

Transition to Monitored Natural Attenuation After 30 Years of Pump and Treat at the Former Uniroyal Site in Edmonton, Alberta

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Site Background

- Chemical manufacturing: 1961 – 1983
 - Chlorophenoxy herbicides
 - Chlorophenolic wood preservatives
- Groundwater remediation system
 - Commenced 1984
 - 7 extraction wells in upper zone
 - year-round operation: 1984 – 2003
 - Seasonal operation: 2003-2014
 - Trial shutdown in 2014
 - Transition from pump & treat to MNA



Constituents Evaluated

- Initial Evaluation – 2014
 - 2,4-dichlorophenoxyacetic acid (2,4-D)
 - 2,4,5-trichlorophenoxyacetic acid (2,4,5-T)
 - total phenolics
- Updated Evaluation – 2024
 - 2-methyl-4-chlorophenoxyacetic acid (MCPA)
 - pentachlorophenol (PCP)
 - 2,3,4,6-tetrachlorophenol
 - 2,4,6-trichlorophenol
 - 2,4-dichlorophenol



Groundwater Plume Analytics® Tools

Ricker Method® Plume Stability Analysis

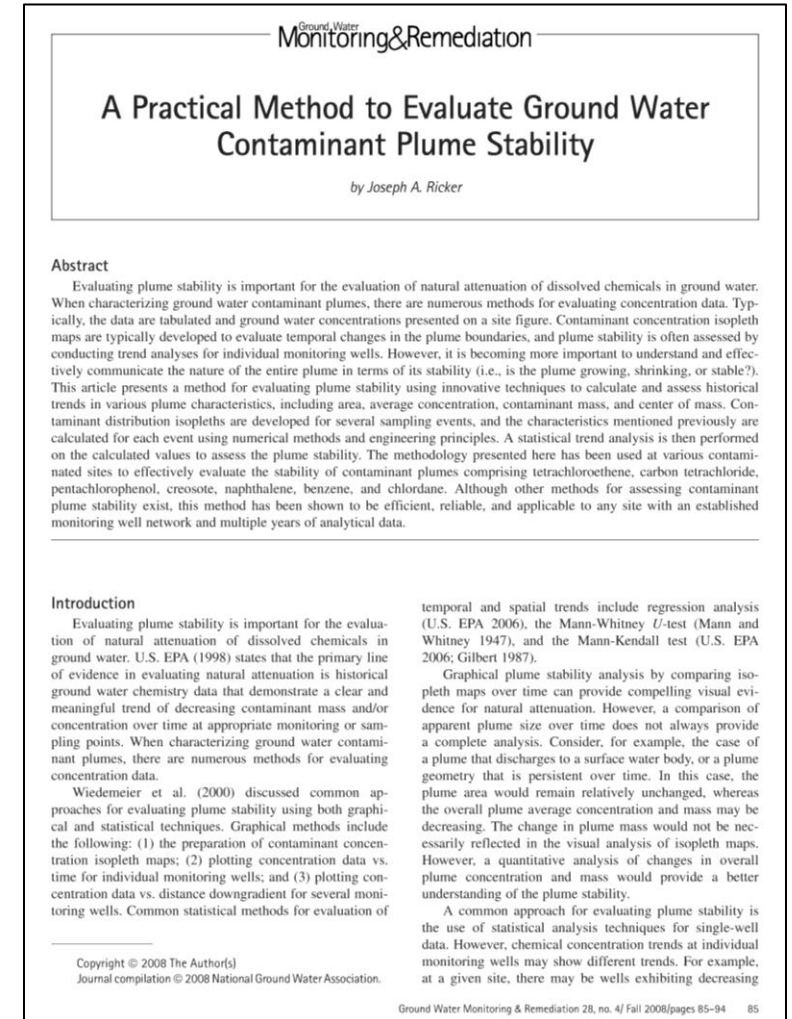
- Published in Groundwater Monitoring & Remediation, 2008

Spatial Change Indicator™

- US Patent No. 10,400,583

Remediation System Benefit Analysis (RSBA®)

- US Patent No. 9,299,038



Groundwater Plume Analytics® Services

Upper Sand

2,4-D

2,4,5-T

Phenolics

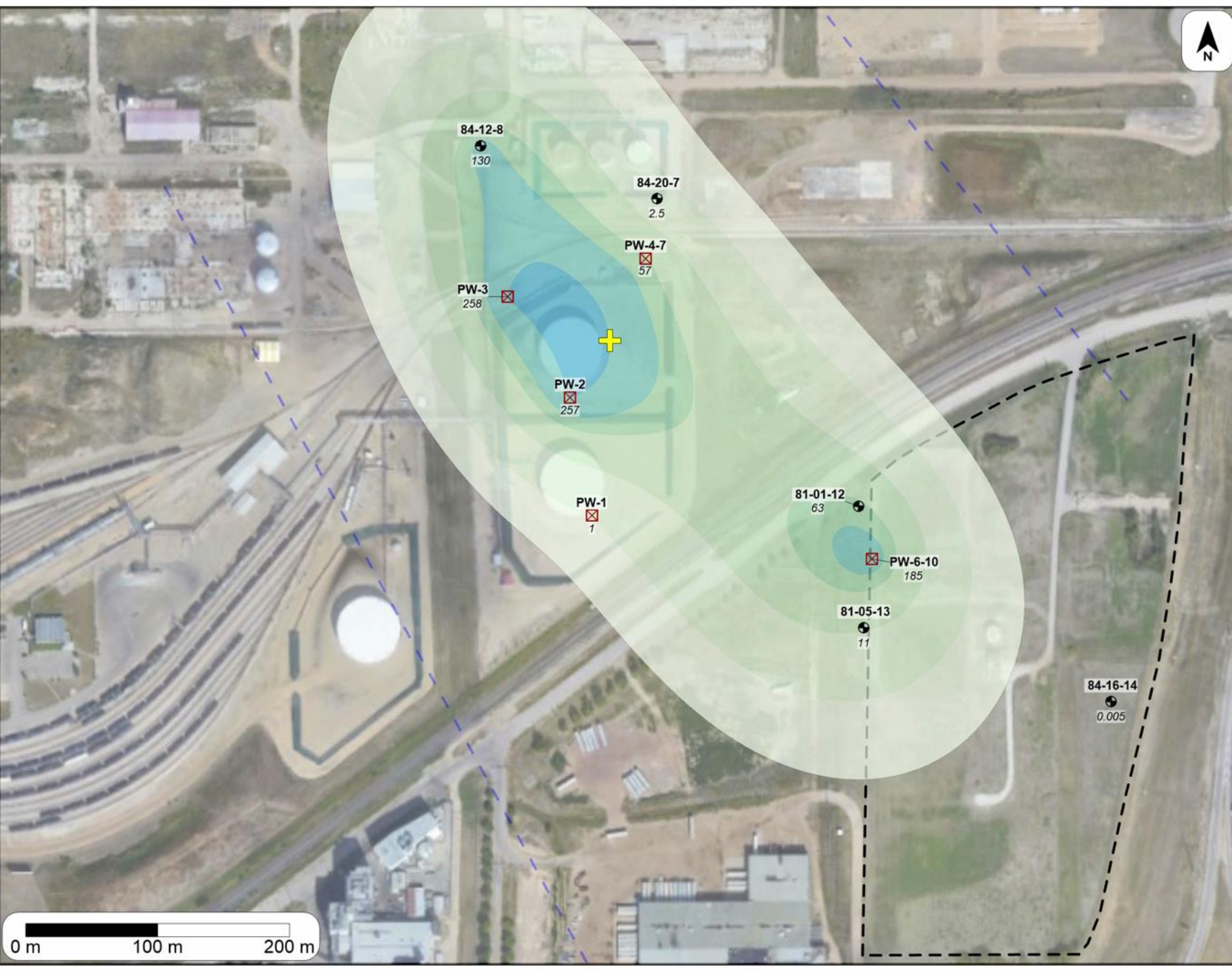
MCPA

PCP

2,3,4,6-
Tetrachlorophenol

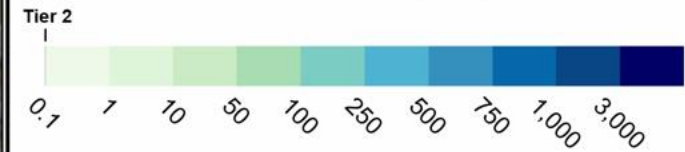
2,4,6-
Trichlorophenol

2,4-
Dichlorophenol



2,4-D Upper Sand Sep-1984

Concentration (mg/L)

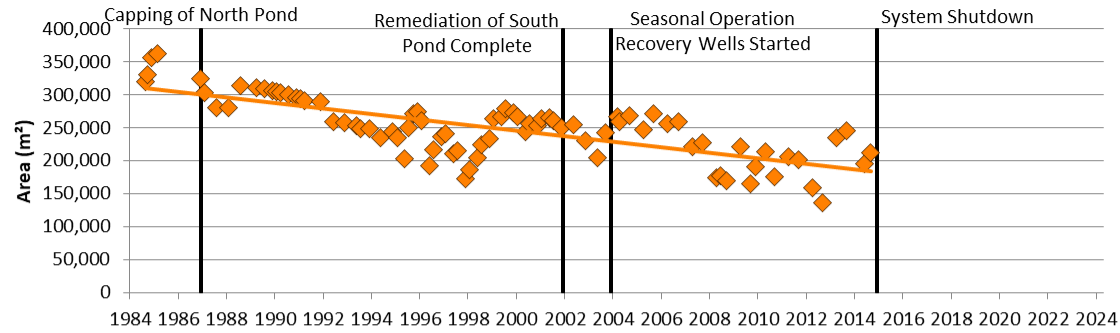


Plume Characteristics

Plume Area: **319,972 m²**
Plume Average Concentration: **17.3 mg/L**
Plume Mass Indicator: **11,610 kgs**

- | | |
|---|----------------------|
| Monitoring Well | Plume Center of Mass |
| Hanging Well | Control Point |
| Extraction Well | Property Boundary |
| 112 Concentration (mg/L) | Control Fence |
| Well Not Sampled (Assigned Value Shown) | |

2,4-D Plume Area (Upper Sand)



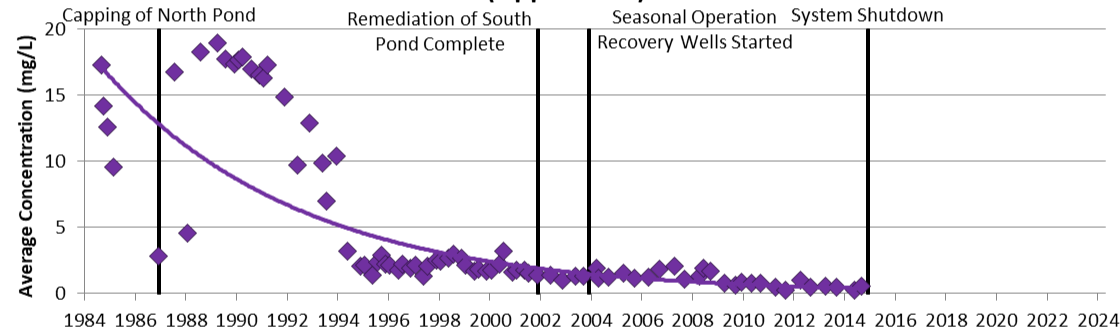
Sep-1984 to Sep-2014

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

2,4-D Plume Average Concentration (Upper Sand)



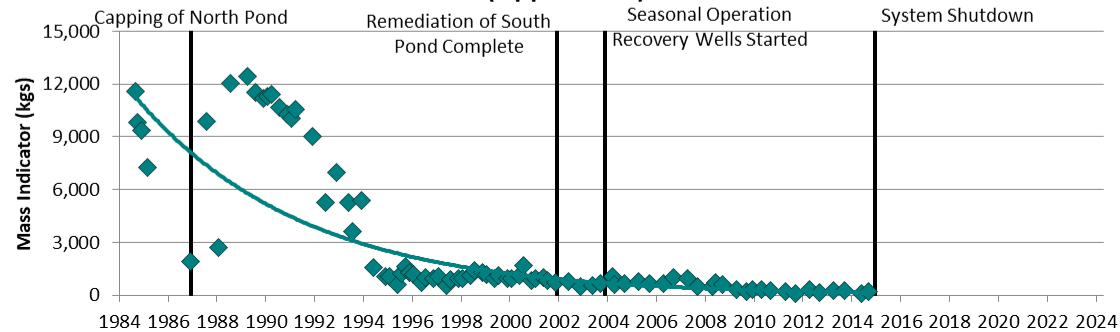
Sep-1984 to Sep-2014

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

2,4-D Plume Mass Indicator (Upper Sand)

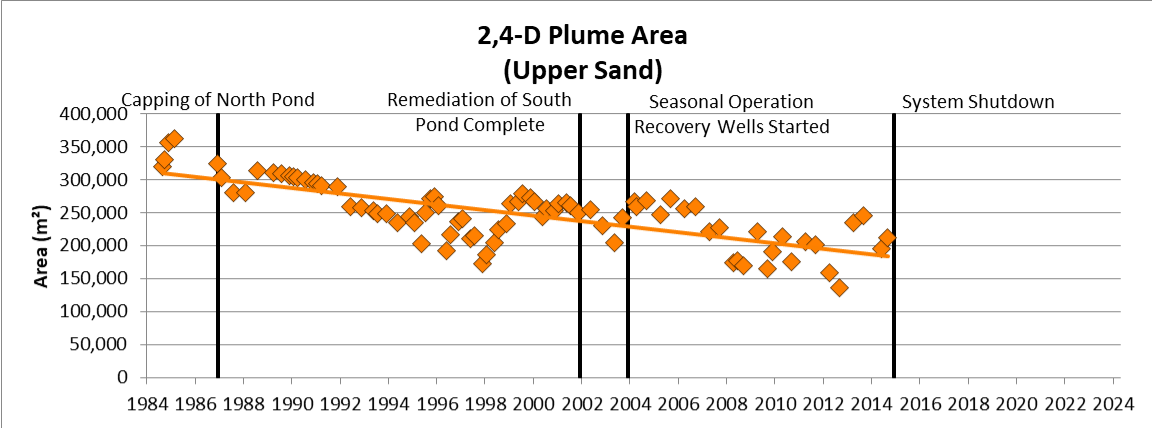


Sep-1984 to Sep-2014

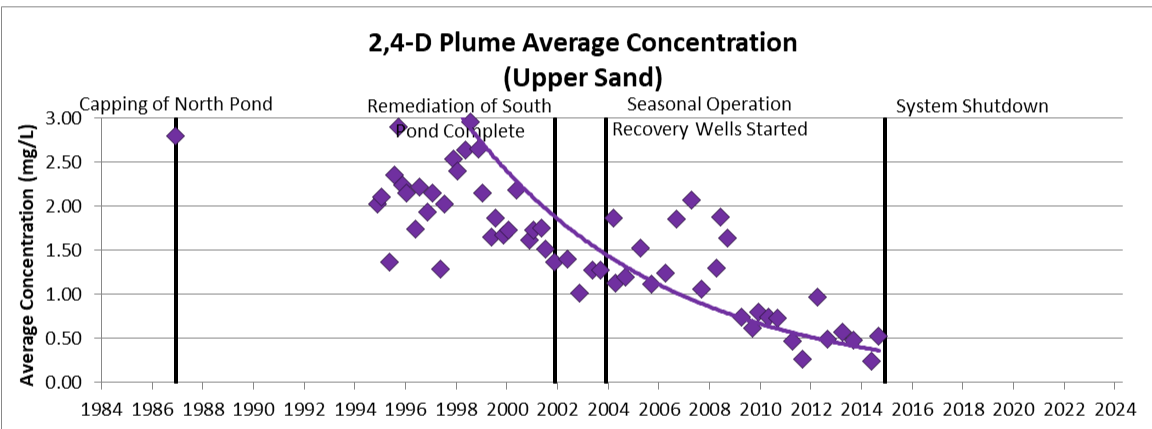
Decreasing Trend

Mann-Kendall: >99% Confidence

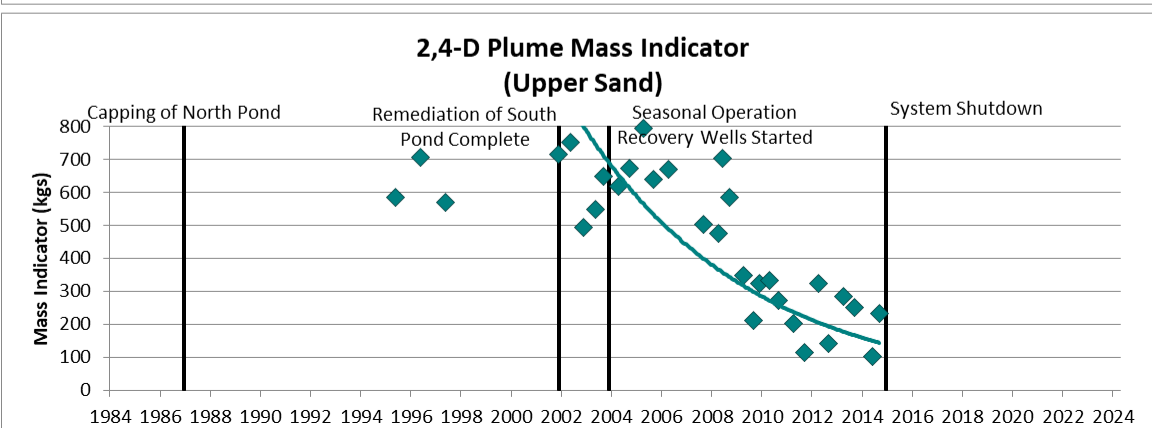
Regression: >99% Confidence



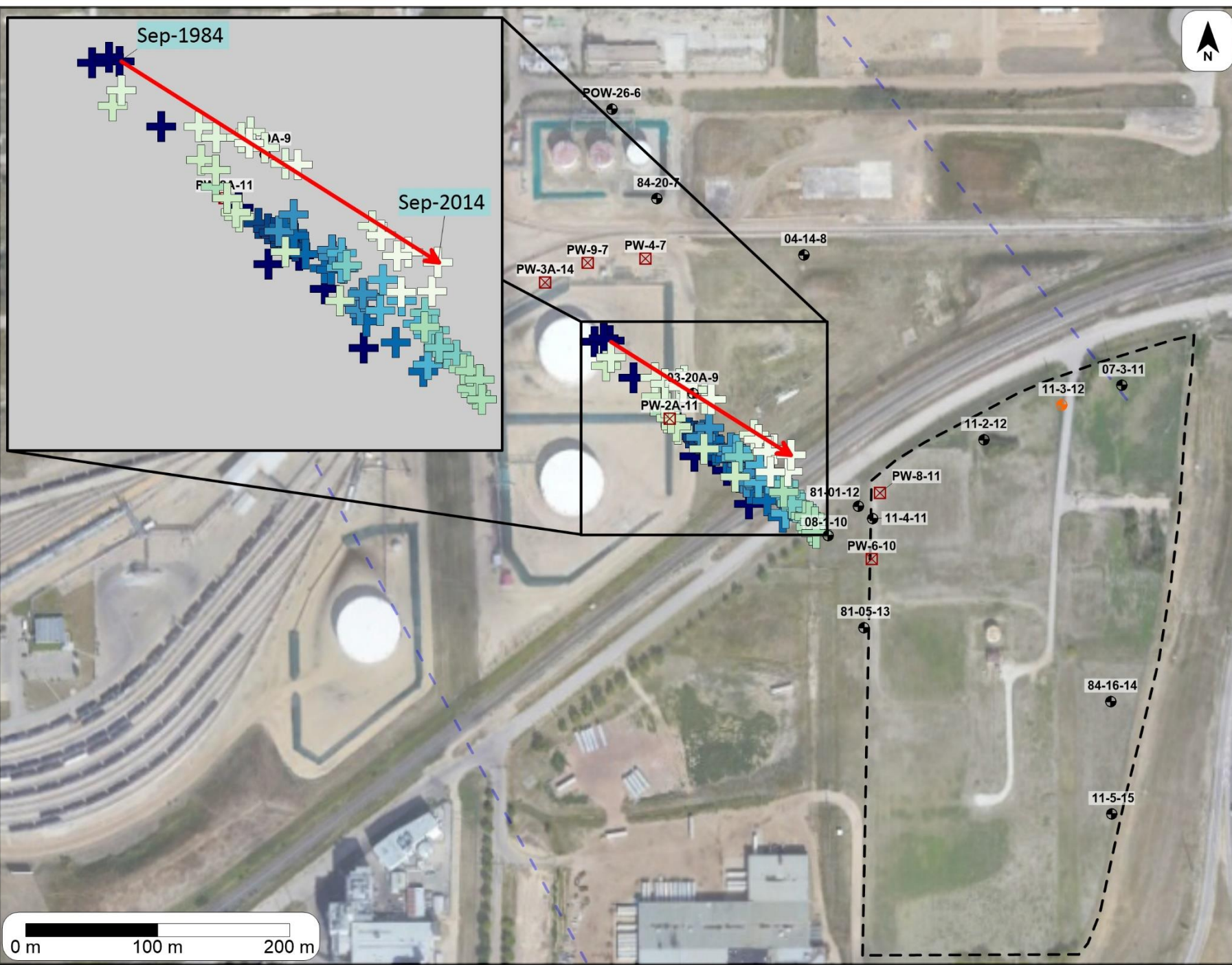
Sep-1984 to Sep-2014
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Mann-Kendall: >99% Confidence
Regression: >99% Confidence



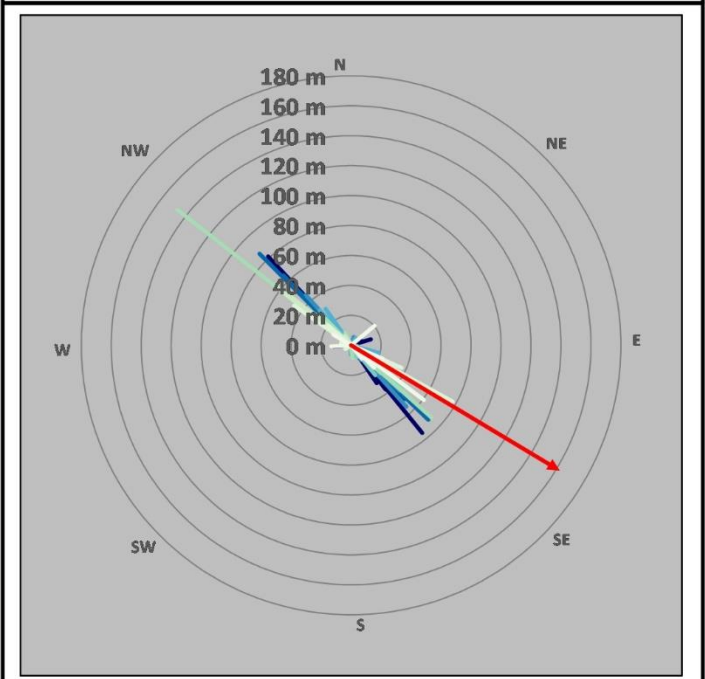
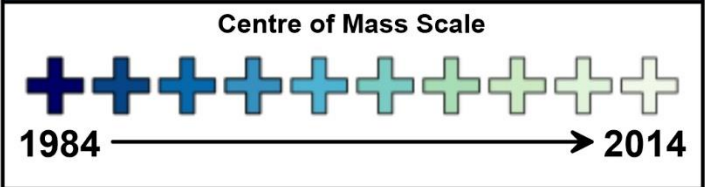
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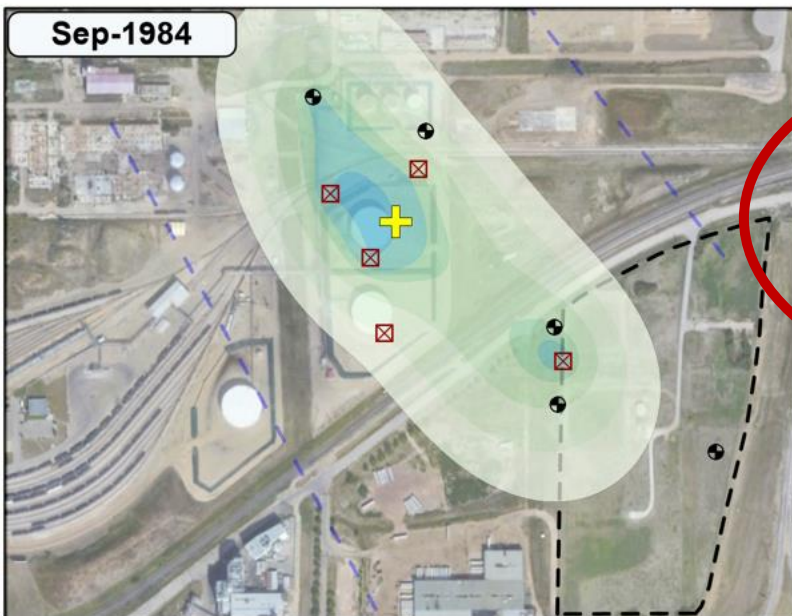


2,4-D Upper Sand

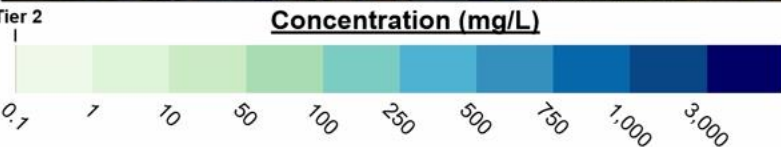


- Monitoring Well
- Hanging Well
- Extraction Well
- Centre Of Mass Movement
- Net Movement
- Control Point
- Property Boundary
- Control Fence

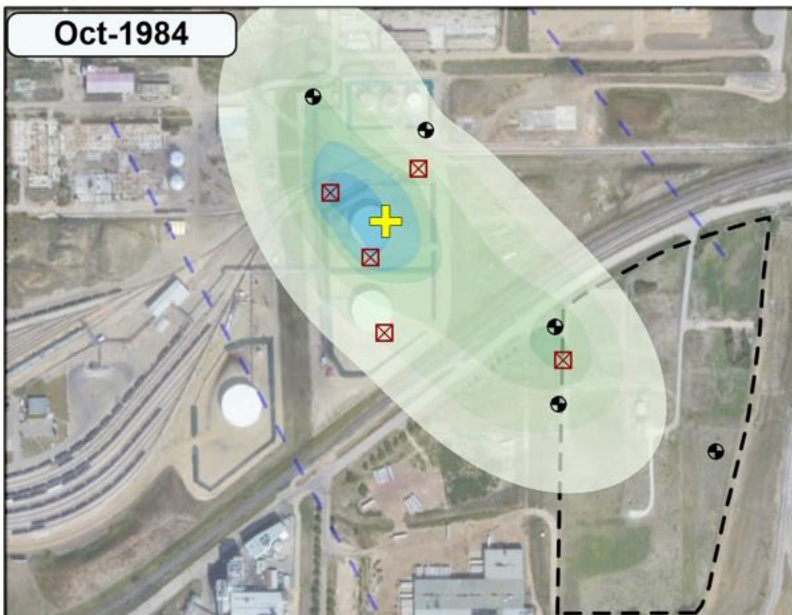
Sep-1984



Concentration (mg/L)



