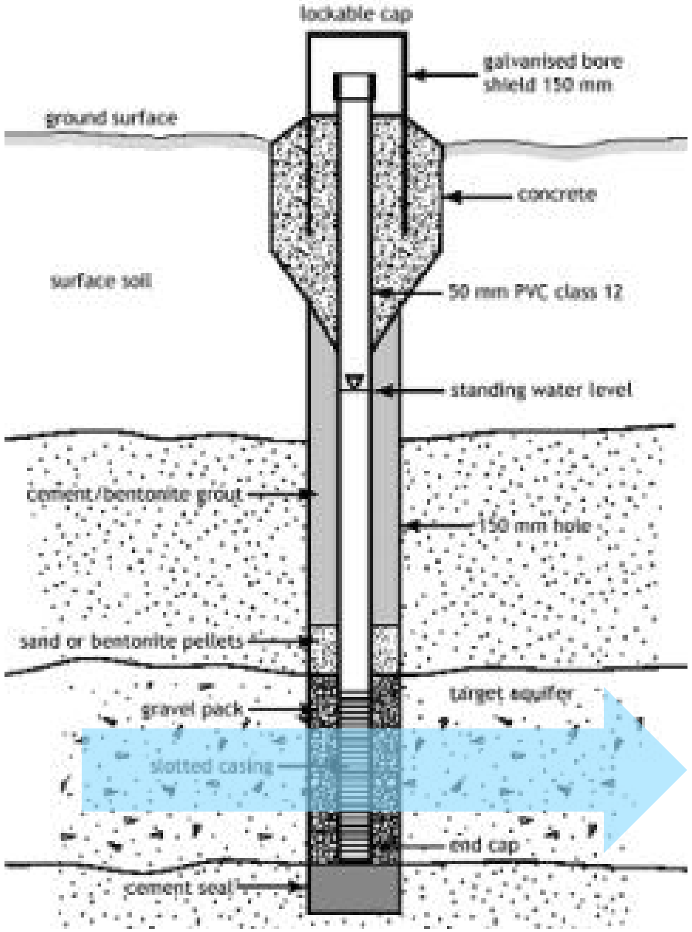
Advances in field sampling:

No-flow versus Low-flow

SEPTEMBER 2015

OVERVIEW

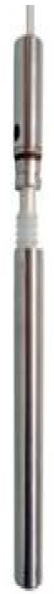
- Low-flow samplers used as standard for GMEs
- No-flow samplers
  - Also known as non-purge, passive, grab, snap, discrete interval samplers
  - 3 sizes of no-flow samplers used:
    - 0.6L & 2L (completed)
    - 1L (in progress)
- Trial at 2 sites with the same geology in western Melbourne
- Comparative results
- Stratification
- Data quality
- Technical acceptance
- Commercial benefits



Geoscience Australia 2009

NO-FLOW COMPARED TO LOW-FLOW

Low-flow (Micropurge®)



Advantages

- Purge parameter stabilisation
- Multi-task during sampling

Limitations

- Slow sampling
- Multiple equipment requirements
- Waste water disposal
- Under reports VOCs (Britt et al 2010)

No-flow (HydraSleeve™)

Advantages

- Limited equipment
- Simple set up (pre-sampling set up)
- Quick sampling
- No waste water disposal

Limitations

- No purge – single set of water quality parameter readings
- Large volume samplers

HYDRASLEEVE™ TRIALS – WESTERN MELBOURNE SITES

Site A

- Current major hazard facility
- Geology – Fractured basaltic rock
- Aquifer – Shallow 8-10mBGL, Seg C
- GME analytical suite: TRH, BTEX, naphthalene, lead

- Comparative trial conducted May 2013
  - x10 locations, 0.6L HydraSleeves™

Site B

- Former major hazard facility
- Geology – Fractured basaltic rock
- Aquifer – Shallow 8-10mBGL, Seg C
- GME analytical suite: TRH, BTEX, naphthalene, SVOCs, VOCs, phenols, metals, cyanide, inorganics

- Comparative trial conducted December 2014
  - x10 locations, 2L HydraSleeves™
- Comparative trial conducted September 2015
  - x10 locations, 1L HydraSleeves™

LOW-FLOW SAMPLER – MICROPURGE®

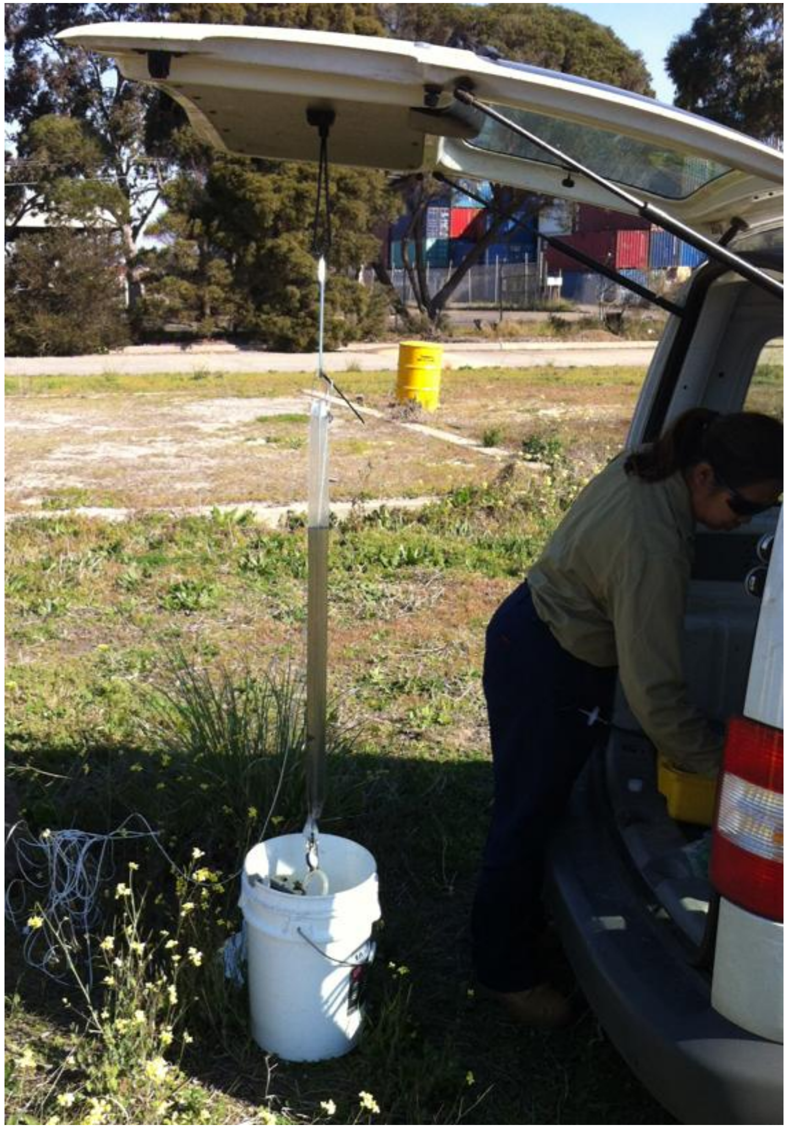
- → Lower the pump to required sample depth
- → Purge water until stabilised
- → Record water levels during pumping
- → Record field parameters (water quality meter)
- → Fill sample bottles:
  - Site A 10 locations
  - Site B 10 locations

- → Set up 0.25hr/well
- → Sampling time required 0.75hr/well

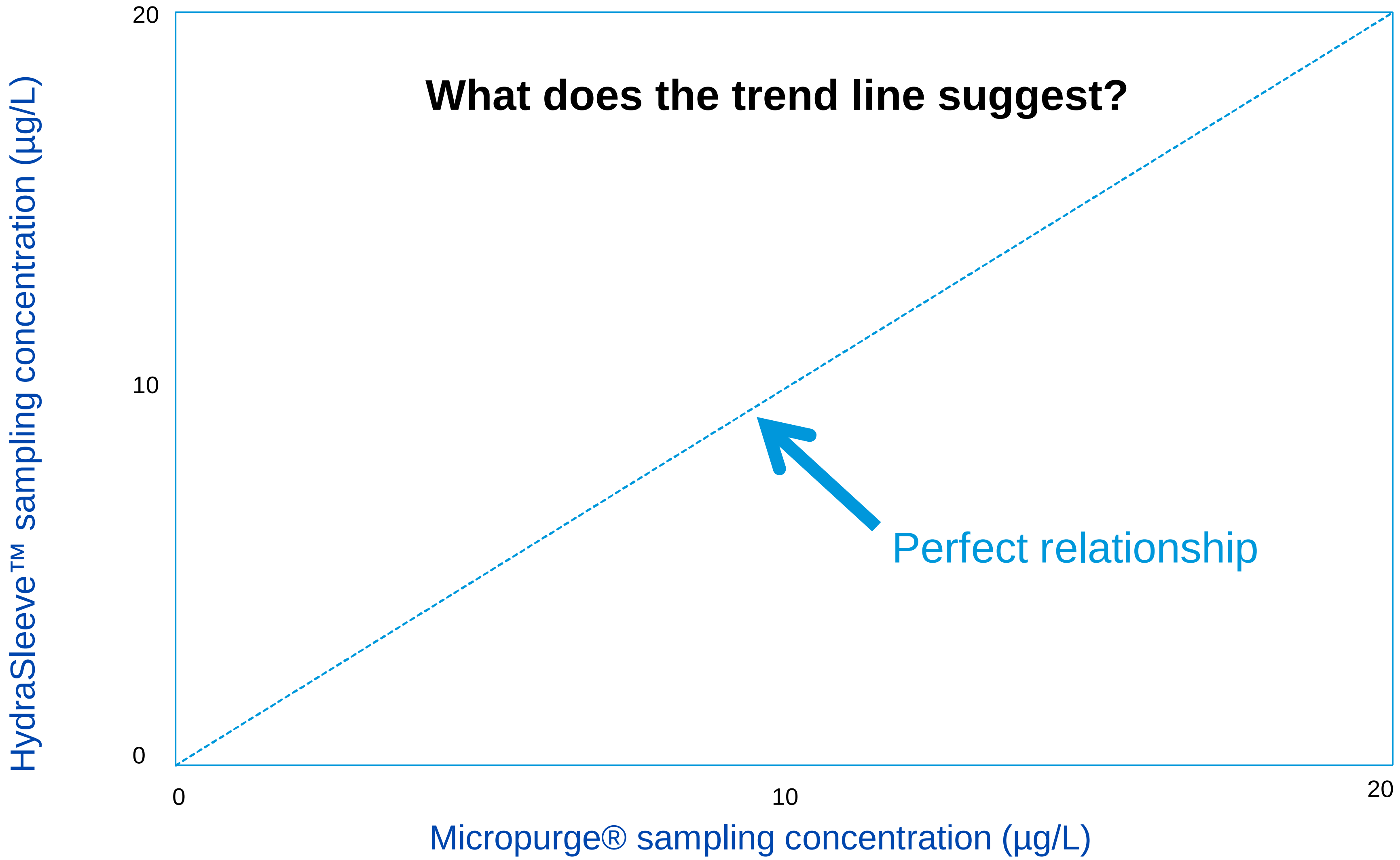
NO-FLOW SAMPLER – HYDRASLEEVE™

- Lower the weighted HydraSleeve™ to below required sample depth.
- Allow water column to equilibrate – max 1hr for 0.6L to 1L (3 days for 2L) samplers
- Retrieve HydraSleeve™, hang and fill sample bottles (straw):
  - Site A 10 locations - 0.6L samplers
  - Site B 10 locations – 2L samplers
  - Site B 10 locations – 1L samplers (in progress)
- Subsample transferred to purge cell for field parameters

