as much as practicable" until recently
- Affects approximately 20-25% of MRBCA sites

Solution

April 2016 – MoDNR releases the Draft Guidance "Addressing Light Non-Aqueous Phase Liquids at Petroleum Storage Tank Sites".

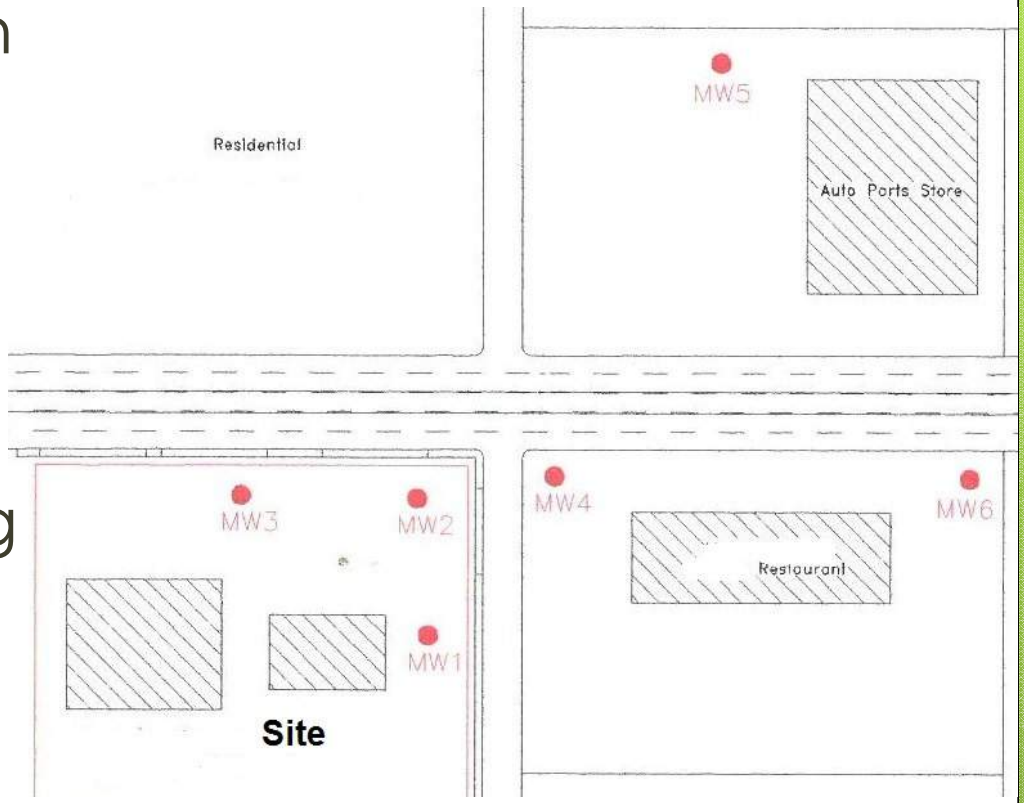
- Supplements the 2004 & 2013 MRBCA Guidance documents
- References available peer-reviewed resources (ITRC, ASTM, etc.)
- Provides guidance for preparing LCSMs, using either quantitative (metrics) or qualitative (weight of evidence) methods

Case Study: Springfield, MO

- **Site** – former 1950s gas station, currently equipment rental/repair business
- **Release discovery** – UST Closure in 1998 (gasoline)
- Some soil impact left in place due to site / equipment limitations

