EPA Vapor Intrusion Workshop

Measurement-Based Methods for Protective & Defensible Chlorinated VI Exposure Determinations

MEW/Moffett Field Buildings 15 and 17 – A Review of Multiple Published Studies; Site in IECC Climate Zone 3C

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35th Annual International Conference on Soils, Sediments, Water, and Energy, Amherst, Massachusetts, October 22nd, 2019

References

- Brenner, David. "Results of a long-term study of vapor intrusion at four large buildings at the NASA Ames Research Center." *Journal of the Air & Waste Management Association* 60, no. 6 (2010): 747-758.
- Brenner, D. and M. Walraven “Revised Human Health Risk Assessment NASA Research Park Moffett Field, California July 28, 2003 “ https://www.sec.gov/Archives/edgar/data/1664703/000119312518190488/d96446dex106.htm
- Haley and Aldrich 2009 “Final Supplemental Remedial Investigation Report for Vapor Intrusion Pathway Middlefield-Ellis-Whisman Study Area, Mountain View and Moffett Field, California, June. https://www.navfac.navy.mil/niris/SOUTHWEST/MOFFETT_FIELD_NAS/N00296_003903.PDF
- Haley and Aldrich 2009 “Final Supplemental Feasibility Study for the Vapor Intrusion Pathway Middlefield-Ellis-Whisman Study Area; June 29, 2019 https://semspub.epa.gov/work/09/2324674.pdf
- Haley & Aldrich, 2011 “Site-wide Vapor Intrusion Sampling and Analysis Work Plan for Response Action Testing” September 29. https://semspub.epa.gov/work/09/100002742.pdf
- Mactec Engineering and Consulting Inc. 2005 “Report on Long-term Indoor Air Quality Monitoring; Buildings 15, 16, 17, 20, n-210 and N243” NASA Ames Research Center, Moffett Field California
- Mills, William B., Sally Liu, Mark C. Rigby, and David Brenner. "Time-variable simulation of soil vapor intrusion into a building with a combined crawl space and basement." *Environmental science & technology* 41, no. 14 (2007): 4993-5001.
- Noreas for NAVFAC “Draft 2019 Installation Restoration Site 28 Air Sampling and Vapor Intrusion Tier Response Evaluation Report, July 2019 https://semspub.epa.gov/work/09/100018154.pdf

Building 15

- 11,900 square foot,
- steam heated with air conditioning, two HVAC zones
- occupied 24x7
- Main portion and west wing office space; HVAC equipment and garage in east wing
- HVAC adjusted in May 2003 to increase outside air supply, reportedly reducing TCE in indoor air

Building 17

- 3,900 square feet first floor, 3,000 sq ft basement office building constructed 1932-1933 with small crawlspace beneath the stairs to hold mechanical equipment
- Basement is 6 ft below grade and 2 ft above grade.
- Building 17 is steam heated and occupied during the work week on the first floor only.

Photo reprinted from https://www.cmu.edu/cmnews/extra/030108_growingwest.html

The university's West Coast campus is headquartered in Building 17 of the historic Shenandoah Plaza in Moffett Field, Calif.

Conceptual Site Model (From https://rmcs-1.itrcweb.org/6-2-moffett-mew-regional-plume-california/

USEPA. 2012f. Supplemental Sitewide Feasibility Study, Middlefield-Ellis-Whisman Superfund Study Area. USEPA Region 9.

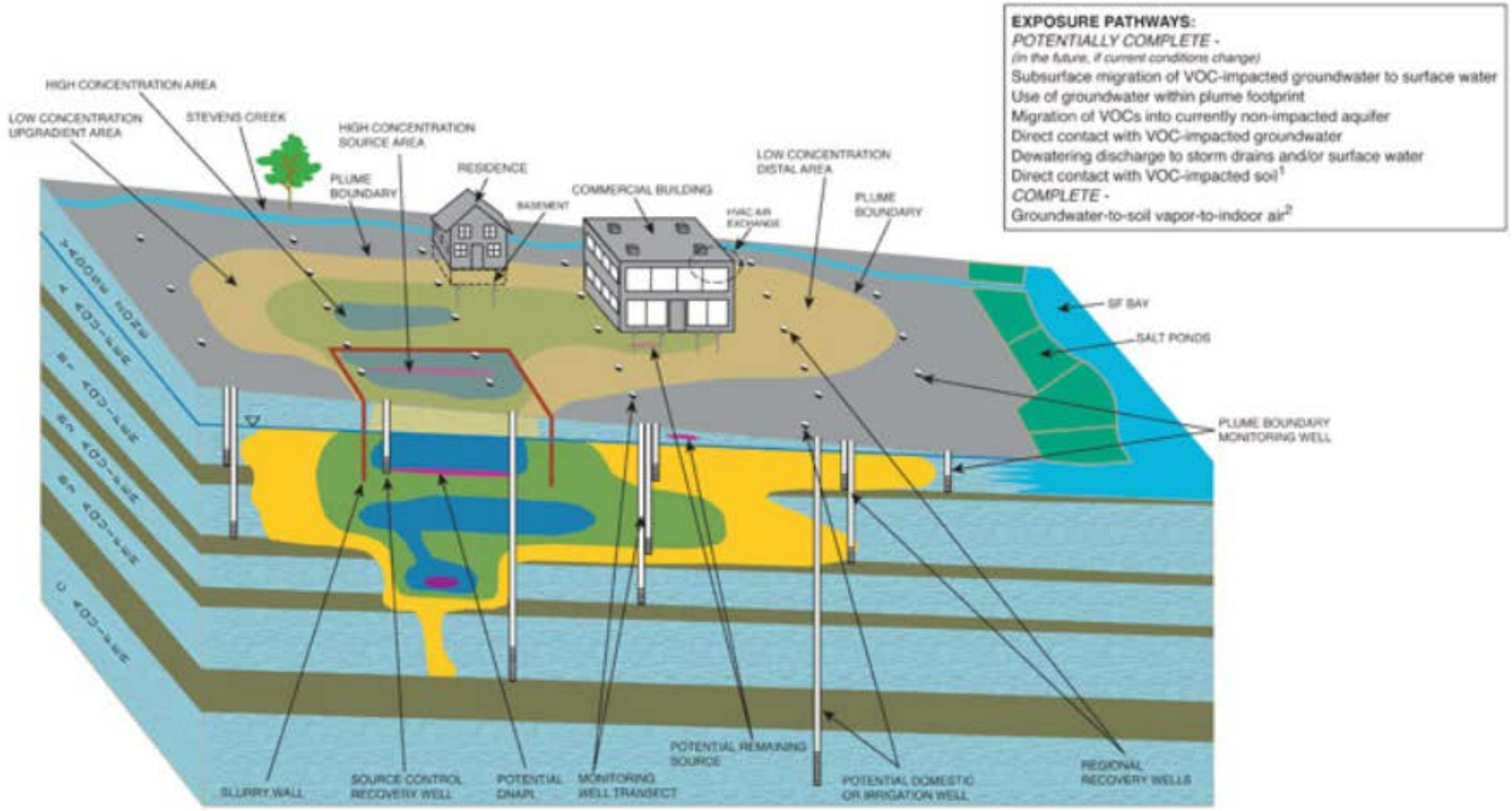


Figure 11. CSM for Moffett-MEW regional plume (USEPA 2012f).

