Convective Flow Monitoring and the Influence of Cover Material

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BC MEND ARD/ML WORKSHOP

Soil, Geomembrane and Non-Traditional Dry Covers

Vancouver, B.C.

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Teck

O'Kane Consultants
Integrated Geotechnical Engineering Services
Specialists in Unsaturated Zone Hydrology

SRK Consulting
Engineers and Scientists

Technical Panel

- Technical Panel formed to investigate the incident and generate lessons for industry

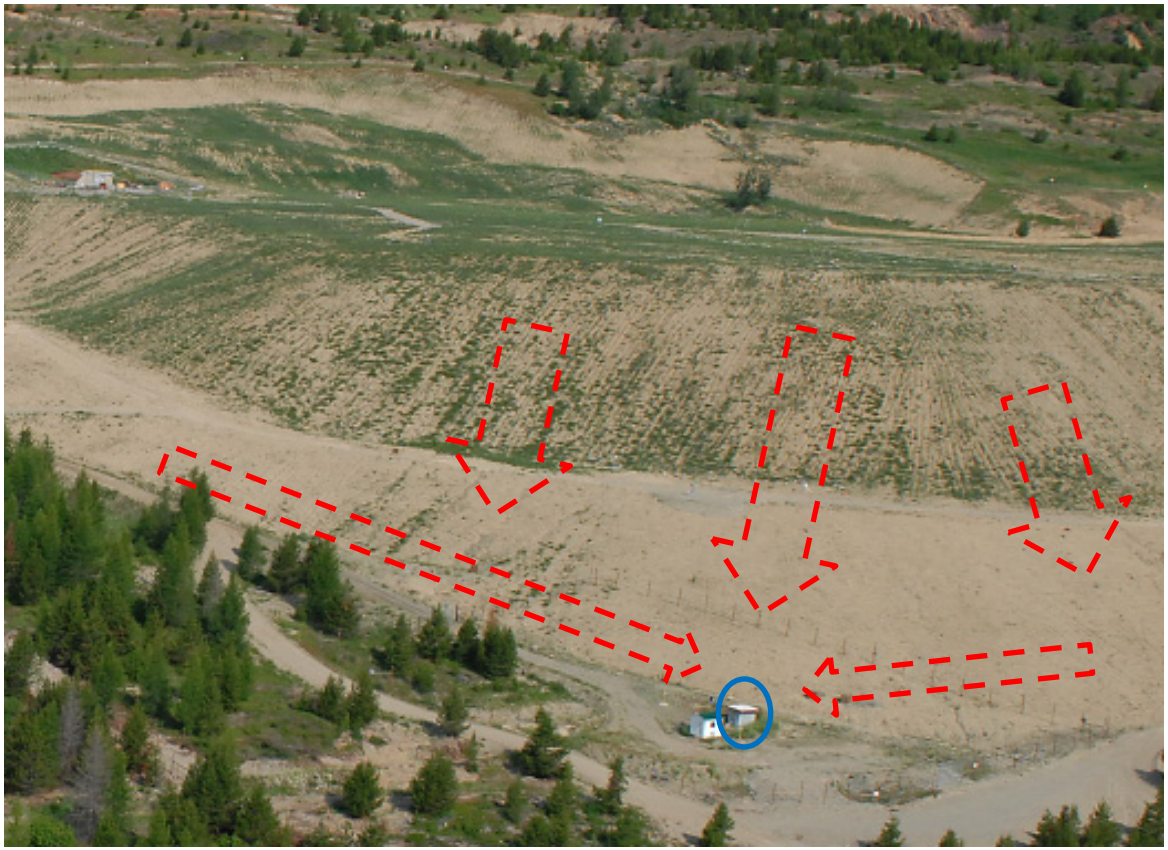
- Kim Bellefontaine
- Ricci Berdusco
- Bruce Dawson
- Daryl Hockley
- Al Hoffman
- Diane Howe
- Walter Kuit
- Dr. John Meech
- Mike O'Kane
- Clem Pelletier
- Mark Phillip
- Andy Robertson
- Dr. Ward Wilson

MEMPR and Consultant Teck and Consultants U.B.C. Independent

Presentation Outline

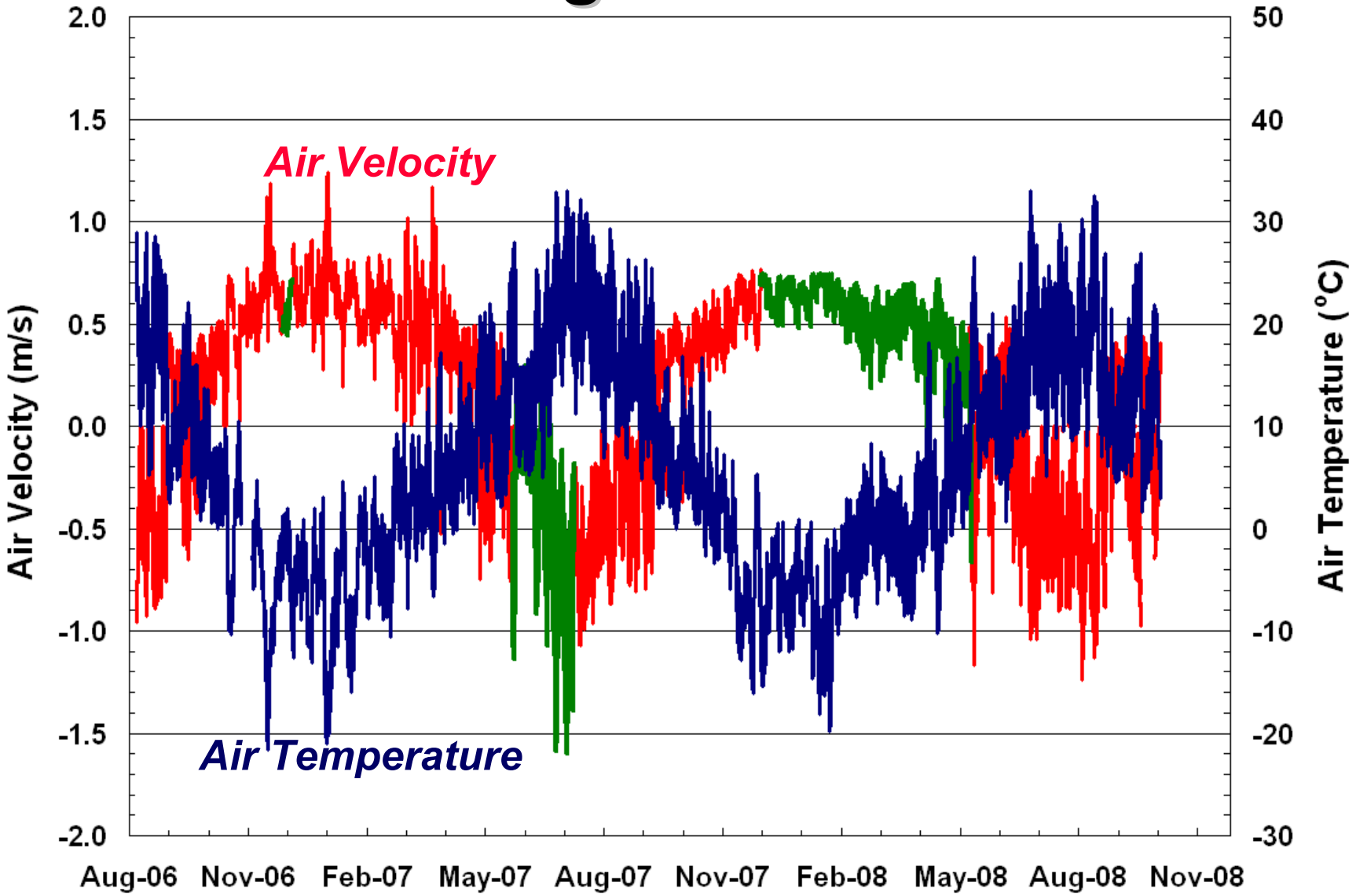
- *Project Background*
- *Gas Trap and Convective Flux Measurements*
- *Premature Snowmelt Area Characterization*
- *Convective Flux and Gas Composition Changes*
- *Conclusions*

