# Section 7
# Remedial Action Permit for Ground Water with Long Term Monitoring

Rich Lake

# MNA Administrative Process

- Remedial Action Workplan
  - Proposes evaluating MNA as a remedy
  - Submit Fact Sheet for DEP to establish CEA (if not already established)
- Remedial Action Report
  - Documents lines of evidence to support MNA as an applicable remedy (**critical step**)
- Remedial Action Permit for Ground Water
  - Submit Fact Sheet as necessary for DEP to revise CEA
- Issue Limited Restricted Use RAO (for GW)

# MNA Administrative Process

- Remedial Action Protectiveness/Biennial Certification
  - Presents long term monitoring results
  - Document remedy remains protective
- Termination of Remedial Action Permit - Groundwater
  - Documents GWQS have been achieved
  - Request that DEP lift CEA
- Issue Unrestricted Use RAO (for GW)
  - **After** permit is terminated

# RA Permit: Why do we need Long Term Monitoring (LTM)?

- **MNA is a Ground Water Remedy**
  - Ensure long term protectiveness to receptors
  - Verify the predicted attenuation to GWQS
  - Evaluate whether external influences jeopardize the protectiveness of the remedy

# Long Term Monitoring (LTM)

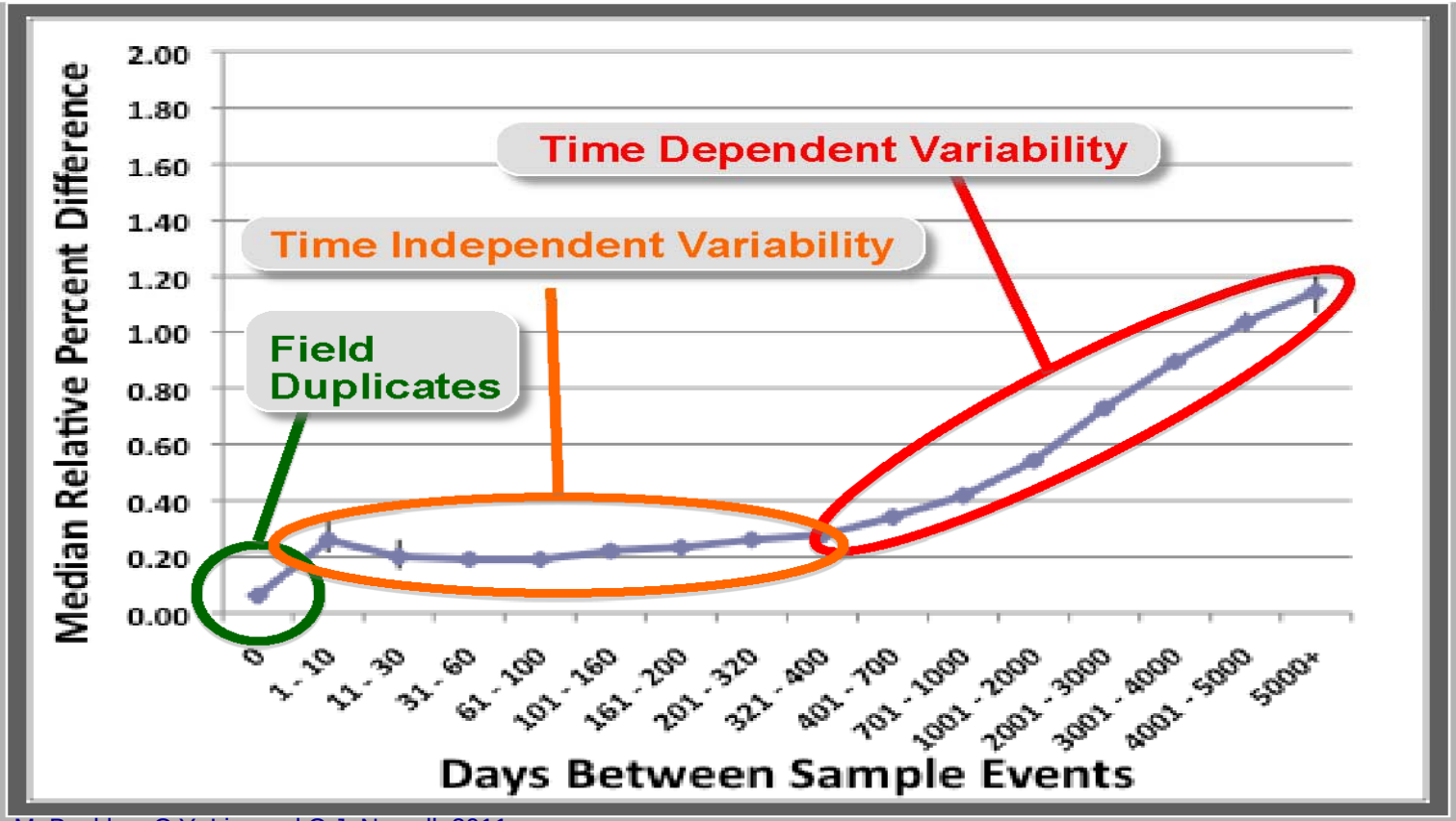
- Design of the LTM Program is based on:
  - Location of plume relative to receptors
  - Type of contaminant
  - Existing long term monitoring data
  - Relative contaminant levels
- Propose in Remedial Action Permit Application for Ground Water
  - Default biennial reporting