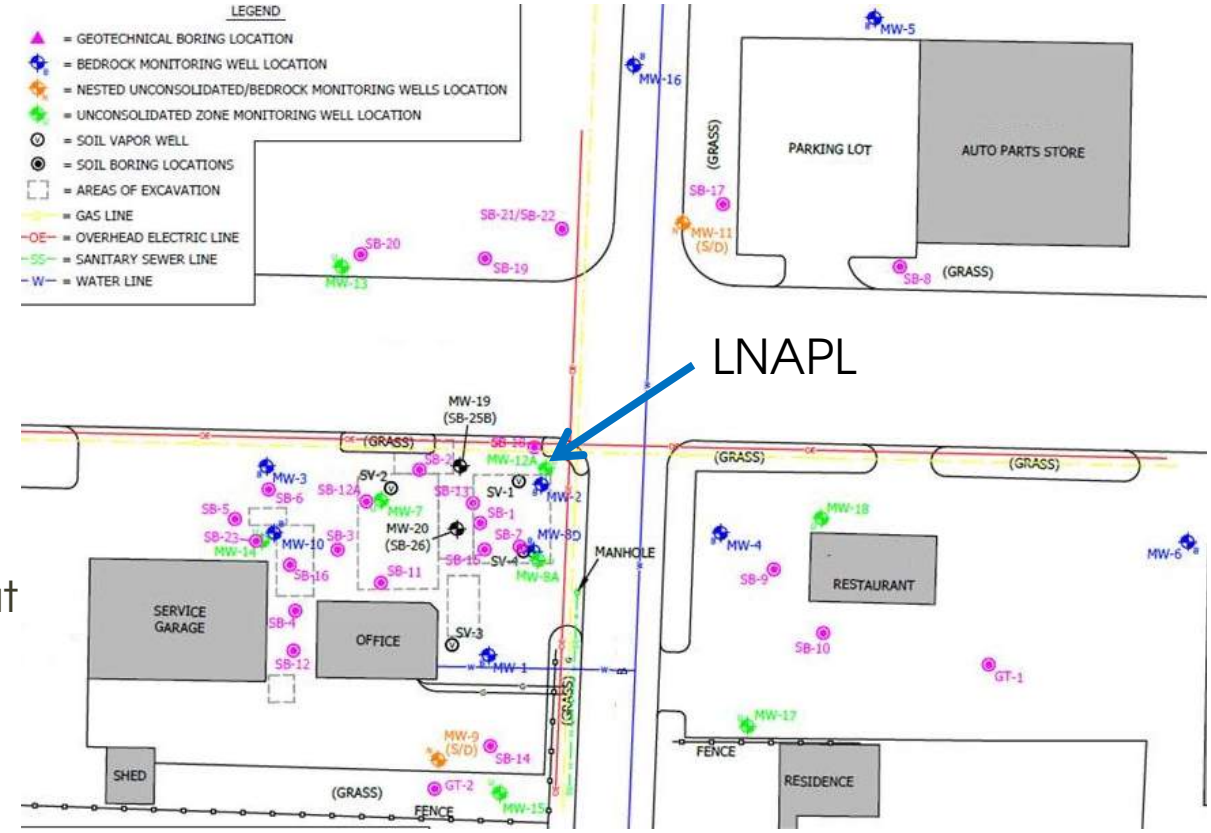
Case Study: Springfield, MO

- Site Characterization begins 2000 (pre-MRBCA)
- 6 shallow bedrock wells installed
- 2002 – LNAPL in 2 of the onsite monitoring wells



Fast Forward 14 years…

- 641 cu yds soil excavated
- 84 soil samples
- 20 rounds of GW sampling
- 12 unconsolidated monitoring wells
- 11 shallow bedrock wells
- 10 months of transducer data
- 8 soil vapor points
- 3 years pump & treat system
- 3 spring samples
- 2 geotechnical samples
- 2 consultants
- 1 MDPE event
- <1 inch of LNAPL in one well



What do we do with all this data?