Location of Buildings over Groundwater Plume

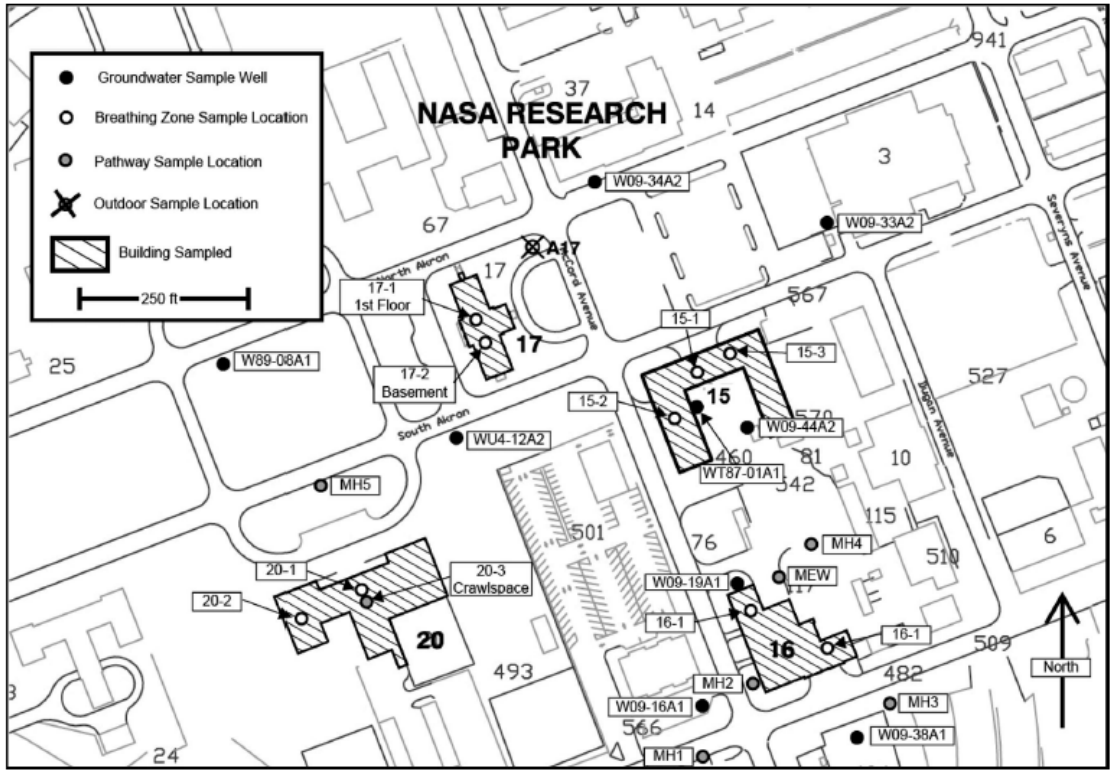
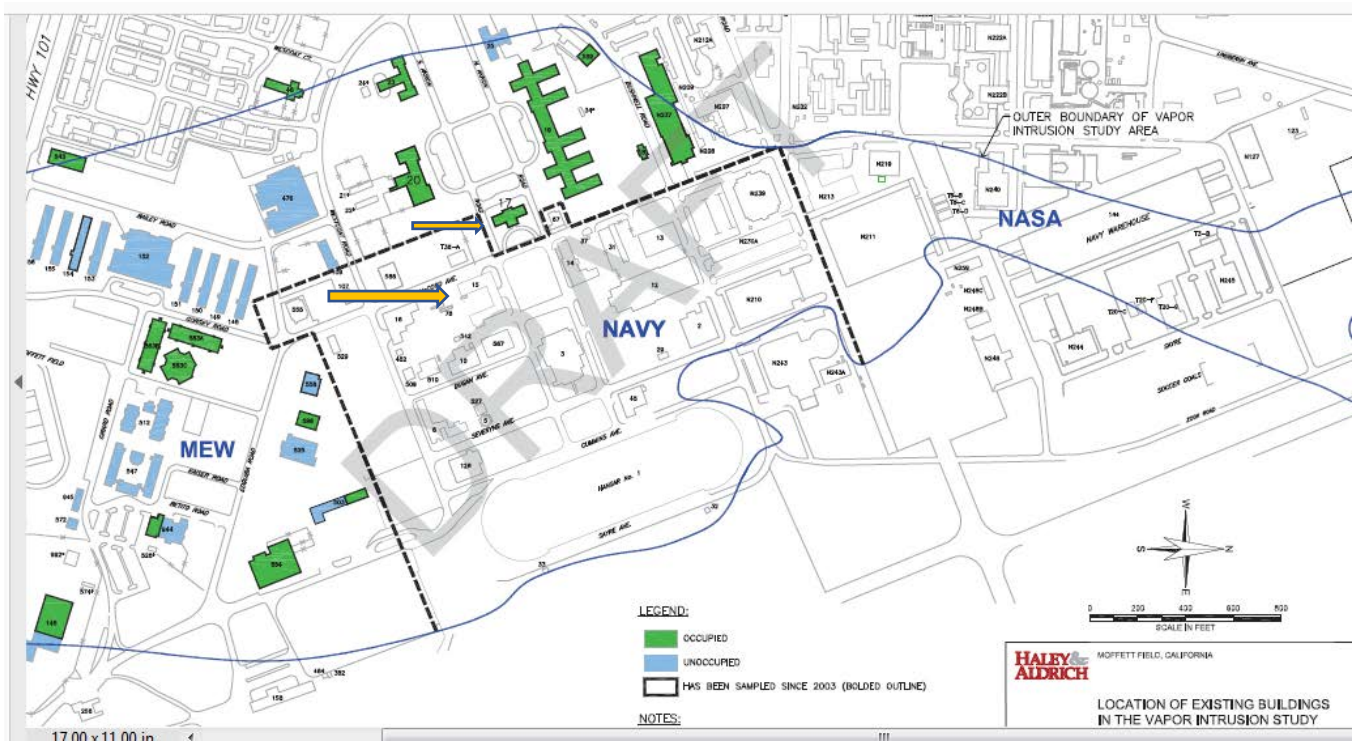
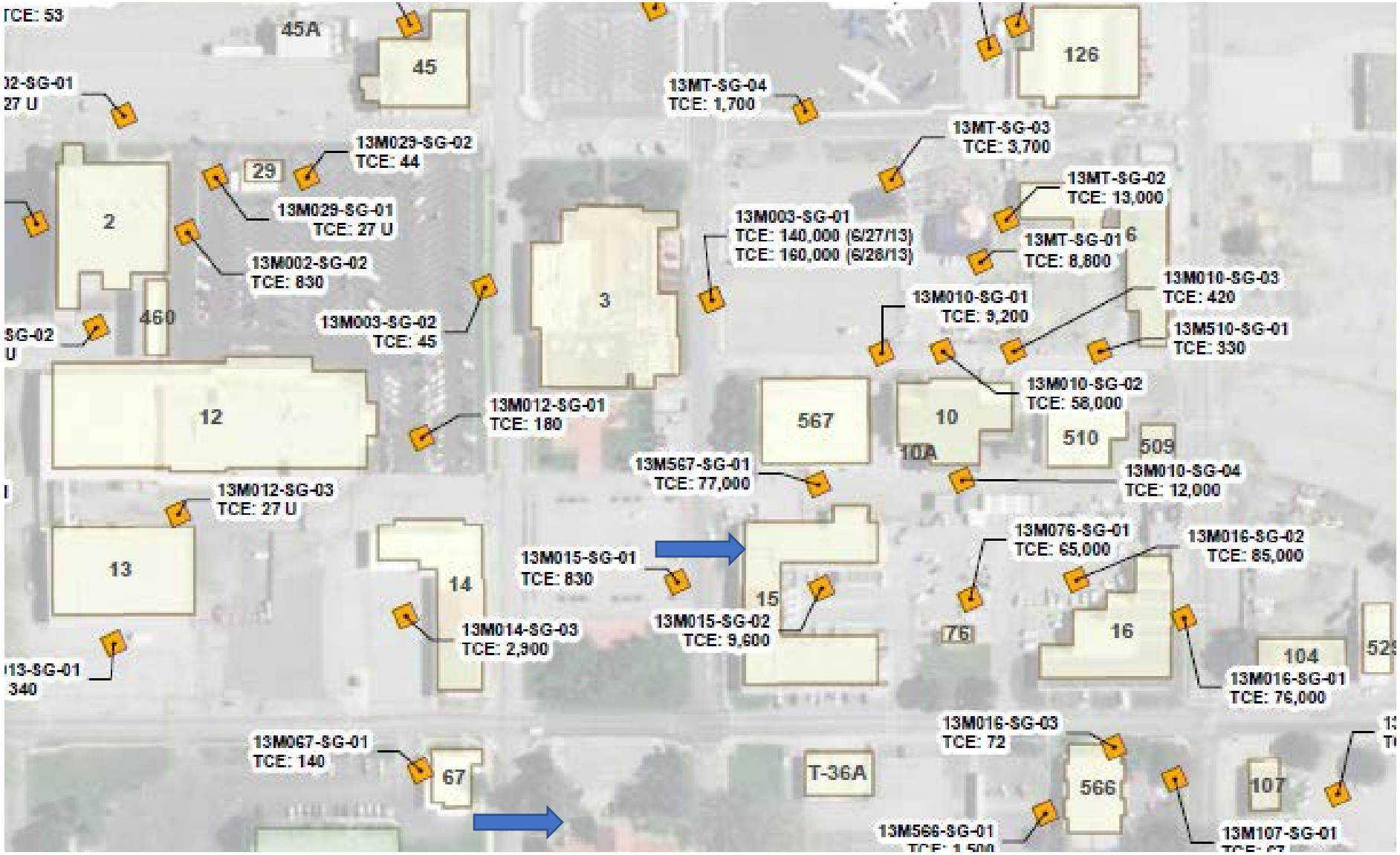


