HOW TOMORROW MOVES

ARCADIS

DIRECTED GROUNDWATER RECIRCULATION
…..Fast Track To Site Closure

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AGENDA

- Project Background
- Site-Wide Remedial Activities
- Directed Groundwater Recirculation (DGR) Goals and Objectives
- DGR System Components
- Groundwater Monitoring/Performance
- Results

PROJECT BACKGROUND

Adjacent Property

Major Urban Thoroughfare

Railroad Property

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BACKGROUND

Assessment Process (Phase I, II, III)

- Completed ~ 4 years
- 377 soil borings
- 149 monitoring wells
- 1,346 soil samples
- 294 groundwater samples
- ~ 77 samples/acre

Site COCs

- Metals (Sb, Pb, Zn & Hg)
- PCBs
- CVOCs

Site Groundwater

- Trichloroethene
- Cis-1,2-dichloroethene
- Vinyl chloride

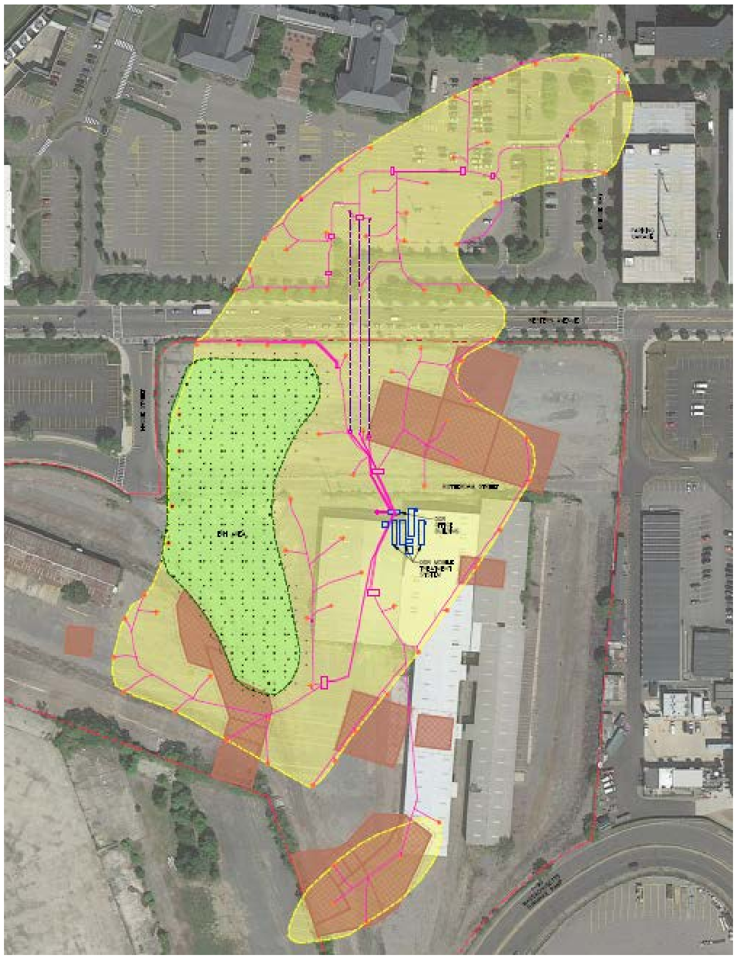
BACKGROUND (CONTINUED)

Challenge Groundwater plume covers 12 acres and 3 properties

Driver Pending Property Transfer

Objectives
- 60 percent mass removal in 6 months – property transfer
- GW Regulatory Standards in 15 months - Closure