Sullivan Mine Incident

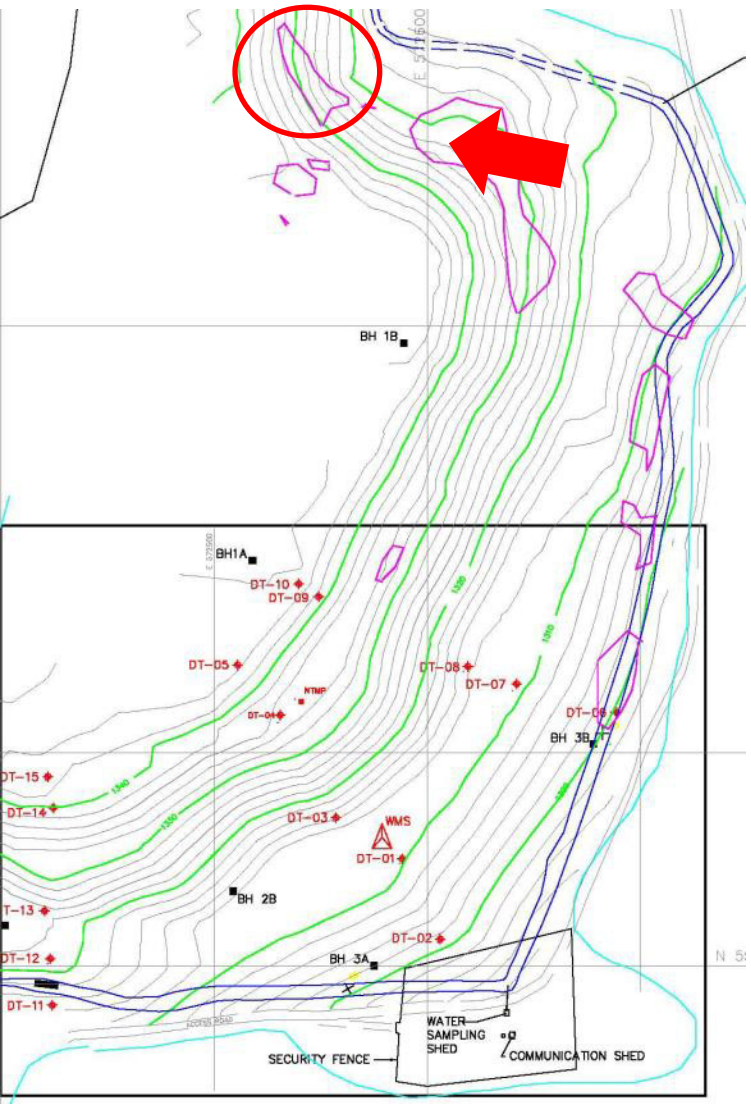


http://www.mediaroom.gov.bc.ca/sullivan_mine/sullivan_mine.htm

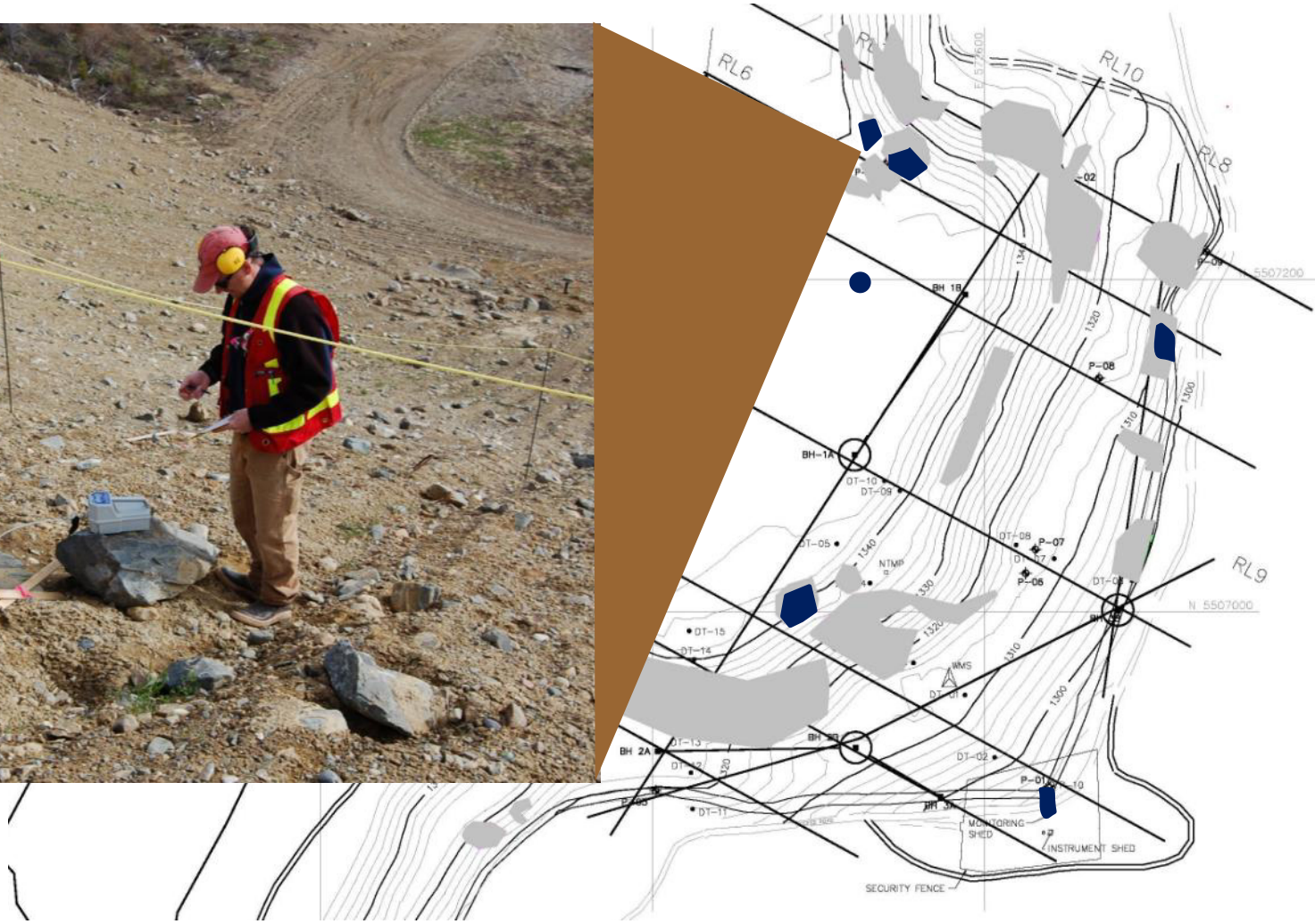
Monitoring Station Air Flow



Premature Snowmelt Areas (PSAs)



PSAs and Vents



Premature Snowmelt Area

Pore Gas Vents

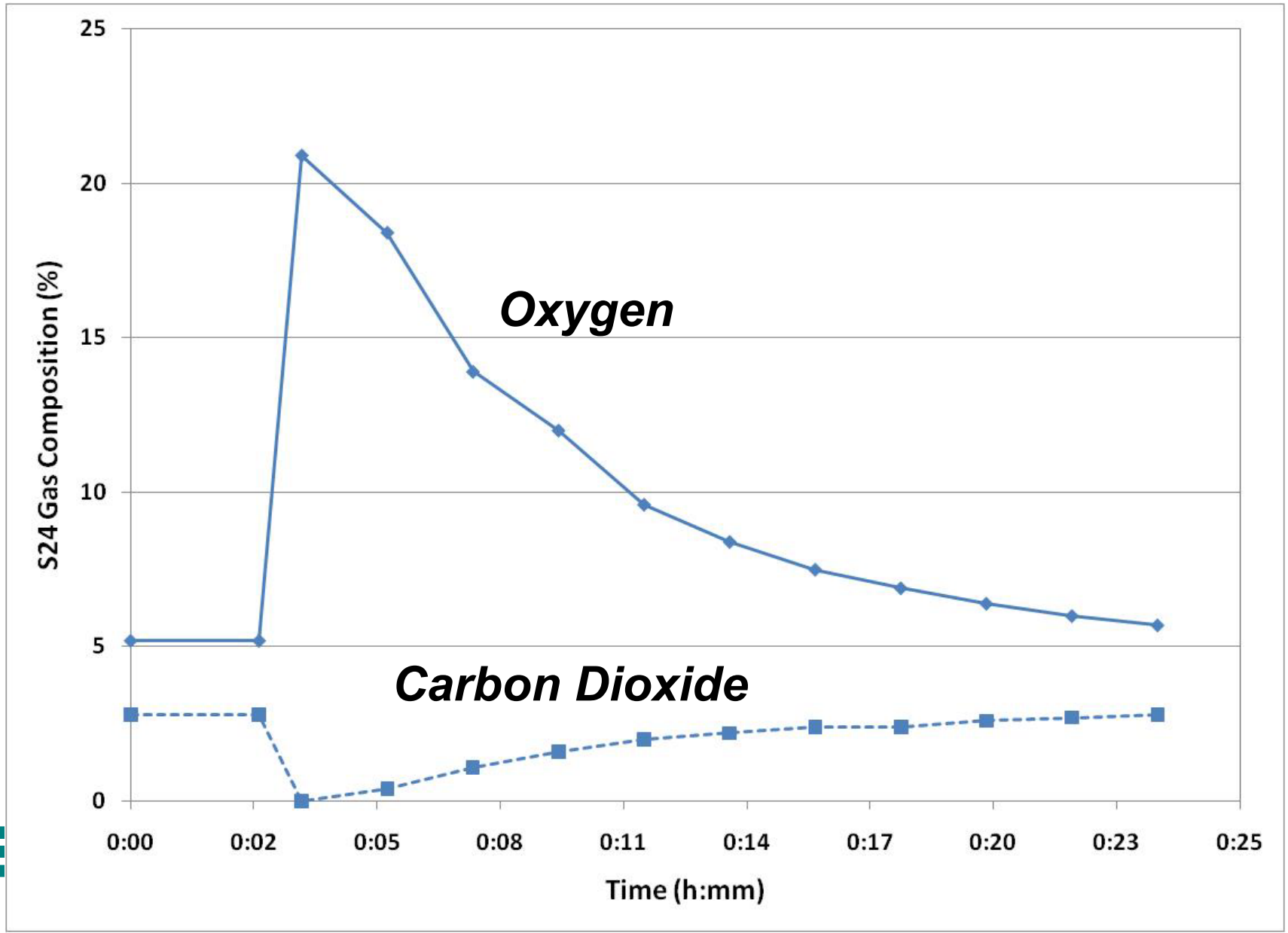
Surface Pore Gas Vent Survey

- ***Understand magnitude of pore gas venting***
- ***Gas Traps placed on surface of dumps***
  - *Jan 2009 (18 – North, South & No. 1 Dumps)*
  - *Feb 2009 (20 – No. 1 Dump)*
  - *April 2009 (20 – No. 1 Dump)*
- ***4 Gas Trap Classes***
  - *Control*
  - *Normal*
  - *Biased*
  - *Uber-biased*

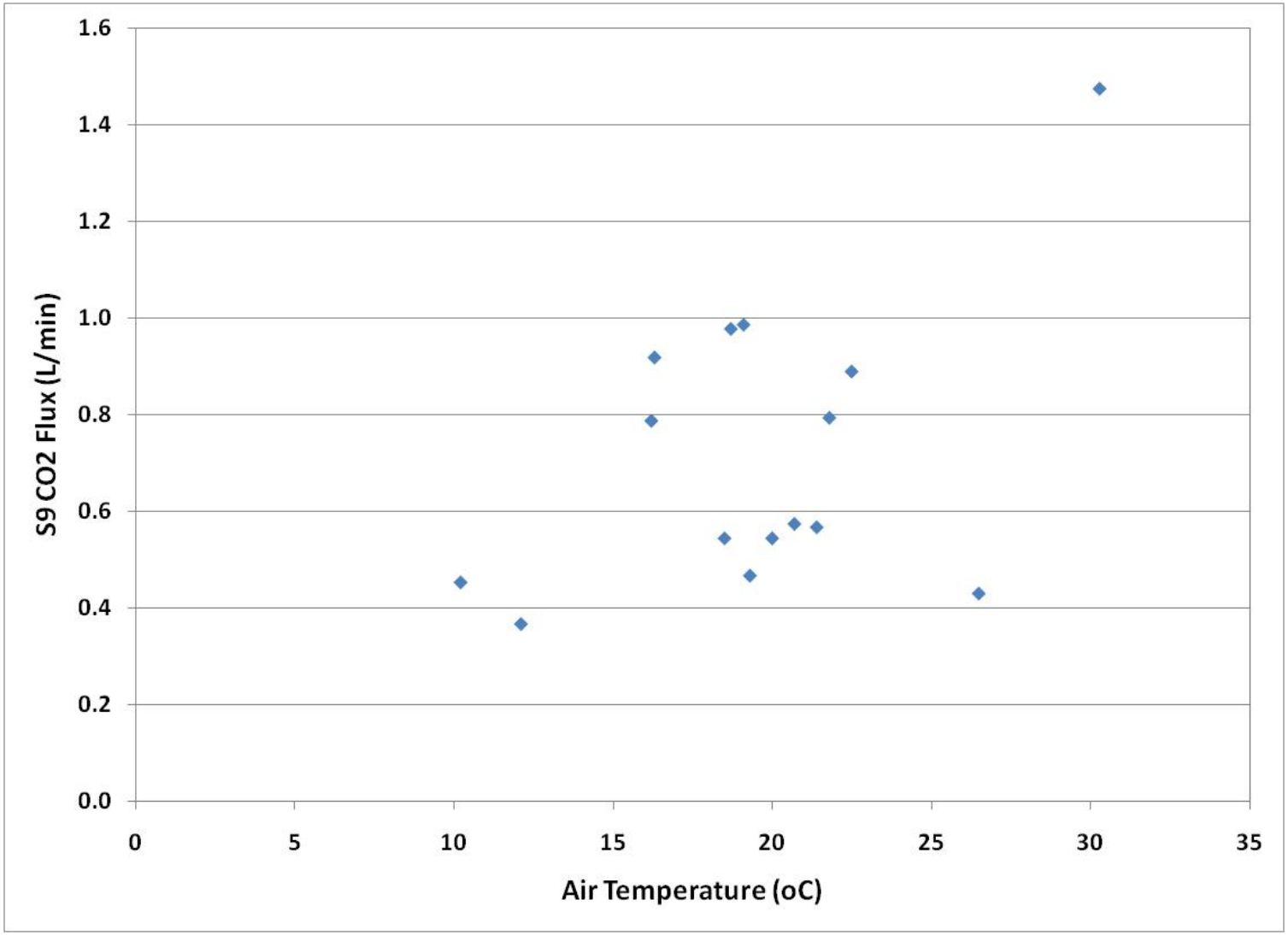
Gas Trap Assumptions & Design

- Gas trap acts as a Continuously Stirred Tank Reactor.
- The initial gas composition measured is the composition of the pore gas entering the gas trap over the test period.