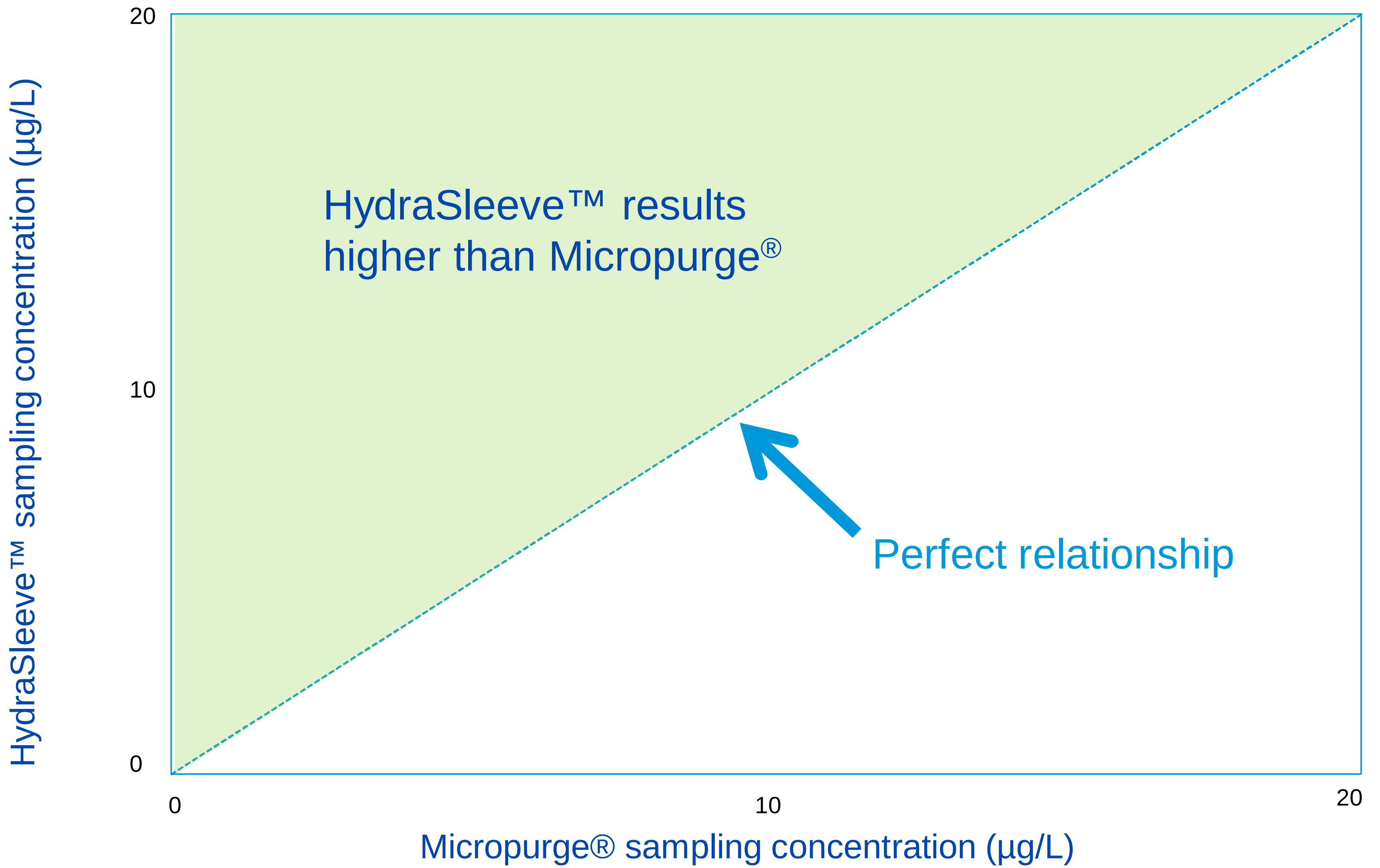
- Prep 0.2hr/well
- Sampling time required 0.5hr/well