Oct-1984

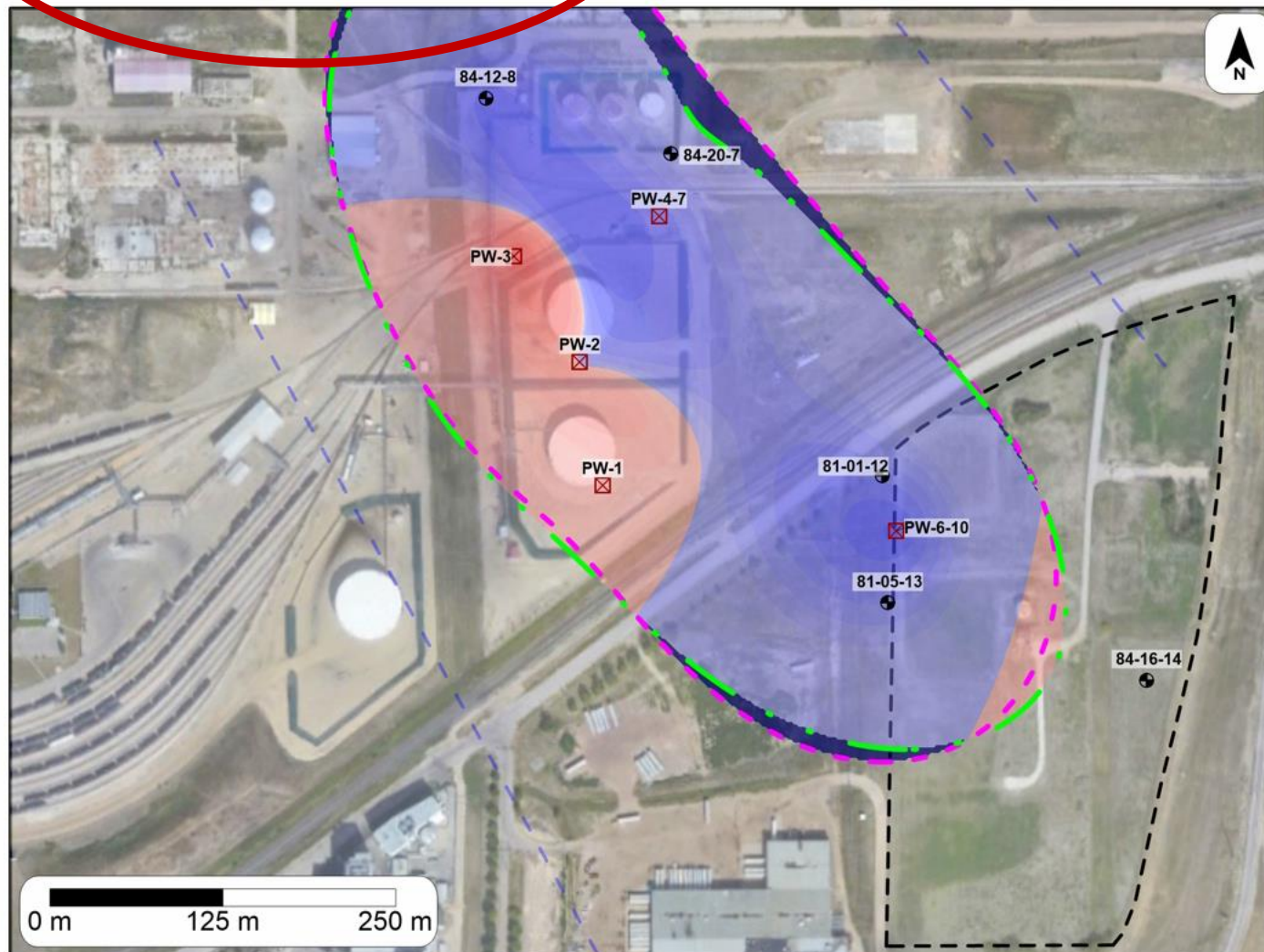


2,4-D Upper Sand Spatial Changes Sep-1984 vs Oct-1984

Plume Characteristics

Area: **3% Increase**
 Average Concentration: **18% Decrease**
 Mass Indicator: **15% Decrease**
 Mass Increase: **575 kgs Increase**
 Mass Decrease: **2,339 kgs Decrease**

- | | |
|-----------------------------|------------------------|
| ● Monitoring Well | ✚ Plume Centre of Mass |
| ⊙ Hanging Well | ● Control Point |
| ⊠ Extraction Well | --- Property Boundary |
| --- Sep-1984 Plume Boundary | --- Control Fence |
| --- Oct-1984 Plume Boundary | |



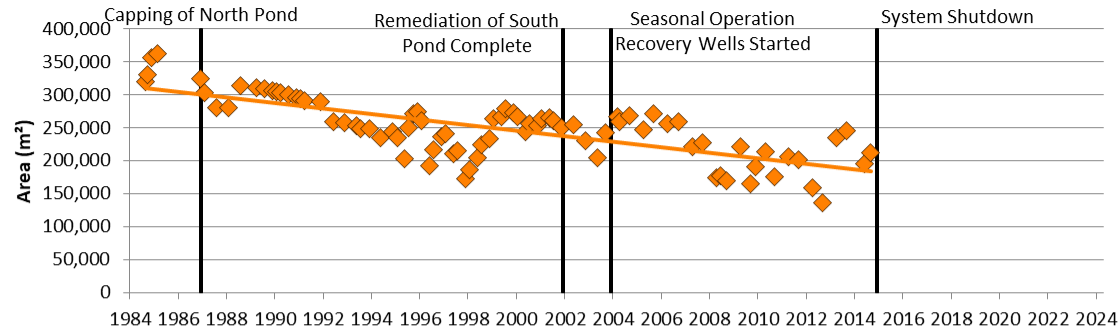
Spatial Change
Indicator™
Increase



Decrease

wsp

2,4-D Plume Area (Upper Sand)



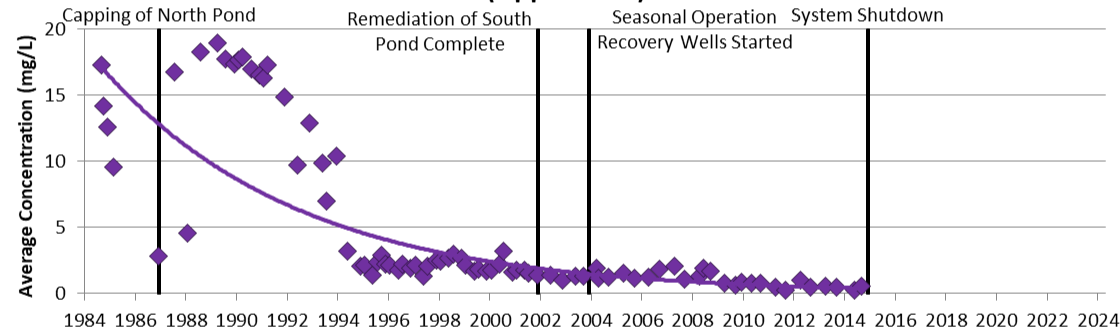
Sep-1984 to Sep-2014

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

2,4-D Plume Average Concentration (Upper Sand)



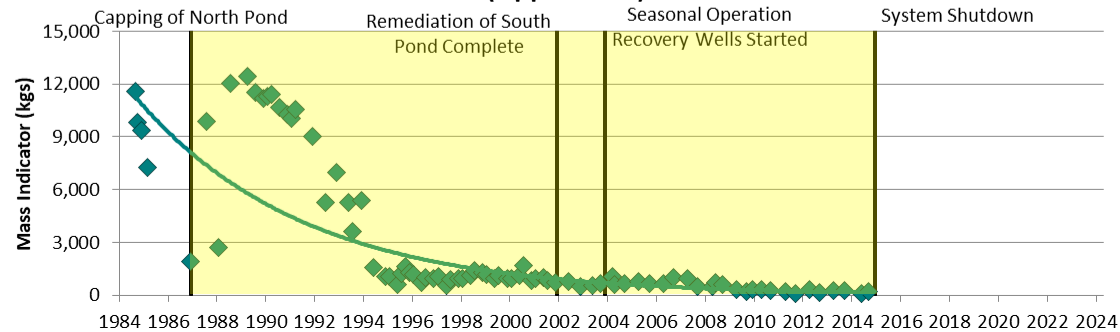
Sep-1984 to Sep-2014

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

2,4-D Plume Mass Indicator (Upper Sand)

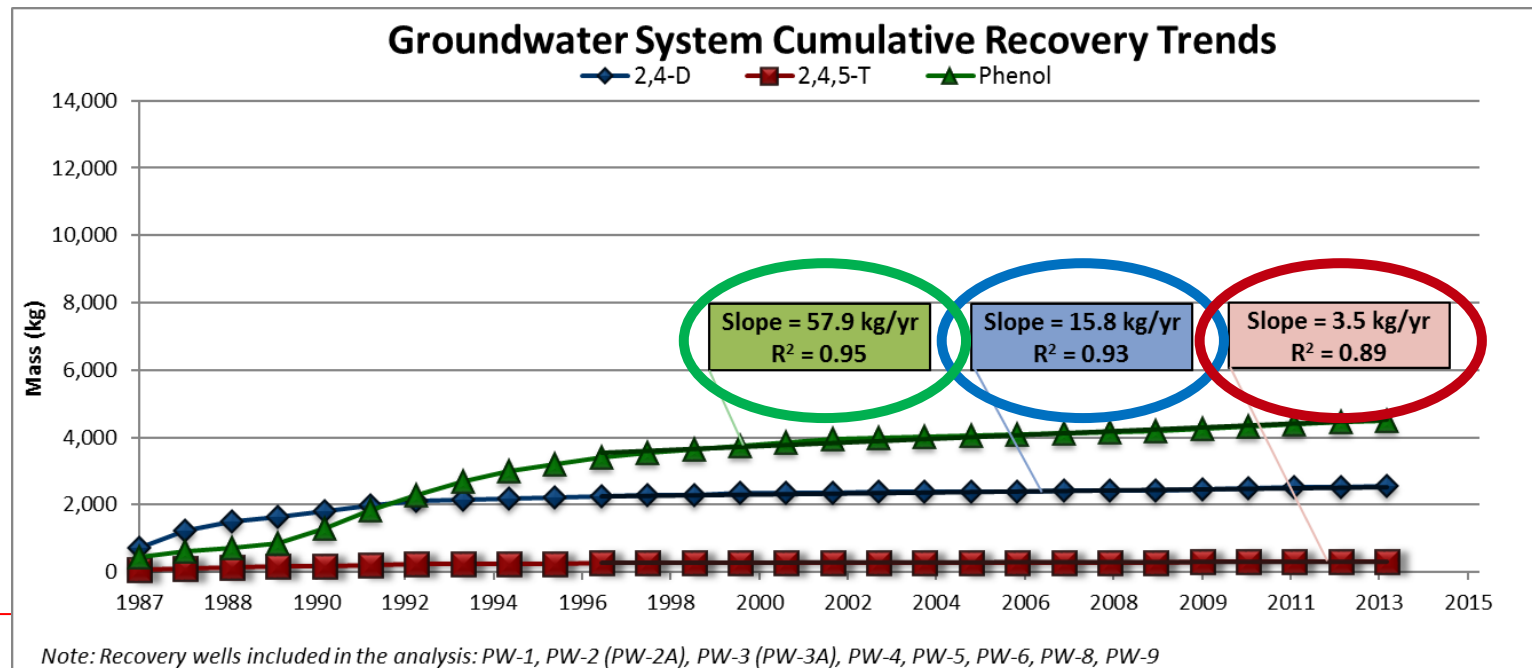
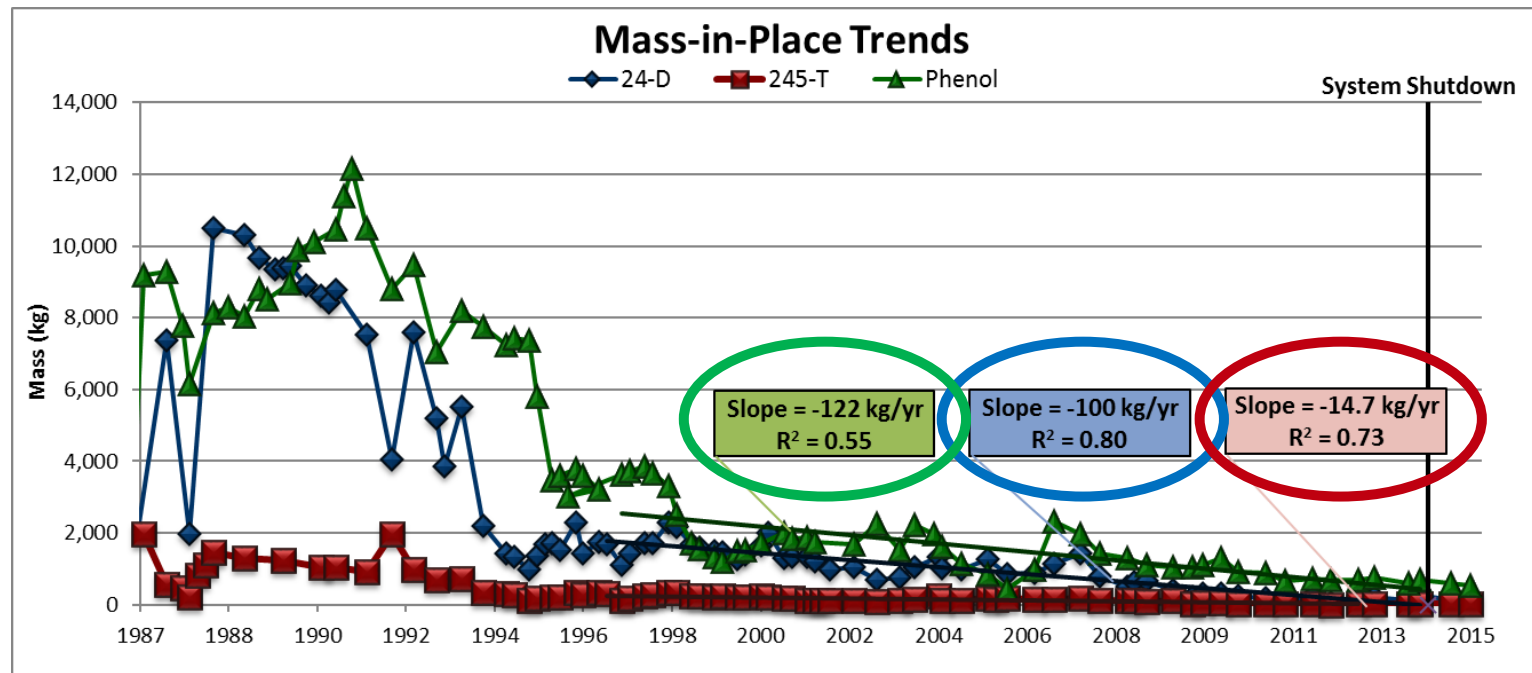


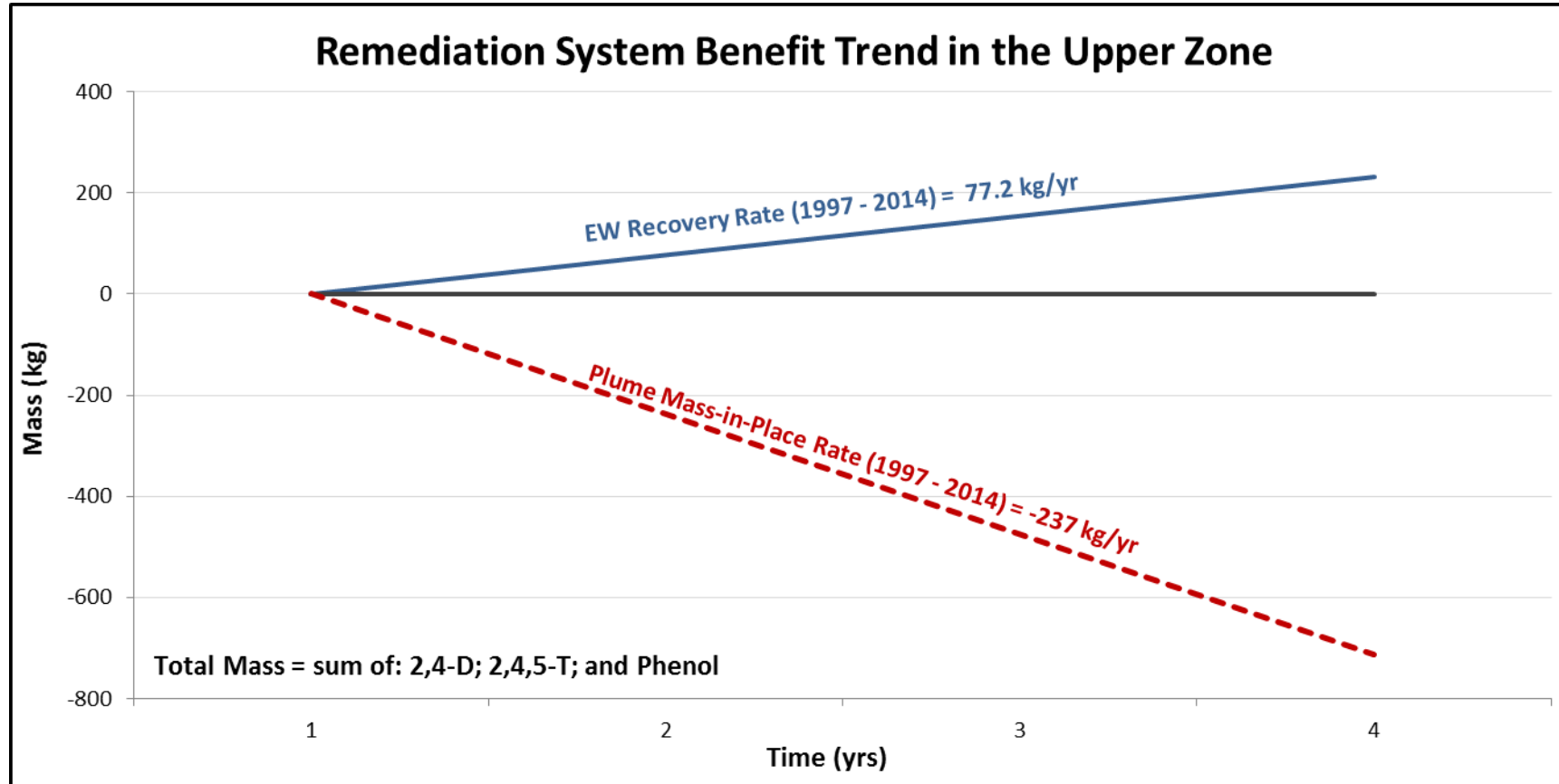
Sep-1984 to Sep-2014

Decreasing Trend

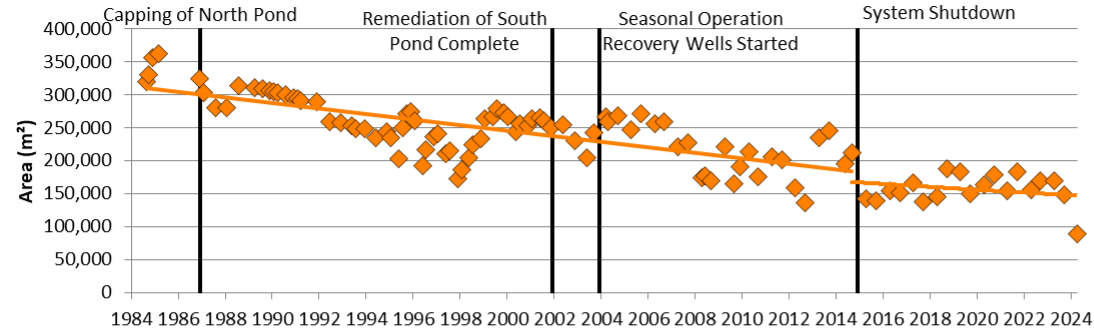
Mann-Kendall: >99% Confidence

Regression: >99% Confidence





2,4-D Plume Area (Upper Sand)



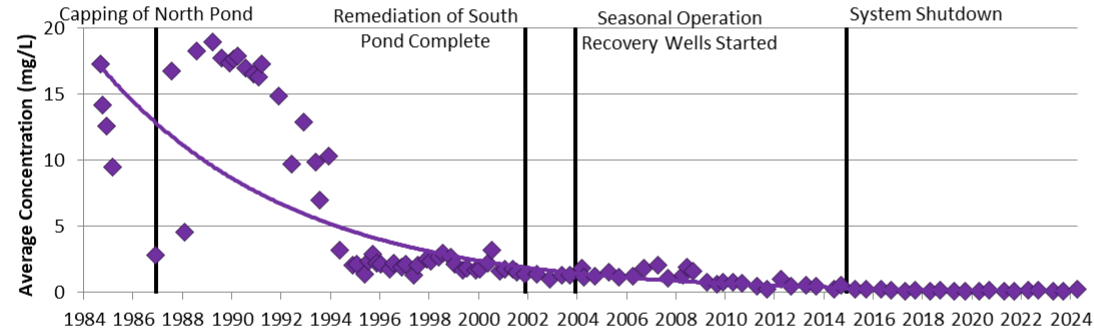
Sep-1984 to Sep-2014

Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024

Stable/No Trend
Mann-Kendall: 56% Confidence
Regression: 68% Confidence

2,4-D Plume Average Concentration (Upper Sand)



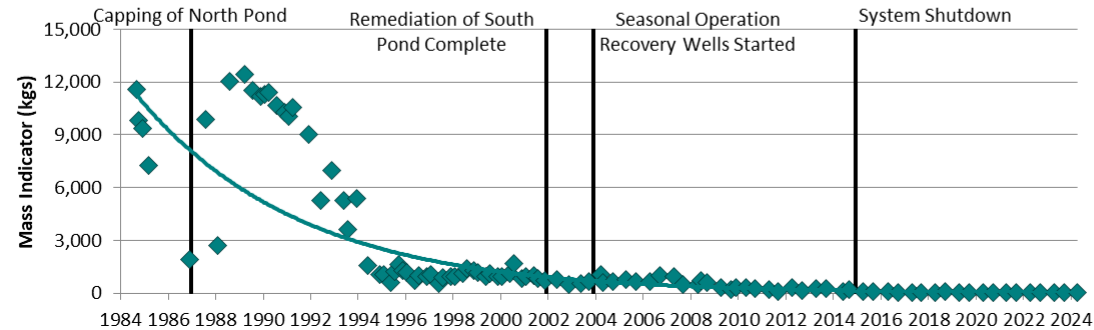
Sep-1984 to Sep-2014

Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024

Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence

2,4-D Plume Mass Indicator (Upper Sand)

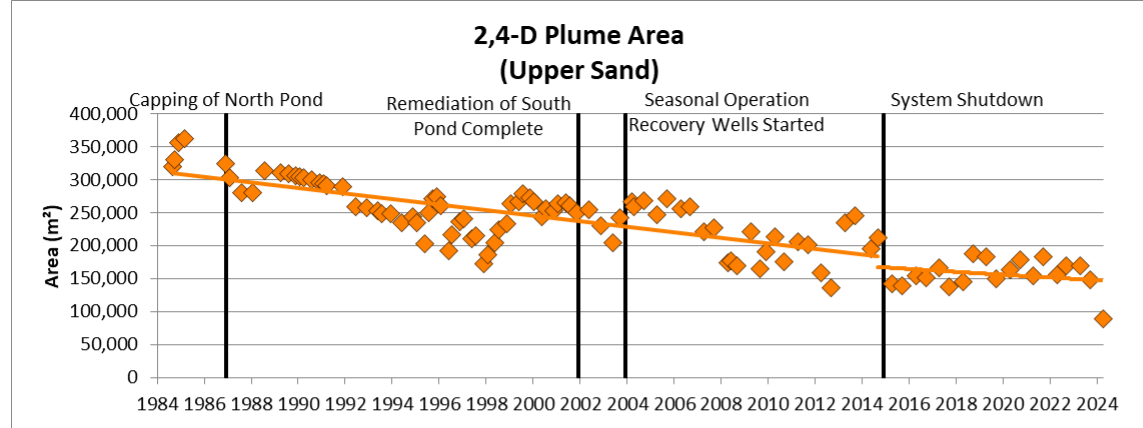


Sep-1984 to Sep-2014

Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

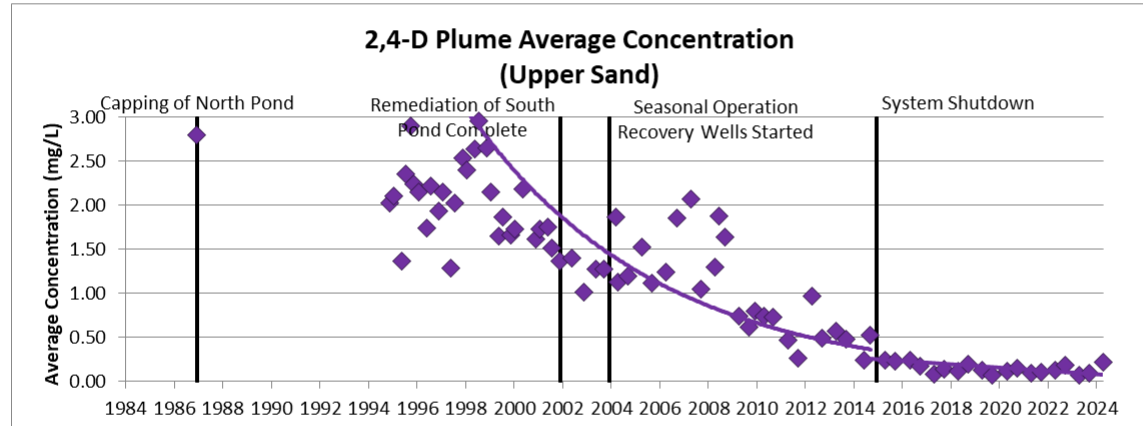
Sep-2014 to May-2024

Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence



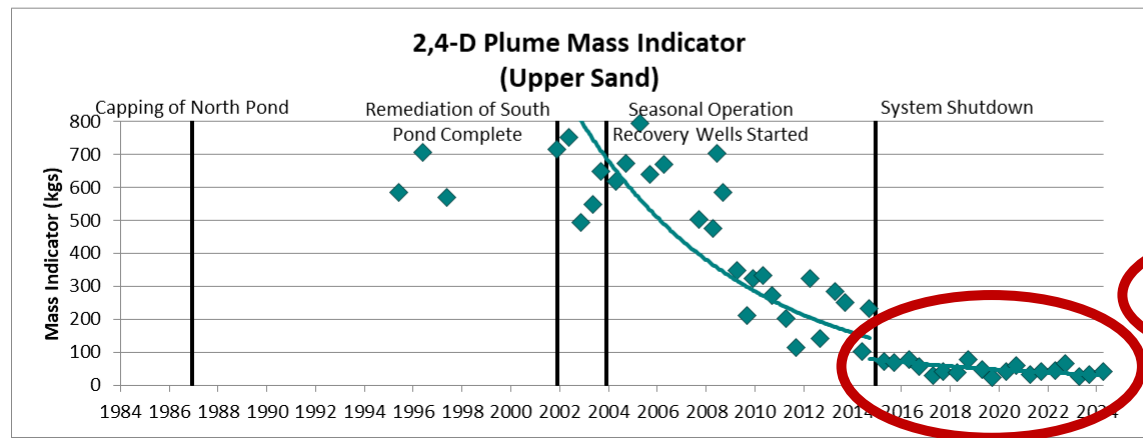
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Stable/No Trend
Mann-Kendall: 56% Confidence
Regression: 68% Confidence



Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

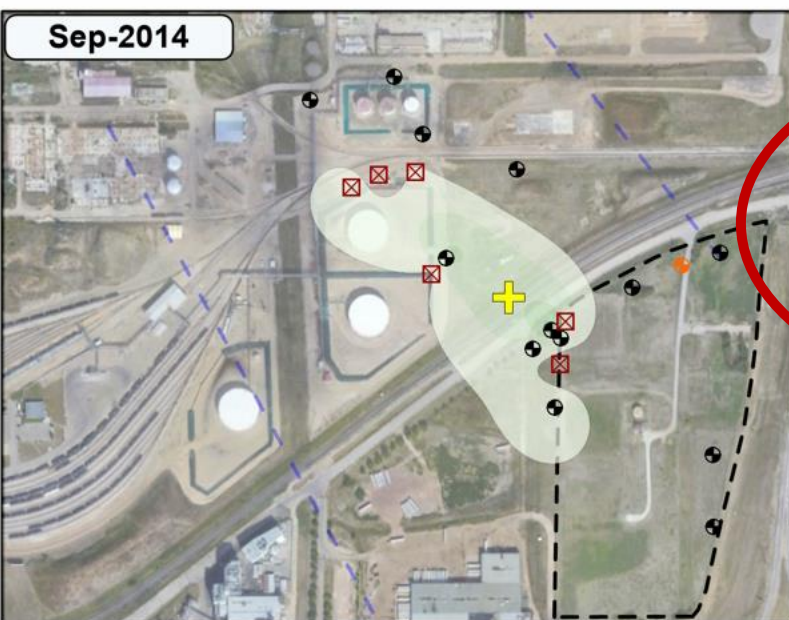
Sep-2014 to May-2024
Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence



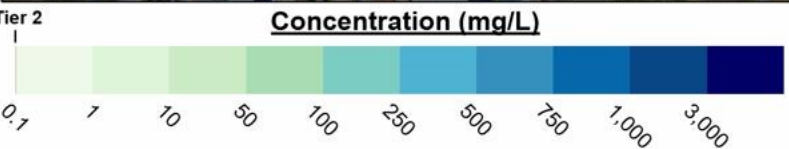
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence

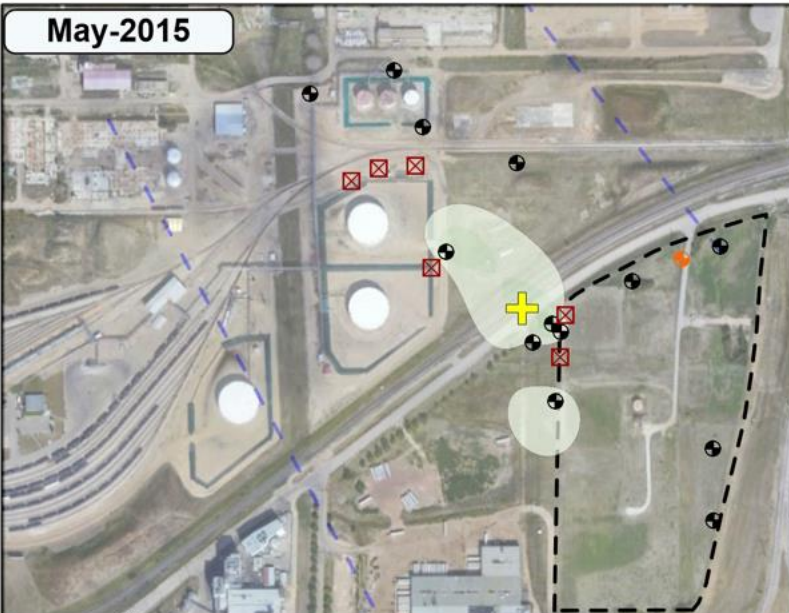
Sep-2014



Concentration (mg/L)



May-2015

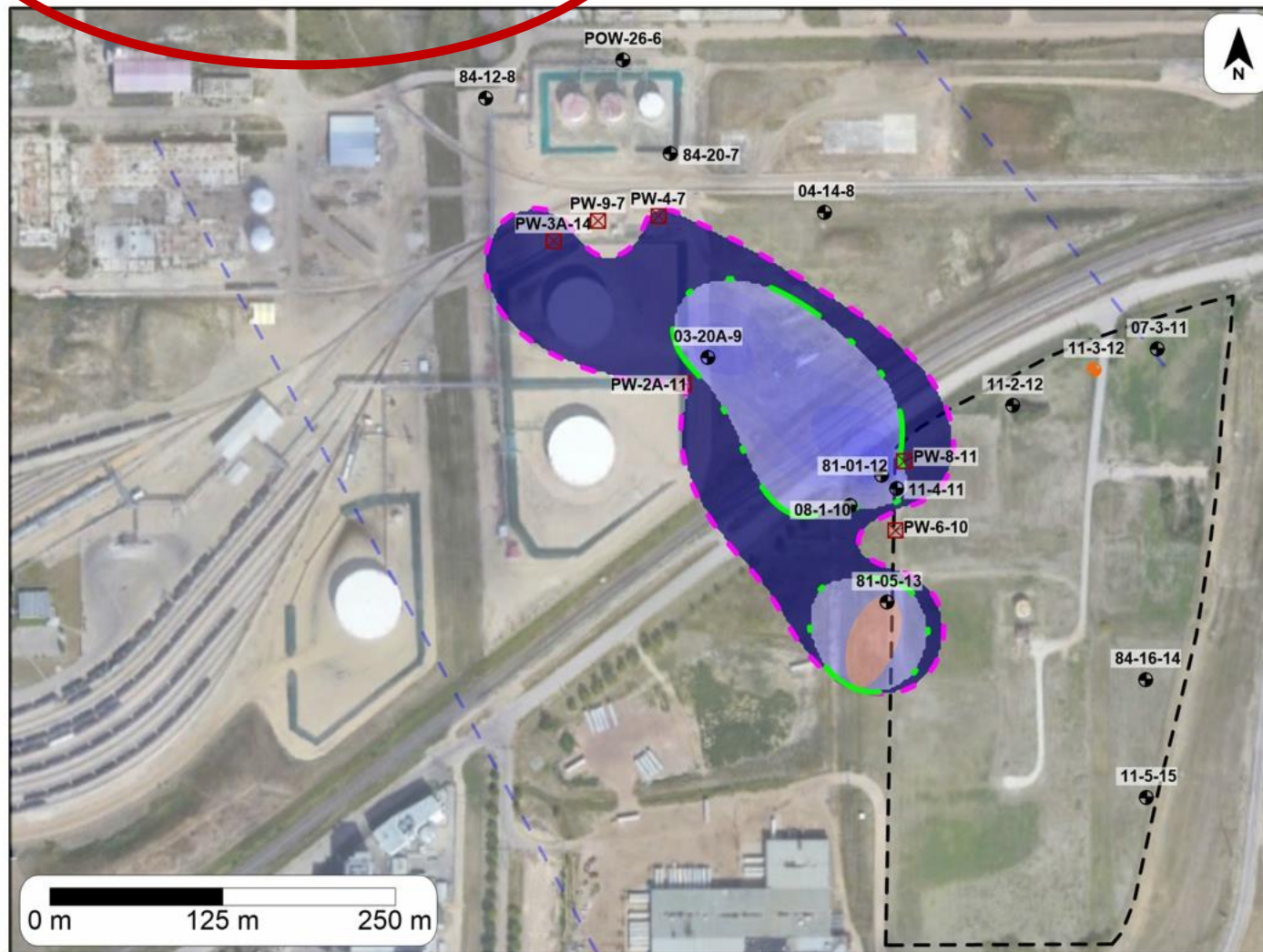


2,4-D Upper Sand Spatial Changes Sep-2014 vs May-2015

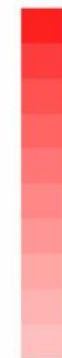
Plume Characteristics

Area: **33% Decrease**
 Average Concentration: **54% Decrease**
 Mass Indicator: **69% Decrease**
 Mass Increase: **0.27 kgs Increase**
 Mass Decrease: **162 kgs Decrease**

- Monitoring Well
- Hanging Well
- Extraction Well
- Sep-2014 Plume Boundary
- May-2015 Plume Boundary
- Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence



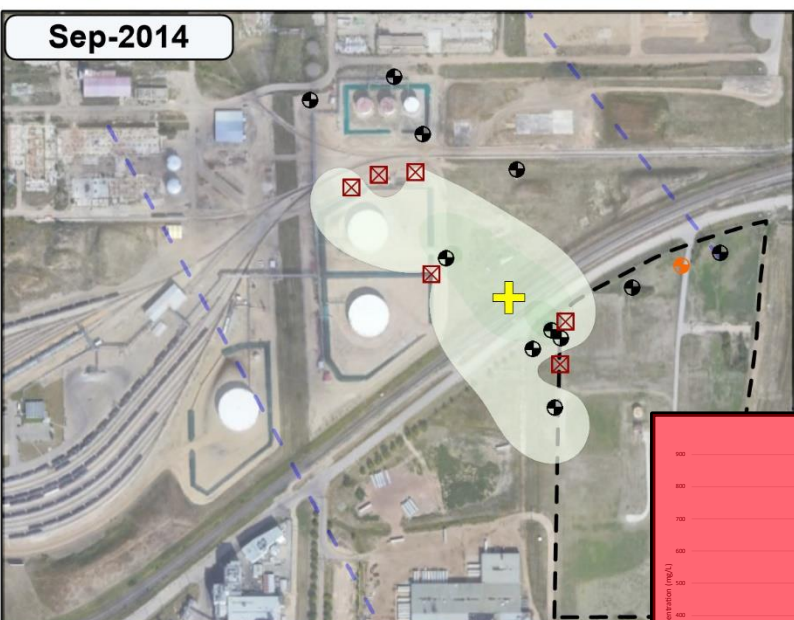
Spatial Change
Indicator™
Increase



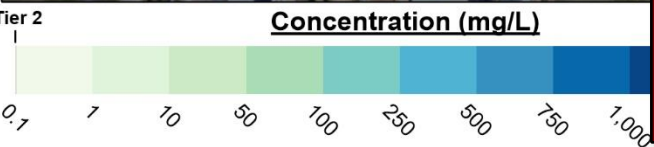
Decrease



Sep-2014



Concentration (mg/L)



May-2024

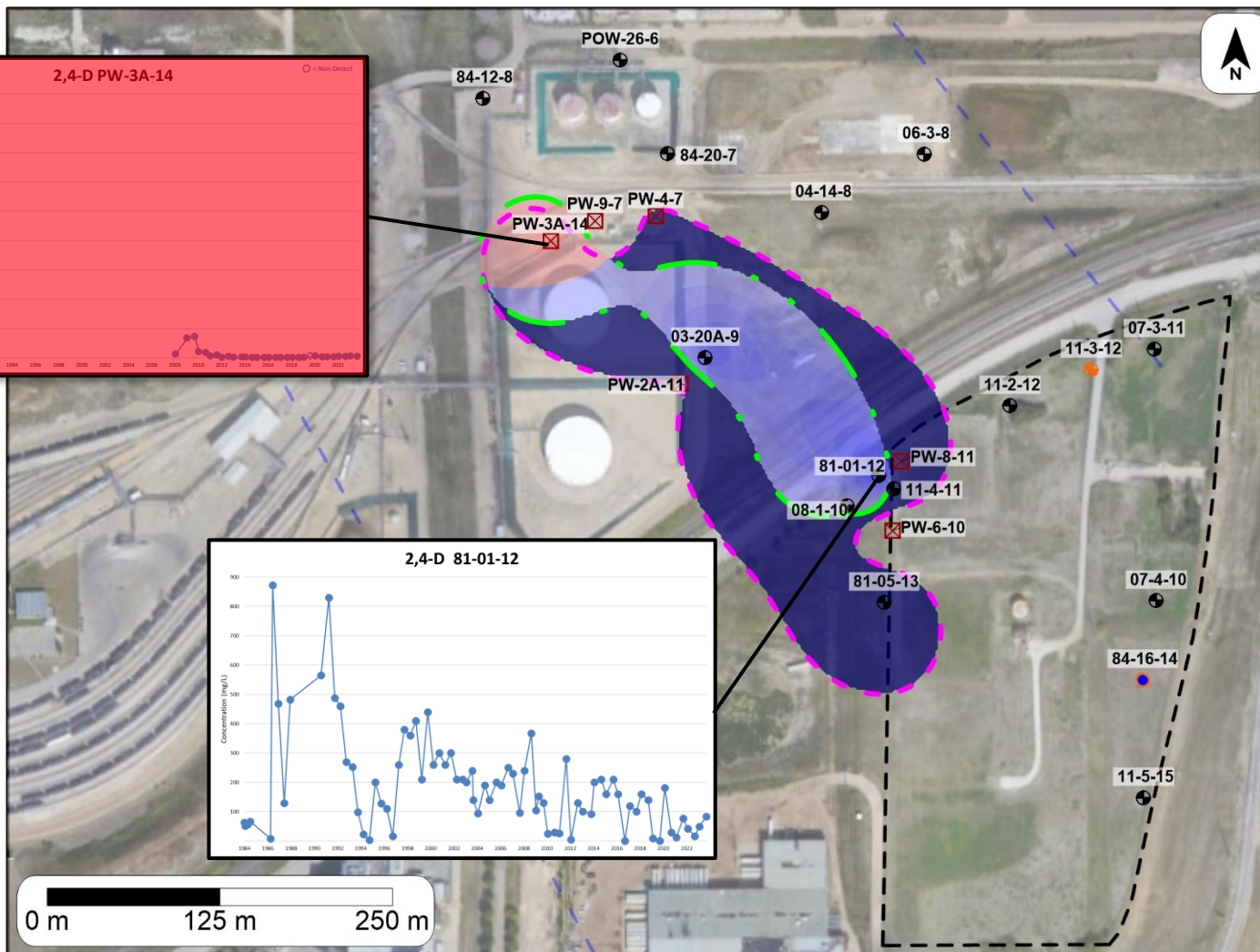


2,4-D Upper Sand Spatial Changes Sep-2014 vs May-2024

Plume Characteristics

Area: **58% Decrease**
 Average Concentration: **59% Decrease**
 Mass Indicator: **82% Decrease**
 Mass Increase: **2.68 kgs Increase**
 Mass Decrease: **195 kgs Decrease**

- Monitoring Well
- Hanging Well
- Extraction Well
- Sep-2014 Plume Boundary
- May-2024 Plume Boundary
- Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence

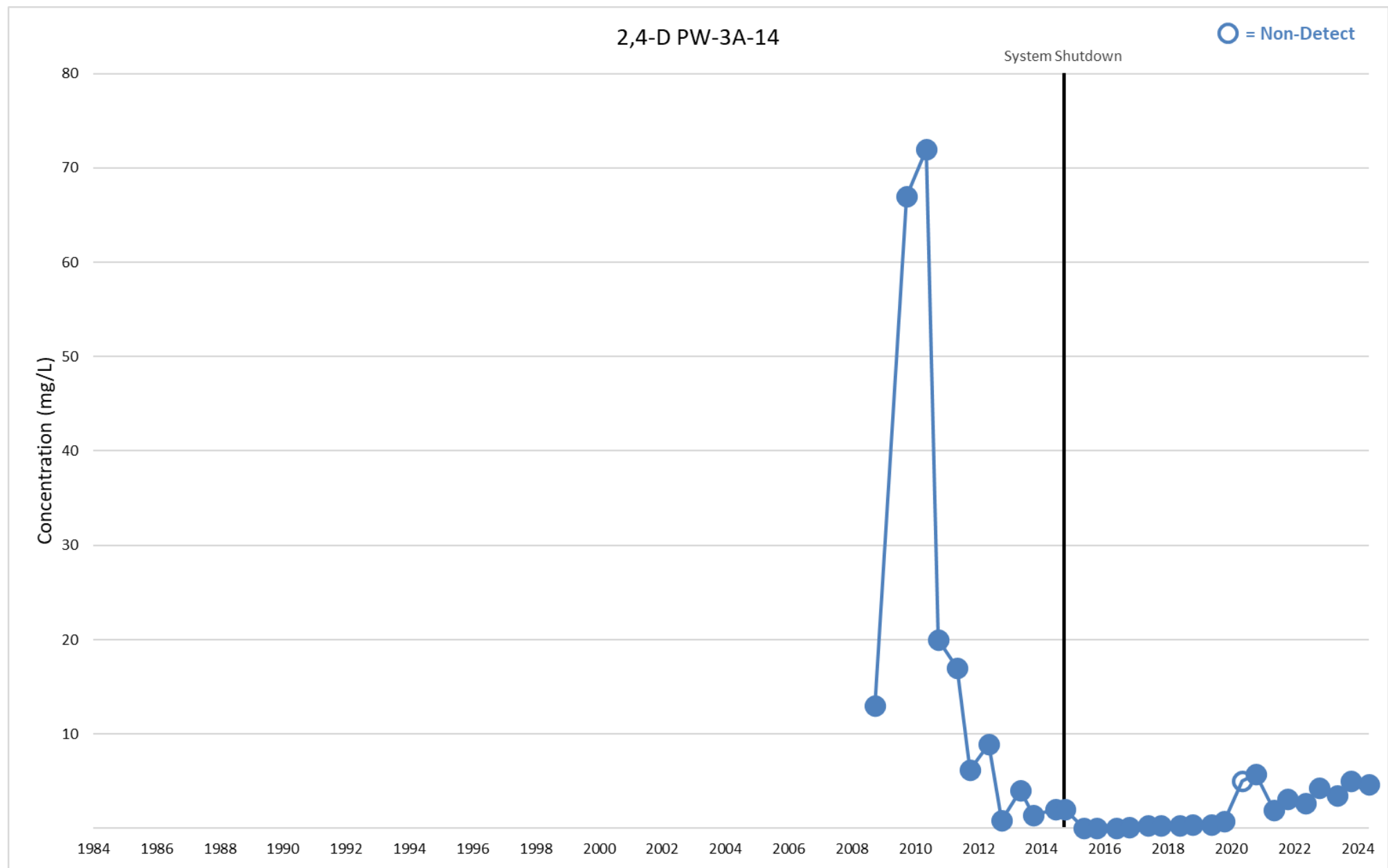


Spatial Change
Indicator™
Increase

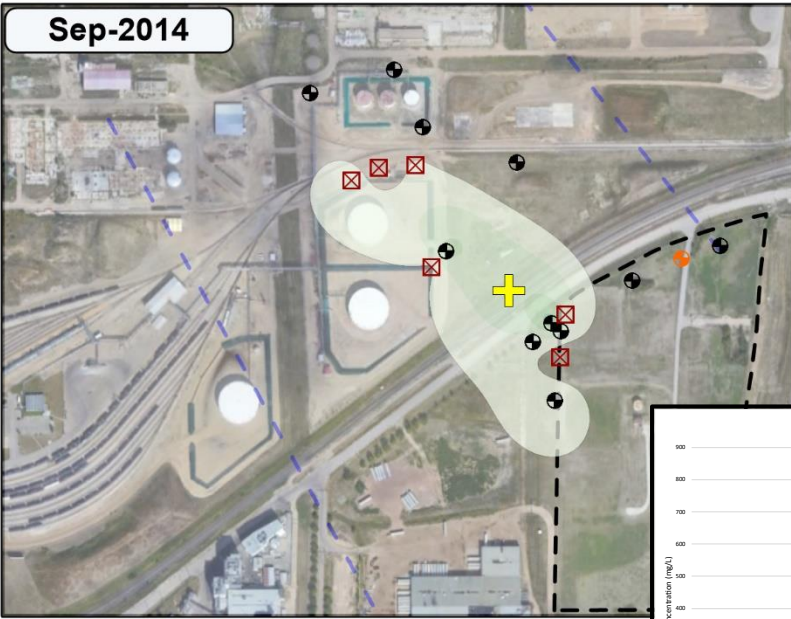


Decrease





Sep-2014

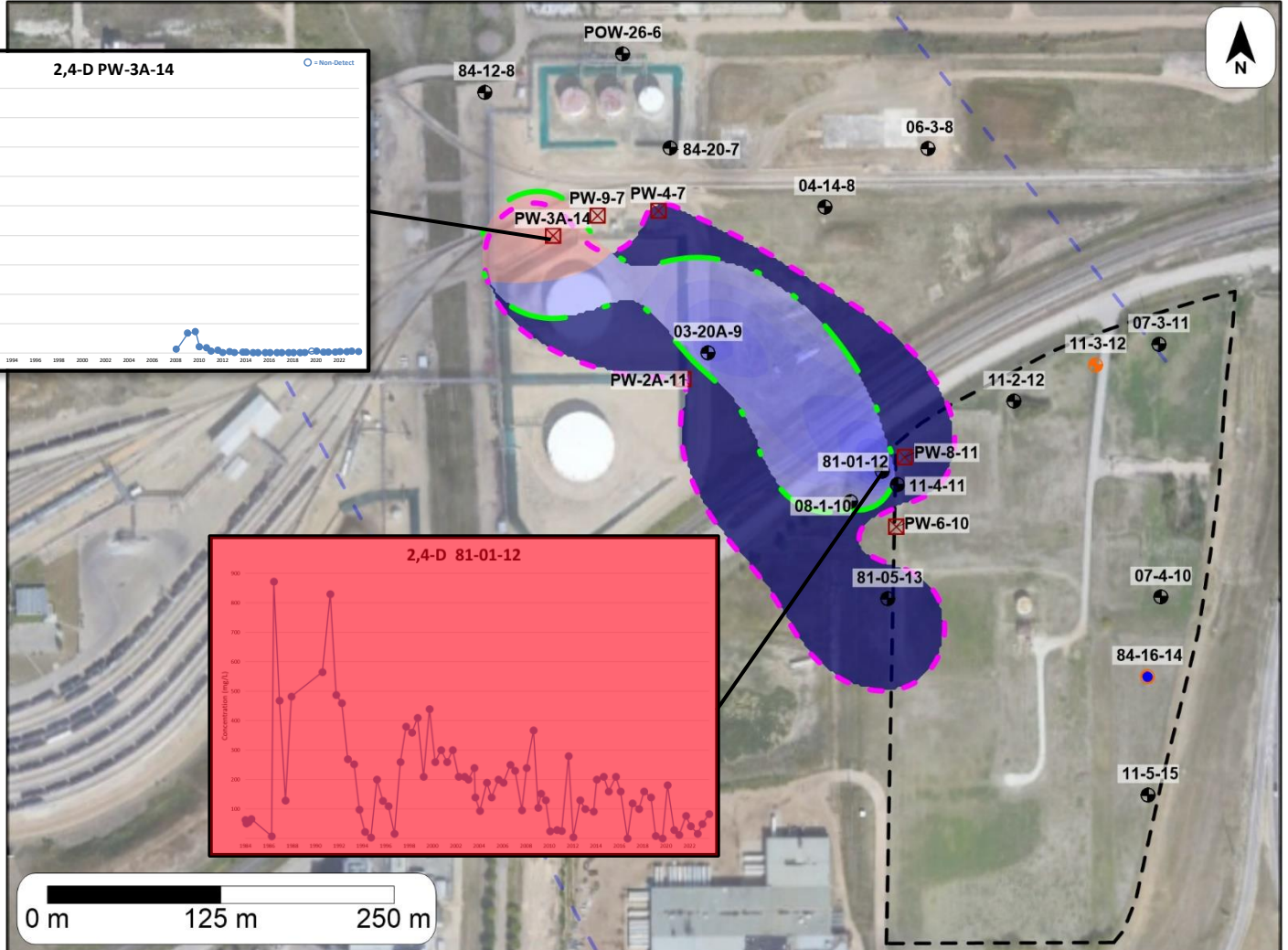
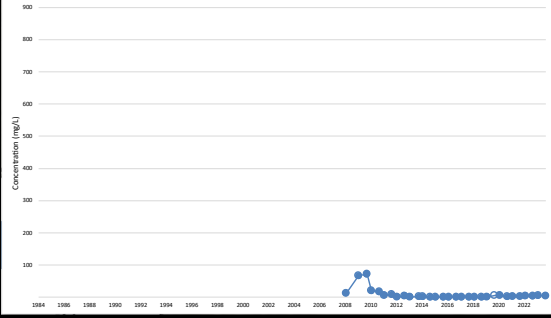


Plume Characteristics

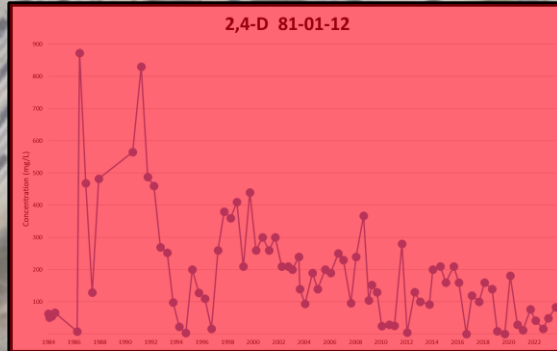
Area: **58% Decrease**
 Average Concentration: **59% Decrease**
 Mass Indicator: **82% Decrease**
 Mass Increase: **2.68 kgs Increase**
 Mass Decrease: **195 kgs Decrease**

- Monitoring Well
- Hanging Well
- ⊠ Extraction Well
- Sep-2014 Plume Boundary
- May-2024 Plume Boundary
- ✚ Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence

2,4-D PW-3A-14



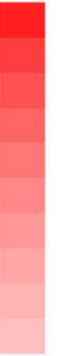
2,4-D 81-01-12



May-2024

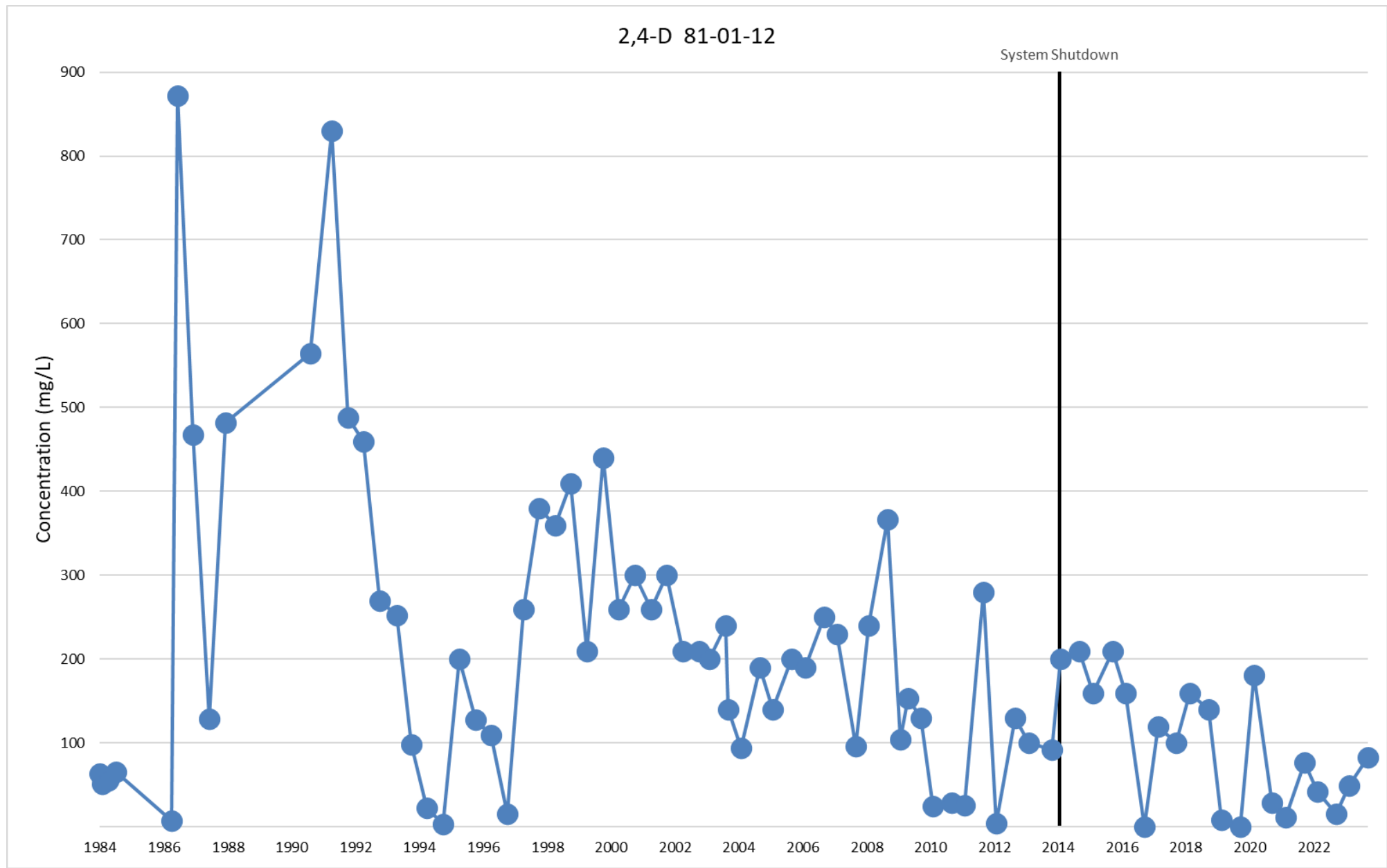


Spatial Change
Indicator™
Increase



Decrease





Groundwater Plume Analytics® Services

Upper Sand

2,4-D

2,4,5-T

Phenolics

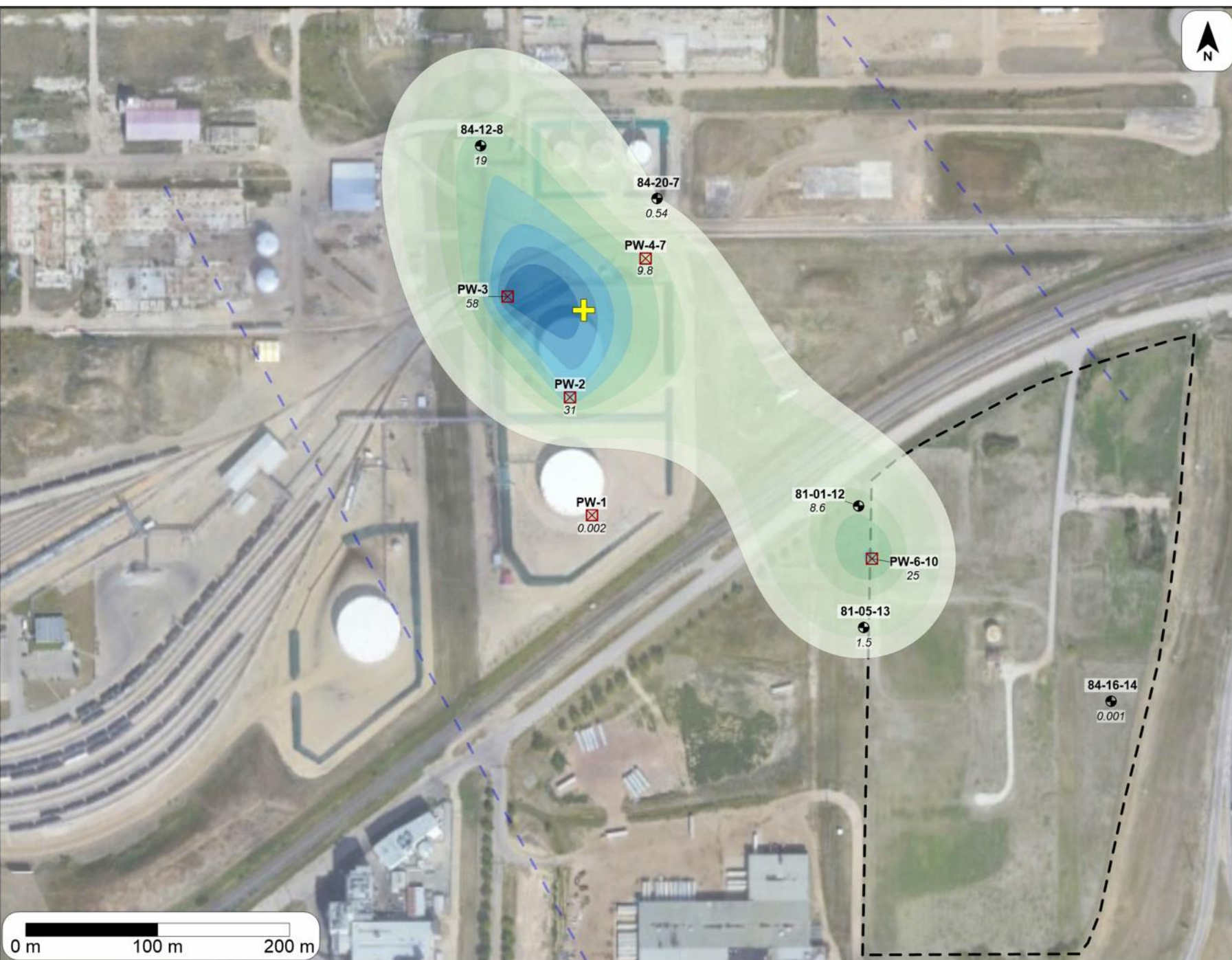
MCPA

PCP

2,3,4,6-
Tetrachlorophenol

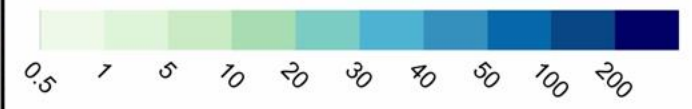
2,4,6-
Trichlorophenol

2,4-
Dichlorophenol



2,4,5-T Upper Sand Sep-1984

Concentration (mg/L)