Figure 1. Building and sample locations.



- IECC Zone 3C warm-marine Koppen Csb (Mediterran)
- Buildings near each other
- Approximately at midline of plume

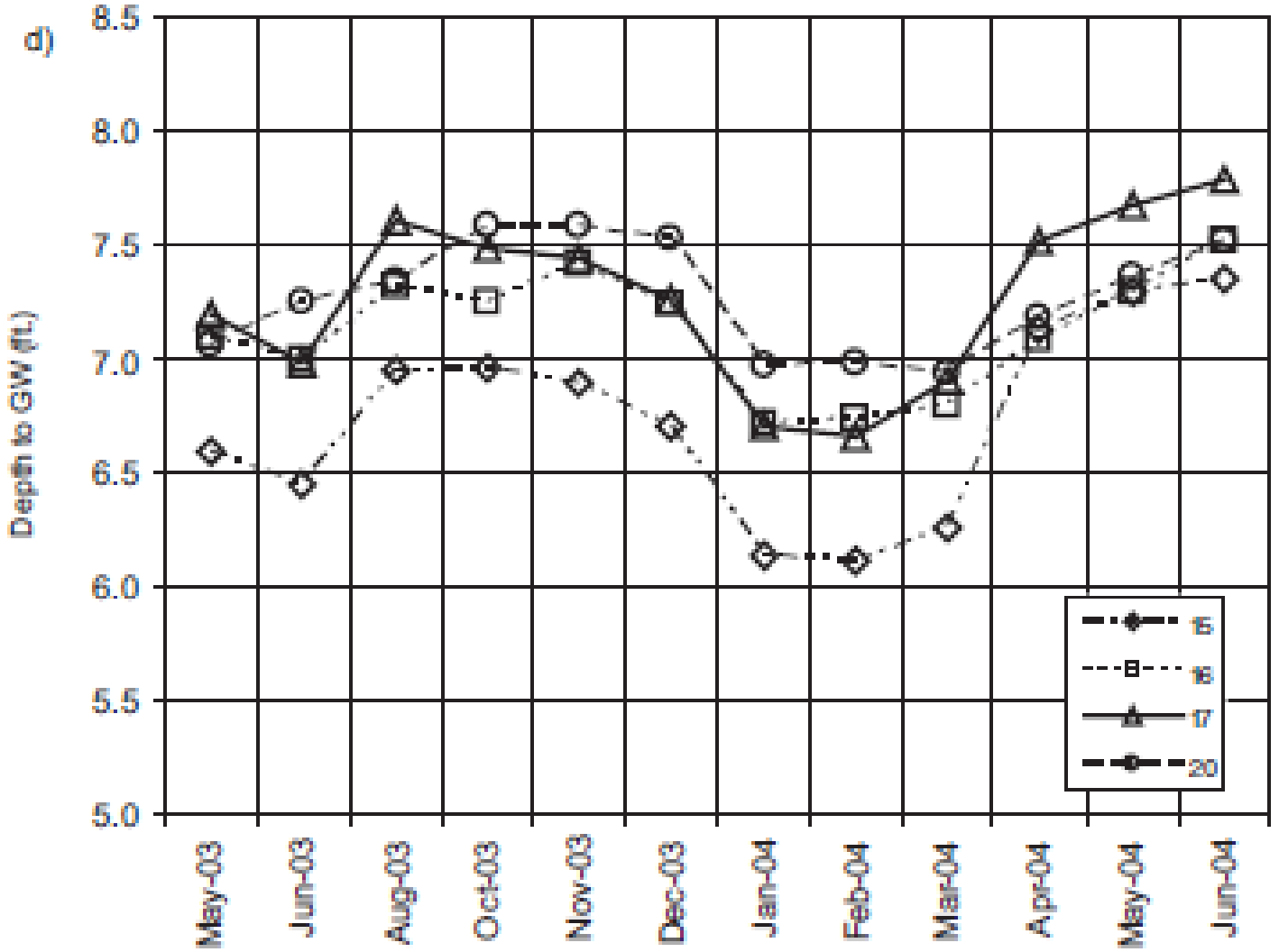
More Recent TCE in Soil Gas in Building 15 and 17 Vicinity



