Pace Analytical®

Single Tube Sampling and Analysis of Volatile and Semi-Volatile Organics in Air. The Cost Effective Green Solution

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Working Together to Protect Our Environment and Improve Our Health

Outline

- Introduction
- Traditional Air Methods
- Thermal Desorption
- The data and performance
- Results from site sampling

Traditional Air Methods Overview

Typical air methods include (example: perimeter monitoring):

PM10 (particulates)

TO-15 (VOCs)

TO-13 (PAHs)

TO13 Overview

- Heavy solvent use
- Requires an electrician for on-site sampling
- Expensive equipment
- Labor and time intensive
- 7-day holding time

Extraction time measured in days…
…plus liters of solvent!

TO15 Overview

- Whole air sampling
- Proven Method – Gold Standard for Volatiles
- Generally fixed reporting limits
- Bulky and higher shipping costs
- Labor and supply intensive

TO17 (Thermal Desorption) Overview

- Variable sampling volume to achieve desired reporting limits
- Highly portable with greatly reduced shipping and sampling costs
- Enables single tube sampling encompassing both TO13 and TO15 analyte lists (gases to heavy PAHs)
- Available hydrophobic sorbents enable high volume sampling
- Numerous applications
  - Vapor intrusion
  - Source testing
  - Site monitoring

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Automated Thermal Desorption Gas Chromatograph/ Mass Spectrometry (ATD/GC/MS)

What is Thermal Desorption?

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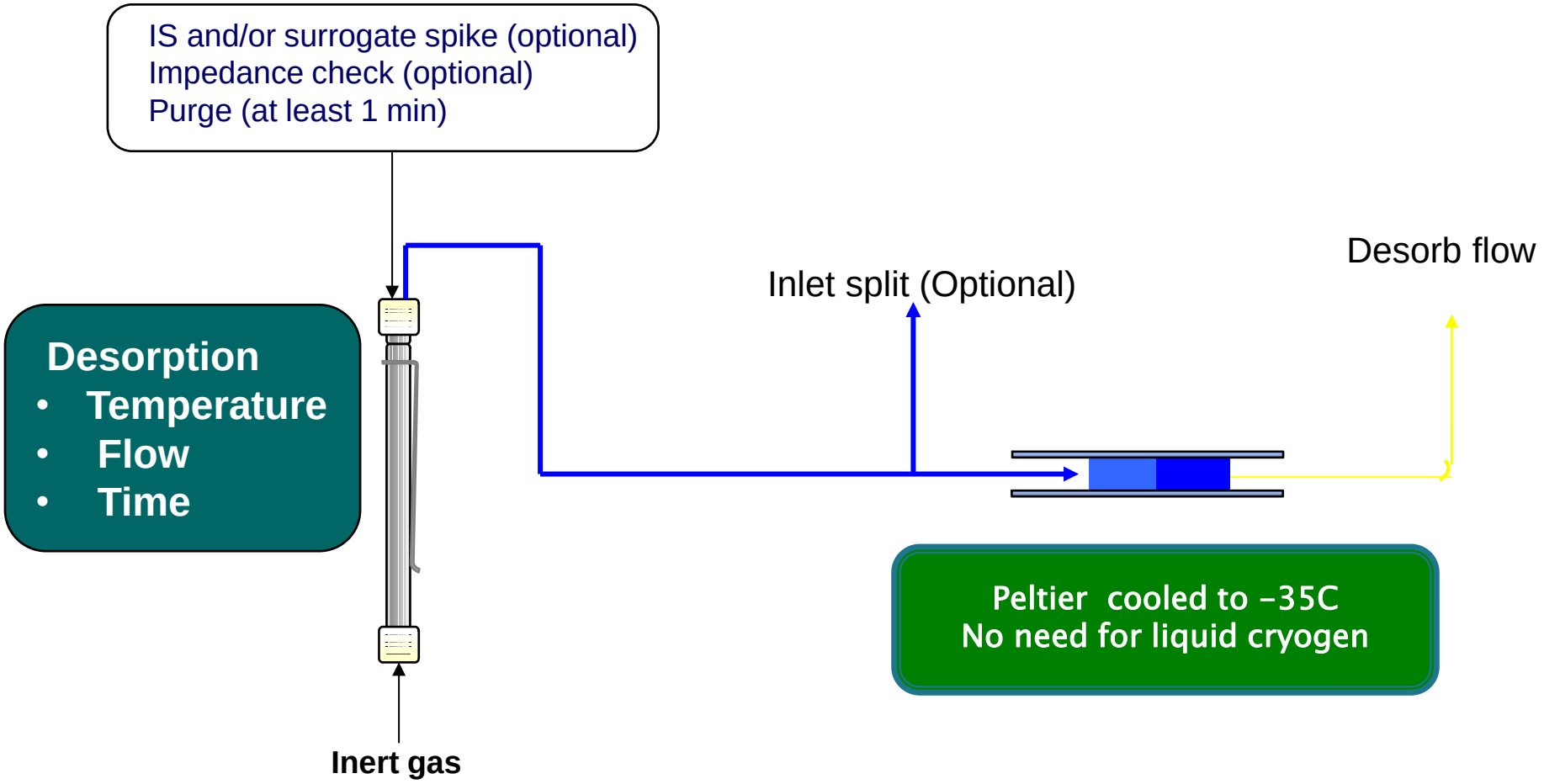
- Thermal desorption (TD) is the process of collection and desorption of analytes from solid sorbents using heat and a flow of inert gas, rather than solvent extraction.
- Analytes are then focused onto a cold trap prior to entering the analytical column, resulting in higher responses and narrow, more symmetric peaks
- TD is highly sensitive and can significantly lower detection limits