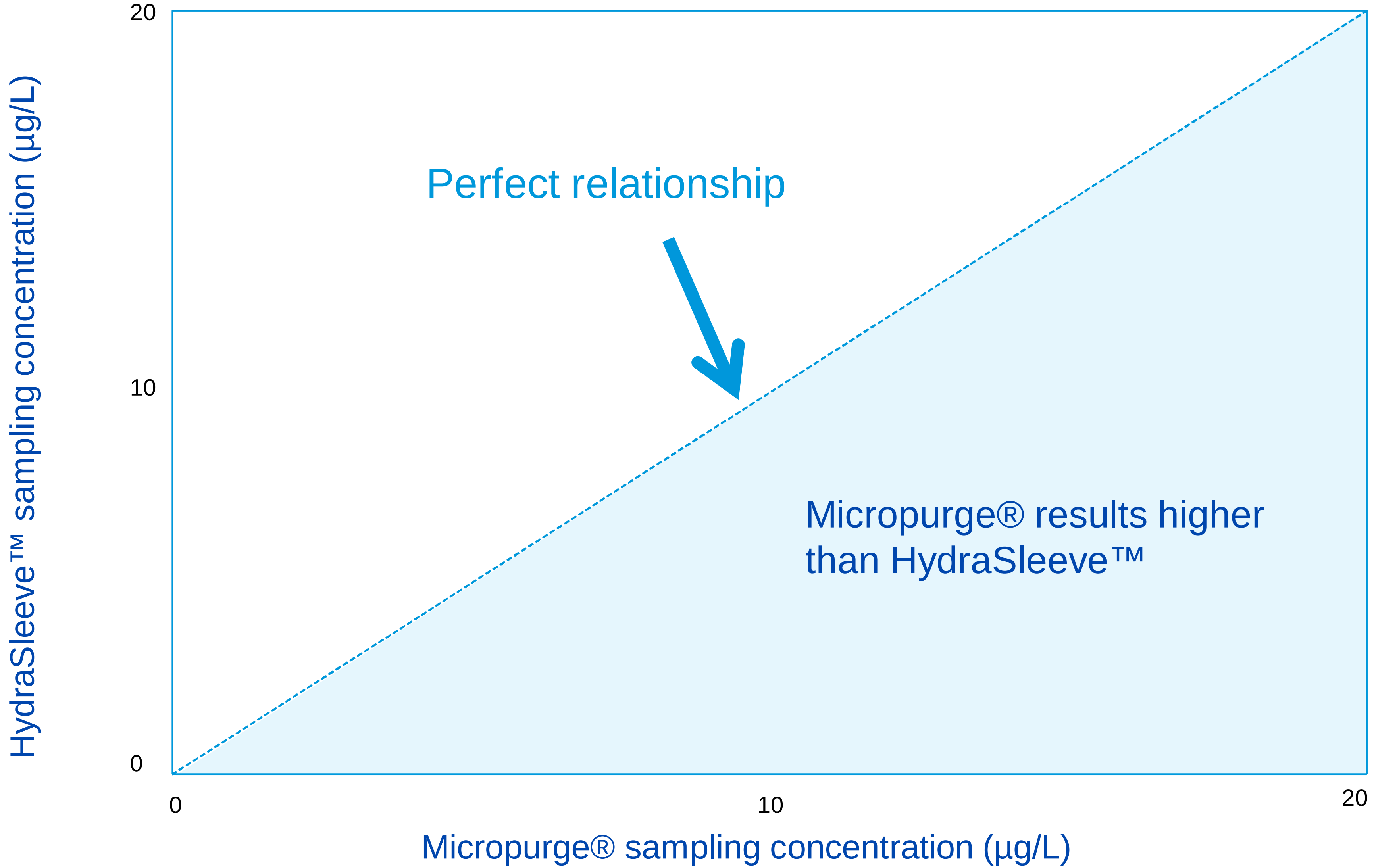
COMPARISON OF RESULTS



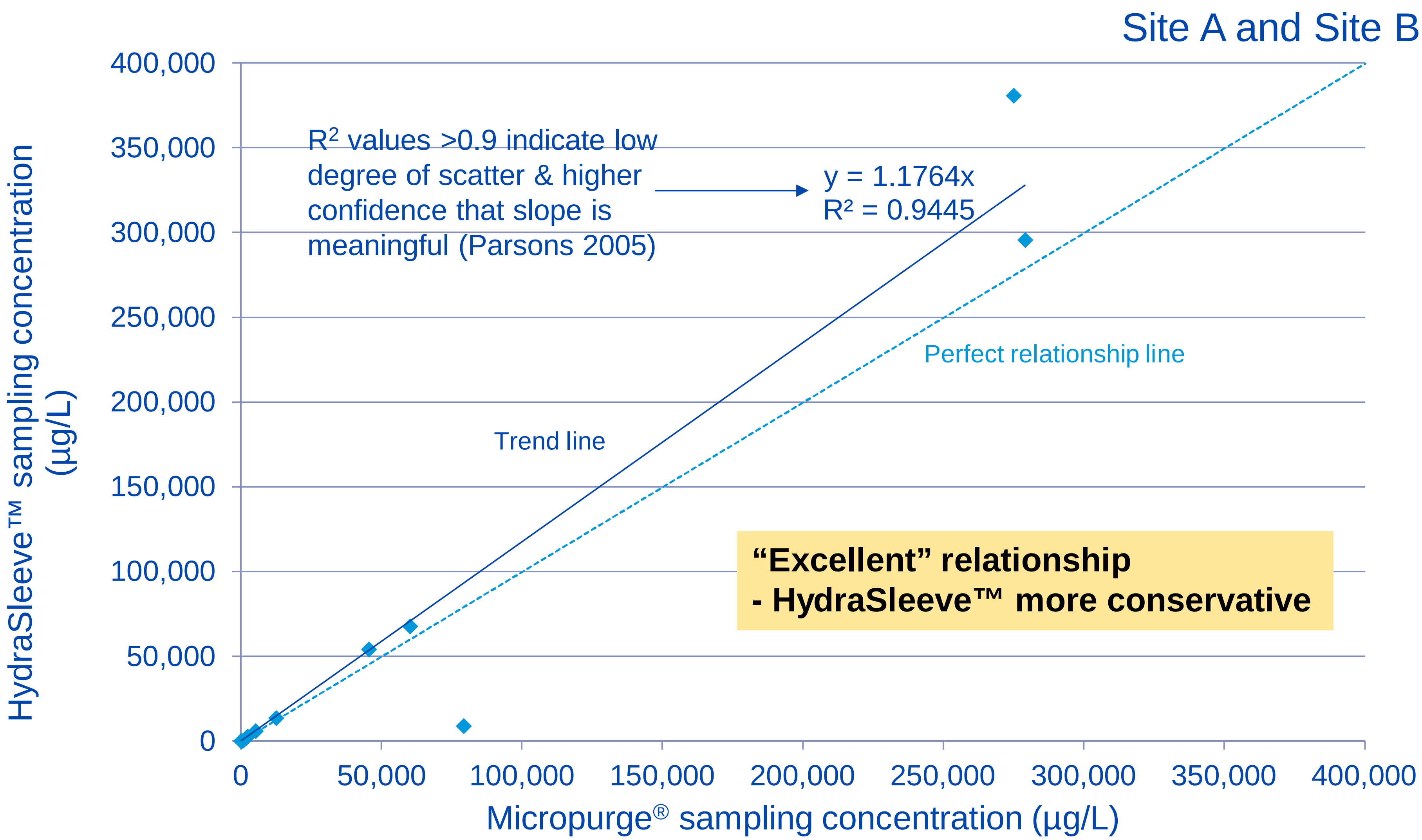
COMPARISON OF RESULTS



COMPARISON OF RESULTS



BENZENE



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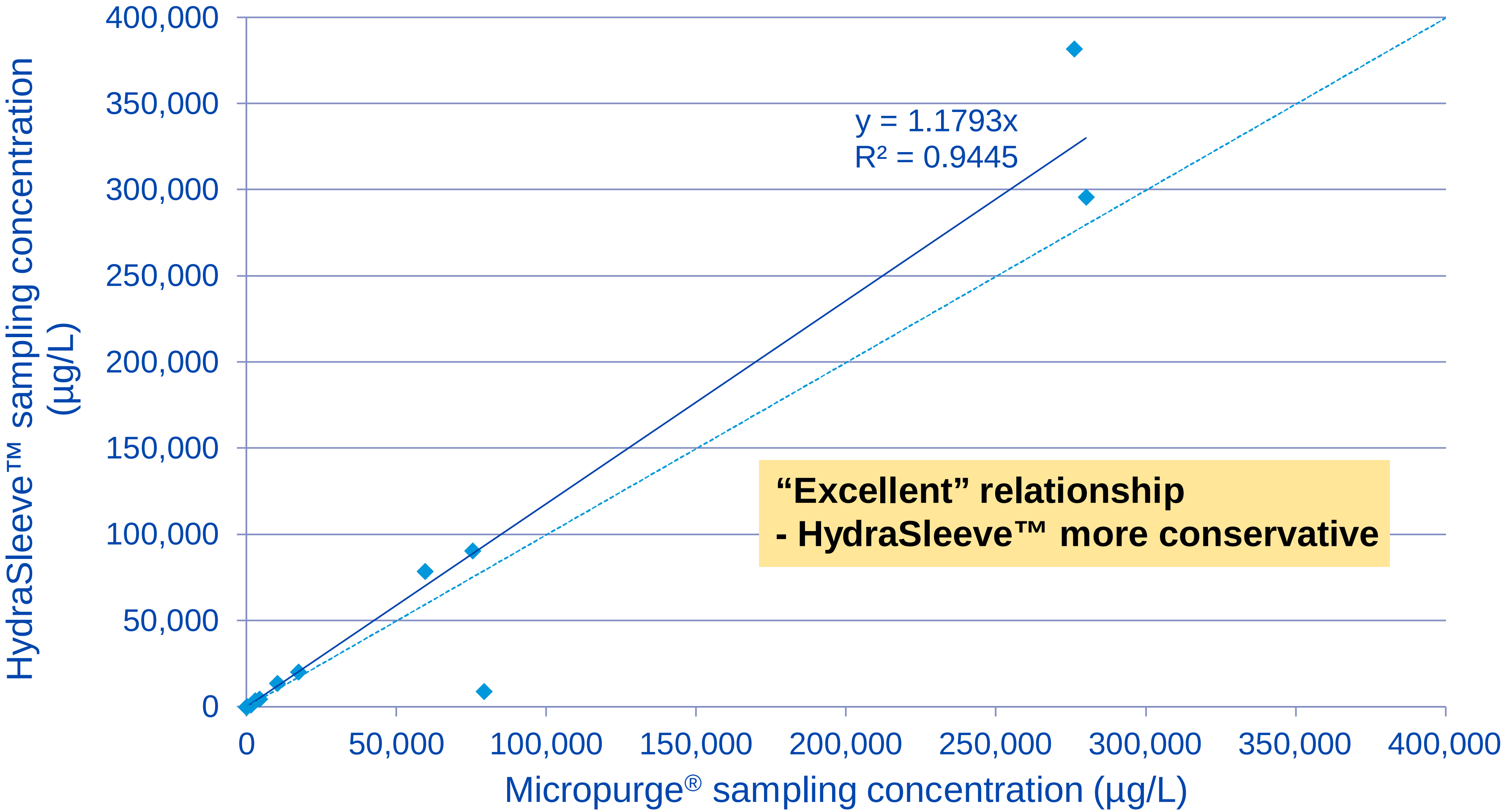
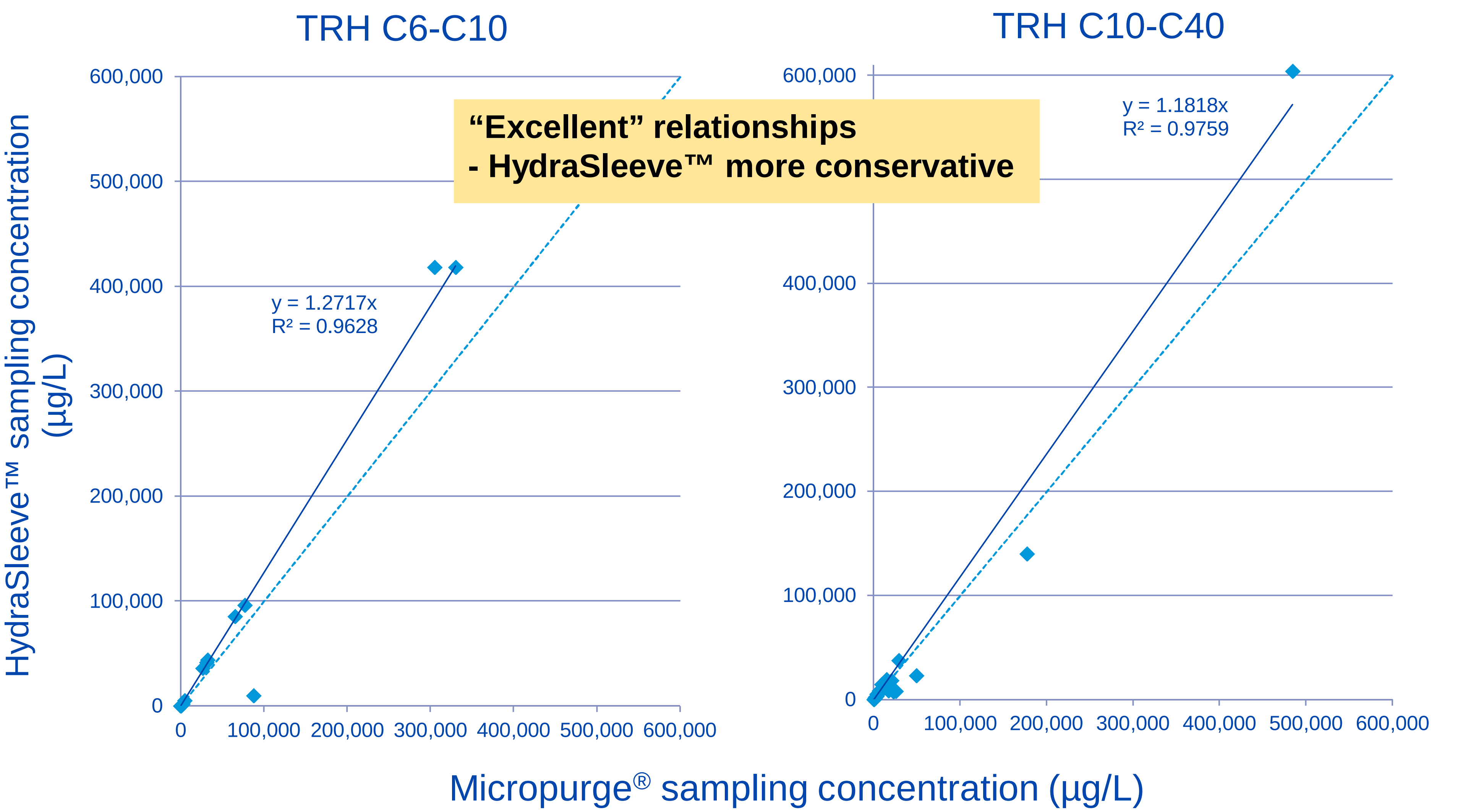
BTEX