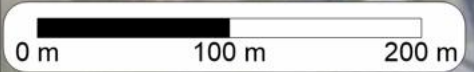
Plume Characteristics

Plume Area: **90,609 m²**

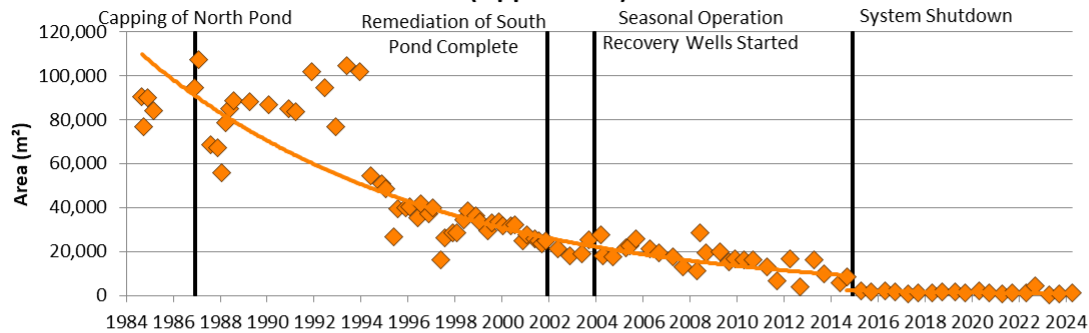
Plume Average Concentration: **8.7 mg/L**

Plume Mass Indicator: **1,664 kgs**

- | | |
|---|----------------------|
| Monitoring Well | Plume Centre of Mass |
| Hanging Well | Control Point |
| Extraction Well | Property Boundary |
| 112 Concentration (mg/L) | Control Fence |
| NS (146) Well Not Sampled
(Assigned Value Shown) | |



2,4,5-T Plume Area (Upper Sand)



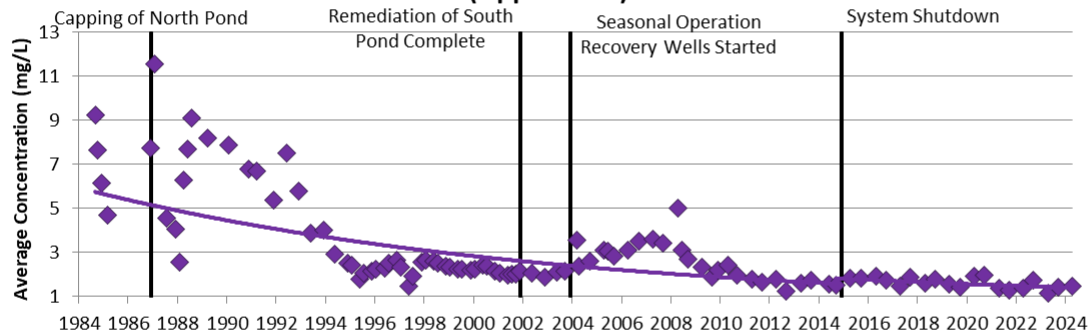
Sep-1984 to Sep-2014

Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024

Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 97% Confidence

2,4,5-T Plume Average Concentration (Upper Sand)



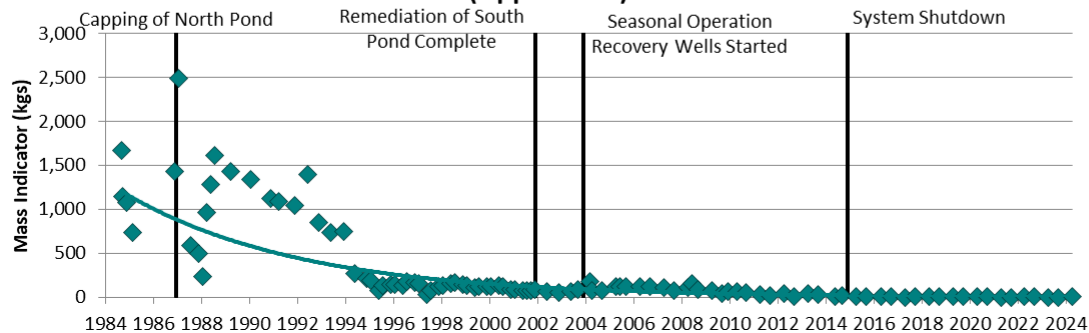
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Sep-2014 to May-2024

Decreasing Trend
Mann-Kendall: 98% Confidence
Regression: 99% Confidence

2,4,5-T Plume Mass Indicator (Upper Sand)

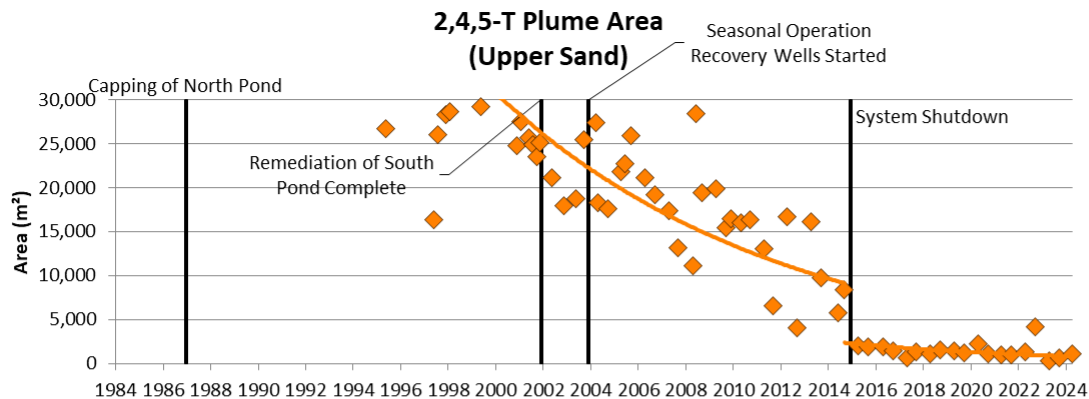


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Decreasing Trend
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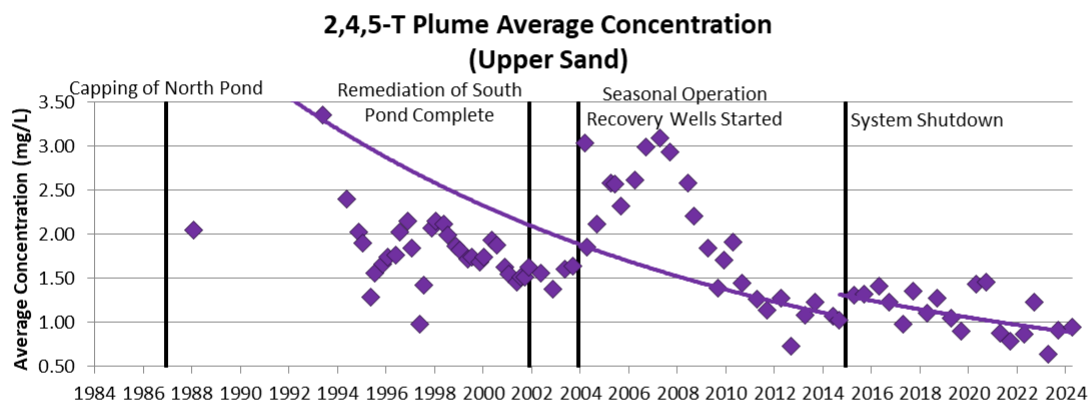
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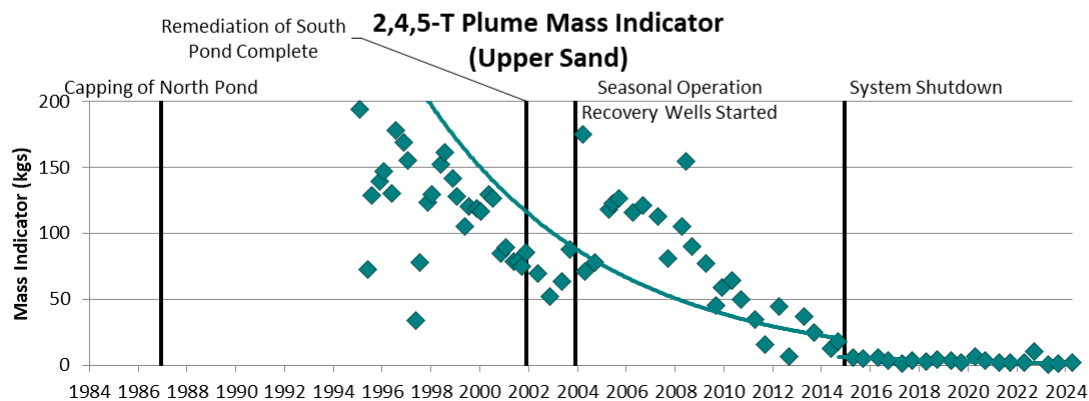
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Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: 97% Confidence



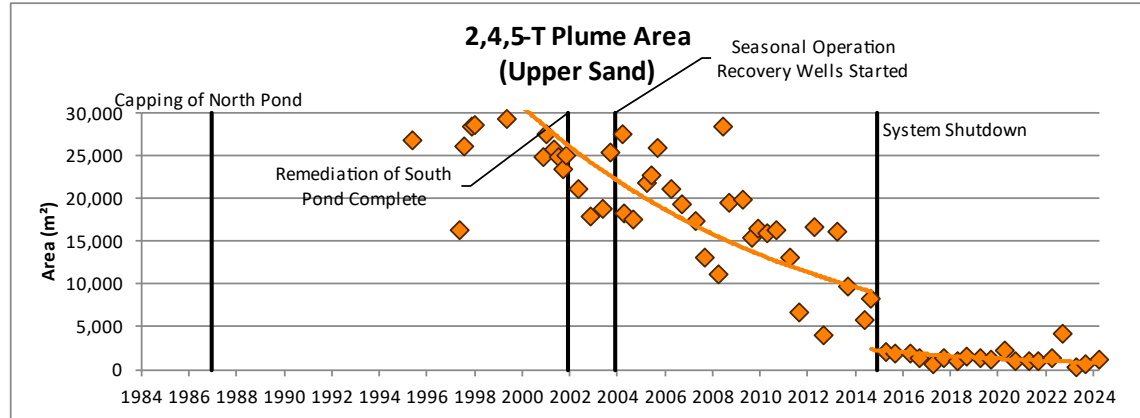
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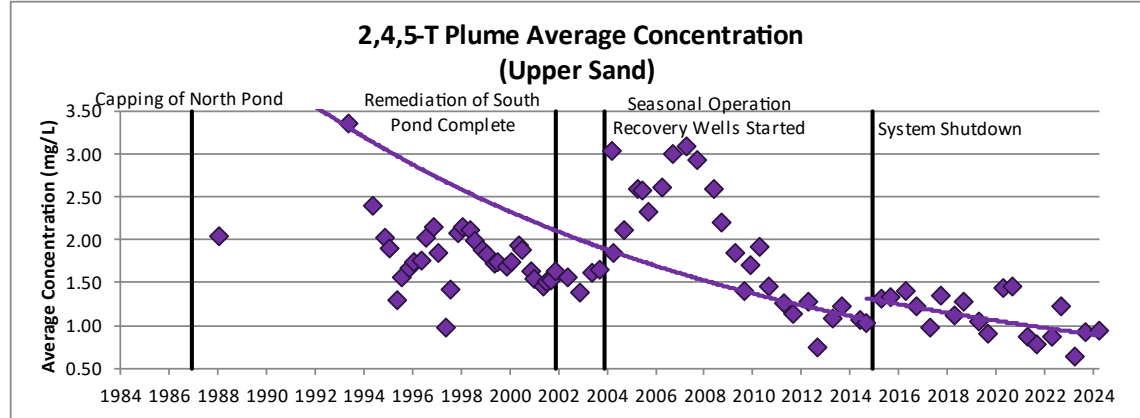
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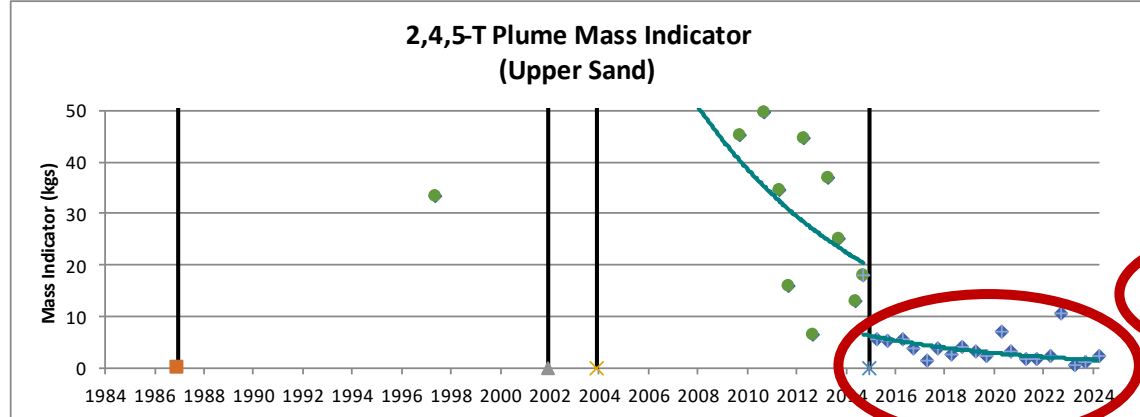
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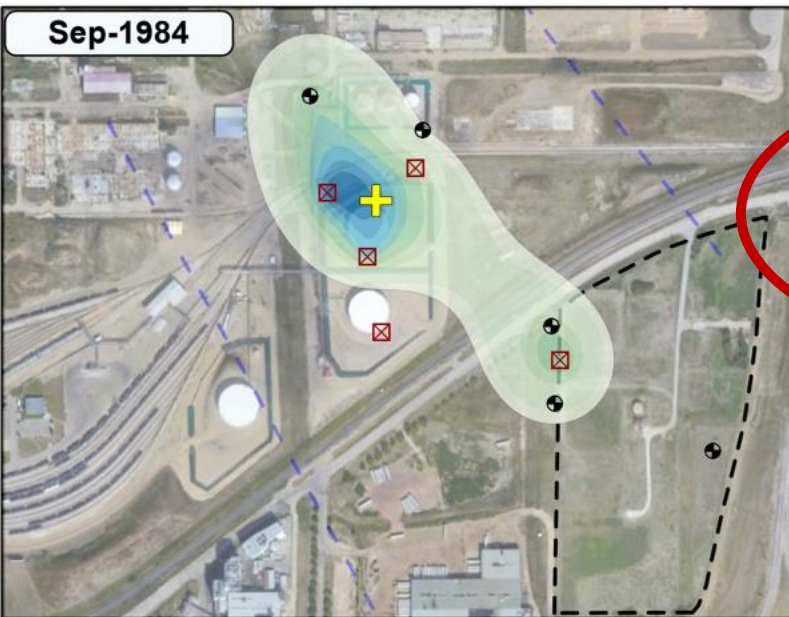
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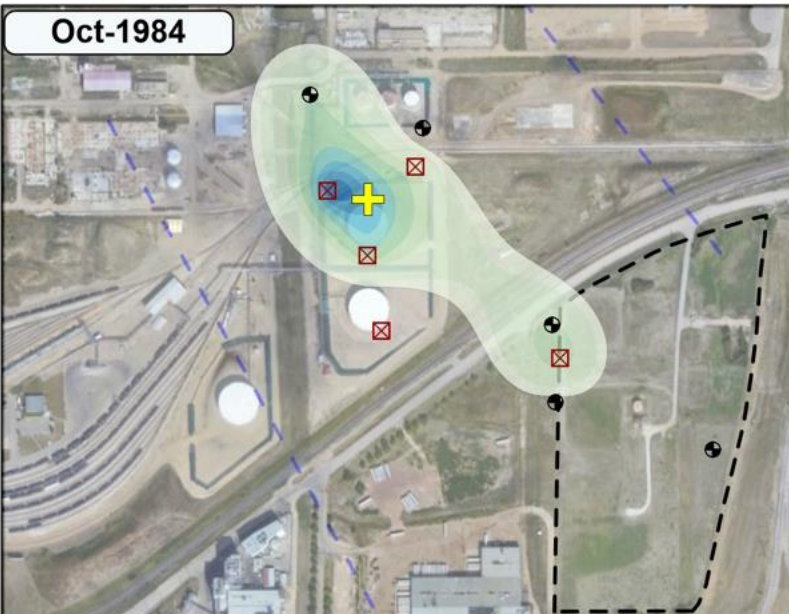
Sep-1984



Concentration (mg/L)



Oct-1984

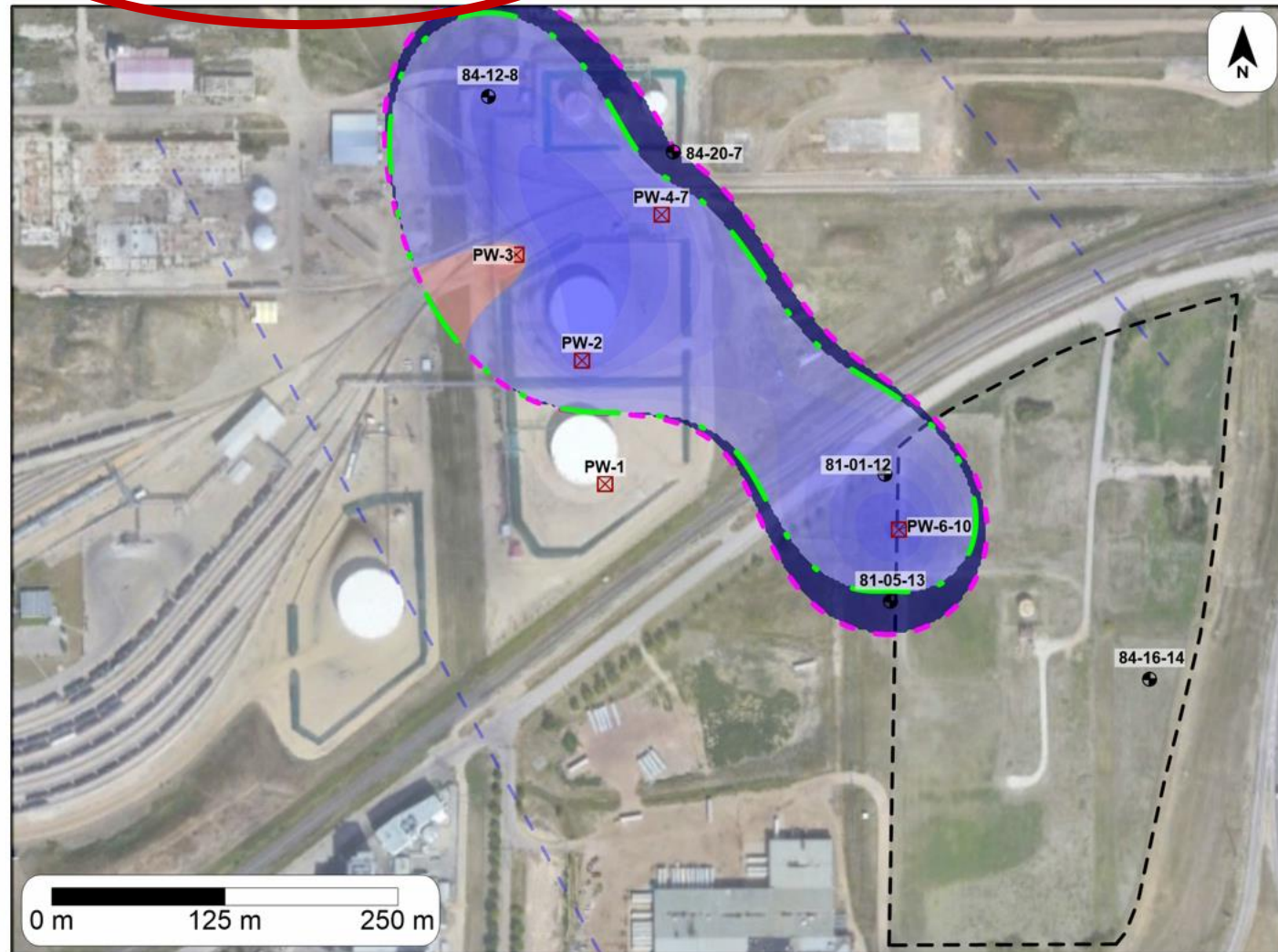


2.4.5-T Upper Sand Spatial Changes Sep-1984 vs Oct-1984

Plume Characteristics

Area: **15% Decrease**
 Average Concentration: **18% Decrease**
 Mass Indicator: **31% Decrease**
 Mass Increase: **1.78 kgs Increase**
 Mass Decrease: **515 kgs Decrease**

- Monitoring Well
- Hanging Well
- ⊠ Extraction Well
- Sep-1984 Plume Boundary
- Oct-1984 Plume Boundary
- ⊕ Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence



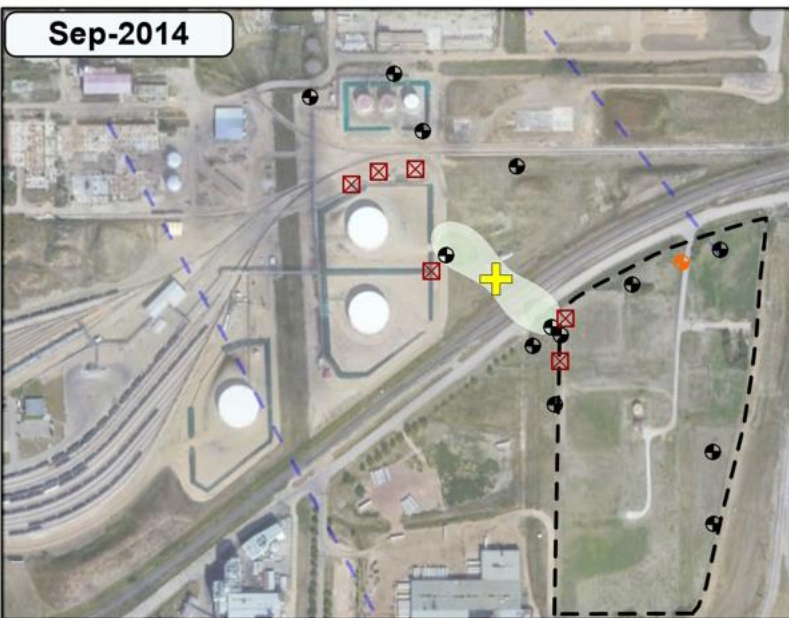
Spatial Change
Indicator™
Increase



Decrease



Sep-2014



Concentration (mg/L)



