Remote Monitoring of VOCs in Groundwater for Daily Plume Management Decisions

OTCO Water Laboratory Analyst Workshop
May 11th, 2017

Willie Steinecker
Targeted Compound Monitoring (TCM)
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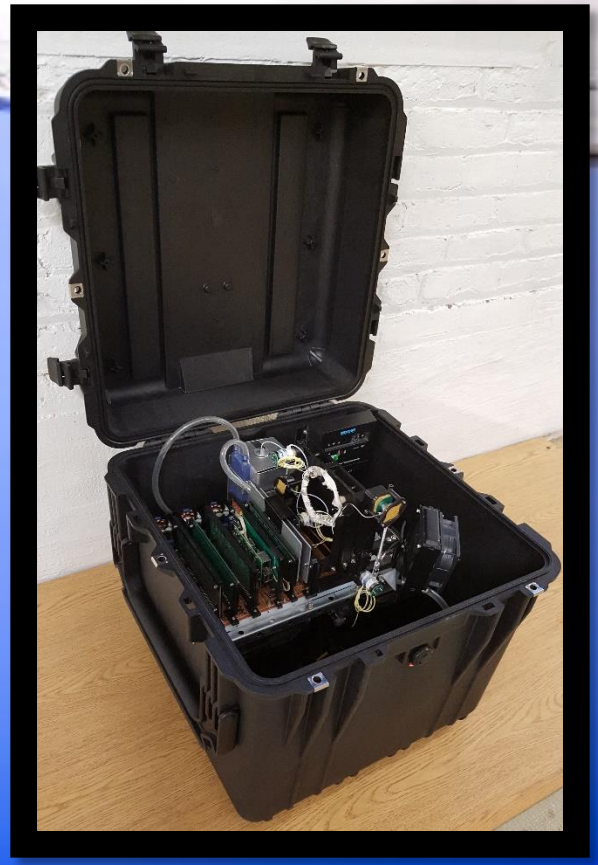
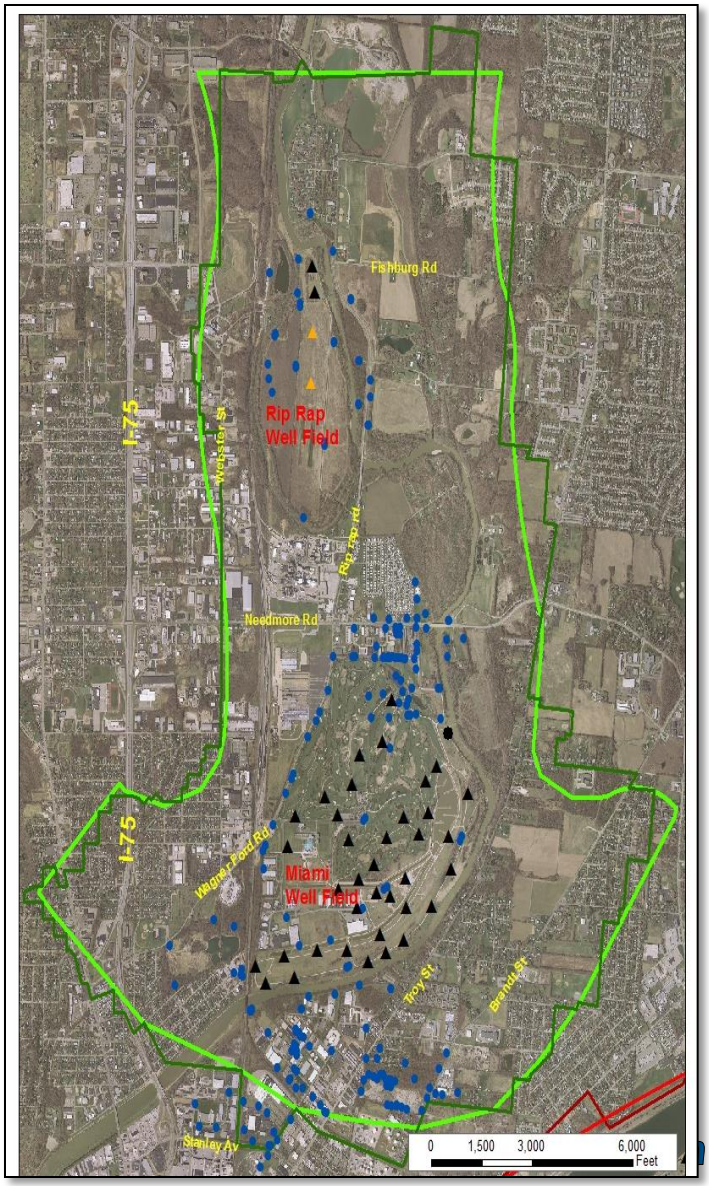


Today's Talking Points

- How/why did this get started?
- Has it been validated?
- Remote capabilities, maintenance
- Service model vs. selling units
- What have we seen so far?
- Ground water research
- PFCs (PFOS/PFOA)…
- Water level telemetry…

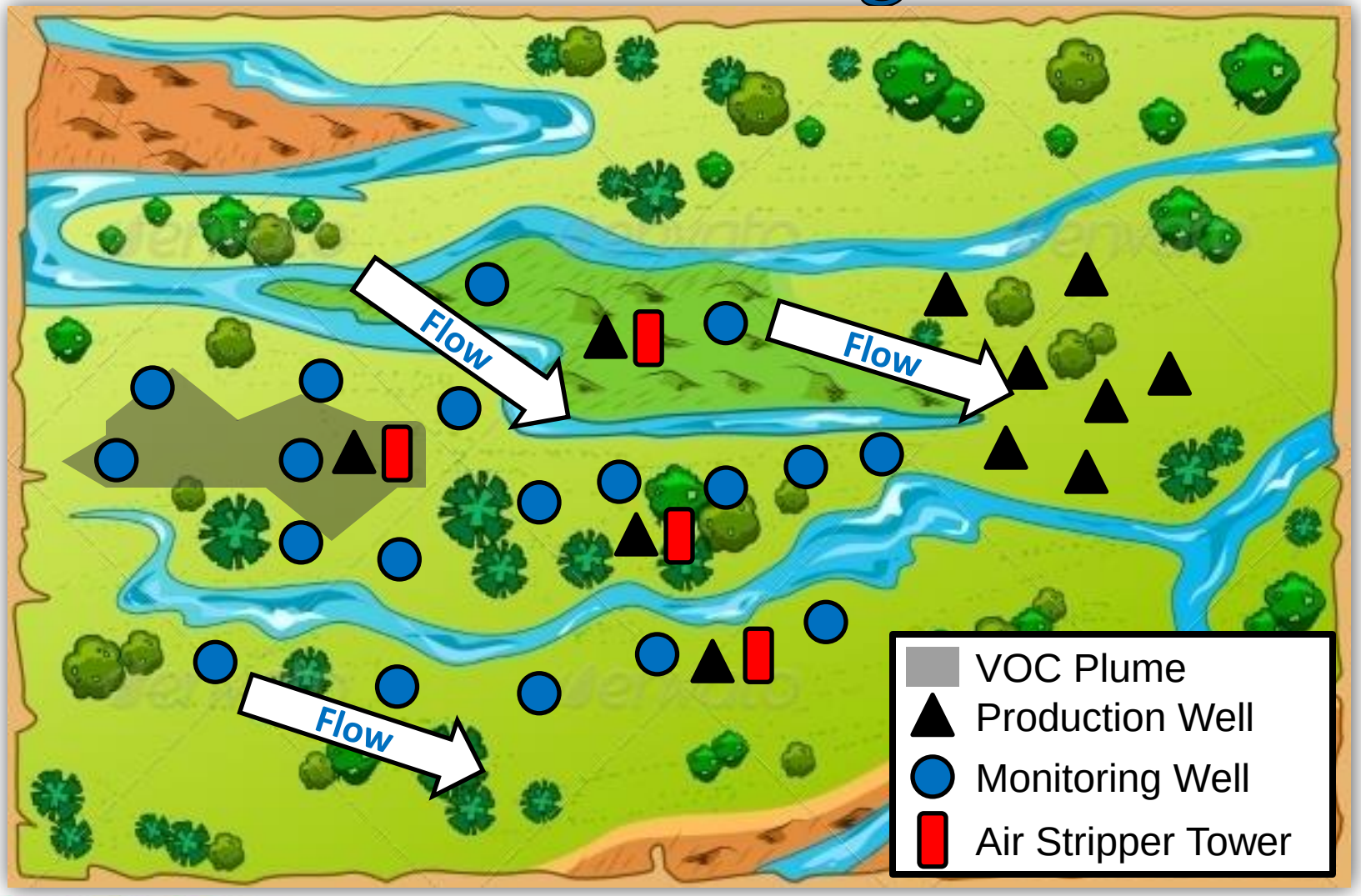
Dayton's Imperative

- Dayton Dept. of Water was looking for VOC monitoring technology
  - Early warning monitoring network
  - VOC plume management
  - Remediation decision making
  - Contamination source location
- **Jim Shoemaker**
- **Aaron Colson**



