

## What happened?

During winter 2016/17, numerous community complaints were received of rotten-egg gas-like odors emanating from the western golf course lakes and waterways.

Still wind conditions and cool mornings combined to exacerbate the problem further. The heavy hydrogen sulfide gas accumulated overnight at ground level and was not dispersing until later in the morning when solar radiation and winds picked up.

Facilities and Communities Department (F&C) and Health, Safety & Environment (HSE) Department began joint investigations.



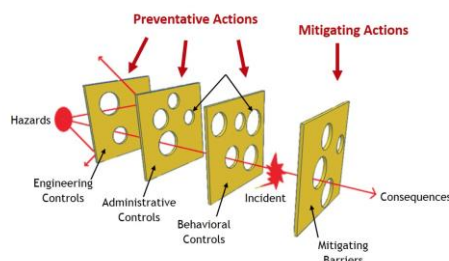
Significant hydrogen sulfide gas detected at the lake



## What was the cause?

The Swiss-cheese model of incident causation illustrates that, although many layers of defense lie between hazards and consequence, there are flaws in each layer that, if aligned, can allow the consequence to occur. Key events that resulted in this particular odor incident were:

1. Historical planting of the deciduous Buttonwood tree (*Conocarpus erectus*) in the vicinity of the lake. The foliage dropped over the years had accumulated and resulted in anoxic 'peat-like' sedimentary layer;
2. Water recirculation pump breaking down approximately 6 weeks prior to the incident and being not quickly repairable, resulting in lake water column stratification and anoxia; and
3. Low winter rates of thermal water convection within the saline lake further promoting anoxic conditions.



Swiss-cheese model of incident causation



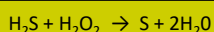
Organic anoxic sediments in the lake system

## How was it solved?



Water recirculation/oxygenation system in operation

Environment Division of HSE recommended rapid oxygenation of the water column using an environmentally benign chemical that breaks down into oxygen and water. Following this activity the hydrogen sulfide odor was eliminated almost immediately.



Key corrective actions undertaken by F&C included:

1. Partial removal of the anoxic sedimentary layer from shallow lakes and waterways. As the Buttonwood trees had previously been removed due to their invasive root systems, the remaining anoxic source required removal; and
2. Water recirculation was re-instated with improved water quality monitoring and pump maintenance.