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PATHWAY TO CLOSURE AT LNAPL SITES

A Case Study

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Railroad Environmental Conference
October 2015

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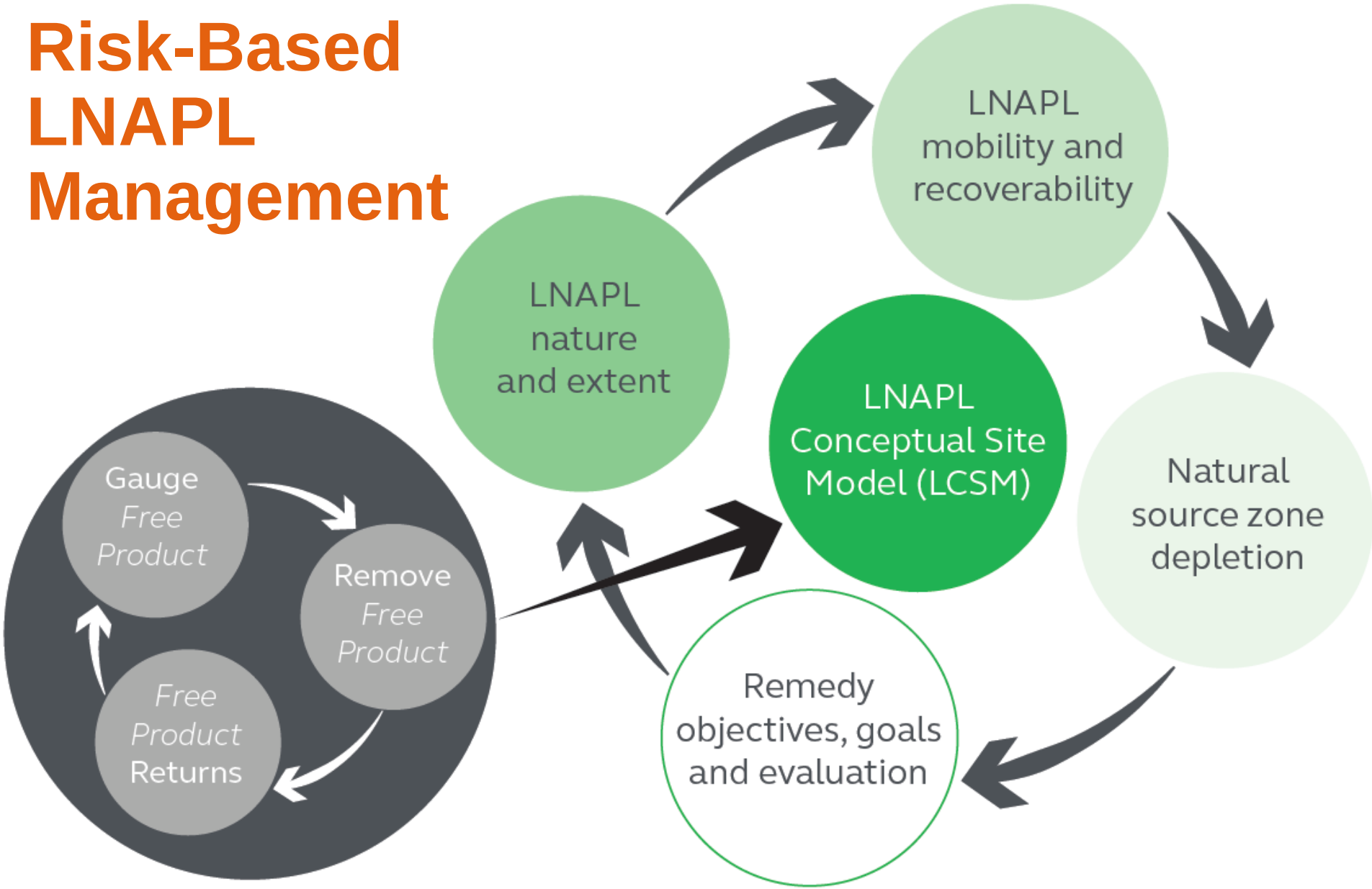
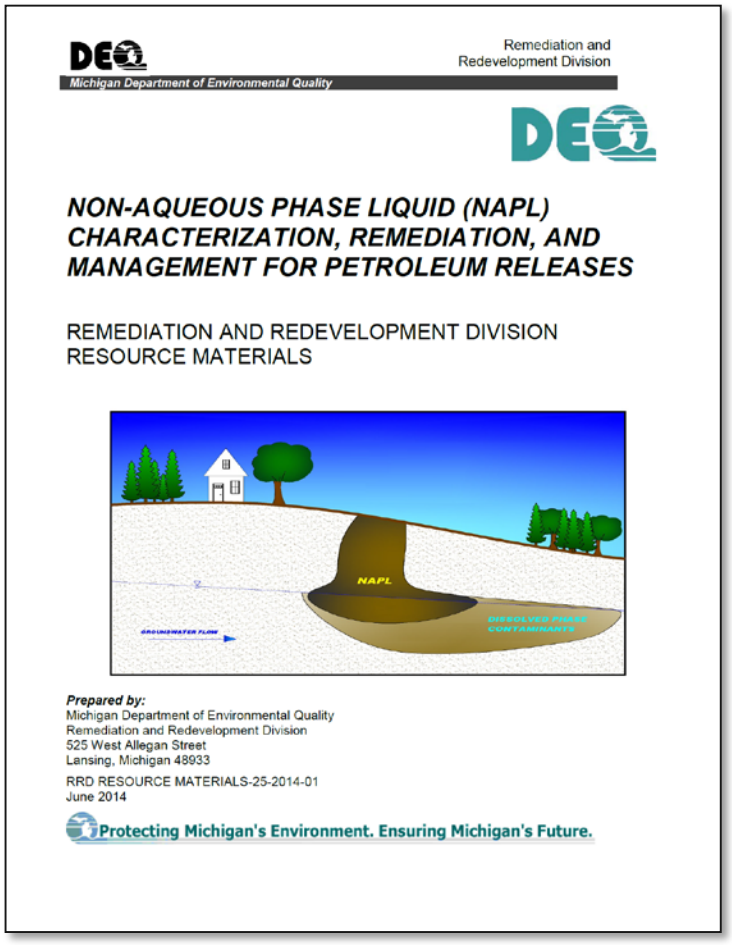
Risk-Based LNAPL Management



