

# Water Intake Protection System



# A detailed analysis of water intake protection systems

## *Challenges, technologies and solutions*

### Introduction

One of the very first steps in any drinking and clean Water Treatment Plant (WTP) is the abstraction of water from a **water source**. Typical water sources used for these applications include boreholes, springs, rivers, reservoirs, lakes and the sea. Each water source presents a specific set of challenges and characteristics yet they may all be subject to **anthropogenic pollution events**, such as oil and chemical spills from roads, industry, household and even from malicious acts of polluting.

In this document we will discuss how these pollution events can affect a WTP, how an early warning system can be used to protect the WTP from damage caused by pollution and how the Multisensor Systems' MS1200 Total VOC monitor has been used in hundreds of WTP around the world to protect assets and ensure high standards of compliance in drinking water quality without costly disruption.



Figure 1 - A river water intake

### Sources of water pollution

There are many potential sources for water pollution. Some typical examples include:

- Illegal Disposal of Waste
- Road and Rail Accidents
- Damage to Pipelines
- Commercial and Pleasure Craft and Shipping
- Stored Fuel Oil in Commercial and Domestic Applications
- Chemical Spills from Industry
- Historic Groundwater Contamination
- Military Installations
- Malicious Acts and Terrorism

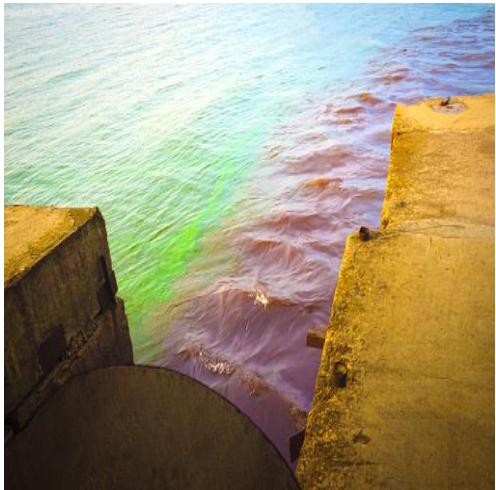


Figure 2 – Water Pollution

According to studies conducted by UNESCO, much of the **industrial wastewater** generated around the world is discharged **untreated** into open watercourses, which reduces the quality of larger bodies of water and can contaminate aquifers<sup>1</sup>. In the US, 60% of the water comes from freshwater sources but nearly a quarter of rivers and streams are so heavily polluted they are hazardous to human health<sup>2</sup>. In China in 2018, 57% of surface fresh water was categorised as “non Grade II” which means it was not suitable for use in drinking water<sup>3</sup>. Finally, in Europe, more than 60% of surface waters have reached an acceptable standard for the European Environment Agency<sup>4</sup>. These examples show that the story is the same everywhere. The quality of our water sources has been steadily deteriorating. At the same time, a growing population and increasingly **stringent regulations** mean the demand for high quality water is also increasing. The task for operators and water quality managers in meeting this demand whilst dealing with unpredictable levels of pollution is extremely challenging.

## Effects of water pollution on a Water Treatment Plant

When polluted water enters a WTP various issues can arise that depend upon the size of the pollution event, the nature of the contaminants present, the design of the plant and the treatment processes to name but a few. Usually, during a pollution event, critical points to consider include:

- **Activated carbon filters, RO membranes and filters:** expensive to replace and/or clean
- **Regulatory compliance:** some pollutants will go through the process and reach the population
- **Disruption of supply:** in some cases, production will have to be suspended to clean the WTP
- **Loss of revenue:** when water companies are paid for the amount of delivered water
- **Public relations disaster:** the media is always hungry for the next “environmental scandal”

**Clean-up costs:** takes time, resources, effort and money



Figure 3 – RO membranes and filters both suffer from oil spills and pollution events

<sup>1</sup> <http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/facts-and-figures/all-facts-wwdr3/fact-36-industrial-wastewater/>

<sup>2</sup> [https://www.epa.gov/sites/production/files/2016-03/documents/fact\\_sheet\\_draft\\_variation\\_march\\_2016\\_revision.pdf](https://www.epa.gov/sites/production/files/2016-03/documents/fact_sheet_draft_variation_march_2016_revision.pdf),

<sup>3</sup> <https://www.statista.com/statistics/1065058/china-share-of-river-water-quality-across-the-country/>

<sup>4</sup> <https://www.eea.europa.eu/publications/state-of-water/>

## Pollution Events and VOCs

Pollution is a very general term, a definition is:

*"the presence in or introduction into the environment of a substance which has harmful or poisonous effects."*

To date, there are more than 100,000 listed toxic chemicals and WTP only routinely test for a small percentage (~ 5%). Additionally, for most plants these tests are carried out on a monthly or annual basis, rather than daily. This makes it very difficult to react rapidly to pollution events.

For the design of an on-line early warning system that can be used and relied upon in a real-life scenario, it is important to focus on one of the most common sources of water pollution: Volatile Organic Compounds (VOCs).