# Sampling Frequency

- **Performance Monitoring Wells**
  - Goal: Verify attenuation
  - Frequency depends on:
    - Contaminant levels relative to the GWQS
    - Historic ground water data
- **Sentinel Monitoring Wells**
  - Goal: Protect receptors
  - Frequency depends on:
    - Distance to potential receptors
    - Performance monitoring well frequency

# Performance Monitoring Well Sampling Frequency

## RESULTS: TIMESCALE




McHugh, T.E., L.M. Beckley, C.Y. Liu, and C.J. Newell. 2011.

# Table 4: Recommended Monitoring Well Sampling Frequency

| Situation | Performance Well Sampling Frequency | Sentinel Well Sampling Frequency | Reporting Schedule |
|---|---|---|---|
| Permit issued | Annual years 1-4 * | ½ travel time to nearest receptor or annual, whichever is more frequent | With CEA Biennial Certification |
| After 4 years | Biennial years 5-8 * | ½ travel time to nearest receptor or biennial, whichever is more frequent | With CEA Biennial Certification |
| After 8 years | **BTEX:** Every 8 years for the remainder of the permit.<br><br>**Contaminants other than BTEX > 10X GWQS:** every 4 years<br><br>**Contaminants other than BTEX < 10X GWQS:** every 8 years for remainder of the permit | ½ travel time to nearest receptor or the same frequency as the performance wells, whichever is more frequent | With next scheduled CEA Biennial Certification |

# Example: Performance Monitoring Well Sampling Frequency

## Existing Data

- Source removed in 1989
- Annual sampling from 1990 to 2000
- Biennial sampling from 2000 to 2011
- TCE < 10x GWQS in 2011

## According to Table 4

- Based on the long duration of prior data, investigator may proceed to the last row of the table
- Sample every 8 years through the duration of the permit.