The Regulatory Spectrum

LNAPL may be left in place if lack of risk demonstrated	LNAPL recovery to the maximum extent practicable	LNAPL recovery to a prescriptive well thickness, e.g. less than 0.01 feet	Residual LNAPL is unacceptable
MI, TX, WI, IN, CA, MN, MA, VA, IA, PA, KS, MS	IL, OH, WV, OR	IL, NV, NM, MT	NJ

Changes in Regulatory Policy



DEQ Michigan Department of Environmental Quality

Remediation and Redevelopment Division

DEQ

NON-AQUEOUS PHASE LIQUID (NAPL) CHARACTERIZATION, REMEDIATION, AND MANAGEMENT FOR PETROLEUM RELEASES

REMEDIATION AND REDEVELOPMENT DIVISION
RESOURCE MATERIALS

Prepared by:
Michigan Department of Environmental Quality
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525 West Allegan Street
Lansing, Michigan 48933

RRD RESOURCE MATERIALS-25-2014-01
June 2014

Protecting Michigan's Environment. Ensuring Michigan's Future.

- LNAPL Presence ≠ Risk
- Emphasis on LCSM
  - LNAPL extent (vertical/horizontal),
  - Composition concerns,
  - Saturation concerns
- LNAPL in well ≠ Recoverable
  - Replaced prescriptive LNAPL thickness with LNAPL transmissivity criterion