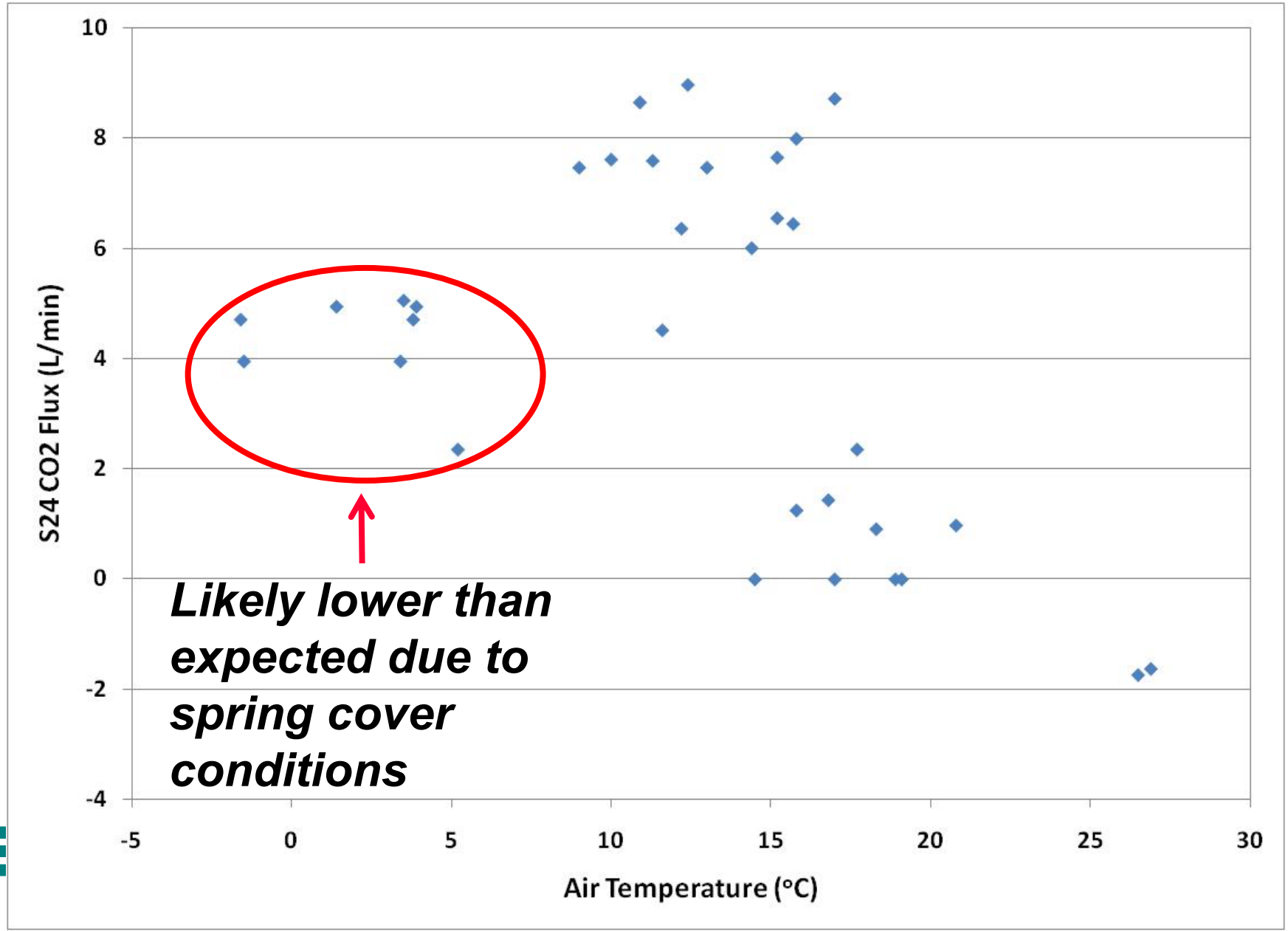
Gas Flux Test Results



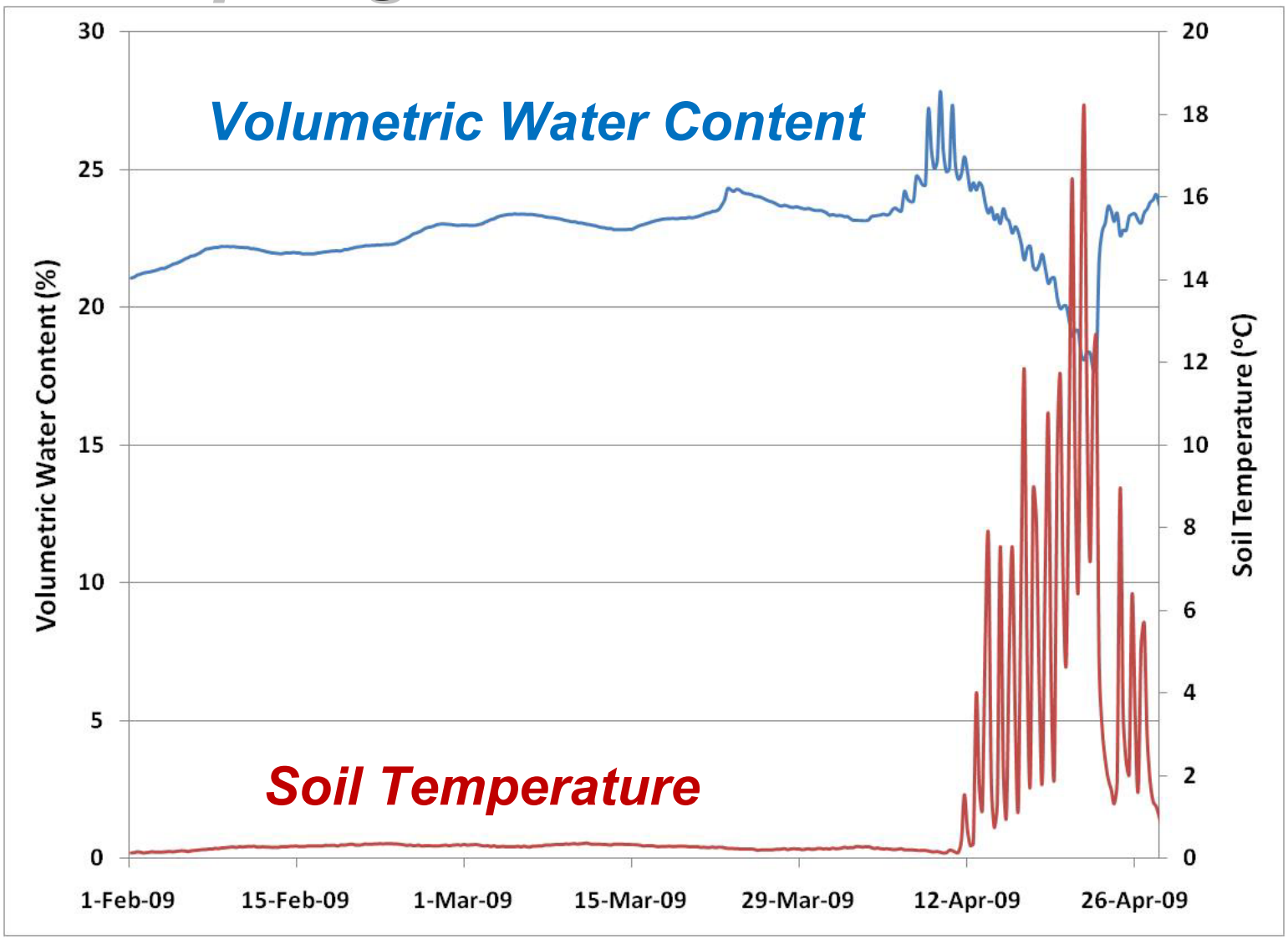
Flux Results at Toe



Flux at Crest

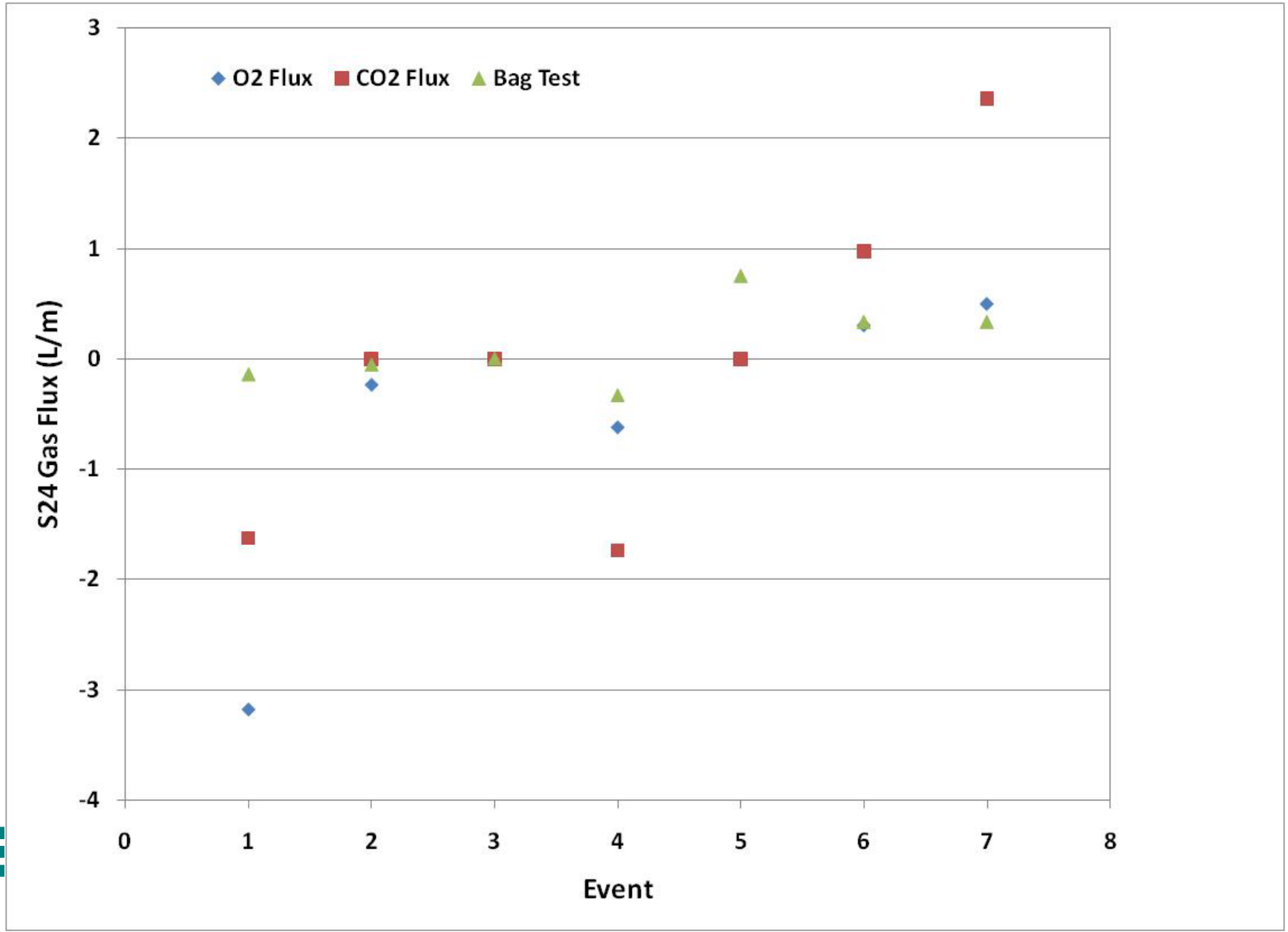


Spring Cover Conditions – 5 cm



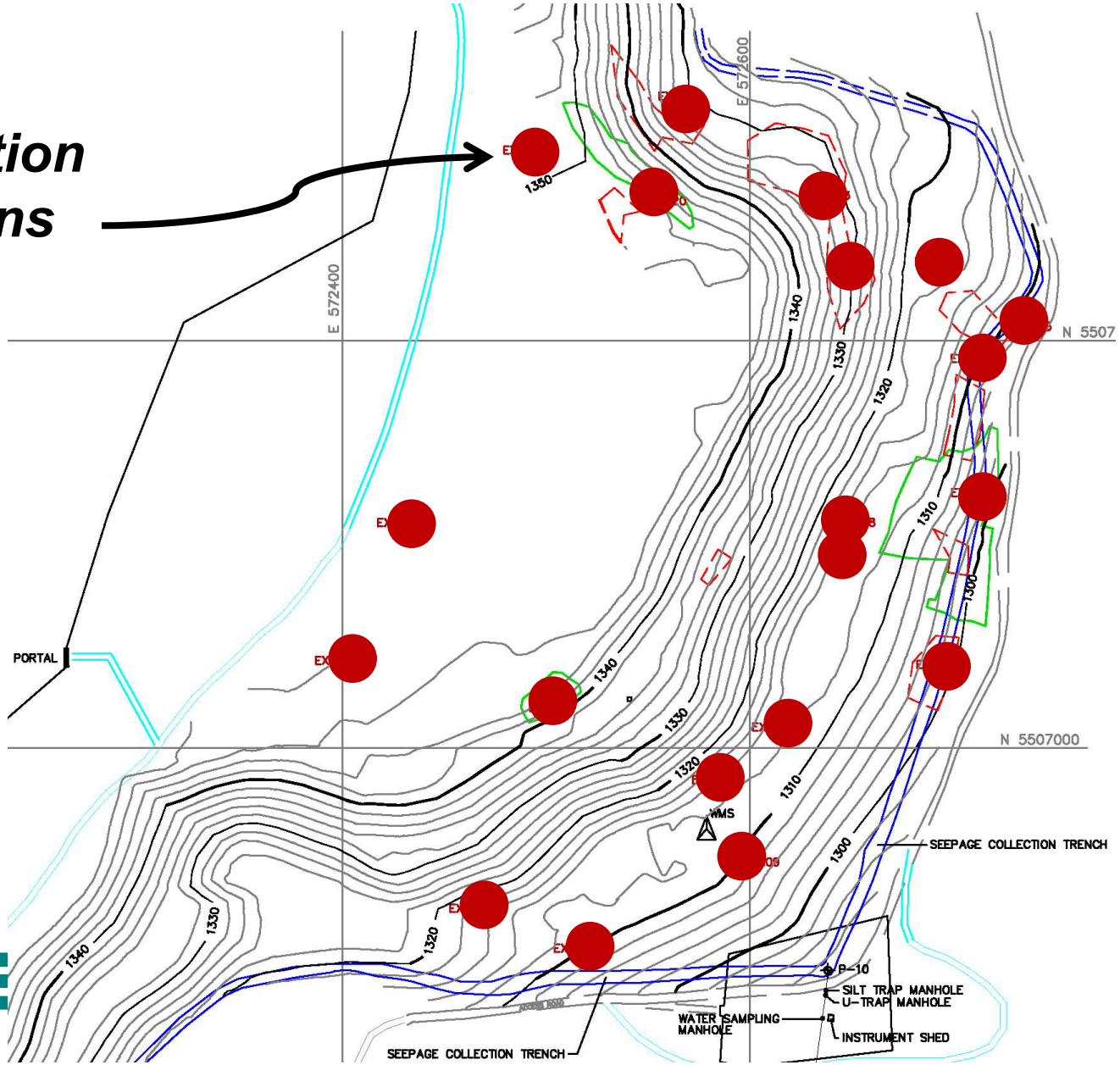
Gas Flux Bag Tests

CSTR vs. Bag Test Flux Results



PSA Characterization