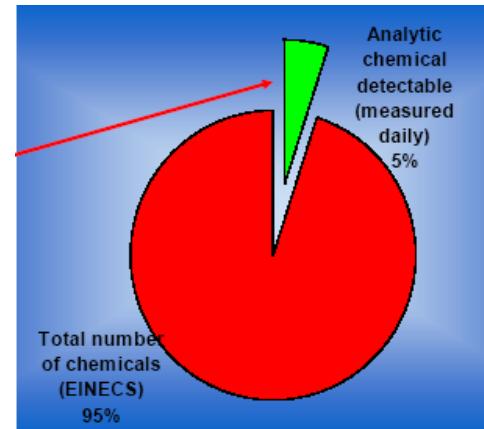


Figure 4 – Percentage of tested chemicals

VOC	Industrial Source
BTEX (Benzene, Toluene, Ethyl benzene, Xylene), Hexane, Cyclohexane and Trimethylbenzene.	Petrol, diesel, fuel oil, paint thinners, oil based stains and paints, insecticides, mineral spirits and furniture polishes
Acetone, Ethyl Alcohol, Isopropyl Alcohol, Methacrylates , Ethyl Acetate	Nail polish and remover, colognes, perfumes, rubbing alcohol, hair spray
Tetrachlorethene(PERC) and Trichloroethene (TCE)	Dry cleaning liquid, spot removers, fabric/leather cleaners
d-limonene (citrus odour), a-pinene (pine odour), isoprene	Citrus (orange) oil or pine oil cleaners, solvents and some odour masking products
Tetrahydrofuran, Cyclohexane, Methyl ethyl ketone (MEK), Toluene, Acetone, Hexane, 1,1,1-Trichloroethane, Methyl-iso-butyl ketone (MIBK)	PVC cement and primer, various adhesives, contact cement, model cement
Methylene chloride, Toluene, older products may contain Carbon Tetrachloride	Paint stripper, adhesive (glue) removers
Methylene chloride, PERC, TCE, Toluene, Xylenes, Methyl ethyl ketone, 1,1,1-Trichloroethane	Degreasers, aerosol penetrating oils, brake cleaner, carburettor cleaner, commercial solvents, electronics cleaners, spray lubricants
1,4-Dichlorobenzene, Naphthalene	Moth balls, moth flakes, deodorisers, air fresheners
Freon (Trichlorofluoromethane, Dichlorodifluoromethane)	Refrigerant from air conditioners, freezers, refrigerators, dehumidifiers
Heptane, Butane, Pentane	Aerosol spray products for some paints, cosmetics, automotive products, leather treatments, pesticides
Formaldehyde	Upholstered furniture, carpets, plywood, pressed wood

Table 1 - Sources of VOCs from Industrial Sources

Measuring Total VOCs is a good way to look for anthropogenic pollution as hydrocarbons are present in many man-made products and VOCs are not naturally present in high concentrations in watercourses. Table 1 shows the relationship between many VOCs and potential industrial sources.

For a more detailed analysis of the risks associated with VOCs, information can be found in the report titled: "Volatile Organic Compounds - Understanding the Risks to Drinking Water" by the UK National Centre for Environmental Technology<sup>5</sup>.

Throughout the course of this article we will be referring to **Total Volatile Organic Compounds (TVOC)** as a measure for all VOCs, hydrocarbons, pollution and oil in water. This is the general approach taken by Multisensor Systems: by detecting TVOC it is possible to have a comprehensive, wide detection spectrum which will result in the best possible protection for a WTP.

## VOC Detection Approaches and Issues

There are various measurements and detection methods for VOCs. Laboratory based techniques are the most accurate methods for detecting VOCs. However, they are also the **slowest and most expensive** techniques on the market. These techniques include Gas Chromatography with Mass Spectrometry or Flame Ionisation Detection (FID) analysers, the costs of which can easily run to over \$100K per year.

Laser based methods for detecting oil in water are also available, but these require the **oil to be in an emulsion** state or to have formed a slick on the surface of the water (oil on water). These methods can only detect relatively high concentrations of oil; typically 1 ppm for oil in water and much higher for oil on water detection. Both of these detection limits may lead to concentrations at which damage occurs to a WTP.

The oil on water detector measures the reflectance change of the surface, a property which changes when layers of oil are present. The system requires a motionless surface, free from dust and debris and must be out of direct sunlight.



Figure 5 – Turbidity in the water source will always pose a problem for optical systems

The oil in water detectors use either light scatter techniques or fluorescence and can often measure down to 1 ppm concentrations. This technique offers 24/7 online monitoring but is susceptible to **false results** if the water has a **high turbidity level**, which is common in surface waters. The detectors need regular maintenance and cleaning of the sample chamber, as particles can clog the system up.

Fortunately, more cost effective, faster and more portable methods of VOC detection are available, such as photoionisation detectors (PIDs) and **Electronic Nose Technology (E-NOSE)**.

<sup>5</sup> <http://dwi.defra.gov.uk/research/completed-research/reports/DWI70-2-292.pdf>

A photoionisation detector (PID) uses an ultraviolet (UV) lamp to irradiate incoming gas. The UV energy ionises the molecules, producing an ionic current which is then measured. PID's are broadband detectors and as such are not selective; they ionise all molecules with a similar ionisation energy to the UV lamp in use that pass through the detector. This means they are good at detecting a wide range of VOCs and they can give a quick on the spot measurement of VOC concentrations.

PID instruments also have some significant disadvantages:

- water vapour, condensation, temperature and quenching can limit their performance to 0.1 ppm (at best under controlled conditions) but typically 1 ppm.
- PIDs need **regular maintenance** and calibration of the UV lamp, driver and detection circuit.
- The cell also needs regular cleaning as dust and microfibres can increase condensation.
- The calibration procedure is **expensive and complicated** and uses 10 ppm compressed isobutylene gas. (See Appendix IV)

**E-NOSE technology** uses a semiconducting material (metal oxide) which is applied to a non-conducting substance (substrate) between two electrodes. The substrate is heated to a temperature (around 400 °C) at which the presence of the analyte gas can cause a reversible change in the conductivity of the semiconducting material

- When no gas is present, oxygen is ionised onto the surface.
- When molecules of the analyte gas are present, they replace the oxygen ions which in turn affects the conductivity.
- This change is measured complex electronic circuits and is directly proportional to the concentration of the gas being measured.

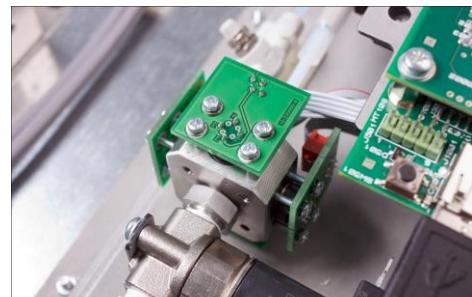


Figure 6 - The Multisensor Systems E-Nose based sensor

This makes the E-NOSE a **broadband VOC detector technology** as any suitable molecule will interact with the semiconductor surface. An example of an instrument using this type of sensor technology is the MS1200 VOC monitor.