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Site Background

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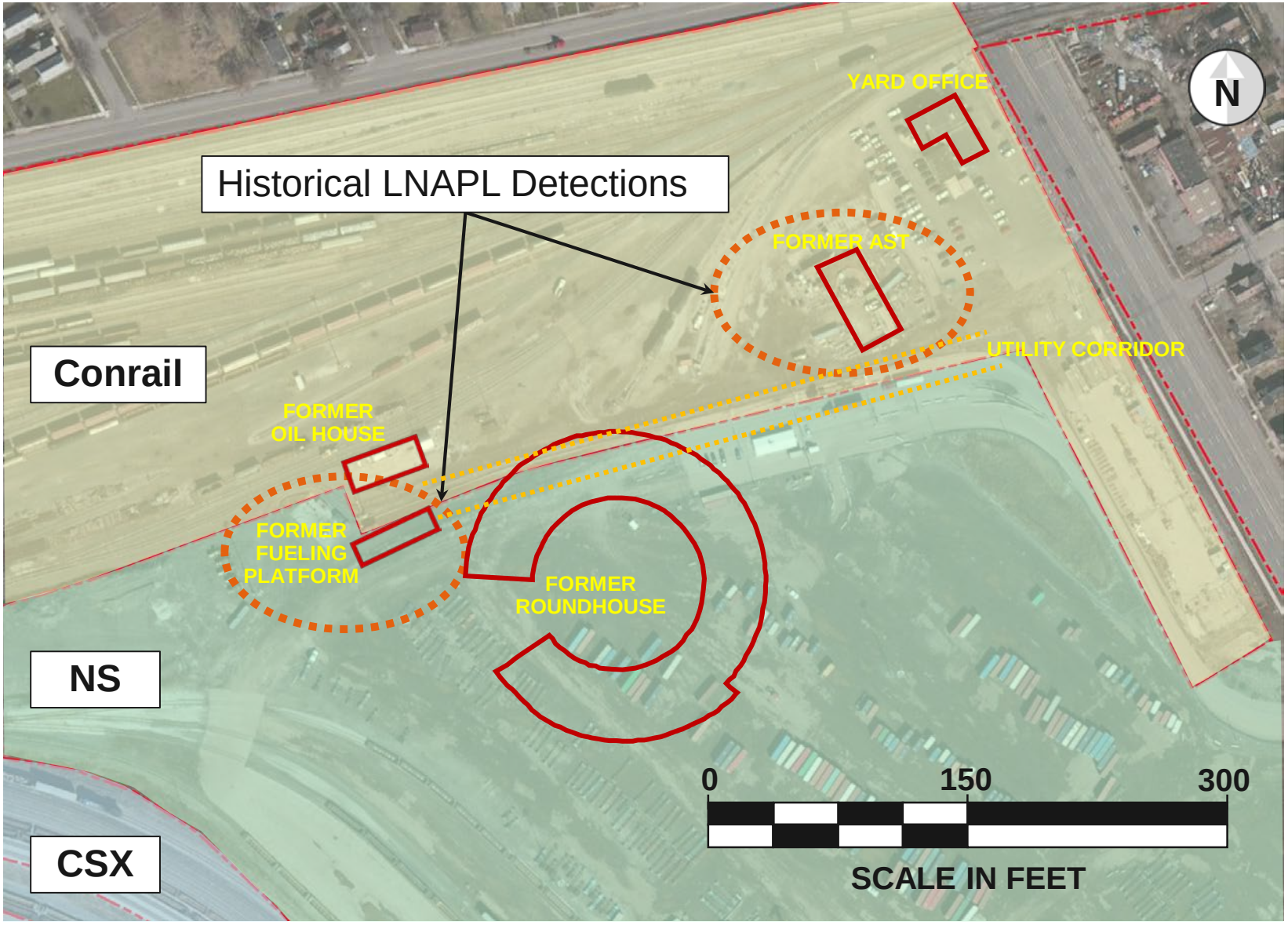

