



Environmental Biotechnology
CRC Pty Ltd

INSTRUMENTATION FOR ENVIRONMENTAL MONITORING

AquaVOC - the in-situ monitor

AquaVOC Pty Ltd

Origins & Status


- ❑ Project initiated by CRC WMPC
- ❑ Developed by the CSIRO with Greenspan and Chemtronics
- ❑ In the last 12 months a complete revamp of the software and the electronics has been completed.
- ❑ Ongoing use by CSIRO for groundwater and marine studies



What are Volatile Organic Compounds (VOC)?

- 
- Broad range of highly reactive organic compounds with significant environmental and health impacts

- 
- For example:

- 
- Ethylene oxide
 - Benzene
 - Formaldehyde
 - Carbon tetrachloride
 - Phenol
 - Chlorofluorocarbons
 - Phosgene
 - Polychlorinated biphenyls



All known or suspected carcinogens and possible mutagens or teratogens.



Volatile Organic Compounds

- Widespread in modern society
- Man made sources include:
 - Traffic
 - Production and use of organic chemicals
 - Transport and processing of crude oil
 - The use and distribution of natural gas
- Major toxic trace pollutant in the environment



Volatile Organic Compounds

- The higher toxicity due in part to their excellent lipid solubility
- Results in exposure of a much wider range of organs in the human body
- Many VOCs react with compounds such as nitrogen oxides and oxygen in the presence of sunlight to produce ozone and other oxidants which in turn contribute to smog formation and aerosol pollution



VOC Contamination

- Uncontrolled releases from agriculture, waste disposal, sewage treatment and industrial storage
- Use of pesticides and herbicides
- Failure of industrial storage devices, especially petroleum products and solvents, and cleaners



Limitations of existing instruments

- Extraction of samples invokes possible contamination or loss of target compounds
- Cost of analysis
- Time for analysis
- Alerts
- 'Real time' remediation or contamination changes



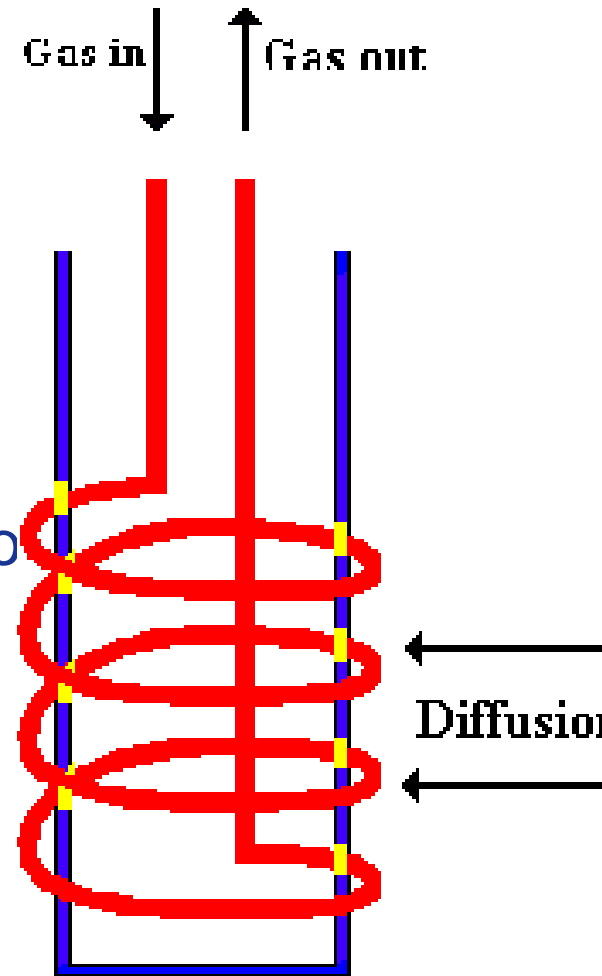
Technology Description

- Innovative aspect of the instrument is the patented *diffusion cell*
- Provides a means of selectively sampling hydrocarbons from within soil or water media and excluding moisture from entering the measurement system
- Potential to provide specific analyses of components



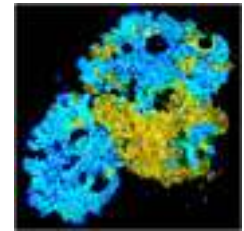
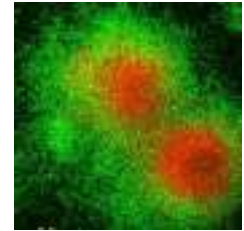
Diffusion Cell

- Consists of a hollow polymer tube secured within a stainless steel frame
- Frame wall perforated with holes to permit ready access of the groundwater or air within the soil/water matrix to the polymer surface.
- The polymer tube is very low permeability to water;
- VOC contaminants diffuse through



Theoretical basis

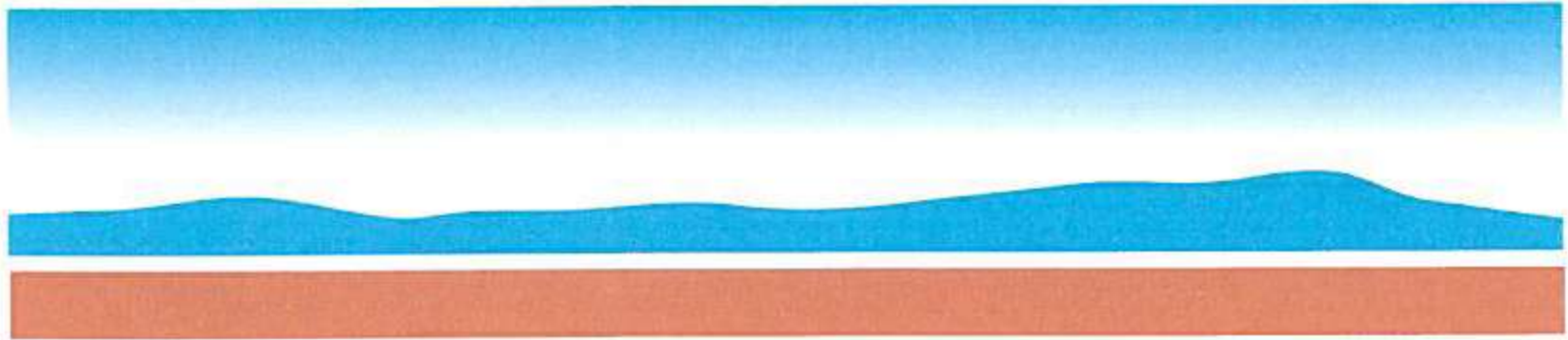
- ❑ Numerical modelling
- ❑ Comparison of real and theoretical performance
- ❑ Practical evaluation and development





CSIRO
AUSTRALIA

CSIRO LAND and WATER



Numerical Codes for Modelling Mass
Transport Processes in VOC Discharge

Modelling outcomes

The theoretical and practical aspects of the design are realisable.

In practice the performance closely resembles the theoretical model.