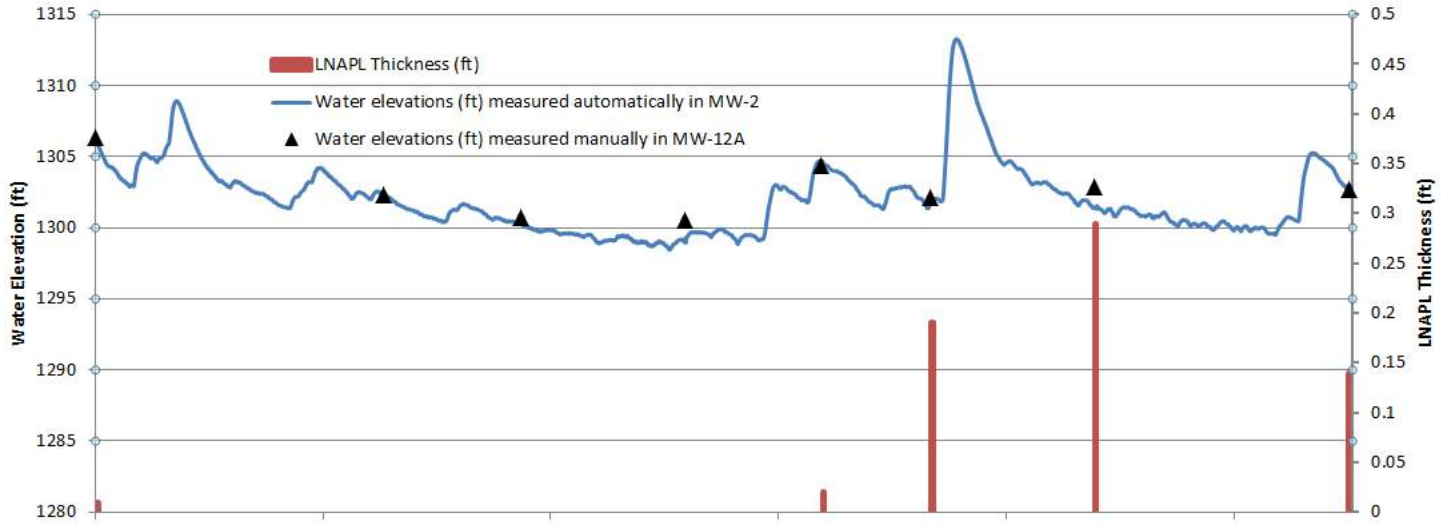
LNAPL Conceptual Site Model

- **Release:** Prior to 1998
- **Type:** Gasoline
- **Volume:** Unknown
- **Threat of Ongoing Release?** No
- **LNAPL Characteristics**
  - Sampled 2013, effective solubility calculated – LNAPL appeared dark and weathered
  - Soil data collected from same area 10 years apart indicates natural degradation

Sample ID	Date	Depth (ft bgs)	Benzene (mg/kg)	TPH-GRO (mg/kg)
SB-1	9/20/1999	28	17	1900
SB-15	8/27/2009	22	4.91	3710
		26	5.06	1040
SB-26	9/19/2015	22	0.43	1400