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LNAPL Delineation - LIF

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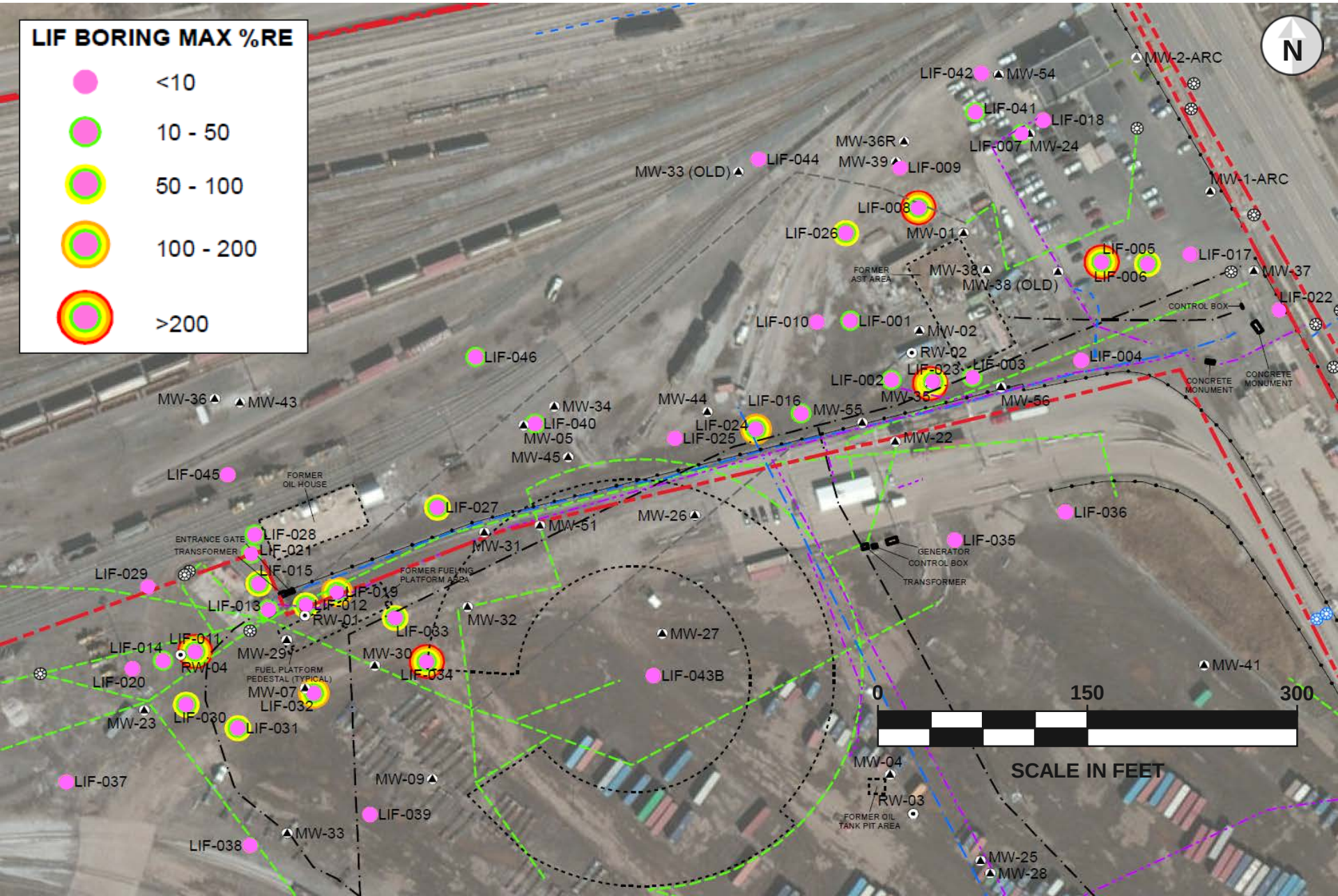
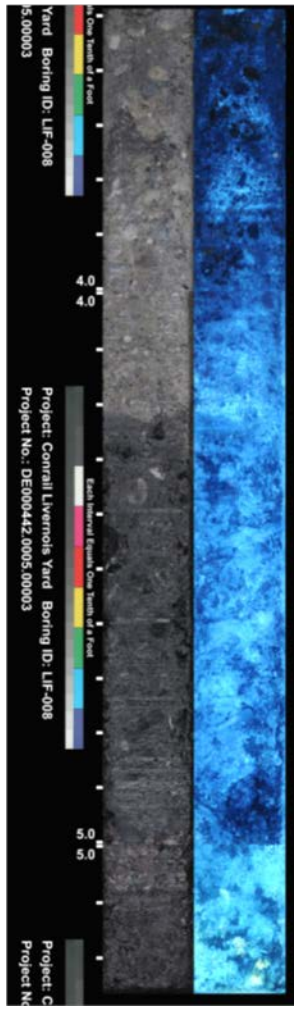


Petrophysical Data

- Fluids (LNAPL/Groundwater)
  - Density
  - Viscosity
  - Interfacial tensions
- Undisturbed Soil Cores
  - Locations/depths based on LIF results
  - Core photography
  - Basic soil properties
  - Field/residual pore fluid saturations
  - Capillary properties