SITE WIDE REMEDIAL ACTIVITIES/REMEDIATION AREAS



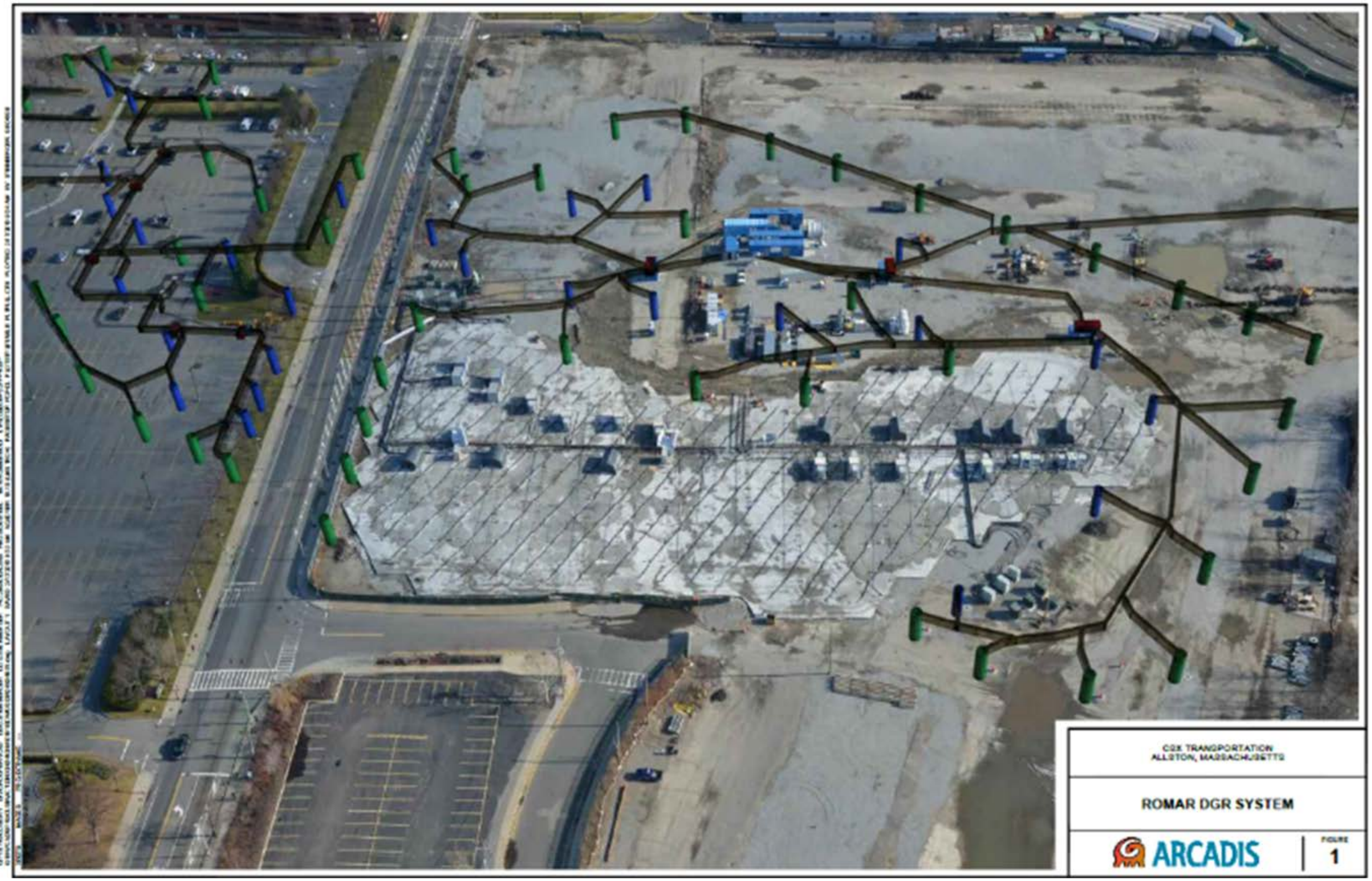
- Areas of Impact
  - GW ~ 12 acre plume
  - Soil - Disposal/Recycling of soils impacted with Petroleum, PCBs, CVOC, metals
  - Remediation Technologies
    - Excavation
    - Electric Resistance Heating (ERH)
    - Directed Groundwater Recirculation (DGR)

SITE-WIDE GROUNDWATER REMEDIAL APPROACH

Directed Groundwater Recirculation (DGR)

- The primary method for treating groundwater within 12 acre boundary within the expedited timeframe
- Expedited removal compared to traditional pump and treat with sanitary sewer discharge
- Started April 22, 2015: currently in Month 7 as of October 22, 2015