CITY OF DAYTON
water
one source
Regional • Reliable • Renewable

VOC Plume Management



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On-line, Automated VOC monitor

purge and trap gas chromatograph for water analysis

Capabilities

- Rugged/weatherproof
- Temperature resistant
- Battery/solar power options
- Low-flow continuous well sampling
  - Pneumatically driven bladder pump
- Automated chemical analysis
  - Lab quality data (<1 ppb LOD)
  - Can target most VOCs
- Wireless communication
- Remote data availability

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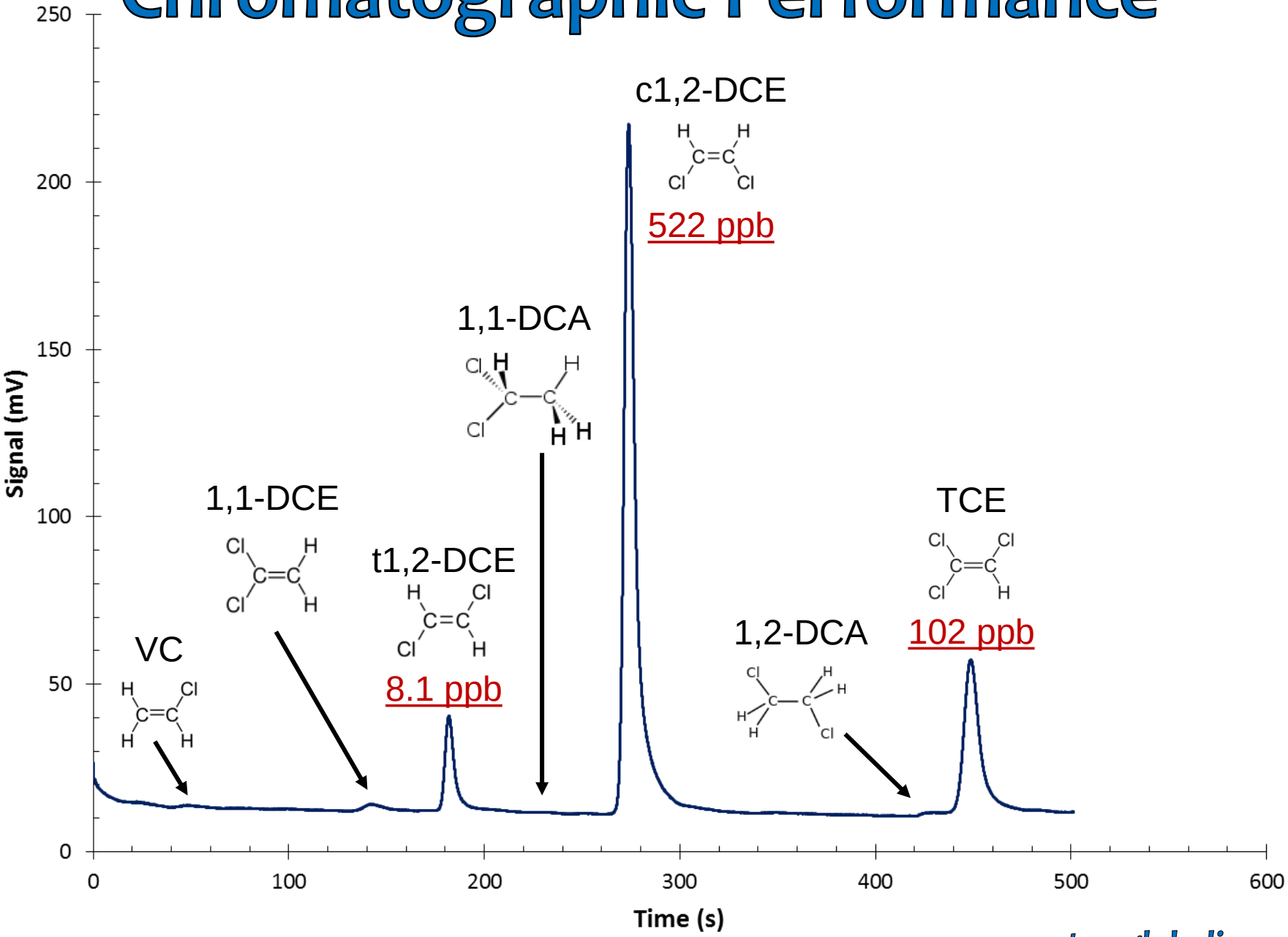
Chromatographic Performance



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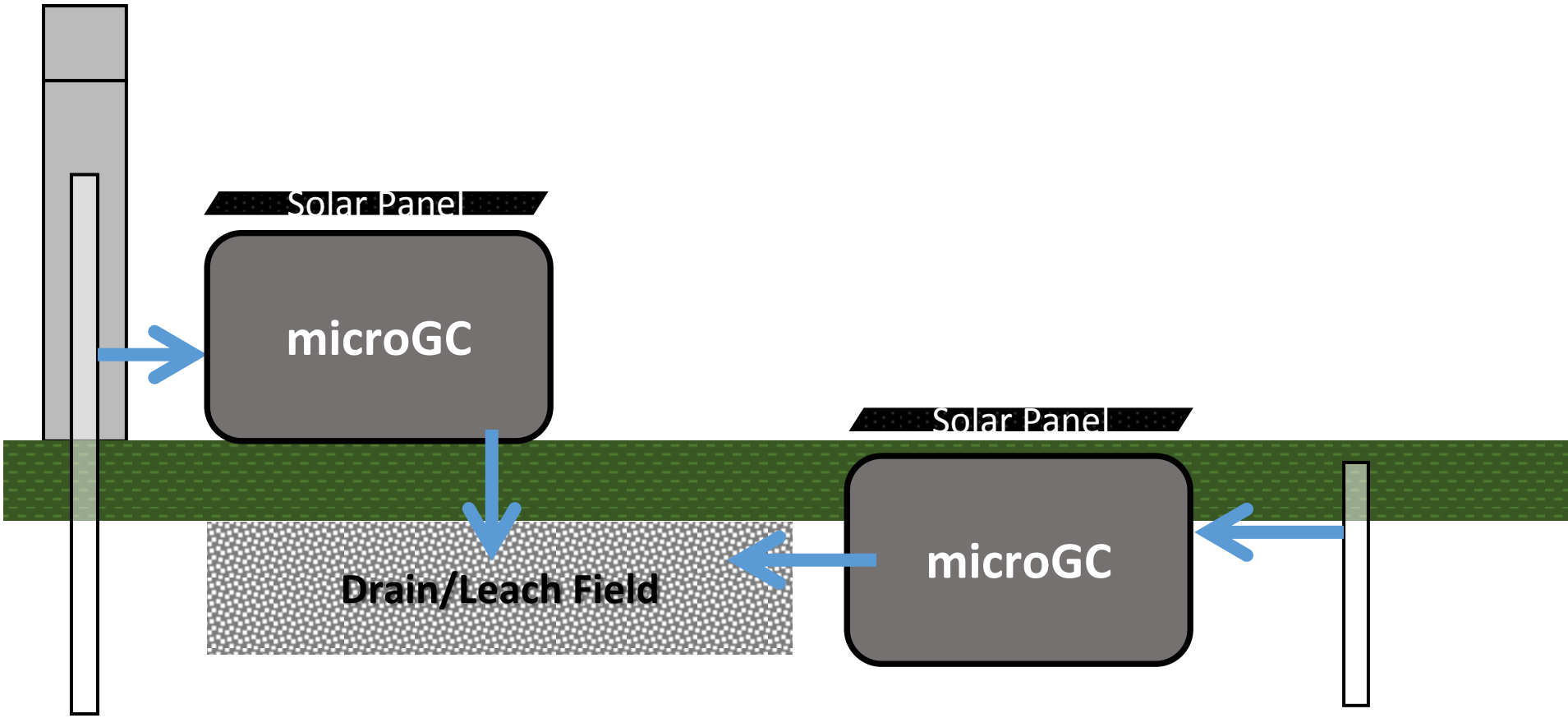
Installation Options