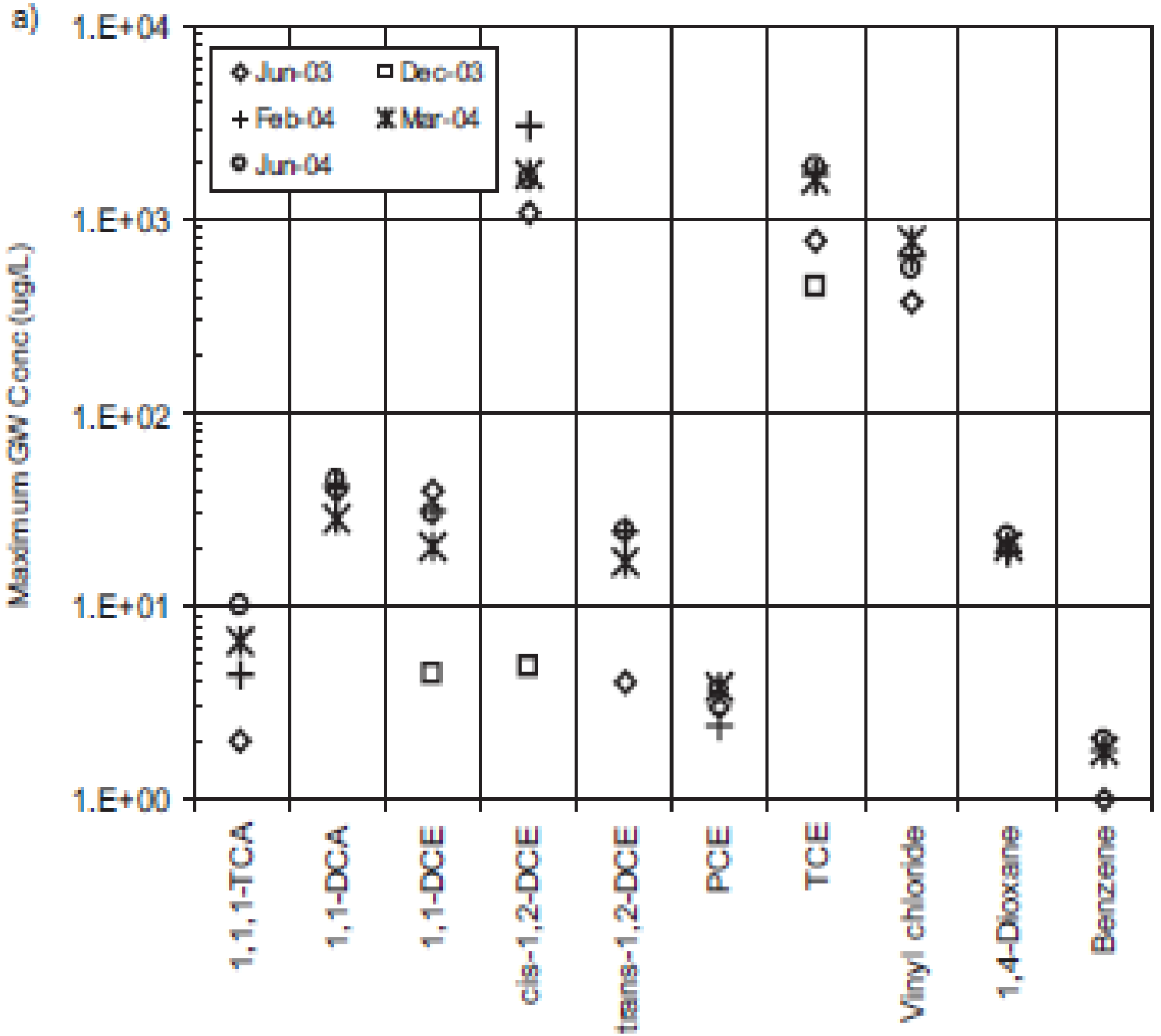
Data Set/Study Design

- A combination of 24- and 8-hr samples were collected in Buildings 15 and 17 (i.e., 24- and 8-hr samples were not simultaneously collected from a given location at any given time)
- 8 hour samples were collected 8 AM-4 PM, 4 PM- 12AM, 12 AM to 8 AM
- 102 samples at indoor location 15-1 which was presented in the most detail, 68 samples at the background locations and 128 samples at the outdoor location near the studied buildings.
- Multiple linear regression models were used to relate indoor concentrations to meteorological variables. Descriptive statistics were calculated by month. 8 hour sample descriptive statistics were calculated for three repetitive shifts.
- Available data included wind speed, barometric pressure, temperature, humidity, wind direction, visibility, and precipitation.
- Groundwater data for shallow monitoring well near subject buildings also available
- No indoor sources of target VOCs identified in database of materials used at the facility and a walk through.

Groundwater Level Variation (from Multiple Wells)

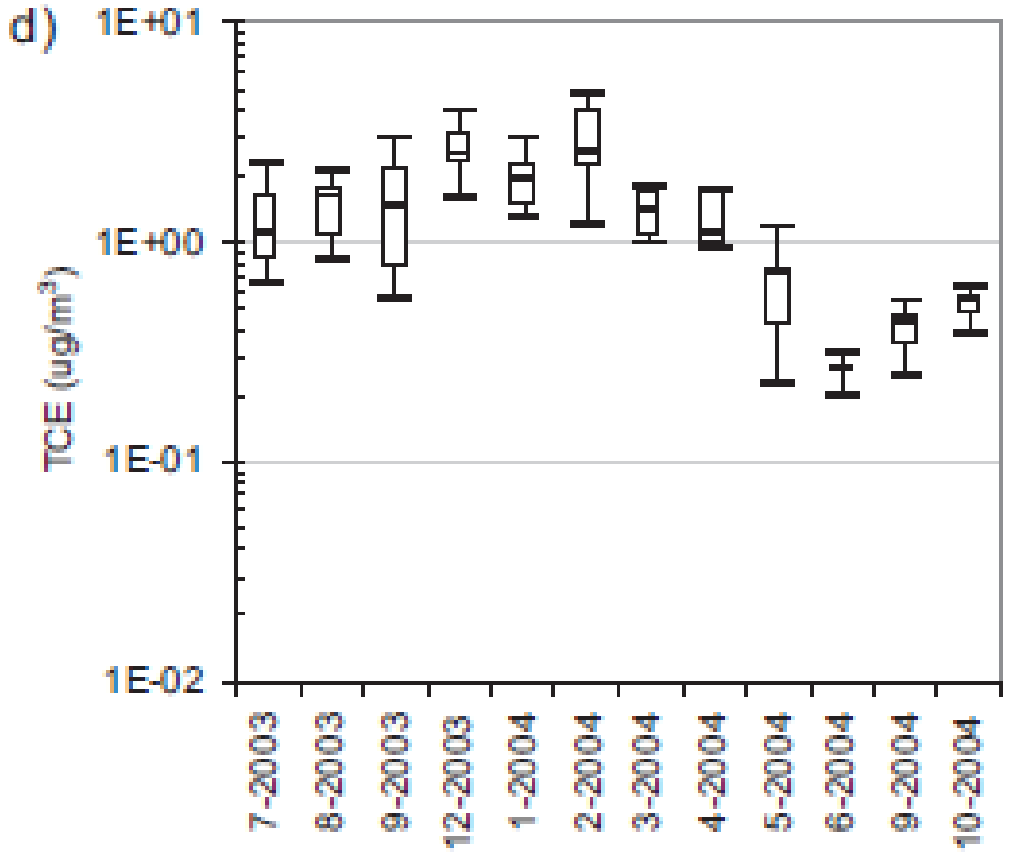


Groundwater Concentration by Month (Max)