DGR SYSTEM VISUALIZATION



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DGR GOALS AND OBJECTIVES

Design

- <12 months to design
- 4 separate scopes

Construct

- Restricted timeframe
- Coordination

Operate

- 90% Uptime
- Complete removal of COCs prior to injection

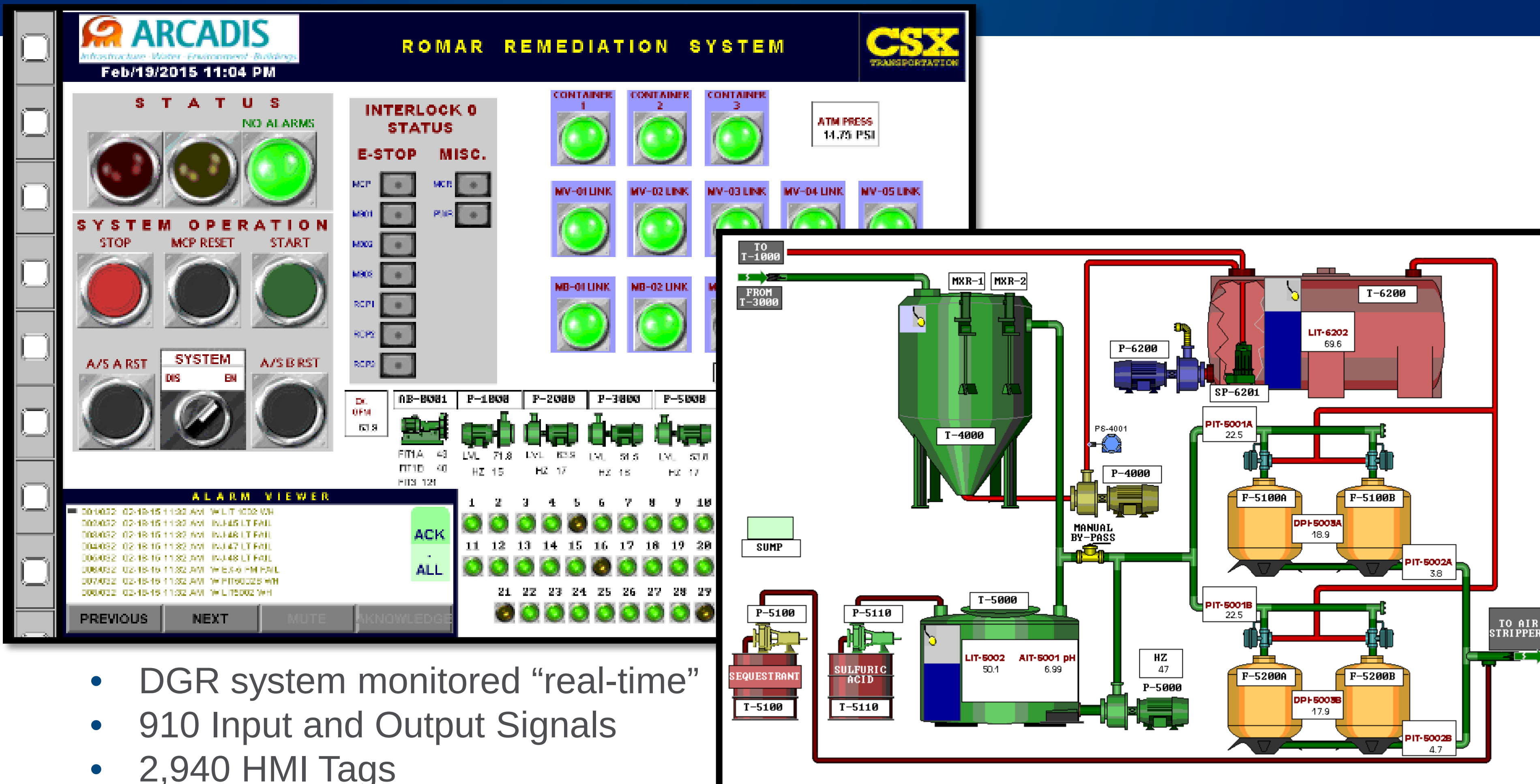
Target Objective

- 60% Removal of COCs in after 6 months of operation

DGR COMPONENTS

- DGR Project Installation Included
  - 30,000 LF of HDPE
  - 65,000 LF Electrical and Communication Wire
  - 3 Directional Drill Borings
  - 54 Injection Wells
  - 6 Manifold Vaults and 3 Manifold Buildings
  - 29 Extraction Wells
