Lac Mégantic disaster increases awareness of water treatment plant vulnerability

By Dr. Mark R Brown

A train pulling 72 tank cars, laden with oil from hydraulic fracturing (fracking) in North Dakota, derailed and exploded in Lac-Mégantic, Québec on July 6, 2013, killing 50 people. Such accidents are a product of the boom in "pipeline on rails" methods of shipping oil. In 2009, a mere 500 tank cars of oil were transported by rail in Canada. For 2013, this was projected to be as high as 140,000 tank cars.

This disaster has heightened awareness in drinking water suppliers to the consequences a similar disaster or local incident would have on continuity and safety of supply.

Incidents have been reported from pleasure craft, commercial vessels, highway accidents, oil and gasoline storage tank failure and industrial incidents. Water plant managers and supervisors consider this an unlikely risk, but one with high impact.

The consequence of having a plant shutdown for cleaning and replacement of filter beds, or membranes, is severe enough on its own. However, contamination passing through the plant will require water quality announcements and will cause significant scrutiny from the media and public.

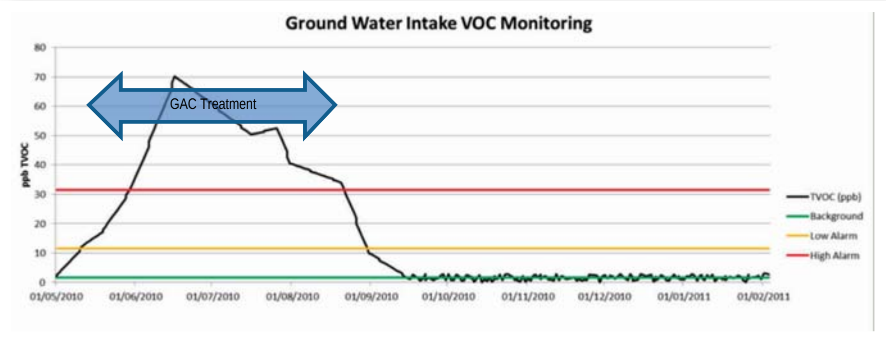

Figure 1. Groundwater intake VOC monitoring.

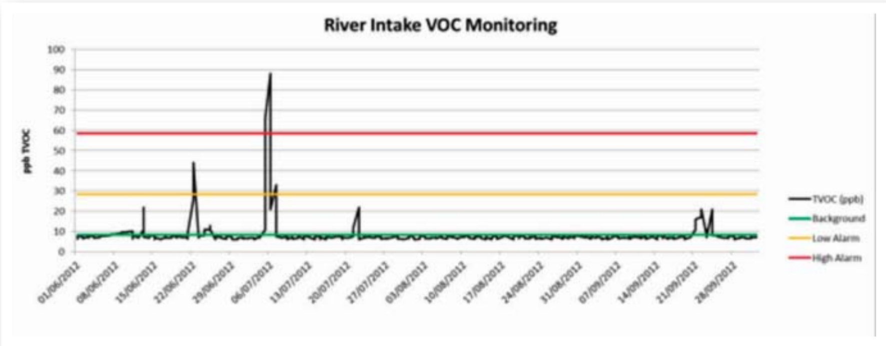

Figure 2 shows that, over the period from June to October 2012, there were several incidents at this intake to the water plant.

Health risks

A significant perceived risk is benzene contamination of the drinking water supply. Benzene forms between 0.62 to 1.0% of crude oil and refined gasoline. Levels are regulated at a maximum concentration of 0.5µg/l in drinking water across the developed world. Long-term exposure to high levels of benzene can cause leukemia.

Monitoring for benzene in treated water is both costly and difficult to perform with sufficient frequency to give operators, managers and customers confidence in the results. Results are often received several days after sampling. Also, with changing levels during spill conditions, treatment methodologies are often difficult to plan.

Groundwater

Contamination of an aquifer is rarely an immediate effect of spills. Volatile organics (VOCs) migrate through the soil and rock, which results in delayed peaks in incoming levels to the plant. However, with complex geology and hydraulics, spills can affect drinking water supplies tens of miles away from the incident.

Each aquifer has a low natural total VOC (TVOC) content and any significant increase will normally be an indicator of chemical contamination. There are few online techniques for measuring this, particularly at levels below 100ppb. One method is the use of electronic nose sensors to "sniff" the air above the water. The Multisensor MS1200-SYS Total VOC monitoring system does this.

It is non-contact, and reagent free, and provides an immediate response to incoming VOCs. The system works by sampling air in a controlled sample tank. It then correlates the results, using gas laws, to show µg/l TVOC in the water. Accuracy is ±10% at 80 µg/l toluene equivalent. Readings are reported every 20 minutes to a 4-20mA output, on a unit display or by triggering relays based upon user defined alert levels. This allows immediate action to be taken, and changing VOC trends to be identified.

An example is shown in *Figure 1,* where contamination was present for four months, peaking at 70 µg/l TVOC. It was above the high alarm level for three months. In the period where the contamination was high, mobile activated carbon adsorbers were deployed onsite and for the peak period of three months. Finished water was treated with granular activated carbon polishing filters, to remove residual VOCs

MS1200 VOC concentration monitor.

(primarily benzene).

The ability to accurately monitor incoming TVOC levels in real time ensured carbon was only used at the times required and, more importantly, was deployed prior to system contamination. The result was safe water, at minimal cost to the consumer.

Surface water

Surface water plants are vulnerable to spills of chemicals and hydrocarbons, as current monitoring methods do not provide immediate online results with the accuracy and frequency required to protect them. Rapid action is required on identification of contamination, due to the dynamic and ever changing nature of surface water sources.

In one case, waste oil was illegally dumped directly upstream from a water plant intake. The resultant contamination was identified by an operator, as it was passing through the plant into the distribution system, and the plant was shut down.

Lost production and re-routing of water supply caused significant disruption and resulted in additional cost to the plant operating company. However, the largest cost was the cleanup procedures required prior to re-commissioning. Replacement of the sand-anthracite filter beds, carbon absorbers and detergent flushing of the pipework was the major cost.

This plant now operates with the Multisensor MS1200-SYS Total VOC monitoring system which was installed at the intake from the river. As most plants are unmanned throughout the night, the relays in the Multisensor monitor automatically control the intake pumps. If gross contamination is identified, the relay within the unit switches off the intake pumps and alerts the control center of the problem.

Each river has a natural background TVOC level which changes throughout the seasons but tends to be in the range 5-10 µg/l. The low alarm is, therefore, set at 20 µg/l above background level. This is purely an early warning to potential problems. Corrective actions are to perform further investigation and review trends for TVOC levels. The high alarm is set at 50 µg/l above background level. This automatically triggers shutting down the intake pumps and alerts the control center.

Figure 2 shows that, over the period from June to October 2012, there were several incidents at this intake to the water plant. The majority were small localized contamination events, which had no significant effect on water quality.

However, in early July an event caused the inlet pumps to be switched off. This incident was traced back to a localized spillage. The automated system allowed the contamination to pass downstream, before the plant was placed back into service.

Conclusion

Remedial costs from contaminated intake water are significant. Therefore, monitoring for incoming VOCs should be an integral part of plant protection. Unfortunately, monitors are often only installed after a pollution event has occurred.

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