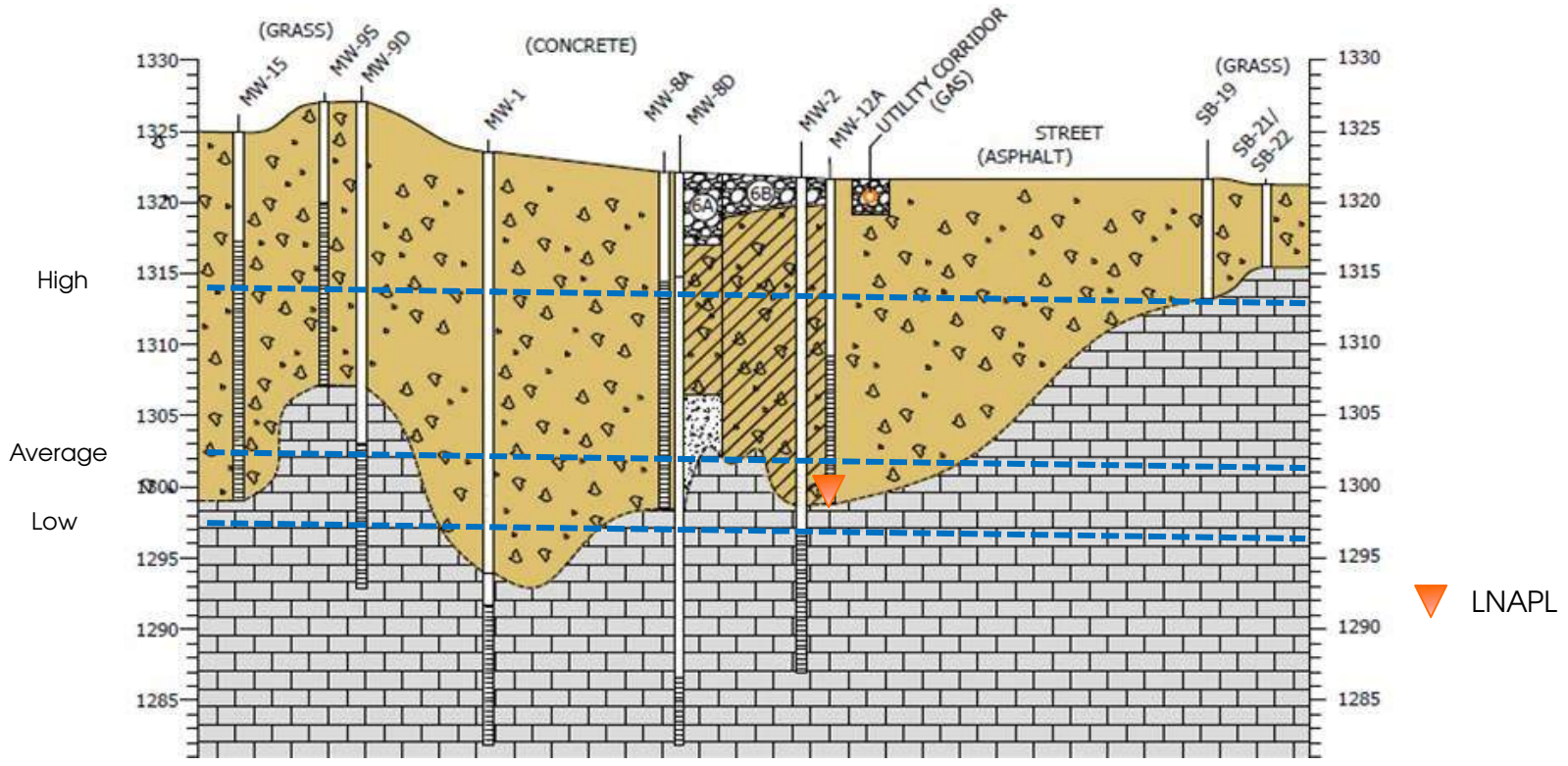
LCSM – Extent of Impact

- **Soil** – isolated to few areas that could not be excavated
- **GW** – dissolved phase impact present in both perched zone and shallow bedrock, delineated onsite
- **LNAPL** – present in 1 unconsolidated well (previously found in two bedrock wells during low water conditions)
  - only appears after drops in water table
  - found only near the soil/bedrock interface (epikarst)



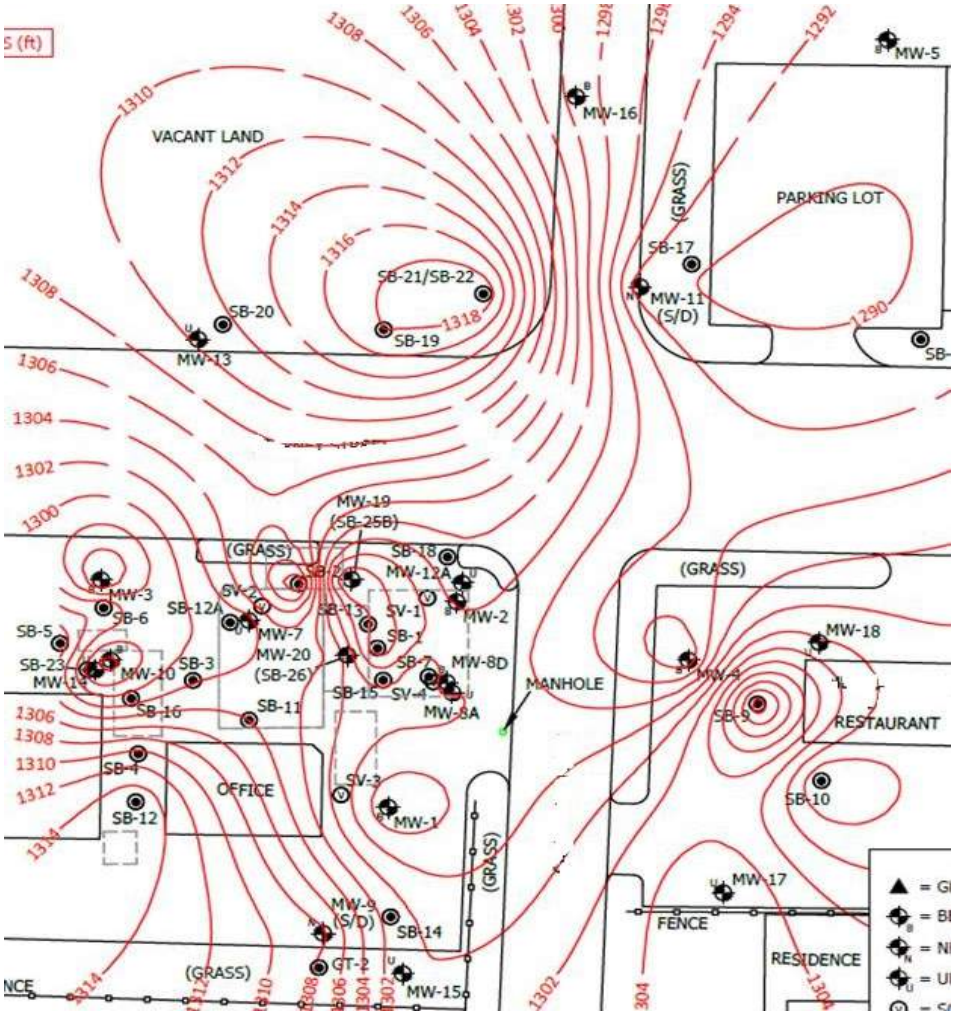
LCSM - Lithology

- Soil – clay with varying amounts of chert
- Also numerous excavations on site, some to bedrock