Stick-up Well

Flush-Mount Well



Fluidic Connections

Well Head

Enclosure

Drain/Leach Line

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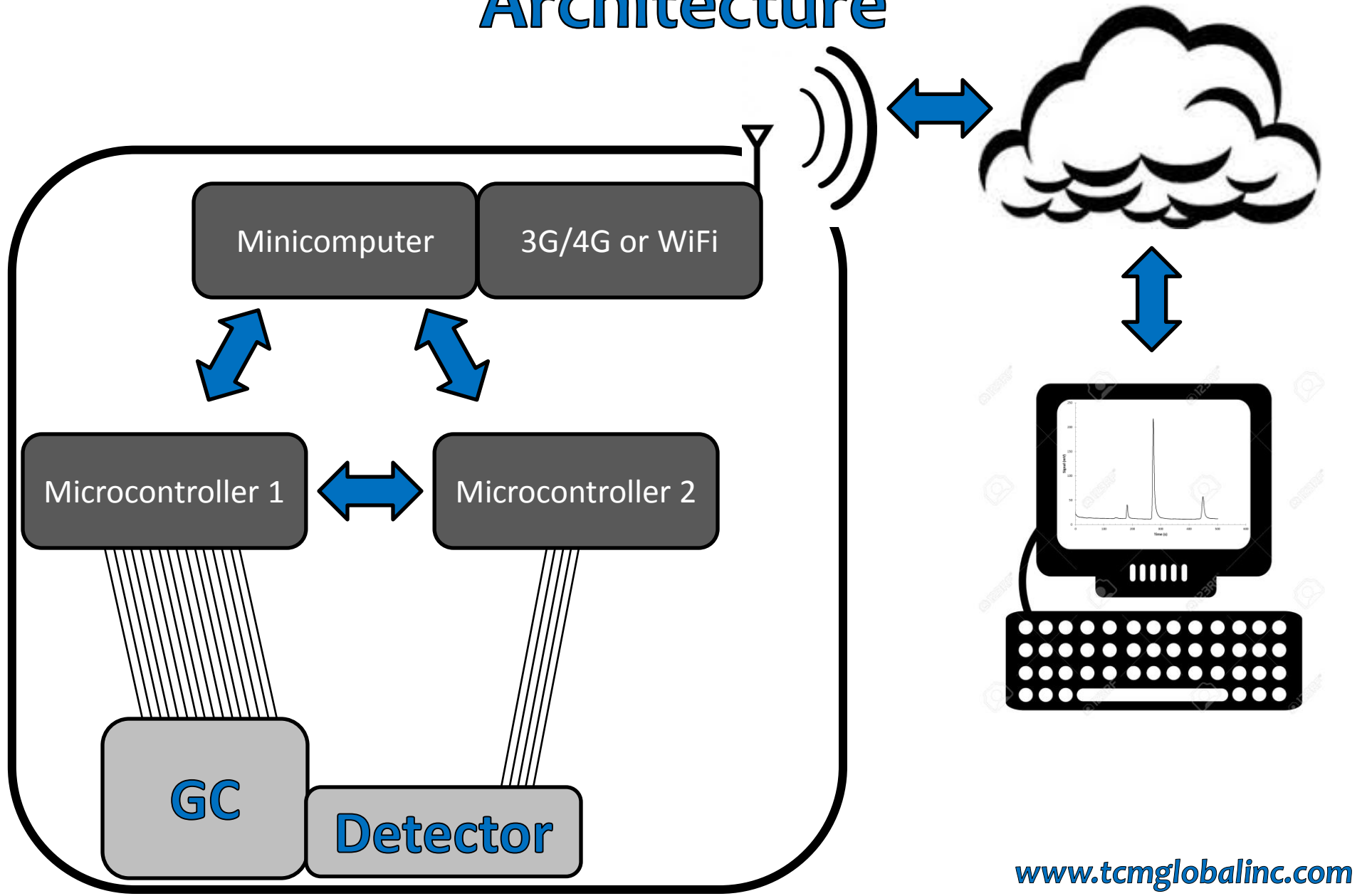
Remote/Autonomous Electronics Architecture



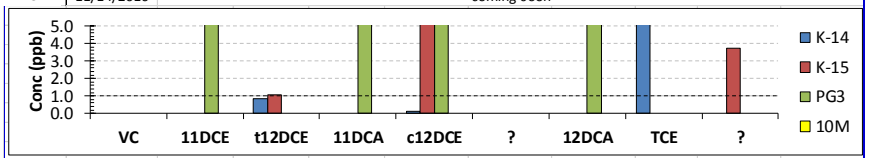
Daily Reporting (Dash Board)