May-2015

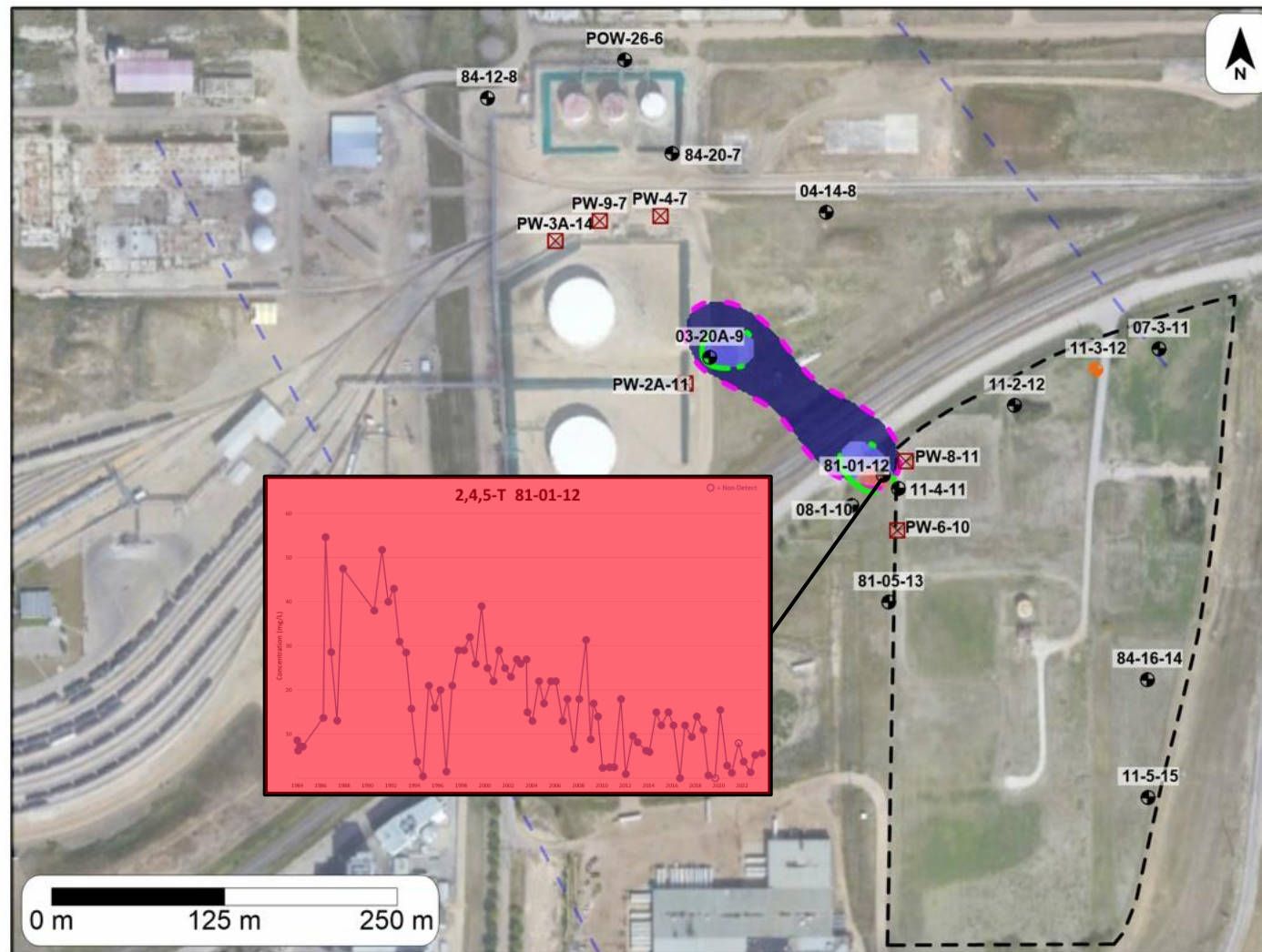


2,4,5-T Upper Sand Spatial Changes Sep-2014 vs May-2015

Plume Characteristics

Area: **76% Decrease**
 Average Concentration: **27% Increase**
 Mass Indicator: **69% Decrease**
 Mass Increase: **0.91 kgs Increase**
 Mass Decrease: **13.3 kgs Decrease**

- | | |
|-----------------------------|------------------------|
| ● Monitoring Well | ✚ Plume Centre of Mass |
| ○ Hanging Well | ● Control Point |
| ⊠ Extraction Well | --- Property Boundary |
| --- Sep-2014 Plume Boundary | --- Control Fence |
| --- May-2015 Plume Boundary | |

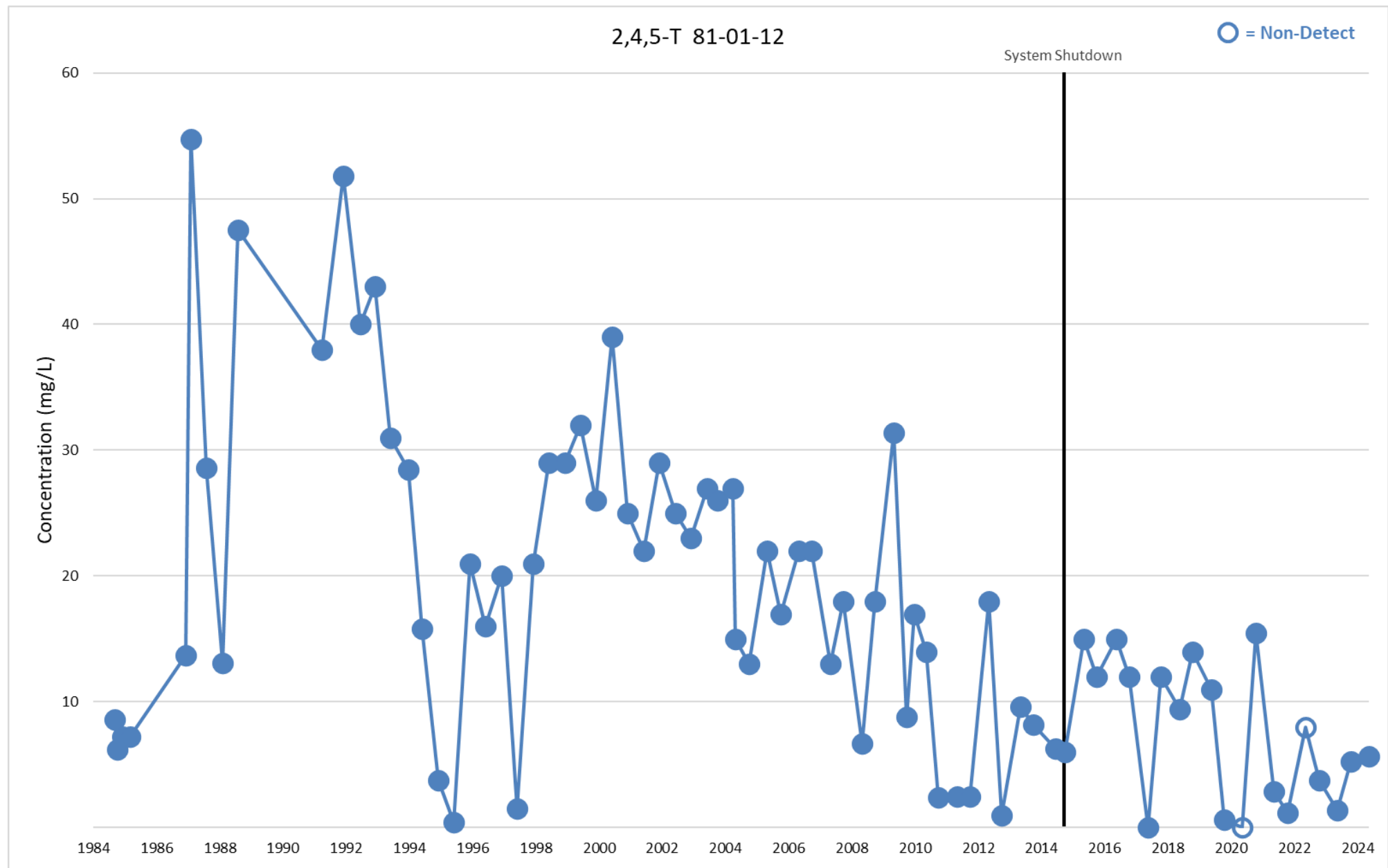


Spatial Change
Indicator™
Increase



Decrease





Groundwater Plume Analytics® Services

Upper Sand

2,4-D

2,4,5-T

Phenolics

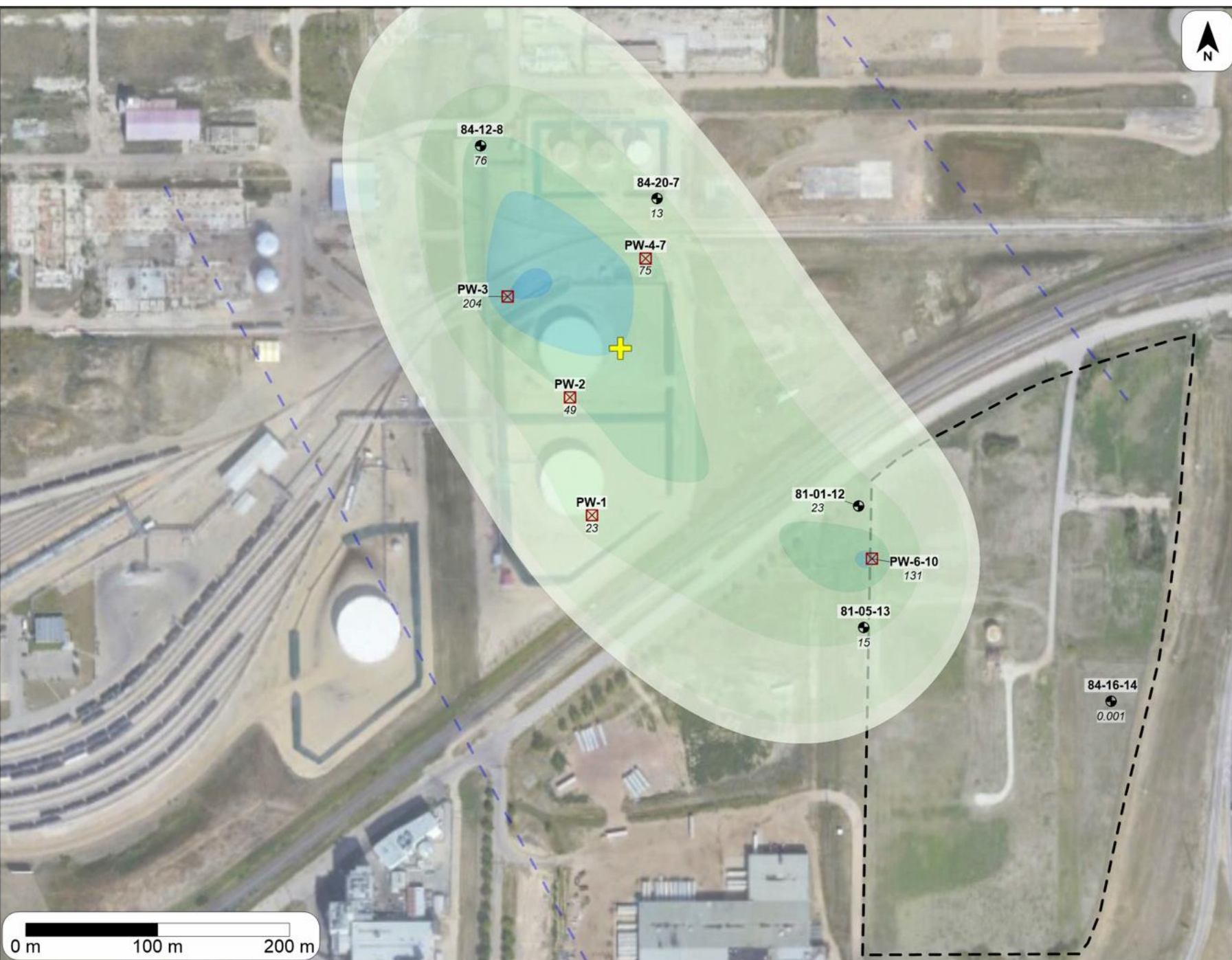
MCPA

PCP

2,3,4,6-
Tetrachlorophenol

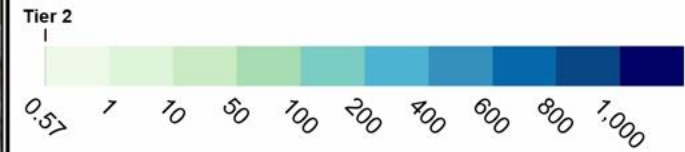
2,4,6-
Trichlorophenol

2,4-
Dichlorophenol



Phenolics Upper Sand Sep-1984

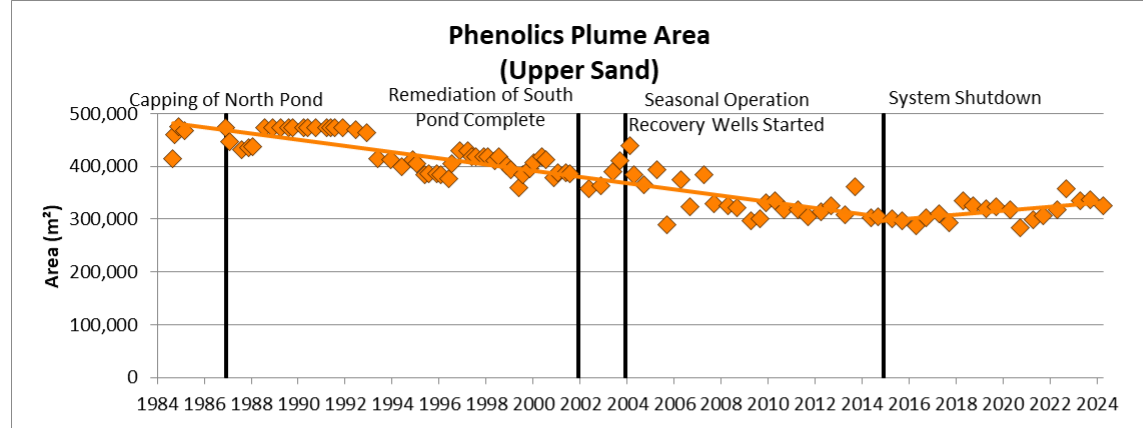
Concentration (mg/L)



Plume Characteristics

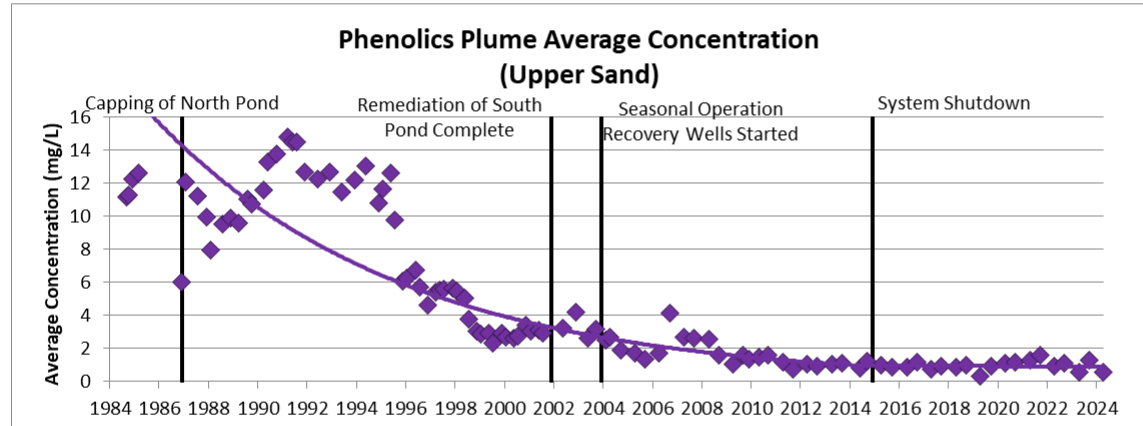
Plume Area: **414,422 m²**
Plume Average Concentration: **11.2 mg/L**
Plume Mass Indicator: **9,706 kgs**

- | | |
|--|----------------------|
| Monitoring Well | Plume Center of Mass |
| Hanging Well | Control Point |
| Extraction Well | Property Boundary |
| 112 Concentration (mg/L) | Control Fence |
| NS (146) Well Not Sampled (Assigned Value Shown) | |
| Extrapolated Well | |



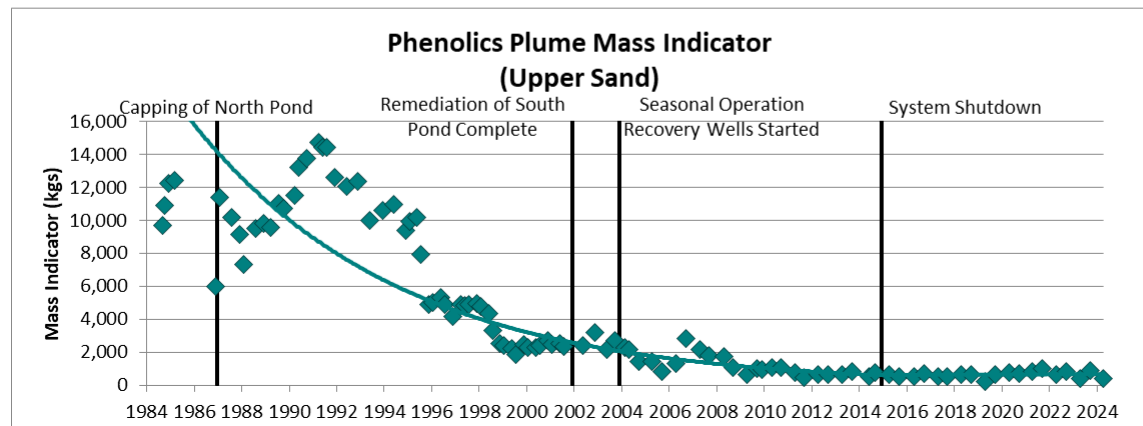
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Increasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence



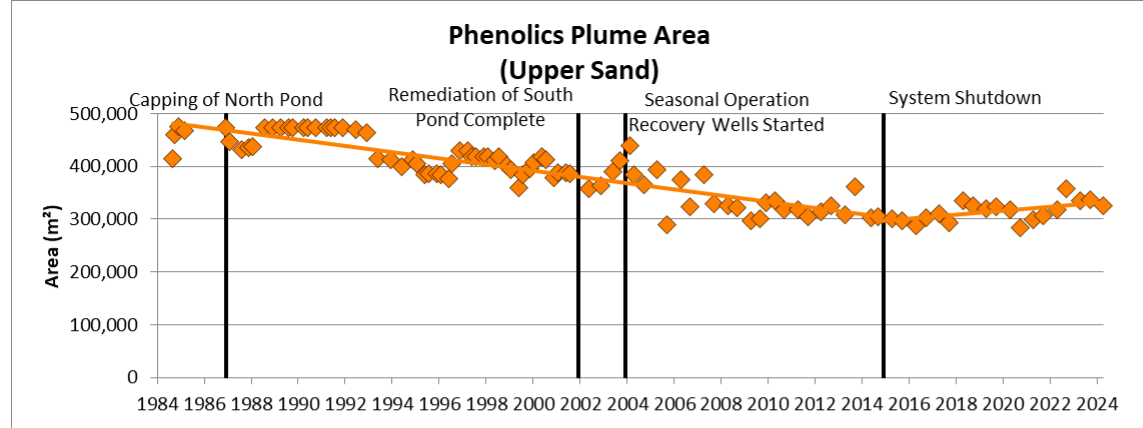
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Stable/No Trend
Mann-Kendall: 73% Confidence
Regression: 18% Confidence



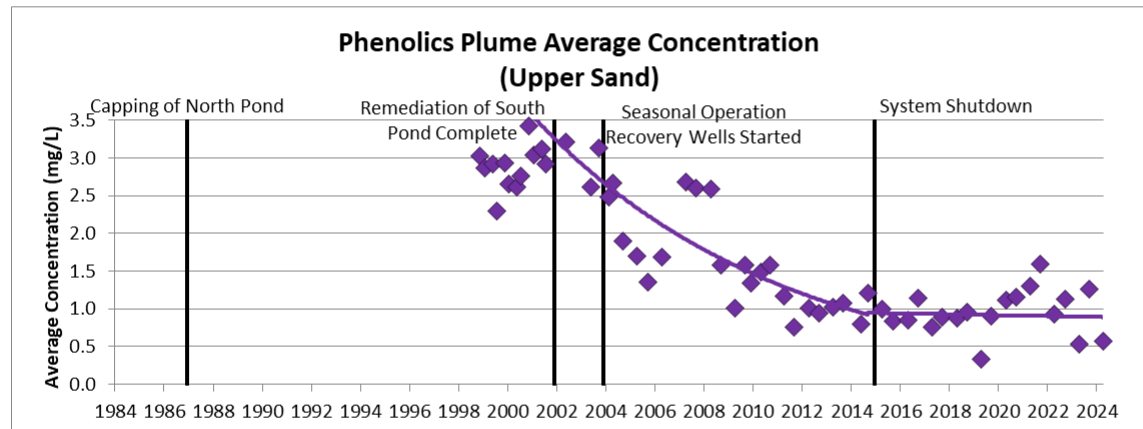
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
No Trend
Mann-Kendall: 81% Confidence
Regression: 40% Confidence



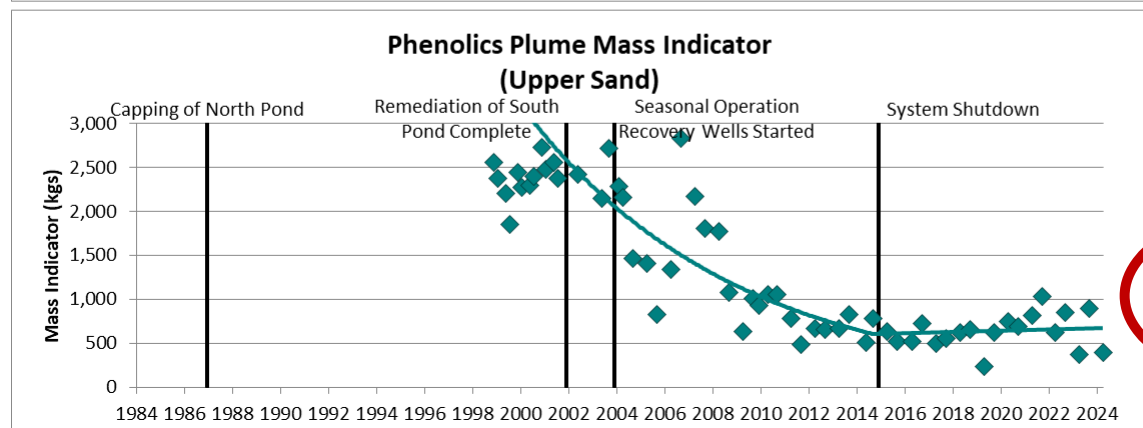
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Increasing Trend
Mann-Kendall: 99% Confidence
Regression: 99% Confidence



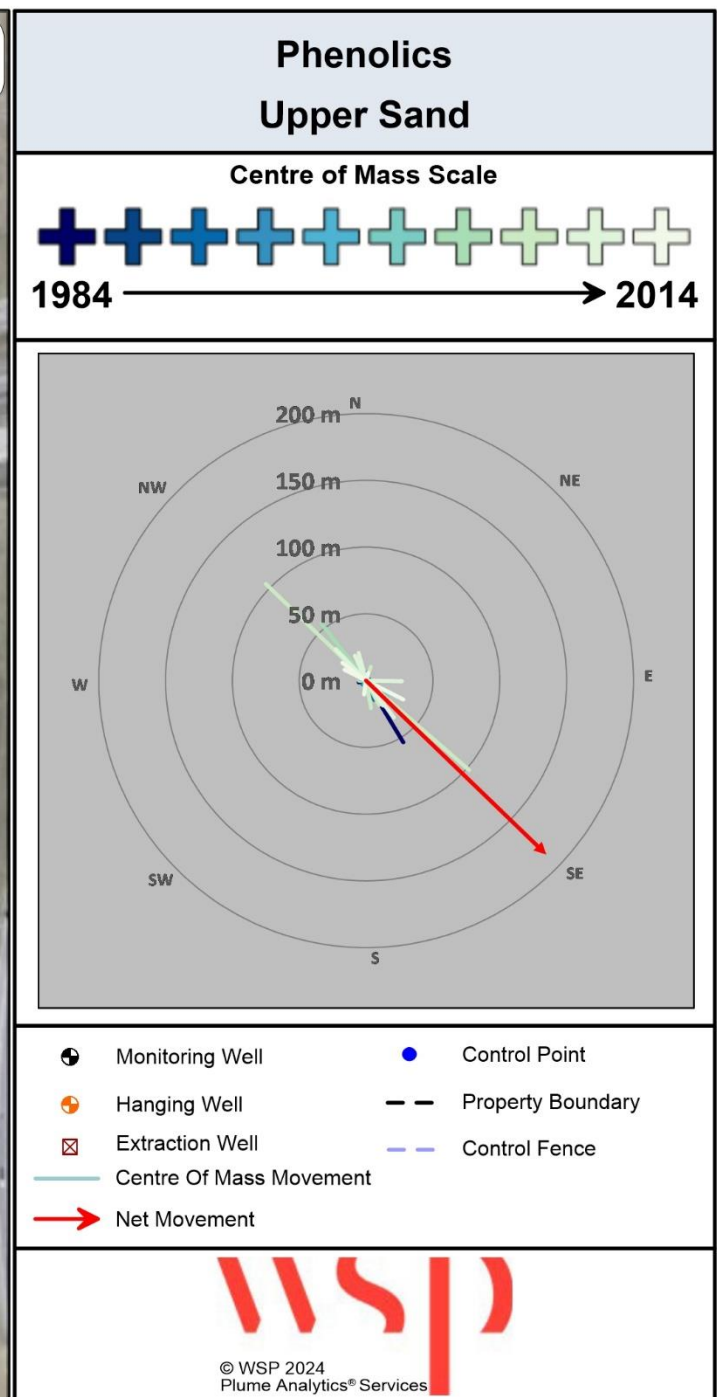
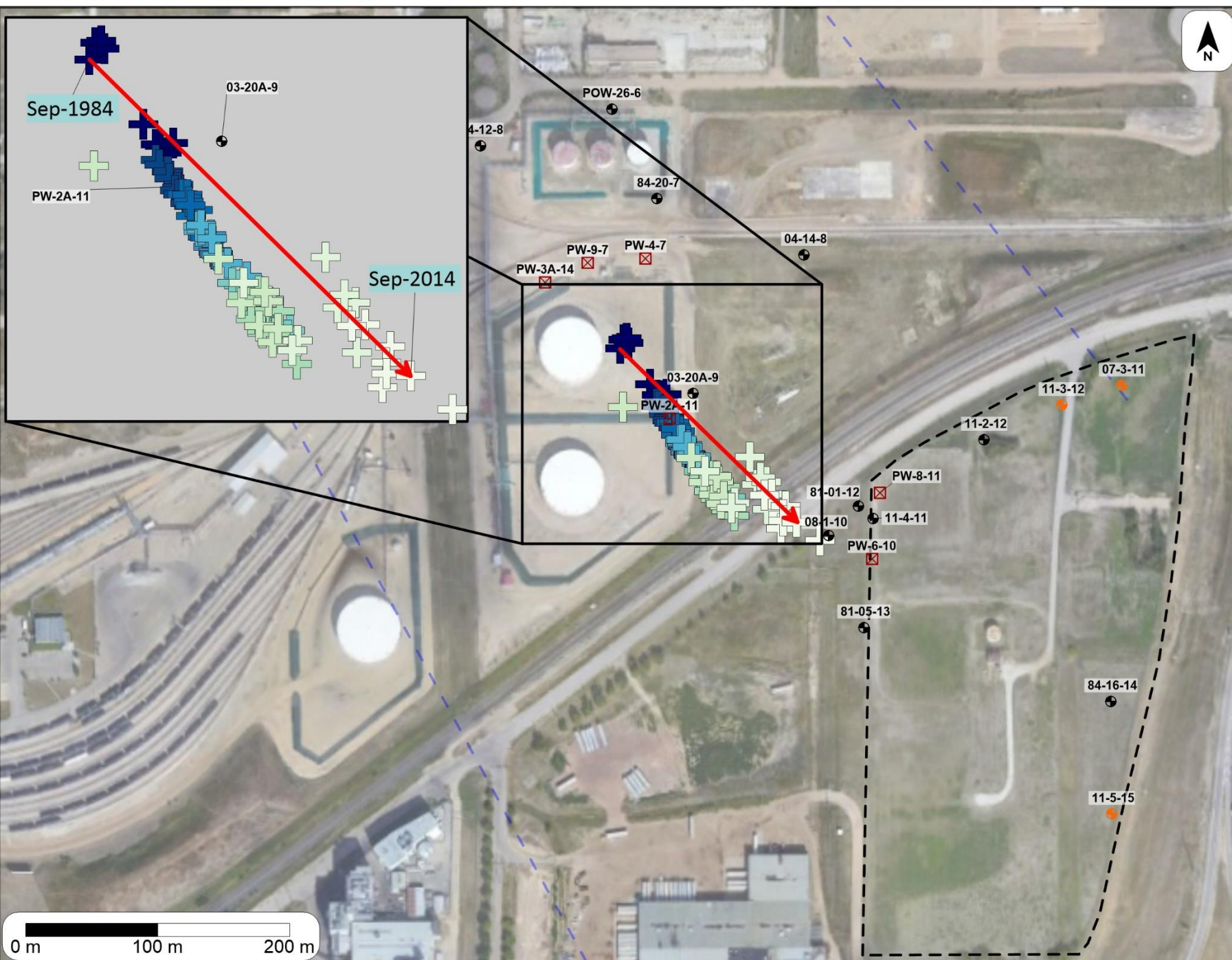
Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Sep-2014 to May-2024
Stable/No Trend
Mann-Kendall: 73% Confidence
Regression: 18% Confidence