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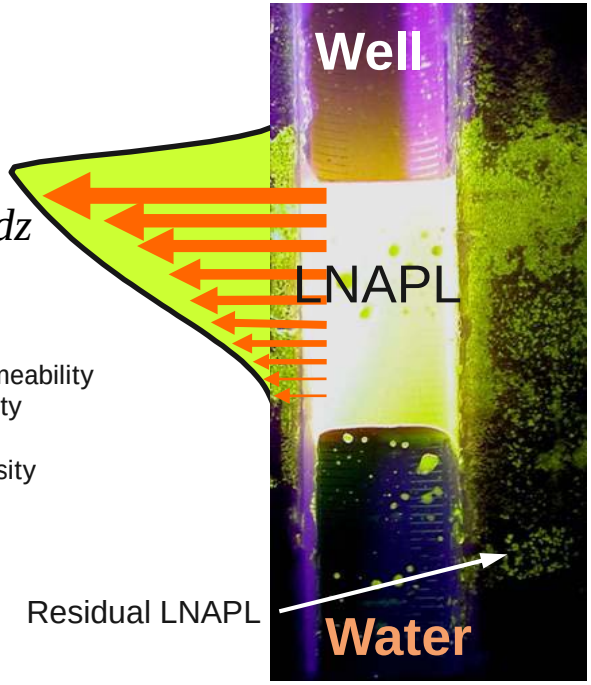
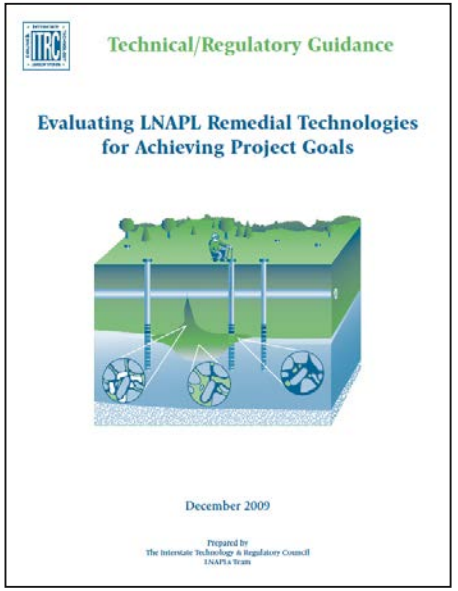
LNAPL Transmissivity

- Ideal Metric for Evaluating Recovery Potential
  - ITRC (2009): 0.1 – 0.8 ft^2/d
  - Michigan Department of Environmental Quality: 0.5 ft^2/d
- ASTM Guidance (E2856) Provides Industry Best Practices

$$T_n = \left(\frac{k \rho_n g}{\mu_n} \right) \cdot \int_{z_{nw}}^{z_m} k_{rn} \, dz$$

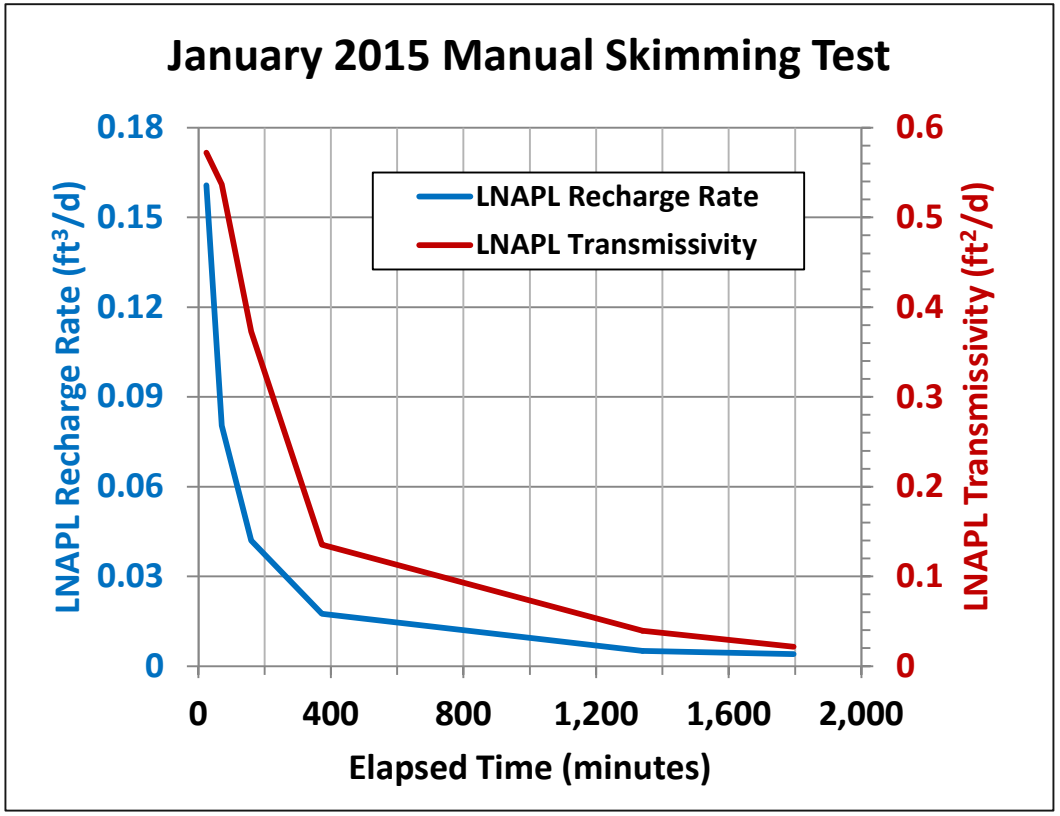
k = permeability
k_{rn} = relative permeability
ρ_n = LNAPL density
g = gravity
μ_n = LNAPL viscosity
z = elevation