This method has the advantages of:

1. High sensitivity i.e. the monitor can detect **VOC concentration levels down to 1 ppb**.
2. Sensors have a long life and do not require cleaning.
3. The sensors **auto zero** before every sample measurement to take into account sensor drift and aging effects. This is done by passing filtered clean dry air over the sensors at every sample cycle.
4. There are 2 filter materials used in the monitor, a dust filter and activated carbon. These are the only consumables used in the system and only need replacing every 6 months.
5. Due to the robustness of the sensor technology the monitors can be deployed as an **online monitoring system** giving 24/7 detection and accurate measurement.

A validation check procedure has been developed; this method introduces a 200 ppb toluene in water solution, the monitor then samples the air/toluene vapour mixture to check the response.

## Operating principle of the Multisensor Systems TVOC Sensor<sup>6</sup>

The precise mechanism for gas sensing with semiconductors (and in particular metal oxide sensors) is still an area of active research and is not fully understood<sup>7</sup>. When semiconductor particles are heated in air at high temperature, oxygen is adsorbed onto the surface, trapping free electrons from within the semiconductor electronic band structure<sup>8</sup>. These electrons are immobilised at the surface, creating an electron-depleted region known as the space charge layer (for an n-type semiconductor). The space charge layer can be explained as an upward band bending of the conduction band compared to the flat band scenario.

When reducing analyte molecules are present, or indeed any species that will carry out competitive adsorption on the surface of the semiconductor, the number of oxygen species present on the surface is decreased. This process liberates immobilised electrons back into the conduction band, reversing the band bending and in so doing decreasing the space charge layer. This leads to an increase in conductivity. The scale of the increase in conductivity will be directly proportional to the number of analyte molecules present at the surface.

Figure 7 shows schematically how the electronic band structure of the semiconductor changes when exposed to an analyte molecule as well as the generally accepted molecular model for this ionosorption theory (adapted from<sup>9</sup>).

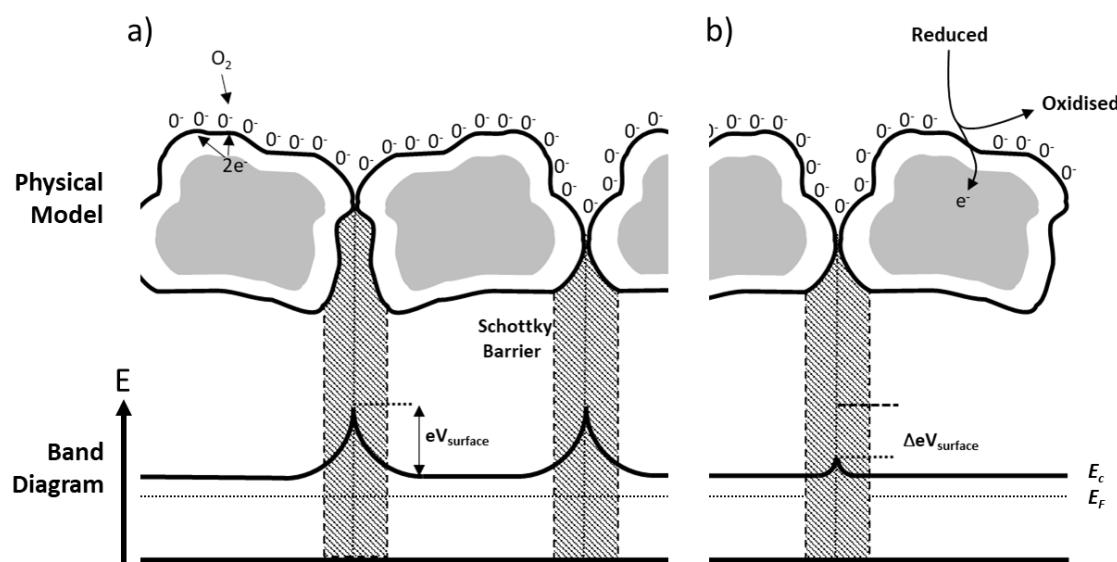


Figure 7 - a) Schematic showing the band diagram and physical model for a metal oxide heated in air; b) Schematic showing the same metal oxide exposed to a reducing analyte molecule which correspondingly increases the conductivity of the metal oxide.

<sup>6</sup> <https://www.multisensor.co.uk/ms-documentation/ms1200/ms1200-oil-in-water-monitor.pdf>

<sup>7</sup> S. R. Morrison, "The Chemical Physics of Surfaces," *Chem. Phys. Surfaces*, 1990, doi: 10.1007/978-1-4899-2498-8.

<sup>8</sup> N. Yamazoe and K. Shimano, "Basic approach to the transducer function of oxide semiconductor gas sensors," *Sensors Actuators B Chem.*, vol. 160, no. 1, pp. 1352–1362, Dec. 2011, doi: 10.1016/j.snb.2011.09.075.

<sup>9</sup> M. E. Franke, T. J. Koplin, and U. Simon, "Metal and Metal Oxide Nanoparticles in Chemiresistors: Does the Nanoscale Matter?," *Small*, vol. 2, no. 1, pp. 36–50, Jan. 2006, doi: 10.1002/smll.200500261.

When an analyte molecule departs the surface, oxygen will re-adsorb and increase the band bending again, a process often referred to as recovery. The length of time for analyte molecules to desorb and the surface to recover to its initial state is dependent on a large number of factors. Similarly, the overall sensitivity of the sensor is determined by a range of complex properties and can be tuneable.

## Putting everything together: Multisensor Systems' Approach

The oil in water analyser was born by putting together the e-nose technology developed by Prof. Krishna Persaud, PhD, FRSC, FInstMC<sup>10</sup>, the metal oxide physics and Henry's Law of partial pressure.

The principle of operation is the measurement of **headspace gases** from a sample tank containing the water to be measured. Ideally water flows through continuously to allow constant protection.

According to Henry's Law, the concentration of gases in the headspace is proportional to the concentration of the substance in the water. Therefore, measurement of the headspace gases provides a technique to determine the concentration of contaminants in the sample water.

The MS1200 works by passing water through a sample tank as shown here. The **volatile components** in the water will pass into the headspace above the water and form an equilibrium.

The headspace gases are sampled continuously and passed over the sensors which respond to the Volatile Organic Compounds (VOCs) in the headspace. This response is analysed by the instrument and a concentration value is generated, based upon the relationship between the concentration present in the headspace and that in the water.