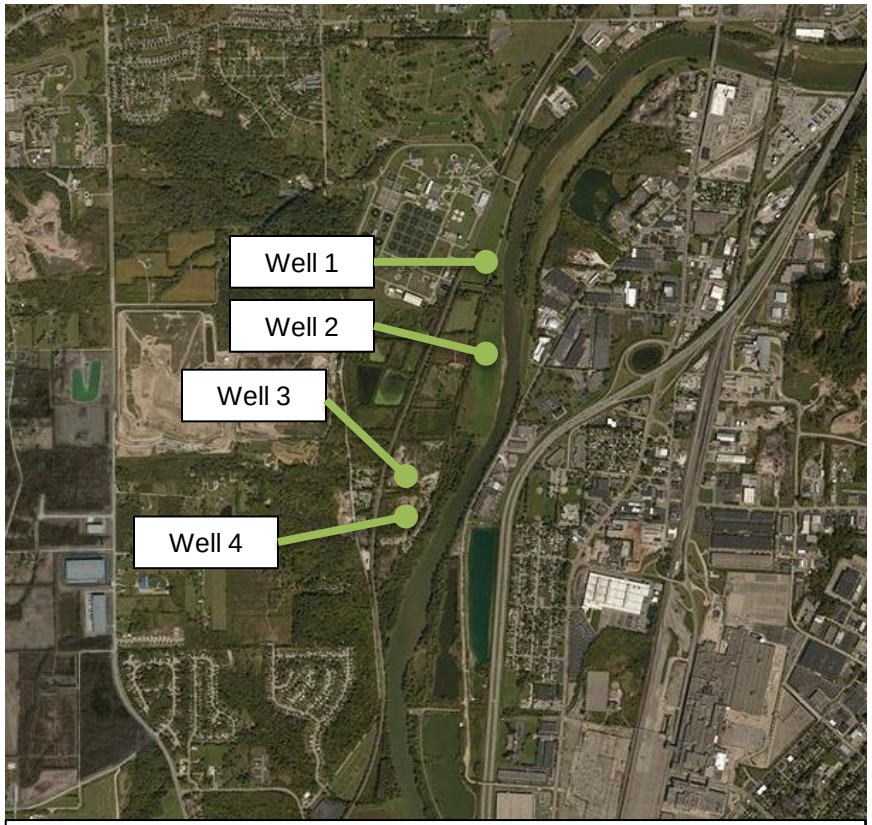
Online VOC Monitoring Update

Page One: Monitoring locations and Most Recent Results

Most Recent Results

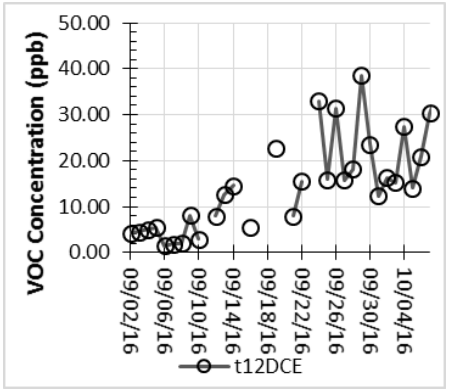
	Date	VC	11DCE	t12DCE	11DCA	c12DCE	?	12DCA	TCE	?
Well 1	11/19/2016	0.0	0.0	0.8	0.0	0.1	0.0	0.0	6.1	0.0
Well 2	11/17/2016	0.0	0.0	1.1	0.0	90.1	0.0	0.0	0.0	3.7
Well 3	11/14/2016	0.0	12.6	0.0	74.9	26.4	0.0	66.8	0.0	0.0
Well 4	11/14/2016	coming soon								

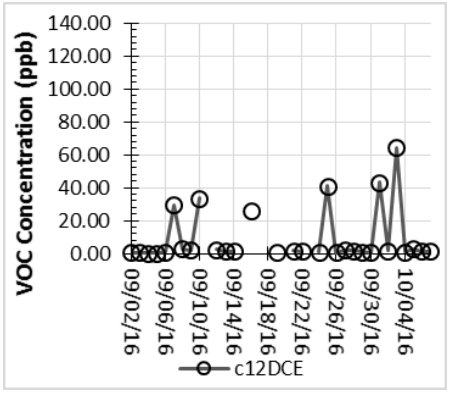


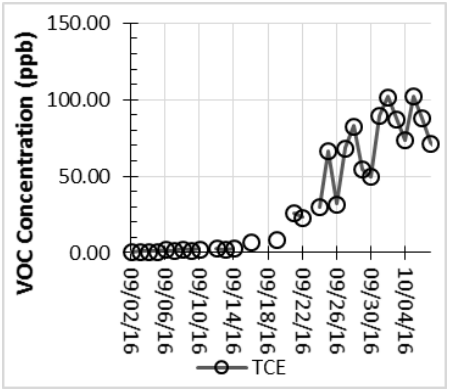


***This monitoring data is shown with permission from an anonymous customer; however, this fictitious map is only for illustrative purposes.*

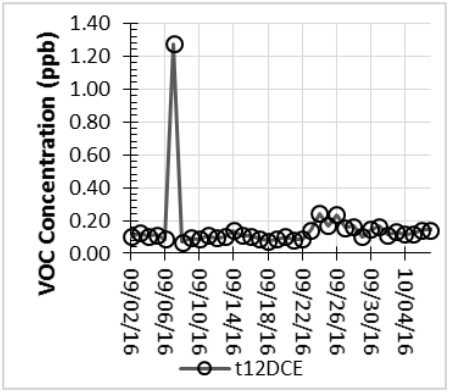
Well 1

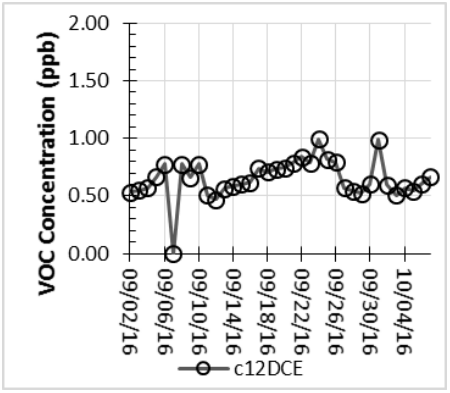


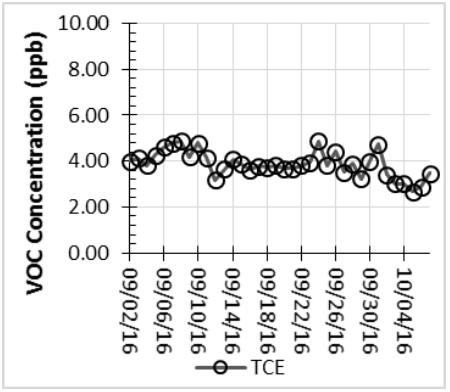




Well 2







Field Picture

K-14 (unit #1)

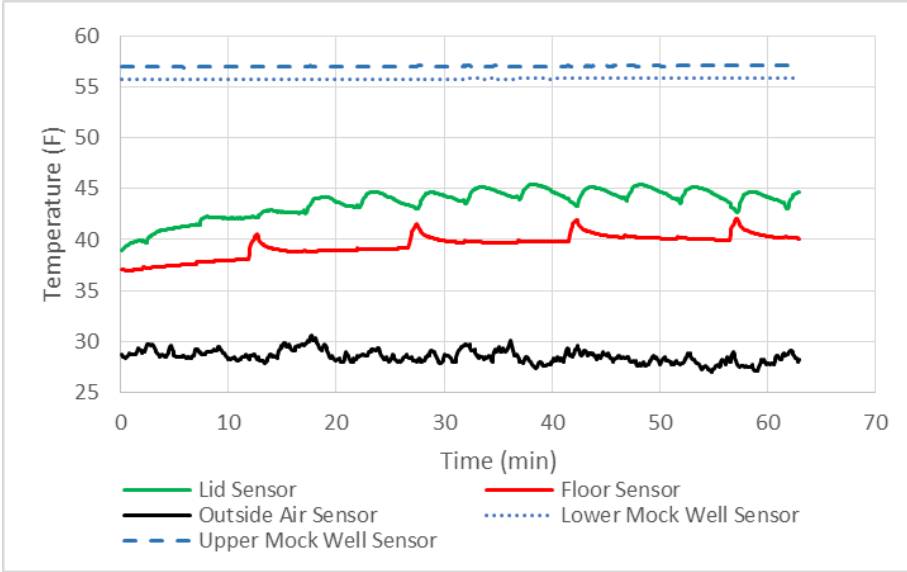
PG-3 (unit #3)

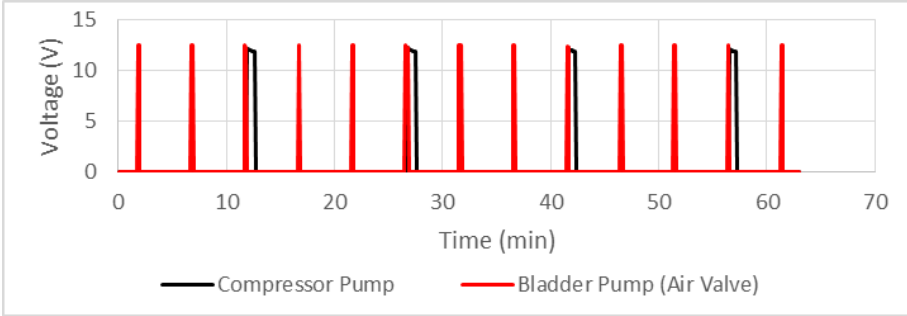
K-15 (unit #2)