Excavation Locations

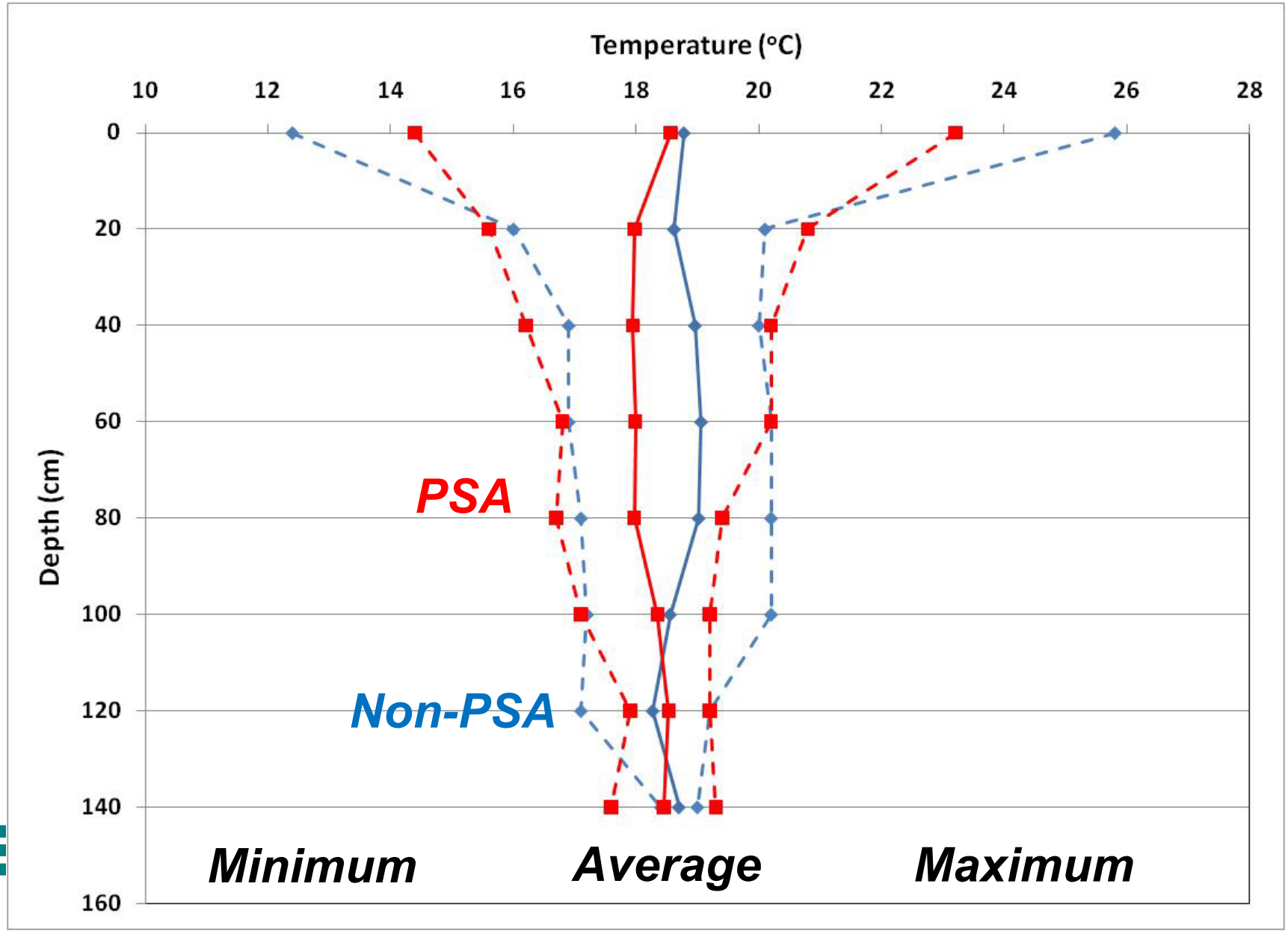


PSA Characterization Effort

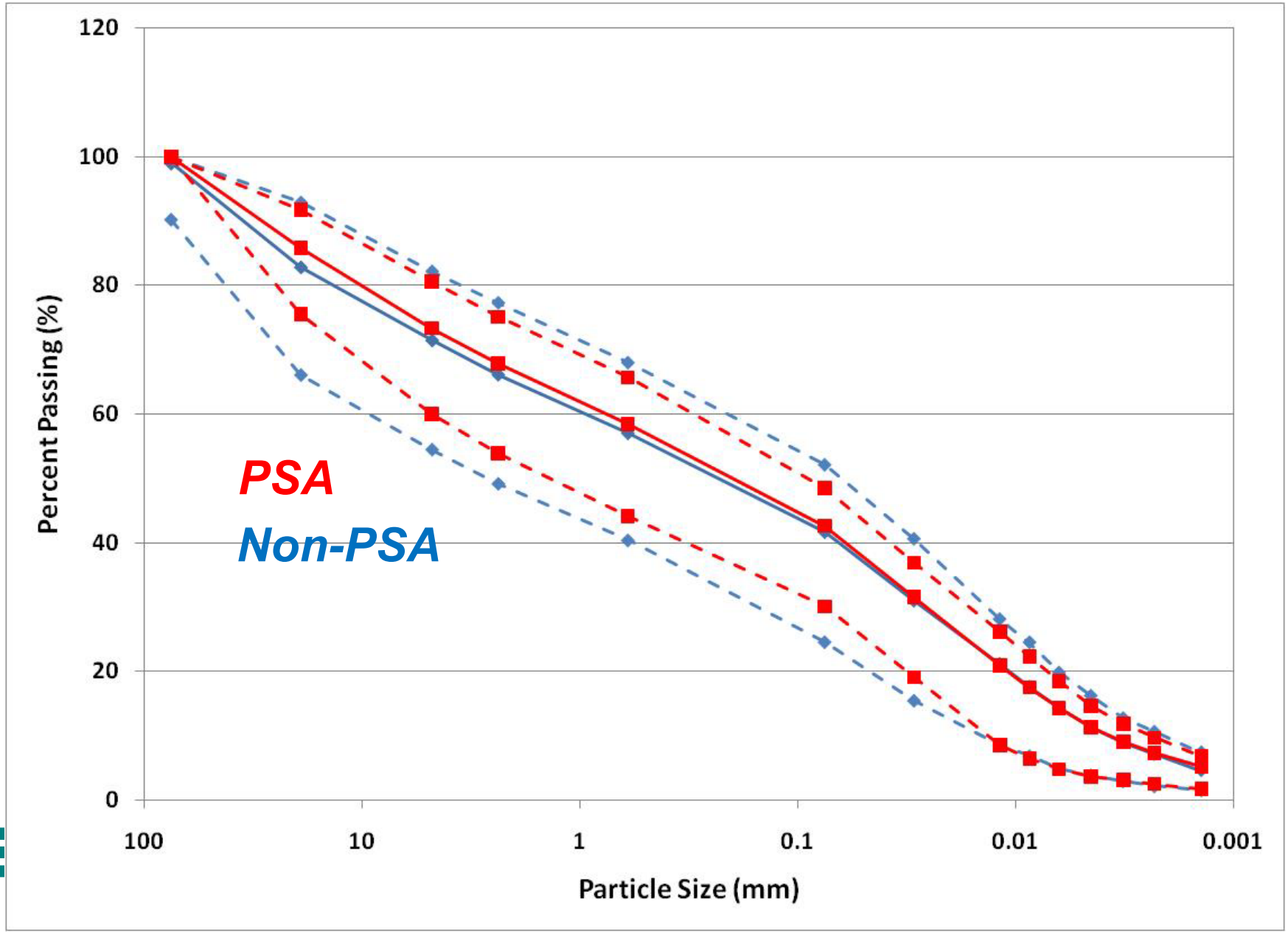
- Excavations to waste rock

- Temperature
- Moisture Content
- PSD
- Density
- Thickness

Soil Temperature



Particle Size Distribution

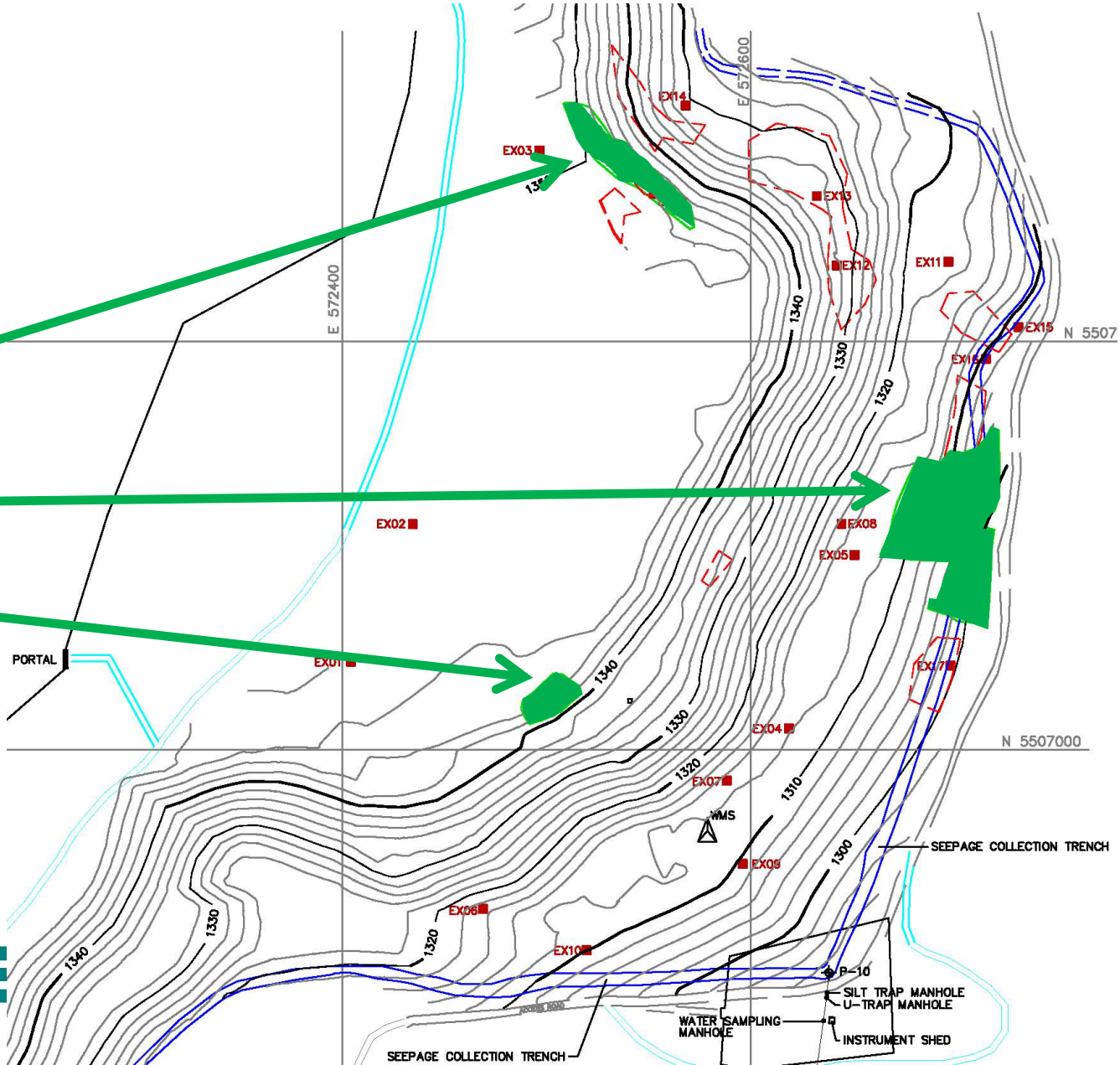


Moisture

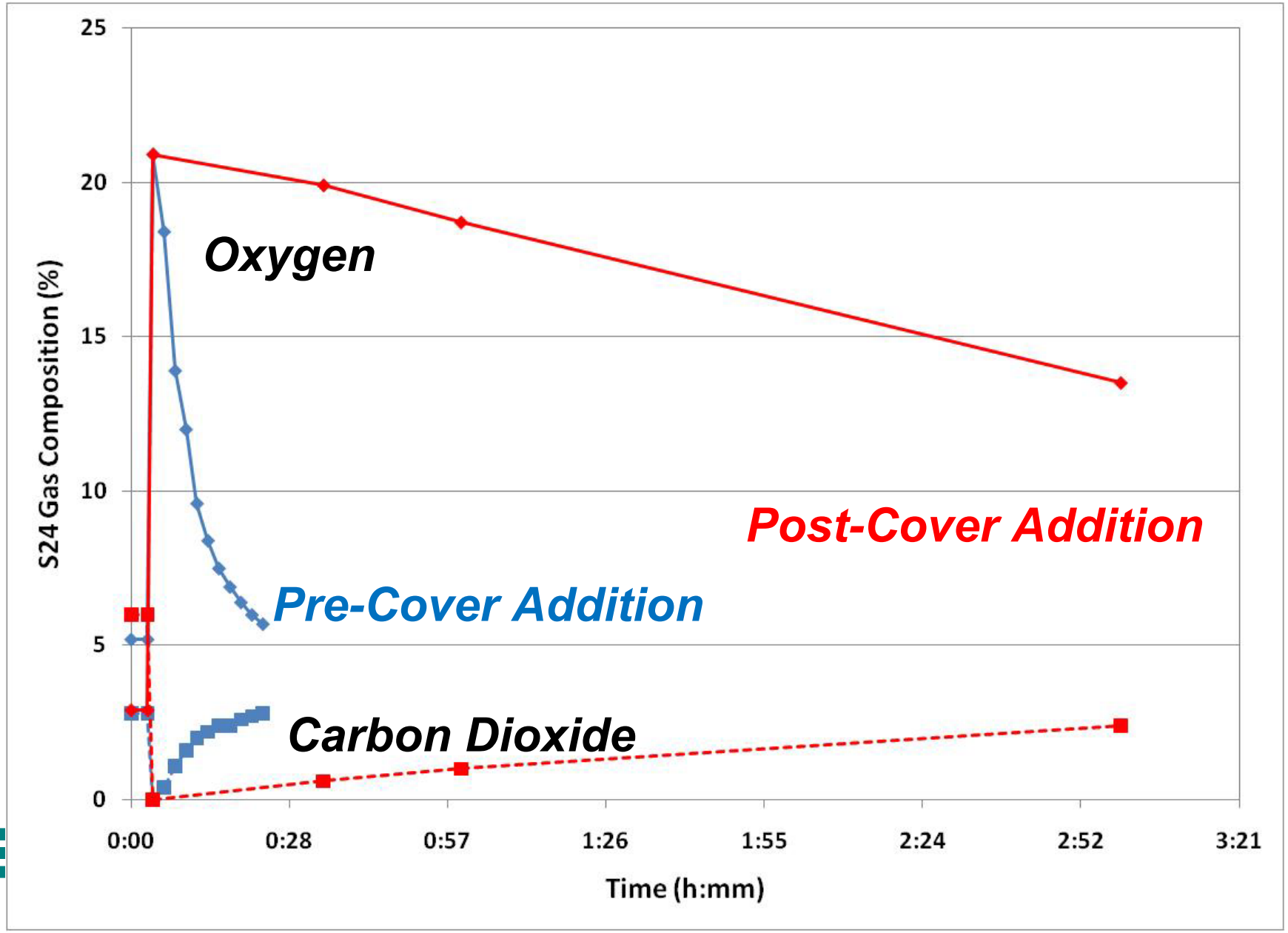