Thanks to this system, it is possible to rapidly determine when a contamination event occurs and allow the user to take appropriate actions to protect the process, the filters and the assets and **keep operations running smoothly**.

The MS1200 is now installed in hundreds of sites across the UK and the world and is helping protect WTPs from pollution events on a daily basis. After installing the first unit and seeing the benefits, many

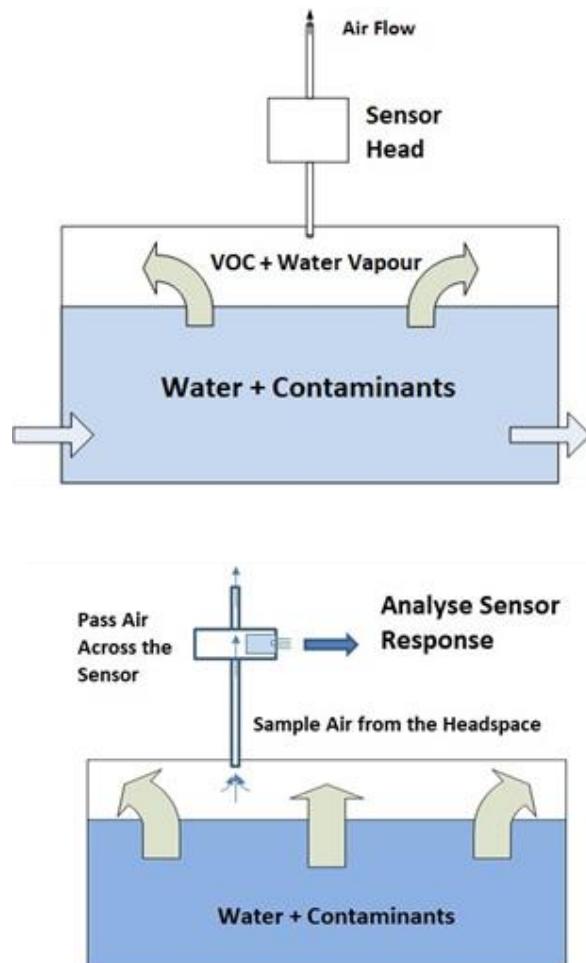


Figure 8 - Representation of the headspace sampling system

<sup>10</sup> Prof. Krishna Persaud is one of the directors of Multisensor Systems and the Chief Scientific Officer for the company. The first prototype was conceived in the early 2000s' to help a UK water company to protect its activated carbon filters from pollution events.

water companies have returned to purchase further instruments to protect their vital water intakes typically starting with areas at highest risk.

## The MS1200 TVOC Monitor: Product Specifications

The following table summarises some of the most important specifications of the MS1200 (as of April 2020). To see the most up to date version, please refer to the following link:

<https://www.multisensor.co.uk/ms-products/oil-in-water-monitor/>



Parameter	Operational Requirements	
	Minimum	Maximum
Supply Voltage	90 V AC	240 V AC
Power Consumption:		
Standard Version		15 W
Touch Screen Version		45 W
Water Supply	2 l/min	
Water Pressure	4.0 bar	
Working Temp: Ambient	0 °C	40 °C
Working Temp: Water	1 °C	40 °C
Sampling Period	Continuous	1 hour
Detection range	1 ppb	3000 ppb
Repeatability	-2%	+2%
Accuracy	-10%	+10%
Display range (Default)	0 ppb	1000 ppb
Analogue Output	4 mA	20 mA
Analogue Output Isolation	400 V	
Relay Voltage	50 V	
Relay Current	5 A	
Flow Switch	Contacts closed if flow below set point	
Instrument Case	IP65, Coated Mild Steel	
Sample Tank Material	Stainless Steel or Acrylic	
Weight	25 kg	
Dimensions	1170 x 490 x 300 mm	

Given the remote locations of many water abstraction points, the MS1200 was designed to be very robust, require little maintenance, both in terms of spare parts and service, and to be extremely reliable.

**Installation** is a very straightforward process: the instrument requires a connection to a power source, the water source and to waste. It is supplied mounted on two panels and should be bolted directly to a wall or onto a frame.

**Validation** of systems in the field is achieved using the Multisensor **Validation Kit** which presents a standard concentration to the instrument.

# Field Data

# Laboratory Tests

# External Testing

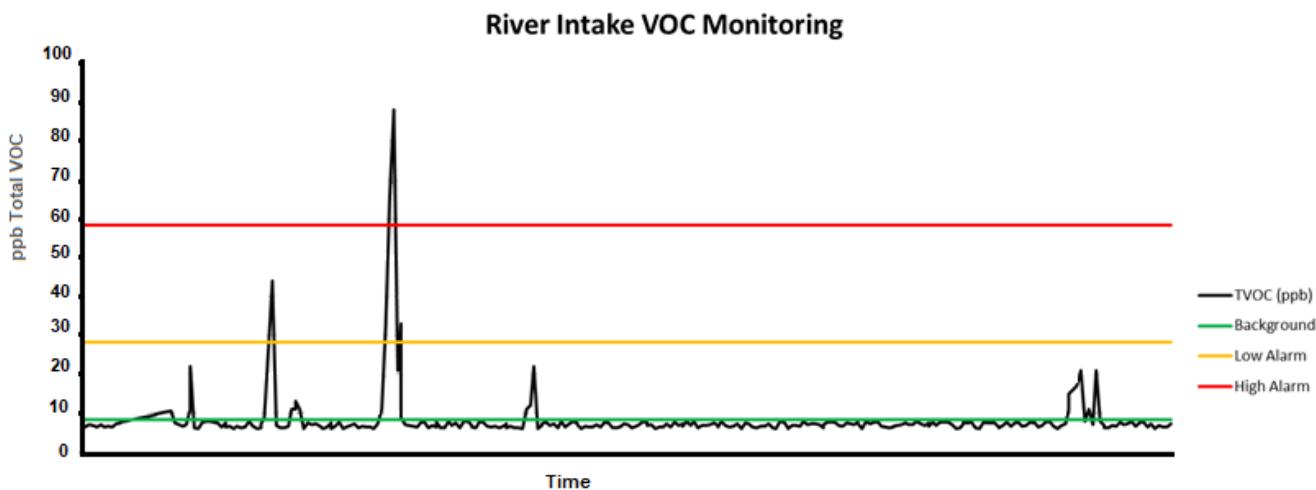


## Field data

Throughout the years Multisensor Systems have developed a rich body of knowledge not only in the development of oil in water monitors but also in the understanding of the dynamics, levels and characteristics of different water intakes.