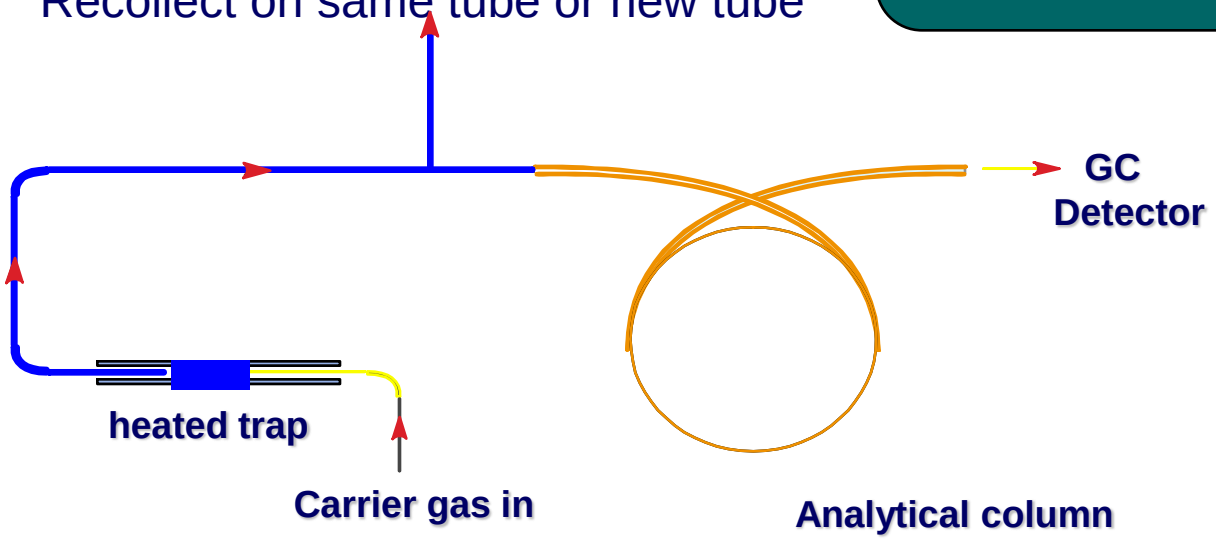
Step 1: Sample Tube Primary Desorption



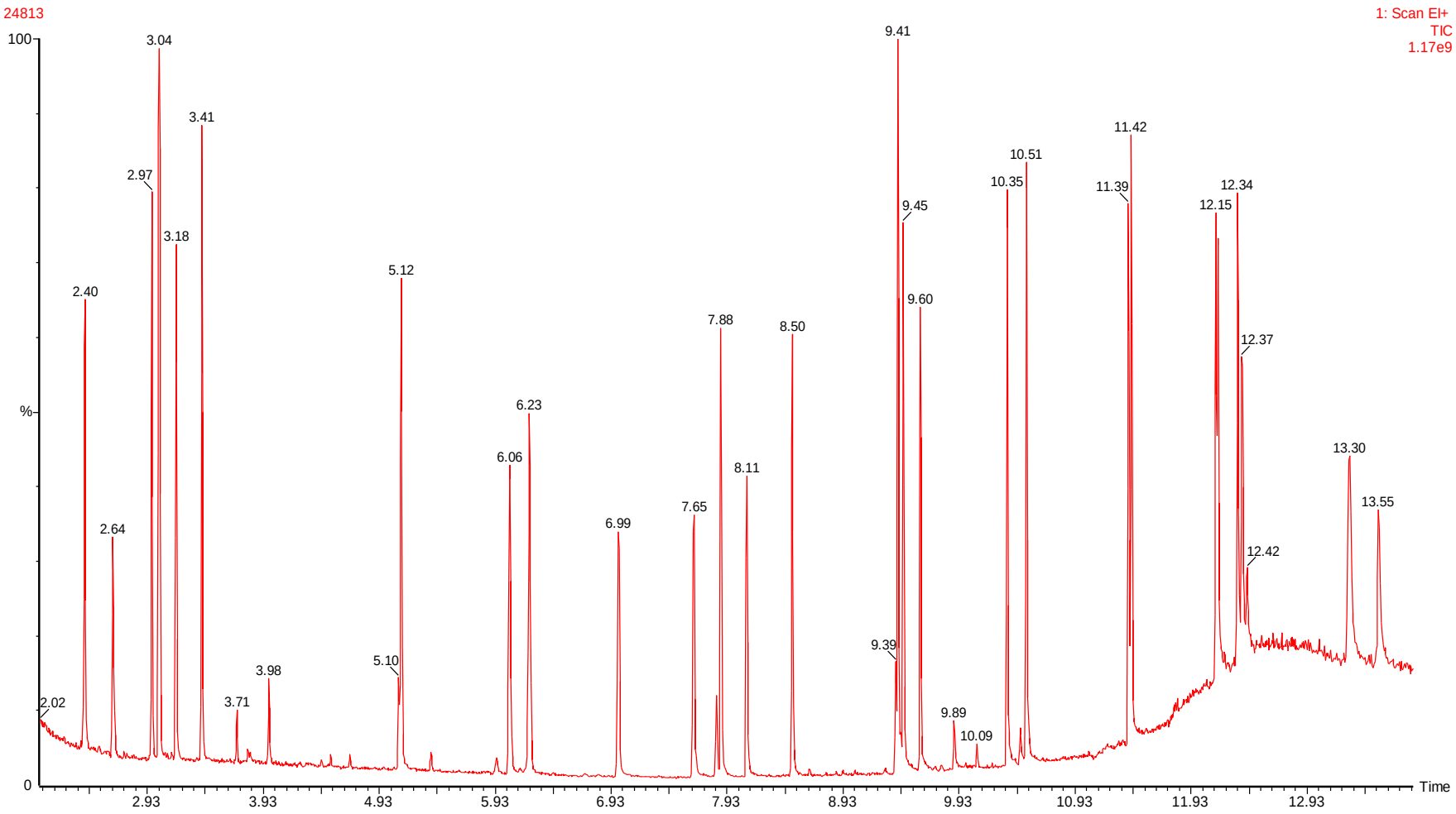
Stage 2: Transfer of Sample to Analytical Column

Column Flow = 2.5mL/min
Recollect Flow = 10mL/min
%Recollected = 80%

Optional 'outlet' split or
Recollect on same tube or new tube



Example Chromatogram (BTEX + PAHs)



What is Breakthrough?