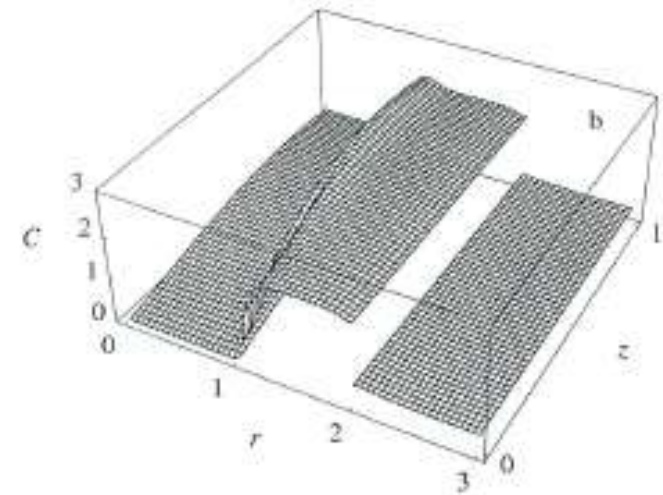
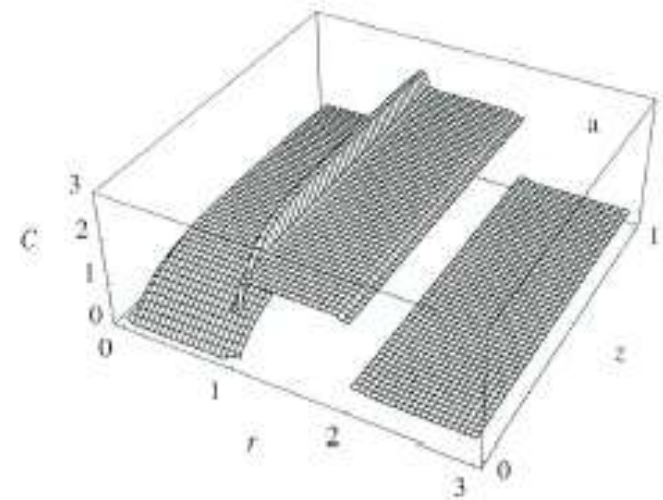


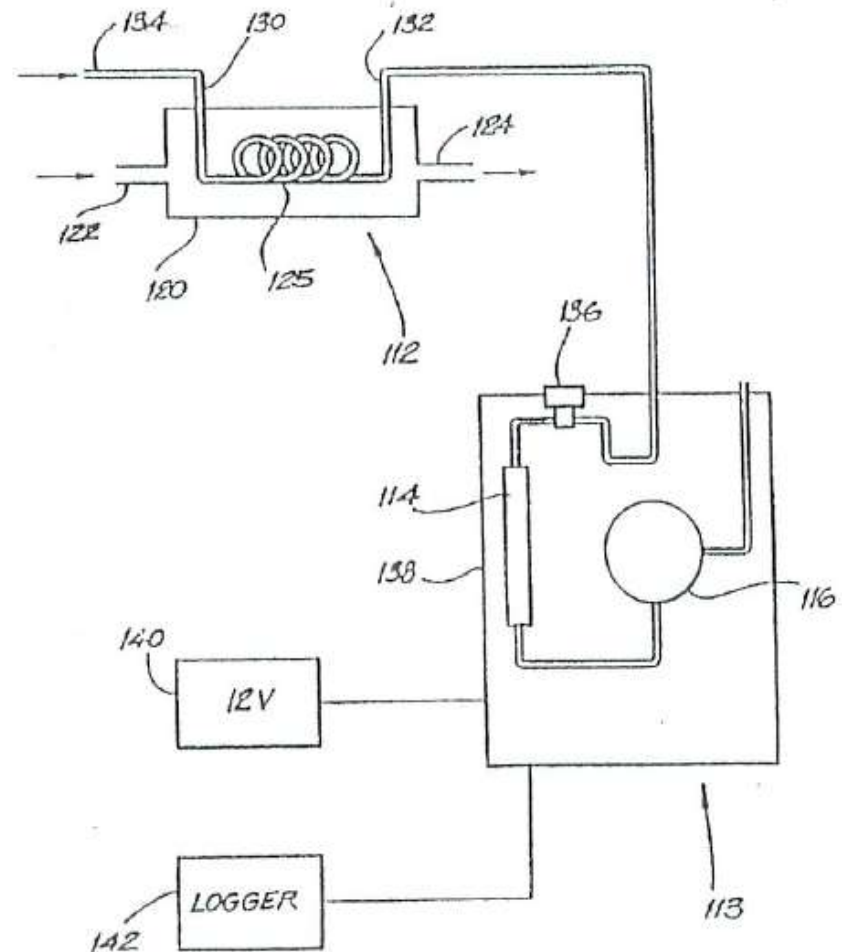
Figure 5.2: Two snapshots in time of an advective purging of the inner gas space in an idealised three-phase model of a VOC Probe, calculated using VOCMODEL. The plots show concentration plotted versus r and z for a model three phase system corresponding to an inner gas phase ($0 \leq r \leq 1$, $D = 5$), a polyimide tube phase ($1 < r \leq 2$, $D = 0.3$), and a sampled bath phase ($2 < r \leq 3$, $D = 1$). Part (a) corresponds to $t = 0.0025$; part (b) corresponds to $t = 0.02$. Discretisations of $\Delta r = 0.05$ and $\Delta z = 0.02$ were used for the VOCMODEL run. The advective velocity $v_z = 5$ in the positive z direction for the inner subdomain, elsewhere it is zero.

The Patent

(54) Title: ENVIRONMENTAL MONITORING OF ORGANIC COMPOUNDS

(57) Abstract

Environmental monitoring of low concentration of organic compounds in a medium such as ground water is effected by using a diffusion cell (112) having a polymeric membrane formed into a helical tube (125) and immersed in the environmental fluid so that organic compounds at ppb ppt concentrations diffuse into and through the polymeric material. A carrier gas in the polymeric tube acquires a concentration of the organic compounds substantially in equilibrium with the concentration of the organic compounds in the environmental fluid. For the purpose of permitting monitoring with detectors (116) which are not sensitive to extremely low levels of organic compounds, a concentrating device such as a thermal desorption tube (114) can be provided for processing the gas and periodic thermal activation to discharge therefrom organic compounds to be detected at a sensor.



Measurement

- Air and sample guided to a commercial metal oxide sensor resulting in an electrical signal which the instrument is calibrated to present in terms of the contaminant concentration
- The electronics package within the housing includes a data logger as well as signal conditioning
- Readings from channels are internally logged for later remote interrogation, or transmitted directly to an external system for display, manipulation and alarm

Sample Transport

- A steady state rate of diffusion is established through the polymer
- A stream of clean dry air slowly passes through the tube and carries away contaminants
- The gas stream plus contaminants passes through the hollow tube to the instrument's electronics housing.
- Housing contains a set of valves to control the air flow to up to detection devices



Application

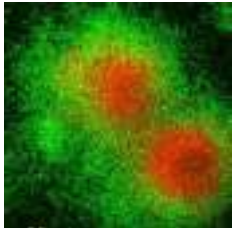
- The present generation configured to detect:
 - BTEX class of compounds (Benzene, Toluene, Ethylbenzene and Xylene)
 - Chlorinated hydrocarbons such as trichloroethane.
- Installation in small diameter bores (50 to 100mm) into the soil or groundwater to depths typically up to 30m.
- The instrument is designed to give in-situ readings & to be operated unattended over an extended period of time.