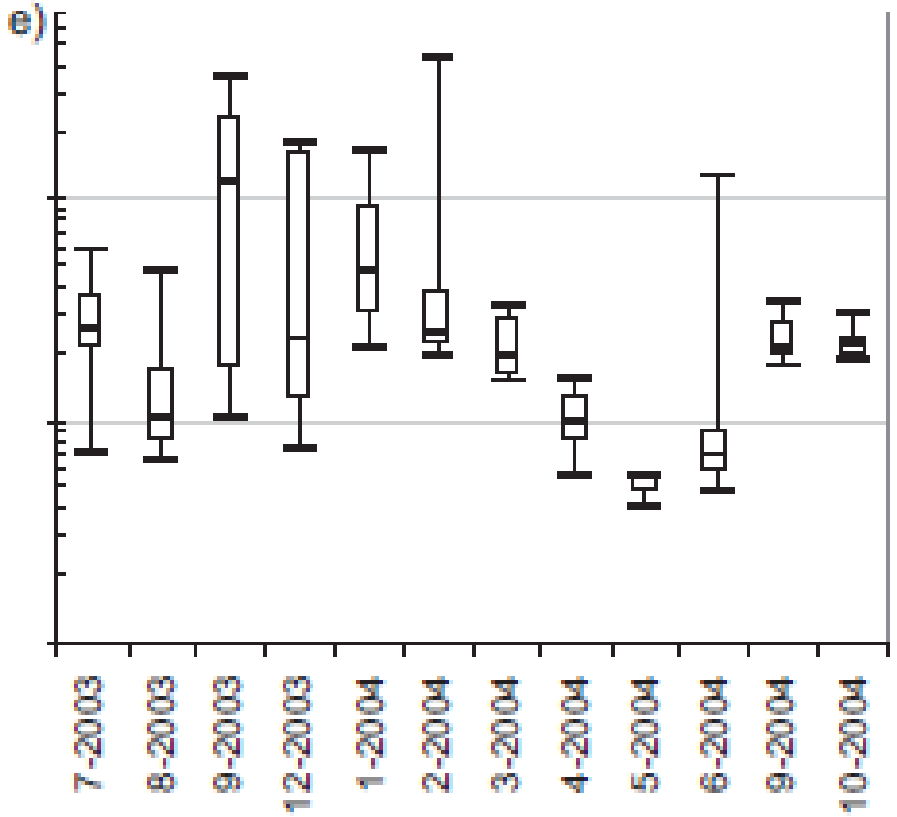


Temporal Variability of Indoor Air

Building 15 Station 15-1

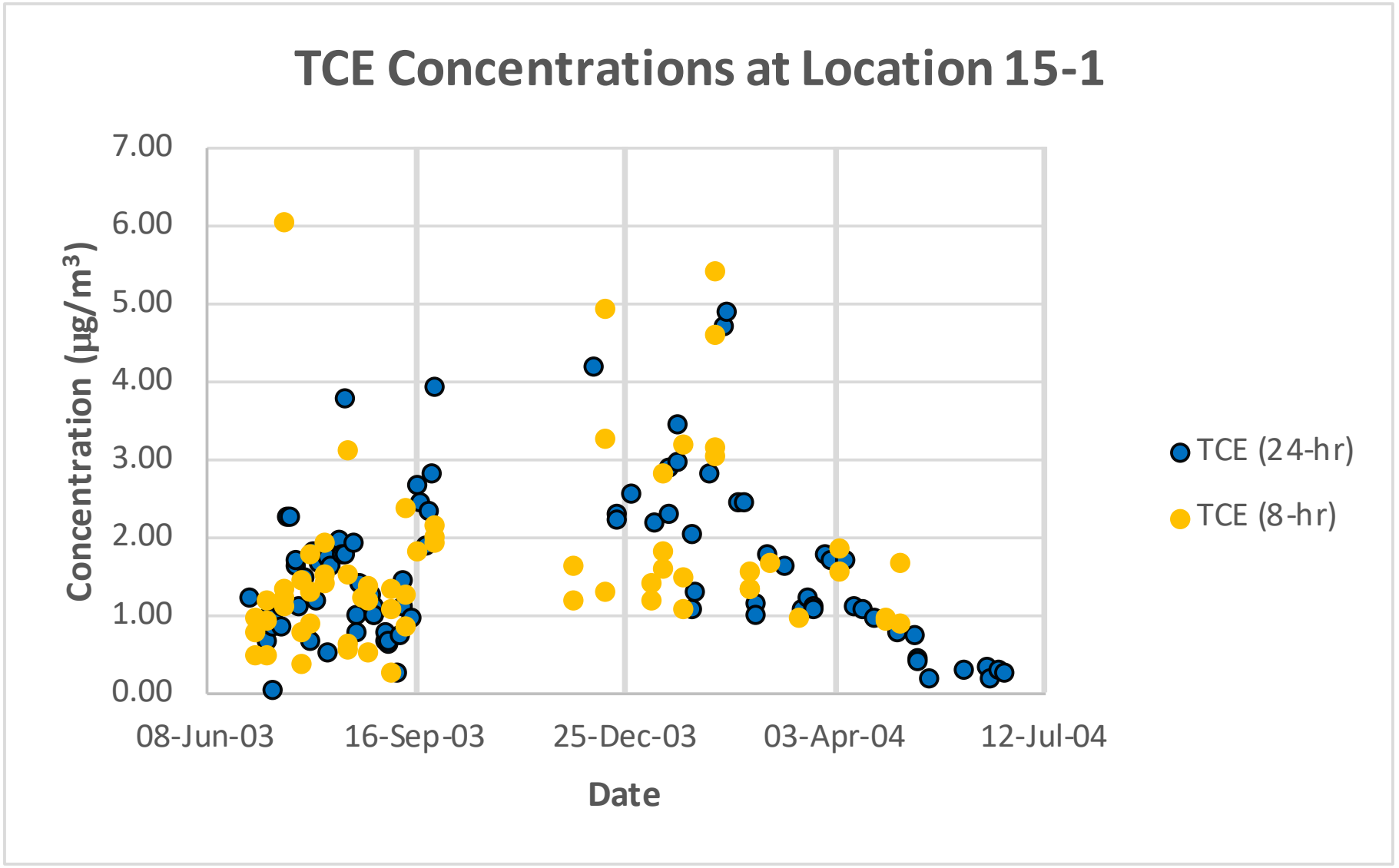


Outdoor Station A17



Daily TCE Building 15

- Peak primarily between September 2003 and February 2004