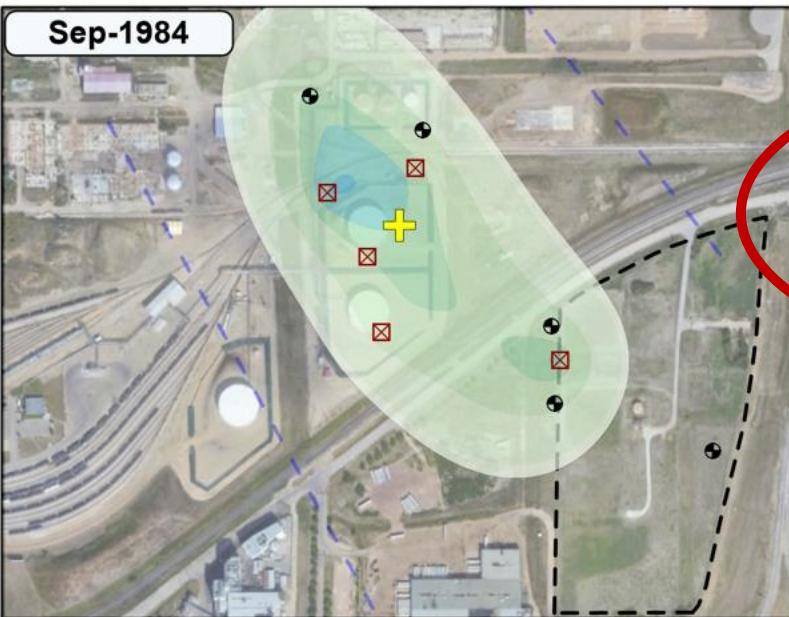


Sep-1984 to Sep-2014
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

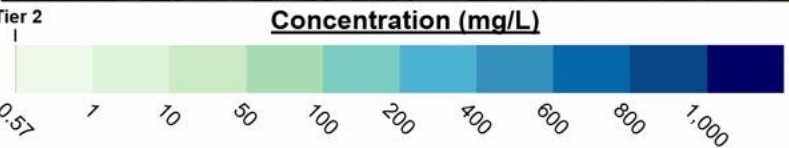
Sep-2014 to May-2024
No Trend
Mann-Kendall: 81% Confidence
Regression: 40% Confidence



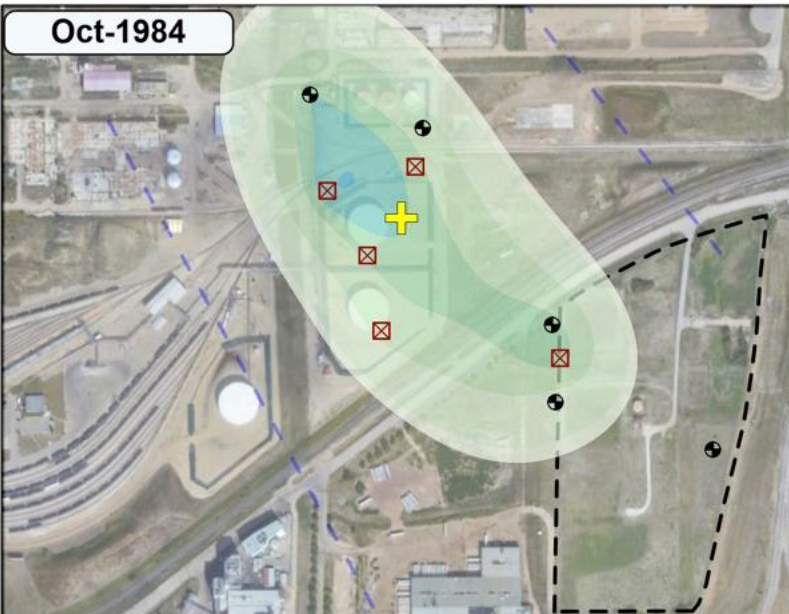
Sep-1984



Concentration (mg/L)



Oct-1984

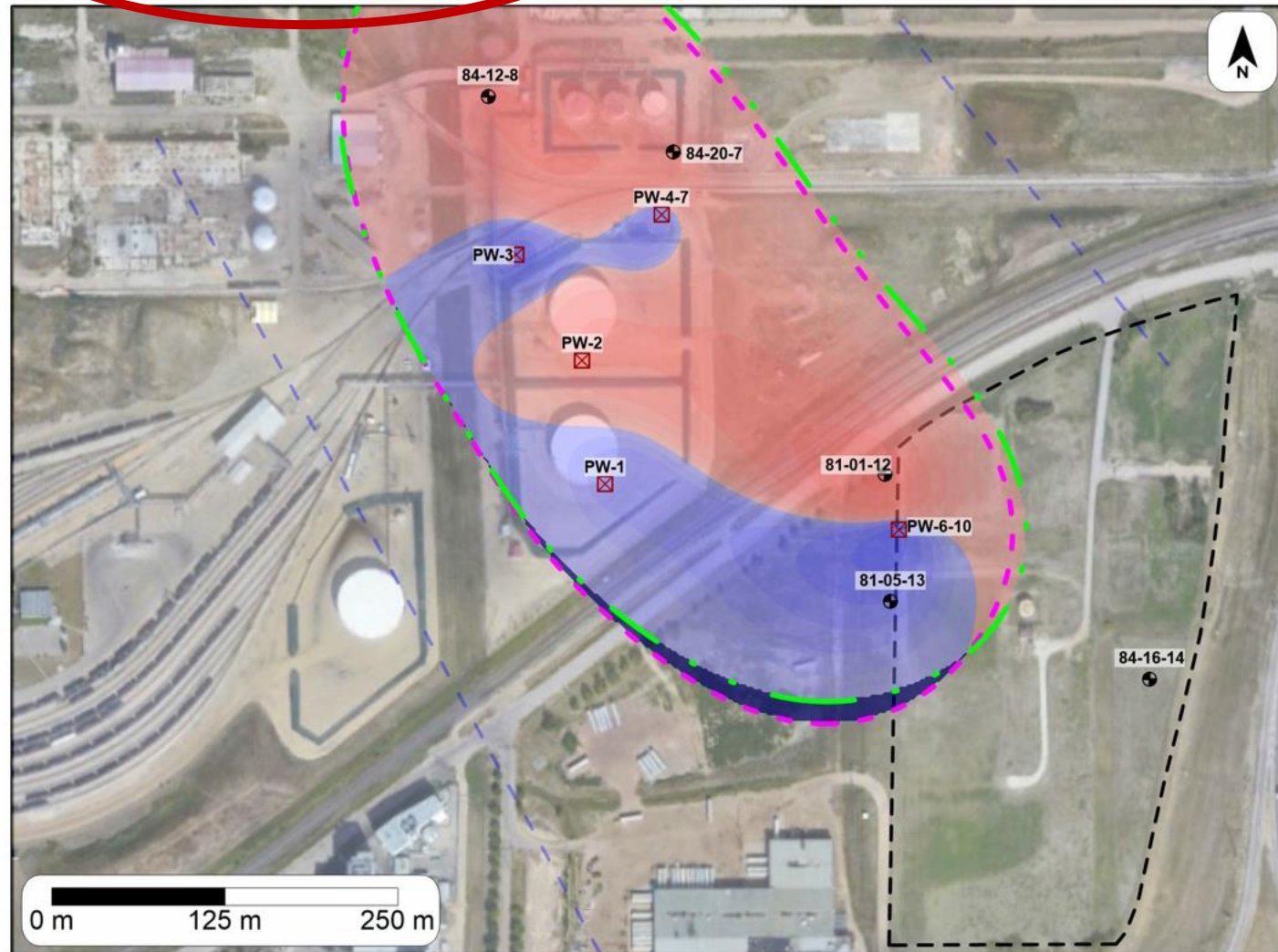


Phenolics Upper Sand Spatial Changes Sep-1984 vs Oct-1984

Plume Characteristics

Area: **11% Increase**
Average Concentration: **1% Increase**
Mass Indicator: **12% Increase**
Mass Increase: **1,601 kgs Increase**
Mass Decrease: **405 kgs Decrease**

- Monitoring Well
- Hanging Well
- ⊠ Extraction Well
- Sep-1984 Plume Boundary
- Oct-1984 Plume Boundary
- ⊕ Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence



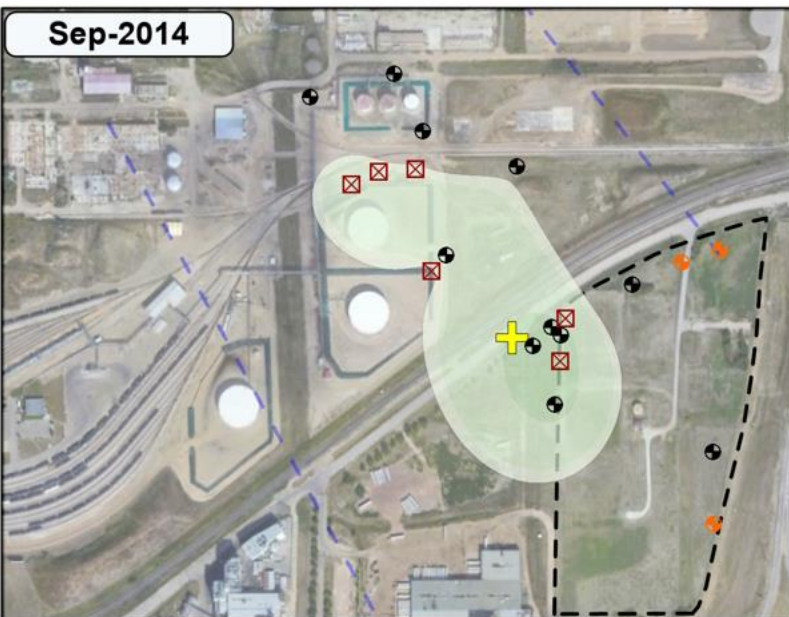
Spatial Change
Indicator™
Increase



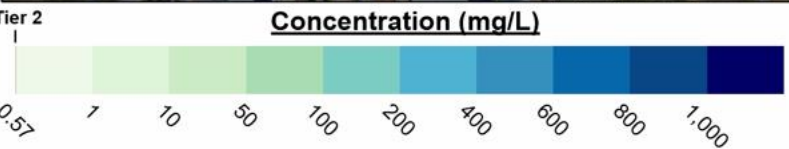
Decrease



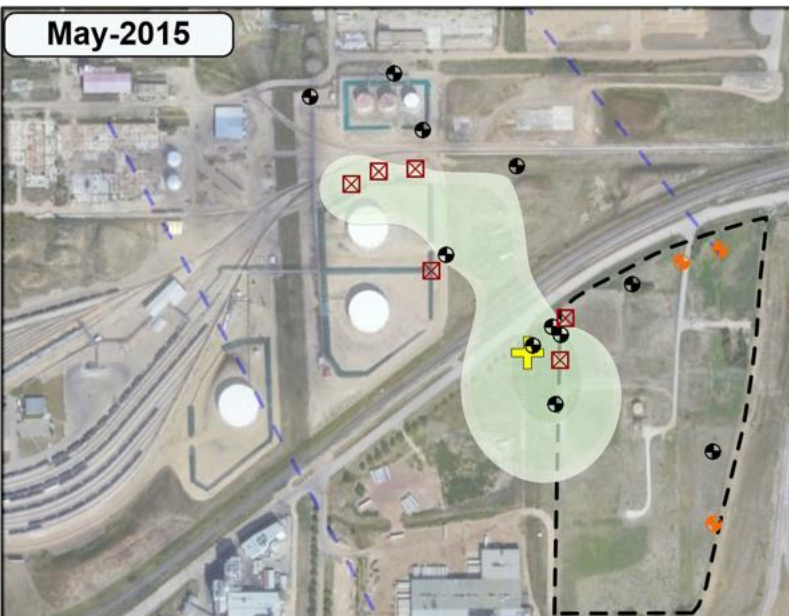
Sep-2014



Concentration (mg/L)



May-2015

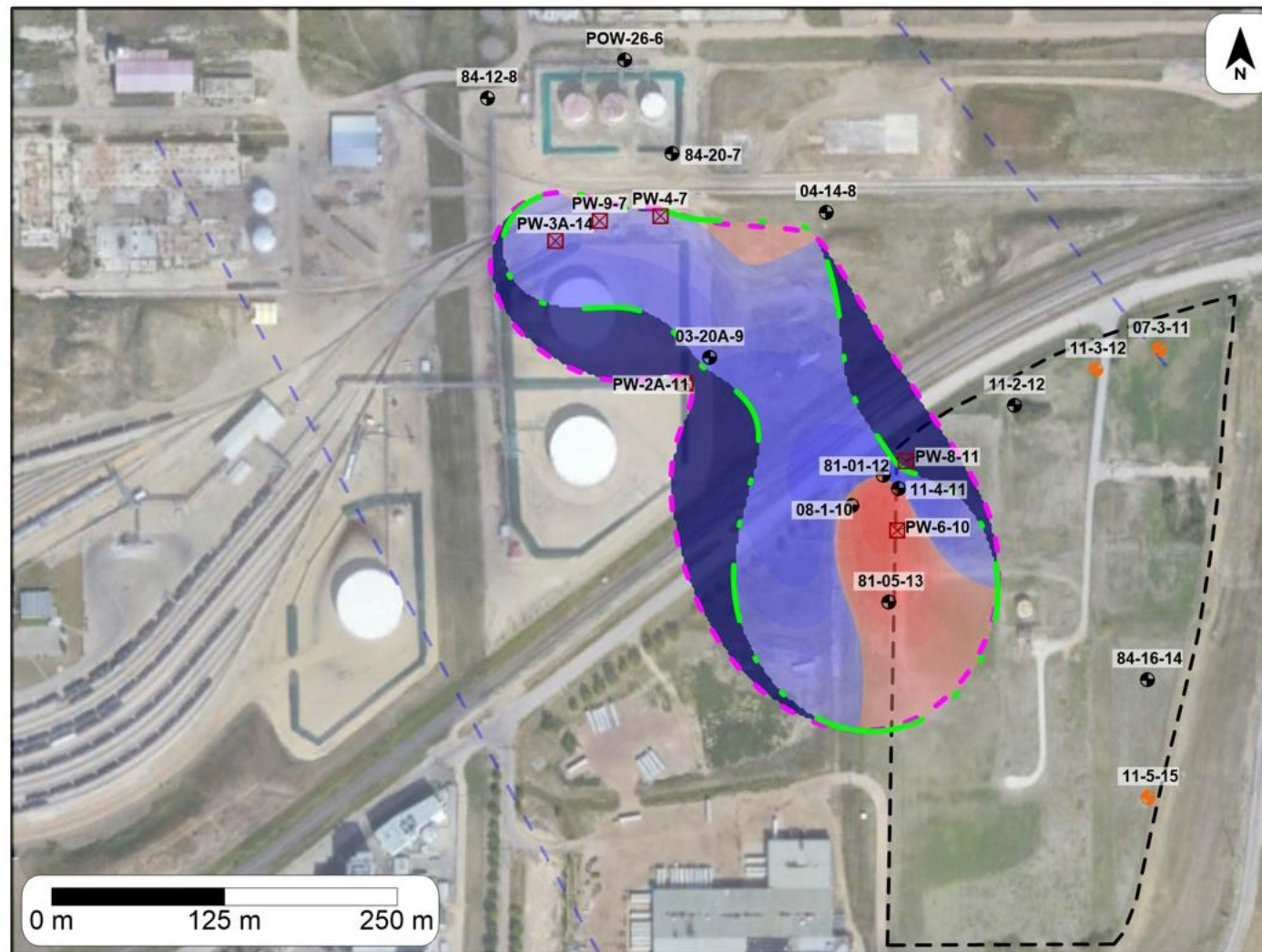


Phenolics Upper Sand Spatial Changes Sep-2014 vs May-2015

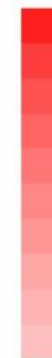
Plume Characteristics

Area: **1% Decrease**
 Average Concentration: **18% Decrease**
 Mass Indicator: **19% Decrease**
 Mass Increase: **77.1 kgs Increase**
 Mass Decrease: **223 kgs Decrease**

- | | |
|-----------------------------|------------------------|
| ● Monitoring Well | ✚ Plume Centre of Mass |
| ○ Hanging Well | ● Control Point |
| ⊠ Extraction Well | --- Property Boundary |
| --- Sep-2014 Plume Boundary | --- Control Fence |
| --- May-2015 Plume Boundary | ○ Extrapolated Data |



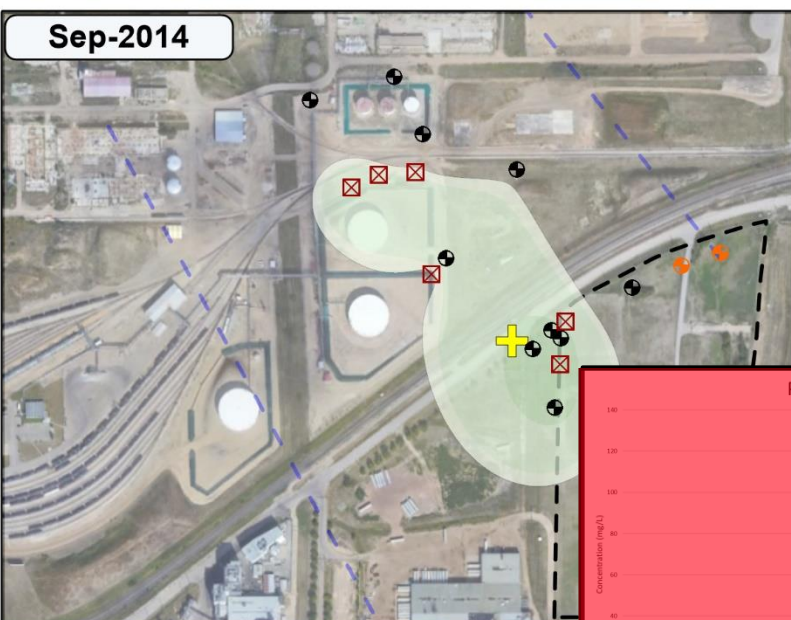
Spatial Change
Indicator™
Increase



Decrease



Sep-2014

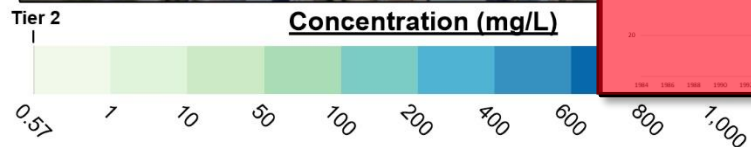
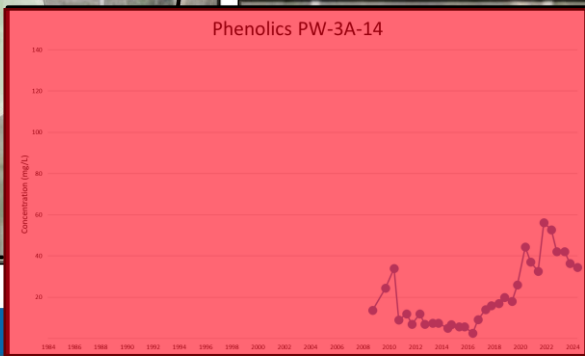


Plume Characteristics

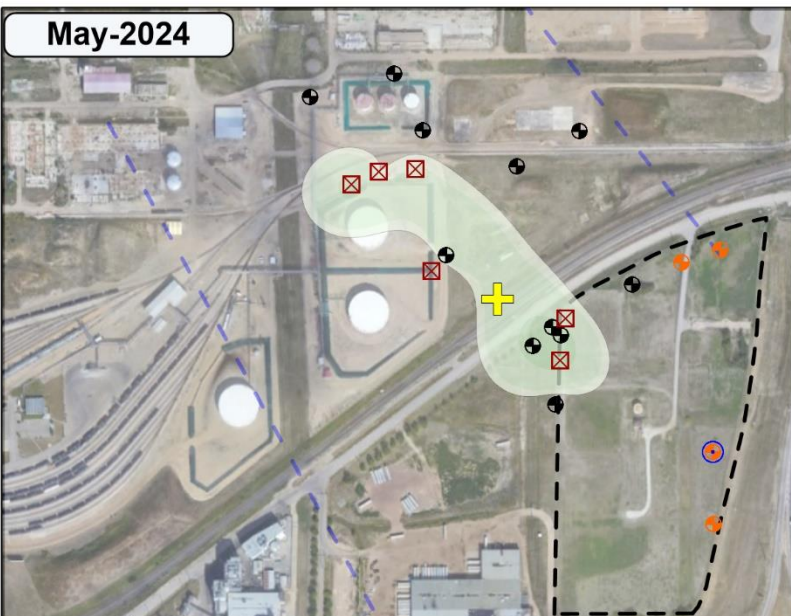
Area: **7% Increase**
 Average Concentration: **53% Decrease**
 Mass Indicator: **50% Decrease**
 Mass Increase: **62.3 kgs Increase**
 Mass Decrease: **449 kgs Decrease**

- Monitoring Well
- Hanging Well
- Extraction Well
- Sep-2014 Plume Boundary
- May-2024 Plume Boundary
- Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence
- Extrapolated Data

