New Continuous Monitoring Technologies for Vapor Intrusion, Remediation and Site Assessment:

Benefits of Time series Data

Dr Peter Morris, Geoff Hewitt

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Why Do We Monitor Ground Gas/Vapors?

KR2

- Health and Safety – range of toxic affects explosion, suffocation
- Vapor Intrusion, methane and petroleum h/c

Slide 2

KR2 either capitalize the whole heading or change the capital g's to lower case

Karen Robinson, 6/13/2012

Loscoe UK, 24th March 1986

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KR4

Mexico, 15th November 2010 Swamp Gas

7 people died

Slide 4

KR4 headings aren't consistent

Karen Robinson, 6/13/2012

Objectives of Ground Gas/Vapor Monitoring

- Determine the true subsurface vapor/gas regime
- Predict how this may change in the future
- Currently achieved by:
  - Discrete periodic static measurements of vapor/gas concentrations
  - The vapor/gas regime is inferred

Flawed approach

- Many environmental parameters show high temporal variability, therefore, their representative measurement requires multiple measurement.

- In the case of vapor/ground gas risk assessment flaws in the existing multiple measurement approach have been identified explicitly in the literature in the UK (Wilson & Card, 1999) and are subject to continuing correction (e.g. CIEH).

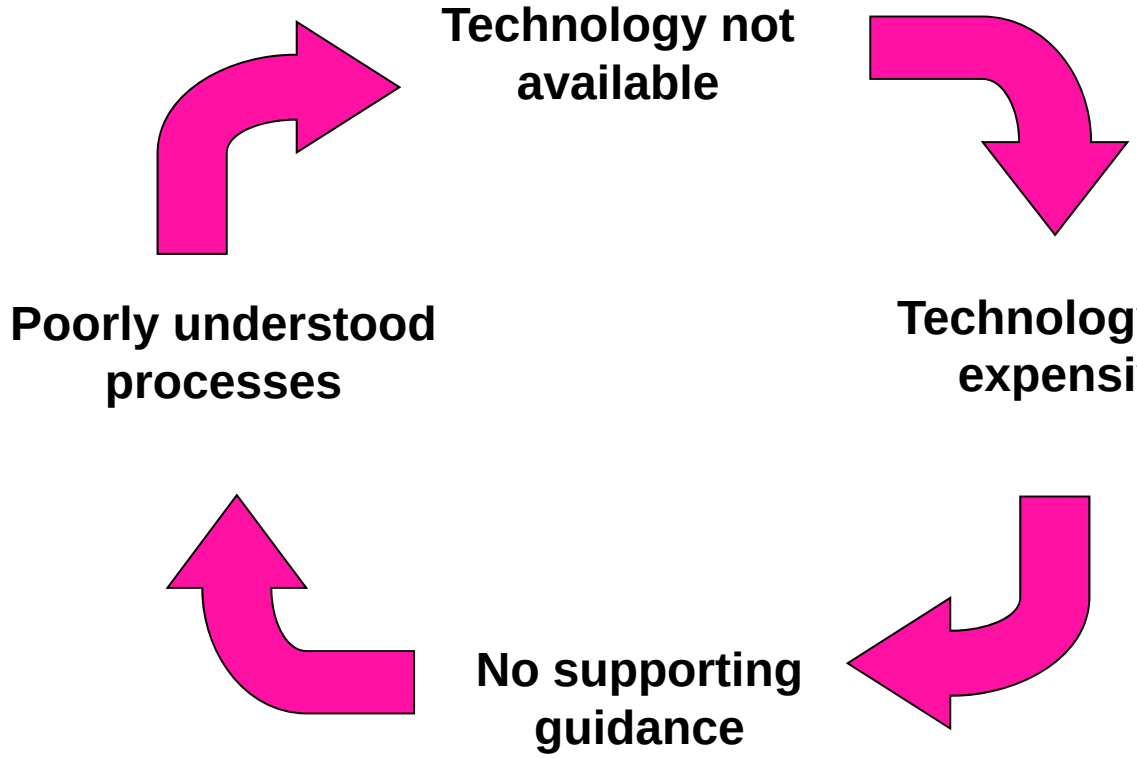
Underlying Causes

- The two underlying causes of these flaws are that, whilst accurate quantification of risk requires accurate measurement of gas/vapors concentration and fluxes:

- They are not measured directly: concentration of vapor in the ground is inferred from periodic (weekly – monthly) sampling of vapor/gas accumulated within a borehole (or soil sample) The relationships these inferences are based on will be highly site-specific.

- And, concentrations are likely to be temporally variable.

No significant change in monitoring technique?



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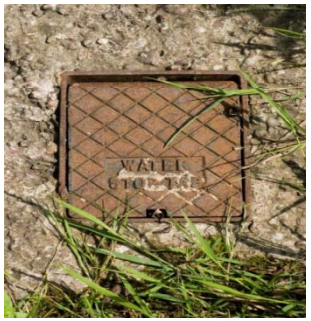
How did it change?

- Developed new technology
- Improved ground-gas risk prediction by in-borehole monitoring (IRP-IGM)
- Government funded project
- Guidance note

GasClam

Key features

- Continuous monitoring of VOC,CH_4, CO_2, O_2, H_2S, CO barometric & borehole pressure and water level
- CSA UL approved
- Extended deployment, up to 1 month based on hourly sampling
- Robust stainless steel design
- Fits directly in 50mm borehole (easy to adapt)
- Easy to use and deploy
- Venting and vented modes
- Modem



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Variable VOC concentrations?

	WS1 June 09	WS1 July 09
Compound	**ug/m³**	**ug/m³**
Methylcyclohexane	<0.6	150
Methylisobutylketone	<0.5	<0.4
Dimethyldisulfide	<1	<0.8
Toluene	25	370
Butyric Acid	<4	<3
n-Octane	37	580
Ethyl Butyrate	<0.9	<0.8
Butyl Acetate	<0.8	<0.7
Tetrachloroethene	<0.3	<0.3
EthylCyclohexane	<0.4	190
Chlorobenzene	29	550
EthylBenzene	640	1900
m-Xylene + p-Xylene	33	840
n-Nonane	17	780
Styrene	<0.4	150

Variability of VOC's as detected by 'spot' sampling – suma canister Brownfield site NW UK

Confusing data, problem with sampling?