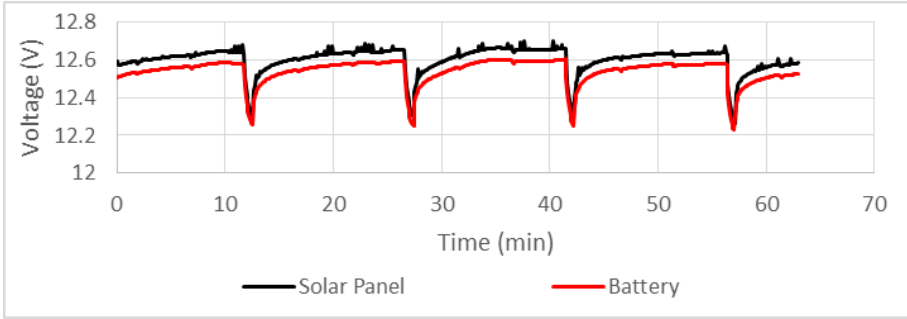
10M (unit #4)

Geothermal Performance

- Consistently maintains >35° F
  - Tested to -22° F
- Freeze/failure testing
  - No permanent damage
  - Self-starts when thawed







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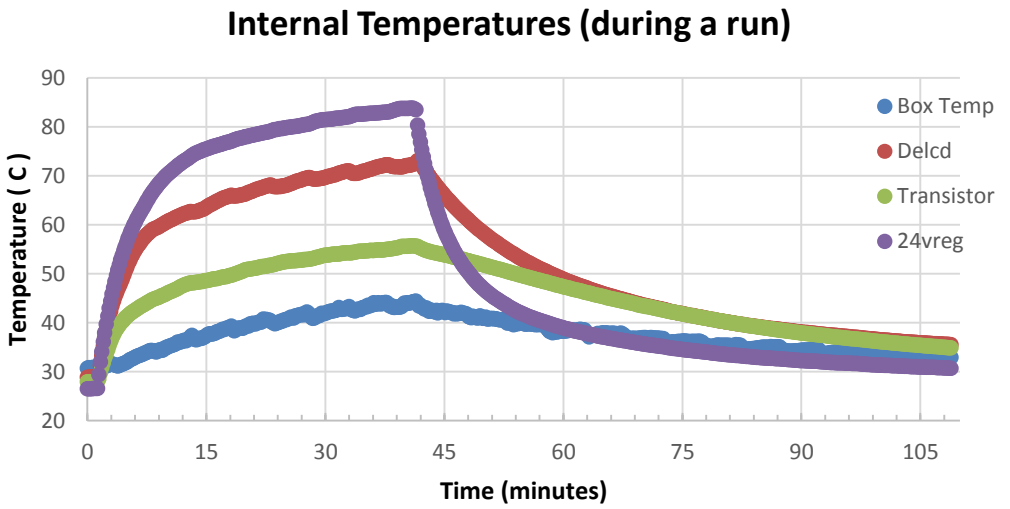
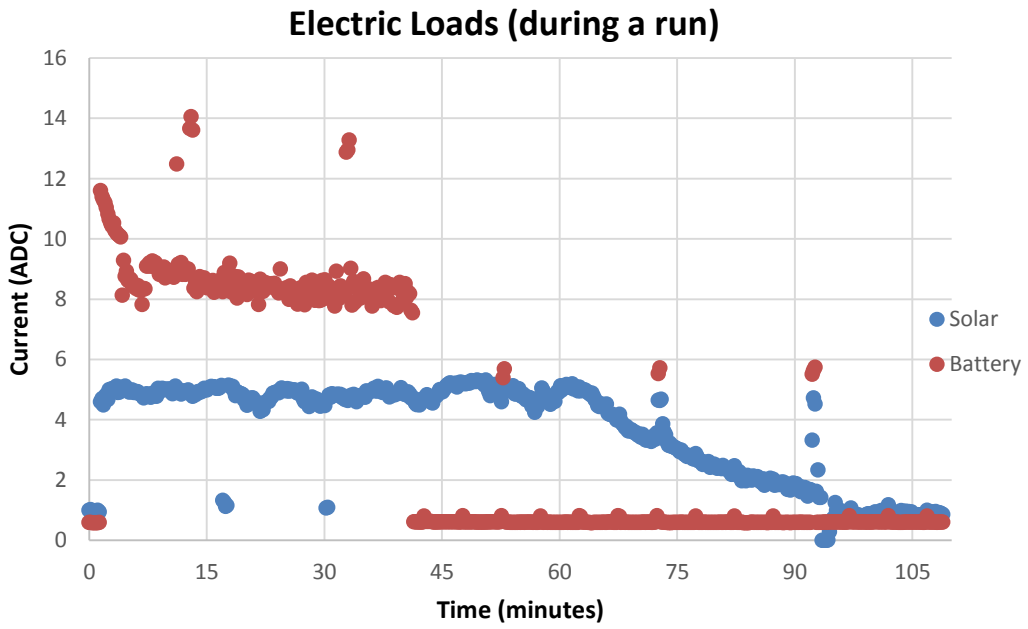
Solar Performance

- **30-60 minutes downtime required between runs for cooling**



- Max current draw is 14 amp
  - Average is ~9 amp
- Solar current on cold/cloudy day is 5 amp
- 1 hour GC operation requires at least 1 hour of partial sun to recharge battery
- **Multiple GC analyses per day are possible!**



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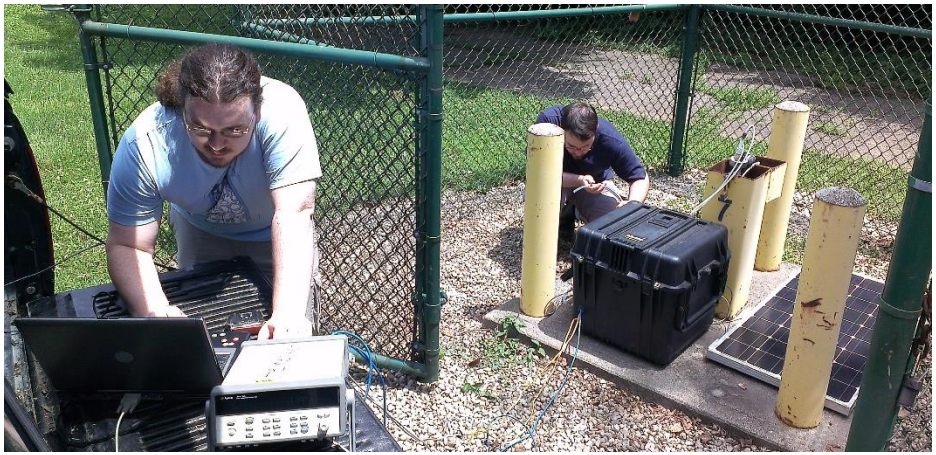
Weather Resistance

Winter, Spring, Summer, Fall | -22° F to 103° F



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Validation

- Primary validation: standard first principles approach
  - Perform frequent calibrations, monitor drift
  - Periodically run standards during sample testing to verify calibration
  - Can't use internal standards in the field, but they wouldn't help anyway
- Secondary: parallel sampling
  - Icing on the cake if they agree
  - If they disagree, primary validation will guide understanding of why
- Error and instrumental analysis
  - TCM design drifts by no more than 20% over 12 months
    - When properly serviced/maintained
      - Our audit log ensures system accuracy
    - Positive errors are not generally possible
      - Several system failures can generate large negative errors

Maintenance, QC, Calibration

- Majority of Maintenance is performed remotely
  - Many embedded sensors to monitor health/performance
  - Hands-on maintenance scheduled in advance
  - Remotely manage power (for low-solar periods)
- All QA/QC is performed remotely
  - Vitals indicate flow and temperature
  - Chromatographic metrics monitored continuously
- GC calibration required 1-2 times a year
  - Scheduled to coincide with other maintenance
  - Maximum drift is +/- 20% over 6 months

Commercialization – SERVICE MODEL

- Monthly fee, like renting with benefits
  - TCM takes responsibility for accuracy, not you!
  - TCM works with customer to place units in field
  - TCM handles maintenance, calibration, QA, QC
  - Data hosted via TCM website
  - Reduces technical burden on customer, saving resources for data analysis and decision making
  - **Far more affordable than purchasing, training, etc.**

