HOLISTICALLY OPTIMISING ODOUR CONTROL SPEND IN SEWER NETWORKS

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Our client, a regional council (hereafter known as 'Council') was facing increased operating costs from its wastewater network based chemical dosing systems, greater than other similar sized councils. Council currently uses 8 different chemicals to manage odours in their networks. The effectiveness of these existing chemical dosing systems had also been called into question. It was identified that potential savings from the rationalisation of chemical dosing systems could occur to allow Council to reduce its overall costs and provide more effective services for their customers. In identifying the potential for cost savings due to a reduction in chemical dosing, Council acknowledged that there may be knock on effects on odour complaints or acceleration of corrosion. Council commissioned MWH (now part of Stantec) to investigate odours from its networks with a view of reducing overall spend whilst maintaining compliance with their odour related Key Performance Indicators (KPIs).
This case study investigated over 30 different dosing systems through six of Council's sewage catchments. Special focus was given to minimising impacts to the downstream Sewage Treatment Plants (STPs) and complaints to the neighbouring community.

YEAR CASE STUDY WAS IMPLEMENTED

2015 to 2017

CASE STUDY SUMMARY

The holistic odour control study included a review of existing chemical dosing systems, mapping of odour complaints and septicity modelling to identify where knowledge gaps occurred. The network underwent 4 weeks of hydrogen sulphide (H_2S) and liquid phase sampling to baseline the current operation. After baselining, key chemical dosing systems were shut down as a trial whilst monitoring gas phase H_2S concentration to identify their effects.
The study identified that 19 of the 31 chemical dosing systems were ineffective, predominantly due to their type and location. By removing the ineffective systems, and in some cases providing some localised alternate solutions and/or corrosion protection, Council could, potentially, halve their odour based operating costs in the six catchments whilst maintaining their odour KPIs. Effects to STPs were quantified and found to be relatively minimal.

CASE STUDY DETAIL

Background Information

Sivert and Stuetz (2010) investigated the sewer odour management practices of 8 Australian water utilities to understand the most prevalent liquid phase septicity mitigation measures and the circumstances under which each were used. The most common liquid phase odour removal techniques generally fall under one of the following categories:

1. Preventative – Prevents the generations of sulphide within the wastewater
2. pH shift – Increases the pH of the wastewater to reduce hydrogen sulphide evolution into the gas phase
3. Reactive – Reacts with sulphide to produce inert solid particulates

Sivret and Stuetz (2010) identified seven different chemicals commonly used either presently, in the past or planned for the future in the water industry. The authors identified that magnesium hydroxide was the most prevalent chemical for sulphide control in Australia. Sodium hydroxide was the second most prevalent chemical, however only 60% of the sites operated continuously with the remainder only operating during warmer months. Iron salts and nitrate are used widely around Australia. Oxygen dosing was once used extensively; however it is the chemical which has shown the greatest decline in Australia despite being identified as one of the cheapest chemical dosing technologies. Odour neutralisers are occasionally dosed. Biomaterials are no longer used in the water utilities that were surveyed (Sivret and Stuetz, 2010; Ganigue et al., 2011).

Council uses the chemicals listed in Table 1 below, predominantly for odour mitigation purposes. It was identified that the ongoing operating cost of these chemicals were greater than other similar sized councils. Council engaged MWH in 2015 to investigate the effectiveness of its existing chemicals and to identify a preferred dosing strategy going forward.

Table 1: Chemicals used by Council in its catchments for odour control

Chemical	Use
Liquid Oxygen	Prevents anaerobic conditions developing and partially reacts with sulphide developed. When reacting with already developed sulphide, additional reaction time is needed. Used widely within the Council catchments at to protect particular downstream assets. Dosing typically occurs either into the upfront part of a rising main or just upstream of the downstream asset it is designed to protect. No feedback system is used for control. Some oxygen is deemed to reduce the aerator requirements on the downstream STP.
Gaseous Oxygen	As above but typically used for smaller installations than liquid oxygen.
Compressed Air	Compressed air operates similarly to oxygen injection, however it is limited to the portion of air that is oxygen (approximately 20%).
Hydrogen Peroxide	Hydrogen peroxide (H_2O_2) is an effective oxidising agent for sewage systems. Hydrogen peroxide actively oxidises odorous compounds, and then breaks down to water and oxygen, providing extra oxygen source in

Chemical	Use
	the sewage. It required approximately 0.25-0.5 hours to complete the reaction.
Iron Salts	Iron salts are a proven method of reducing network septicity and chemically binds sulphides that have formed in the rising main into non-soluble precipitate. As a result, sulphide is removed from the liquid phase. The iron salt reaction is quick (a matter of minutes) compared to others.
Chlorine	Chlorine is a powerful oxidising agent which can be effective in oxidising odorous compounds in sewage. Care needs to be taken to ensure that the chlorine added does not result in undesirable compounds being formed in the sewage (e.g. organochlorines) or in having detrimental effects on the receiving sewage treatment plant.
Biological control	Several biological control mechanisms are available in the market. Biological control typically are marketed as containing ‘selected, naturally occurring fast growing Hazard Group 1 micro-organisms with a wide range of metabolic capabilities’ or ‘free enzymes, nutrients and activated carbon’. They are generally designed to reduce COD/BOD levels with sufficient retention time at STPs according to the supplier’s specifications. Biological controls are used as a means of reducing fats and greases in a vacuum system. Chemical is dosed at each vacuum pot and is used to maintain vacuum valve functionality with odour control as a secondary benefit. Council identified that this chemical was effective at providing control of fats and greases within the vacuum pots and would remain in operation irrespective of its performance or otherwise with respect to odour and septicity management.