  - 7,300 LF of Trench

MTS SYSTEM MONITORING



- DGR system monitored “real-time”
- 910 Input and Output Signals
- 2,940 HMI Tags
- 23 Nodes (Ethernet Connections)

GROUNDWATER MONITORING AND PERFORMANCE

Plume Boundaries

- VOC Plume Prior to November 2014 Baseline
- Flushing Zones Boundaries
- ERH Footprint

N

0 200

SCALE IN FEET

Groundwater Analytical Data

- Groundwater monitoring well

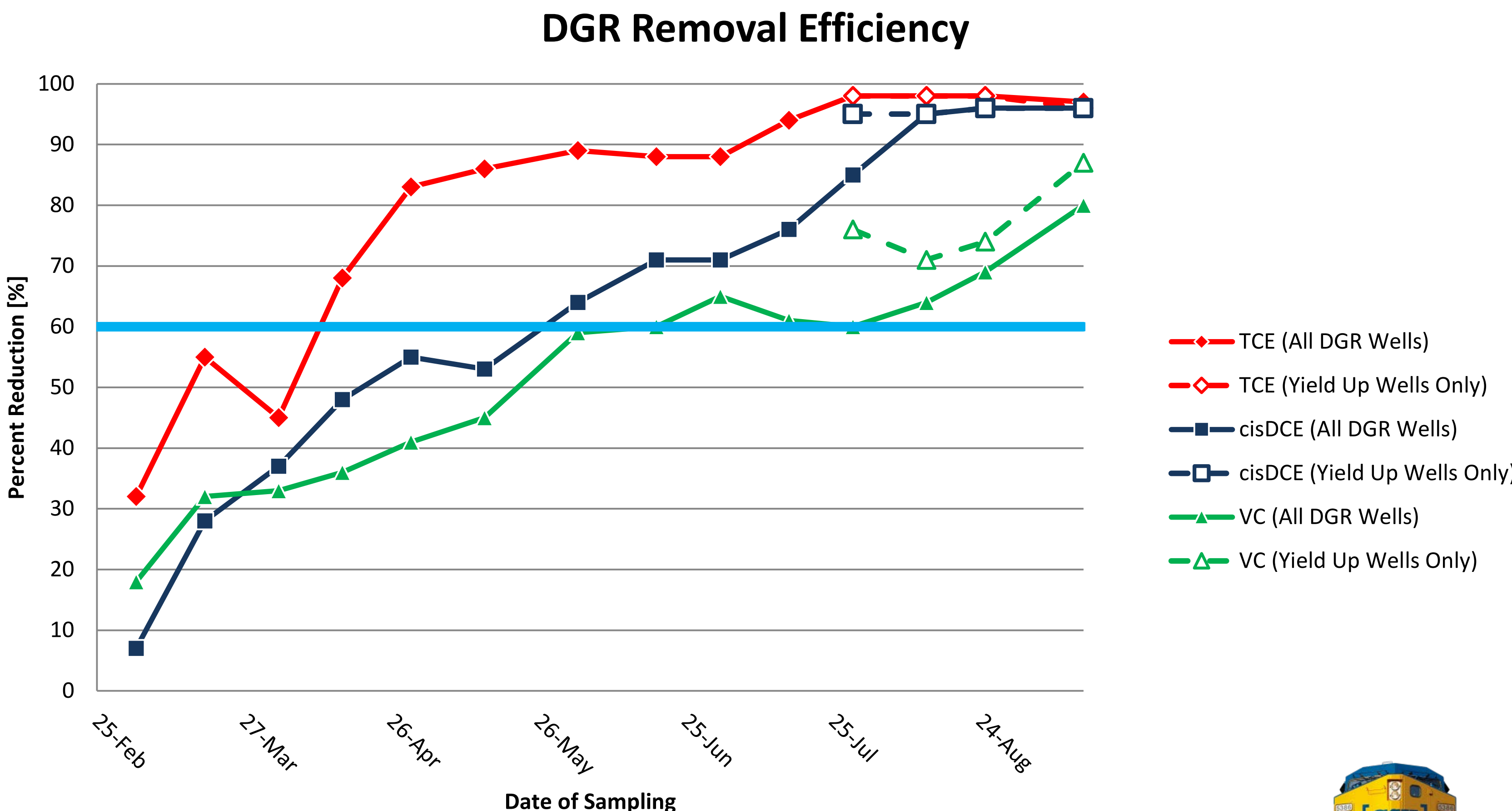
TCE	Cis-1,2-DCE	VC	Comparison to GW2
>50 ug/L	>200 ug/L	>20 ug/L	>10xGW2
5 – 50 ug/L	20 – 200 ug/L	2 – 20 ug/L	GW2 – 10xGW2
<5 ug/L	<20 ug/L	<2 ug/L	<GW2
Non-detect	Non-detect	Non-detect	Non-detect