Command Center

- TCM application specialists handle everything remotely
  - Monitoring state of health
  - Monitoring GC performance metrics
  - Overseeing GC quality control
    - **Peak identification and quantification**
  - Scheduling maintenance visits
  - Emergency alerting, diagnostics

Examples…

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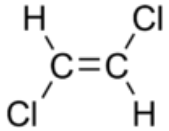
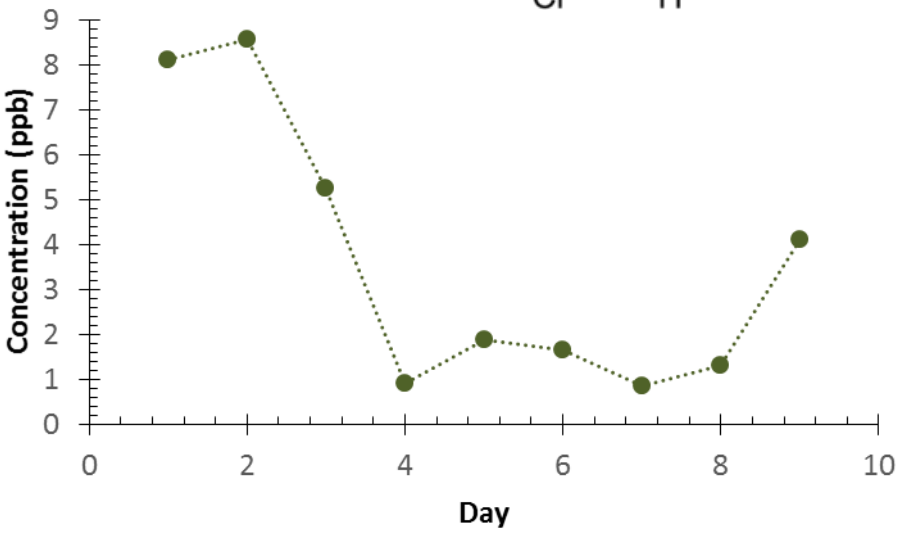
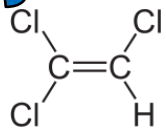
Field Data – First Nine Days

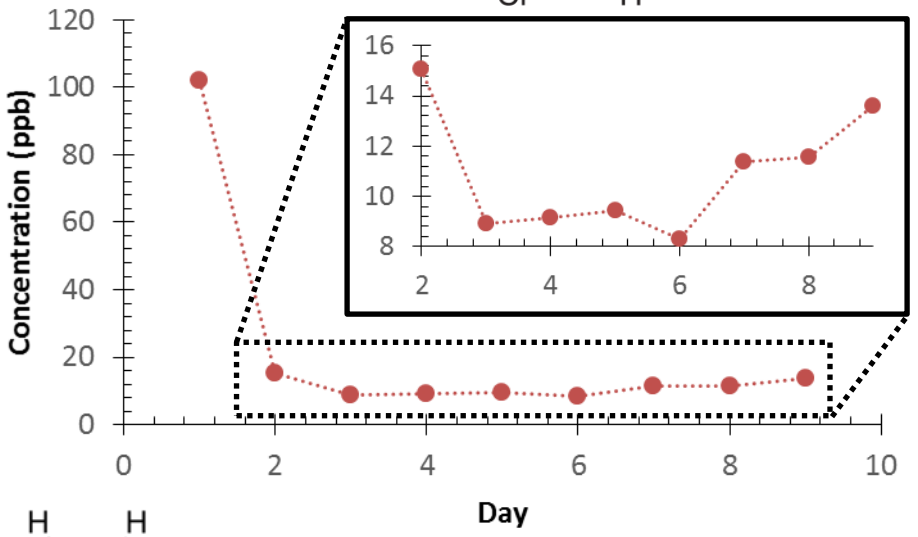
t1,2-DCE



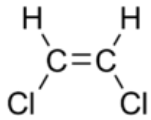


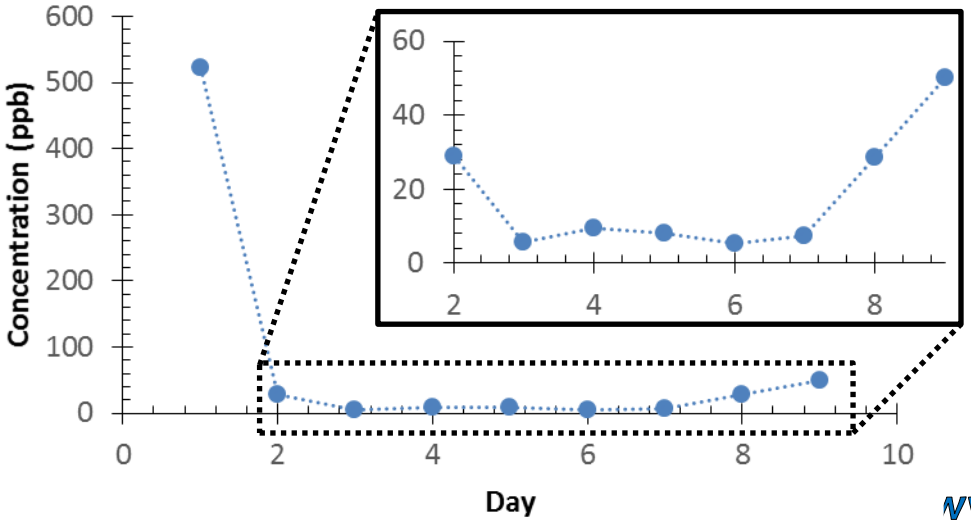
TCE





c1,2-DCE





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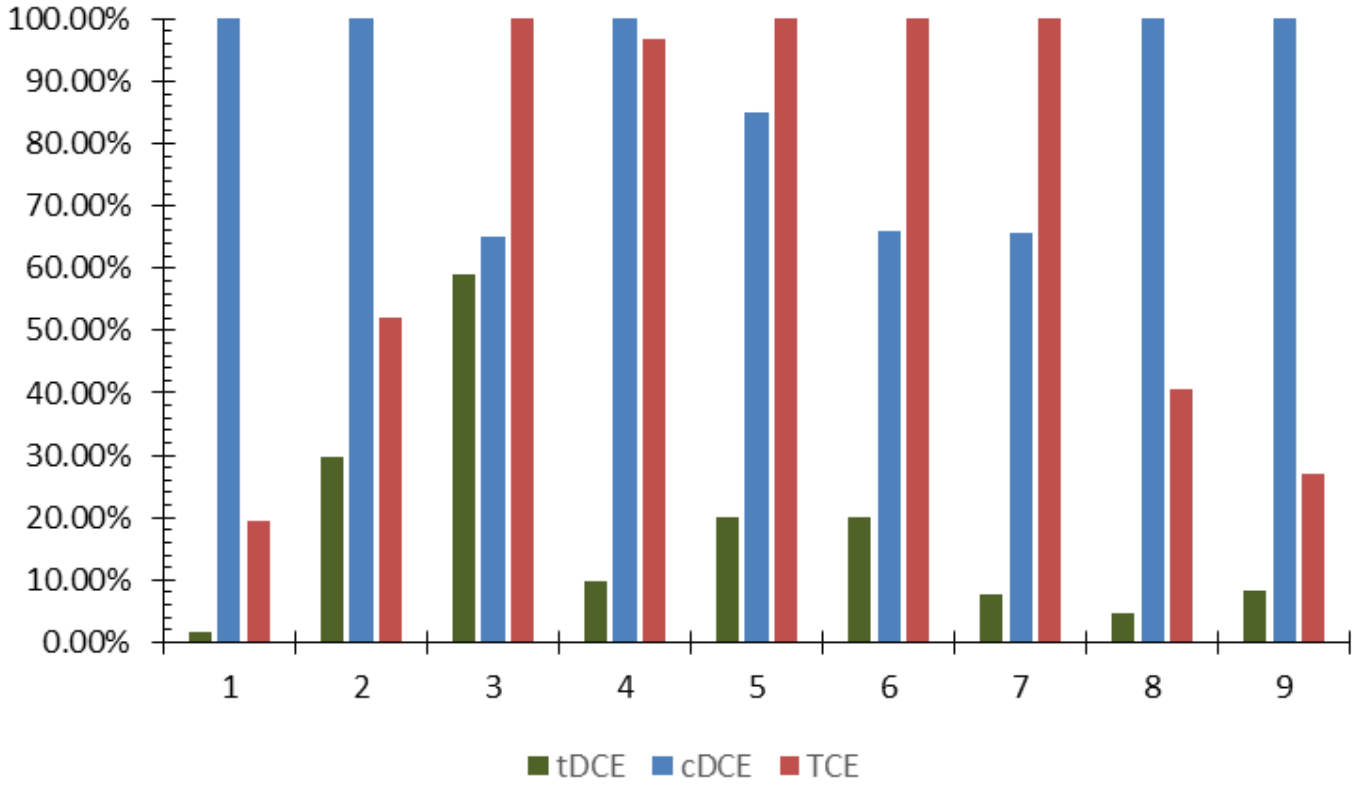
Normalized Concentration Distributions