Phenolics PW-3A-14

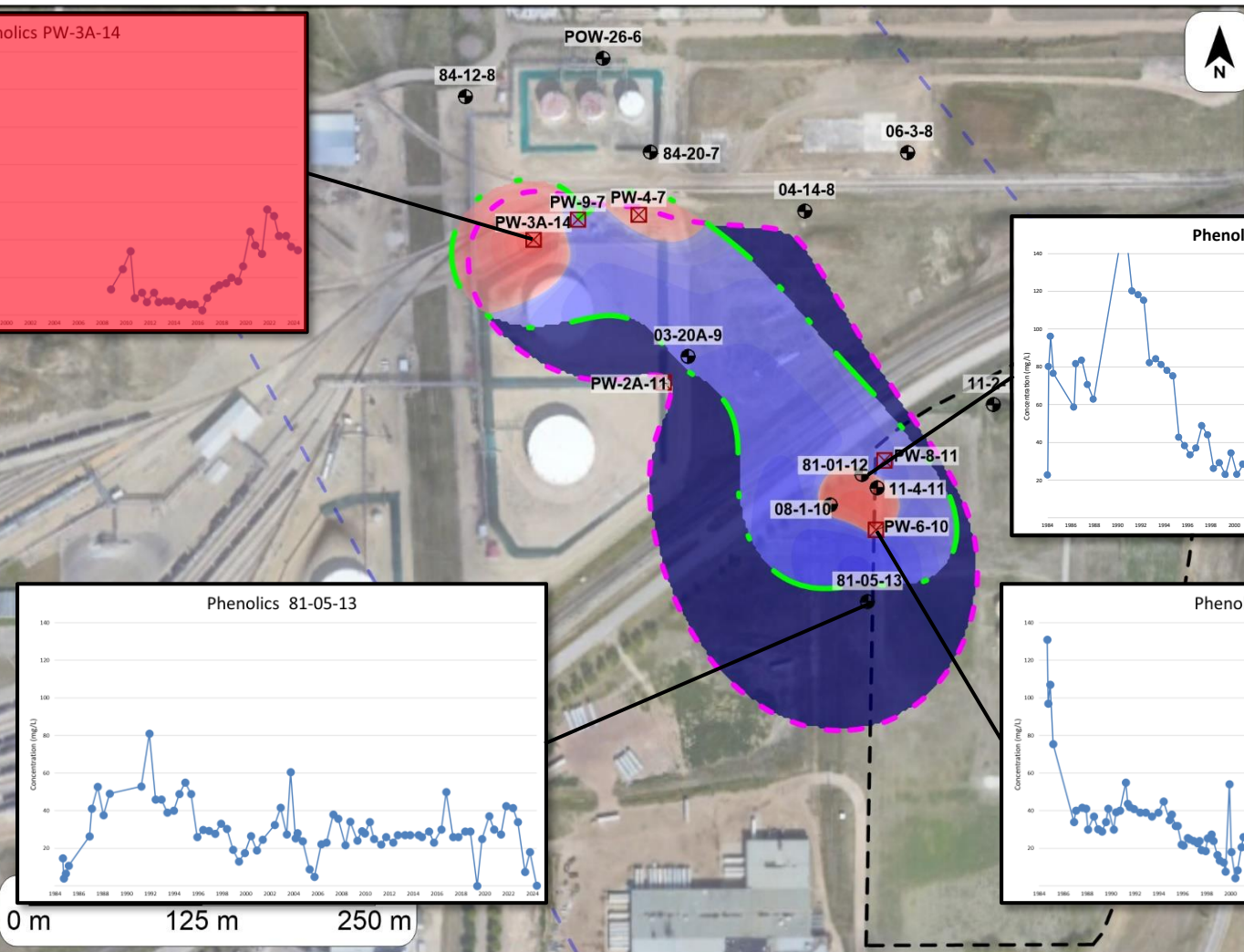


May-2024

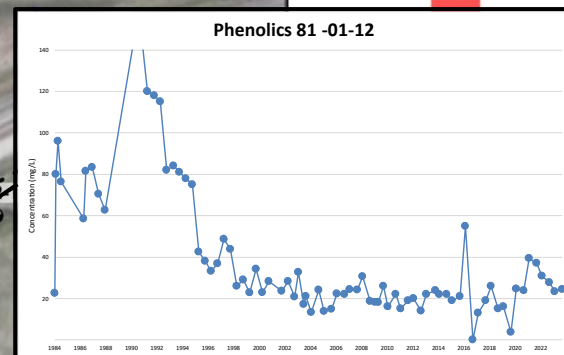


Phenolics Upper Sand Spatial Changes Sep-2014 vs May-2024

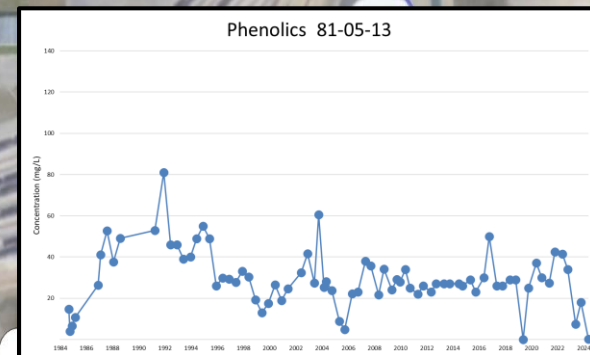
Spatial Change Indicator™
 Increase



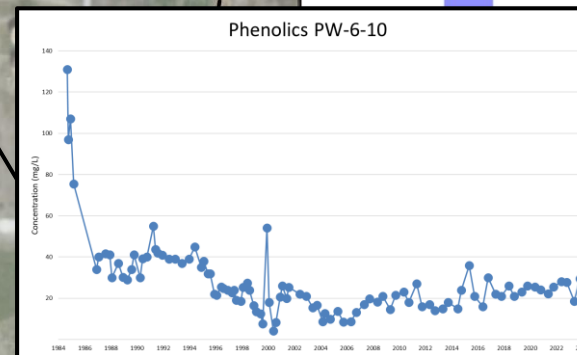
Phenolics 81-01-12



Phenolics 81-05-13

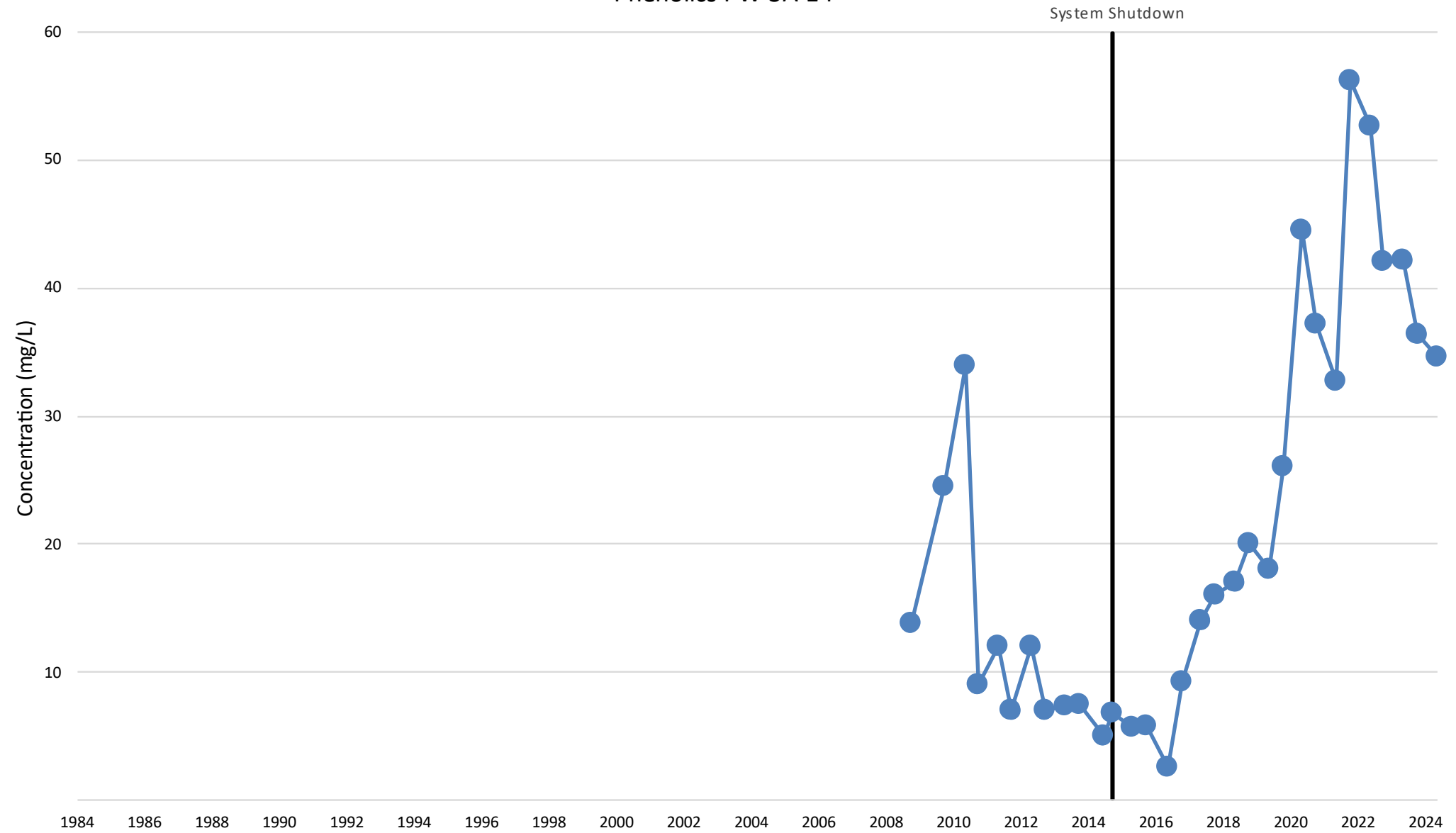


Phenolics PW-6-10

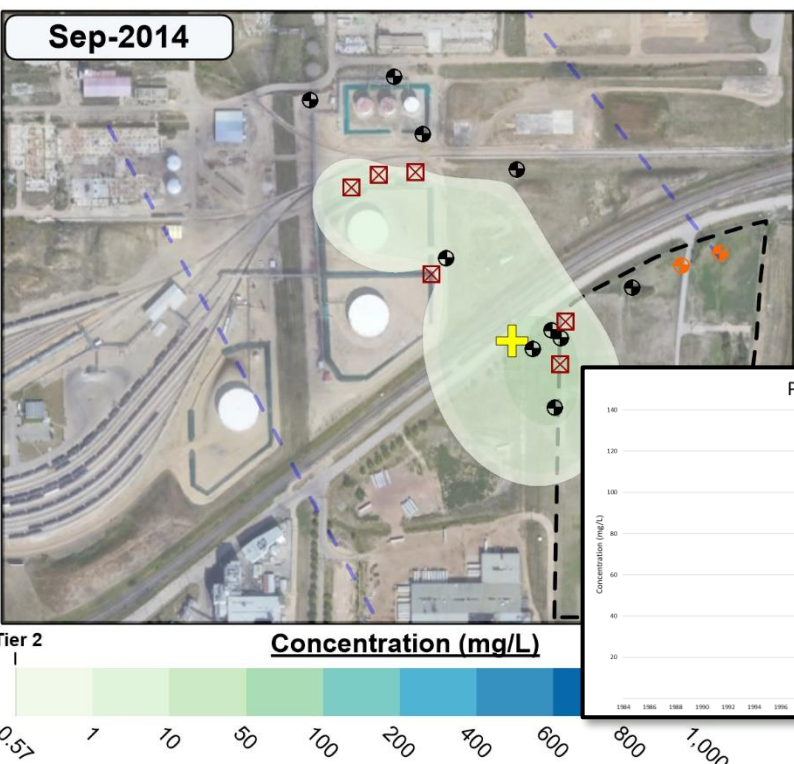


0 m 125 m 250 m

Phenolics PW-3A-14



Sep-2014

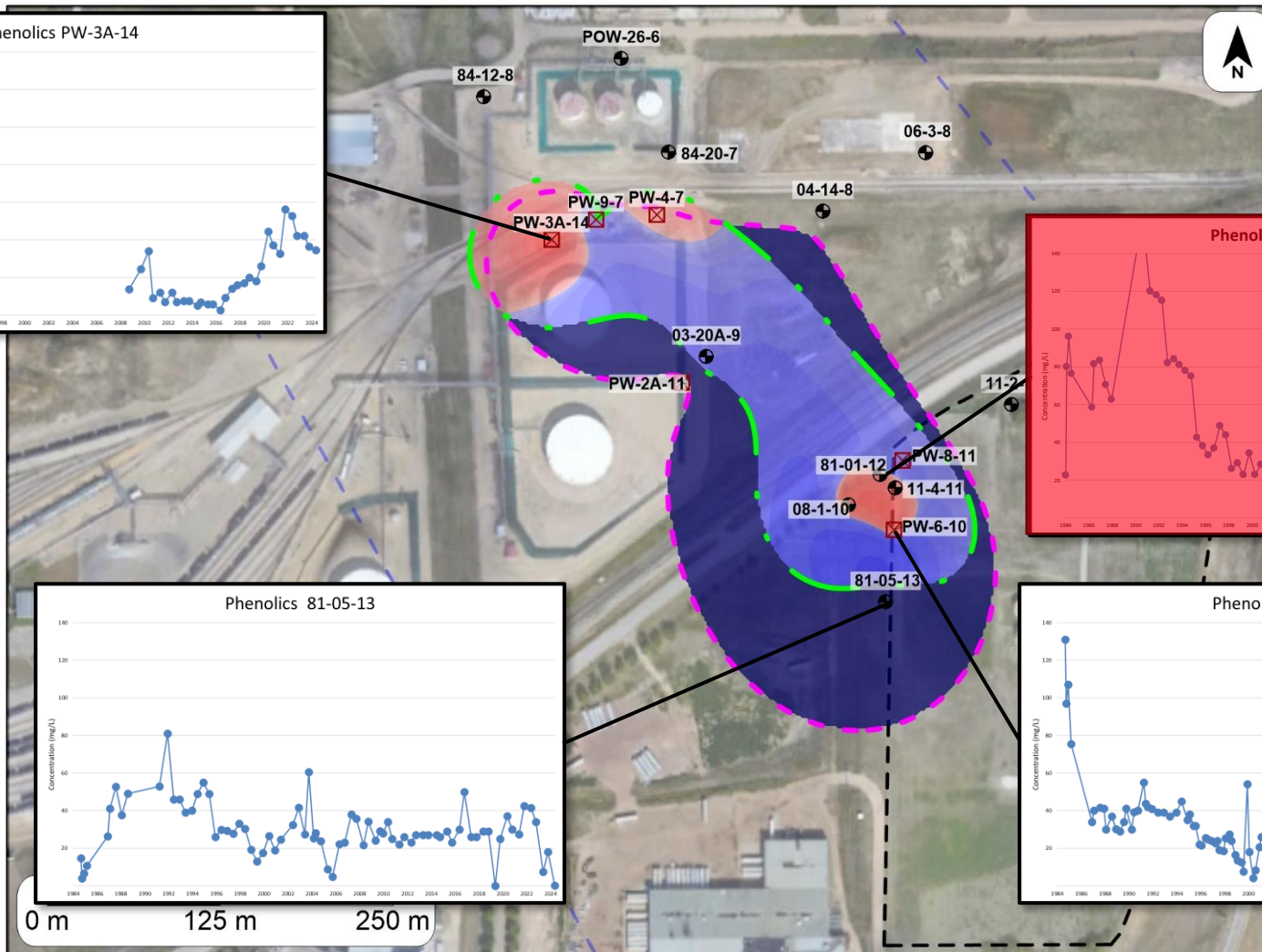
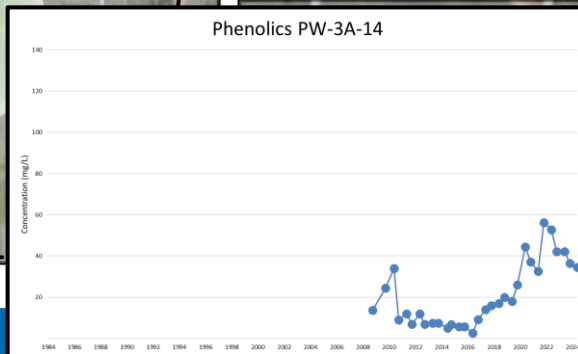


Phenolics Upper Sand Spatial Changes Sep-2014 vs May-2024

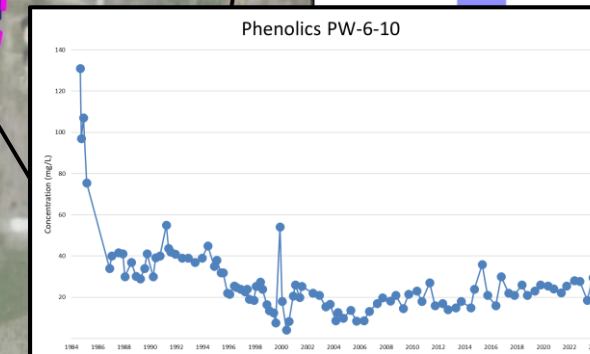
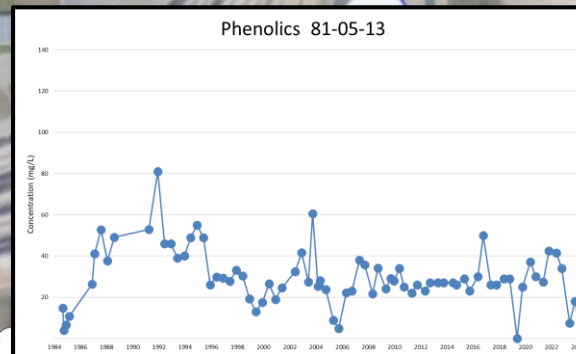
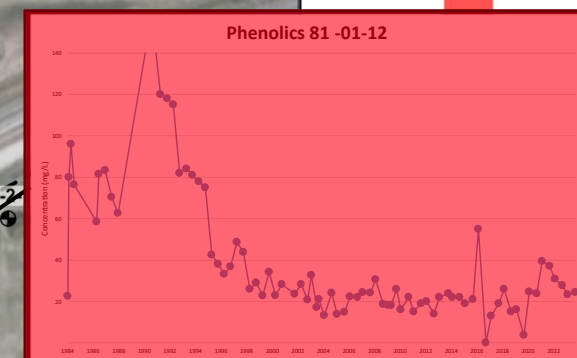
Plume Characteristics

Area: **7% Increase**
 Average Concentration: **53% Decrease**
 Mass Indicator: **50% Decrease**
 Mass Increase: **62.3 kgs Increase**
 Mass Decrease: **449 kgs Decrease**

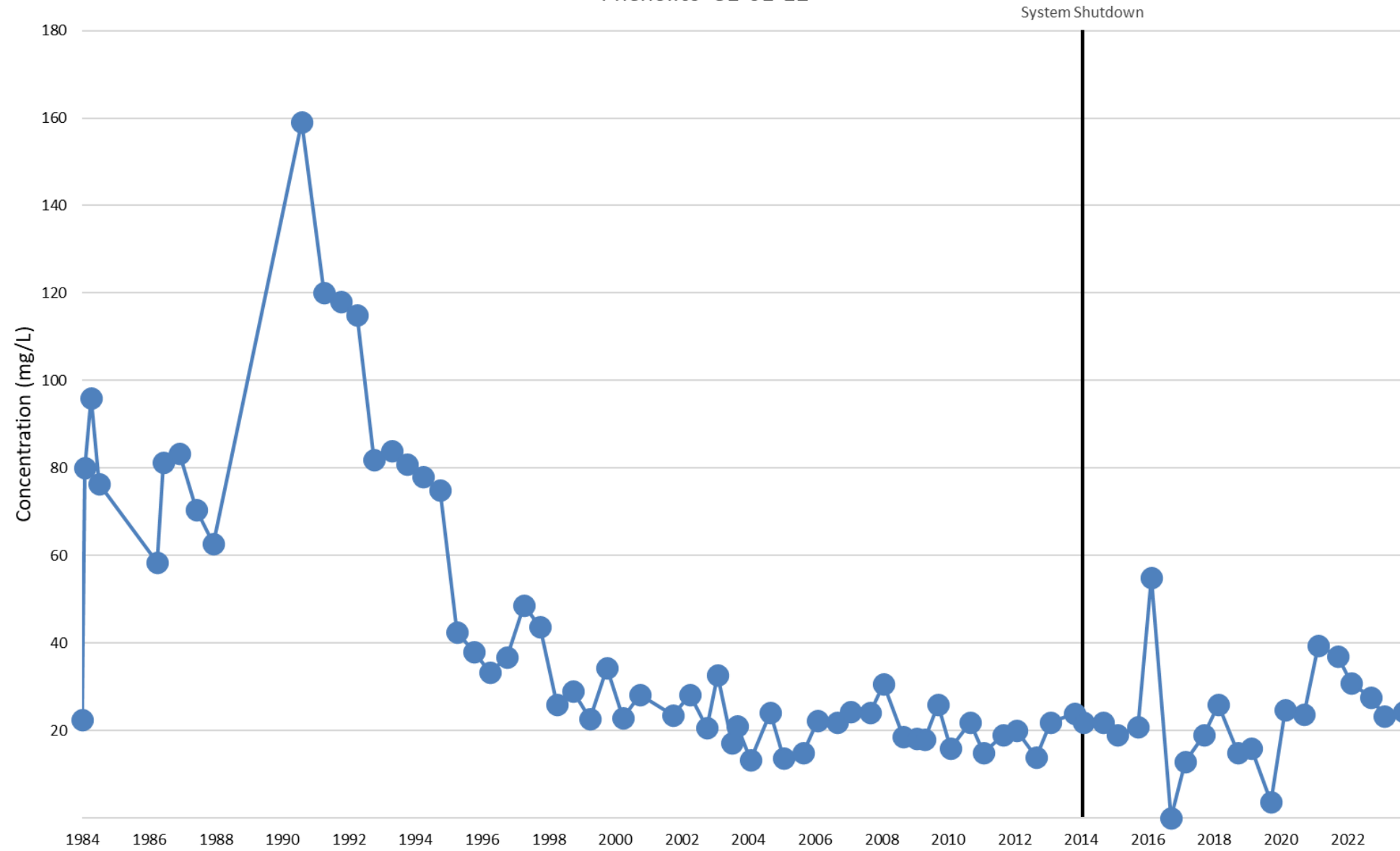
- Monitoring Well
- Hanging Well
- Extraction Well
- Sep-2014 Plume Boundary
- May-2024 Plume Boundary
- Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence
- Extrapolated Data



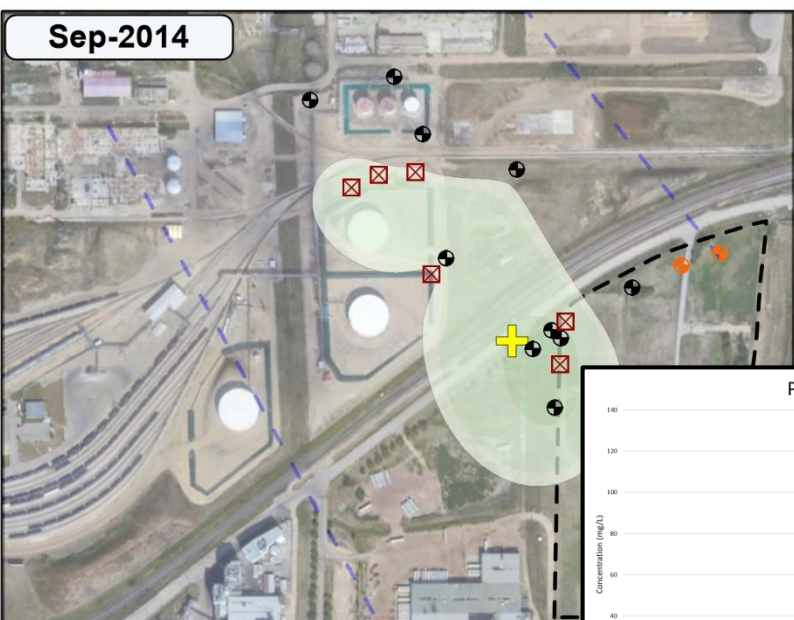
Spatial Change Indicator™
 Increase



Phenolics 81-01-12



Sep-2014

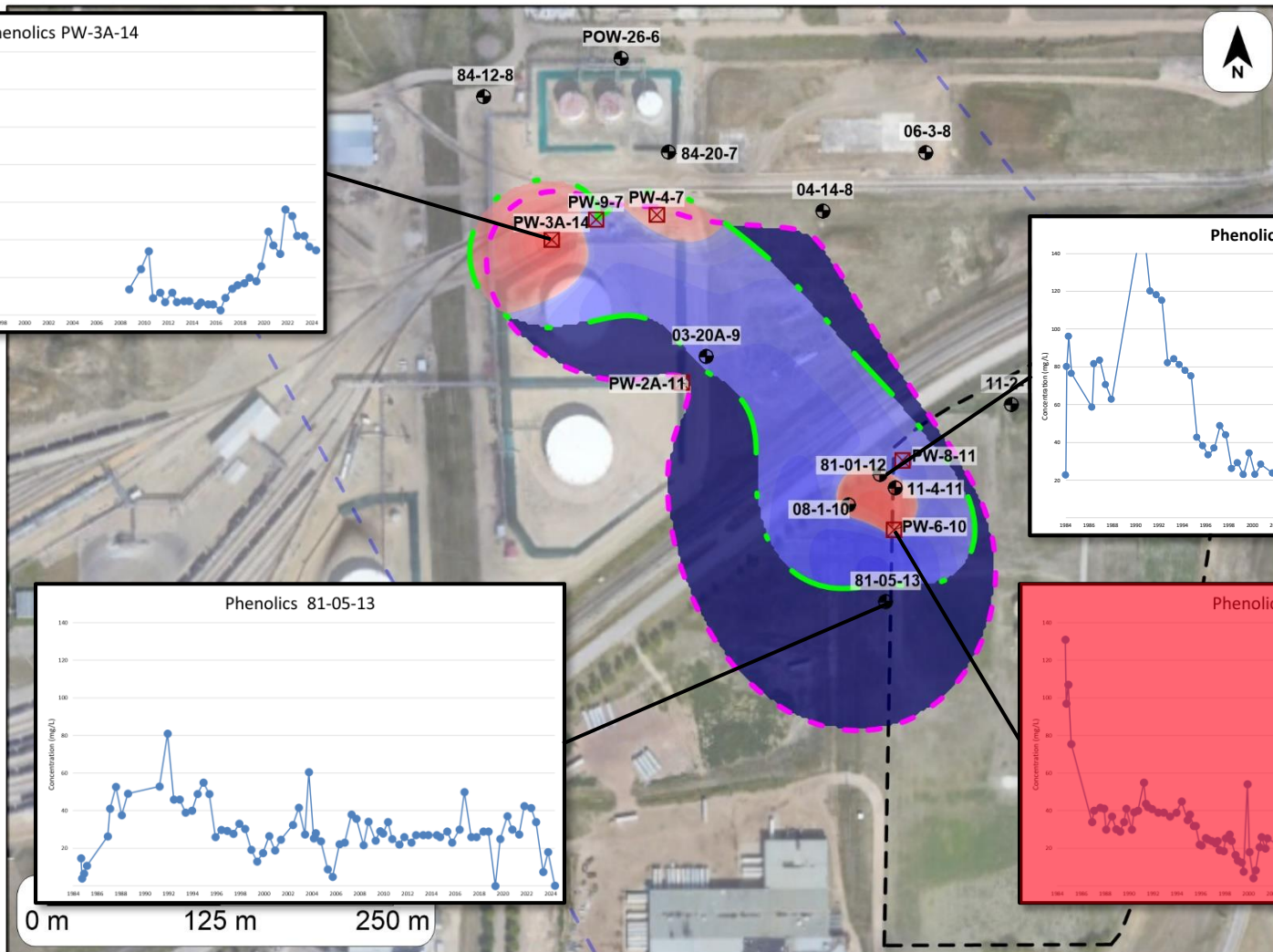
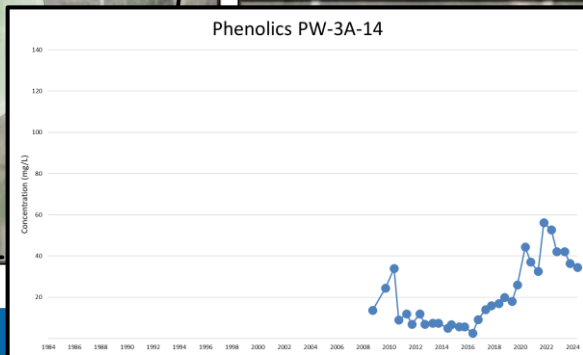


Plume Characteristics

Area: **7% Increase**
 Average Concentration: **53% Decrease**
 Mass Indicator: **50% Decrease**
 Mass Increase: **62.3 kgs Increase**
 Mass Decrease: **449 kgs Decrease**

- Monitoring Well
- Hanging Well
- Extraction Well
- Sep-2014 Plume Boundary
- May-2024 Plume Boundary
- Plume Centre of Mass
- Control Point
- Property Boundary
- Control Fence
- Extrapolated Data

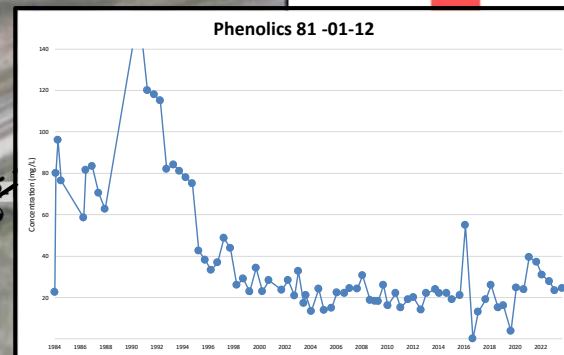
Phenolics PW-3A-14



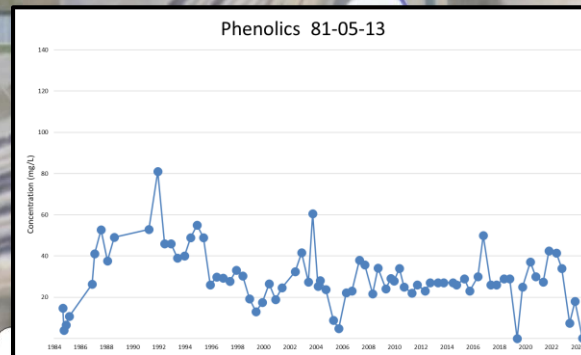
Spatial Change Indicator™
 Increase



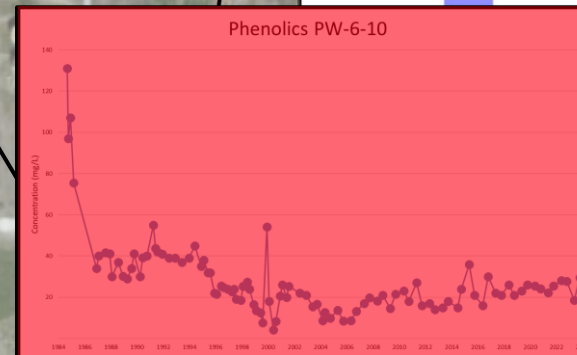
Phenolics 81-01-12



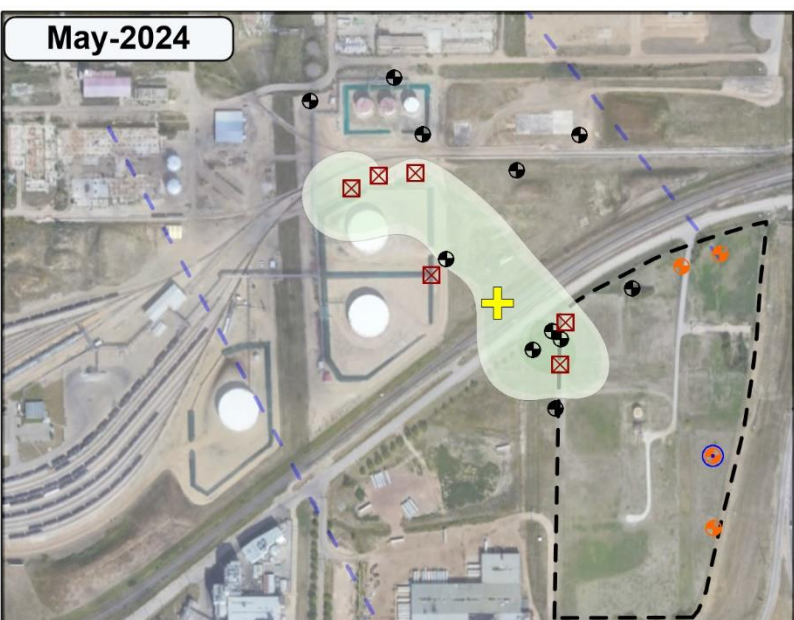
Phenolics 81-05-13



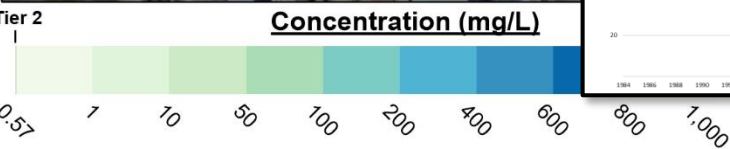
Phenolics PW-6-10

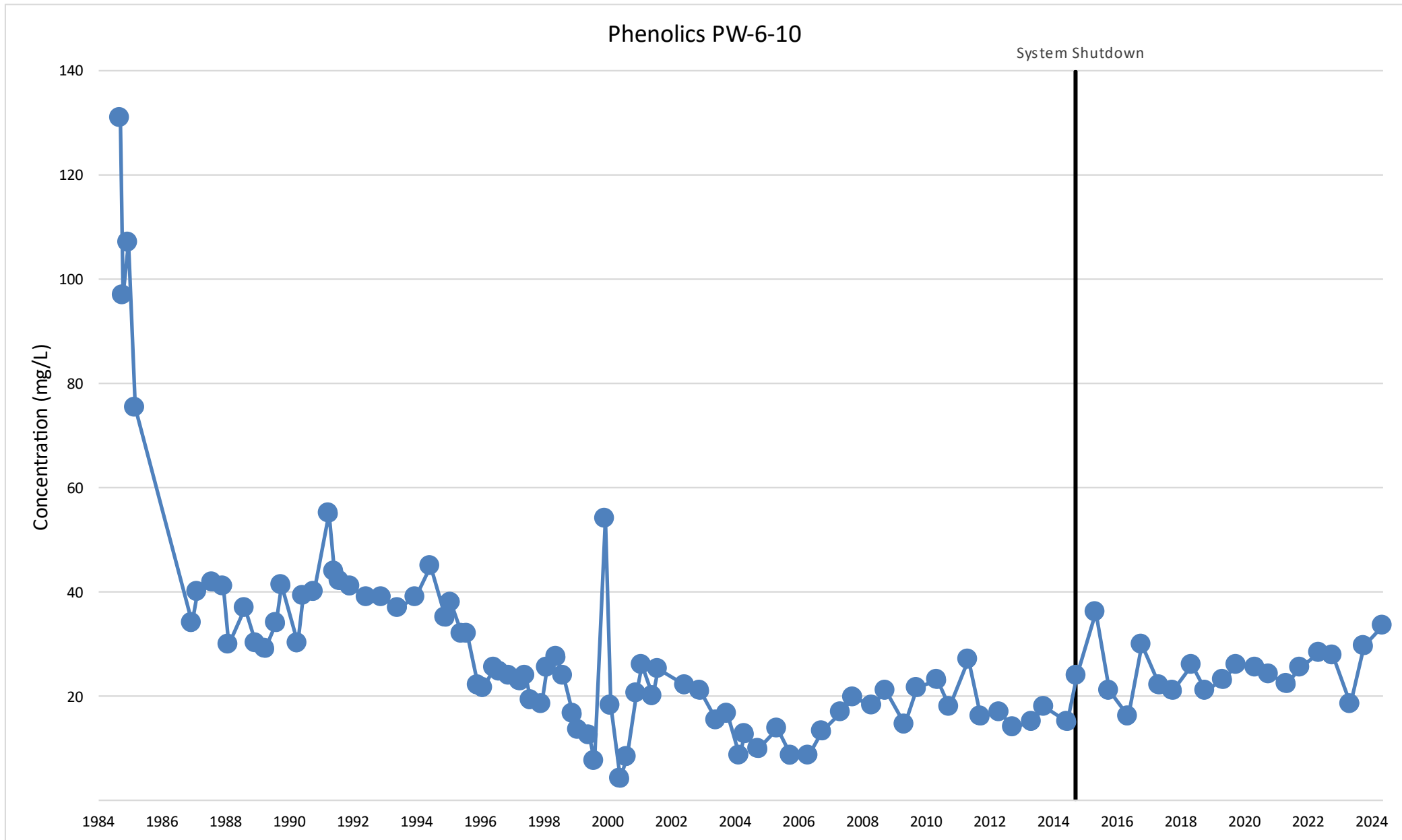


May-2024



Concentration (mg/L)