- Occurs when target (regulated) compounds are not adsorbed by adsorbents
- EPA TO-17 definition "The volume sampled when the amount of analyte collected in a back-up sorbent tube reaches a certain percentage (typically 5%) of the total amount collected by both sorbent tubes"

Results of Laboratory Breakthrough

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- A primary TD tube was attached to a gaseous standard to continuously deliver target compounds to mimic a real-world sampling event
- A BT tube was attached and monitored on a regular basis.
- Ultimately the primary tube was loaded with >200mg analyte with no detectable breakthrough

Target Analyte	% BT	% BT	% BT
Benzene	nd	nd	nd
Toluene	nd	nd	nd
Ethyl Benzene	nd	nd	nd
m & p - Xylenes	nd	nd	nd
o - Xylene	nd	nd	nd
Naphthalene	nd	nd	nd
2-Methylnaphthalene	nd	nd	nd
1-Methylnaphthalene	nd	nd	nd
Acenaphthylene	nd	nd	nd
Acenaphthene	nd	nd	nd
Fluorene	nd	nd	nd
Phenanthrene	nd	nd	nd
Anthracene	nd	nd	nd
Fluroanthene	nd	nd	nd
Pyrene	nd	nd	nd
Benzo[a]anthracene	nd	nd	nd
Chrysene	nd	nd	nd
Benzo[b&k]fluoranthene	nd	nd	nd
Benzo[e]pyrene	nd	nd	nd
Benzo[a]pyrene	nd	nd	nd
Indeno[1,2,3-c,d]pyrene	nd	nd	nd
Dibenz[a,h]anthracene	nd	nd	nd
Benzo[g,h,i]perylene	nd	nd	nd

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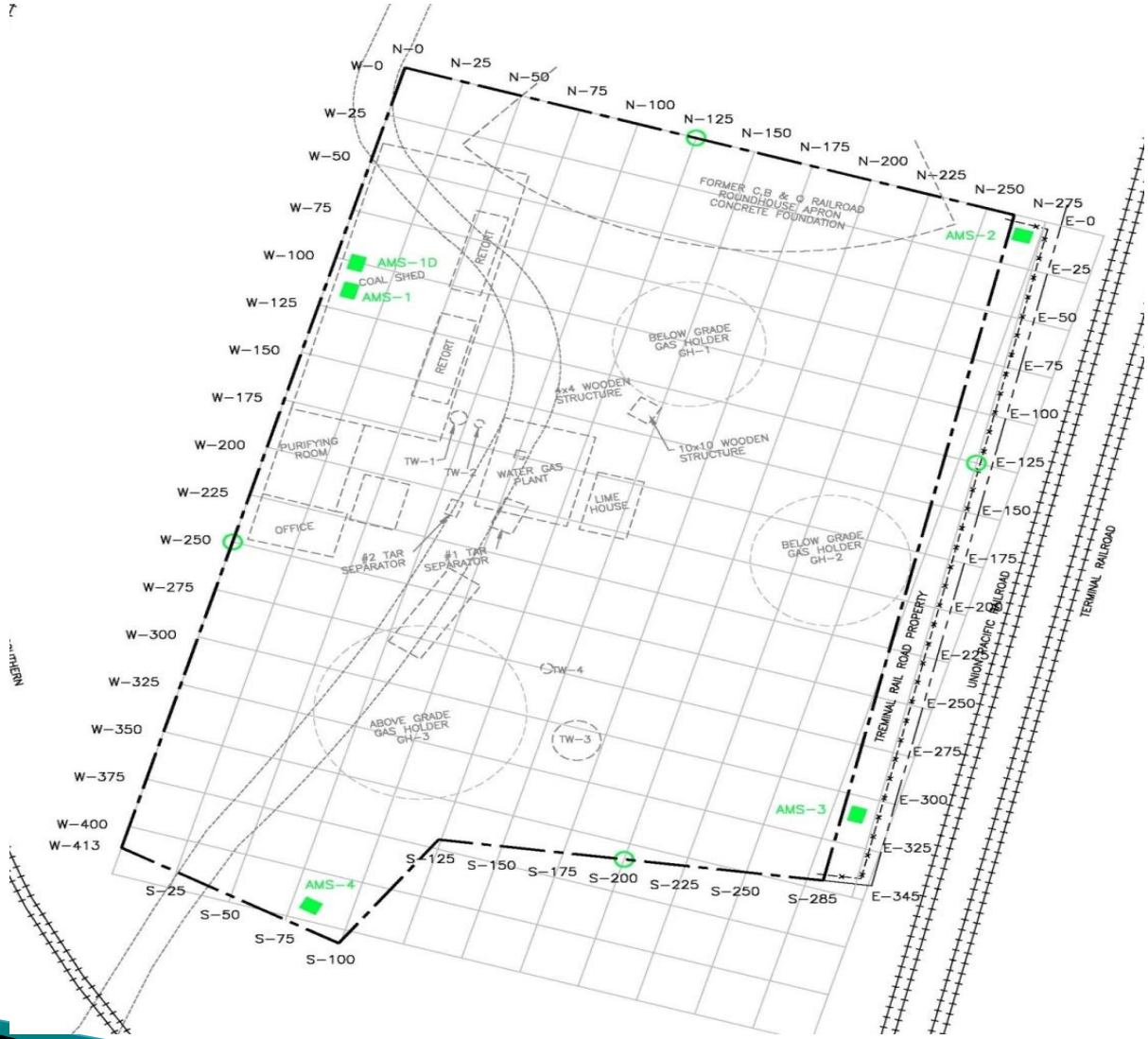
Site Study

Experiments and Results

Air Monitoring Study Parameters

- Compare TO-13, TO-15, and TO-17 results from an active MGP remediation site
- 72-hour sample collection periods
- Two sample locations selected (AMS-01 and AMS-03)
- Three 72-hour samples from each site were selected for comparison