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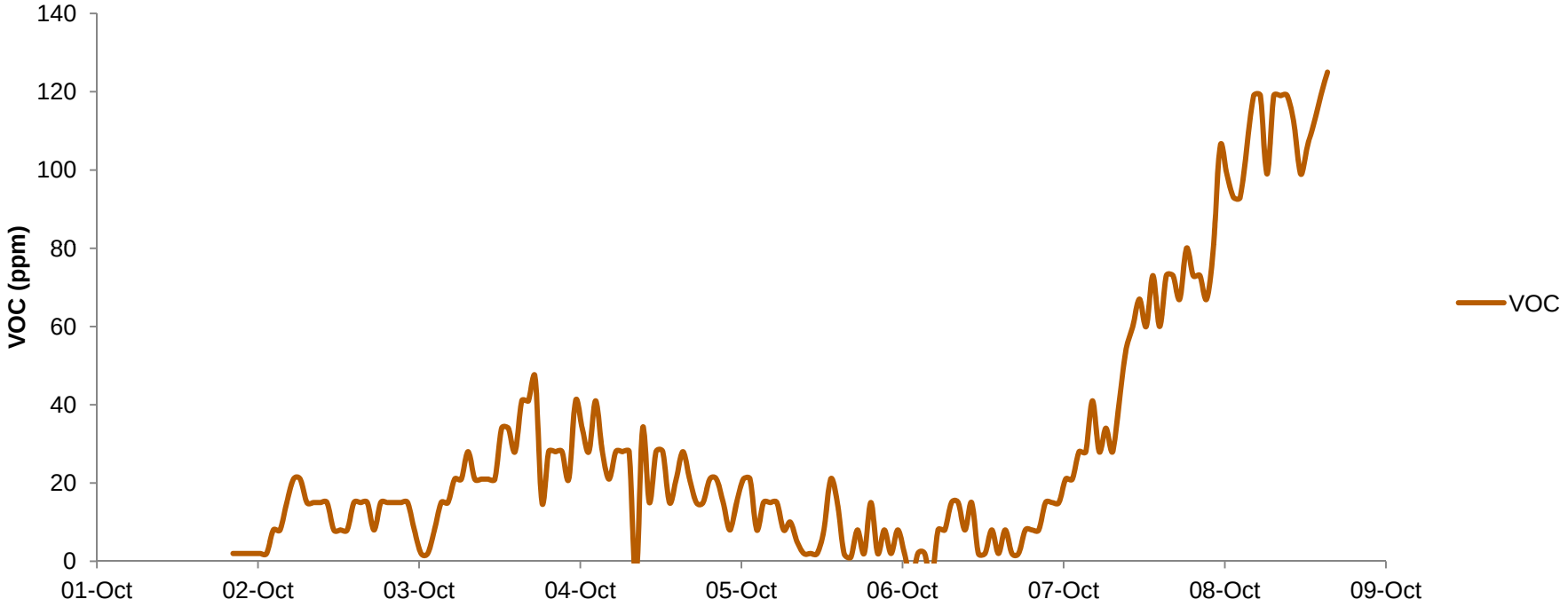
Variable VOC concentrations?



Continuous VOC data indicates concentrations are variable

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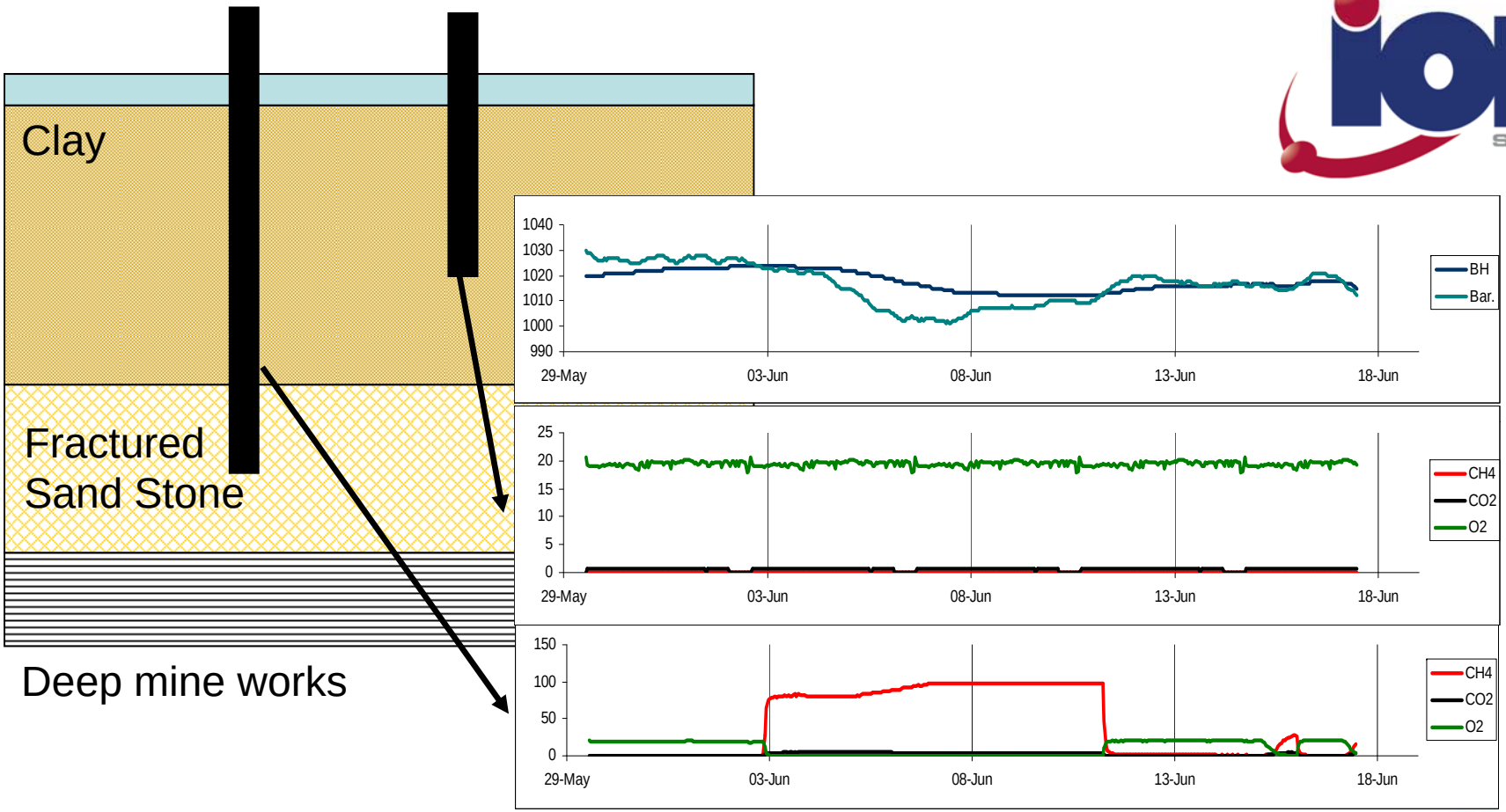
Processes controlling intrusion/migration

The principal controls on gas migration are:

- Differences in fluid pressure – **atmospheric pressure** and **water table** changes
- Change in **temperature**
- Ground **permeability** – vegetation, meteorology, development