Features

Benefits of the VOC Monitor:

- Integrated continuous monitoring system for pollutants (BTEX and/or TCE)
- Onsite log of results and trends
- Low onsite sampling skills/costs
- Results obtained faster than laboratory analysis
- Unattended operation
- Remote communications capability


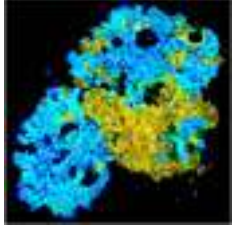
Existing specifications



The AquaVoc is a semi quantitative device for measuring VOC in liquids in the range of 20ppb to 50ppm.



The device can measure total VOC but not differentiate between VOC or identify specific VOC.



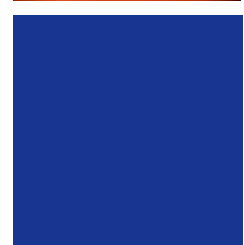
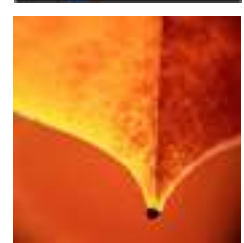
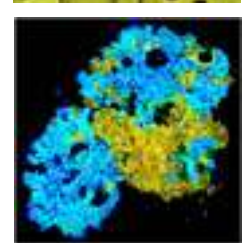
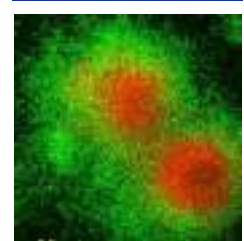
The device comes in a box the size of a shoe box which contains the electronics and has a long probe connection for sampling.



Recent Applications

- CSIRO have used the device for measuring VOCs in the Ocean in order to help discover oil deposits and oil contamination at sea.
 - They have conducted detailed successful use of the new model in the past 12 months
- VOC monitoring at contaminated groundwater site in Sydney
 - Results are confidential