- Little difference in moisture content between PSA and non-PSA
- Difference existed between locations on a flat surface (greater moisture content) and those on a slope

Cover Thickness

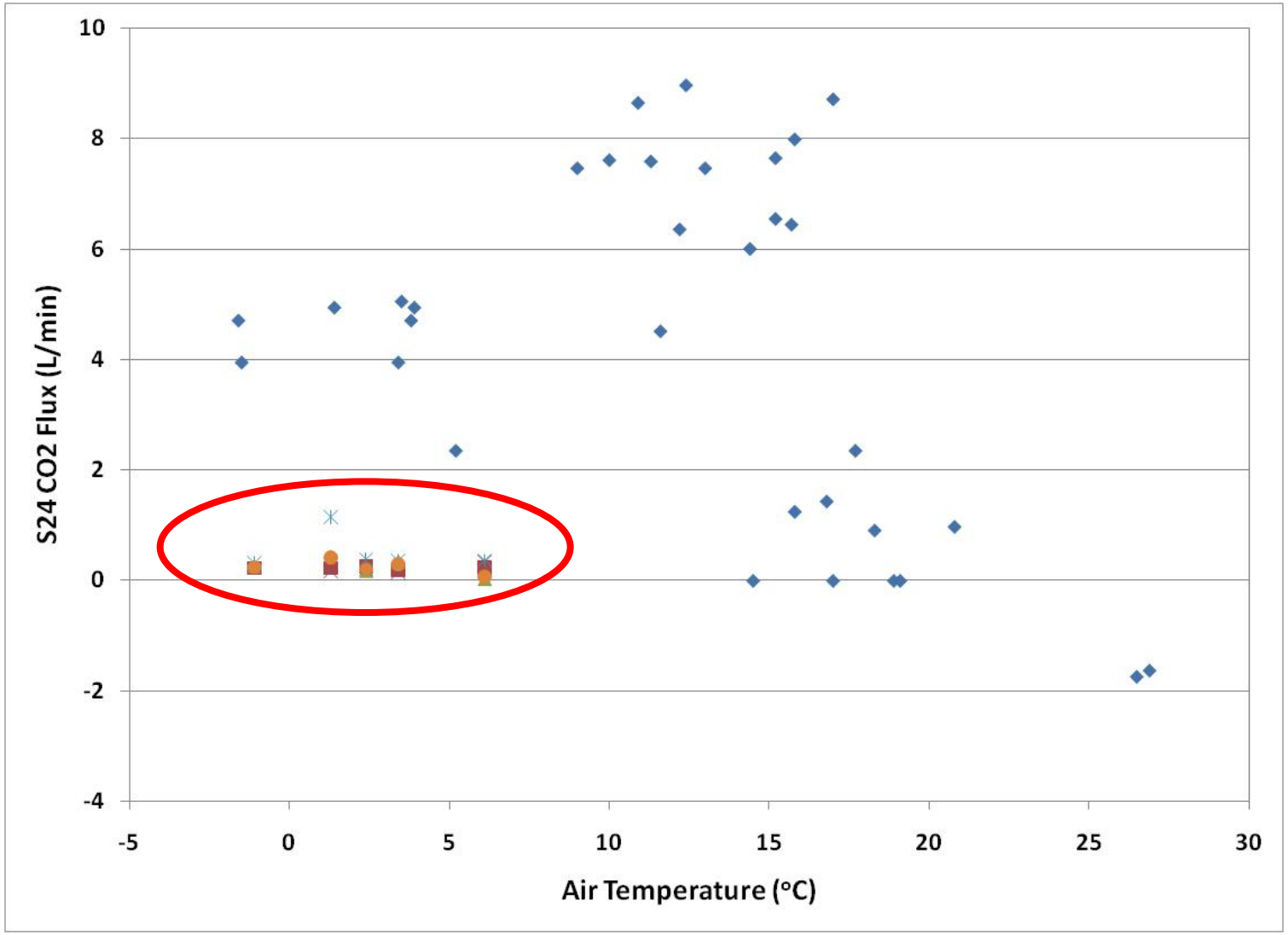
- Convective vents located in thin cover areas
- 0.3 m
- 0.4 m
- 0.75 m
- Cover material added to 1 m design