Concentration increases when borehole pressure > **atmospheric pressure**

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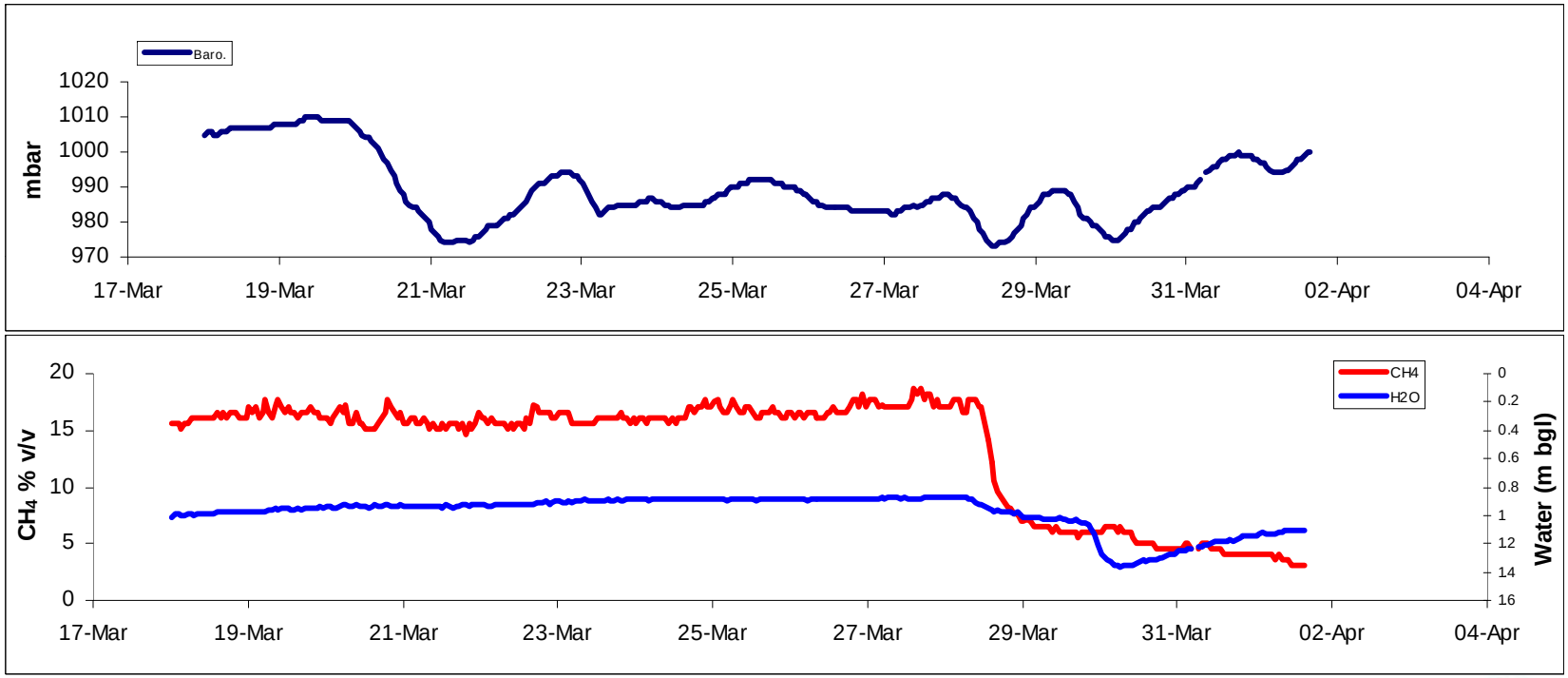
Water Table



Another environmental parameter required to explain observations: **water table**

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Temperature and Concentration

Bangor Gardens, Maine – Military Housing
UST leaking

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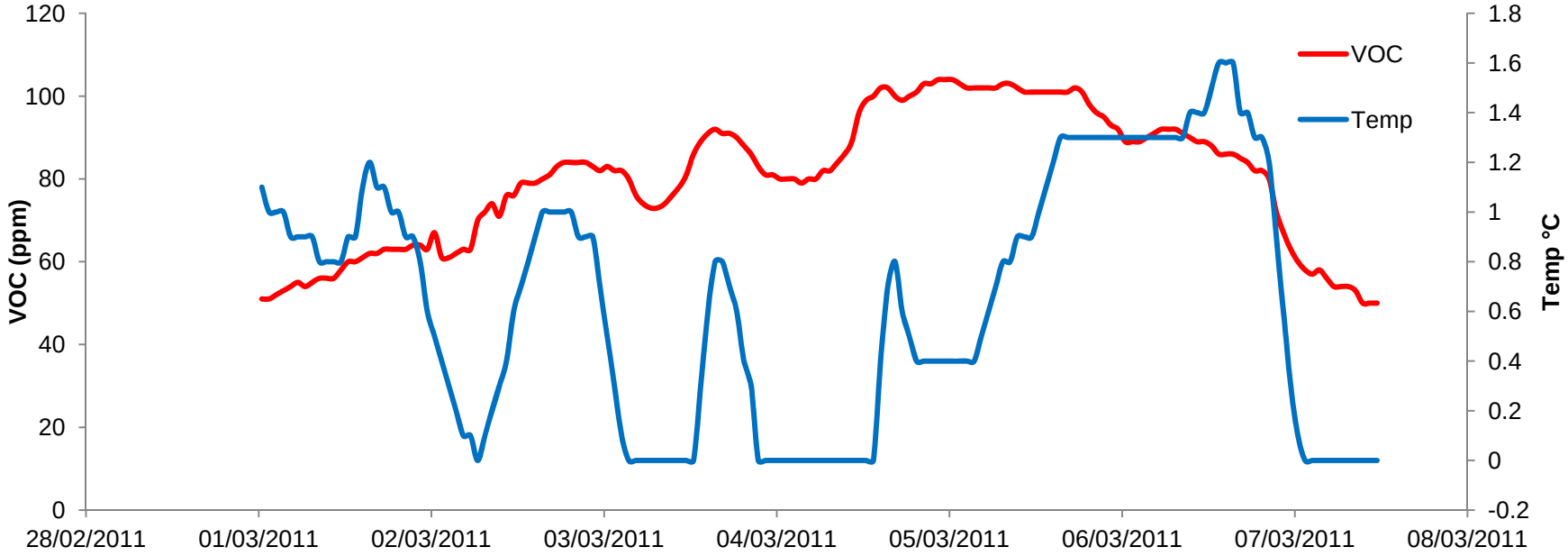
1°C change results in 35 ppm!