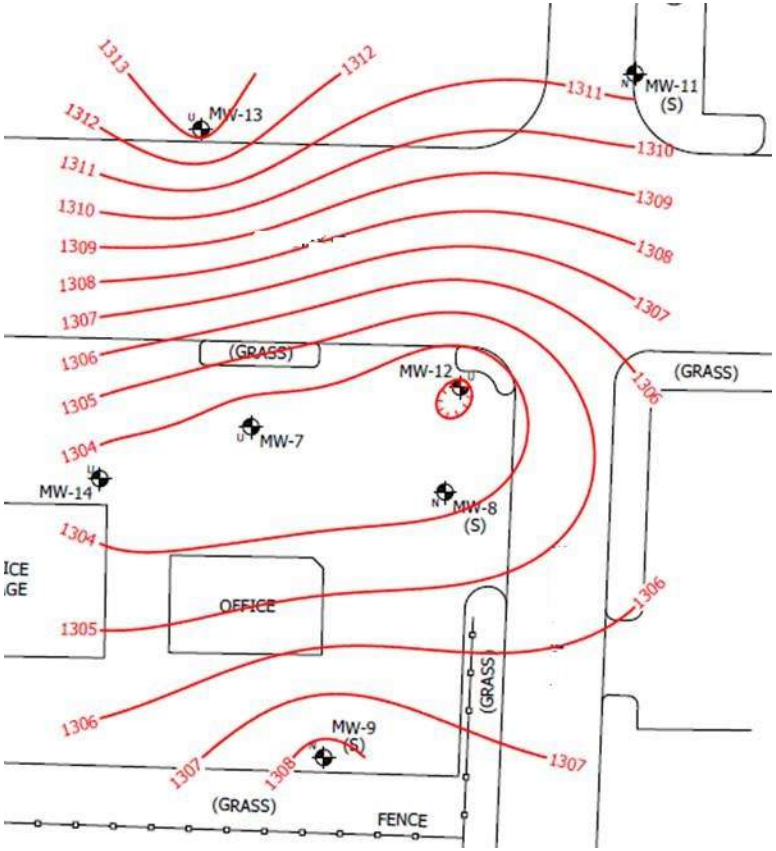
LCSM – Lithology (cont'd)

- **Burlington-Keokuk Limestone:** pinnacles & cutters
- **Depth to bedrock:** 4 – 32 ft bgs