Chemical dosing in sewer networks is used for both odour mitigation and corrosion control. When chemicals are no longer used, H_2S increases in sewers can lead to biogenic corrosion on susceptible sewer assets and the reduction in asset lifetime. Council identified this issue, however their sewers within these catchments are predominantly small diameter (<300mm) and made from non-corrodible materials. Where susceptible manholes, particularly at rising main discharges, were identified as suffering from (or expected to be suffering from) biogenic corrosion, the refurbishment costs needed to be included in the overall odour strategy.

Council also identified that modifying the dosing system within the network could affect the performance of the STPs, both in the liquid stream and in the gas (foul air treatment) stream. Where modifications were made to the chemicals within the network, the effects on the STPs would also need to be accounted for and, where possible, mitigated.

Case Study

The investigation was provided in three phases as per below:

Phase 1 – Current Knowledge

This phase identified current knowledge of the system and any knowledge gaps that needed to be filled. This included:

- Modelling the expected H_2S concentration from average flow conditions throughout key areas of the network using MWH's Steady State Rising main Overview Septicity Estimator (MWH SS ROSE™). This model estimates the level of liquid and gas phase sulphide generated within rising mains.
- Reviewing the operation of the network based chemical dosing systems
- Reviewing the spend from each site
- Reviewing gas phase odour control systems at STPs and key sewer pumping stations (SPSs)
- Mapping and identifying causes of odour complaints throughout the networks.

Knowledge gaps were then filled with a 4 week monitoring campaign of gaseous H_2S and liquid phase wastewater quality. A site visit to affected areas was also conducted. Sampling occurred in some areas without chemical dosing to allow for model calibration. An example of gas phase monitoring at one location is shown in Figure 1 along with evidence of H_2S based corrosion attack.

Figure 1: Monitoring at one Discharge Manhole

Phase 2 – Existing Status and Trials

Results from the baselining study in Phase 1 were compared with modelled outcomes after the model was suitably calibrated. The calibration included accounting for wastewater quality, temperature, sulphide flux coefficients and expected turbulence. Where chemical dosing was present, but no or minimal effect was identified from the dosing systems, the dosing effectiveness was identified as being suspect.

These suspect dosing systems were successively shut down for a 1 week trial period to identify the effect on hydrogen sulphide emissions downstream. These downstream assets were those which the dosing system was designed to protect from emission of foul air and the cause of odour complaints. These were generally at discharge manholes, vents, pumping stations or STPs. Odour complaints within the network and wastewater quality at the receiving STP were monitored during this time. Results from the receiving works at one location, Catchment 1 STP, are shown in Figure 2. Results from the trial shutdowns throughout the Catchment 1 network are summarised in Table 2.