Site Map


N-0
N-25
N-50
N-75
N-100
N-125
N-150
N-175
N-200
N-225
N-250
N-275
W-0
W-25
W-50
W-75
W-100
W-125
W-150
W-175
W-200
W-225
W-250
W-275
W-300
W-325
W-350
W-375
W-400
W-413
E-0
E-25
E-50
E-75
E-100
E-125
E-150
E-175
E-200
E-225
E-250
E-275
E-300
E-325
E-345
S-25
S-50
S-75
S-100
S-125
S-150
S-175
S-200
S-225
S-250
S-285
AMS-1D
AMS-1
AMS-2
AMS-3
AMS-4
COAL SHED
RETORT
RETORT
FORMER C.B. & Q. RAILROAD ROUNDHOUSE APRON CONCRETE FOUNDATION
BELOW GRADE GAS HOLDER GH-1
4x4 WOODEN STRUCTURE
10x10 WOODEN STRUCTURE
PURIFYING ROOM
TW-1
TW-2
WATER GAS PLANT
LIME HOUSE
OFFICE
#2 TAR SEPARATOR
#1 TAR SEPARATOR
BELOW GRADE GAS HOLDER GH-2
TW-4
ABOVE GRADE GAS HOLDER GH-3
TW-3
TERMINAL RAIL ROAD PROPERTY
UNION PACIFIC RAILROAD
TERMINAL RAILROAD

Site Setup

TO-17 PAH Sample Configuration

Sample Volumes

72 Hour Sampling Duration

- TO-13 = ~1,000,000 Liters (1000 m^3)
- TO-15 = 6 Liters
- TO-17 = ~45 Liters

Results from the Study – AMS-01

Sample ID	AMS-01-081313		AMS-01-081613		AMS-01-082213	
Analyte	TO13 & 15 ug/m3	TO17 ug/m3	TO13 & 15 ug/m3	TO17 ug/m3	TO13 & 15 ug/m3	TO17 ug/m3
Benzene	0.68	0.38	0.50	0.56	1.9	0.75
Ethyl Benzene	1.8	0.15	1.4	0.29	5.1	0.66
Toluene	15	1.3	1.6	1.1	8.3	1.6
m,p-Xylene	3.7	0.44	2.8	0.83	10	1.53
o-Xylene	1.80	0.14	1.4	0.24	5.1	0.47
Naphthalene (TO15)	1.4	3.1	2.9	1.1	6.2	1.10
Naphthalene (TO13)	0.68	3.1	0.68	1.1	0.082	1.10
2-Methylnaphthalene	0.25	0.62	0.33	0.26	0.044	0.26
1-Methylnaphthalene	0.12	0.26	0.17	0.16	0.031	0.29
Acenaphthylene	0.0058	0.066	0.0073	0.045	0.011	0.065
Acenaphthene	0.13	0.30	0.18	0.14	0.039	0.42
Fluorene	0.070	0.12	0.10	0.042	0.037	0.16
Phenanthrene	0.076	0.055	0.11	0.015	0.065	0.11
Anthracene	0.0039	0.080	0.0039	0.0040	0.0049	0.17
Fluoranthene	0.0092	0.0040	0.014	0.0047	0.021	0.0076
Pyrene	0.0050	0.0032	0.0073	0.0047	0.010	0.0044
Benzo(a)anthracene	0.0006	0.0067	0.0013	0.0047	0.00051	0.0044
Chrysene	0.00089	0.0046	0.0017	0.0047	0.0010	0.0044
Benzo(b+k)fluoranthene	0.00092	0.0088	0.0033	0.014	0.00062	0.0094
Benzo(e)pyrene	0.00051	0.0044	0.0013	0.0084	0.00050	0.0044
Benzo(a)pyrene	0.00048	0.0074	0.0013	0.0047	0.00050	0.0044
Indeno(1,2,3-cd)pyrene	0.00046	0.0044	0.0011	0.0047	0.00050	0.0044
Dibenz(a,h)anthracene	0.00046	0.0044	0.00050	0.0075	0.00050	0.0044
Benzo(g,h,i)perylene	0.00050	0.0081	0.0016	0.0047	0.00050	0.0044