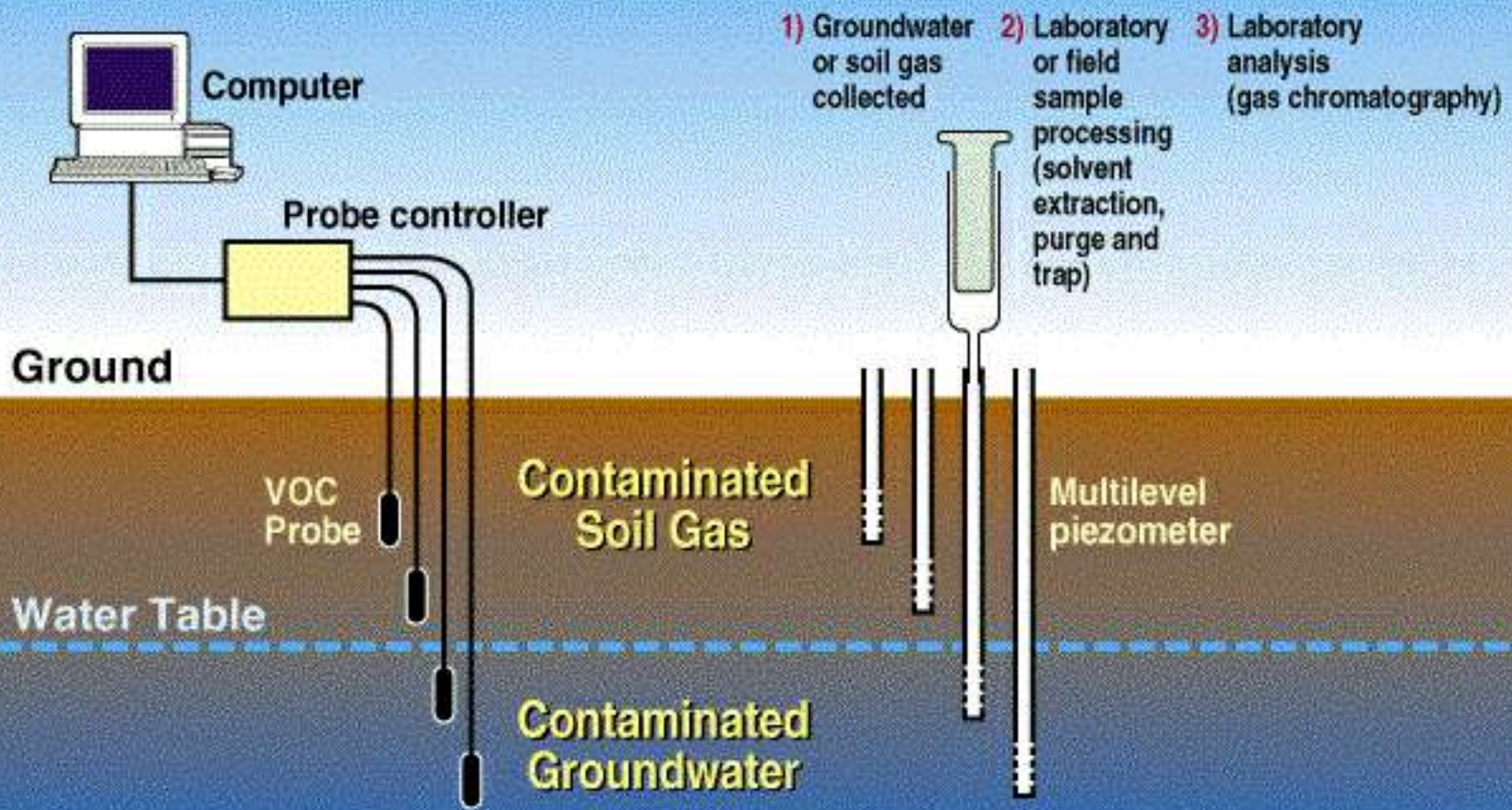
APPLICATION & DESIGN

Commercial in Confidence

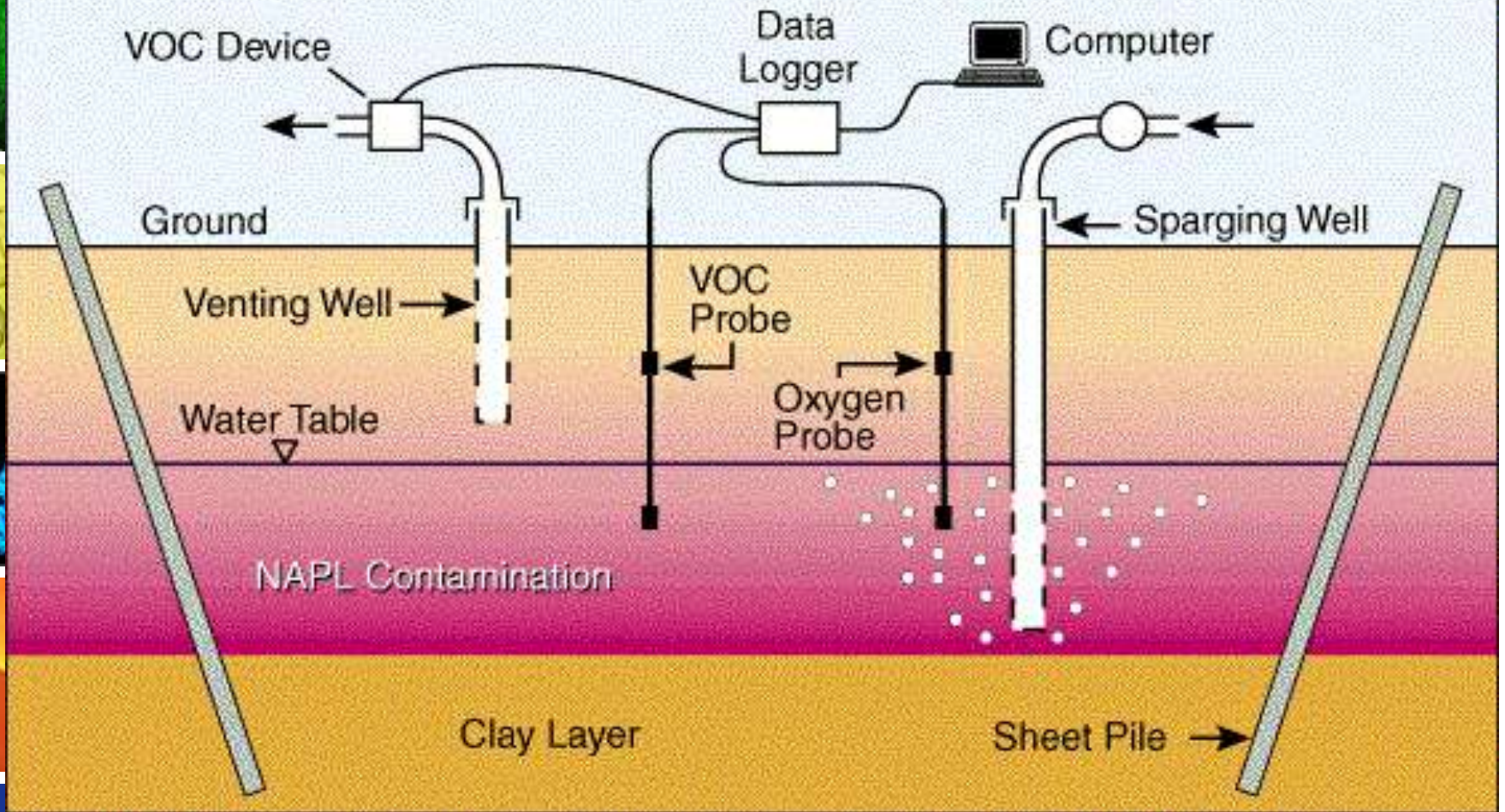


On-line Monitoring

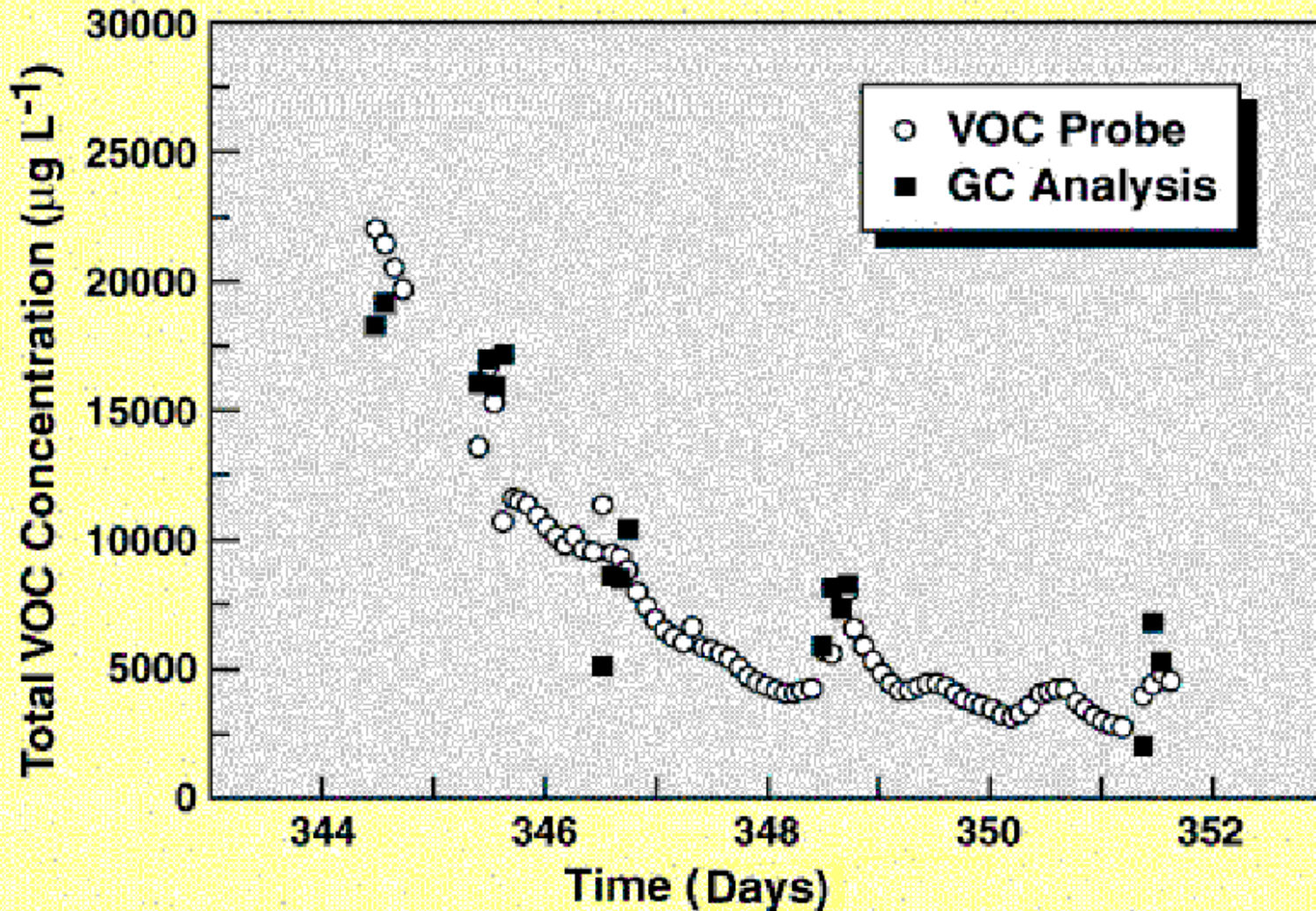
Conventional Monitoring



Hill AFB, (Treatment Cell 3m x 5m)