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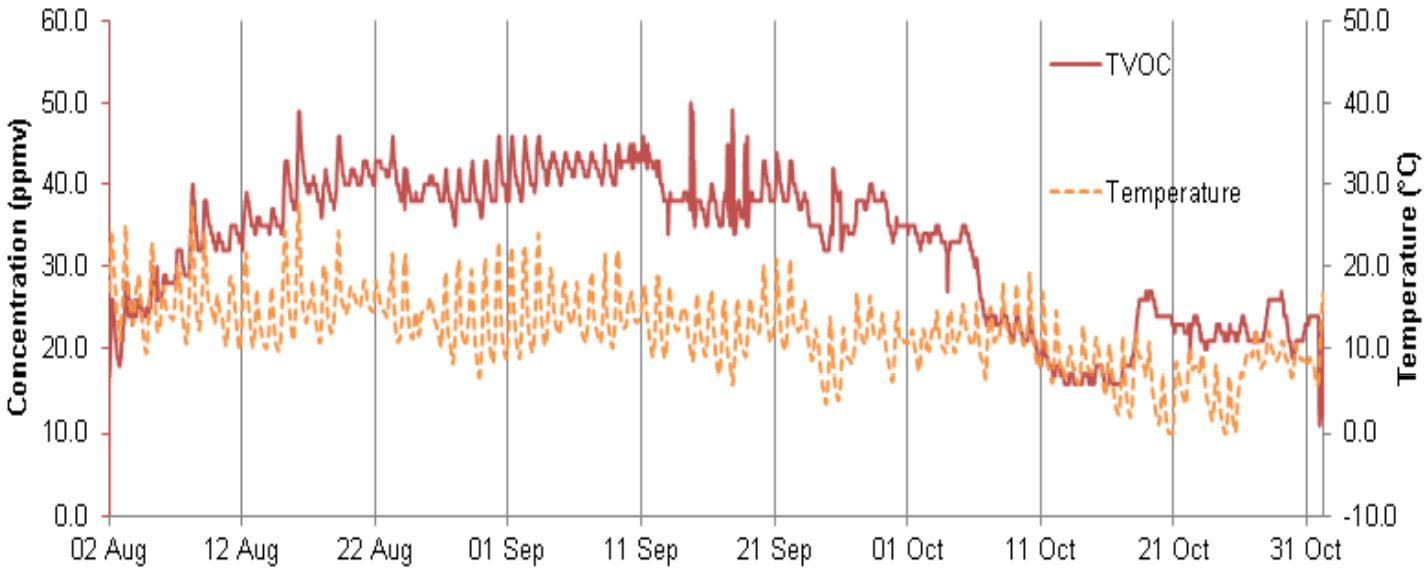
Temperature and Concentration



Vapor wells set below concrete subslab which is heating up during the day and cooling over night

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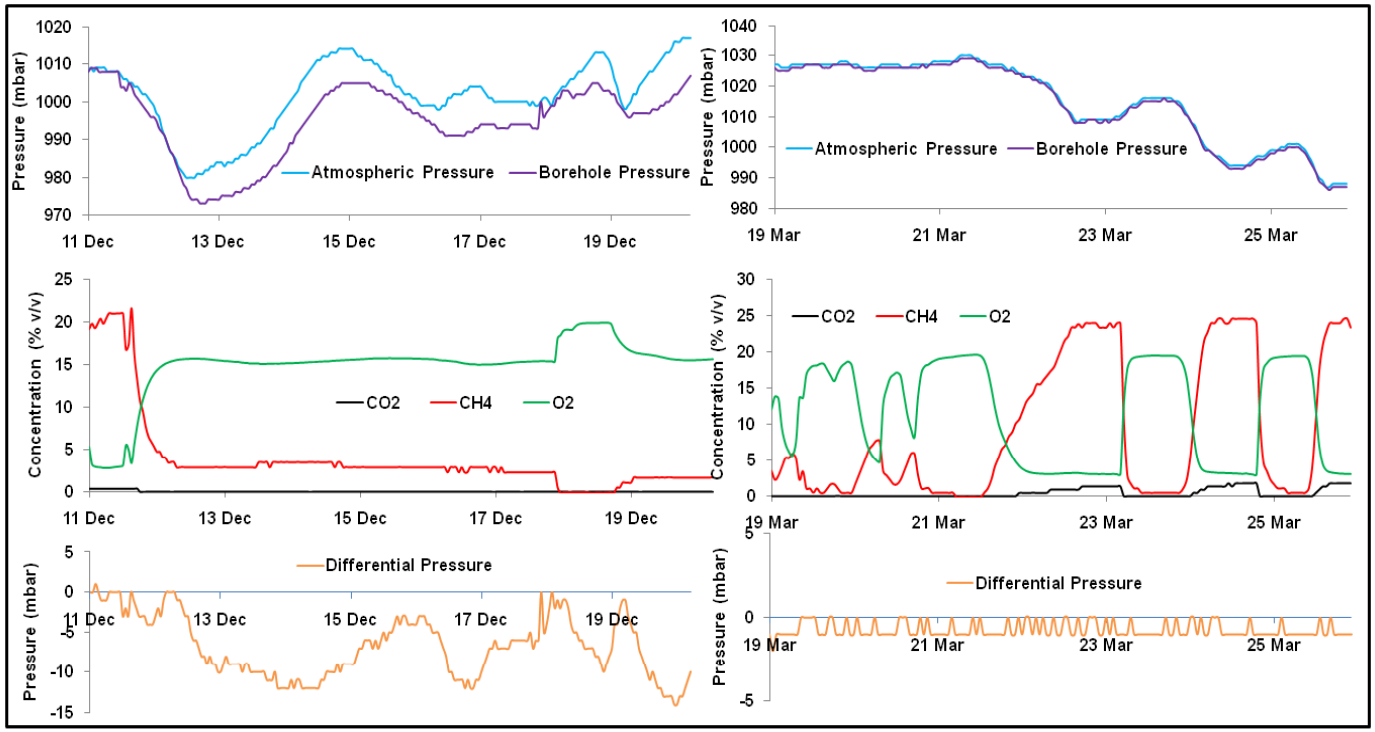
Changing permeability



Frozen ground preventing atmosphere driving gas migration prior to thawing

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Field Data from Contaminated Sites

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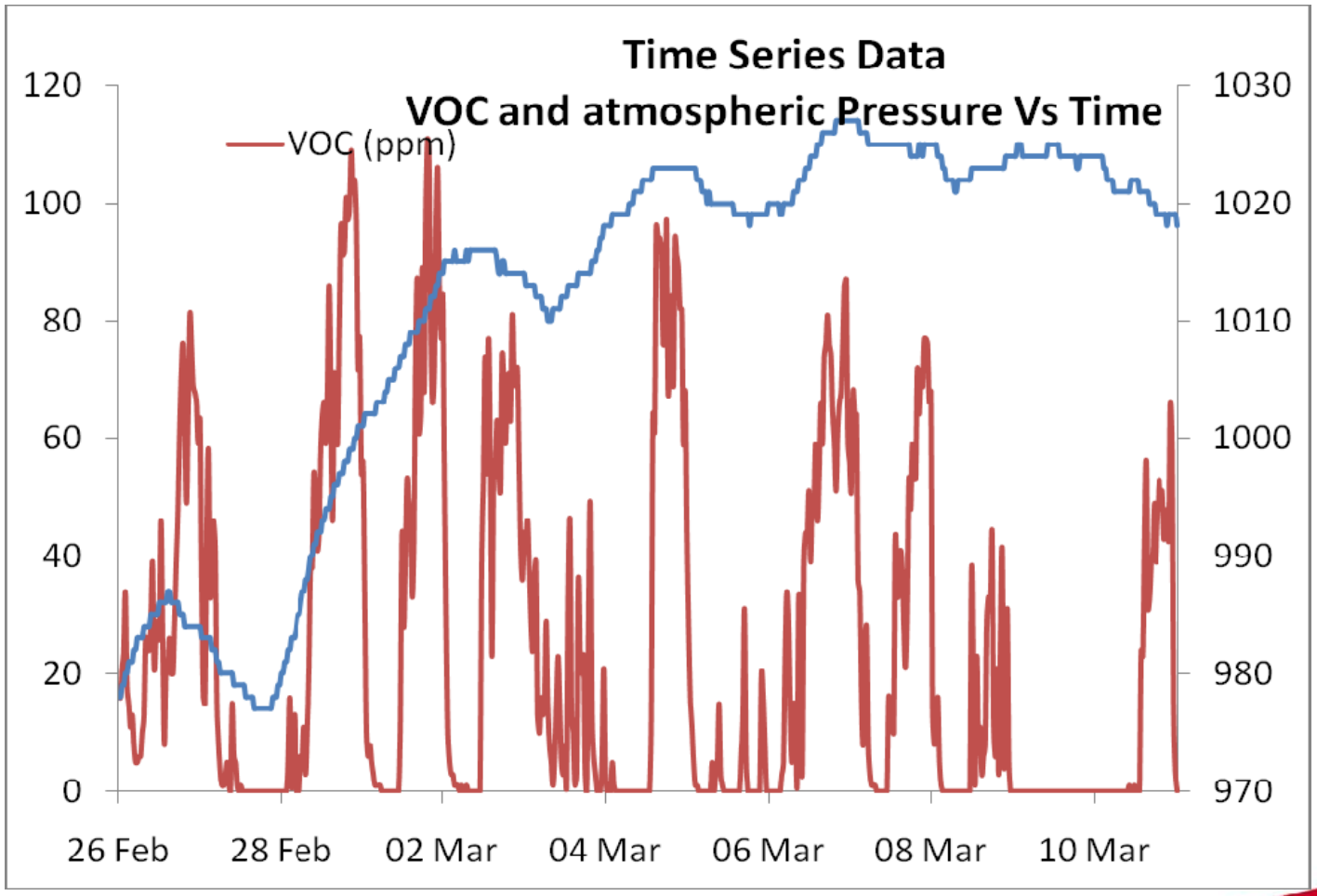
PVI, UK site 2 week study