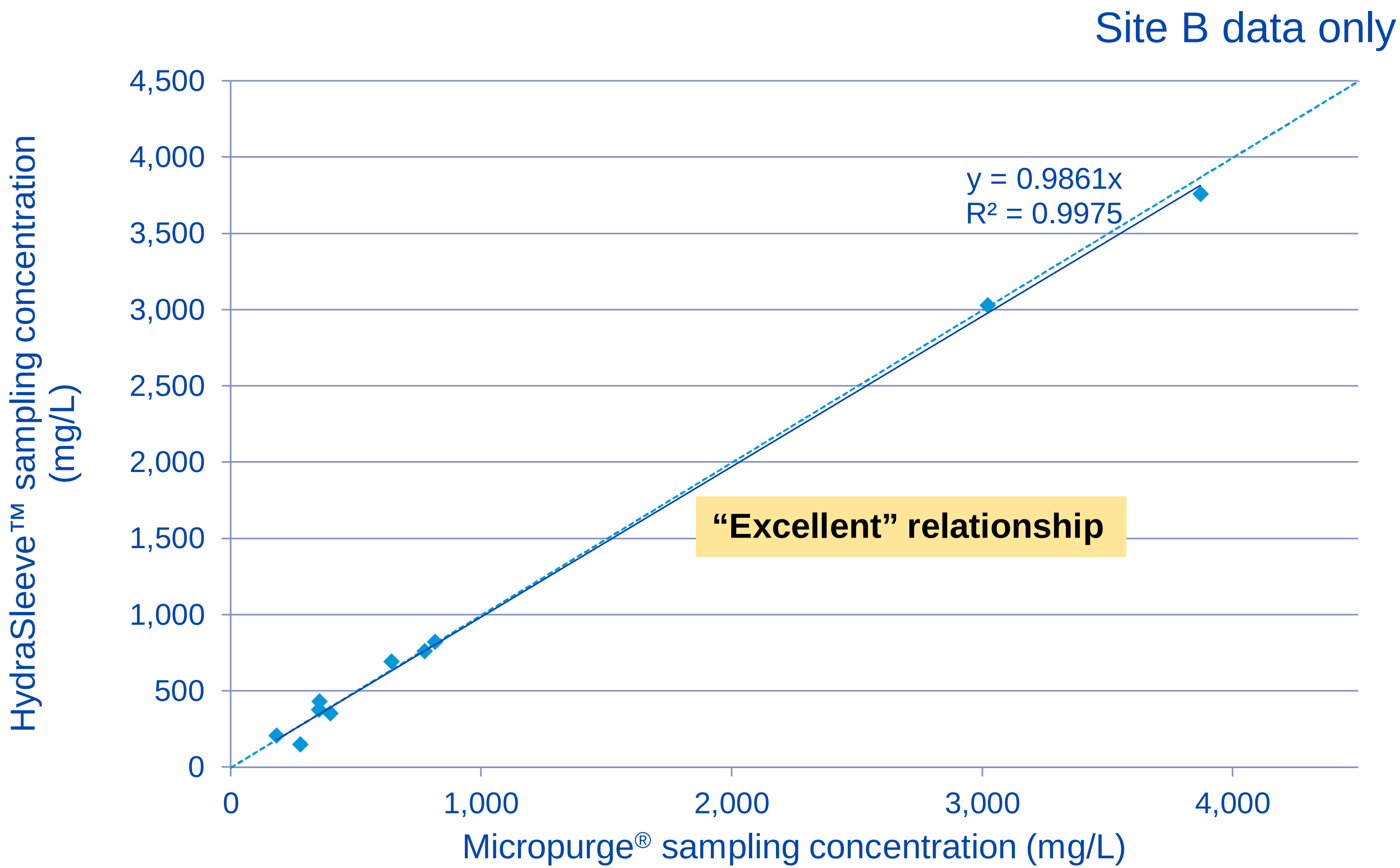
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
HydraSleeve™ sampling concentration (µg/L)
y = 1.1793x
R² = 0.9445
"Excellent" relationship
- HydraSleeve™ more conservative
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
Micropurge® sampling concentration (µg/L)