Chart for Site AMS-01-081313

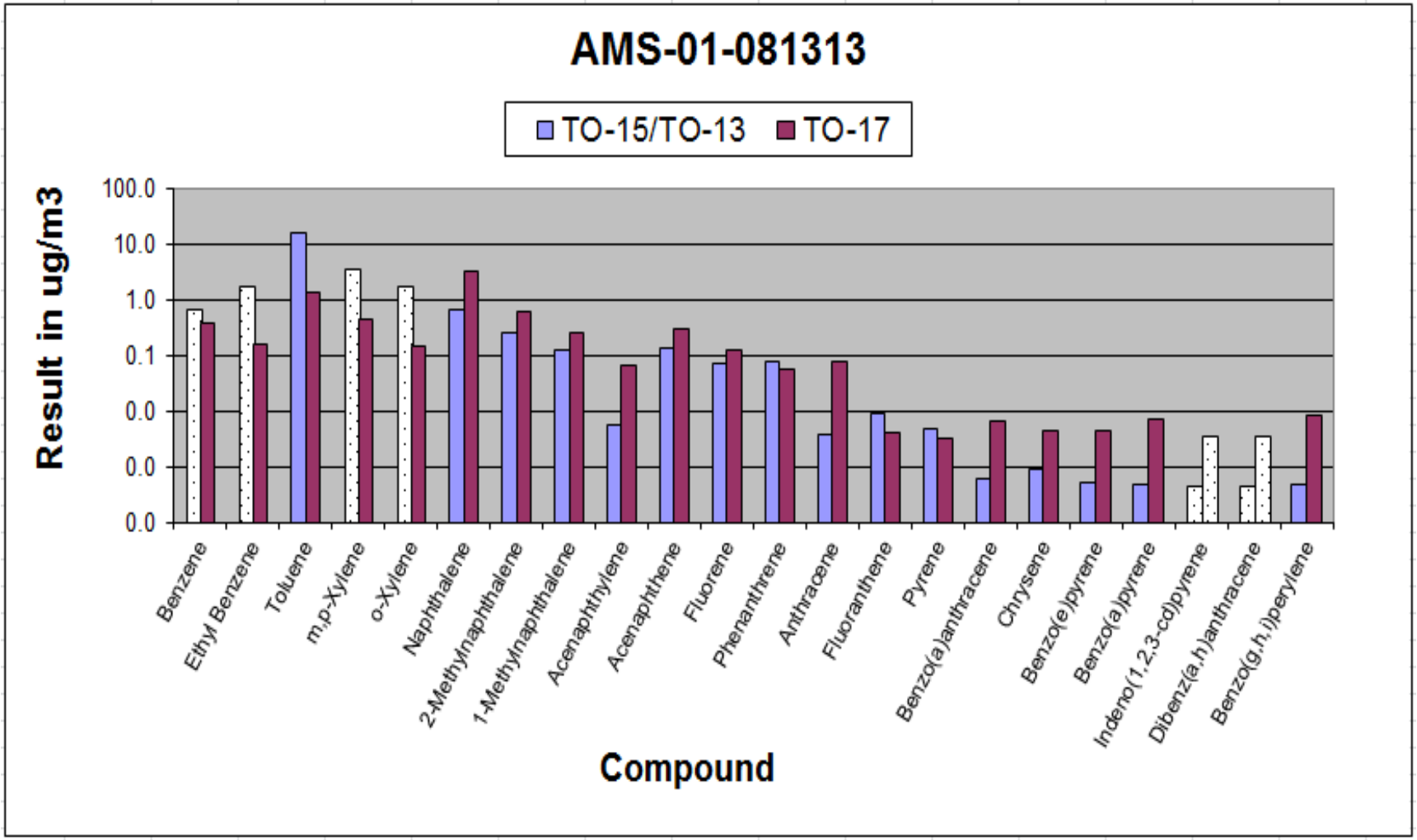


Chart for Site AMS-01-081613

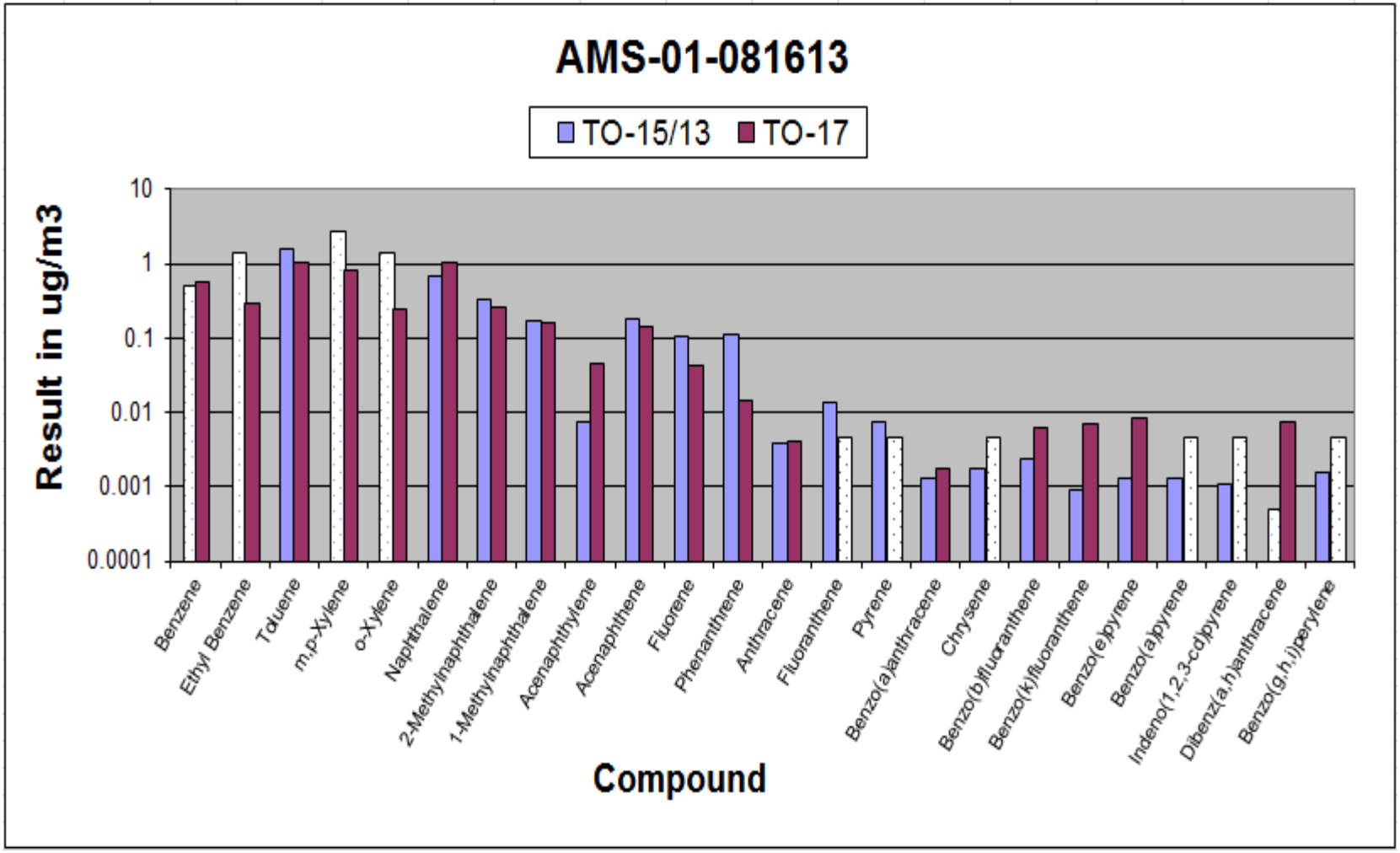
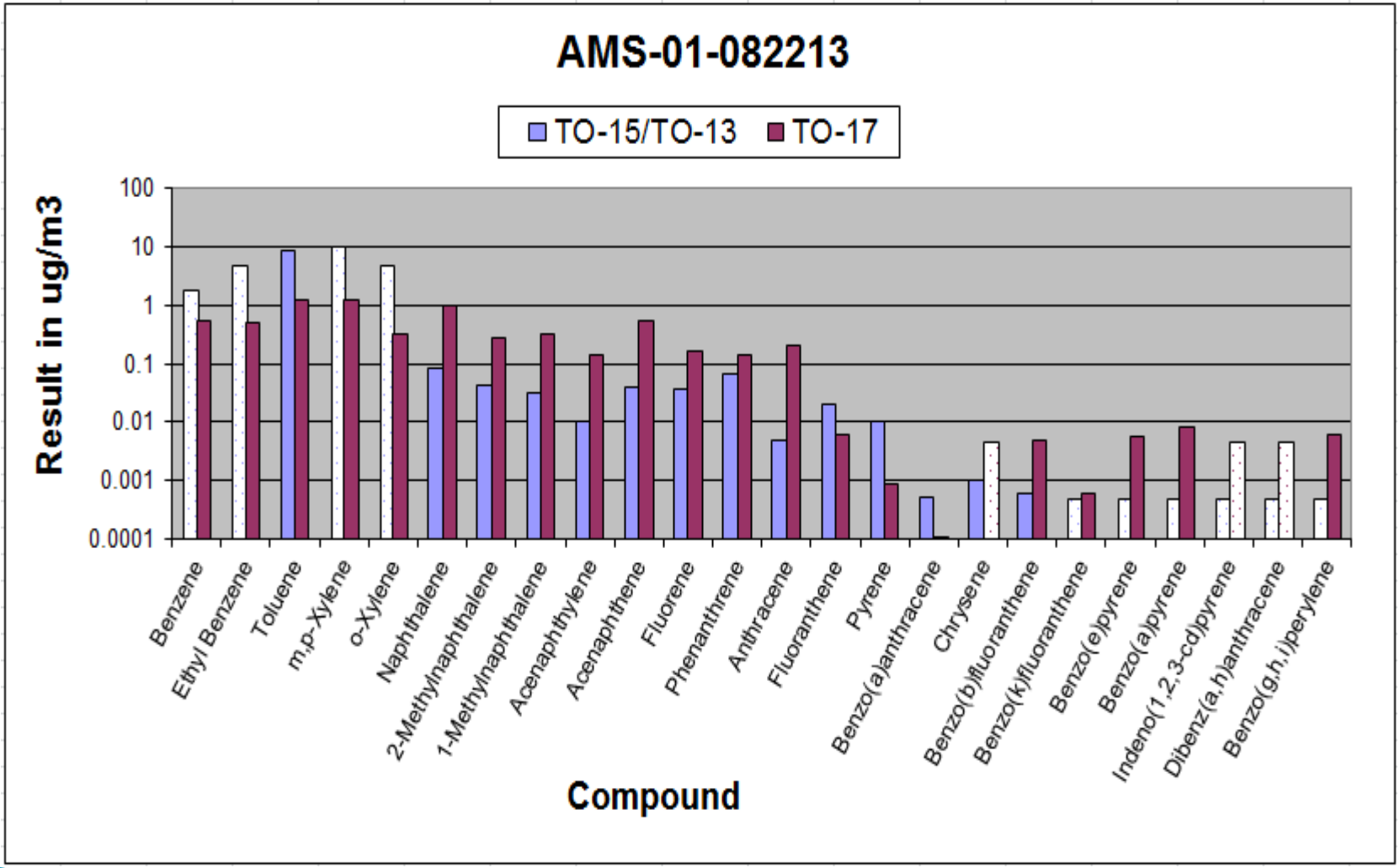