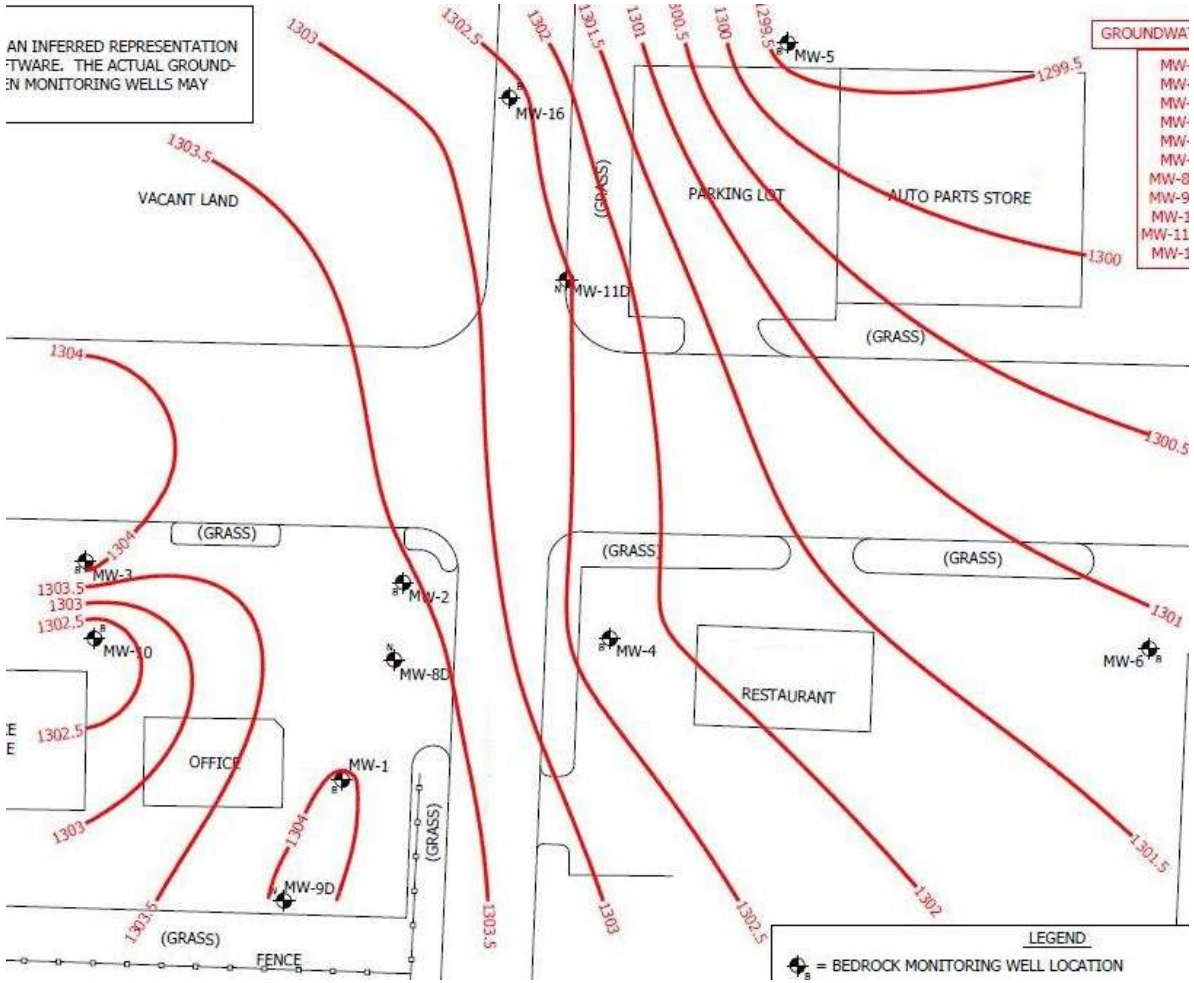
LCSM –Groundwater Table

- **Unconsolidated Zone** – "bathtub effect" due to excavations, variable over time



LCSM –Groundwater Table

- **Bedrock** – consistent flow to northeast



LCSM – Saturation, Mobility, Recoverability

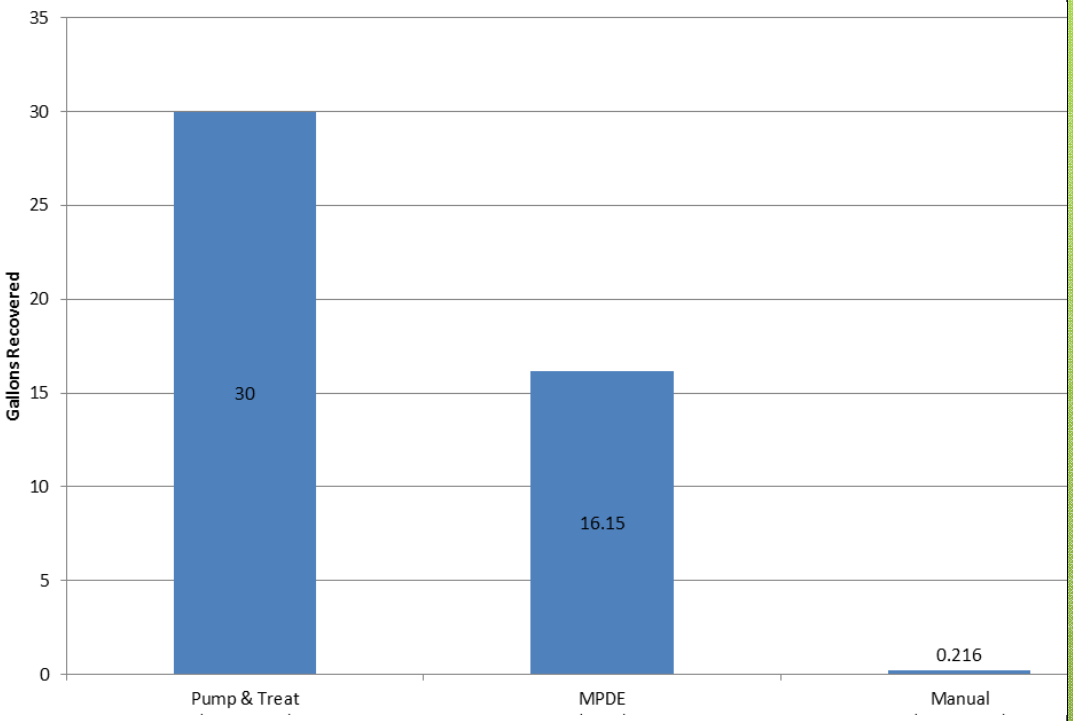
- **Recoverability:** Using pump & treat, MDPE, and manual recovery = 46 gallons recovered over 14 years – Negligible
- **Mobile:** MW-12A (unconsolidated zone) only
- **Saturation:** 0.046 (below 10% default residual)