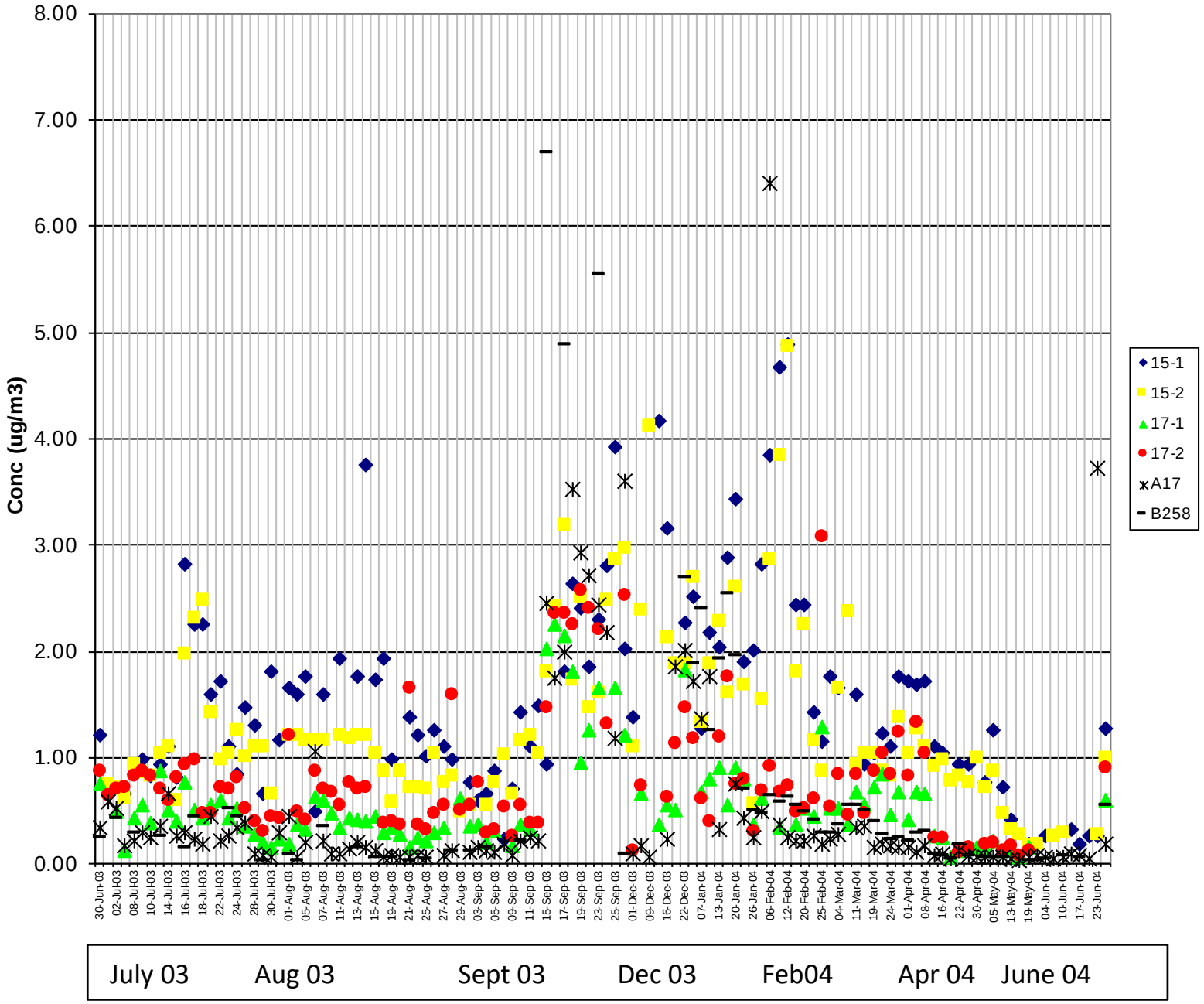


New plot created from historical data

Maximum Daily TCE Buildings 15 and 17

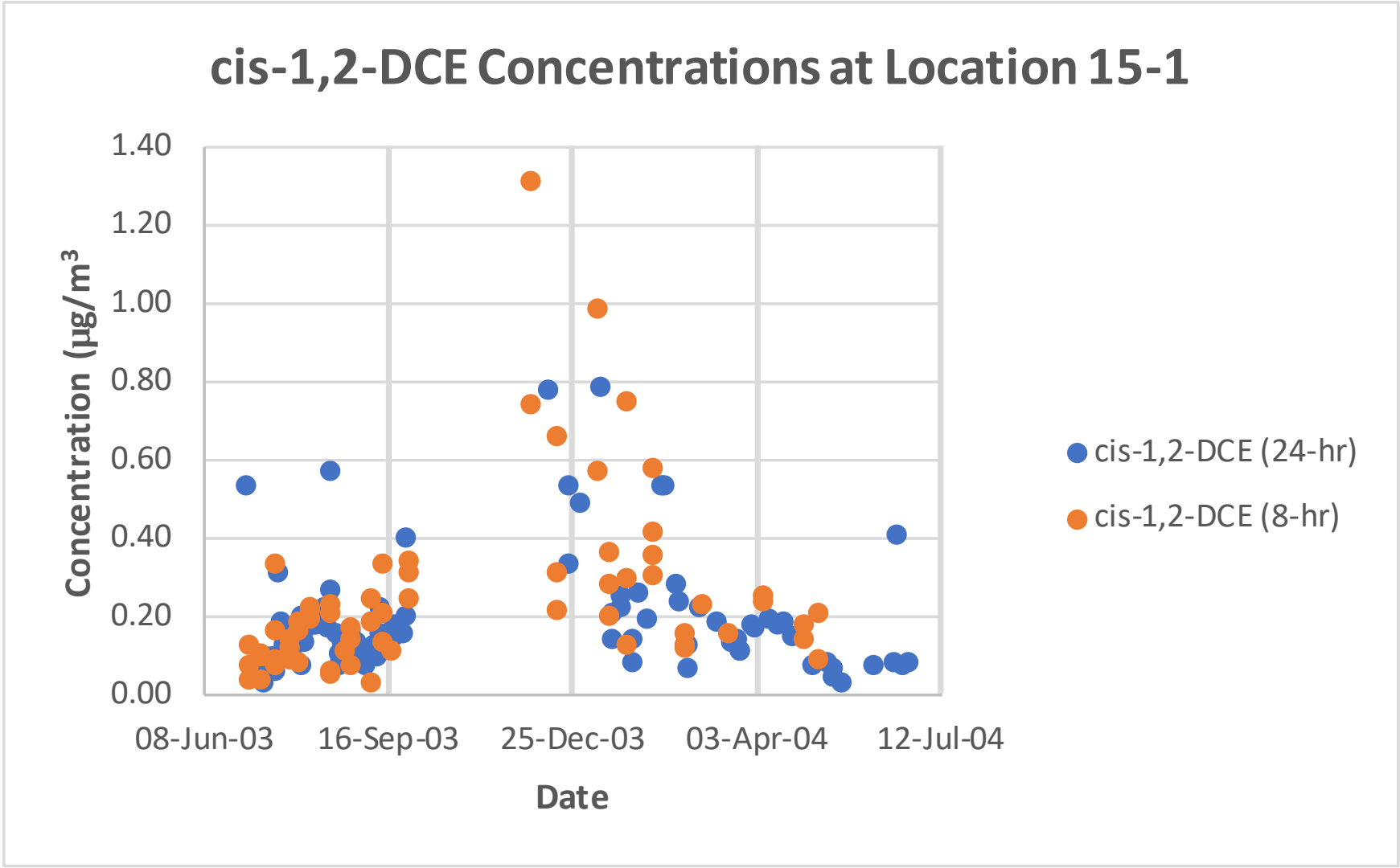
- Peak between September 2003 and February 2004