LNAPL Transmissivity Results

- Field Testing at MW-35:
  - May 2014 Baildown Test: 0.14 ft^2/d
  - January 2015 Skimming Test: 0.04 ft^2/d
- Estimates from Lab Data
  - 0.02 to 0.05 ft^2/d



All Results Below 0.5 ft^2/d Threshold

LNAPL Assessment Summary

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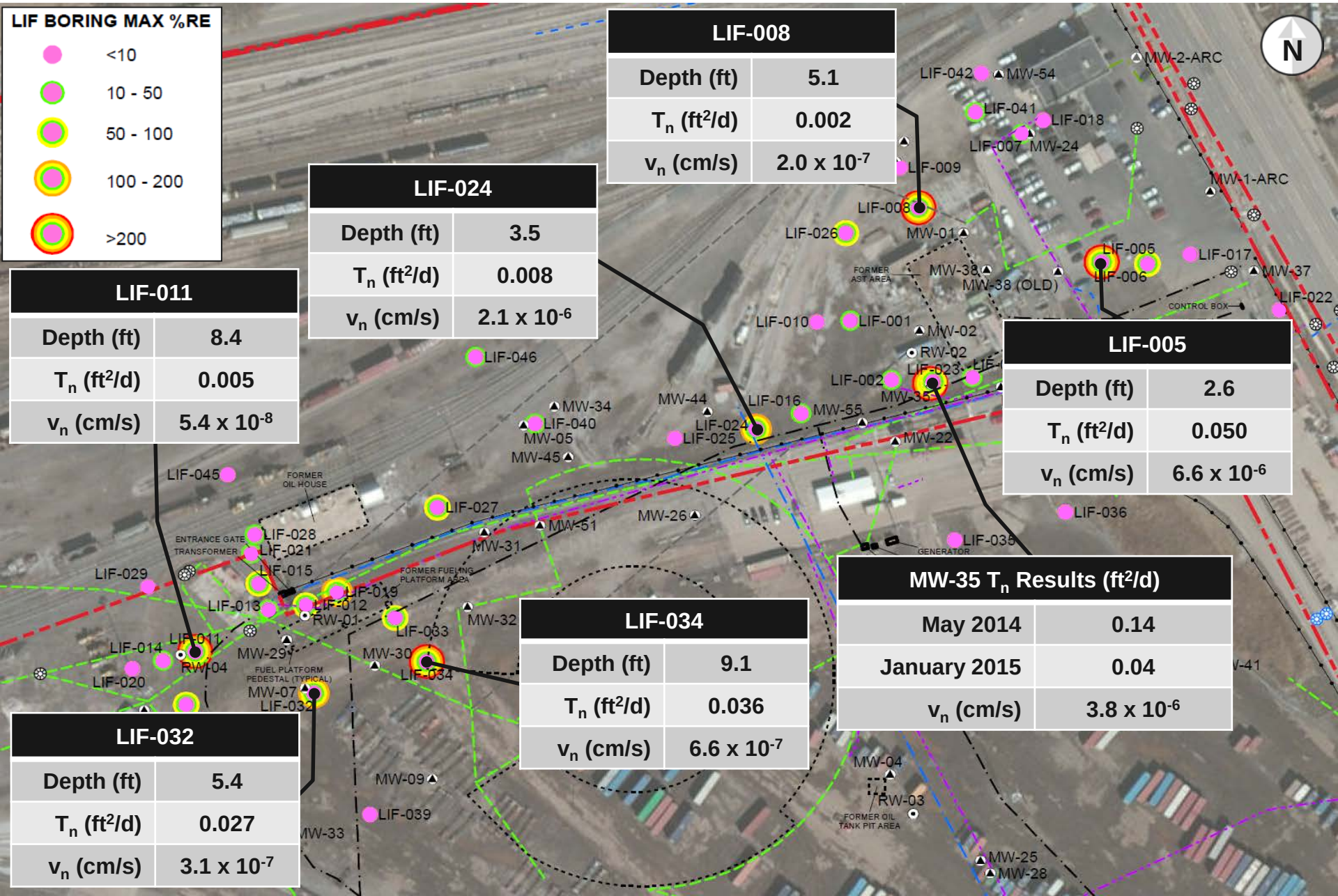