ground - gas solutions limited

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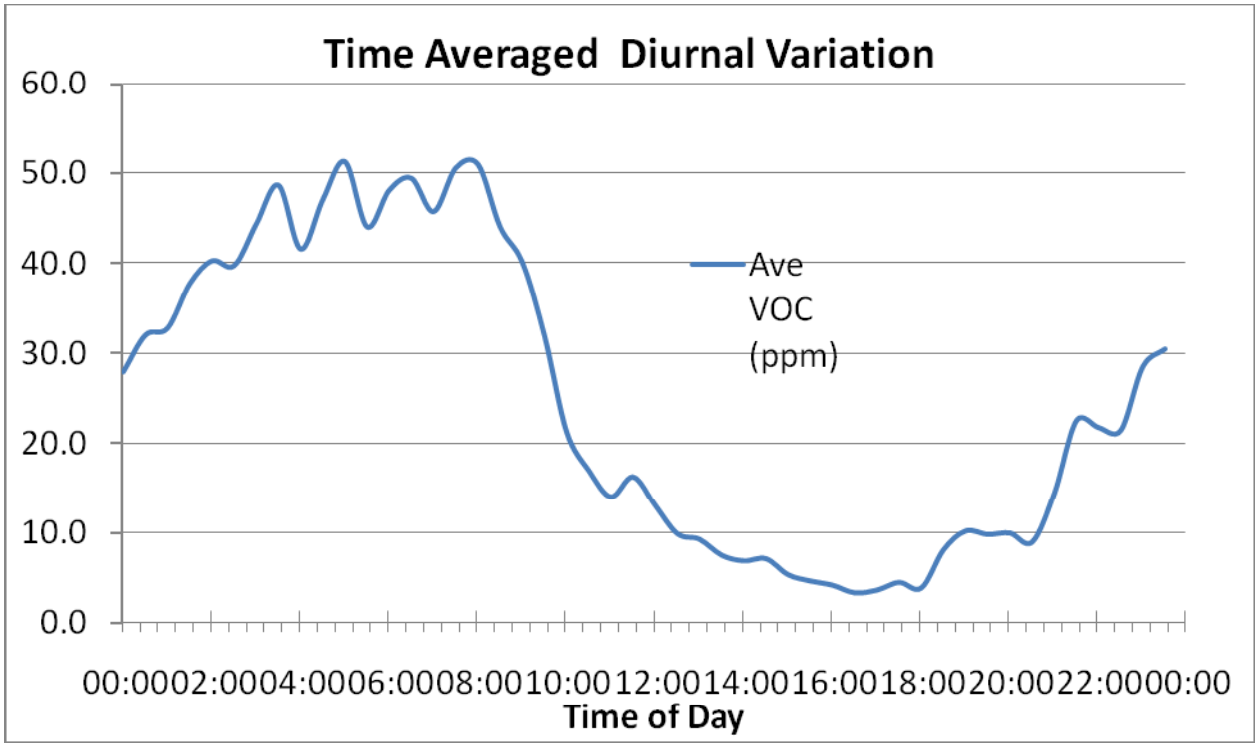
PVI, UK site 24 hour study



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ground - gas solutions limited

In Basement Monitoring

View of Ion Science GasClam installed near entrance door to cellar.

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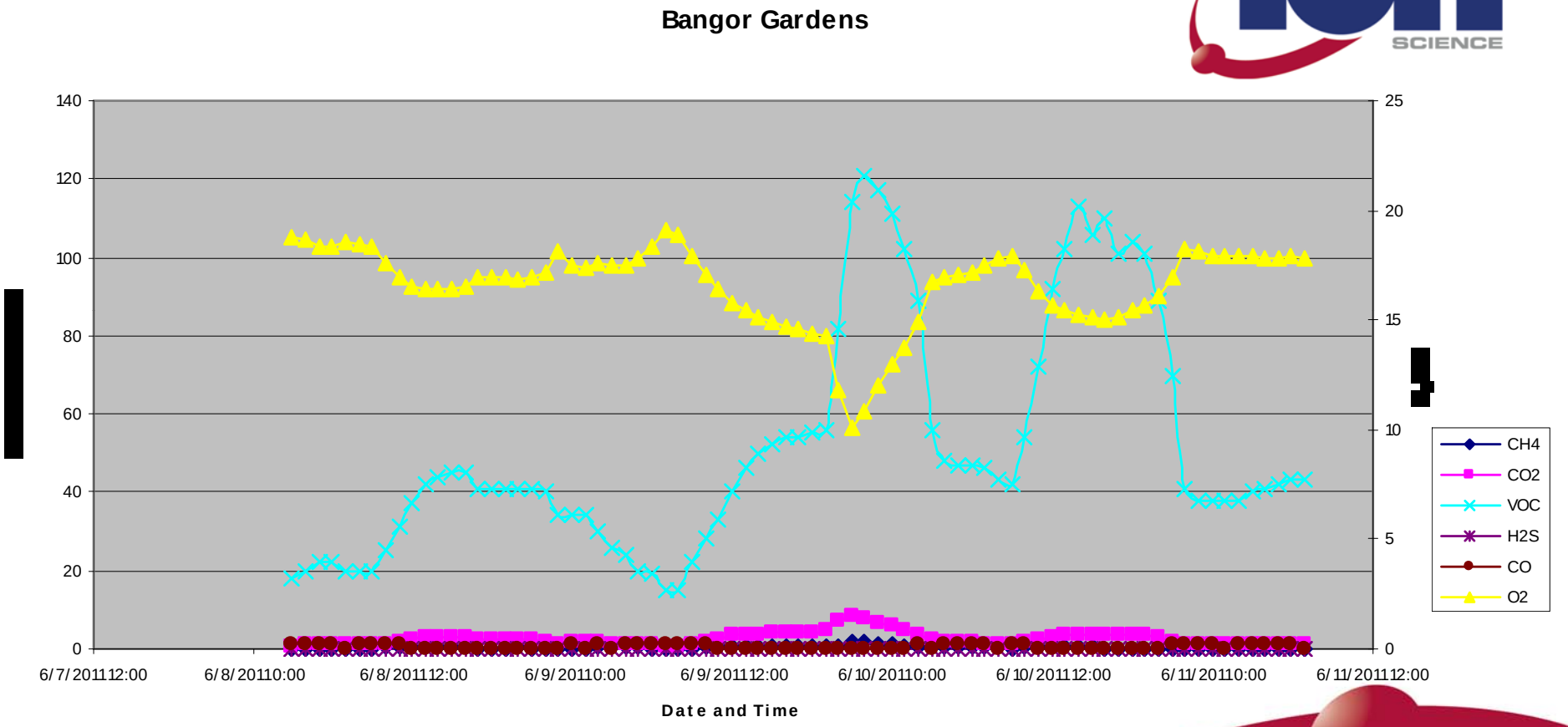
Pre-Remediation