Groundwater Plumes

TCE	Cis-1,2-DCE	VC	Comparison to GW2
>50 ug/L	>200 ug/L	>20 ug/L	>10xGW2
5 – 50 ug/L	20 – 200 ug/L	2 – 20 ug/L	GW2 – 10xGW2

Note:
Groundwater analytical plumes represent most recent data for sampling locations; however, only samples collected on designated dates are shown.

DGR REMOVAL EFFICIENCY



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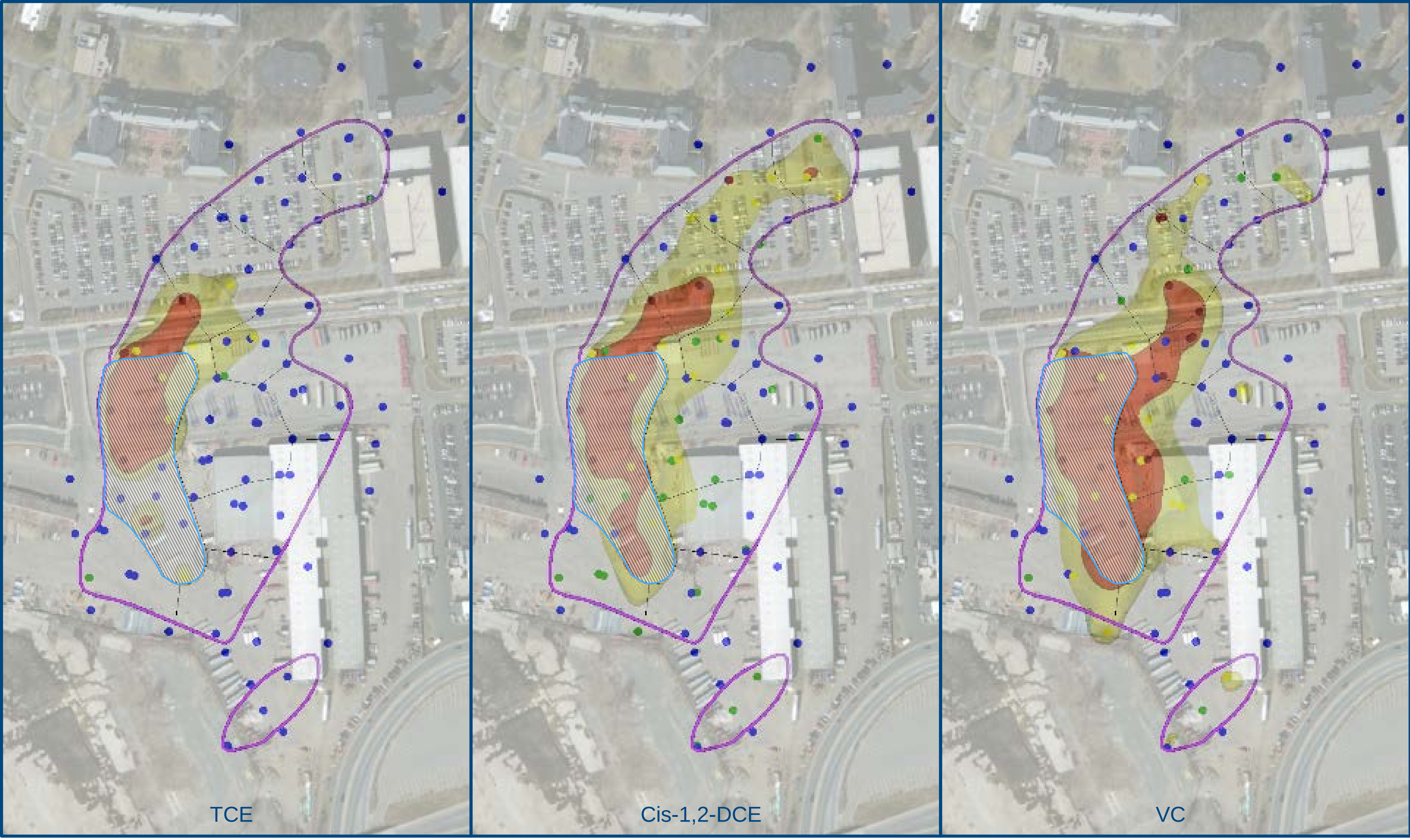
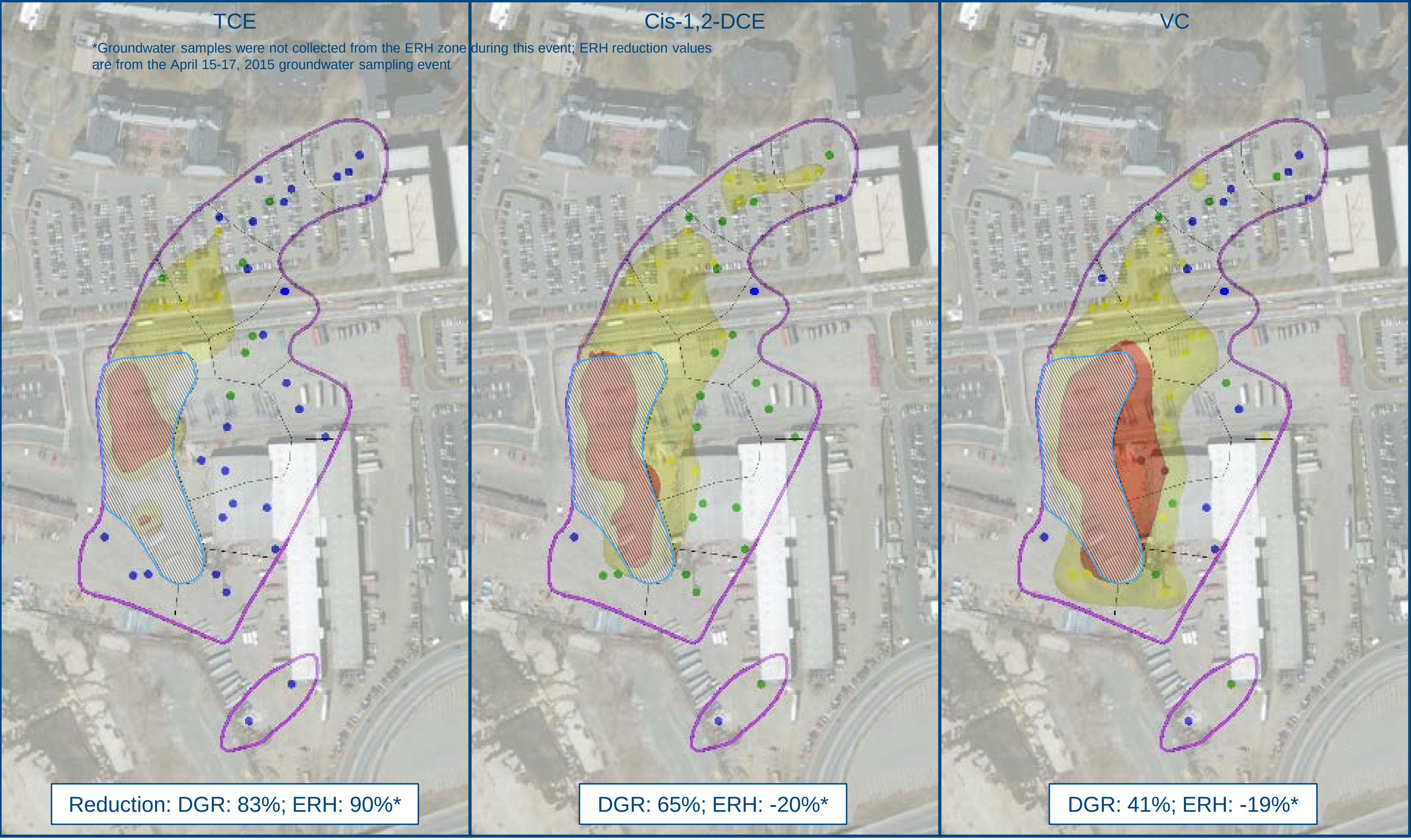