Comparison of VOC probe and GC Analysis Data

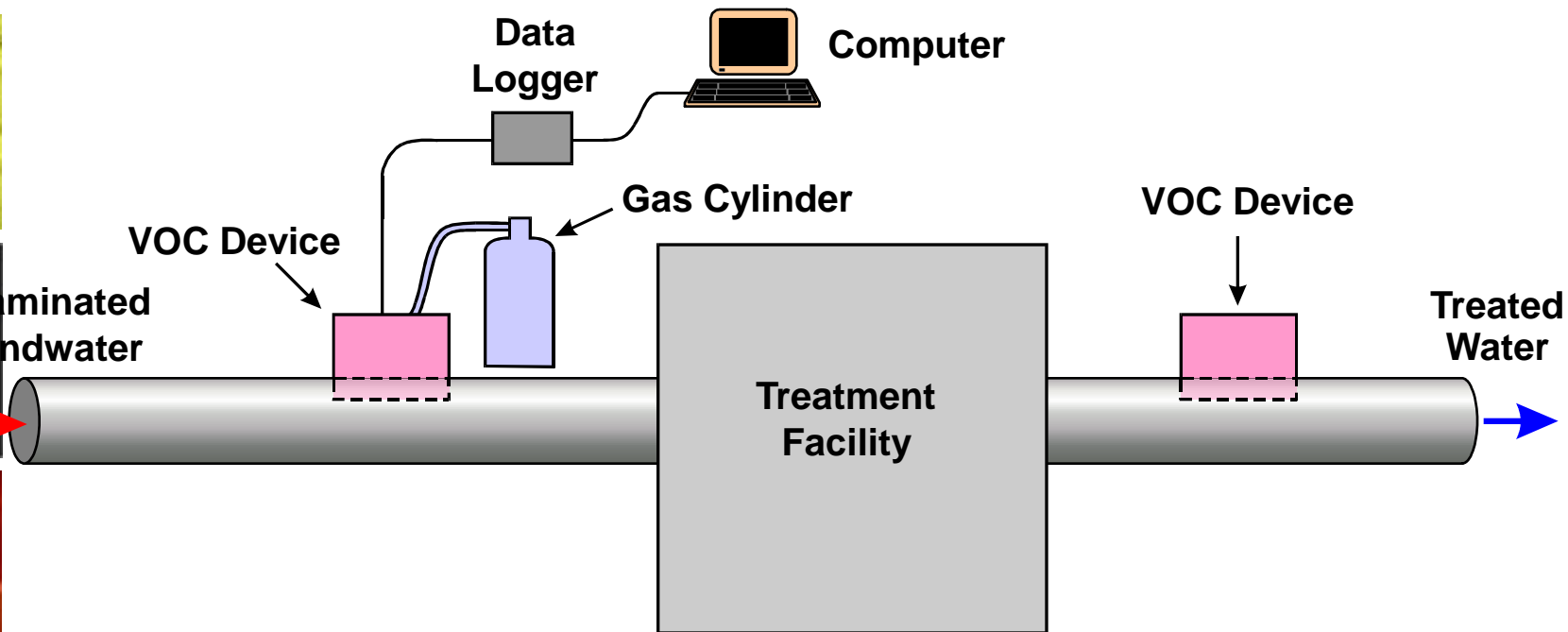
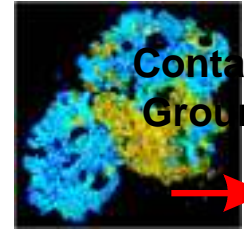
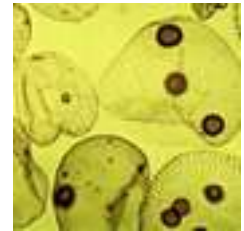
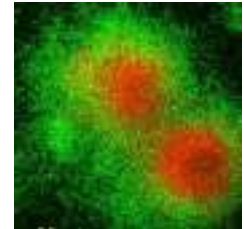


Source USEPA

Commercial in Confidence



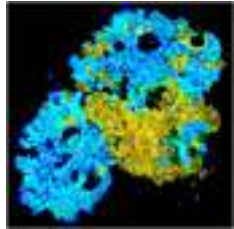
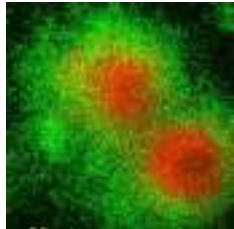
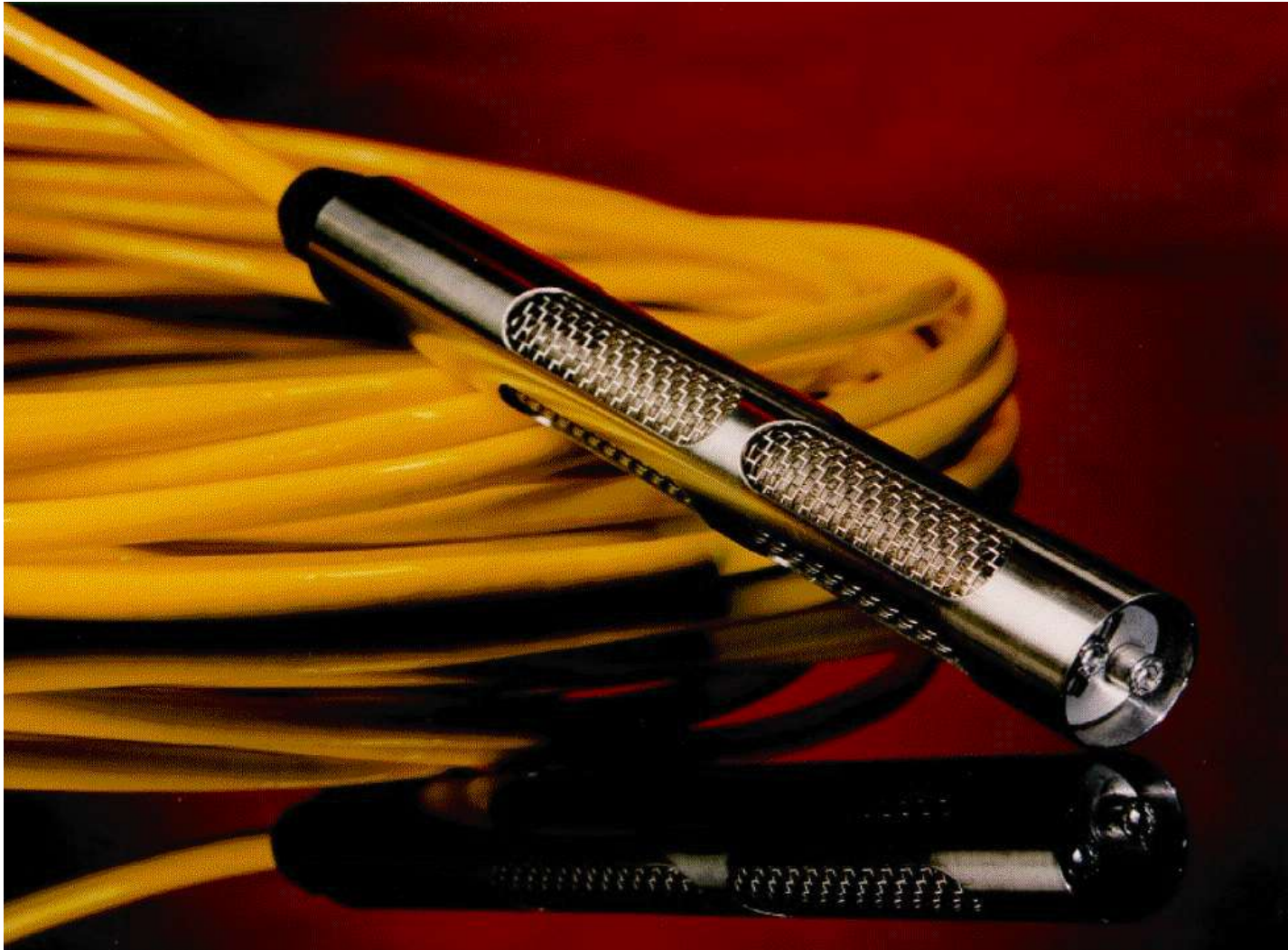
Application: Treatment of Contaminated Groundwater