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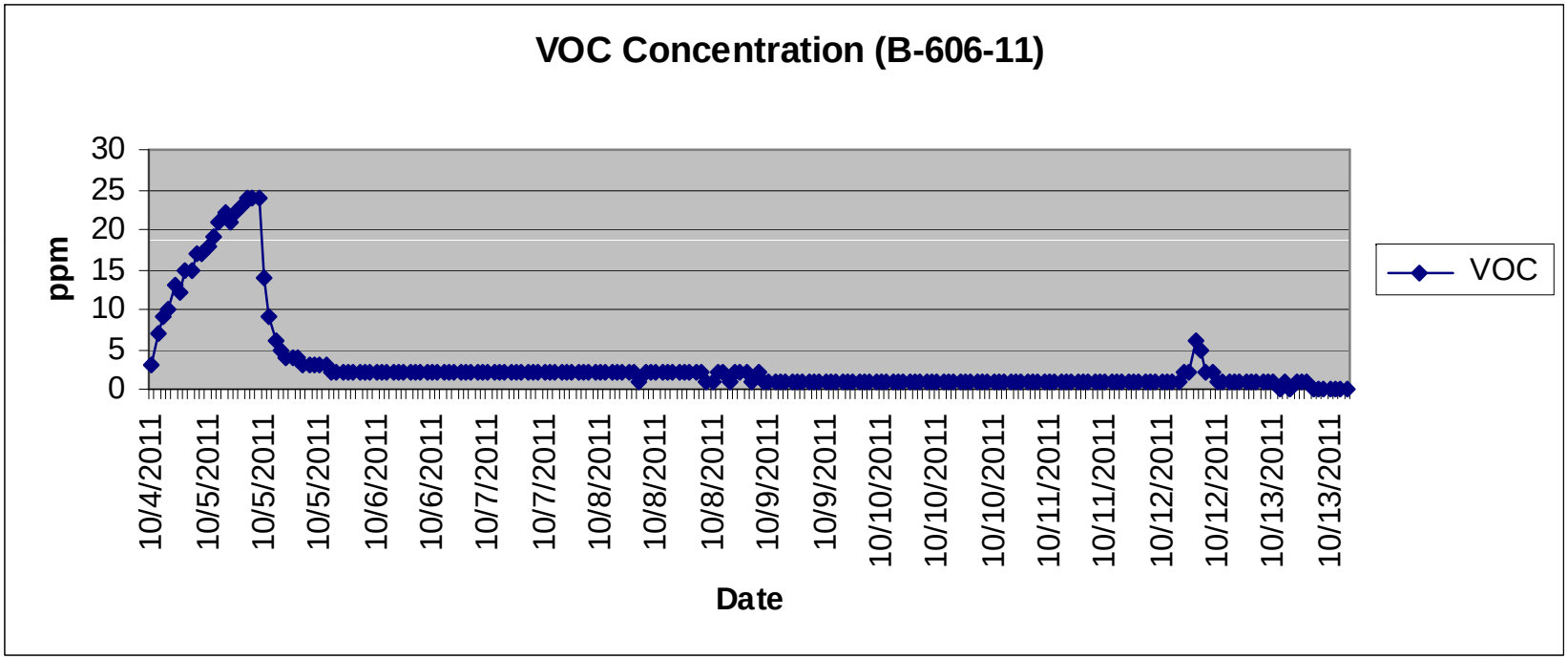
Post Remediation



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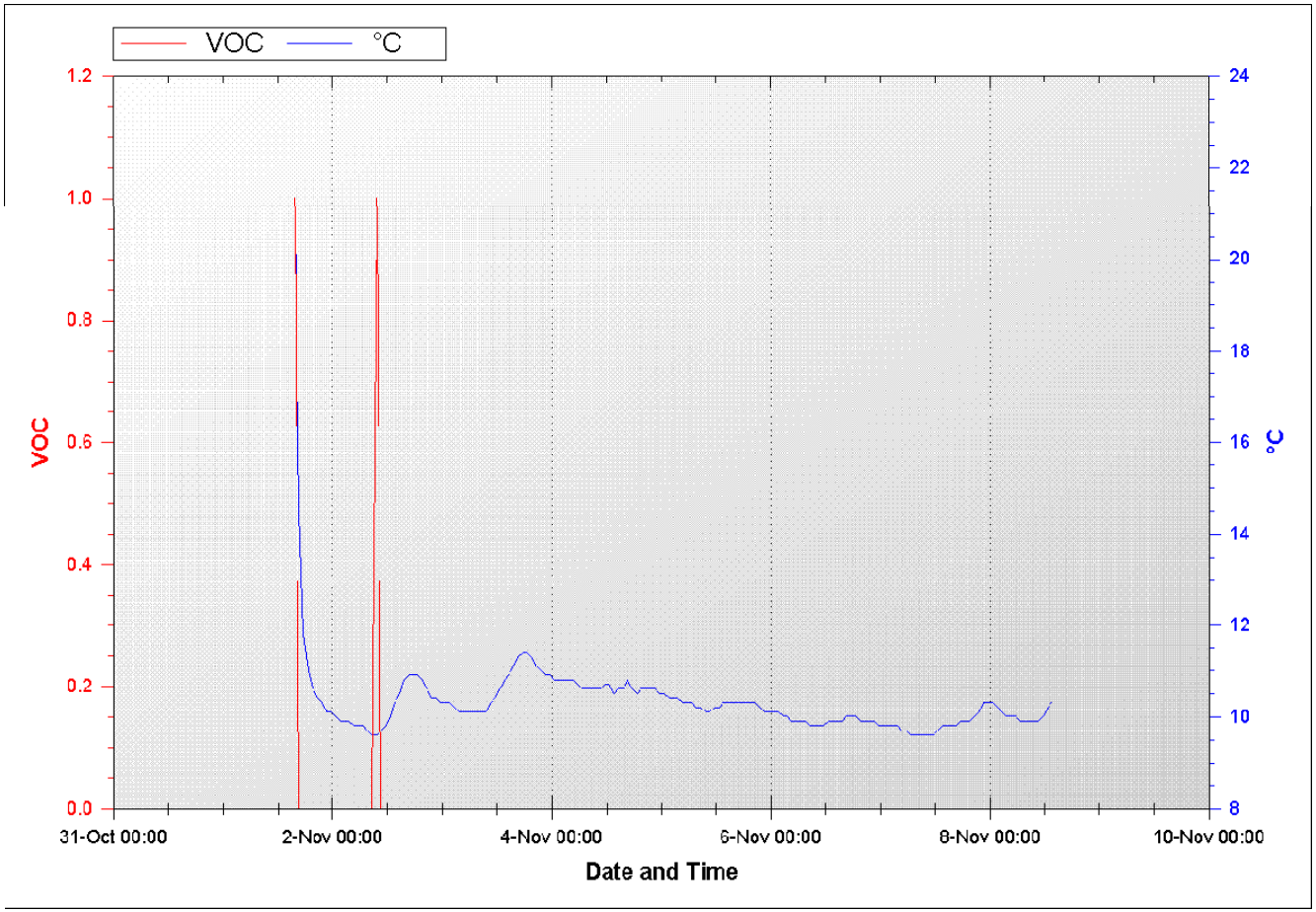
Waterbury, Vermont