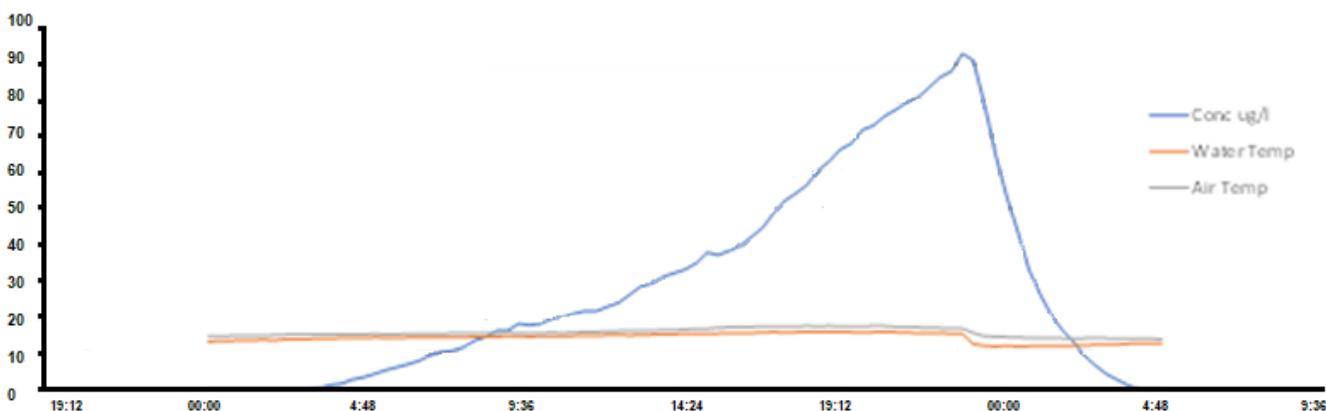
In the example below (Figure 9) we can see what the data from a river monitoring MS1200 looks like. This comes from an instrument installed at a river intake that feeds into a water treatment plant.

Most of the time the system will read around 10 ppb that in this specific application can be defined as “background noise”. A month after this instrument is installed, we see a high-level alarm (higher than 60 ppb) and a low-level alarm (higher than 30 ppb) have been triggered. These sharp peaks in pollution would be impossible to detect with standard GCMS sampling methods.



**Figure 9 – TVOC levels at a water intake over a long period**

The next graph comes from a UK site where the WTP takes its water from a borehole which is usually very clean.



**Figure 10 - Pollution event detected in a borehole**

As we can see at the beginning the readings are at around 0 ppb but start to increase until the pumps are switched off and water from the borehole is not used anymore. After extensive investigation, this message was sent by the WTP:

"I can now confirm that our last two rounds of sampling on Borehole 4 have come back clear of Hydrocarbons. We have however had something come through on the GCMS samples collected on the Tuesday of the site visit.

Both the sample from the Borehole 4 sample tap and the sample collected from the outlet of the Hydrocarbon monitor came back with large peaks of what appear to be 4-chloro-2-methylbutanol and 2-methyl-4-bromobutanol, which I'm told are solvents. I have asked for further information on the concentrations, but I am yet to receive this information. Unfortunately, the laboratory have a UKAS audit this week and so getting information is a little delayed. I am heading to site later this morning to investigate a possible source."

From this example we can see why a Total VOC system to detect pollution event makes sense at water abstraction points. Neither of the compounds would have been on the standard GCMS tests for water abstraction points, these concentration spikes would have therefore been missed and these compounds would likely have persisted through into the customers drinking water.

## Laboratory Tests

While data from the field is important to understand how the instrument performs in real-life conditions, it is often quite difficult to test for specific substances or conditions in the field, that's why we have carried out a number of tests.