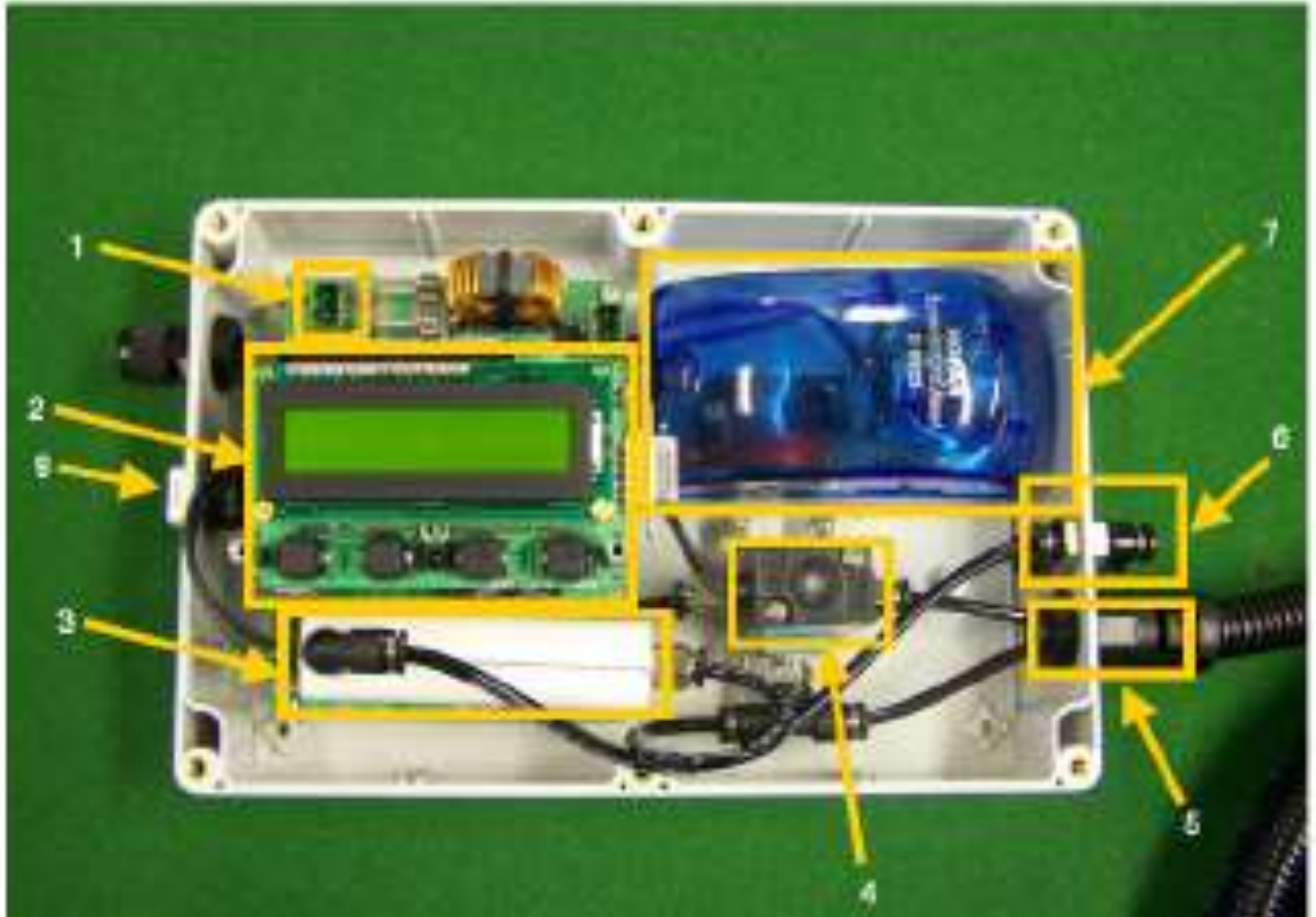
The Instrument Version 1



The Probe



The Instrument Model 2



M2 New compact design

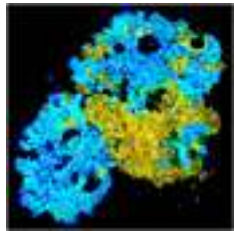
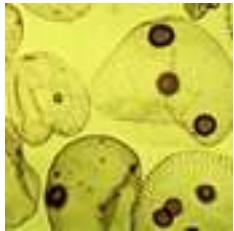
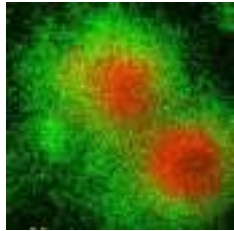
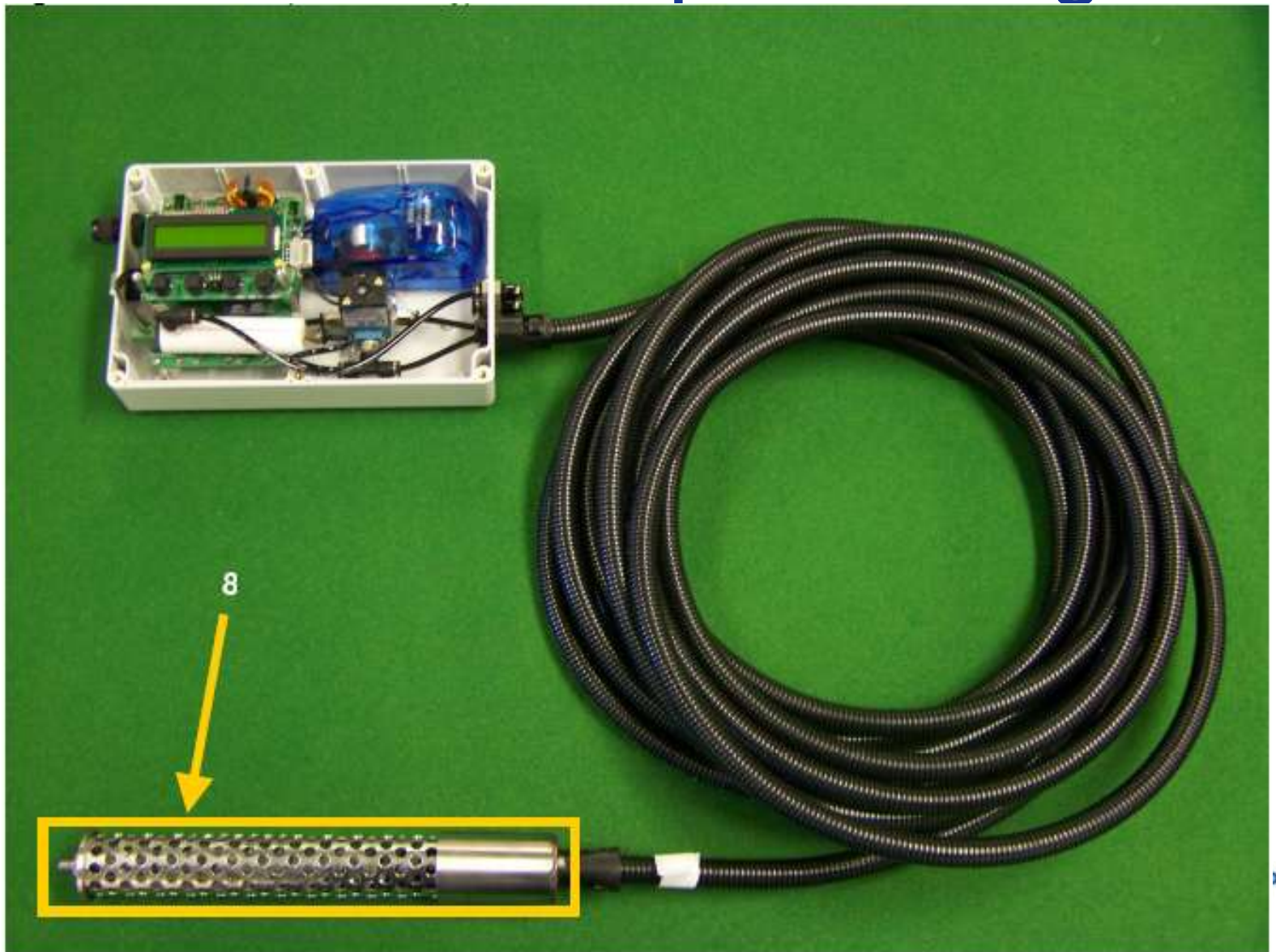