- GasClam with TVOC used by Vermont DEC after Tropical Storm Irene
- Many homes suffered fuel oil leaks as basements were flooded and tanks leaked
- Sites have been remediated and GasClam data was used to look for rebound before confirming site closure

Vermont #1: VOC vs Temp



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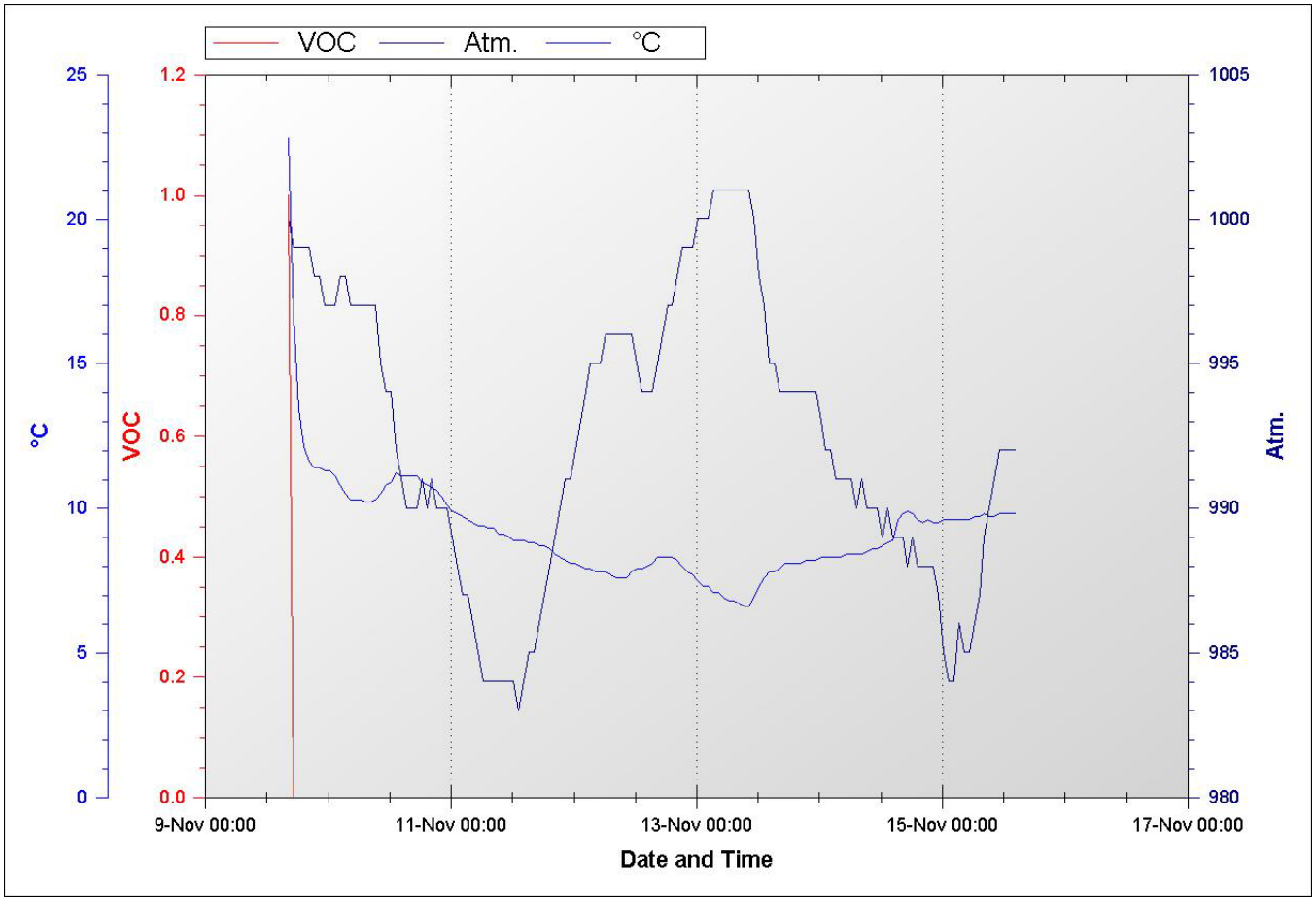
Vermont #2: VOC vs Temp & BP