### Test 1 – Response speed at different concentrations

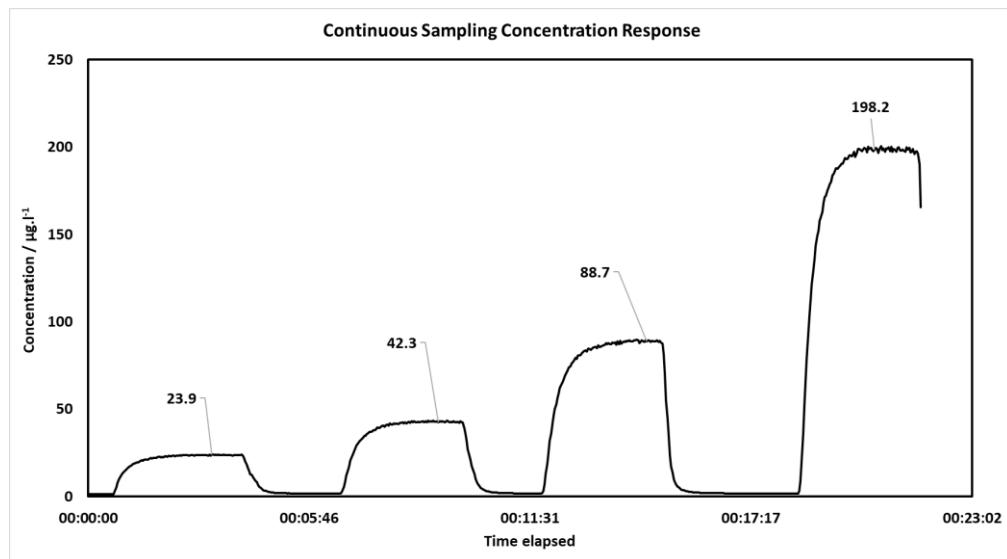


Figure 11 - Speed of response when sampling in continuous mode

### Test 2 – Relative response to various compounds

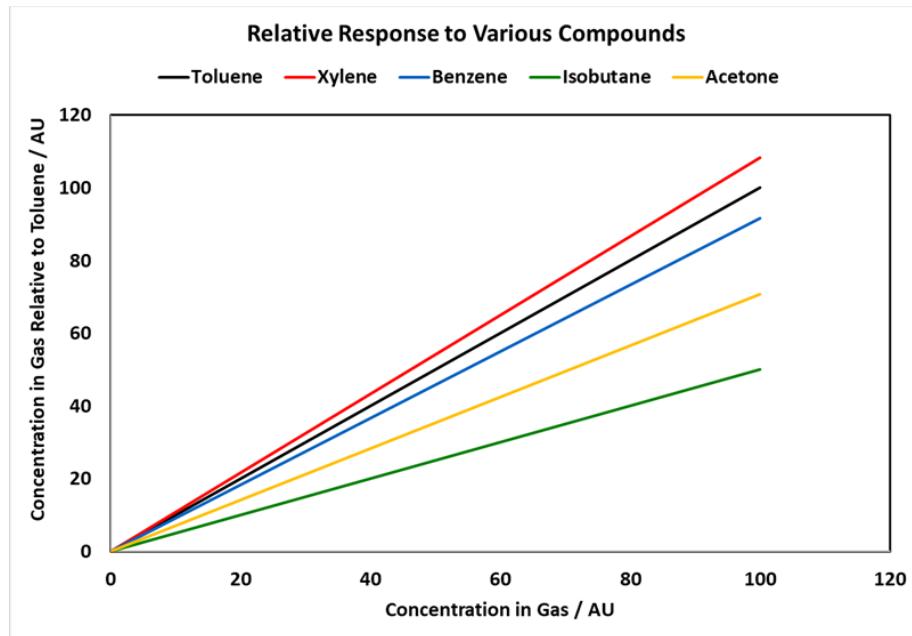


Figure 12 - Response to various compounds

### Test 3 – Concentration response

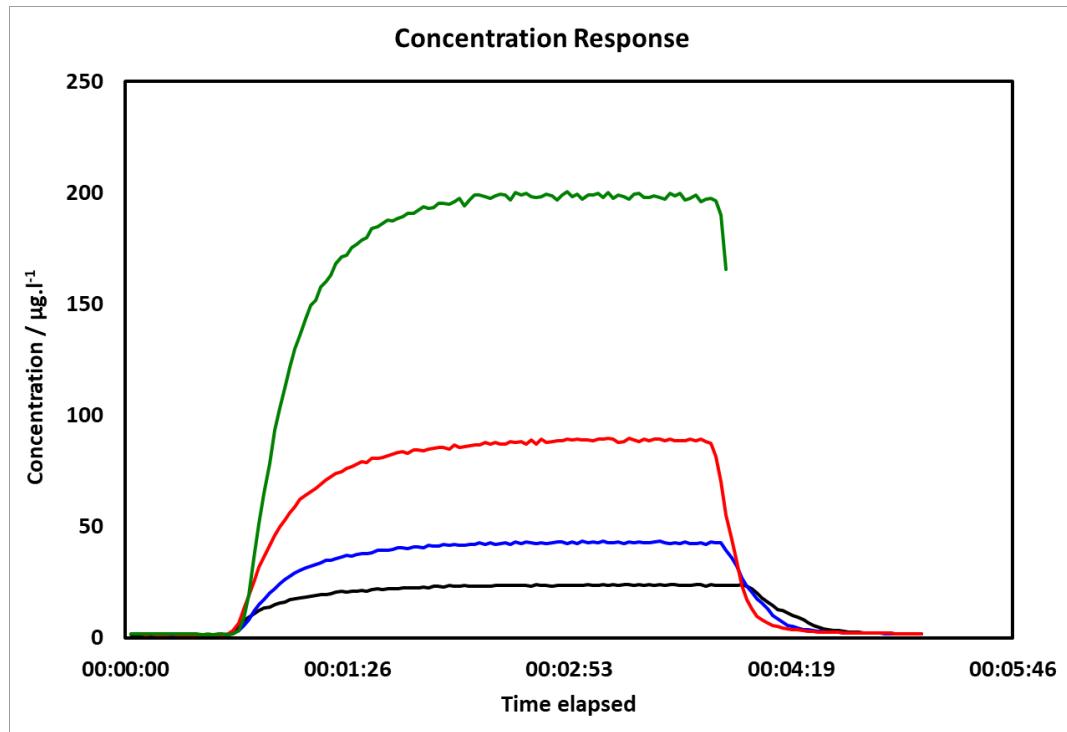


Figure 13 - Response to various concentrations

All these test show that the system reacts to a huge number of different compounds and also responds extremely quickly. Water intakes can be placed very near or very far from a WTP. This means water can take from only a few minutes up to many hours to get into a WTP, depending on the specific circumstances.

Moreover, in some places the regulations will require discrete analysis versus continuous analysis.

All this means that the ability to provide different sampling periods is essential: in some cases, the operator needs a continuous sampling and a very fast response, in some other cases what's needed is a measurement every 15, 30 or even 60 minutes.

The MS1200 can be configured to several different sampling times to accommodate the requirements of the industry.

## Independent Testing

The MS1200 has also been tested by a number of independent organisations. The most recent tests at the date of writing (April 2020) have been carried out by the National Laboratory of Health, Environment and Food of Slovenia in March 2020. An exert from the report on this testing is included here:

### Report on MS1200 Testing – March 2020, Slovenia

Following the validation on the 4<sup>th</sup> March 2020, testing was carried out on the instrument in collaboration with the National Laboratory of Health, Environment and Food in Slovenia. Bottles were prepared through a jointly agreed methodology and measurements of identical samples were measured on the MS1200-01-000195 instrument on site and on a GCMS at the National Laboratory.

The measurements of the MS1200 recorded on site were as follows:

Sample	Reported Concentration / $\mu\text{g.l}^{-1}$	Temperature / °C
0 / Blank sample	4	15.05
50 $\mu\text{g.l}^{-1}$ BTEX	37	14.53
200 $\mu\text{g.l}^{-1}$ Toluene	183	14.45
50 $\mu\text{g.l}^{-1}$ BTEX – repeat measurement	38	14.23
Tank measurement	8	10.36

Table 2 Measurements were conducted with a 20-minute sampling interval at an airflow rate of approximately 84  $\text{ml.min}^{-1}$ . The instrument was calibrated and validated for toluene using Multisensor's standard method.