Note this original is a line chart not XY chart



Daily cis-1,2-DCE Concentrations Building 15

- Peak concentrations December 2003 to March 2004

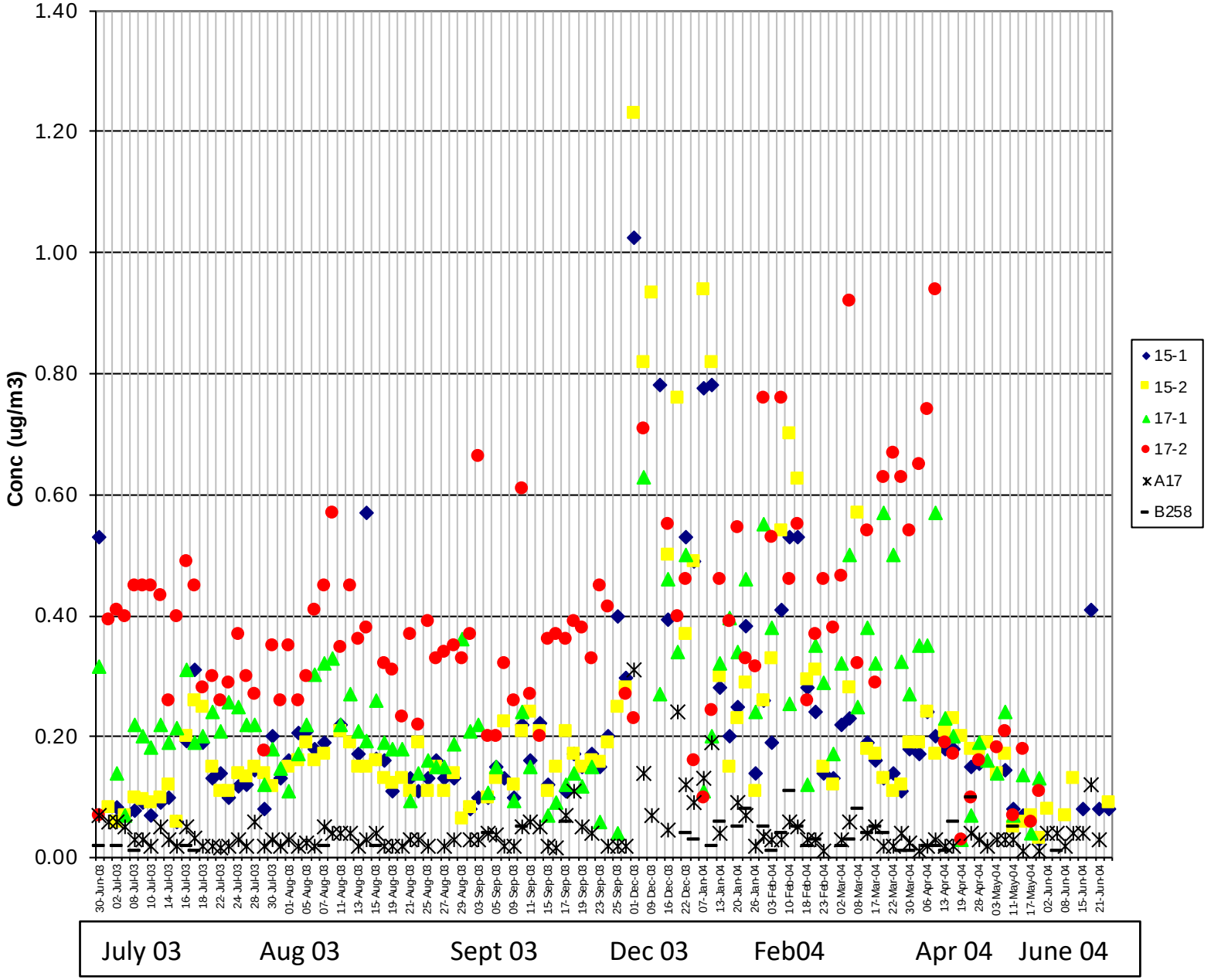


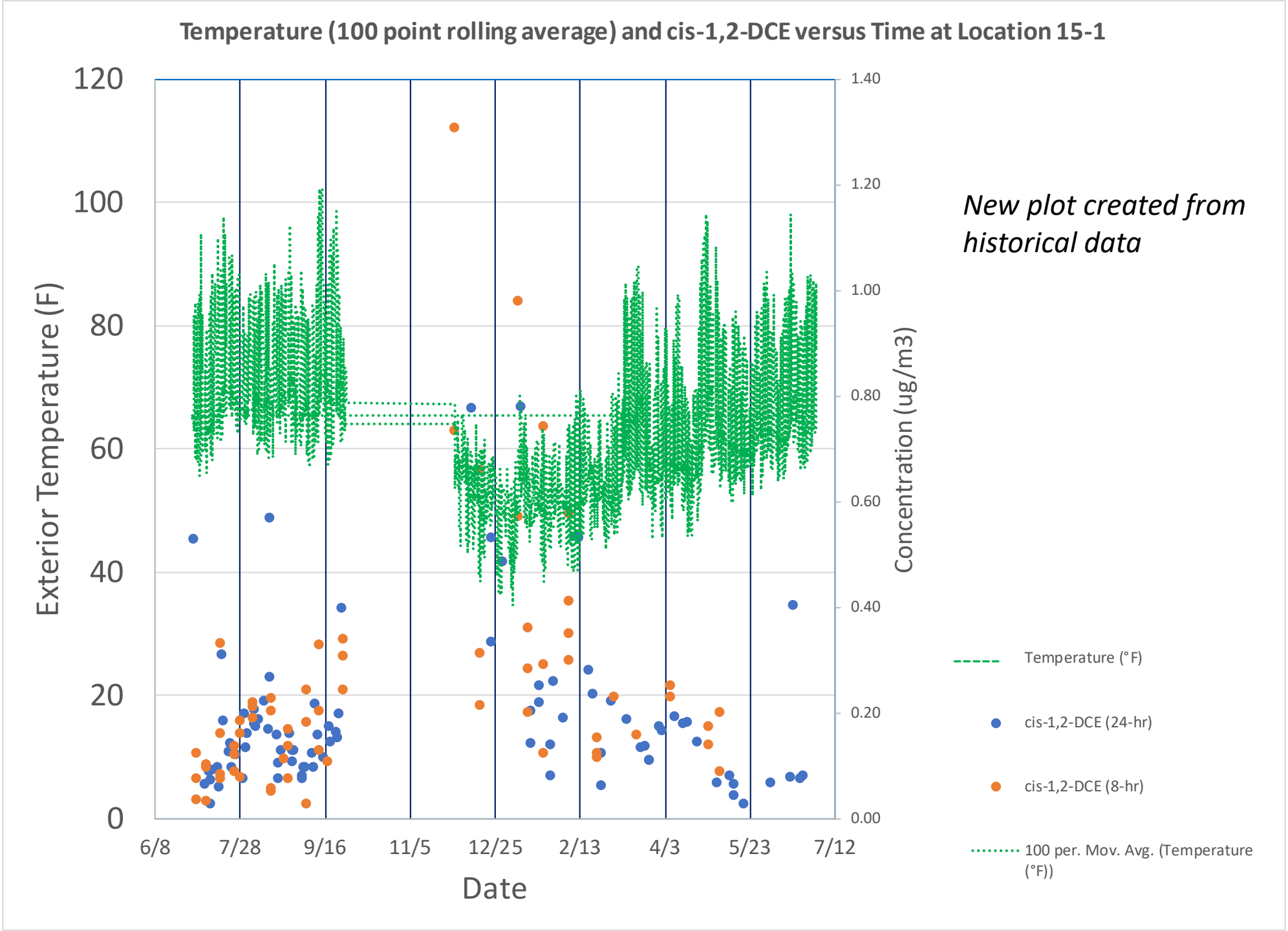
New plot created from historical data

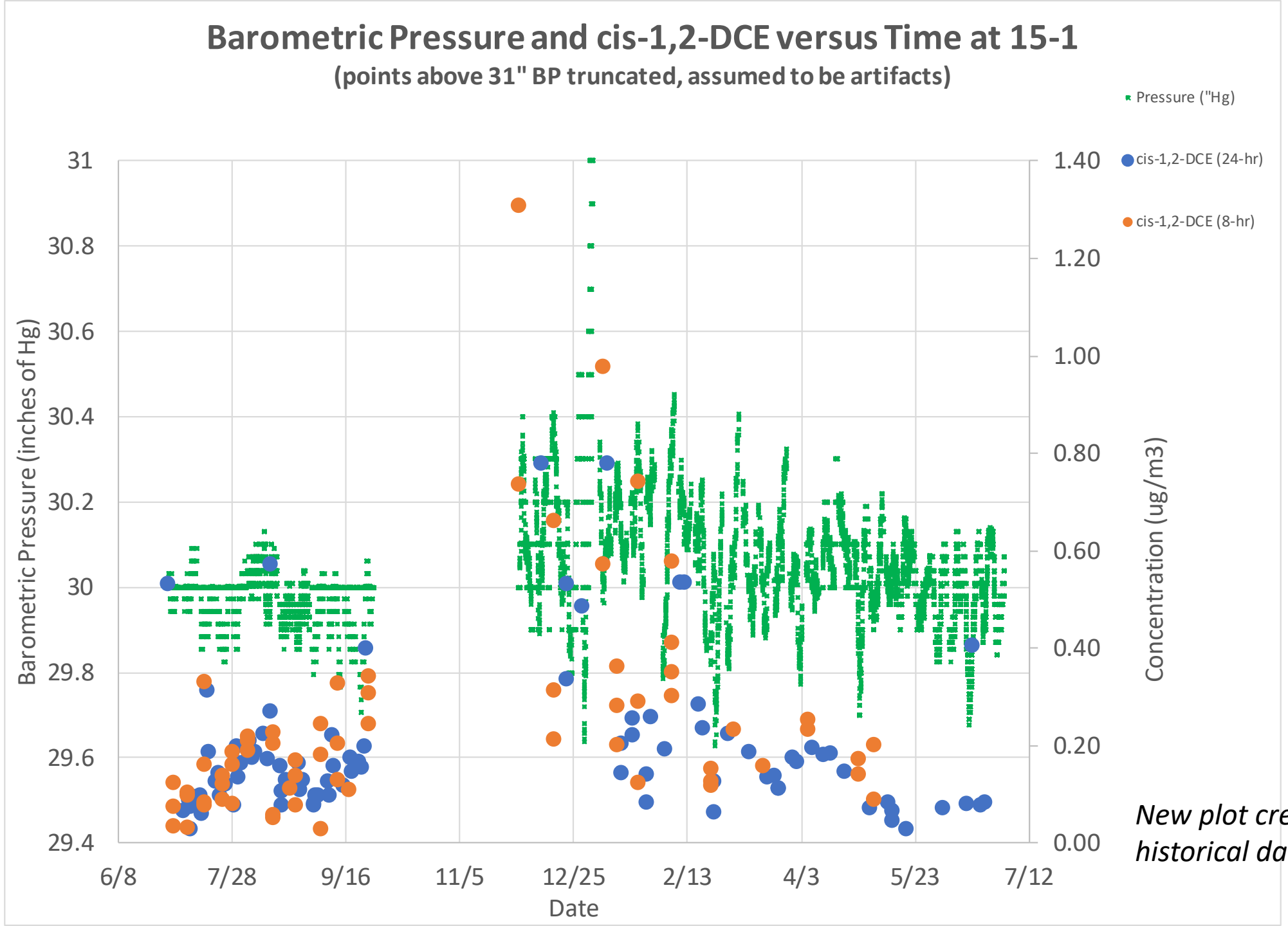
Maximum Daily cis-1,2-DCE Concentrations Buildings 15 and 17