Groundwater Plume Analytics® Services

Upper Sand

2,4-D

2,4,5-T

Phenolics

MCPA

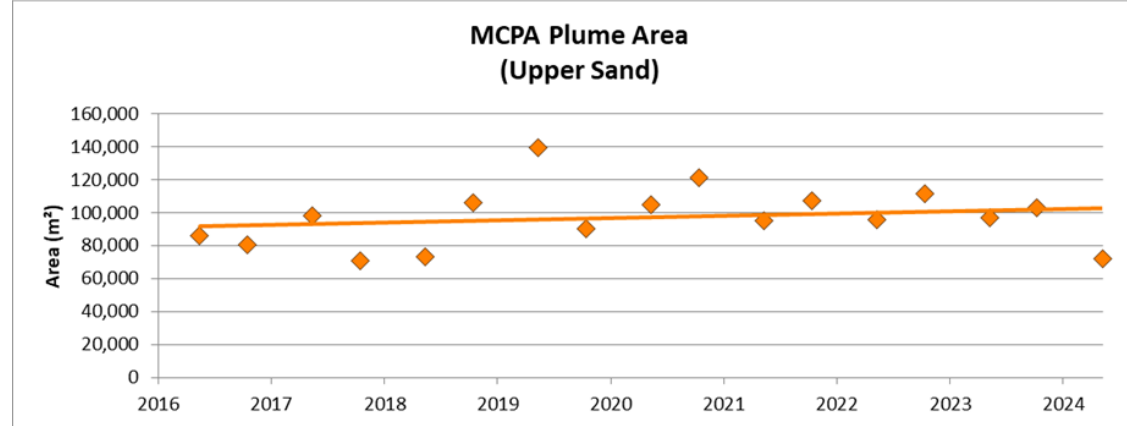
PCP

2,3,4,6-
Tetrachlorophenol

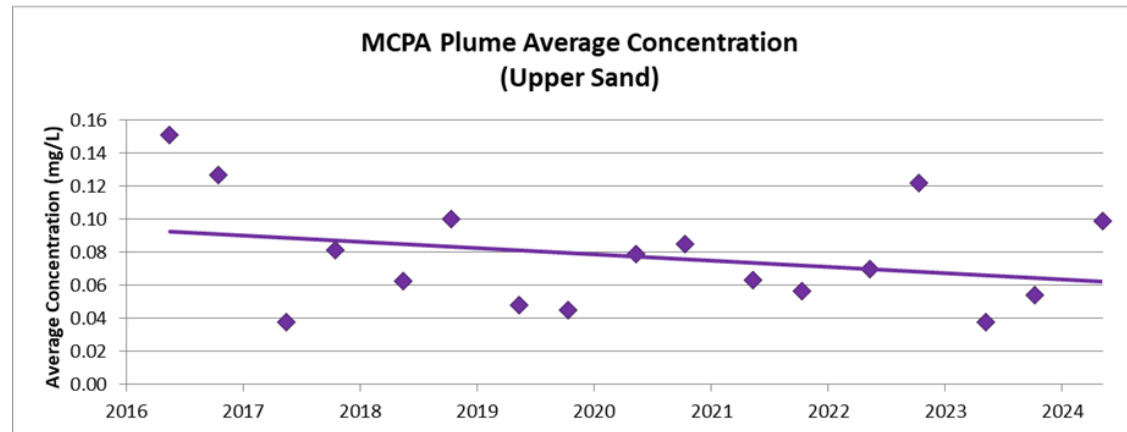
2,4,6-
Trichlorophenol

2,4-
Dichlorophenol

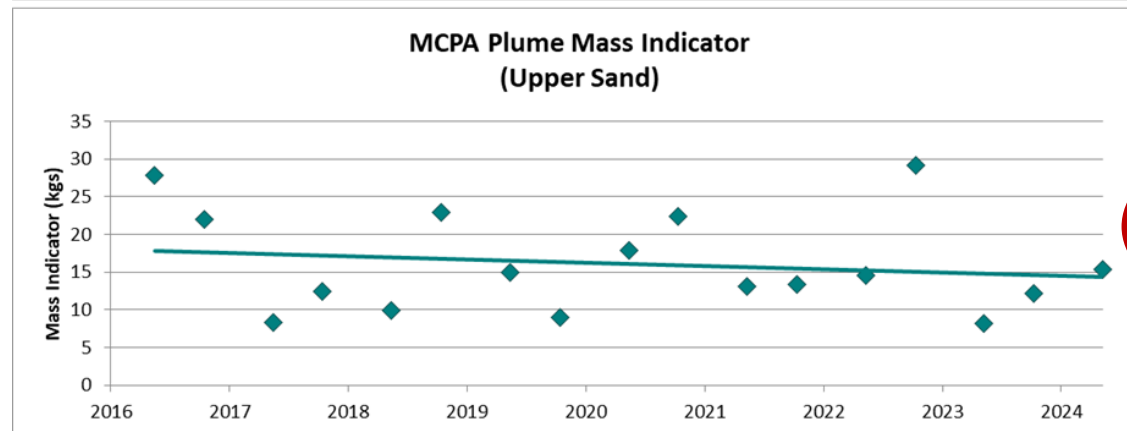
**Additional analyses
in 2024 update**



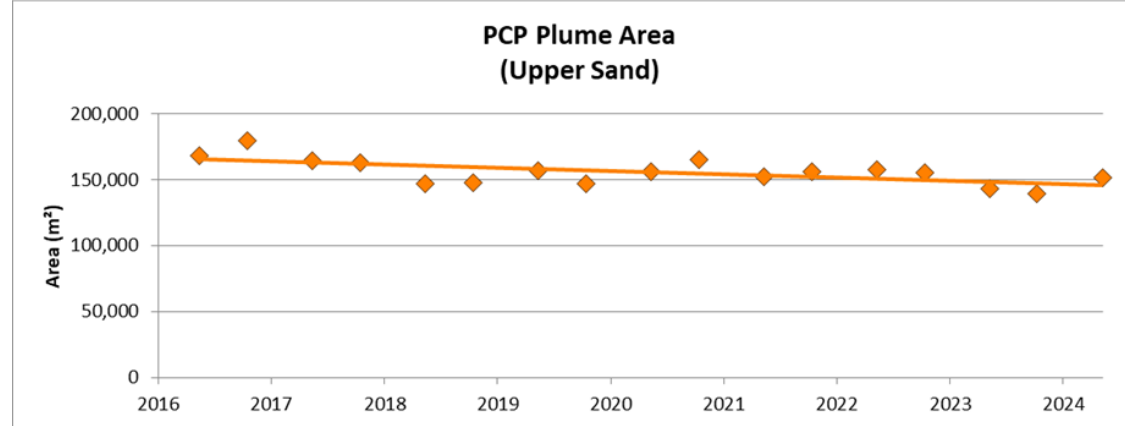
May-2016 to May-2024
 No Trend
 Mann-Kendall: 83% Confidence
 Regression: 53% Confidence



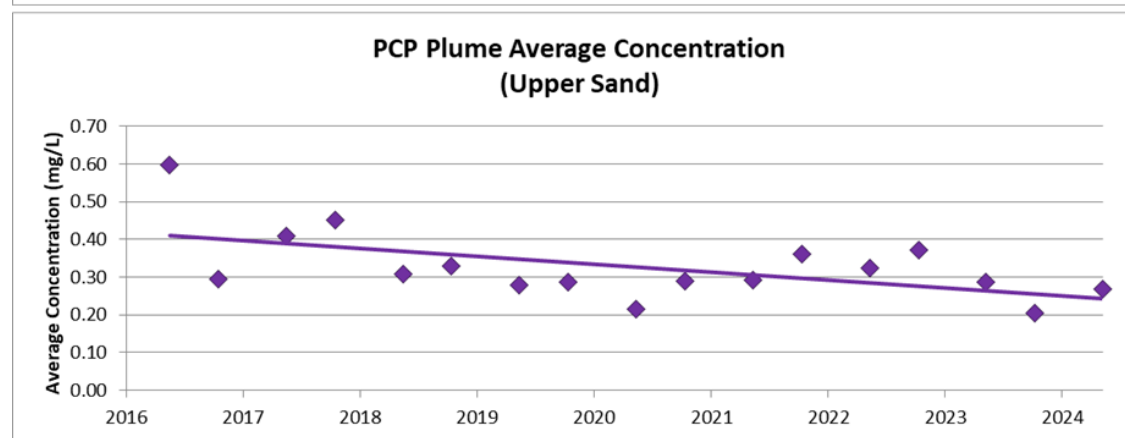
May-2016 to May-2024
 Stable
 Mann-Kendall: 78% Confidence
 Regression: 73% Confidence



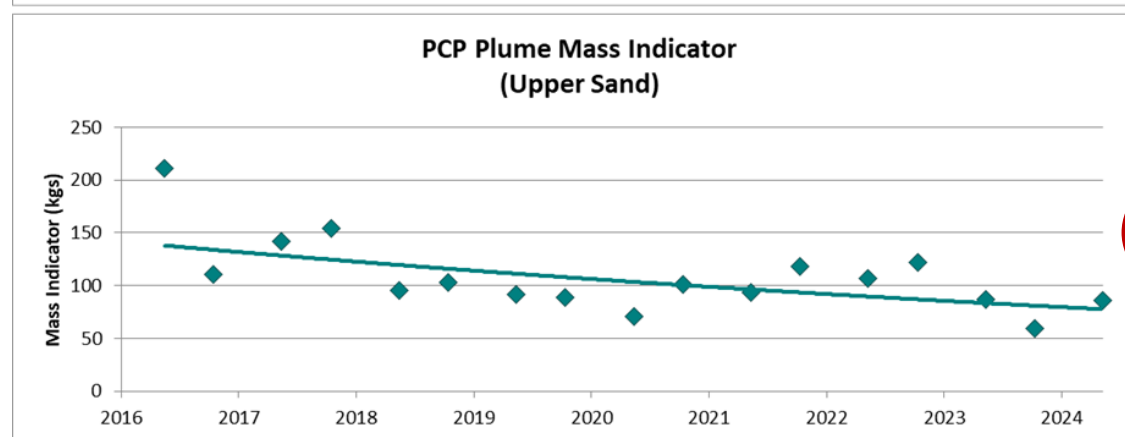
May-2016 to May-2024
 Stable
 Mann-Kendall: 61% Confidence
 Regression: 47% Confidence



May-2016 to May-2024
 Decreasing Trend
 Mann-Kendall: 99% Confidence
 Regression: 99% Confidence

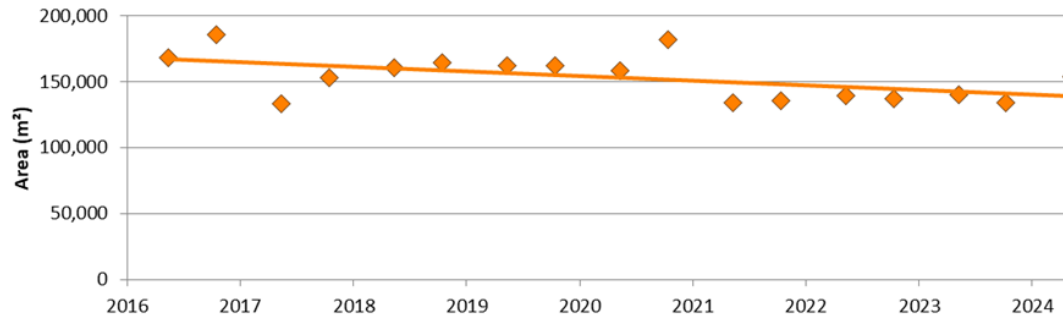


May-2016 to May-2024
 Decreasing Trend
 Mann-Kendall: 97% Confidence
 Regression: 98% Confidence



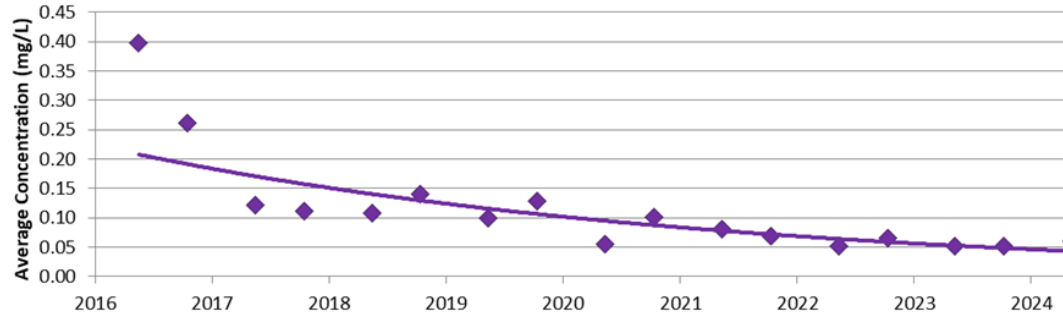
May-2016 to May-2024
 Decreasing Trend
 Mann-Kendall: 99% Confidence
 Regression: 99% Confidence

**2,3,4,6-Tetrachlorophenol Plume Area
(Upper Sand)**



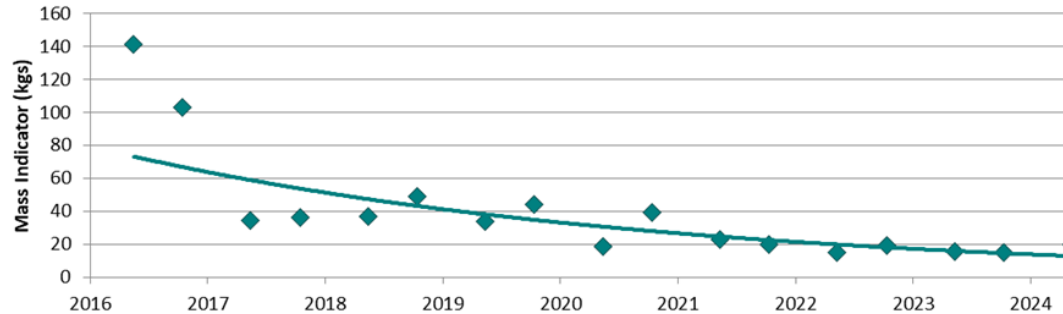
May-2016 to May-2024
Decreasing Trend
Mann-Kendall: 95% Confidence
Regression: 97% Confidence

**2,3,4,6-Tetrachlorophenol Plume Average Concentration
(Upper Sand)**



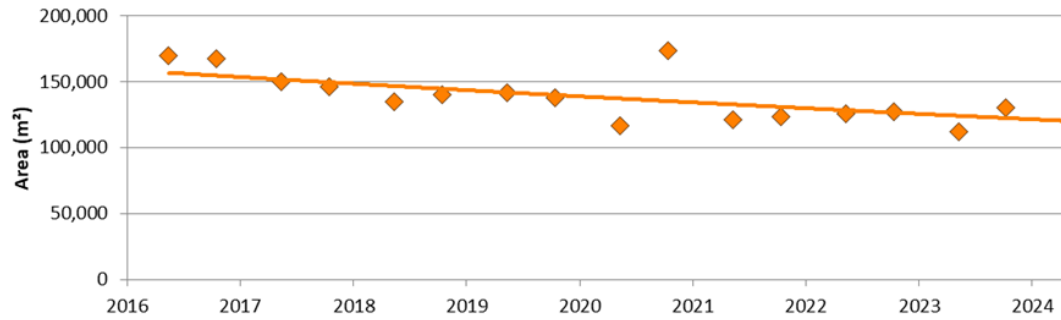
May-2016 to May-2024
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

**2,3,4,6-Tetrachlorophenol Plume Mass Indicator
(Upper Sand)**



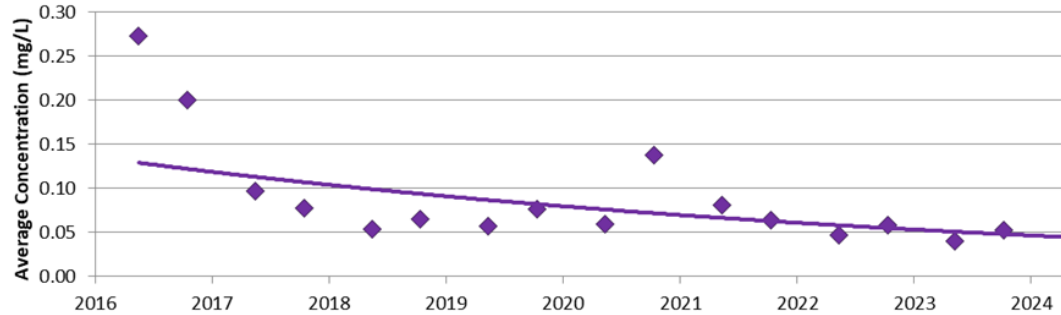
May-2016 to May-2024
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

2,4,6-Trichlorophenol Plume Area
(Upper Sand)



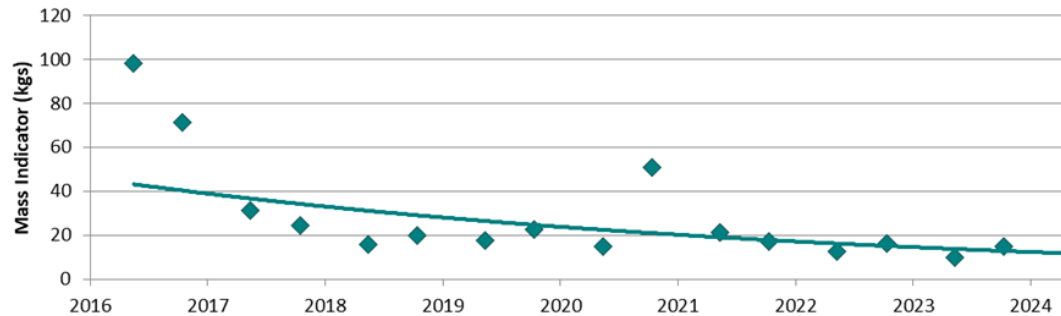
May-2016 to May-2024
Decreasing Trend
Mann-Kendall: 99% Confidence
Regression: >99% Confidence

2,4,6-Trichlorophenol Plume Average Concentration
(Upper Sand)



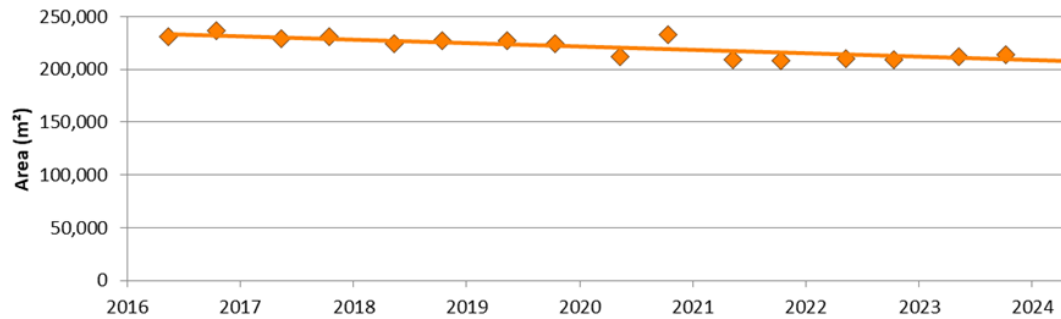
May-2016 to May-2024
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

2,4,6-Trichlorophenol Plume Mass Indicator
(Upper Sand)



May-2016 to May-2024
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

**2,4-Dichlorophenol Plume Area
(Upper Sand)**



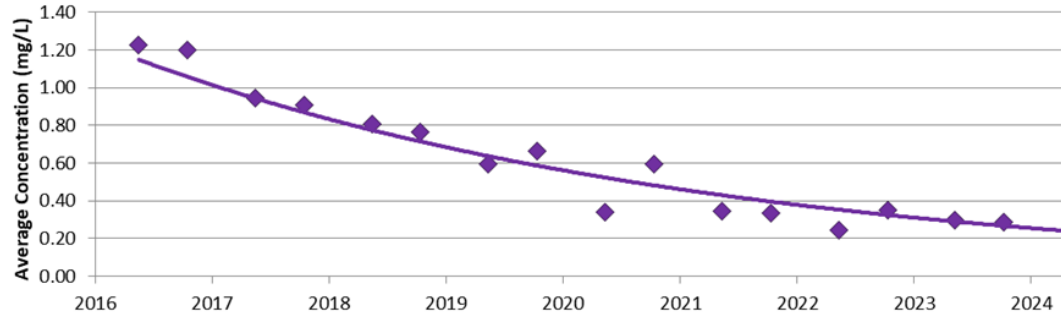
May-2016 to May-2024

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

**2,4-Dichlorophenol Plume Average Concentration
(Upper Sand)**



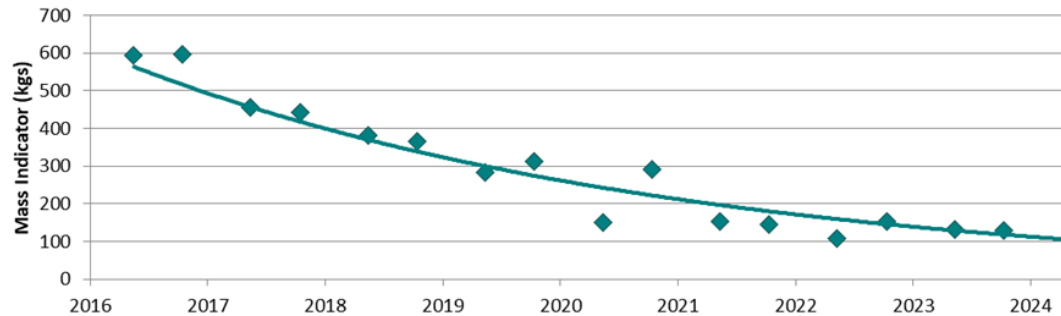
May-2016 to May-2024

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

**2,4-Dichlorophenol Plume Mass Indicator
(Upper Sand)**



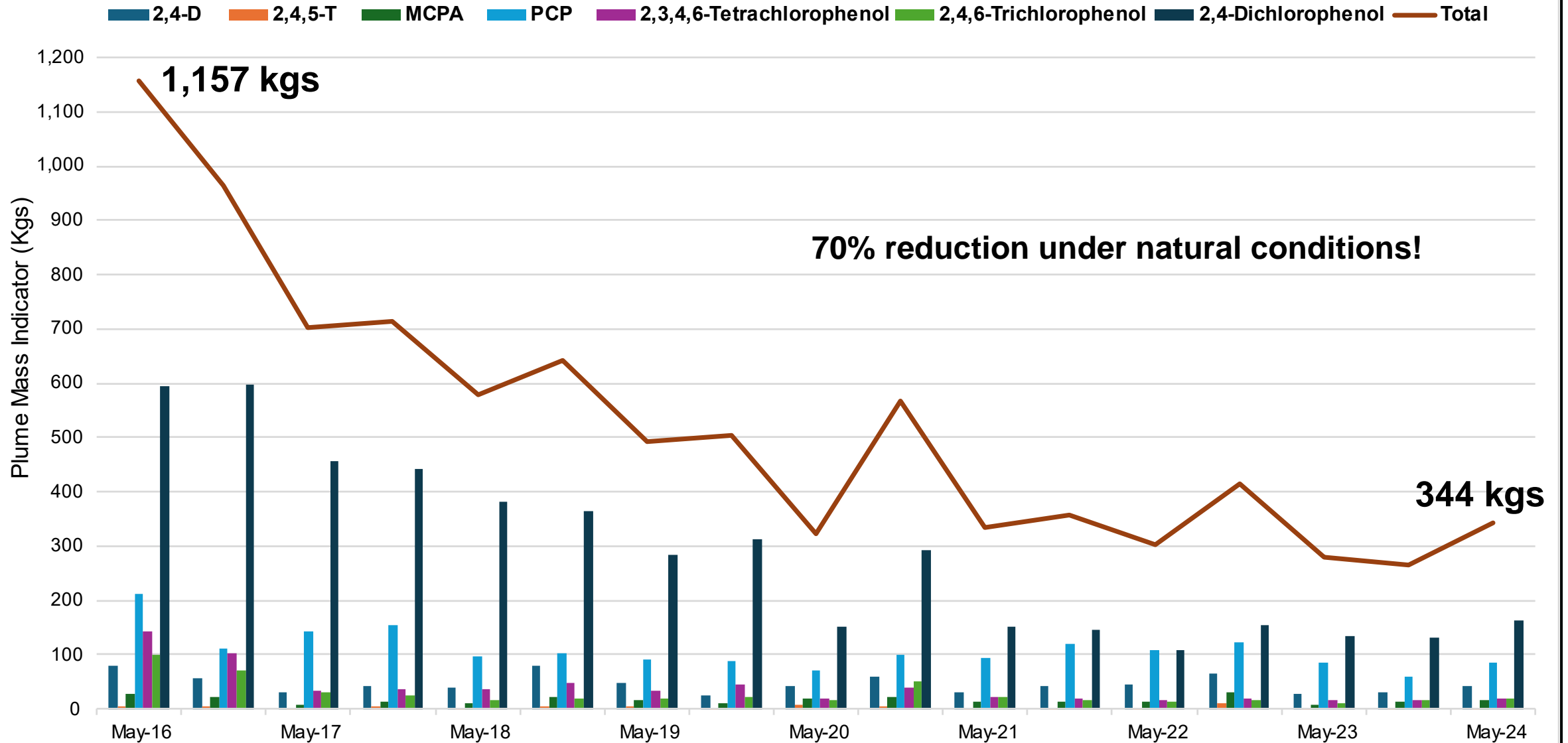
May-2016 to May-2024

Decreasing Trend

Mann-Kendall: >99% Confidence

Regression: >99% Confidence

Plume Mass Trends



Thank you!

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