LIF-008	
Depth (ft)	5.1
T_n (ft^2/d)	0.002
v_n (cm/s)	2.0×10^{-7}

LIF-024	
Depth (ft)	3.5
T_n (ft^2/d)	0.008
v_n (cm/s)	2.1×10^{-6}

LIF-011	
Depth (ft)	8.4
T_n (ft^2/d)	0.005
v_n (cm/s)	5.4×10^{-8}

LIF-005	
Depth (ft)	2.6
T_n (ft^2/d)	0.050
v_n (cm/s)	6.6×10^{-6}

LIF-034	
Depth (ft)	9.1
T_n (ft^2/d)	0.036
v_n (cm/s)	6.6×10^{-7}

MW-35 T_n Results (ft^2/d)	
May 2014	0.14
January 2015	0.04
v_n (cm/s)	3.8×10^{-6}

LIF-032	
Depth (ft)	5.4
T_n (ft^2/d)	0.027
v_n (cm/s)	3.1×10^{-7}

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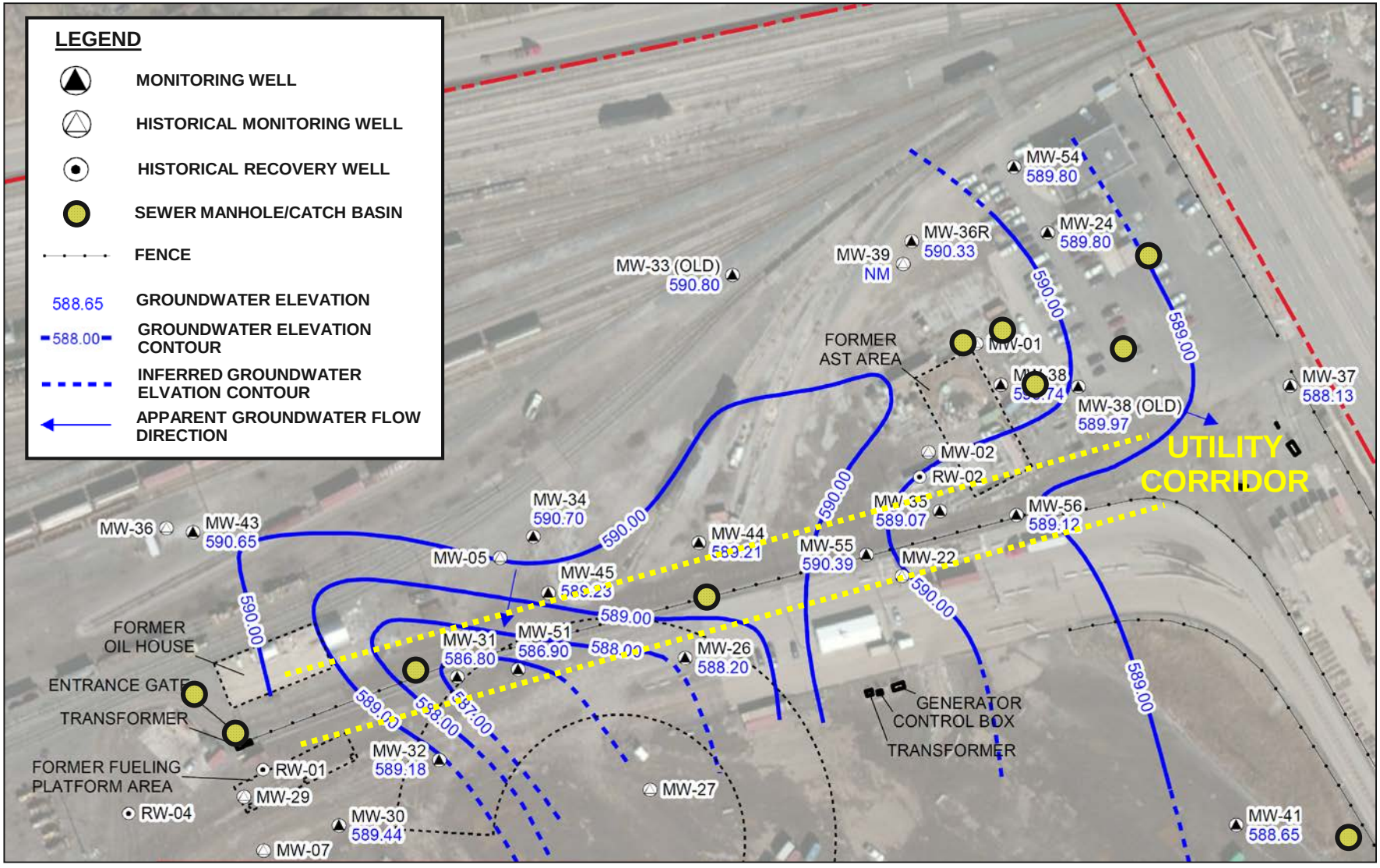
Utility Corridor Evaluation