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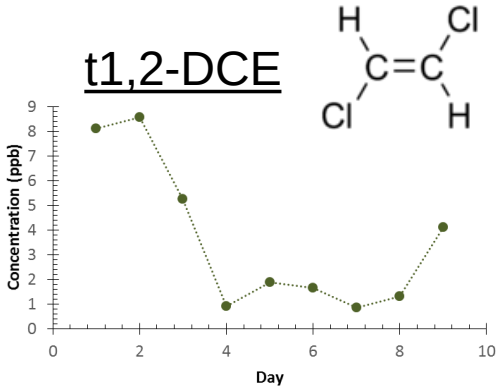
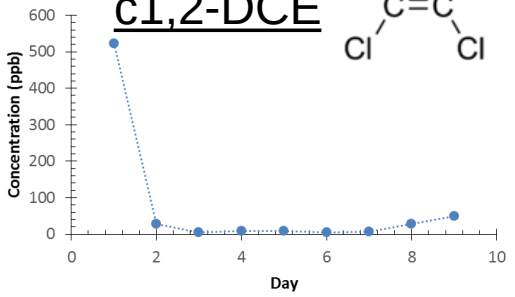


c1,2-DCE



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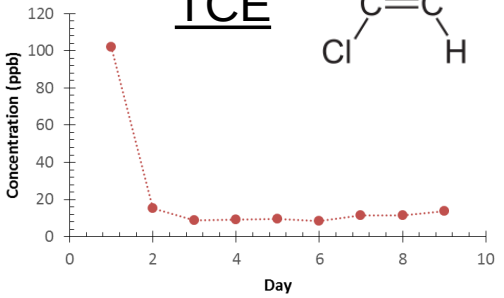

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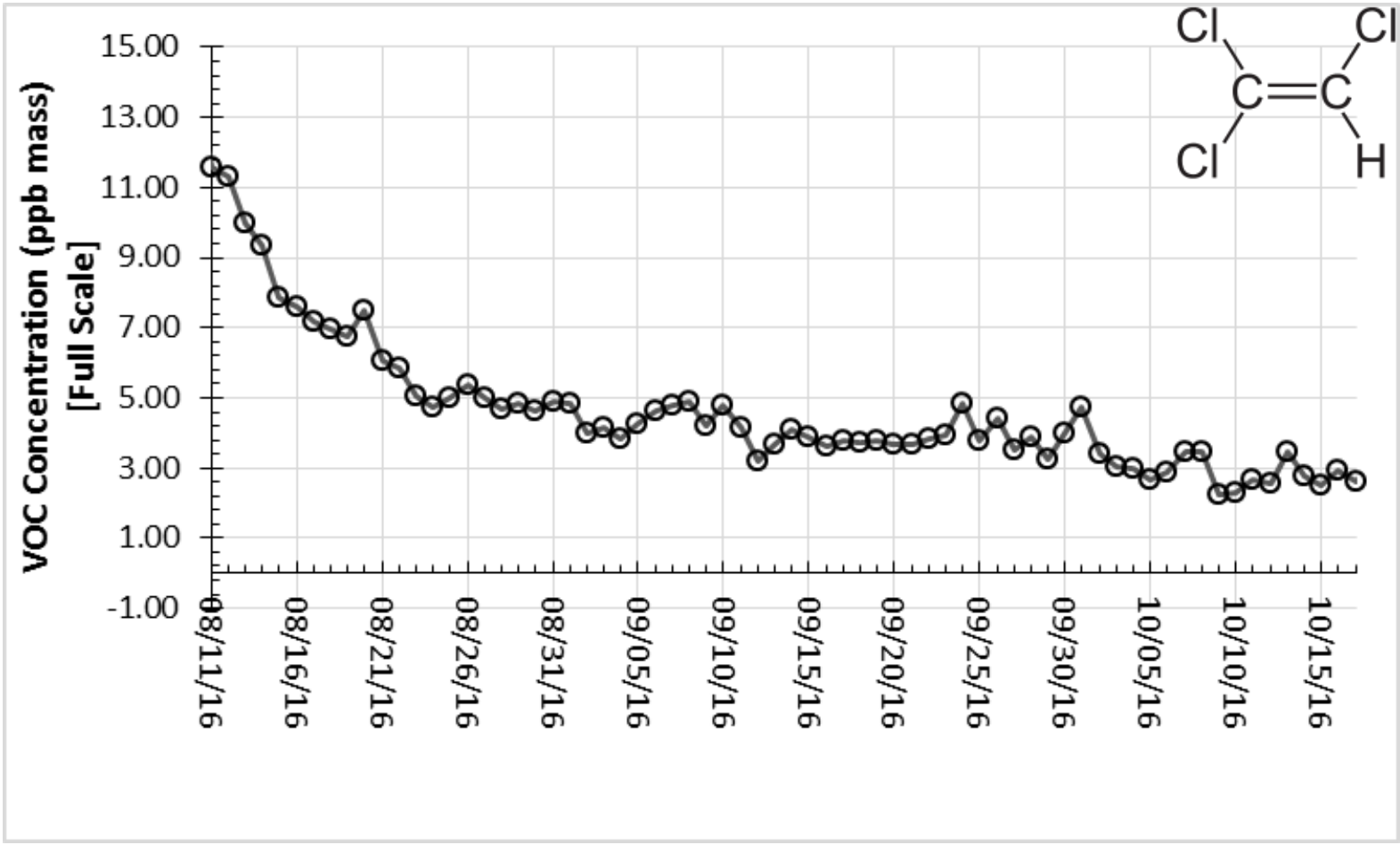
Trends



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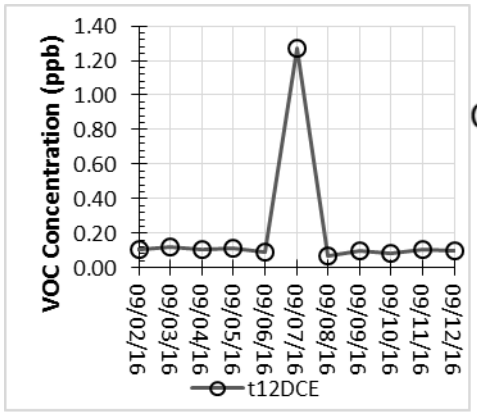
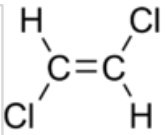
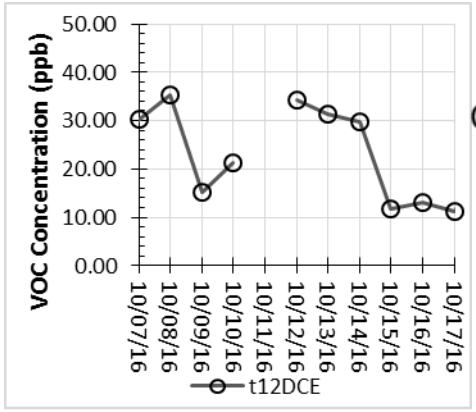
Slugs