Sn = TPH-GRO * (bulk density * 10-6 / porosity * LNAPL density)

"LCSM Tools: Conversion of TPH in Soil to NAPL Saturation", Hawthorne & Kirkman, ANSR Vol 2, Iss 1, Jan 2012

LCSM- Summarize Recovery Efforts To Date

- **1998-1999:** Excavation – 641 cu yds
- **2003-2005**: Pump & Treat – 30 gallons
- **2008:** Mobile Dual Phase Extraction – 16 gallons, mostly vapor phase
- **2013-2015**: Manual bailing – 0.216 gallons



LCSM – Risks Associated w/LNAPL

- **Current onsite** – no (LNAPL not near current building)
- **Future onsite** – no (soil vapor wells in source area – no concentrations over SSTLs; nonresidential RAFU)
- **Construction Worker** – no (depth to LNAPL, GW & soil impact greater than 10 ft bgs)
- **Off-site Current/Future** – no (all impacts delineated onsite)
- **Domestic Use Pathway (current/future)** – incomplete
- **Ecological Risks** – No (area springs sampled)
- **Explosive Conditions** – no
- **Utility Corridors/Preferential Pathways** – no (all impact below 20 ft bgs)

LCSM – Comprehensive Free Product Recovery Plan

- *No risks* present onsite
- **Recovery Objective** – demonstration that LNAPL has been recovered to the extent practicable
- Due to minimal quantities of mobile LNAPL, *quantitative evaluation is not practical*
- Utilize qualitative weight of evidence