# Example: Sentinel Monitoring Well Sampling Frequency

## Existing Data

- Nearest receptor is a potable well 1,000 feet from the downgradient edge of the plume
- Hydraulic conductivity = 20 feet/day
- Hydraulic gradient = 0.015
- Effective porosity = 0.2

## According to Table 4

- Check travel time
  - Calculated seepage velocity is 1.5 ft/day
  - Travel time to receptor is 670 days
  - One half of travel time is used so annual sampling would be appropriate
- Compare to performance well frequency
- Use whichever is more frequent

# Other LTM Considerations

- Analytical parameters
  - COCs, degradation products, geochemical parameters
- Well Network
  - Source, plume fringe, sentinel wells
  - Number of wells is site-specific
- When to sample
  - During the season with highest contaminant levels based on historic data

# Evaluating LTM Results

- Revisit Conceptual Site Model when conditions change
- Four outcomes of evaluation:
  - Continue LTM Program
  - Modify the LTM Program
    - May require permit modification
  - Implement Contingency Remedy
  - Terminate Program (achieved GWQS)
    - Request DEP to Lift CEA
- Document in Biennial Certification report

# MNA Case Study

# Case Study: Background

- Gasoline UST Discharge
- UST Removed
- Contaminated Soil Excavated
- Monitoring wells installed and BTEX > GWQS
- Remedial Action Workplan proposes MNA
  - Additional ground water monitoring proposed to obtain a total of eight rounds

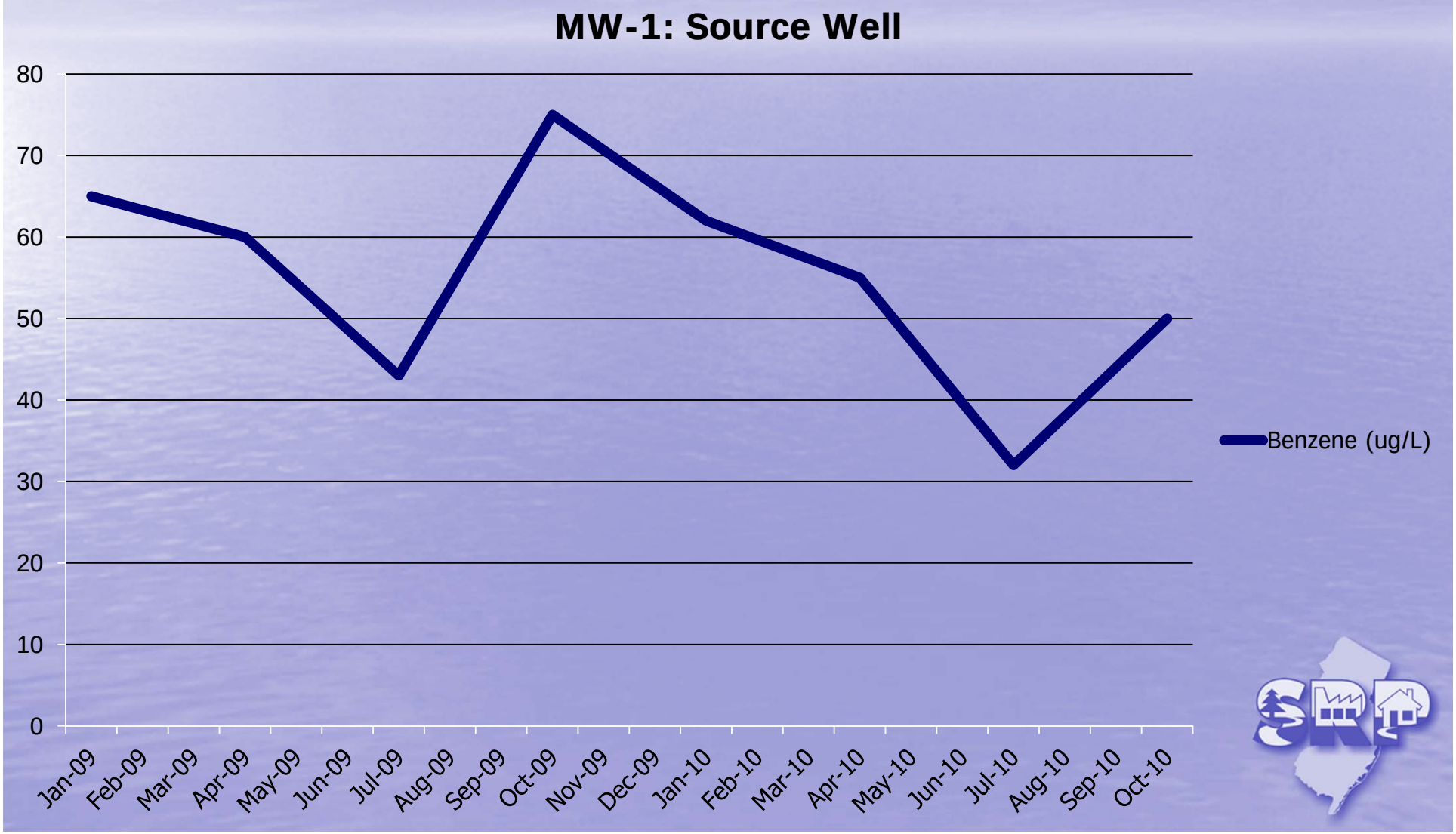
# Case Study: Monitoring Results Benzene (ug/L)

| | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|
| | Source | Plume | Plume Fringe | Sentinel |
| January 2009 | 65 | 3 | 0.1 | ND |
| April 2009 | 60 | 2 | ND | ND |
| July 2009 | 43 | 3 | ND | ND |
| October 2009 | 75 | 6 | 0.2 | ND |
| January 2010 | 62 | 1 | 0.1 | ND |
| April 2010 | 55 | 2 | ND | ND |
| July 2010 | 32 | 2 | ND | ND |
| October 2010 | 50 | 4 | 0.1 | ND |

# Case Study: Primary Line of Evidence – Plume Stability

| | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|
| | Source | Plume | Plume Fringe | Sentinel |
| January 2009 | 65 | 3 | 0.1 | ND |
| April 2009 | 60 | 2 | ND | ND |
| July 2009 | 43 | 3 | ND | ND |
| October 2009 | 75 | 6 | 0.2 | ND |
| January 2010 | 62 | 1 | 0.1 | ND |
| April 2010 | 55 | 2 | ND | ND |
| July 2010 | 32 | 2 | ND | ND |
| October 2010 | 50 | 4 | 0.1 | ND |

# Case Study: Primary Line of Evidence - Graphical Analysis



# Case Study: Primary Line of Evidence - Statistical Analysis

## Mann-Whitney U Test *(Using Wisconsin DNR spreadsheet)*

| | | Compound | MW-1 | MW-2 * | MW-3 | MW-4 |
|---|---|---|---|---|---|---|
| Event | Sampling Date (most recent last) | Days After Prev. Rnd. | Concentration (leave blank if no data) | Concentration (leave blank if no data) | Concentration (leave blank if no data) | Concentration (leave blank if no data) |
| 1st Yr, 1st Qtr | 1-Jan-09 | | 65.00 | 3.00 | 0.10 | 0.05 |
| 1st Yr, 2nd Qtr | 1-Apr-09 | 90 | 60.00 | 2.00 | 0.05 | 0.05 |
| 1st Yr, 3rd Qtr | 1-Jul-09 | 91 | 43.00 | 3.00 | 0.05 | 0.05 |
| 1st Yr, 4th Qtr | 1-Oct-09 | 92 | 75.00 | 6.00 | 0.20 | 0.05 |
| 2nd Yr, 1st Qtr | 1-Jan-10 | 92 | 62.00 | 1.00 | 0.10 | 0.05 |
| 2nd Yr, 2nd Qtr | 1-Apr-10 | 90 | 55.00 | 2.00 | 0.05 | 0.05 |
| 2nd Yr, 3rd Qtr | 1-Jul-10 | 91 | 32.00 | 2.00 | 0.05 | 0.05 |
| 2nd Yr, 4th Qtr | 1-Oct-10 | 92 | 50.00 | 4.00 | 0.10 | 0.05 |
| Error Check, OK if Blank | | | | | | |
| DATA FROM QUARTERLY SAMPLING | | | | | | |
| U Statistic = | | | 4.0 | 4.0 | 7.0 | 8.0 |
| Trend at 90 % probability or more? | | | No Trend | No Trend | No Trend | No Trend |