TOTAL RECOVERABLE HYDROCARBONS

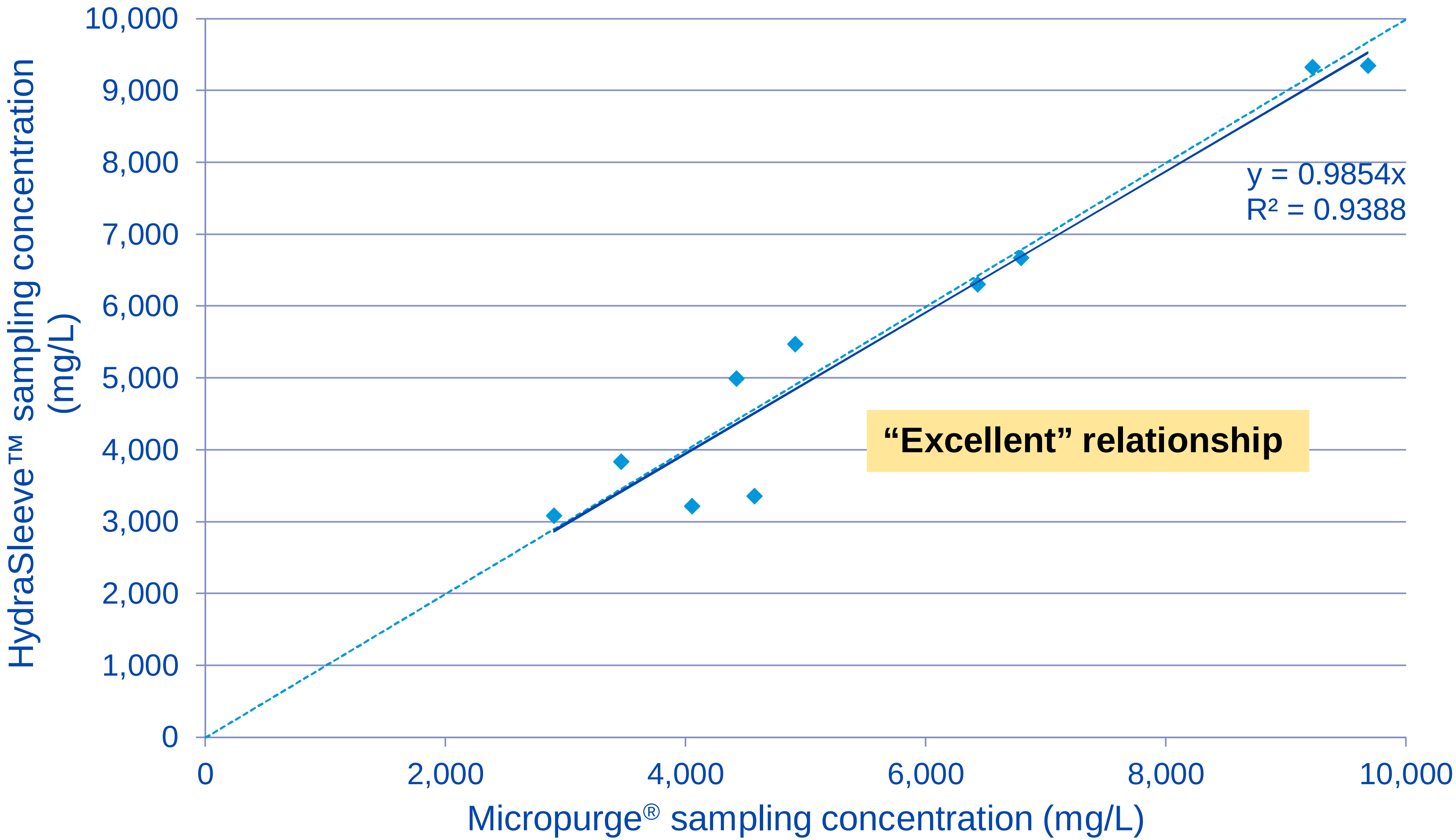


“Excellent” relationships
- HydraSleeve™ more conservative

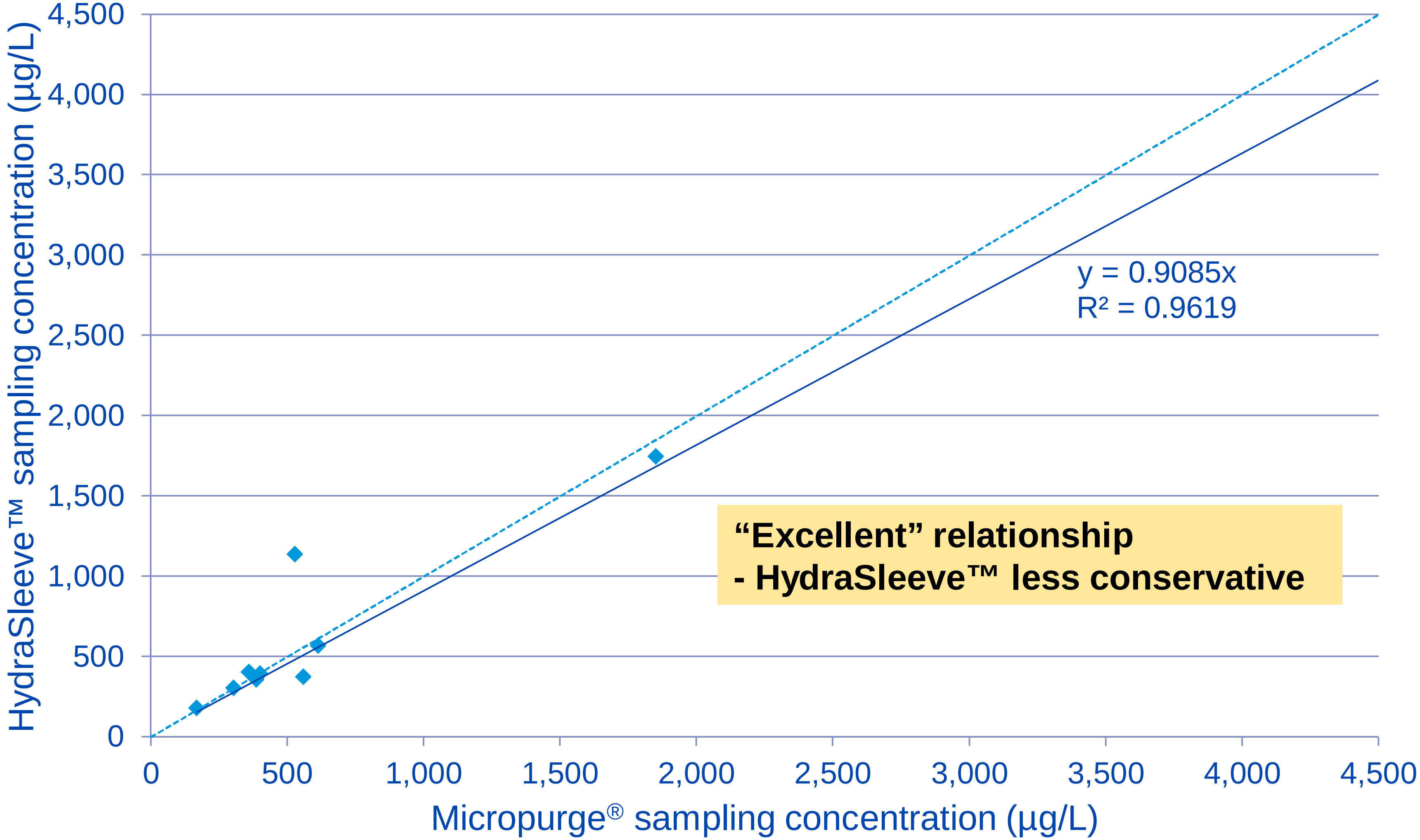
INORGANICS – SULFATE



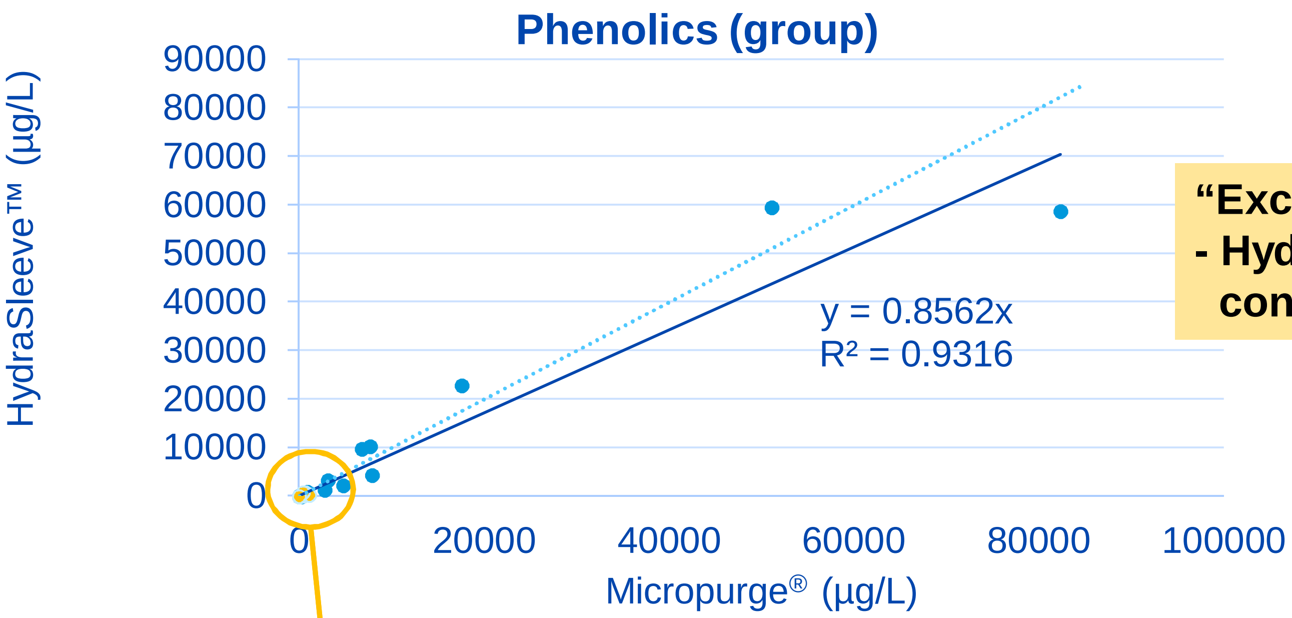
INORGANICS – TDS



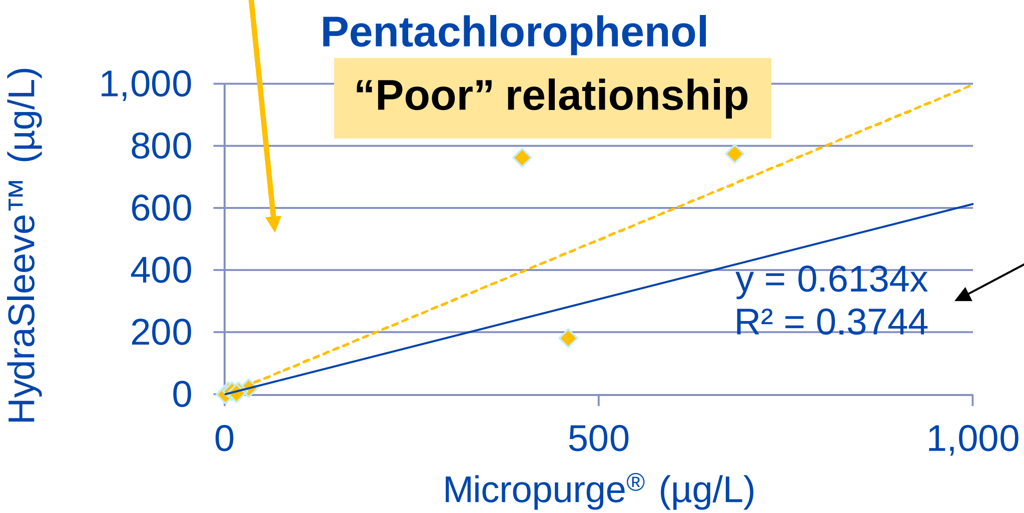
METALS – MANGANESE



PHENOLICS



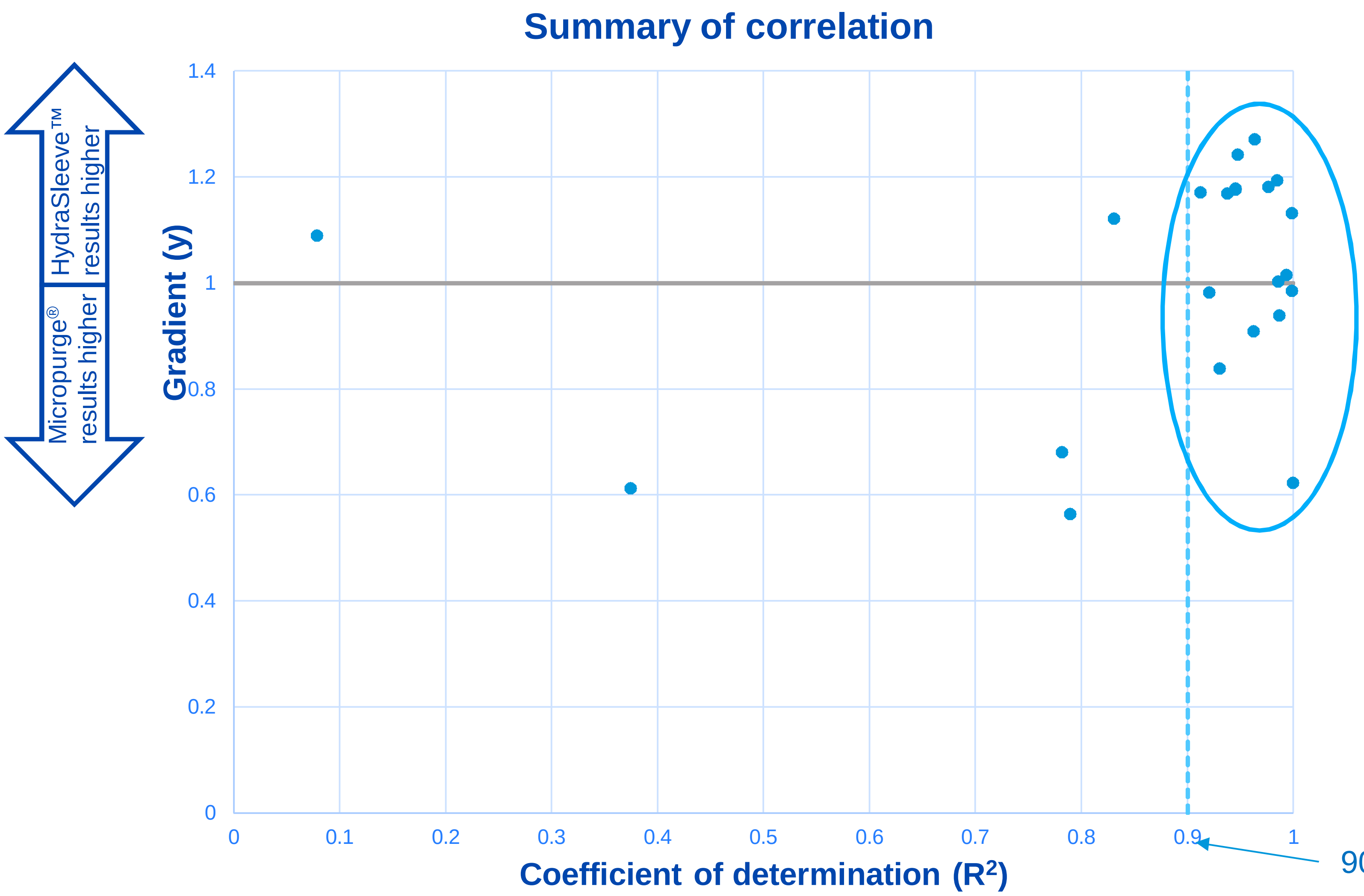
"Excellent" relationship
- HydraSleeve™ less conservative



"Poor" relationship

R^2 values <0.9 indicate greater degree of scatter & low confidence that slope is meaningful (Parsons 2005)