- Peak concentrations December 2003 to March 2004

Note this original is likely a line chart not XY chart

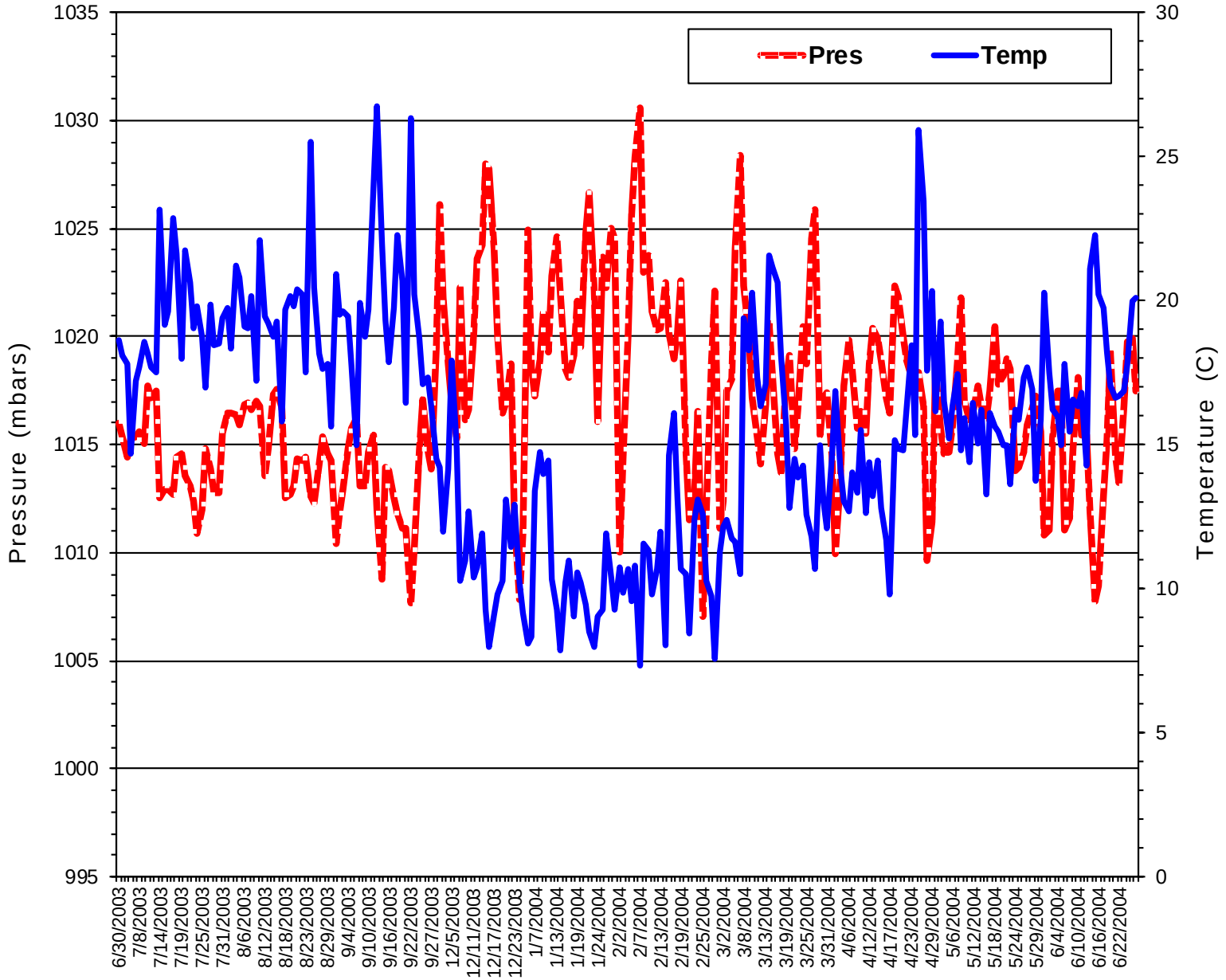



Temperature (100 point rolling average) and cis-1,2-DCE versus Time at Location 15-1
Exterior Temperature (F)
Concentration (ug/m3)
Date
120
100
80
60
40
20
0
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
6/8
7/28
9/16
11/5
12/25
2/13
4/3
5/23
7/12
New plot created from historical data
Temperature (°F)
cis-1,2-DCE (24-hr)
cis-1,2-DCE (8-hr)
100 per. Mov. Avg. (Temperature (°F))



New plot created from historical data

Barometric Pressure and Temperature



Building 15 Results and Conclusions from Original Paper

- For building 15 location 1 data (102 samples) are presented as box and whisker plots for each of 12 nonsequential months. The maximum monthly 95th percentile was approximately 4 µg/m^3 and the minimum monthly 5th percentile was 0.2 µg/m^3. The monthly median range was about 0.25 to 1.5 µg/m^3
- Statistical analysis showed TCE and cis -1,2-DCE were different from background ($p<0.001$), benzene was not
- *"Monthly seasonal variability analysis showed that the indoor air concentration in the four subject buildings was highest in the winter and lowest during the summer months.*
- *The empirical evidence presented shows that the measured indoor air concentration was related to the outdoor air temperature and the depth to groundwater.*
- *Although there appears to be diurnal variation in the concentrations of the primary analytes, as measured by the sequence of three 8-hr samples, the overall differences during the day are small and do not change the overall conclusions drawn from the 24-hr canister samples.*
- *Day-to-day variation over 1 month of sampling generally only varied by a small amount, typically a factor of approximately 2.*

Analysis/Conclusions from Original Paper

- *"Measured indoor air concentration was further investigated by developing multiple linear regression models that accounted for the measured meteorological conditions as reflected in the average daily outdoor air temperature, atmospheric pressure, wind speed, and wind direction. …*
- *These same four meteorological parameters had little or no effect on the measured TCE concentrations. At five locations (15-1, 15-2, 17-1, A17, and B258) none of the four meteorological parameters had a significant effect on the measured concentrations.*
- *At the remaining five locations (17-2, 16-1, 16-2, 20-1, 20-2) the primary meteorological parameters affecting the measured indoor TCE concentrations varied by location. Outdoor temperature and wind speed seemed to have the greatest impact on the greatest number of locations.*
- *For the infiltration pathway (benzene) and the vapor intrusion pathway (TCE), this can be because of building depressurization (wind speed), the stack effect because of heating (temperature), or the use of natural ventilation (temperature and wind speed). However, it would appear that over the range of meteorological conditions measured during the study period, infiltration of benzene from the outdoor air was more affected by the meteor-logical conditions than vapor intrusion of TCE from the subsurface."*

Observations from New Plots

- Low temperature appears correlated with VOCs
- Possible visual associations between pressure swing events and high VOCs
- 8 hr samples appear to show higher peak concentrations