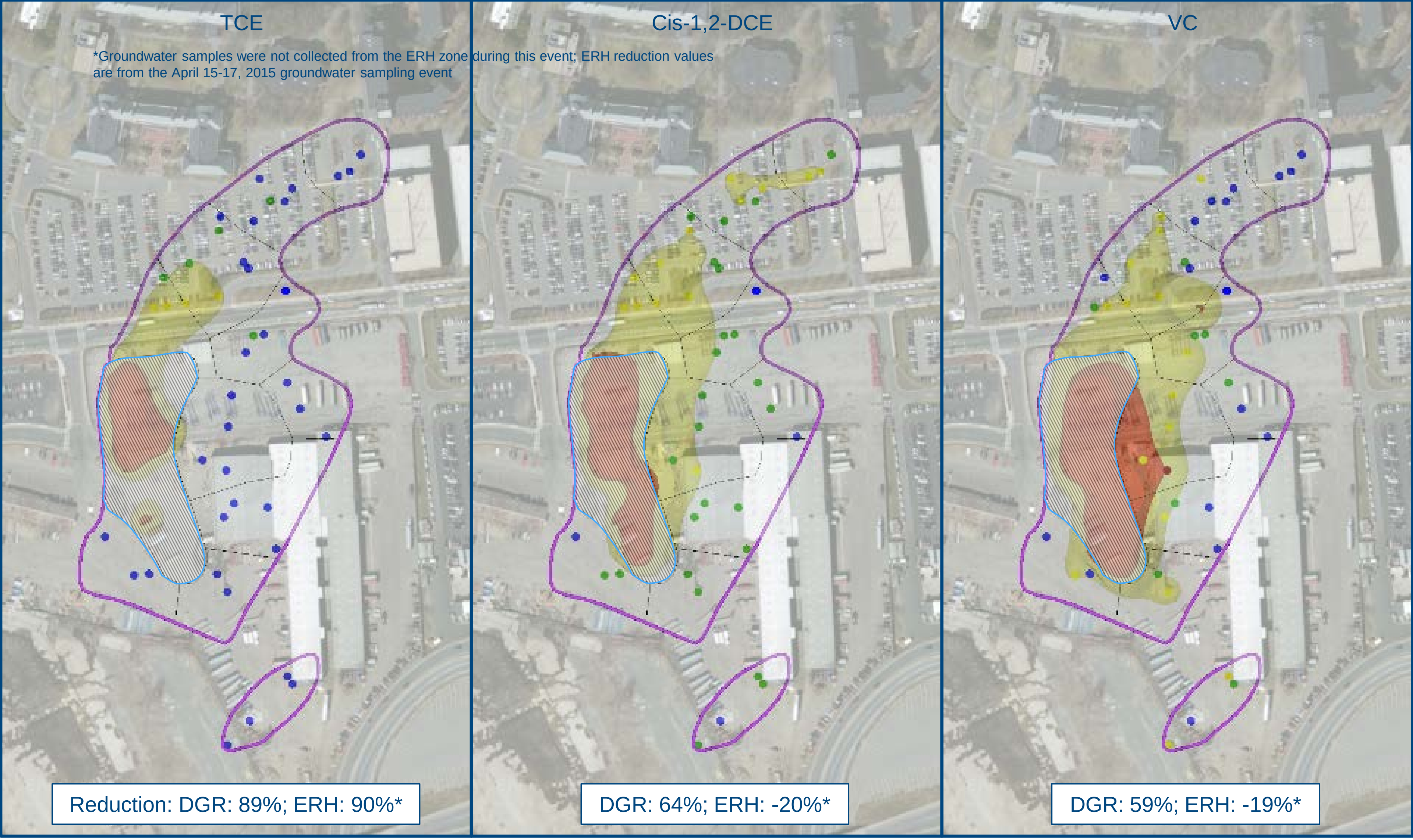
2014 BASELINE GROUNDWATER DATA

FEBRUARY 5–13, 2015 GROUNDWATER DATA

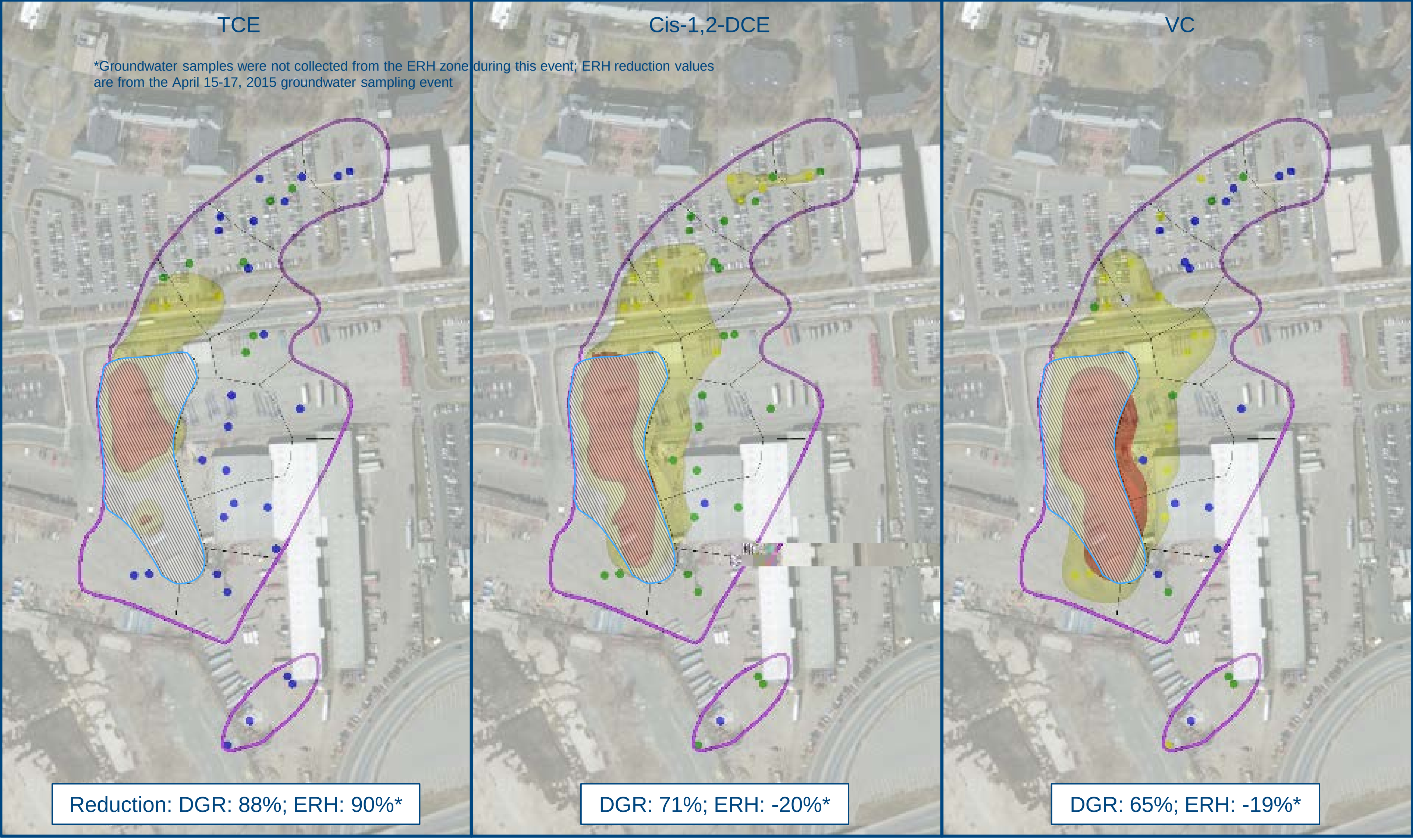
APRIL 2–3, 2015 GROUNDWATER DATA



APRIL 30–MAY 1, 2015 GROUNDWATER DATA



JUNE 1–JUNE 5, 2015 GROUNDWATER DATA



JULY 1–JULY 2, 2015 GROUNDWATER DATA

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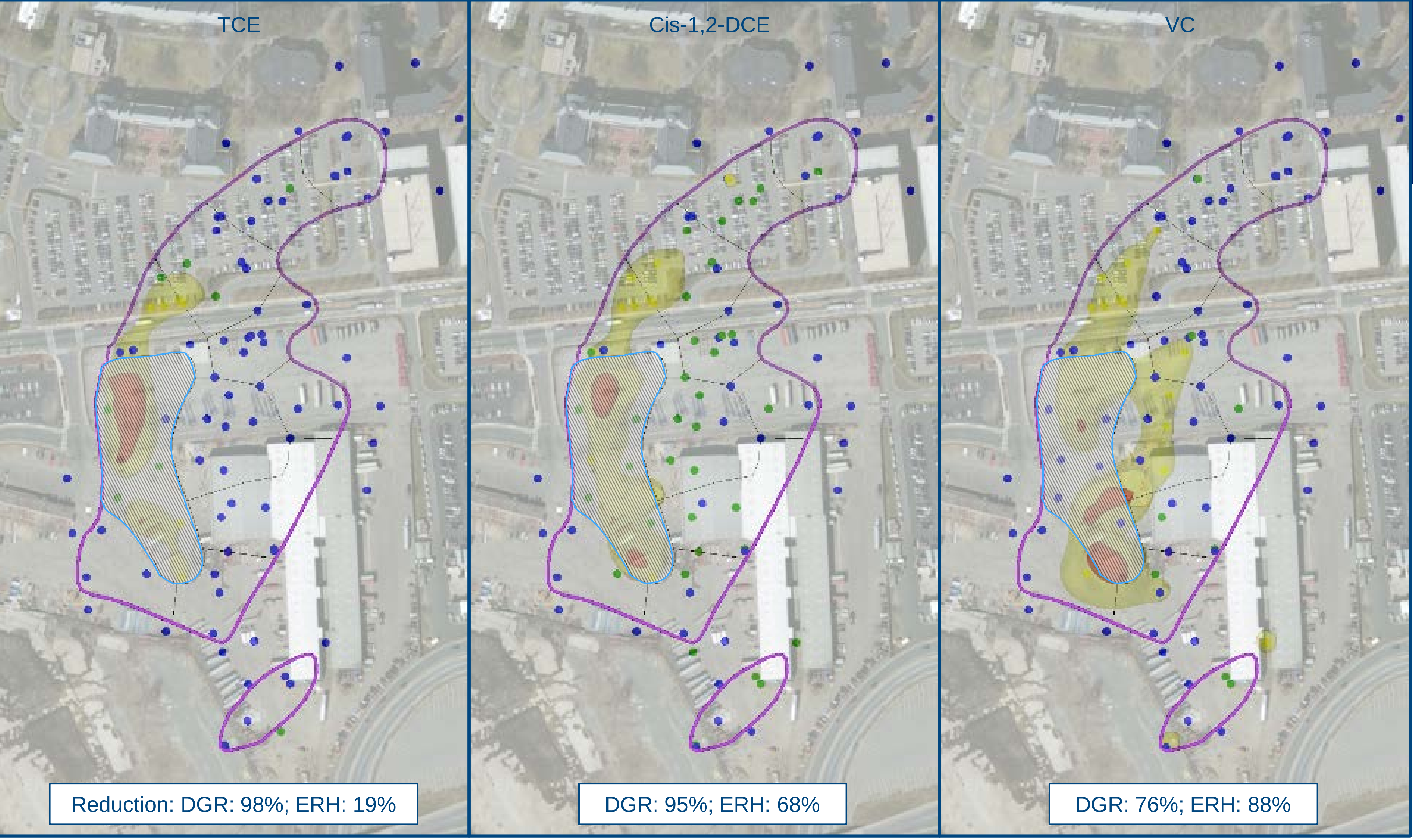
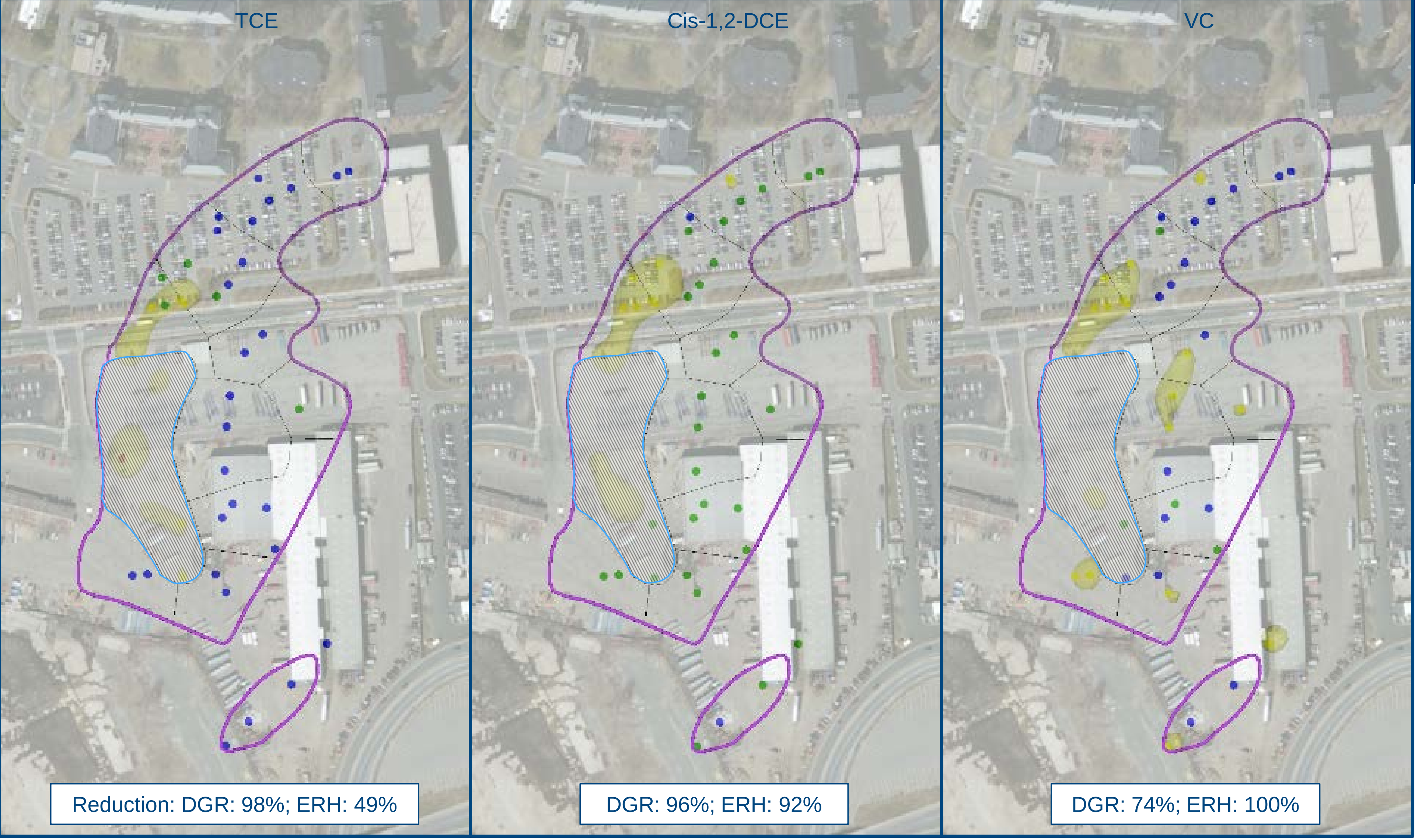


JULY 30–AUGUST 3, 2015 GROUNDWATER DATA



AUGUST 27–SEPTEMBER 1, 2015 GROUNDWATER DATA

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CONCLUSION

Within **<u>6 months</u>** groundwater remediation progress is:

- 98% reduction in TCE
- 96% reduction in cis-1,2-DCE
- 80% reduction in VC

GW-2 standards met in shallow component of aquifer (still to be achieved in deeper component)

DGR is very effective at accelerating remedial objectives as compared to more traditional technologies

- ISCO forecast at 1.5 years, high cost
- In-situ bioremediation significantly longer time frame

Conventional pump and treat system strategies has historically meant long operation and maintenance period and years to achieve site closure.

DGR can be implemented to achieve aggressive treatment timetables and across very large plumes

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