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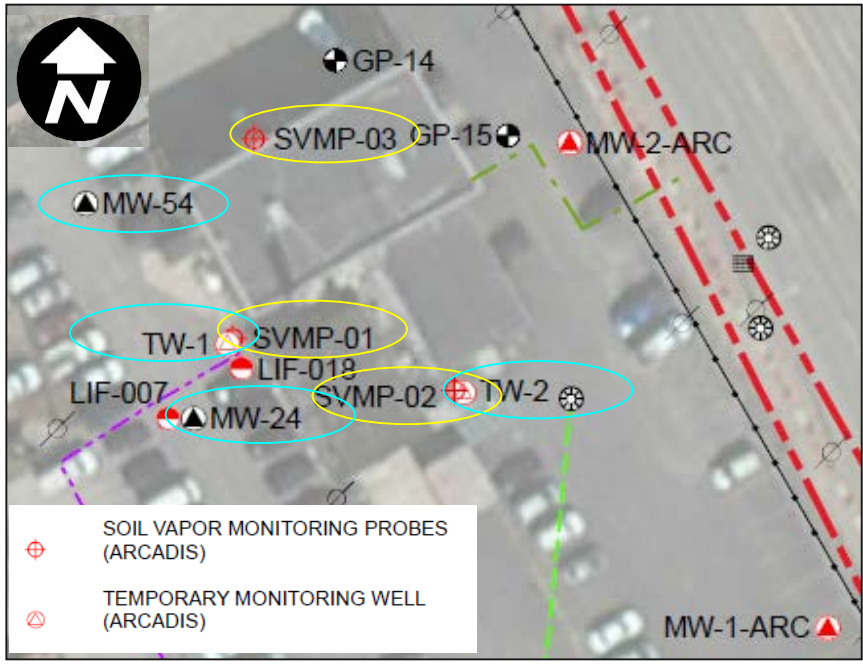
Vapor Intrusion Assessment

- Direct Evaluation
  - Soil Gas Probes
  - Temporary/Existing Wells
- Groundwater Sampling
  - May 2014
- Soil Gas Sampling
  - May 2014,
  - January 2015, &
  - September 2015
- No VI Exceedances



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Investigation Conclusions

- LNAPL Delineation Complete
  - All LNAPL Impacts On Site
- LNAPL is Not Migrating
- LNAPL Recovery is Not Practical
- No Offsite Groundwater Issues
- No VI Concerns

Key Takeaways:

- **Regulatory Policy Changes Catching up with LNAPL Science**
- **Investment in LCSM Reduces Need for Remediation**
- **Regular/Open Communication with Regulatory Agency**

Next Step: Submit Certificate of Completion Request

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Questions/Discussion