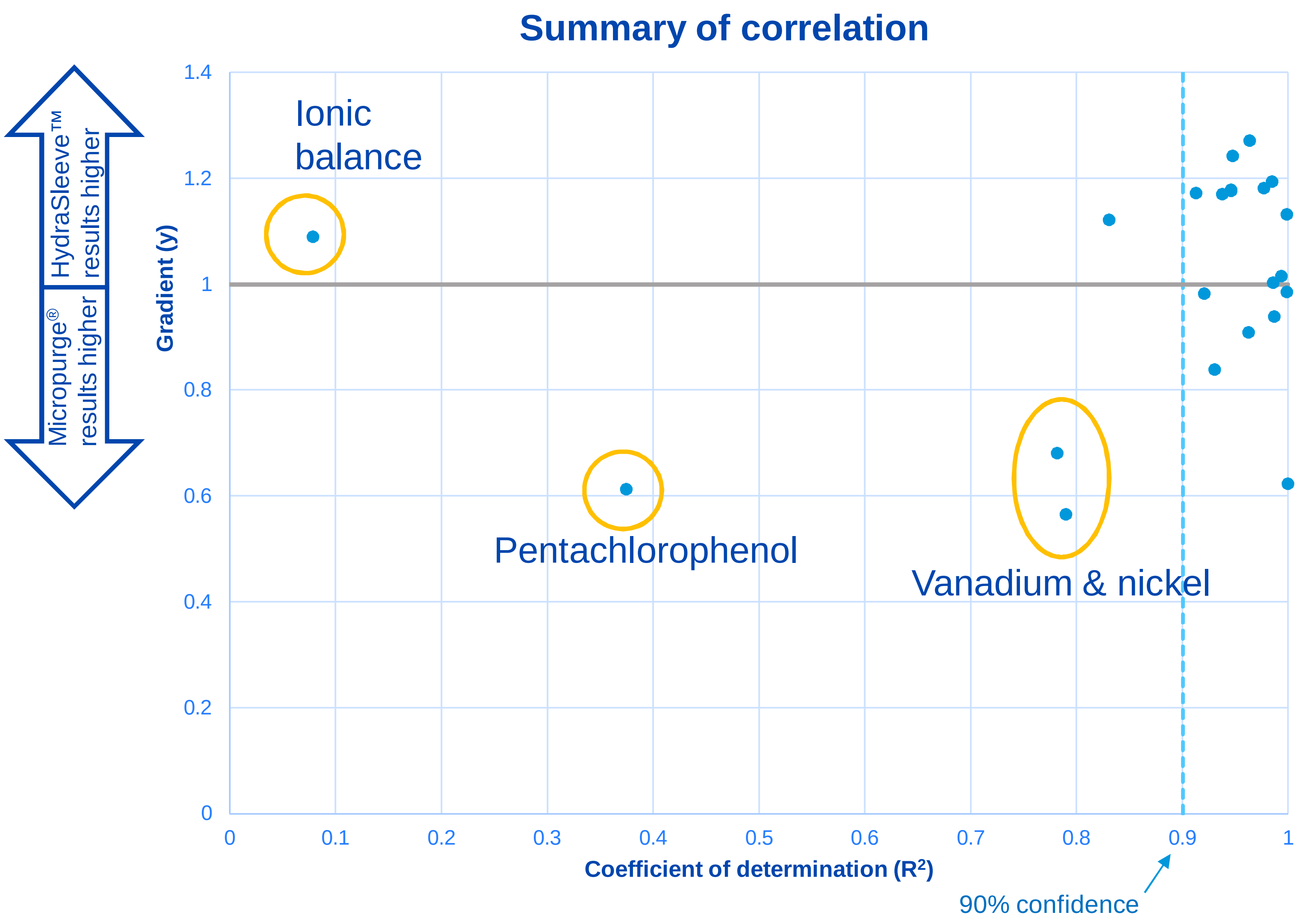
CORRELATION SUMMARY



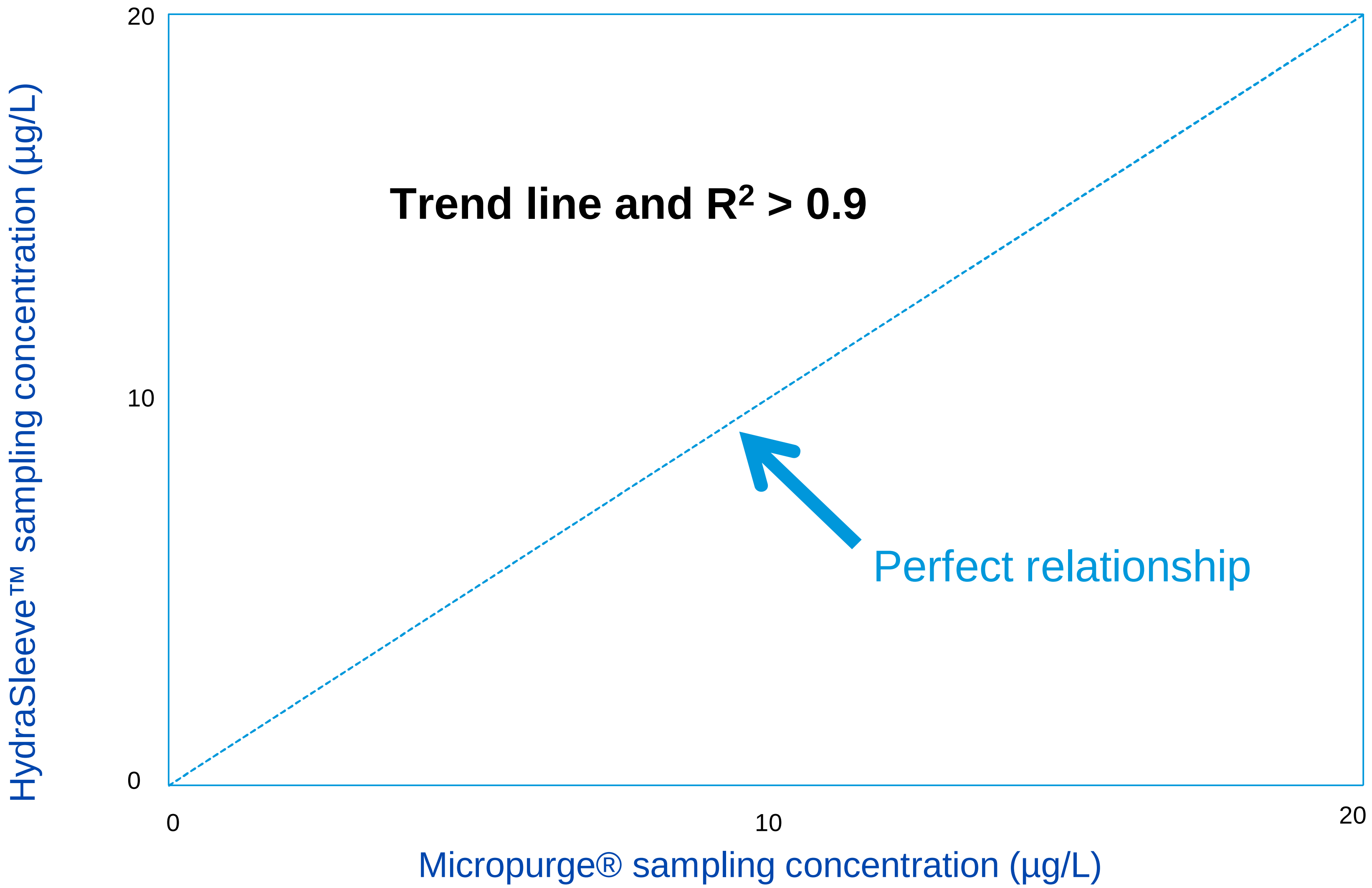
Majority of analytes have good correlation

90% confidence

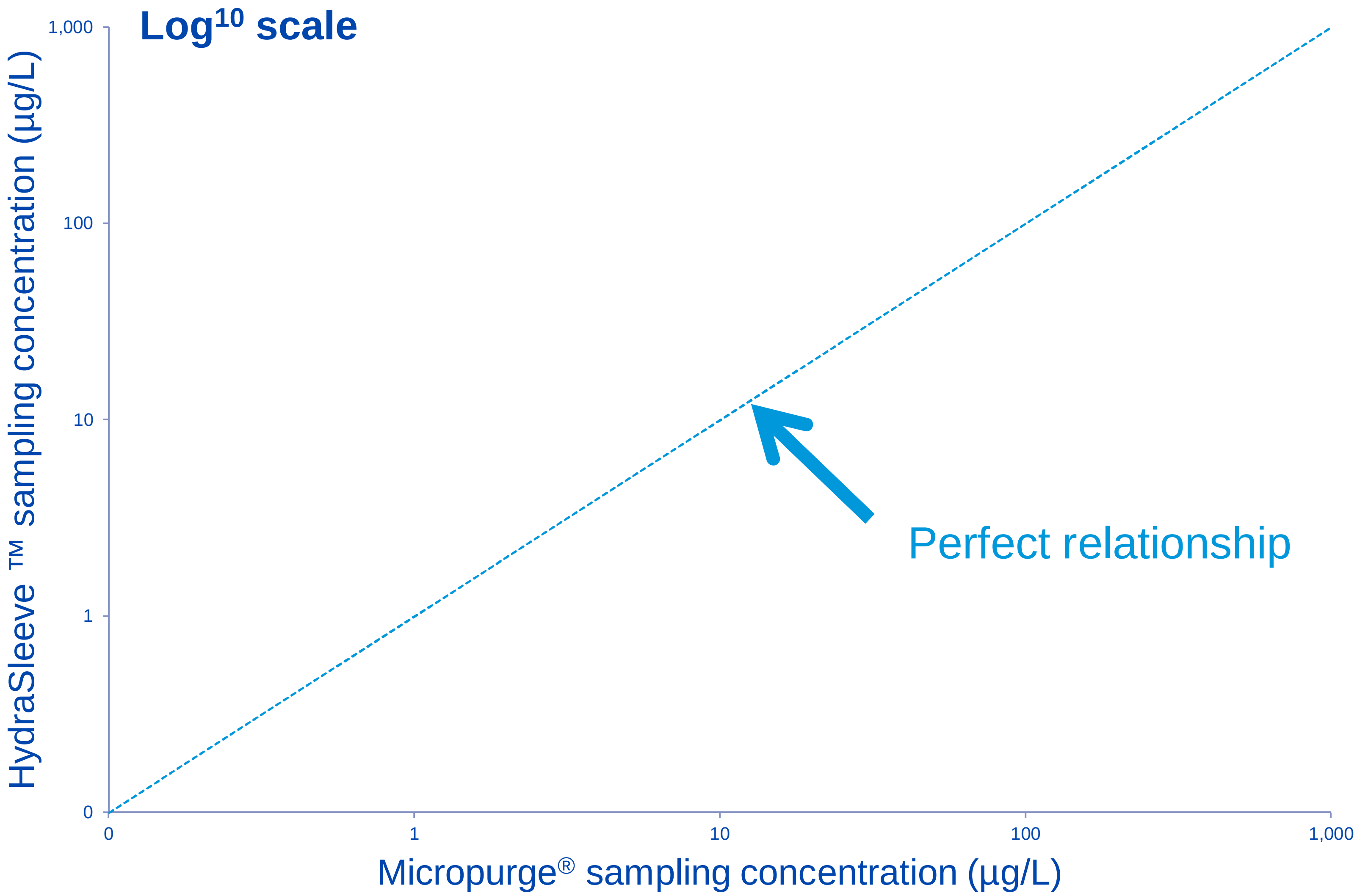
SUMMARY


Summary of correlation
HydraSleeve™ results higher
Micropurge® results higher
Gradient (y)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Ionic balance
Pentachlorophenol
Vanadium & nickel
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Coefficient of determination (R^2)
90% confidence