Chart for Site AMS-01-082213



Results from the Study – AMS-03

Sample ID	AMS-03-081313		AMS-03-081613		AMS-03-082213	
Analyte	TO13 & TO15 ug/m3	TO17 ug/m3	TO13 & 15 ug/m3	TO17 ug/m3	TO13 & 15 ug/m3	TO17 ug/m3
Benzene	0.52	0.54	1.20	0.56	1.2	0.48
Ethyl Benzene	1.4	0.29	1.4	0.29	3.2	0.78
Toluene	2	1.9	1.6	1.1	4.4	0.86
m,p-Xylene	2.8	0.87	2.8	0.83	6.5	0.91
o-Xylene	1.4	0.22	1.4	0.24	3.2	0.26
Naphthalene (TO15)	3.2	6.9	3.3	1.1	3.9	2.4
Naphthalene (TO13)	1.2	6.9	0.95	1.3	0.18	2.4
2-Methylnaphthalene	0.48	0.74	0.51	0.41	0.10	0.67
1-Methylnaphthalene	0.25	0.36	0.26	0.25	0.088	1.2
Acenaphthylene	0.023	0.12	0.0094	0.047	0.17	0.40
Acenaphthene	0.27	0.25	0.30	0.21	0.17	1.7
Fluorene	0.14	0.10	0.17	0.081	0.13	0.45
Phenanthrene	0.16	0.077	0.17	0.019	0.24	0.24
Anthracene	0.023	0.11	0.0061	0.0258	0.016	0.36
Fluoranthene	0.023	0.0092	0.017	0.0047	0.13	0.013
Pyrene	0.023	0.0043	0.0088	0.0047	0.027	0.0018
Benzo(a)anthracene	0.023	0.0051	0.0011	0.0047	0.00074	0.00029
Chrysene	0.023	0.0051	0.0016	0.0047	0.0014	0.0046
Benzo(b+k)fluoranthene	0.046	0.010	0.0027	0.0094	0.00091	0.0092
Benzo(e)pyrene	0.023	0.0051	0.0011	0.0047	0.00050	0.0046
Benzo(a)pyrene	0.023	0.0051	0.0010	0.0066	0.00050	0.0046
Indeno(1,2,3-cd)pyrene	0.023	0.0051	0.0009	0.0065	0.00050	0.0046
Dibenz(a,h)anthracene	0.023	0.0051	0.00050	0.0140	0.00050	0.0046
Benzo(g,h,i)perylene	0.023	0.0051	0.0013	0.0220	0.00050	0.015