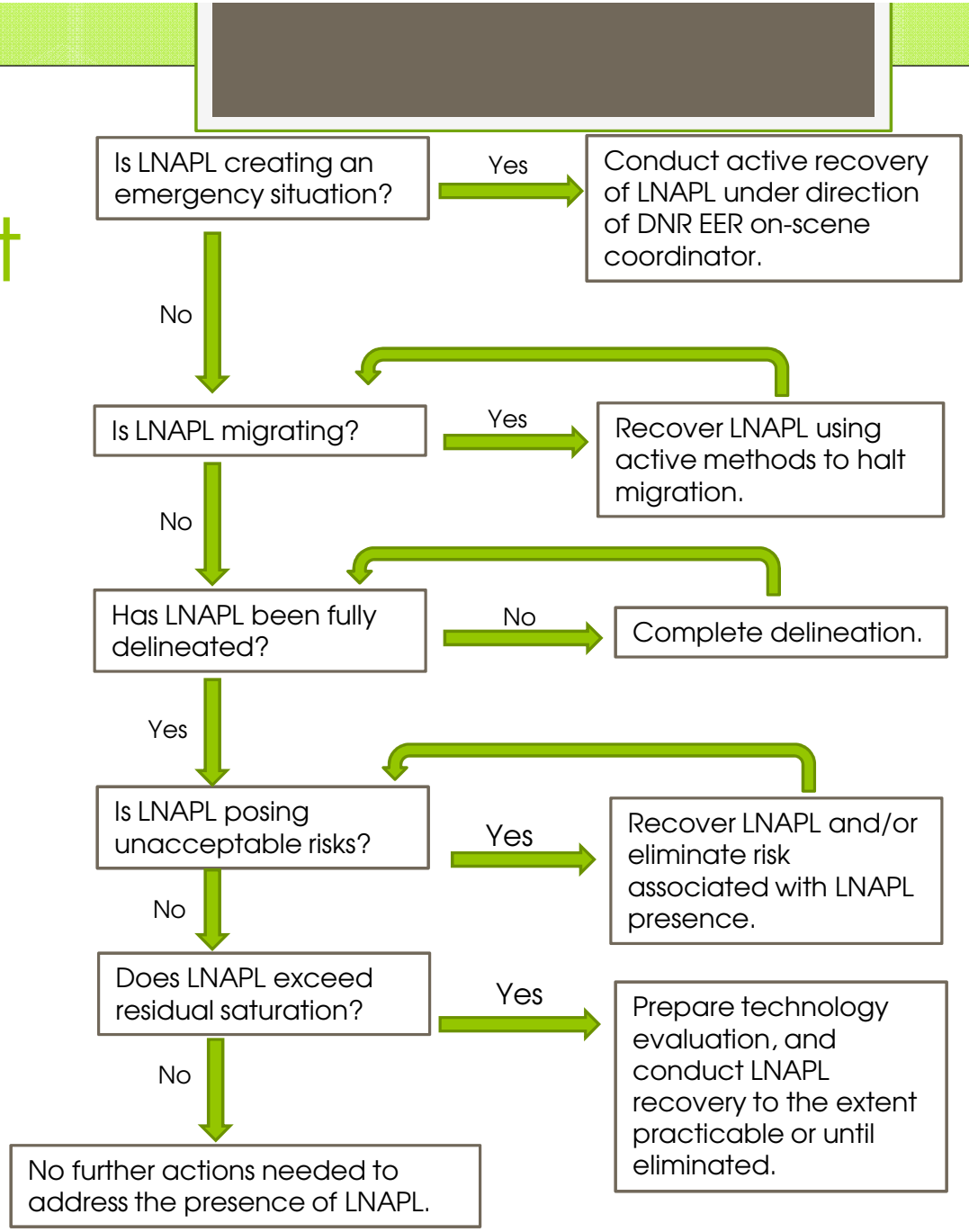
Qualitative Evaluation:

- All potential sources removed
- 641 cu yds source area soil removed
- Extent of LNAPL is fully delineated
- LNAPL recovery efforts - <50 gallons liquid & vapor phase, 99% of which was removed before 2009.
- Remaining LNAPL is weathered & degraded
- Declining TPH-GRO concentrations in soil source area show natural degradation
- Dissolved phase in source area GW decreasing or stable for COCs
- LNAPL during periods of declining groundwater & GRO concentrations indicate residual saturation

CONCLUSION: LNAPL in residual saturation, significant recovery of additional LNAPL unlikely. LNAPL recovered to extent practical.

LNAPL Management Flow Chart

- Modified by EWI from original in the April 2016 Draft LNAPL Guidance



Results & Path Forward

- **November 2016** – MoDNR concurred that LNAPL had been recovered to the extent practicable.
- **Current Status:** plume stability & soil vapor sampling, then Risk Assessment Addendum. NFA possible in late 2017 / early 2018

Potential Future Issues:

- Periodic LNAPL in MW-12A = prevents sampling events for plume stability
- Is additional LNAPL monitoring warranted?
- Dry wells (plume stability)
- Wet soil vapor points (water in line)

Free Product Recovery and Documentation of `As Much As Practicable' Publication 02577

Items Considered When Reviewing Case Study Reporting Costs

- Amount of field work to be documented in the report.
  - The advancement of 2 soil borings/converting each into a MW for LNAPL delineation, 6 LNAPL gauging events, data logger on GW data from 1 well for 2 months, GWM at 21 MWs.

Other Factors Considered . . . .

- The number and types of past LNAPL recovery efforts (historical info to be considered).
  - 1998 UST closure + excavation
  - 1999 excavation
  - 2003-2005 Pump & Treat
  - 2008 MDPE
  - 2013-2015 Bailing
- Cross-sections – EWI included 2

What did it cost?

- Preliminary LCSM with an evaluation of technologies applicable to this site + WPCE to fill data gaps
- Final LCSM - $3,000.00

For Reference

- We have received 58 qualitative LCSMs and of those,
  - Invoices have not been submitted on 15 reports.
  - We are currently processing 4 invoices.
  - We have denied costs for 1 invoice.
  - We have reimbursed less than invoiced on 3 reports.
  - We have reimbursed 100% of what was billed on 39 out of 43 reports (91%).

Questions?