These results compared favourably with the laboratory GCMS results which were reported as follows:

Sample	Reported Concentration / $\mu\text{g.l}^{-1}$
0 / Blank sample	<1 $\mu\text{g.l}^{-1}$
50 $\mu\text{g.l}^{-1}$ BTEX	41 $\mu\text{g.l}^{-1}$
200 $\mu\text{g.l}^{-1}$ Toluene	188 $\mu\text{g.l}^{-1}$

Table 3 Measurements were conducted on a GCMS instrument (GC - Agilent 6890N, MS - Agilent 5975). Separation was performed on a capillary column (Agilent J&W DB - 624 UI capillary column; 121-1324; 20m x 180  $\mu\text{m} \times 1\mu\text{m}$ ). The SIM technique was used for the GCMS detection.

These results confirm that the MS1200 measures and reports the concentration of toluene in water accurately under the conditions of this test. These results further demonstrate that the instrument can accurately measure and report BTEX concentrations in water utilising the same calibration under the conditions of this test. The conditions used for these tests were comparable to real world measuring conditions and the bottle measurement method was a suitable analogue for the sampling tank measurements.

A plot of the results from this test emphasise the accuracy of the MS1200 as an online, robust measurement system compared to a GCMS at the nationally accredited government laboratory.

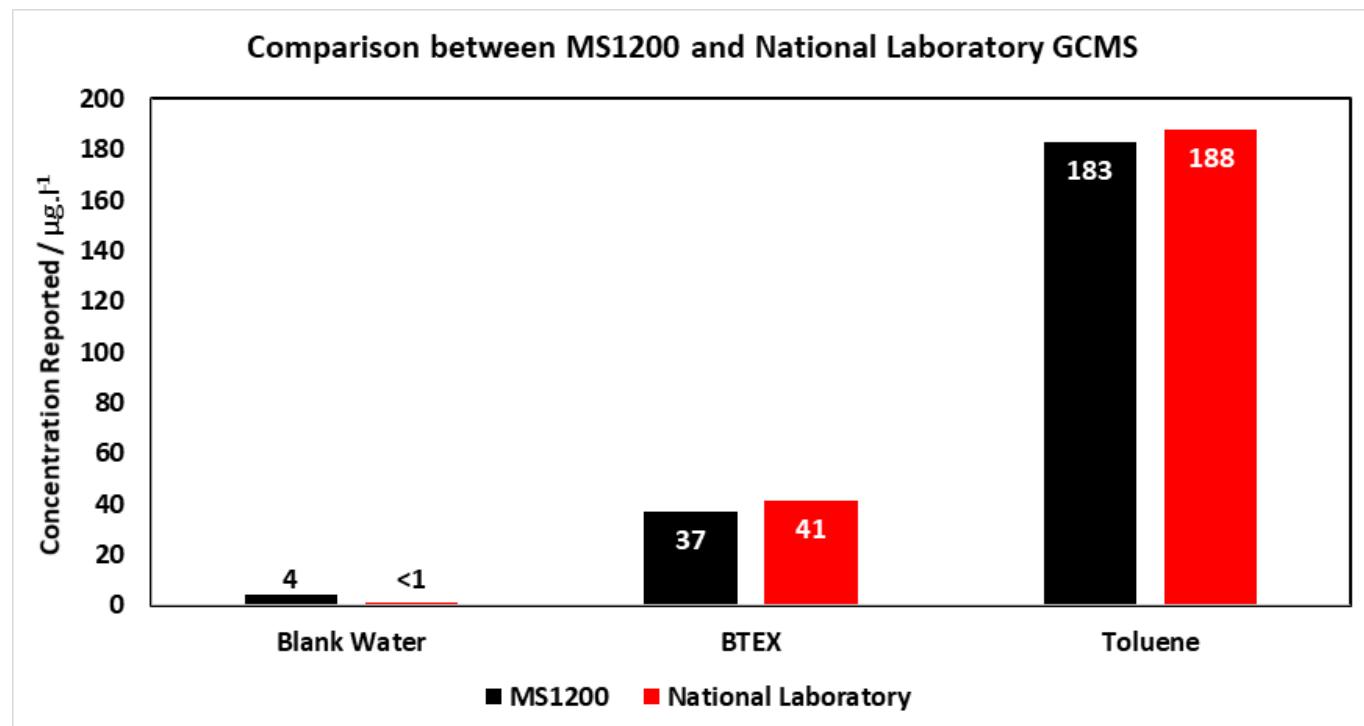


Figure 14 – Comparison between MS1200 and Laboratory Results

## Tested compounds

A comprehensive list of the Total VOC is not practical, however, these are some of the compounds that have been specifically tested.

Compound	Tested	Notes
Benzene	✓	Tested with national laboratory
Chlorobenzene	✓	Multisensor Laboratory (MSL)
Ethanol	✓	MSL
Acetone	✓	MSL
Vinyl Chloride	✓	MSL
Tetrachloroethylene	✓	MSL
Isobutane	✓	MSL
Dichlorobenzene	✓	MSL
Ethylbenzene	✓	Tested with national laboratory
Isopropanol	✓	MSL
Isopropylbenzene	✓	MSL
Naphthalene	✓	MSL
Styrene	✓	MSL
Toluene	✓	Multisensor Systems Standard
Trimethylbenzene	✓	MSL
Xylene	✓	Tested with national laboratory
Chloroform	✓	MSL
Methanol	✓	MSL
Trichloroethane	✓	MSL
Trichloroethylene	✓	MSL
4-chloro-2-methylbutanol	✓	Case Study
2-methyl-4-bromobutanol	✓	Case Study
Range of solvents	✓	MSL
Penetrating Oils	✓	MSL
BTEX mixture	✓	Tested with national laboratory
Diesel	✓	MSL
Petrol	✓	MSL
Alcohols	✓	MSL
n-Heptane	✓	MSL
Formaldehyde	✓	MSL
Acetaldehyde	✓	MSL
Acetic acid	✓	MSL
Propanoic acid	✓	MSL
Trimethylamine	✓	MSL
Methyl Mercaptan	✓	MSL
Methane	✓	MSL

# Case Studies

## How the MS1200

### Works in the

### Field



In the following pages you can find some of case studies. Given the very specific nature of the analyser and the application, it would make no sense to create hundreds of case studies which are all the same (protection of a water intake) for this reason we tried to add a mix of standard and non-standard applications.