VOC Concentration (ppb)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
09/02/16
09/03/16
09/04/16
09/05/16
09/06/16
09/07/16
09/08/16
09/09/16
09/10/16
09/11/16
09/12/16
t12DCE


H
Cl
C=C
Cl
H


VOC Concentration (ppb)
50.00
40.00
30.00
20.00
10.00
0.00
10/07/16
10/08/16
10/09/16
10/10/16
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10/12/16
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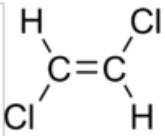
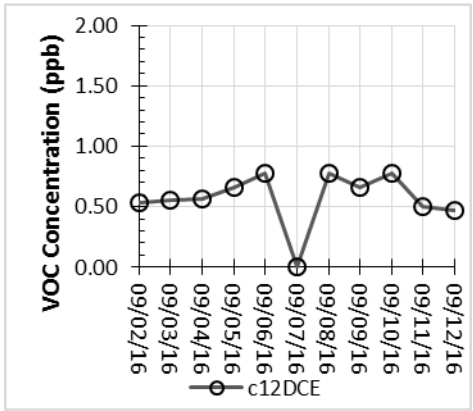
10/15/16
10/16/16
10/17/16
t12DCE


H
Cl
C=C
Cl
H


VOC Concentration (ppb)
2.00
1.50
1.00
0.50
0.00
09/02/16
09/03/16
09/04/16
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09/07/16
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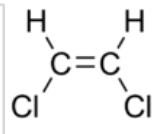
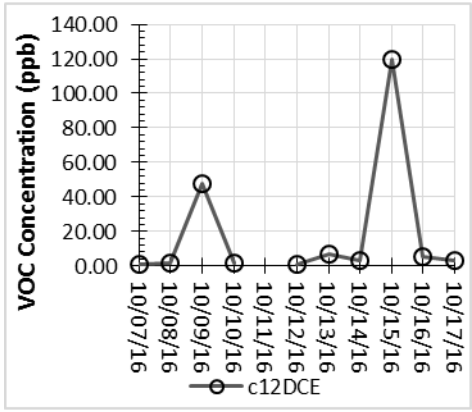
09/10/16
09/11/16
09/12/16
c12DCE


H
H
C=C
Cl
Cl


VOC Concentration (ppb)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
10/07/16
10/08/16
10/09/16
10/10/16
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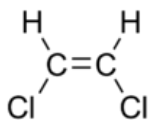
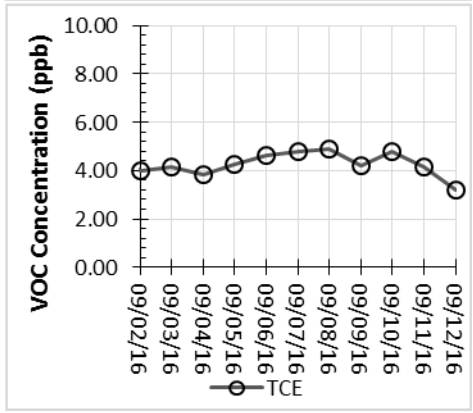
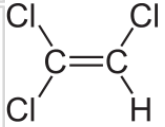
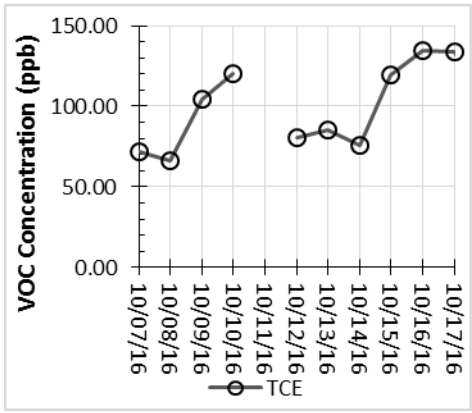
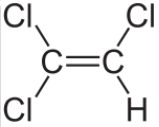
10/15/16
10/16/16
10/17/16
c12DCE


H
H
C=C
Cl
Cl


VOC Concentration (ppb)
10.00
8.00
6.00
4.00
2.00
0.00
09/02/16
09/03/16
09/04/16
09/05/16
09/06/16
09/07/16
09/08/16
09/09/16
09/10/16
09/11/16
09/12/16
TCE


Cl
Cl
C=C
Cl
H


VOC Concentration (ppb)
150.00
100.00
50.00
0.00
10/07/16
10/08/16
10/09/16
10/10/16
10/11/16
10/12/16
10/13/16
10/14/16
10/15/16
10/16/16
10/17/16
TCE


Cl
Cl
C=C
Cl
H

What's Next?

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Ground Water Research

- Sampling rate study: How often do we need to sample?
  - Sample as fast as possible for as long as possible
  - Live data feed at our table
- We need to expand our scope to more groundwater scenarios and other VOCs
  - pumping rates, remediation efforts, etc.
- Correlation against daily events
  - Weather, other well activity, etc.
- Correlation against soil/formation properties
- We need to evaluate how current conceptual models correlate with these results
  - update models?

Perfluorinated Chemicals (PFCs)

- The next frontier after VOCs
- Requires a different technology = liquid chromatography
- TCM is seeking funds to adapt the VOC platform developed for Dayton to monitor PFCs
- DoD's current PFC investigation covers 2,000+ sites.

Wireless Telemetry Unit

- Autonomous data logging for 3rd party telemetry transducers (water level, etc)
  - Builds on our Remote/Autonomous Electronics Architecture
- Solar powered
  - 90-day battery backup
- Autonomously drives transducer, records data
- 3G communications
- Daily/hourly updating
- Remote configurable

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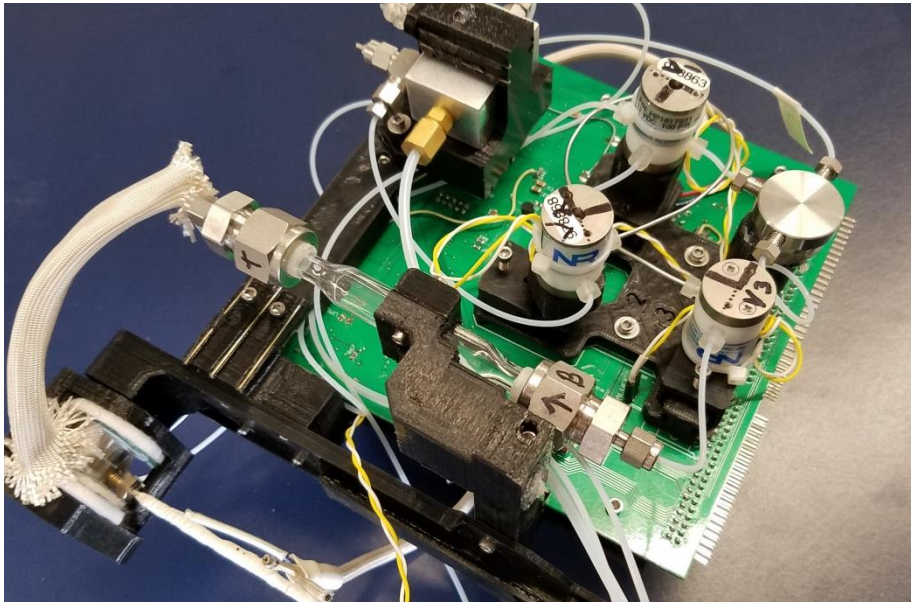
Summary

- Remote Ground Water Monitoring for VOCs
  - The Technology is Here
  - Early Warning Monitoring and Plume Management
  - Ground Water Research has Only Just Begun
- Look for new technology from TCM
  - Water level monitoring
  - PFC monitoring
  - And lots more!

Thanks!

- Questions?
- Please come by the table



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