Chart for Site AMS-03-081313

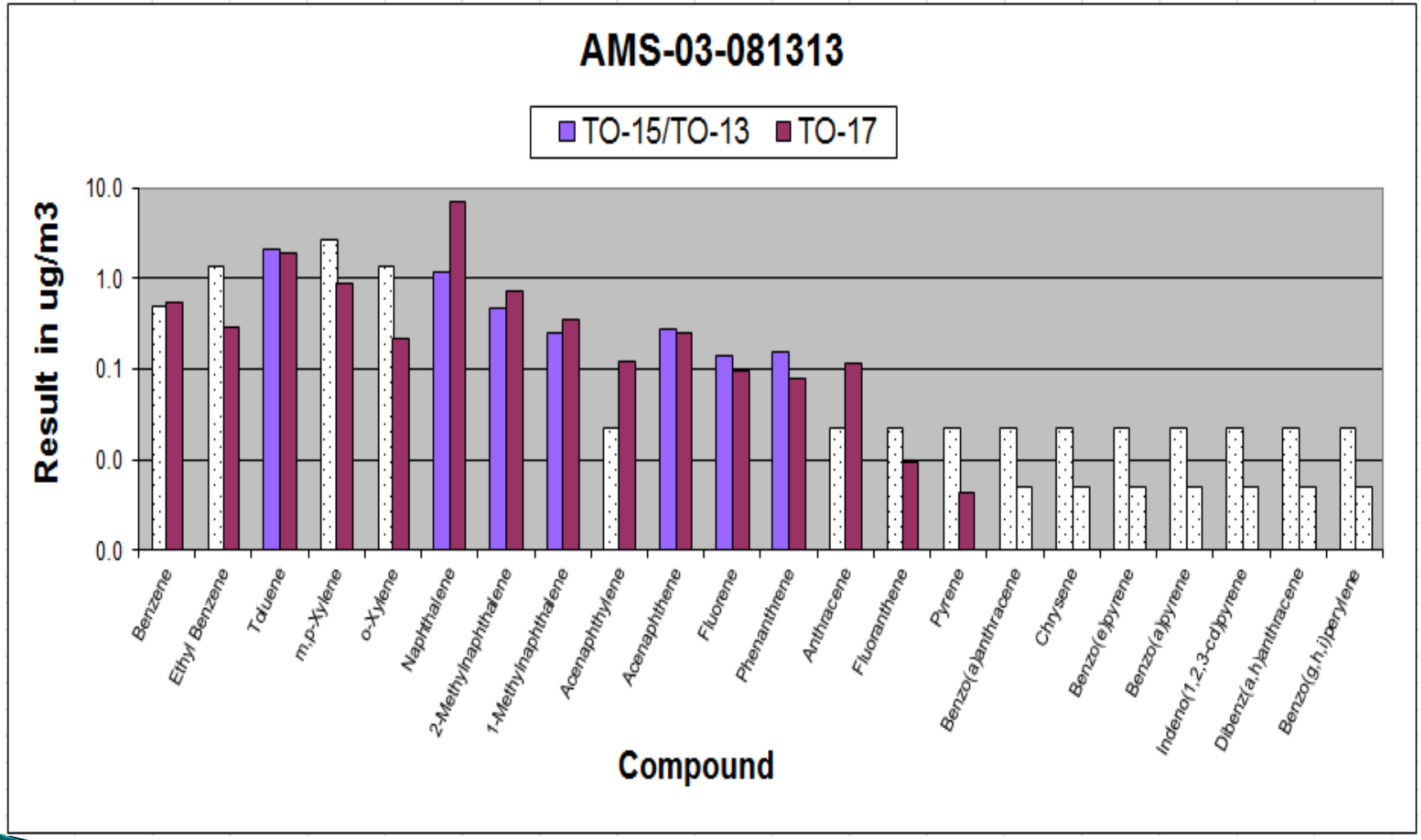


Chart for Site AMS-03-081613

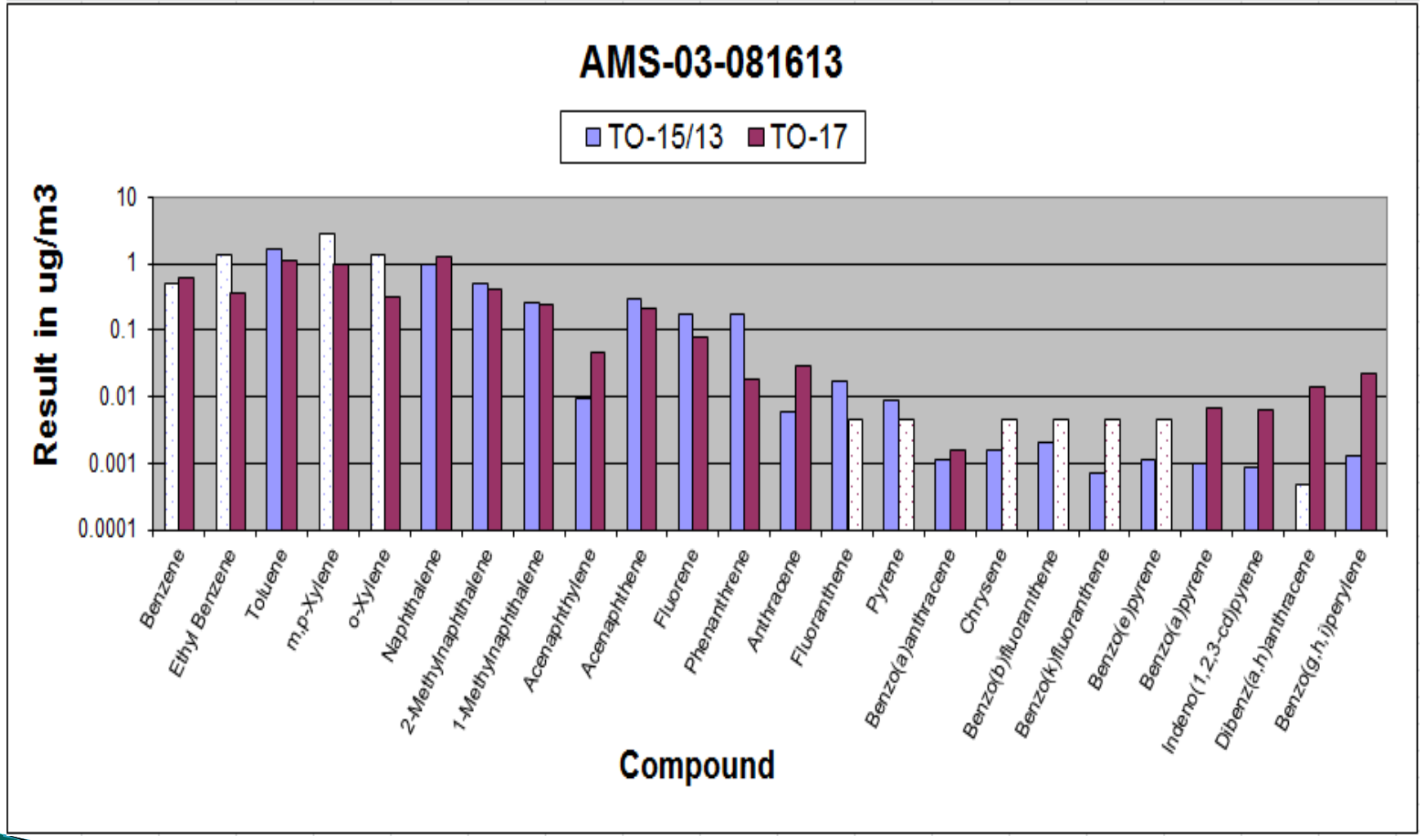
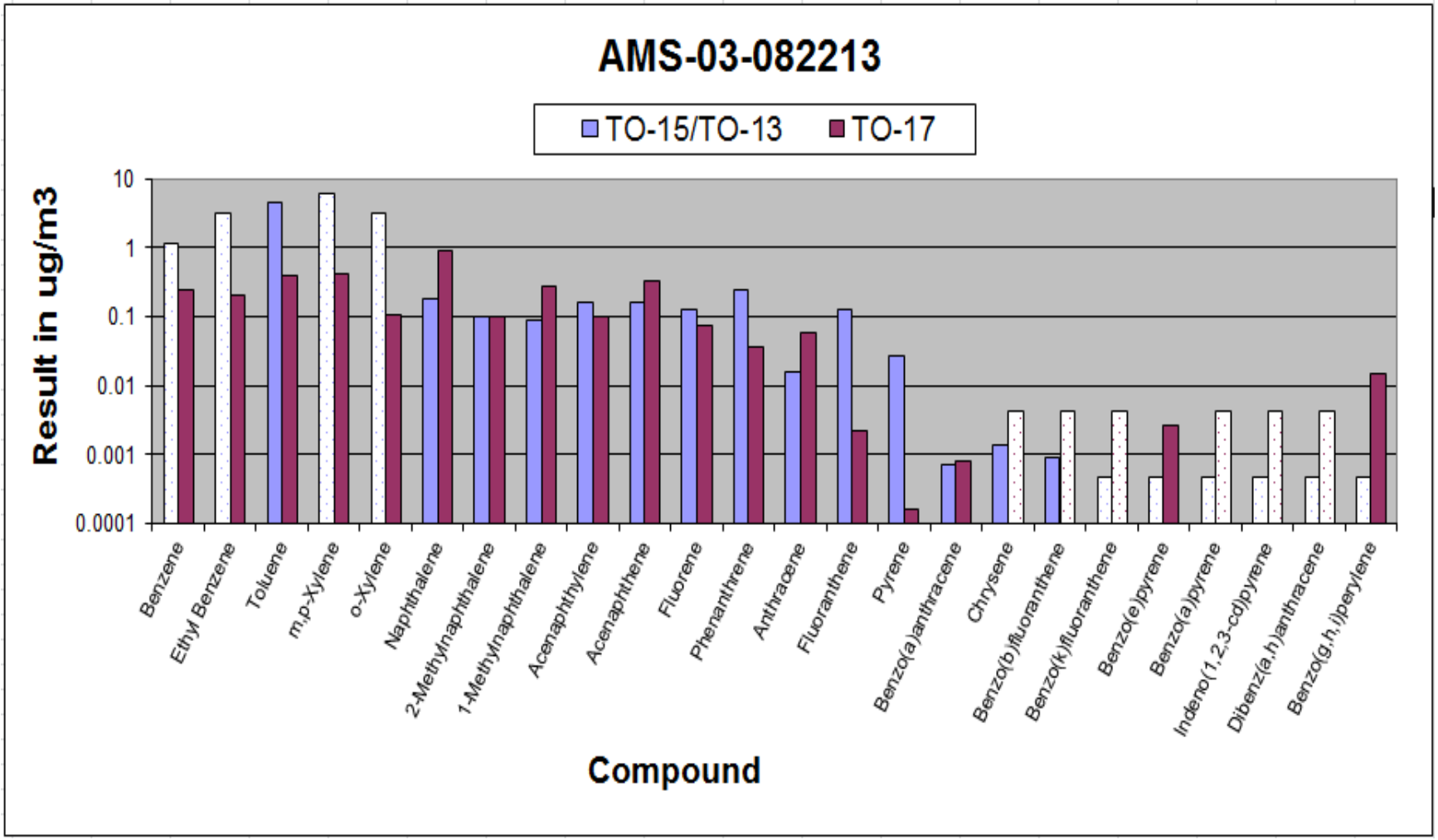


Chart for Site AMS-03-082213



Summary

- Analytical performance proves concept
- Site data suggests this is a better alternative
- One analysis instead of two:
  - Reduce solvent cost and disposal
  - Save on shipping and labor costs
  - Enhance productivity and efficiency
  - Better for our environment … A Greener analysis

Acknowledgments

- Roberta Provost, Air Method Development Specialist, Pace Analytical Services
- Lee Marotta, Senior Scientist, PerkinElmer Instruments
- Amy Jacobson, Specialty Services Manager, Pace Analytical Services

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Thank you!

Questions?

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