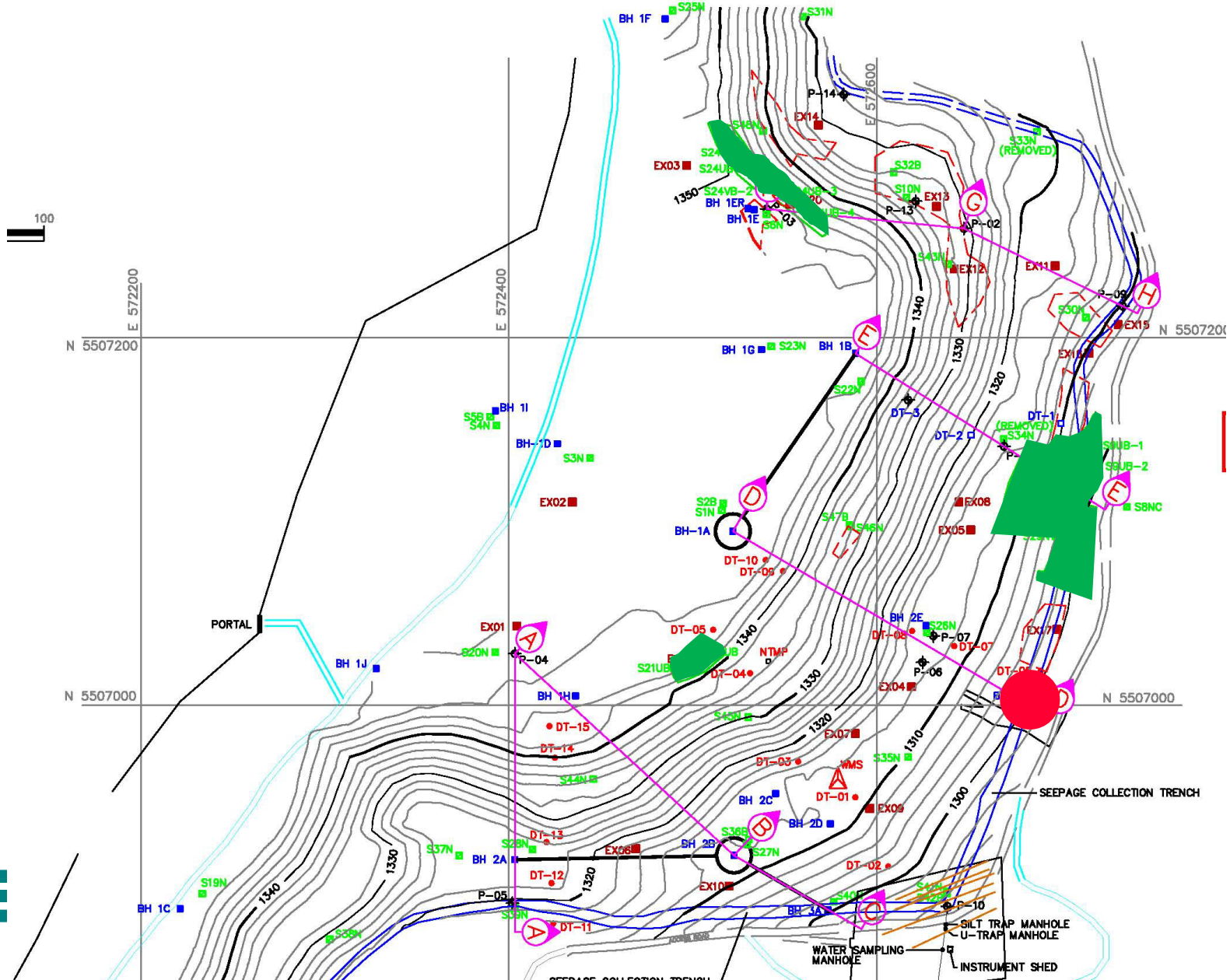
Gas Test Flux Results



Additional Cover Flux Change

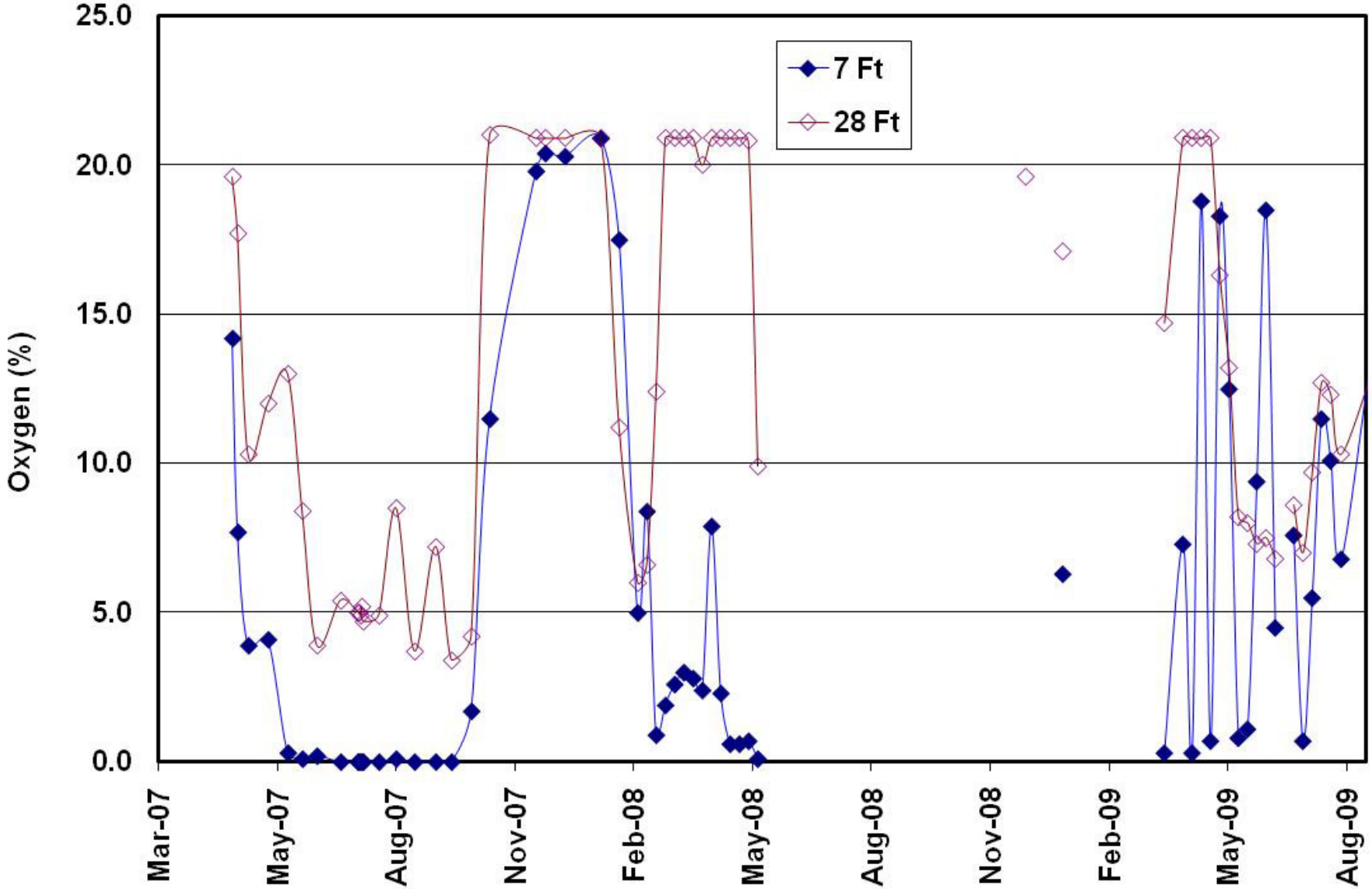


BH-3B Gas Composition



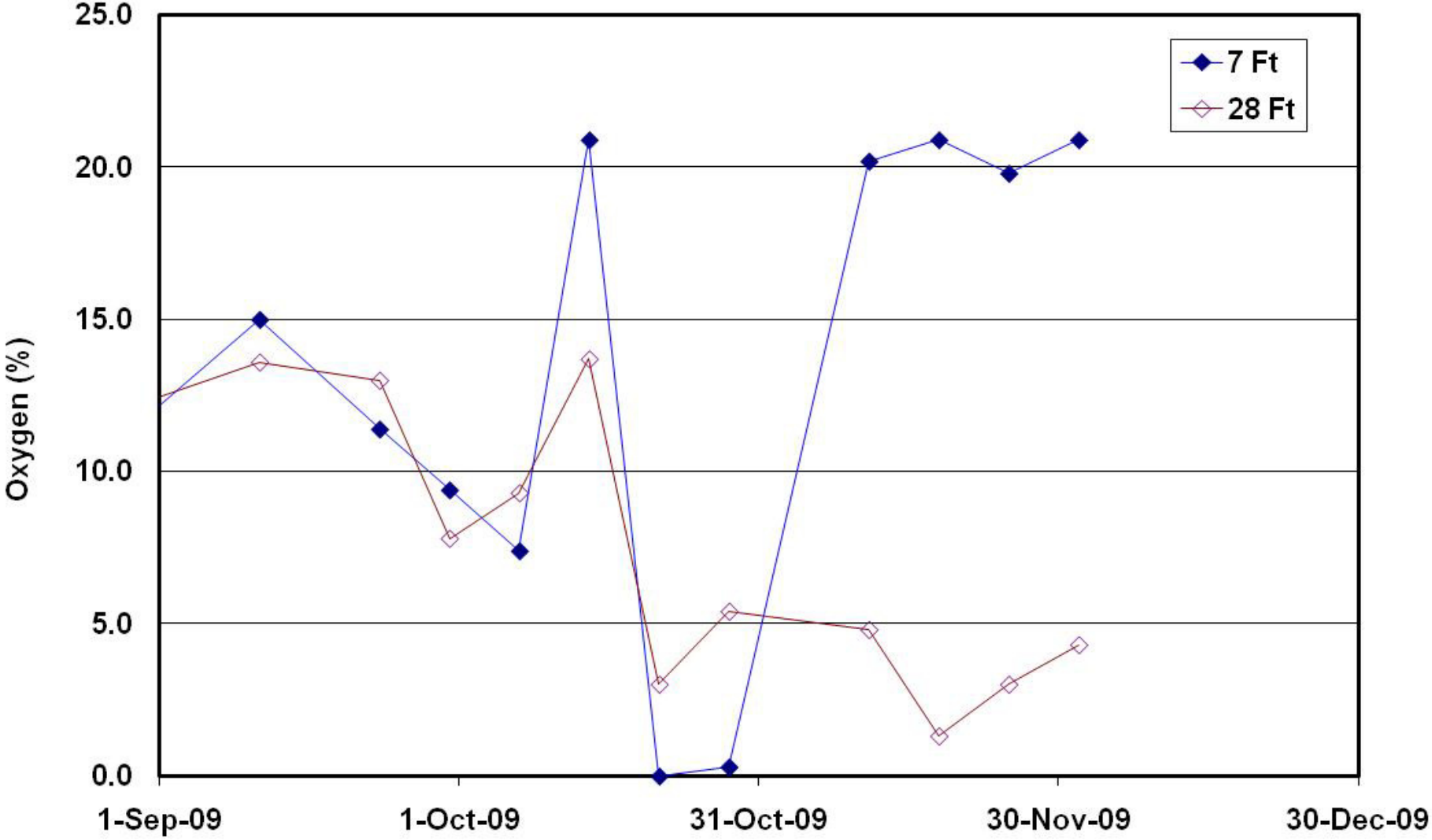
BH-3B Gas Composition Pattern

Oxygen composition normally elevated fall to spring.

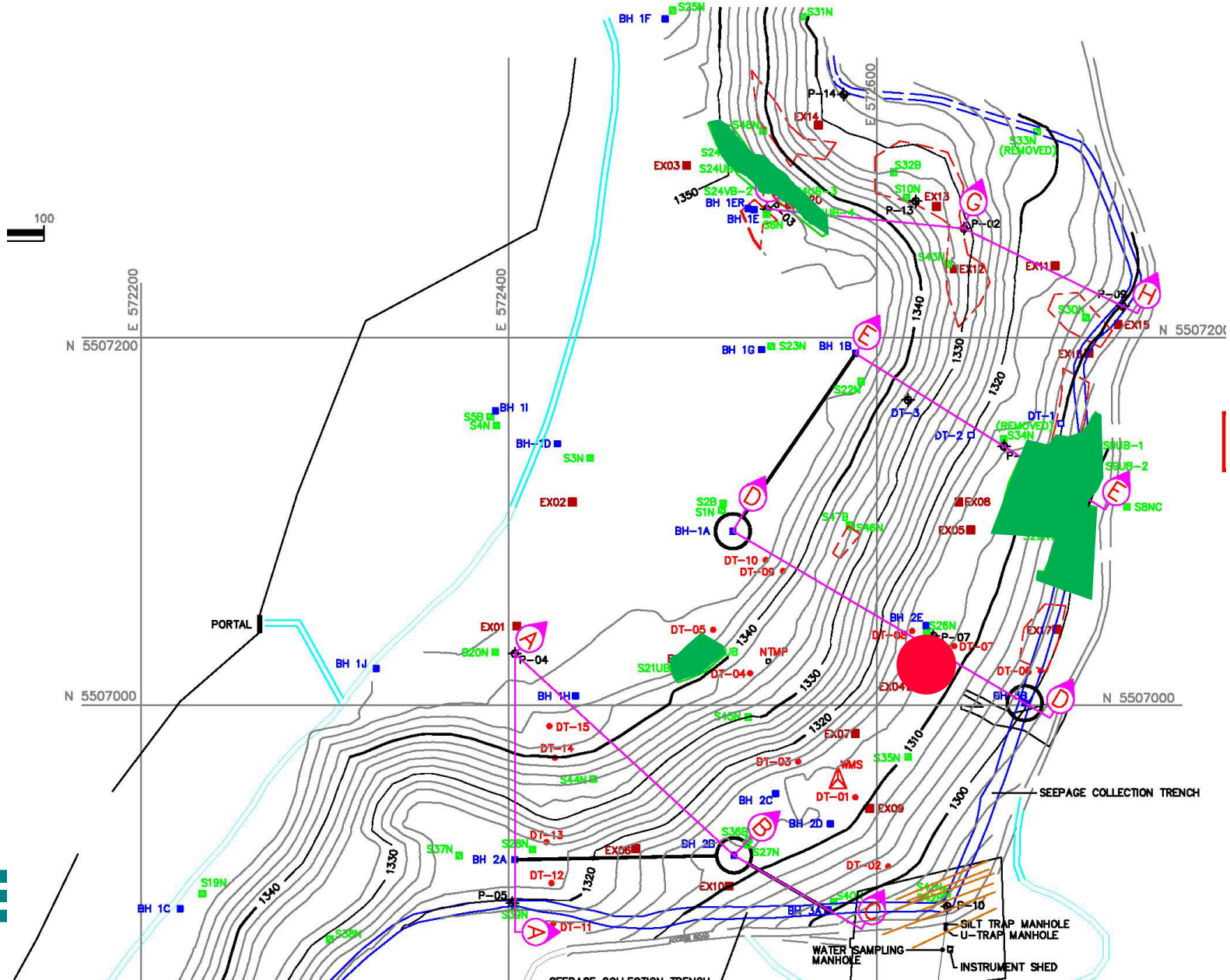


BH-3B Gas Composition

Oxygen composition has dropped fall 2009.