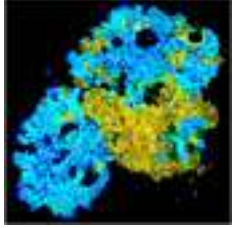

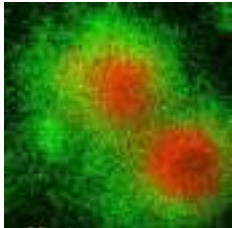


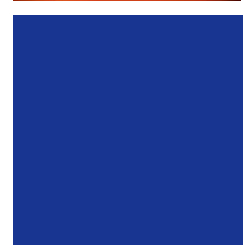
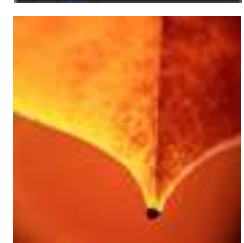
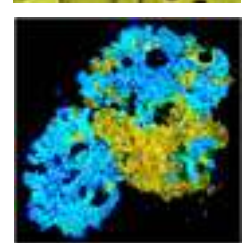
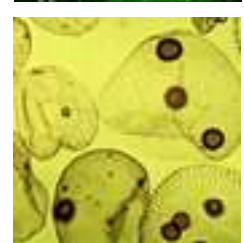
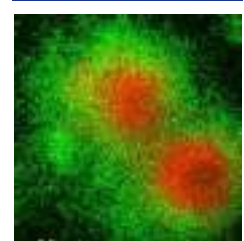
Fig. 1. M2 New compact design. (a) M2 New compact design. (b) M2 New compact design. (c) M2 New compact design. (d) M2 New compact design.

Typical Performance



Measurement Range	BTEX	100 ug to 2 mg/L
	TCE	100 ug to 2 mg/L
	THM	10 to 500 µg/L
Power Supply	240V AC	To be specified
	12 V DC	
Inputs	VOC 4-20 mA	
	Alarm TTL 5V	
	4 digit LCD for local readout	

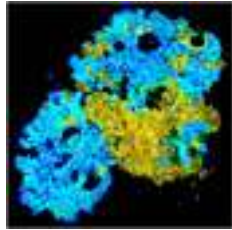
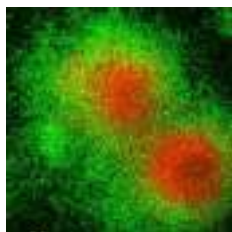




PRODUCTION UNIT

Commercial in Confidence





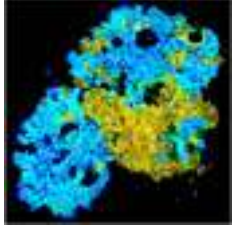
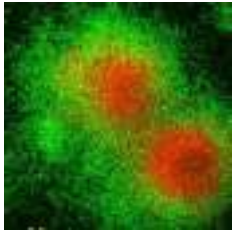
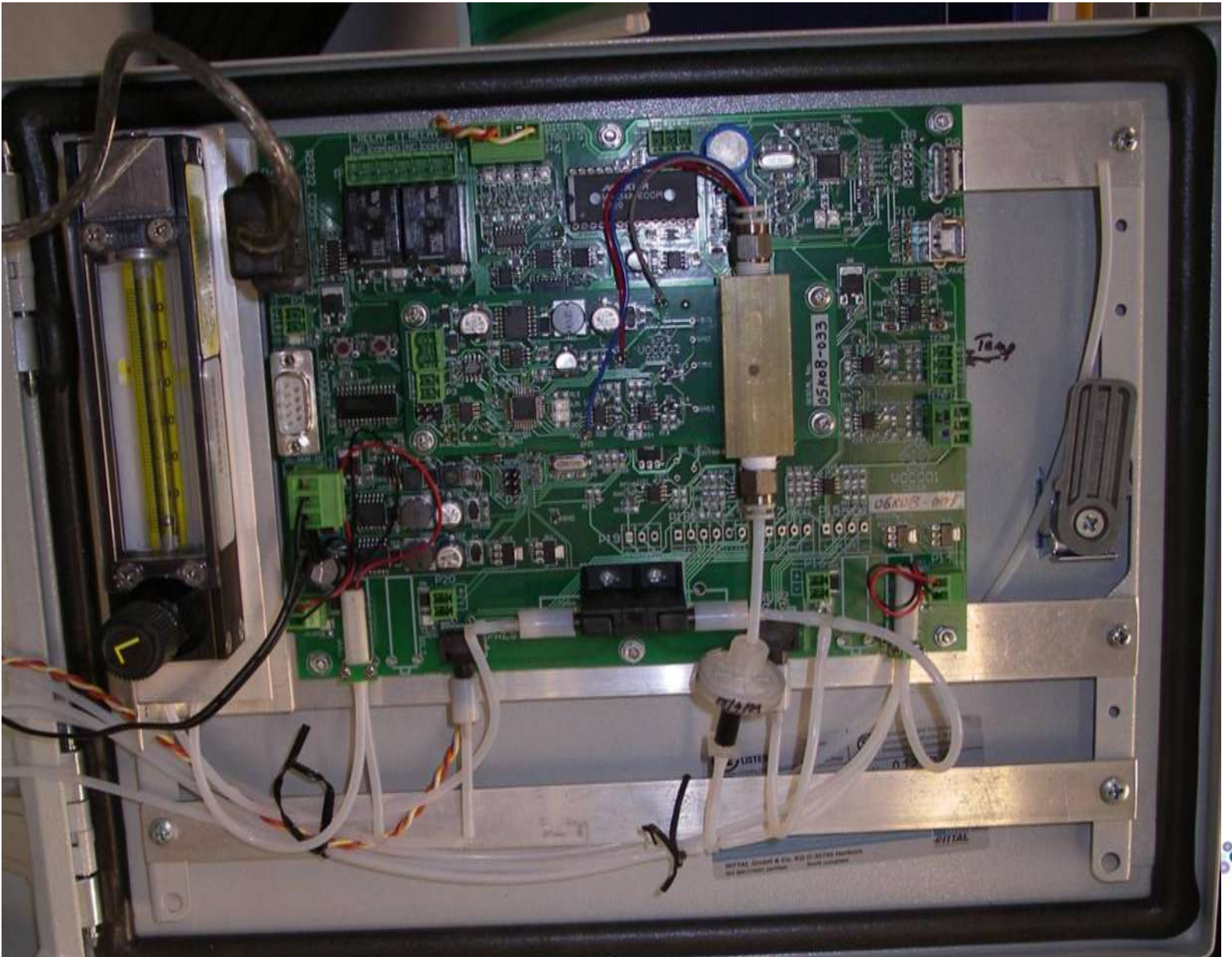
Commercial in Confidence