# Case Study: Primary Line of Evidence - Statistical Analysis

## Mann Kendall *(Using Wisconsin DNR spreadsheet)*

| | Compound -> | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|---|
| Event Number | Sampling Date (most recent last) | Concentration (leave blank if no data) | Concentration (leave blank if no data) | Concentration (leave blank if no data) | Concentration (leave blank if no data) |
| 1 | 1-Jan-09 | 65.00 | 3.00 | 0.10 | 0.05 |
| 2 | 1-Apr-09 | 60.00 | 2.00 | 0.05 | 0.05 |
| 3 | 1-Jul-09 | 43.00 | 3.00 | 0.05 | 0.05 |
| 4 | 1-Oct-09 | 75.00 | 6.00 | 0.20 | 0.05 |
| 5 | 1-Jan-10 | 62.00 | 1.00 | 0.10 | 0.05 |
| 6 | 1-Apr-10 | 55.00 | 2.00 | 0.05 | 0.05 |
| 7 | 1-Jul-10 | 32.00 | 2.00 | 0.05 | 0.05 |
| 8 | 1-Oct-10 | 50.00 | 4.00 | 0.10 | 0.05 |
| | Mann Kendall Statistic (S) = | -12.0 | 0.0 | -1.0 | 0.0 |
| | Number of Rounds (n) = | 8 | 8 | 8 | 8 |
| | Average = | 55.25 | 2.88 | 0.09 | 0.05 |
| | Standard Deviation = | 13.477 | 1.553 | 0.052 | 0.000 |
| | Coefficient of Variation(CV)= | 0.244 | 0.540 | 0.591 | 0.000 |
| Trend ≥ 80% Confidence Level | | DECREASING | No Trend | No Trend | No Trend |
| Trend ≥ 90% Confidence Level | | DECREASING | No Trend | No Trend | No Trend |
| Stability Test, If No Trend Exists at 80% Confidence Level | | NA | CV <= 1 STABLE | CV <= 1 STABLE | CV <= 1 STABLE |

# Case Study: Secondary Line of Evidence

- **Dissolved Oxygen**
  - Dissolved oxygen is the most preferred terminal electron acceptor for petroleum contaminants
  - Upgradient monitoring well – 5 mg/L
  - Source monitoring wells – 0 to 0.5 mg/L
  - Indicative of aerobic biodegradation

# Case Study: Reporting

- RAR Submitted that documents applicability of MNA as a remedy
- Remedial Action Permit Application for Ground Water submitted
- Response Action Outcome (limited restricted use) issued once permit is established

# Case Study: Long Term Monitoring Program

- According to Table 4 of the MNA Guidance:
  - **Performance monitoring wells**
    - Annual years 1-4
    - Biennial years 5-8
    - Every 8 years thereafter
  - **Sentinel monitoring wells**
    - Travel time to nearest receptor is 8 years
    - Sample at ½ travel time, or every 4 years
    - Sample same as performance wells until year 8, then sample every 4 years

# Case Study: Evaluating Long Term Monitoring Results

| | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|
| | Source | Plume | Plume Fringe | Sentinel |
| Oct. 2011 | 55 | 3 | 0.1 | ND |
| Oct. 2012 | 52 | 2 | ND | ND |
| Oct. 2013 | 43 | 2 | ND | ND |
| Oct. 2014 | 38 | ND | ND | ND |
| Oct. 2016 | 25 | ND | ND | ND |
| Oct. 2018 | 20 | ND | ND | ND |

**Conclusion documented in Biennial Certification Report: Continue the LTM program without change**

# QUESTIONS