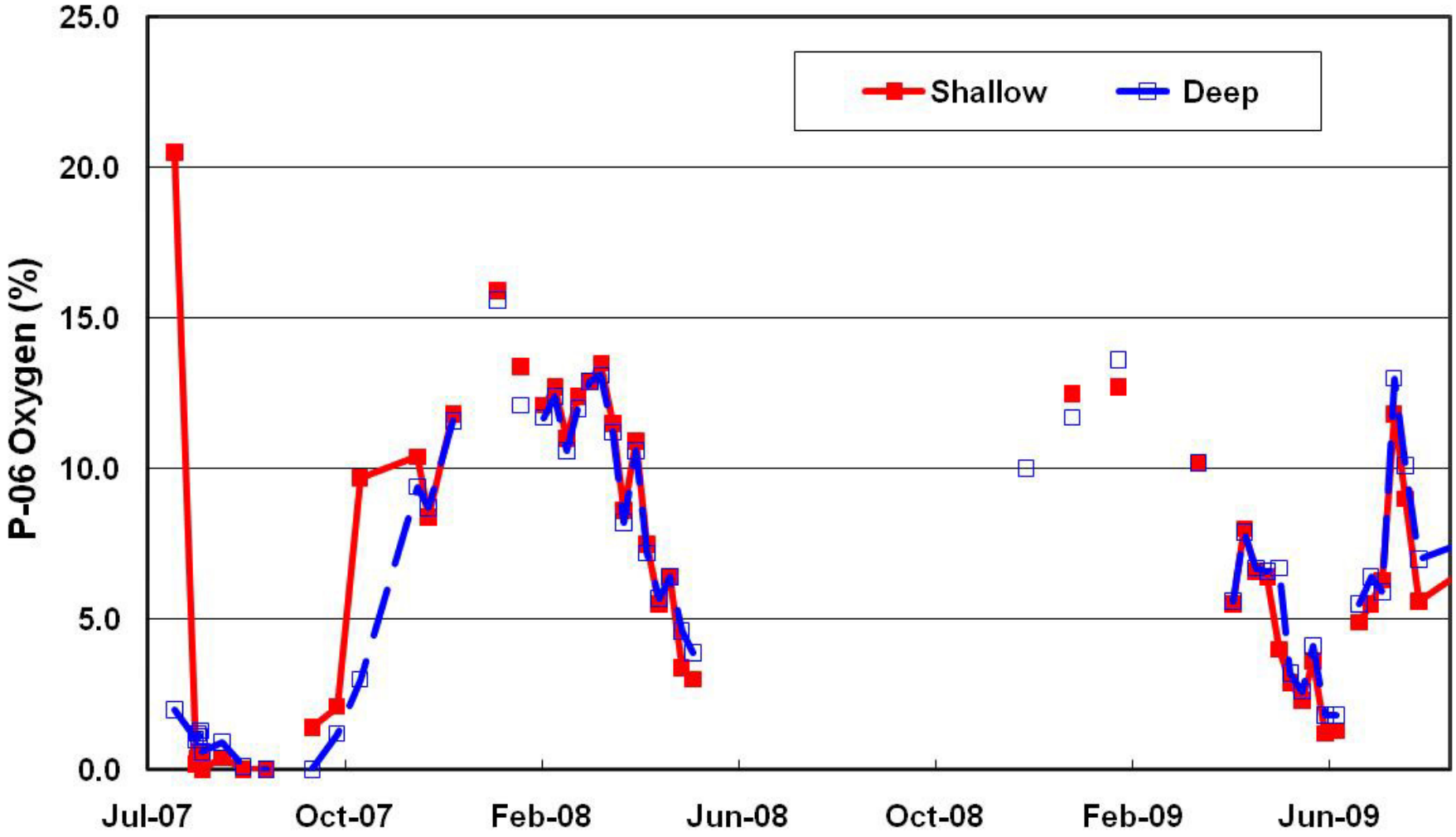


P-06 Gas Composition



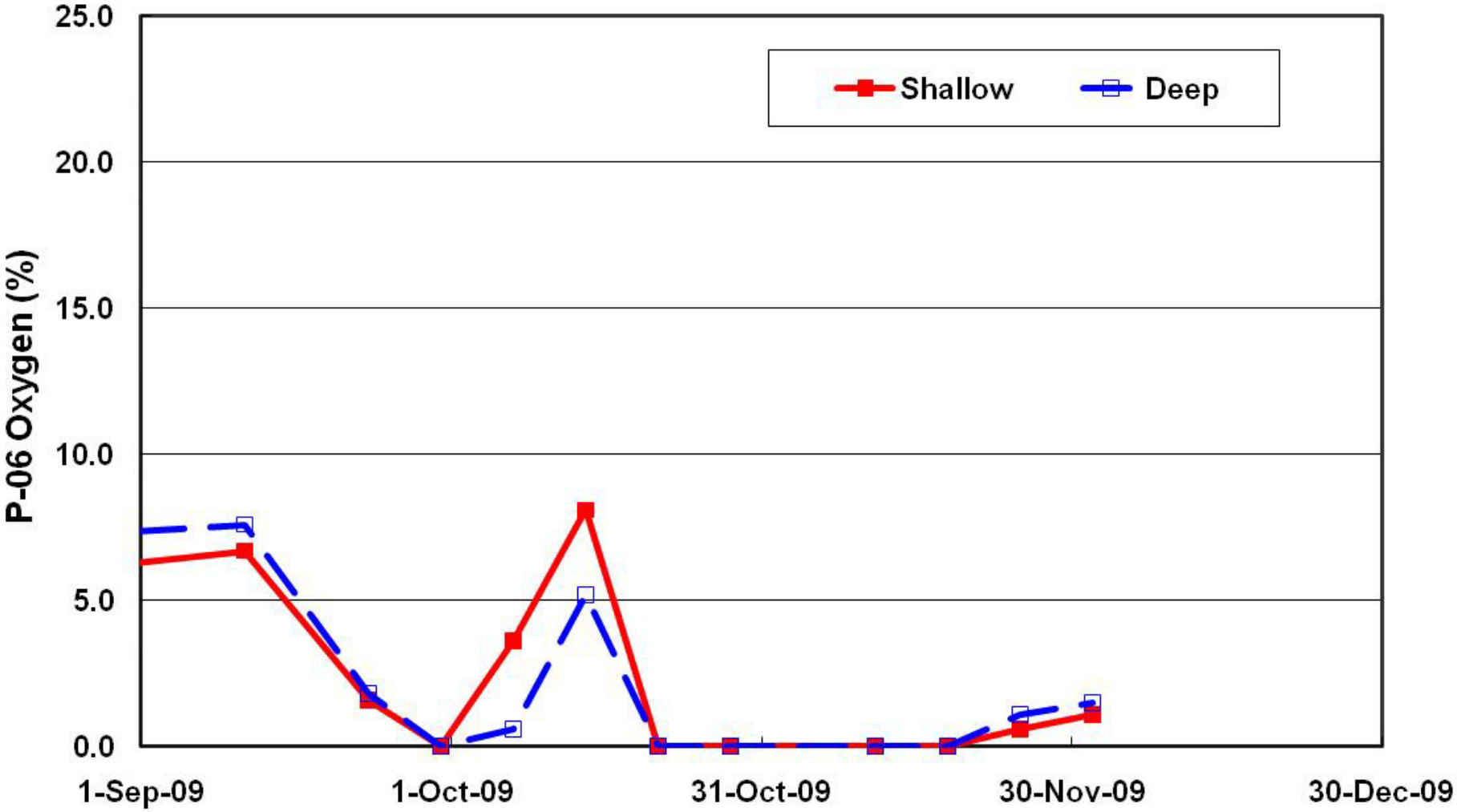
P-06 Gas Composition

Oxygen composition normally elevated fall to spring.

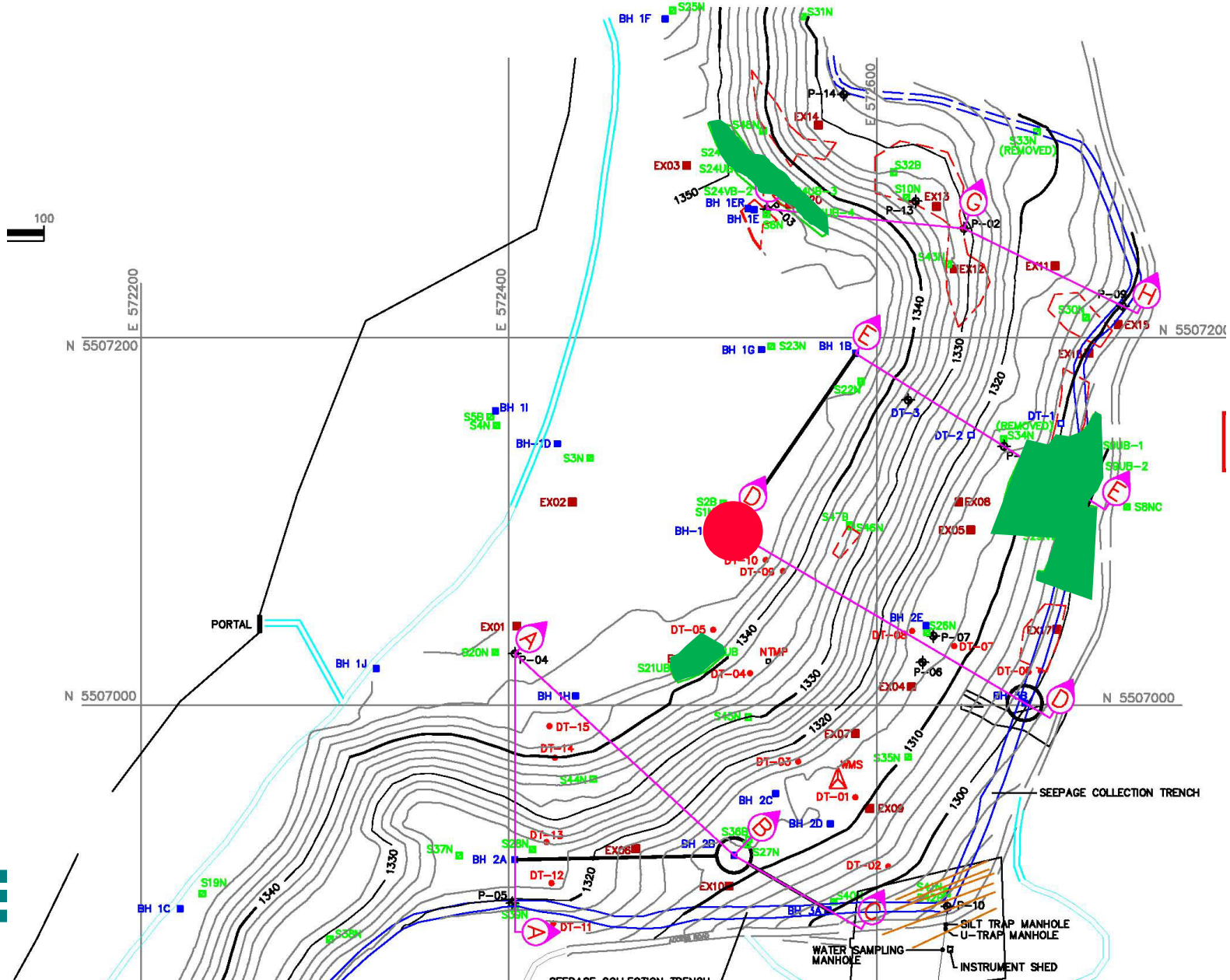


P-06 Gas Composition

Oxygen composition has dropped fall 2009.