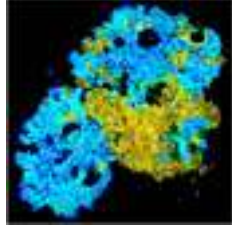
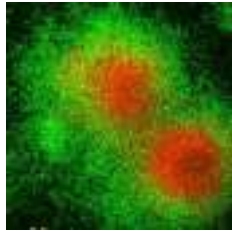
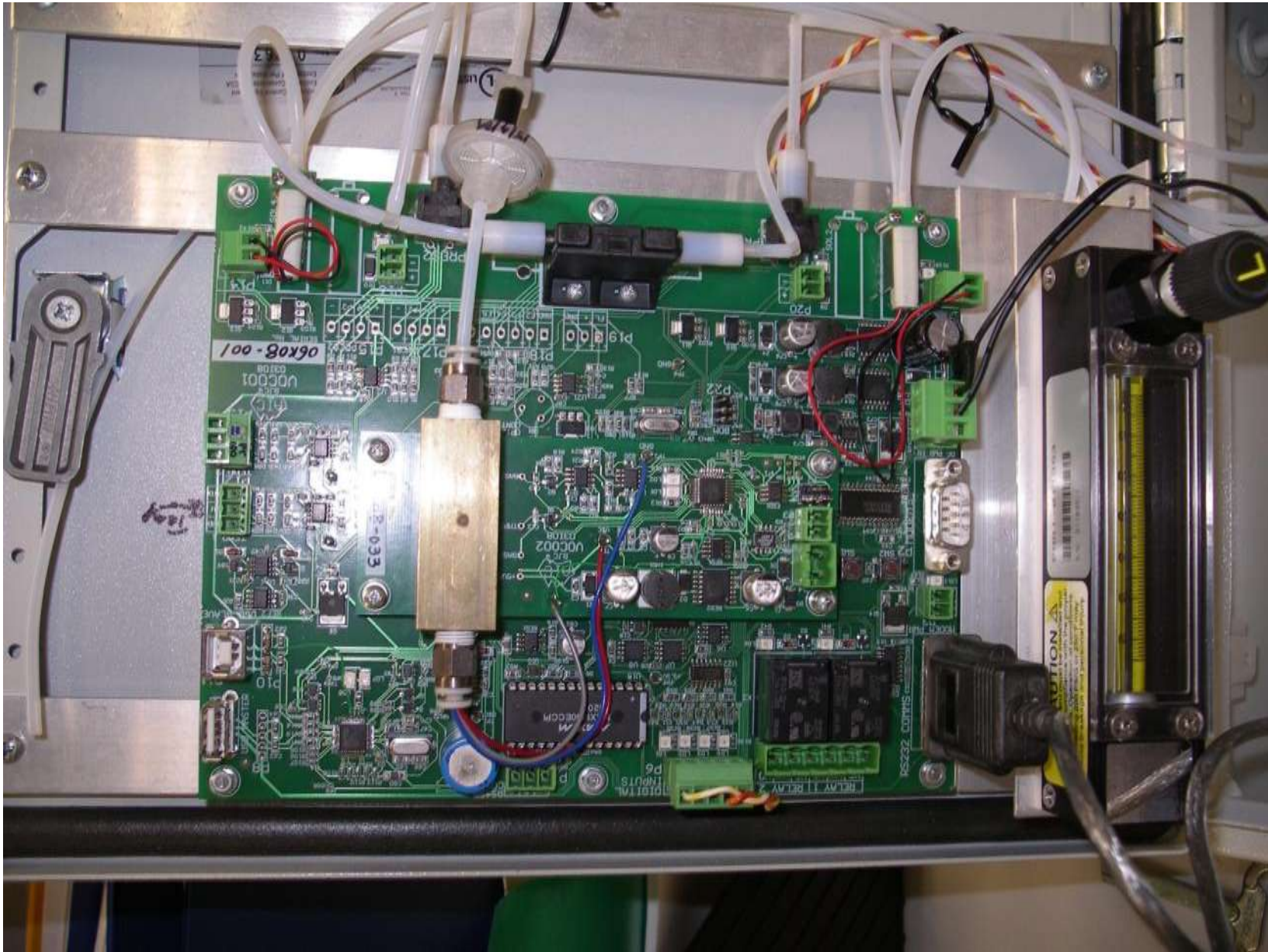




Commercial in Confidence









Commercial in Confidence

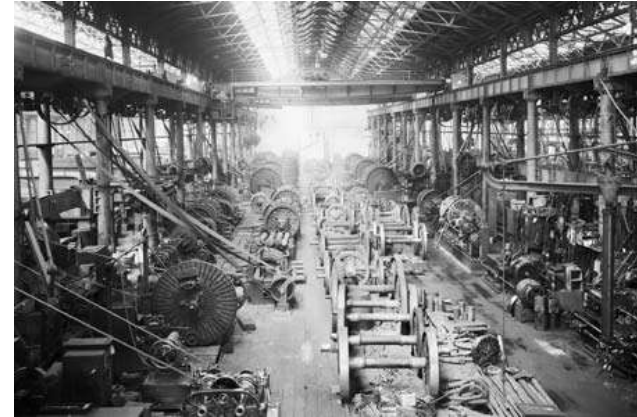
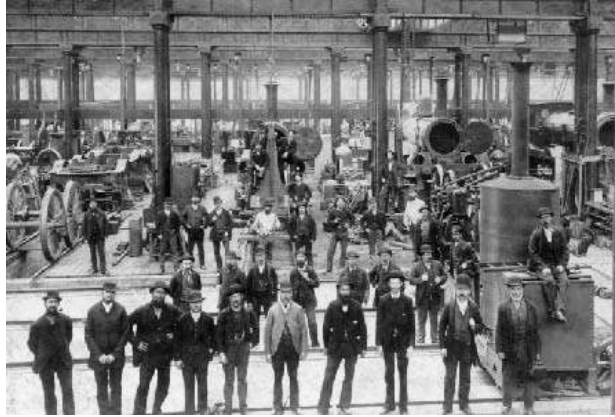


Conclusion

- Practical in-situ instrumentation
- Proven applications for rapid online analysis
- Flexible for application
- Upgrade possible to specific compound analysis



Thankyou



Biotechnology benefiting the environment

Dr. David Garman
Executive Director
Environmental Biotechnology CRC Pty Ltd

Tel: +61 (0)2 9209 4973
Fax: +61 (0)2 9209 4980
Email: b.hamdorf@ebcrc.com.au
Web: <http://www.ebcrc.com.au>

Peter Chrystie
Aqua VOC Pty Ltd