CORRELATION CRITERIA



CORRELATION - SAME ORDER OF MAGNITUDE



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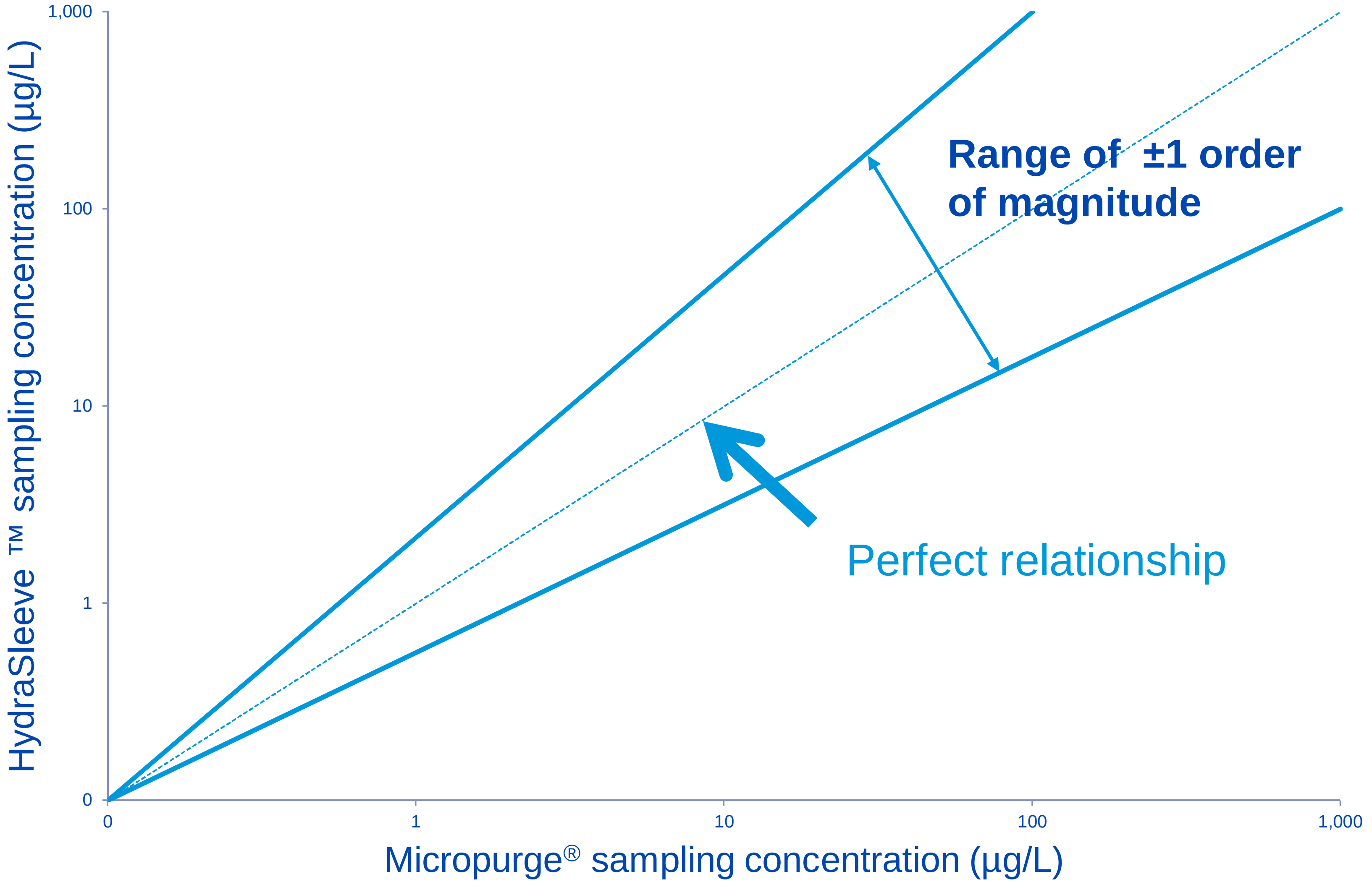
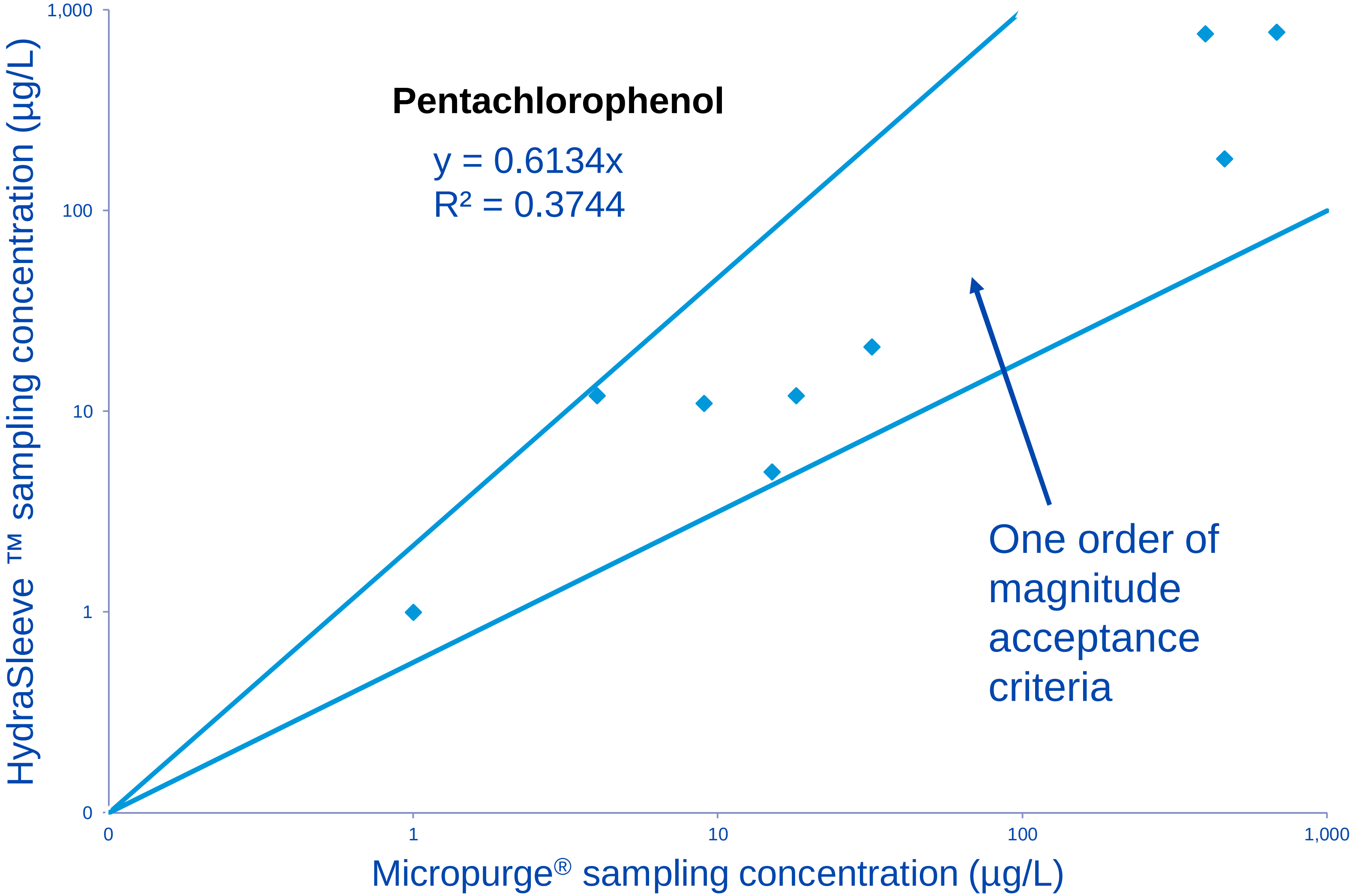