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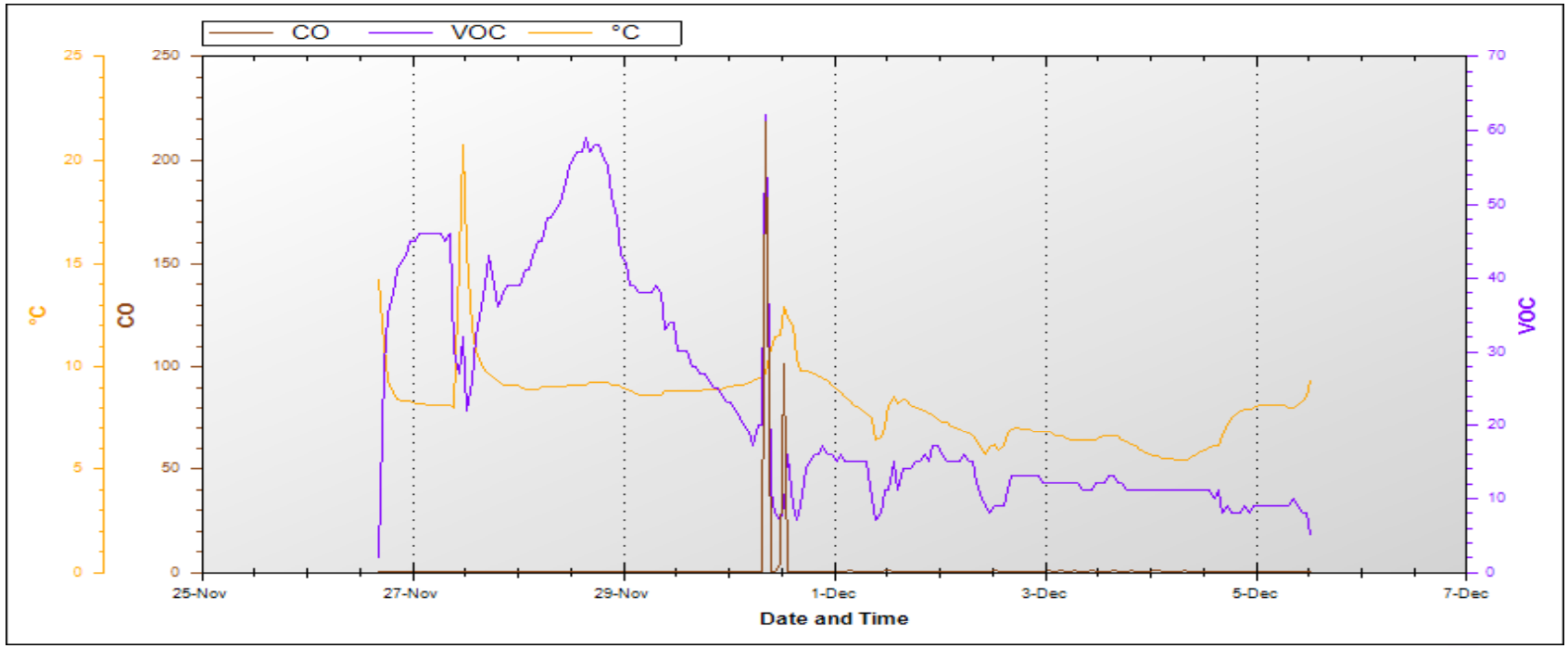
Waterbury, Vermont

- GasClam with TVOC used by Vermont DEC after Tropical Storm Irene
- Sites have been remediated and GasClam data confirmed site closure decisions, no rebound

Old Town, Maine

- GasClam with TVOC is being used by Maine DEP
- Spill occurred on 11/24/11
- Approximately 100 gallons of fuel oil leaked out of an AST in basement of house.
- Approximately 45 gallons of oil were recovered that day

Maine #1: During Remediation



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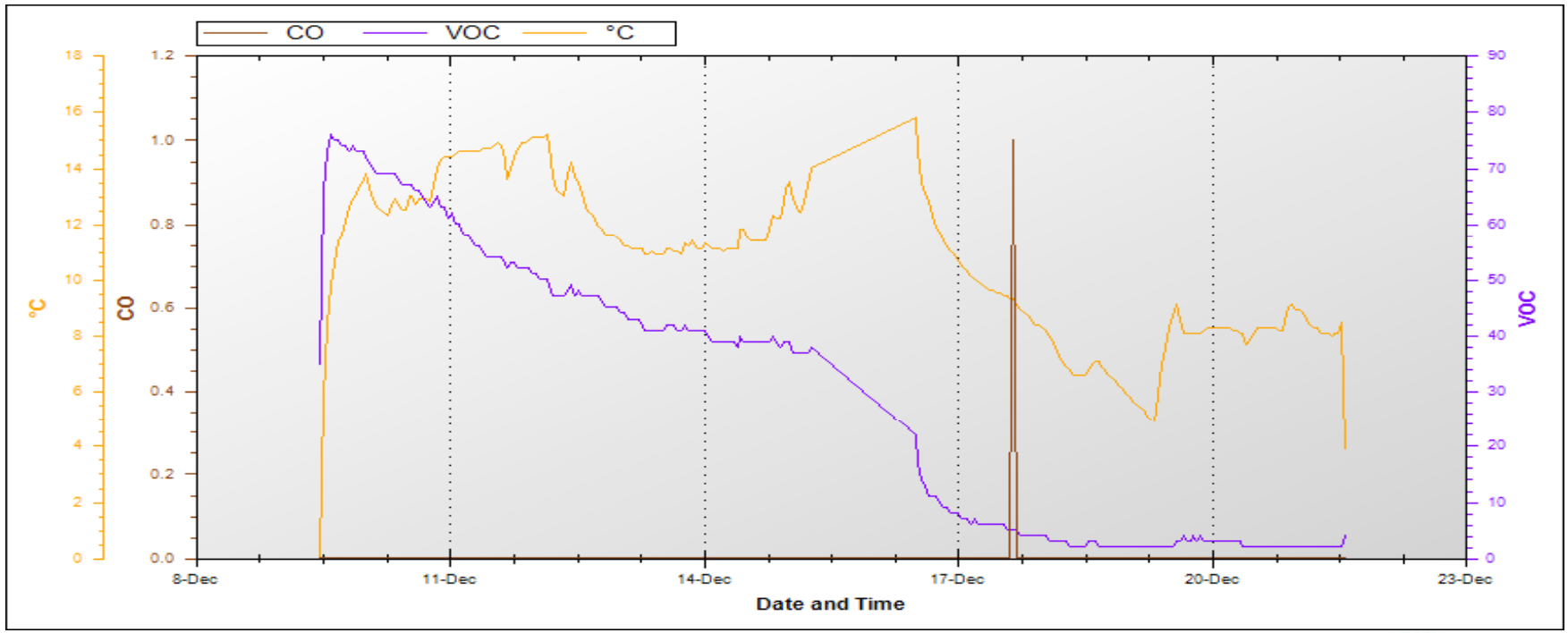
Old Town, Maine

- The two spikes for CO were due to a gas powered concrete cutting machine used to cut the concrete floor for removal

Old Town, Maine

- Additional oil was recovered after a part of the concrete floor was removed and contaminated soil removed
- A sub slab vent was installed prior to pouring the new concrete
- Concrete was poured
- Except for the newly poured concrete the rest of the concrete floor was painted (sealed) with epoxy paint towards the end of the second data set

Maine #2: Post Remediation



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- Data courtesy of Matt Moran, Vermont DEC and Thomas Smith of Maine DEP

- Both Vermont and Maine have invested in GasClam.

CL:AIRE

RB 13
(February 2011)

research bulletin

CL:AIRE research bulletins describe specific, practical aspects of research which have direct application to the characterisation, monitoring or remediation of contaminated soil or groundwater. This bulletin describes how continuous monitoring, rather than a periodic measurement approach, can reduce uncertainty in ground-gas risk assessment.

The Utility of Continuous Monitoring in Detection and Prediction of "Worst Case" Ground-Gas Concentration

Future

- Compound Specific Analysis
- Concentrator for sub ppb
- Beta testing right now

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Much more info at:

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Questions?

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