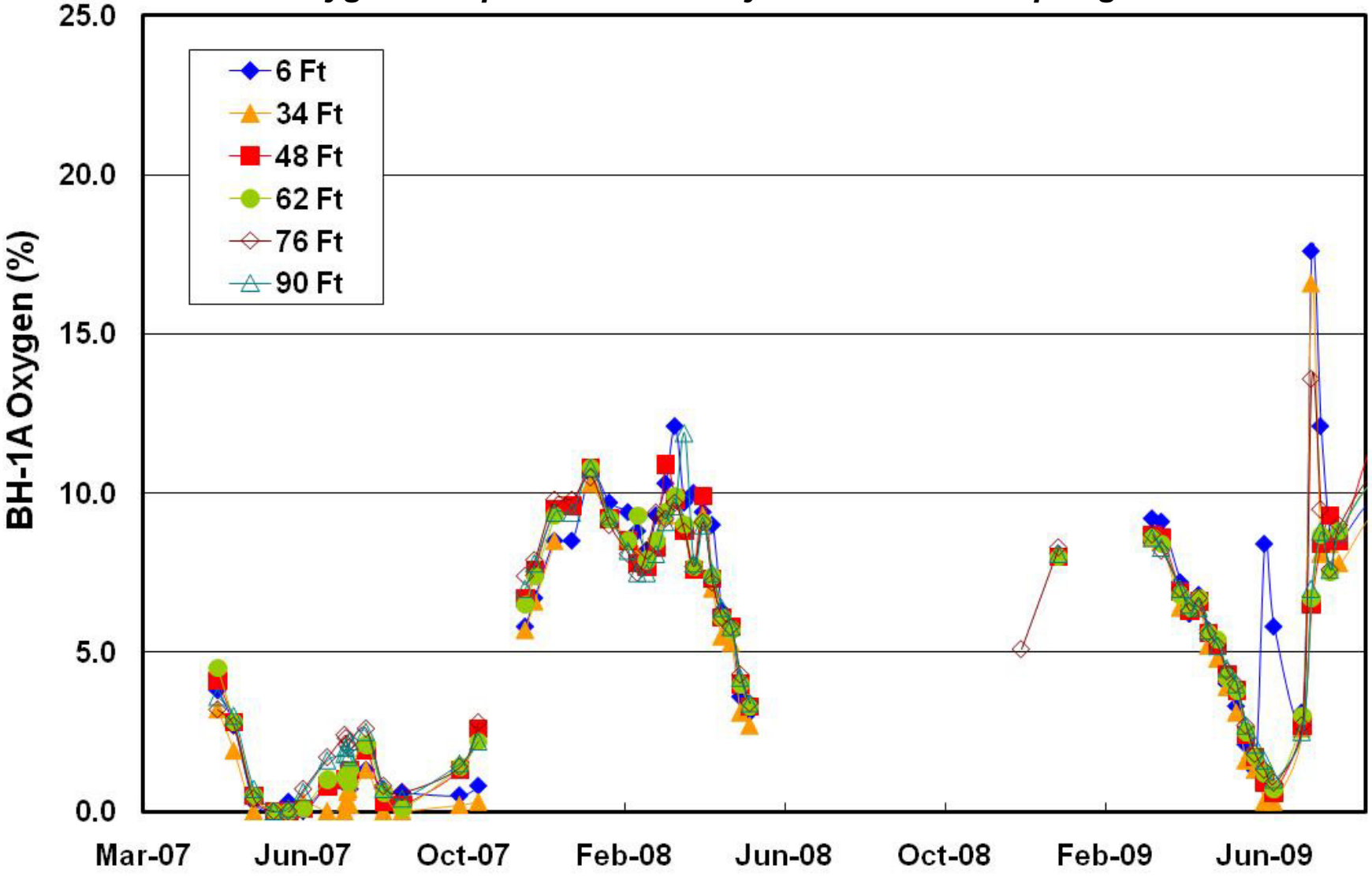


BH-1A Gas Composition



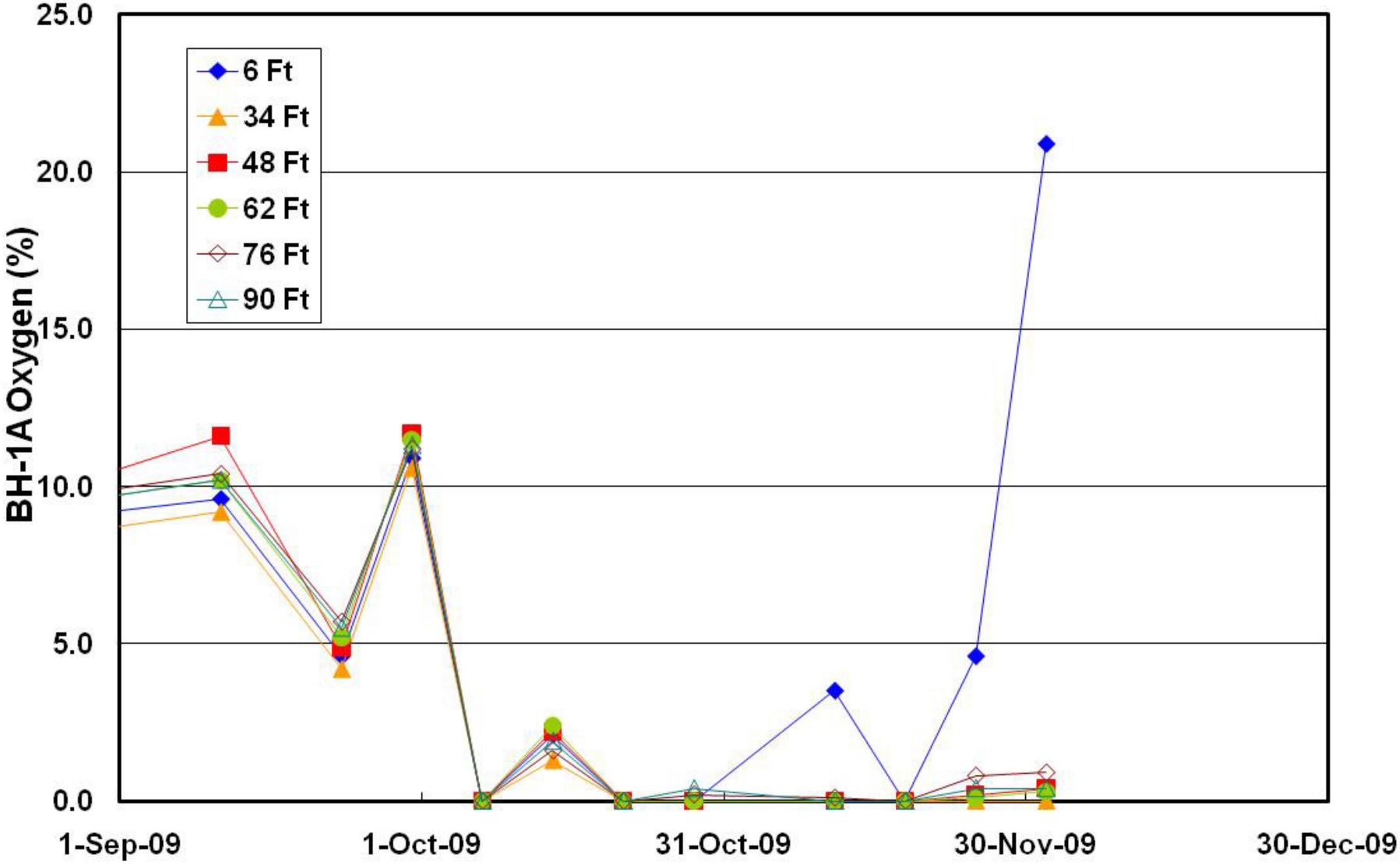
BH-1A Gas Composition

Oxygen composition normally elevated fall to spring.

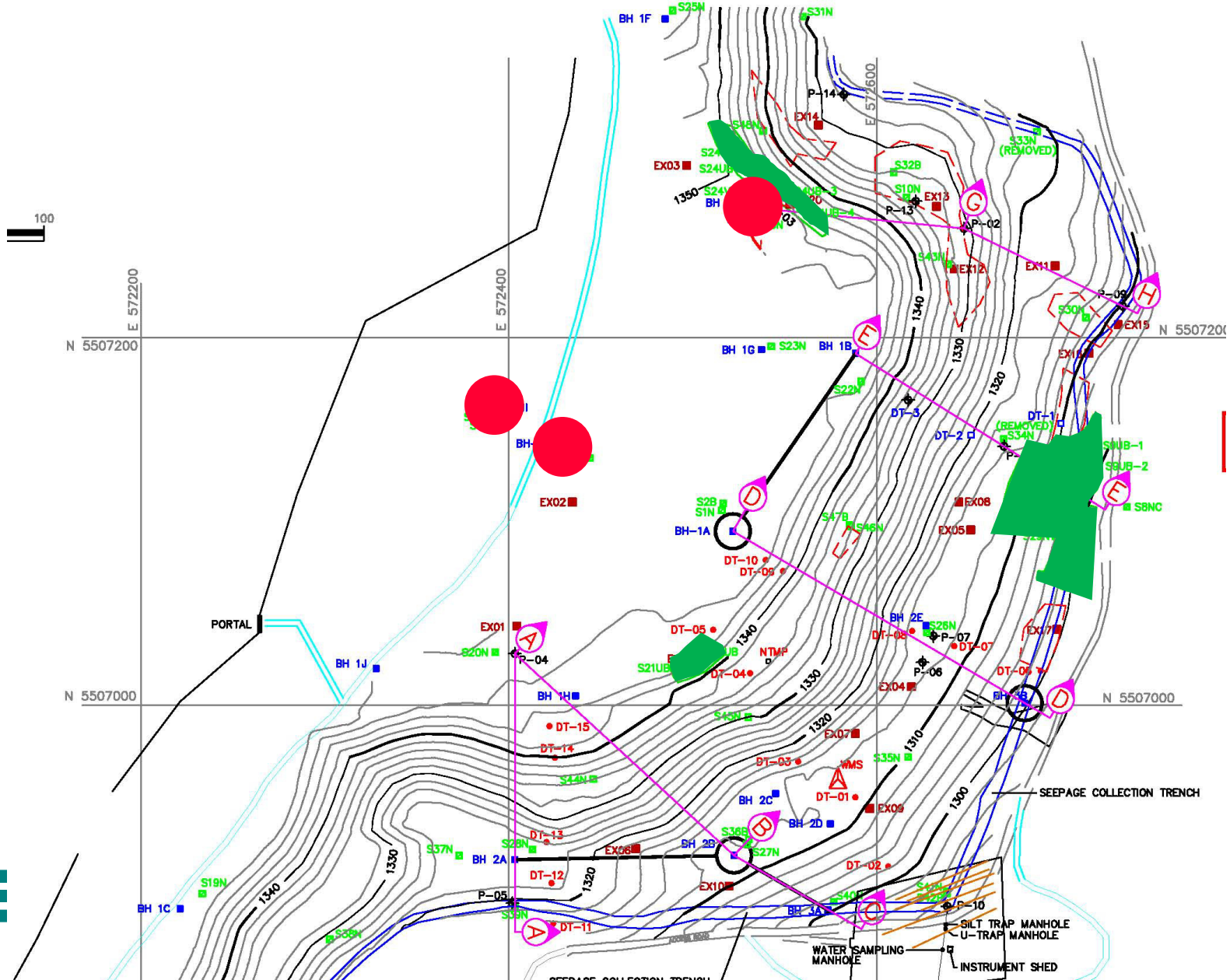


BH-1A Gas Composition

Oxygen composition has dropped fall 2009.



Oxygen reduction site-wide



Conclusions

- Gas traps have been useful tool to measure convective flux
- Measurement of convective flux at both toe and crest have provided an additional confirmation of air flow system
- Waste rock likely has greatest link to PSAs
- Vents linked to thin cover
- Cover construction quality control is important, but sites surveys and observations are helpful

Conclusions

- ***Additional cover has reduced pore gas flux by an order of magnitude***
- ***Effect of the additional cover appears to nearly site wide***
- ***No conclusions on long-term cover performance with respect to air flow***