CORRELATION – SAME ORDER OF MAGNITUDE



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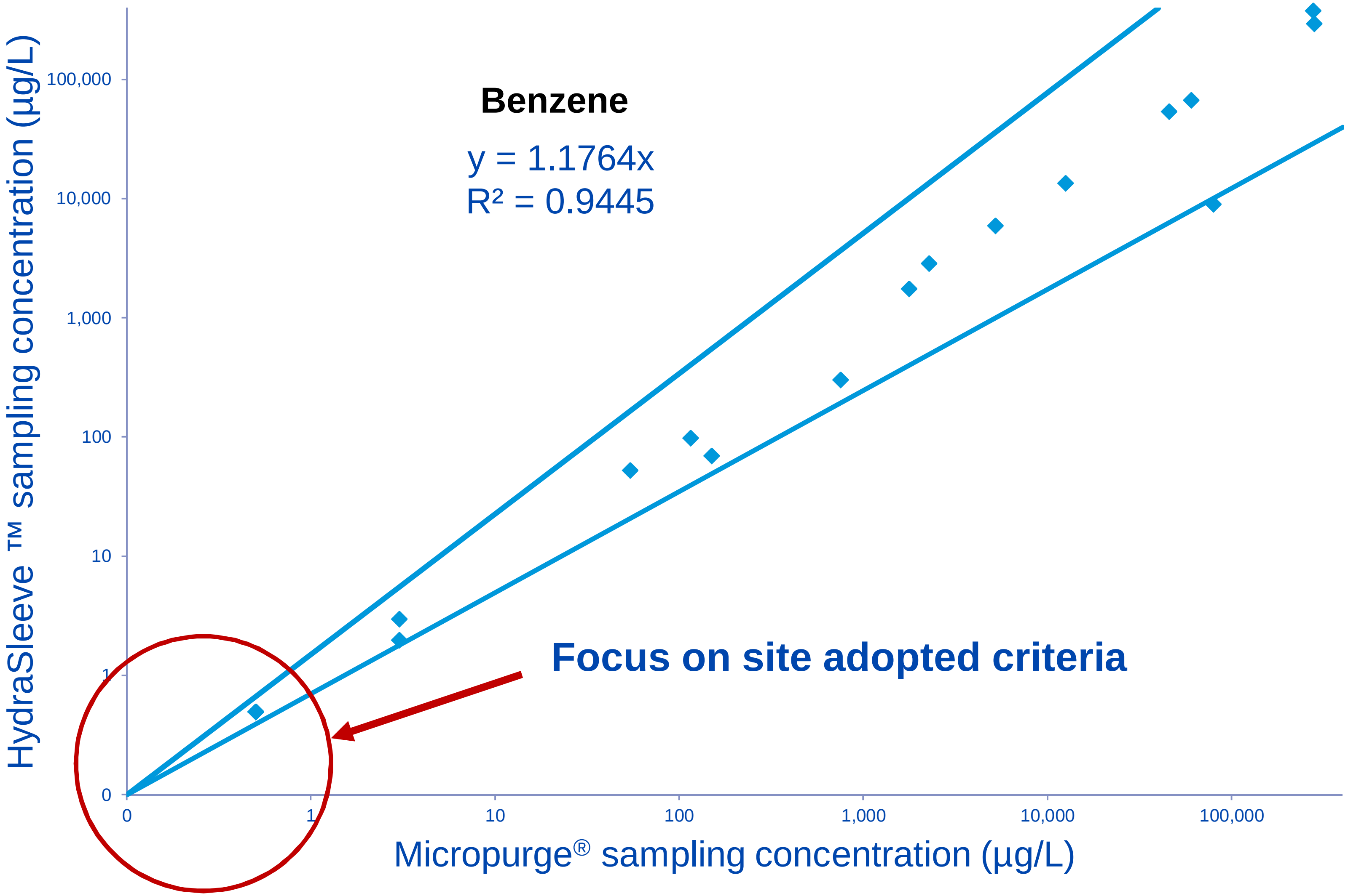
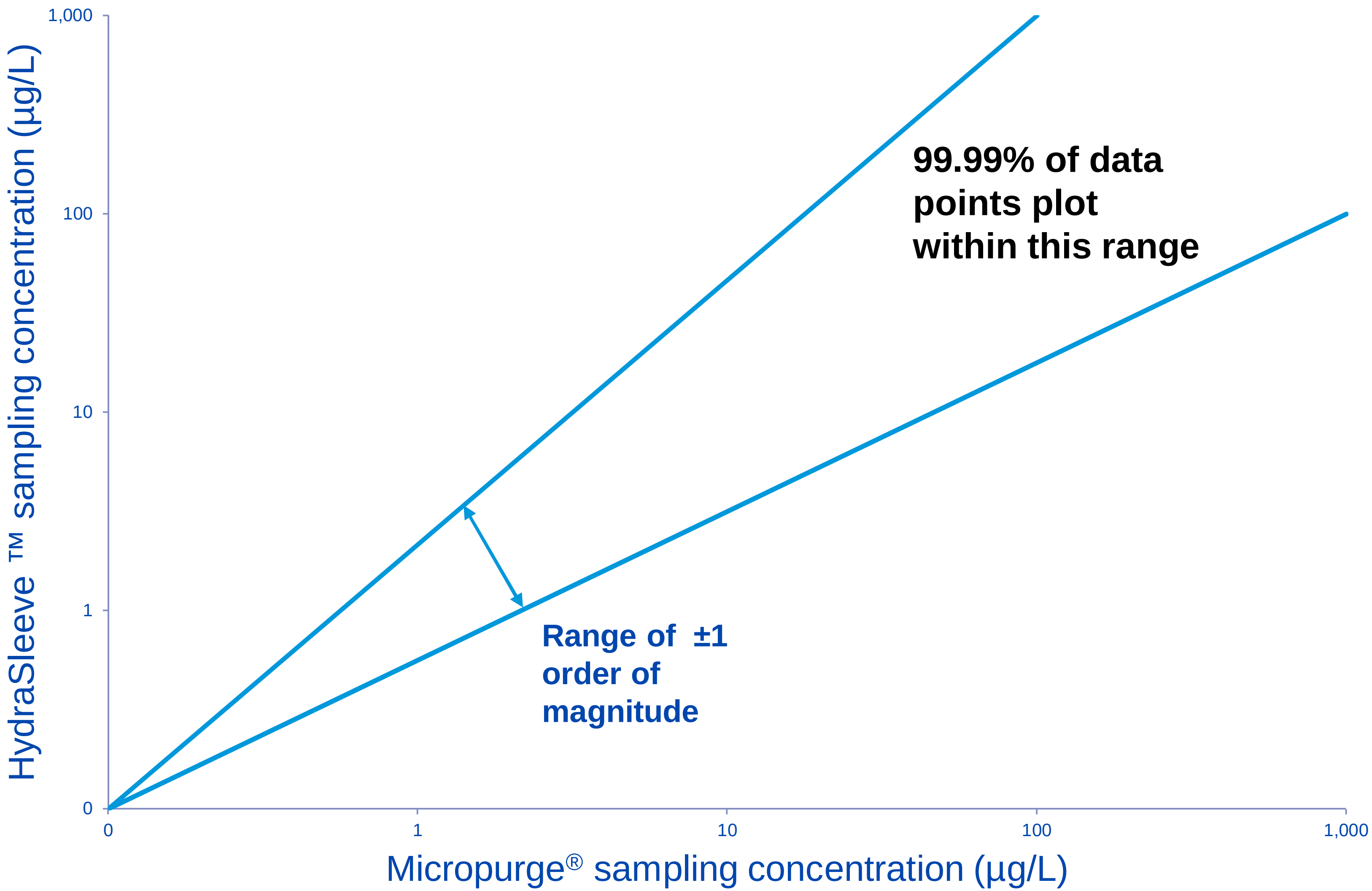
CORRELATION – SAME ORDER OF MAGNITUDE



TRIAL SUMMARY OF CORRELATION



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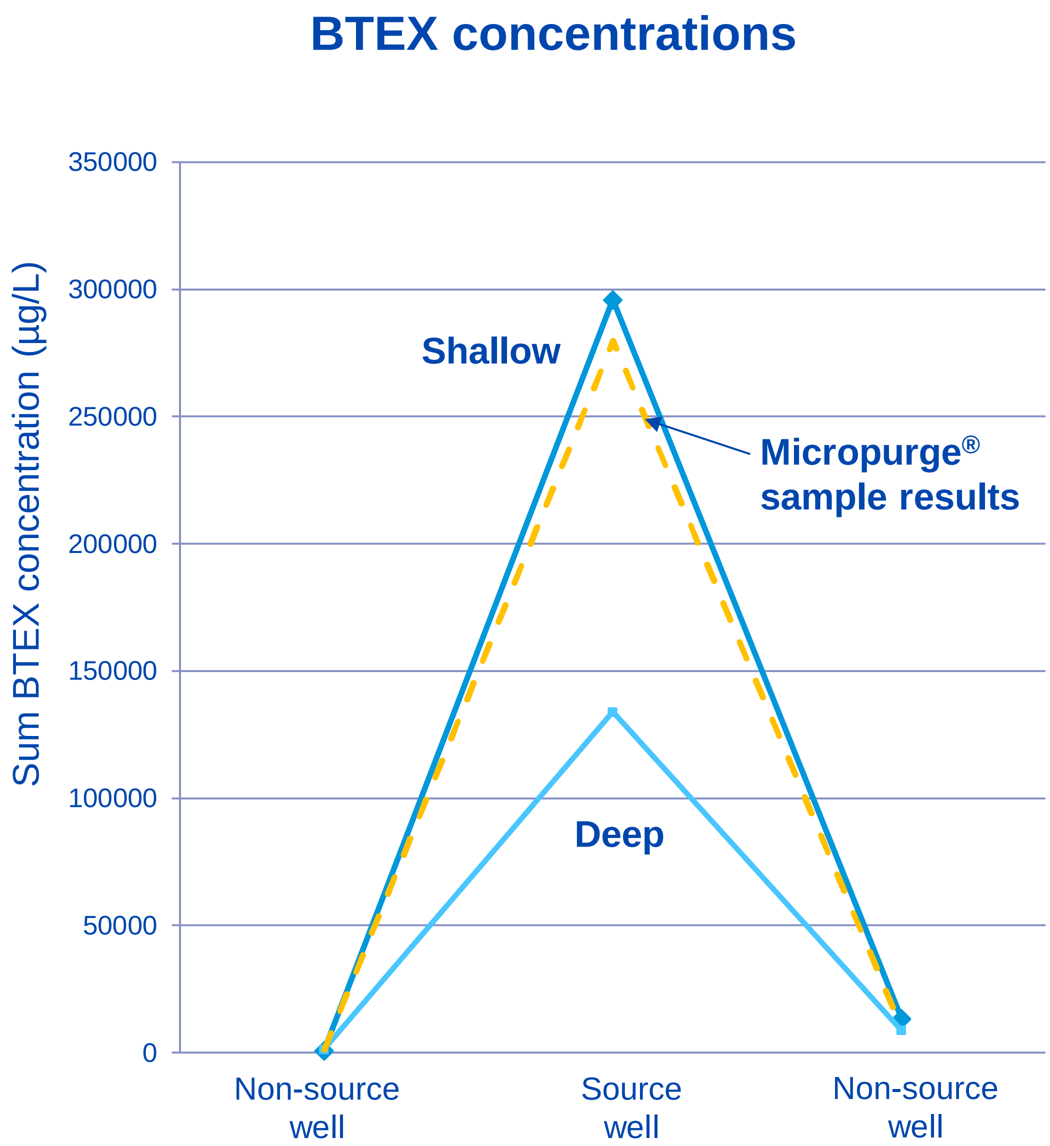
STRATIFICATION

- → Vertical stratification within well
- → Limited dataset
- → HydraSleeve™ can identify vertical stratification
- → HydraSleeve™ can identify source wells



DATA QUALITY

VOCs

→ No-flow results predominantly <u>higher</u> than low-flow results (low-flow potentially under reporting VOCs)

Chlorinated phenols (may not apply to other chlorinated compounds)

→ No-flow results predominantly <u>higher</u> than low-flow results, except pentachlorophenol which was lower

Metals

→ No-flow results predominantly <u>lower</u> than low-flow results

Inorganics

→ Excellent correlation (except ionic balance)

99.99% of no-flow data points in trial are the same order of magnitude as their respective low-flow results

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ACCEPTANCE AND BENEFITS

Technical acceptance

- → Low-flow is accepted by the regulatory community
- → Low-flow is benchmark – assume results are correct
- → No-flow results show excellent correlation for wide range of analytes
  - y, R^2 and order of magnitude level of confidence
  - Allows snap shot of multiple depths at one time
  - Appropriate for low and high yield wells
- → Auditor endorsement of HydraSleeve™ at Site A and working toward endorsement at Site B

Commercial benefits

- → 28% cost saving using 0.6L no-flow samplers over low-flow in the first year and 40% for subsequent years (equivalent to ExxonMobil (2007) findings)
- → No saving for ≥2L samples

REFERENCES

Britt et al (2010). A down hole passive sampling method to avoid bias and error from groundwater sample handling, *Environmental Science & Technology 2010, 44, 4917-4923*

ExxonMobil Global Remediation (2007). Best practice for selection and use of no-purge groundwater sampling methods

Parsons (2005). Results report for the demonstration of no-purge groundwater sampling devices at former McClellan Air Force Base, California. *Prepared for US Army Corps of Engineers, Omaha District & Air Force Centre for environmental excellence & Air Force Real Property Agency*

Pearsall and Eckhardt (1987). Effects of sampling equipment and procedures on the concentrations of TCE and related compounds in groundwater samples. *Spring 1987 Groundwater Monitoring and Remediation*

Sundaram et al (2009). Groundwater sampling and analysis – a field guide. *Geoscience Australia 2009/27 95pp*

US Geological Survey (2012). Comparison of no-purge and pumped sampling methods for monitoring concentrations of ordnance–related compounds in groundwater, Camp Edwards, Massachusetts Military Reservation , Cape Cod, Massachusetts 2009-2010. *Scientific investigations report 2012-5084*

Zumbro (2014). Performance comparison of no-purge samplers for long-term monitoring of a chlorinated solvent plume. *Ninth International Conference on Remediation of Chlorinated and Recalcitrant Compounds – Monterey, CA, 2014*