## Case 1: Monitoring of River Water Intake for Petroleum Contaminants

### **Sector**

Clean Water

### **Application:**

Monitoring of river water intake to detect hydrocarbons contamination from accidental spill

### **Customer**

Water Company, North of England

### **Installation date**

2014

### **Problem**

In early 2013 there was an oil spill into the river from a local petrochemical plant. The water company that abstracts water from the same river was hit with high levels of hydrocarbons and this led to a halt in the production and high costs due to the replacement of filters, pipes and cleaning operations.

### **Product**

MS1200-01-SYS – Standard version, 4-20mA

### **Installation Facts**

The instrument is installed in an outbuilding at around 70 metres from the river from where the water is taken. Water is analysed for hydrocarbons and VOC every 15 minutes and, if there's an increased level, an alarm is triggered and action is taken.

Since the installation the system has protected the water plant on two occasions.



**Figure 15 -** A picture of the unit installed in the outbuilding. The unit is connected to a PLC that records the data and, in case of an accident, triggers an alarm that switches off the intake pumps.

As we can see from the following case study, the instrument can be used not only to protect water intakes, but also to protect water sources, such as lakes and reservoirs, by monitoring the rivers that feed the reservoir. In many cases, a single accident can spoil an entire body of water making it unusable for some time.

## Case 2: Monitoring of Reservoir Feed for Hydrocarbon Contamination

### Sector

Clean Water

### Application

Monitoring of rural watercourse feeding a small reservoir to detect contamination from farm or food processing facilities.

### Customer

Water Company, SW England

### Installation date

2015

### Problem

Persistent small contamination events had put the reservoir which feeds a drinking water treatment plant at risk. Low level contamination preceded a large event in late 2016.

### Product

MS1200-01-SYS – Standard version, 4-20mA with special tank for very high turbidity events.

### Installation Facts

The instrument is installed in an outbuilding and fed by a pump which is also used for other instrumentation. Water is analysed for hydrocarbons and VOC every 15 minutes and, if there's an increased level, the instrument closes a sluice gate via the Alert relays, diverting the contaminated water until the event has passed.

The MS1200 installed saved the reservoir from serious contamination during a large event which resulted in an alternative source being piped to feed the reservoir.



Figure 16 - A picture of the unit installed in the outbuilding. The unit controls a sluice gate which diverts flow away from the reservoir in the event of contamination

The MS1200 can also be used to monitor a borehole or any water source AFTER an accident. There are numerous examples of this application: a train derailing a spilling 10,000 litres of kerosene, a diesel pump bursting a threatening an aquifer, a damaged pipeline or bund area in a chemical plant and so on. The idea is always the same: there's an accident, there's a need to monitor for a long time, standard laboratory analysis are impractical and/or expensive over a period of weeks or months, the MS1200 is installed and the potential contamination monitored.

## Case 3: Monitoring of a borehole to detect potential fuel contamination

### Sector

Borehole Monitoring

### Application

Monitoring a borehole after a diesel spill to ensure the aquifer is not contaminated

### Customer

Water Company, England

### Installation date

2017

### Problem

The water company used a diesel power pump and this led to a spill in the ground. The company wants to ensure that the area has been properly isolated.

### Product

MS1200-01-SYS – Standard version, 4-20mA and relay output

### Installation Facts

After the spill, the area was isolated with a barrier and the water company wanted to be sure that no diesel had reached the aquifer. A few months after the installation, the system started to give high readings of VOCs, however, no diesel was found. After extensive research, two specific solvents were identified in the aquifer. An investigation is currently underway to find the source of the contamination. The water from this aquifer is no longer used to supply the water plant and the company has avoided sending contaminated water into its network.



Figure 17 - A picture of the unit installed in an outbuilding next to the borehole.

In this case we can see the full benefits of a non-contact system like the MS1200. Sometimes the condition of the water can be very challenging (high turbidity, iron and manganese contents and so on) and, in these conditions, other optical based systems would simply not work.

## Case 4: Monitoring a High Iron and Manganese Content Borehole for Hydrocarbons

### **Sector**

Drinking Water

### **Application**

Monitoring a borehole for contamination from a known petroleum spill

### **Customer**

Water Company, UK

### **Installation date**

2014

### **Problem**

The customer wished to monitor hydrocarbon levels in a borehole for drinking water. The customer had attempted to use a UV based system but found that the system would only last a matter of a few days before ferric and manganese deposits stopped the system from functioning

### **Product**

MS1200-01-SYS – Standard version, 4-20mA

### **Installation Facts**

The instrument was installed at the head of the borehole. Hydrocarbon levels less than 10ppb were present. The system was verified with Diesel Concentrations of 6 and 18 ppb were used to validate the operation on-site. The system has operated without failure since installation, showing the system to be immune from the effects of high iron and manganese content water.



Figure 18 - Installed MS1200 in 2014

# Final Considerations

This document has explored the main reasons for protecting water sources and water intakes against pollution events, both in terms of ensuring high water quality to the population and to protect WTPs from high costs and damage. Measuring the Total VOC content of water has been shown to be an excellent method to monitor for a wide variety of pollution events and a number of technologies that can detect VOCs have been discussed. The MS1200 Total VOC monitor and its electronic nose technology have been shown to be superior for high accuracy broadband detection of VOCs in water. Finally, a series of case studies and examples have shown that the robust online measurements of TVOCs provided by the MS1200 have not only held up against national laboratory tests but saved WTPs from millions of dollars of damage over the years.

Multisensor Systems Ltd. always strives to provide the best solutions and the best technologies for the detection of contaminants in water.

If you have any question or a specific application that you want to discuss, we are here to help so please feel free to get in touch.



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