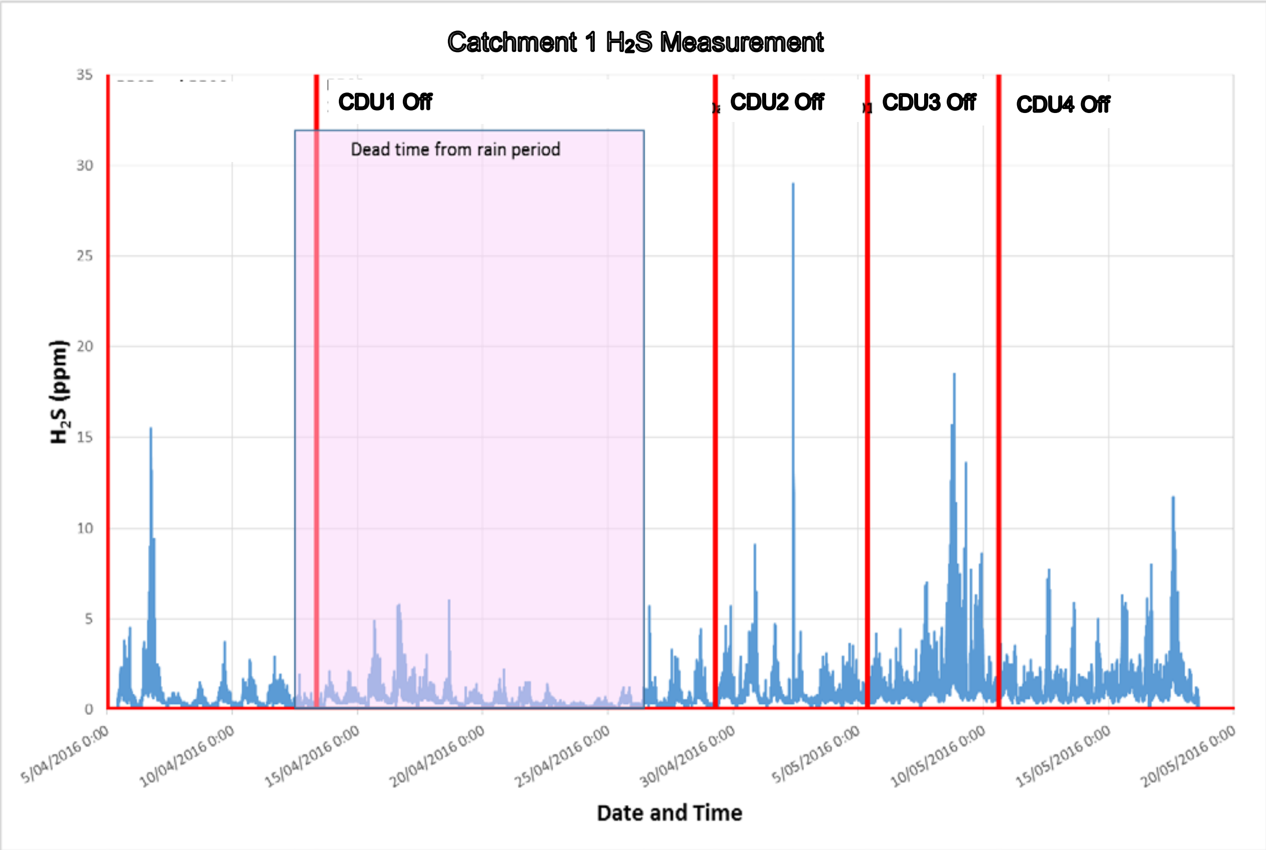

Figure 2: Example of results from chemical dosing shutdown trials

Table 2: Gas phase H_2S concentration results from shutdown trials in one catchment

Sewer Pump Station	Monitoring Location (Downstream)	Chemical Dosed at Sewer Pump Station	Downstream Gas Phase H_2S Concentration (ppm)					
			AP	PP	AA	PA	Average Difference	95% Percentile Difference
SPS1	SPS2	Liquid Oxygen	22.4	39.3	14.2	23.2	-8.17	-16.1
SPS3	SPS1	Hydrogen Peroxide	3.64	7.70	5.04	8.80	1.40	1.10
SPS4	STP1	Hydrogen Peroxide	0.98	2.60	1.47	4.30	0.49	1.70
SPS5	STP1	Hydrogen Peroxide	0.75	2.20	1.23	2.70	0.48	0.50

AP – Average prior to shutdown
PP – 95^{th} Percentile prior to shutdown
AA – Average after shutdown
PA – 95^{th} Percentile after shutdown

Phase 3 – Odour Strategy

Based on the outcome of the trial shutdowns, some chemical dosing systems were found to be ineffective or had impacts that could be managed with other more cost effective controls rather than chemical dosing. Dosing systems were deemed to be ineffective if the difference in average and 95^{th} percentile of H_2S measurements either showed no or minimal change when dosing was switched off. The reason for this ineffectiveness was investigated and found to be predominantly due to insufficient reaction times for oxygen based dosing systems. Some dosing systems had low dose rates which led to their being ineffective.

Whilst it would be possible to move some of these dosing systems upstream in order to provide more effectiveness, the residual H_2S concentration at downstream locations was identified as being manageable with other controls, such as lining of assets or provision of ground level, passive carbon units. For the majority of ineffective dosing systems, the decision was made to remove them and deal with increased H_2S (if any was recorded) at downstream assets, such as STPs.

The odour strategy was developed including:

- Refurbishment of some manholes to provide corrosion resistance
- Replacement of media at some soil bed type biofilters, predominantly at the STPs
- Provision of low pressure passive activated carbon filters at some key vent locations
- Provision of gas phase enclosed biofilters at some key sewer pump stations
- Retention of all iron salt dosing systems and some oxygen (gaseous or liquid) dosing systems
- Retention of one compressed air dosing system
- Removal of remaining dosing systems

The above works were costed both for the savings made from cessation of chemical dosing, and the expenditure required for mitigating residual odour and corrosion issues. The impact on downstream STPs was quantitatively evaluated and found to be minimal.

The above works were estimated to produce a maximum net operational savings of approximately $430K per annum.

As the strategy involved removing ineffective systems, and providing new gas-phase treatment at key odour locations, the strategy was deemed to maintain Council's odour based KPIs with a potential significant saving to Council. The strategy is in the process of being progressively implemented to compare the estimated vs actual savings and odour KPI performance.

REFERENCES

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