3. Industry Partner Report

3.1. Gold Coast Water Activities

3.1.1 Application of Model to the Tugun-Elanora Rising Main

The UQ sewer model with capabilities of predicting: (1) Biological carbon transformations under aerobic, anoxic and anaerobic conditions; (2) Biological sulfur transformations consisting of sulfate reduction and microbial oxidation of sulfide with oxygen and nitrate; (3) Chemical oxidation of sulfide by oxygen; (4) Chemical precipitation of sulfide and several other competing anions by metal ions; and (5) pH variation in wastewater caused by biological and chemical reactions was implemented for Tugun Elanora sewer system. The objective was: (1) to investigate various options for sulfide control at Elanora Treatment Plant; (2) to identify optimal chemical dosing locations and optimize the chemical dosage; and (3) to make cost comparison of different options based on the modeling results.

The Tugun Elanora sewer system consists of 17 pump stations, 1 flow balancing tank, 1 flow splitter, 28.9 km pipe length, average daily flow of 14.3 ML/day. A layout of the system is presented in

Figure **38**. Elanora Wastewater Treatment Plant is consistently experiencing odor problem at the inlet structure and one of the causes of this problem is high sulfide level in sewage arriving from three sewer trunks. The system being investigated here is one of them, and carries a significant portion of the flow.

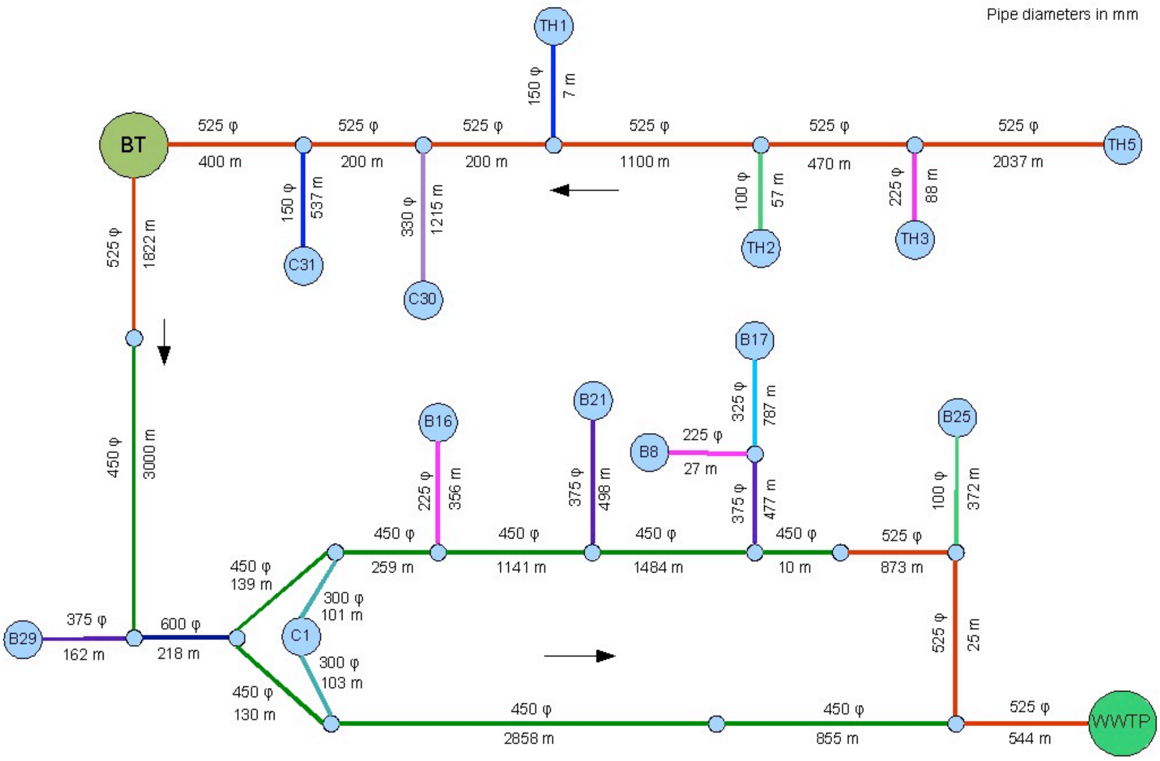


Figure 38. Schematic of the Tugun Elanora Sewer Network

The following options were considered for the control of sulfide:

1. Oxygen
2. Calcium Nitrate
3. Ferric Chloride
4. Ferrous Chloride
5. Magnesium Hydroxide for pH Control

3.1.1.1 Methodology

Target sulfide level at Elanora Treatment Plant was set at 1 mg S/L average with 95 percentile value of less than 3 mg S/L. The location of the injection stations for all the chemicals were chosen by trial (through a series of simulation studies) to achieve the target sulfide level with a minimum chemical consumption. The dosing rates of chemical followed a diurnal pattern based on HRT.

Once the tentative location and the rate of the dosing was obtained, further simulations were carried out to investigate the effects of change in dosing rate and also in the location of injection points on sulfide accumulation. Since most of the chemicals involved multi point injection, only one injection point was moved up or down at a time in the latter case.

The key model parameters such as biofilm oxygen consumption rate (g O_2/m^2-day), nitrate consumption rate (g NO_3^--N/m^2-day), and relevant parameters for precipitation reactions were taken based on the information available from laboratory experiments. Biofilm oxygen consumption rate of 16 g O_2/m^2-day (based on the average consumption of 40 mg/L-h in laboratory reactor) and nitrate consumption rate of 12 g N/m^2-day (based on the average consumption of 30 mg N/L-h in laboratory reactor) were used the simulation.

Please note that while using magnesium hydroxide, the effect of pH change in biological activities has been ignored.

3.1.1.2 Model Setup

The schematic of the sewer model used for simulation is presented in Figure 39. The flow rates and other model data were taken from previous model work presented in PMSC report 10.

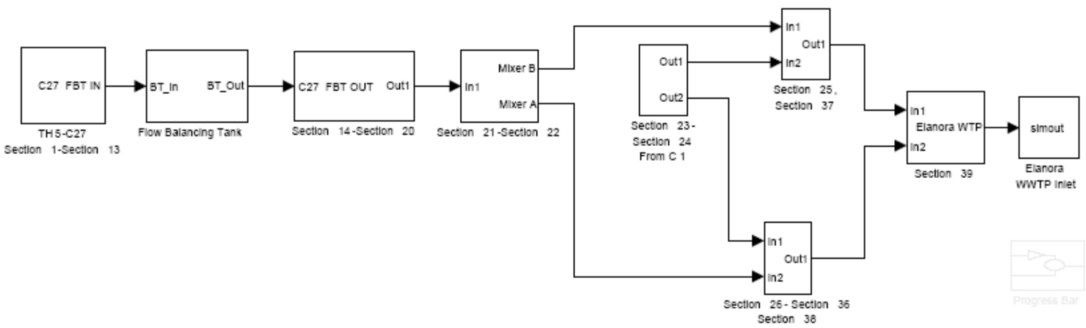


Figure 39. Model setup in SIMULINK

The oxidation model components described in previous section of this report were incorporated into the model to investigate the effects of addition of nitrate and oxygen. The pH component of the model was revised to include the effect of $Mg(OH)_2$ dosing on pH control. The precipitation model parameters were revised as per the experimental results described in a separate section of this report.

The model was first run without the addition of chemicals (normal operation) to establish a base line sulfide level at the inlet of the treatment plant. The simulation results are compared with IC measured sulfide levels in Figure 40. The calibrated model showed excellent match with the measured data and this validated the parameters used in the model.

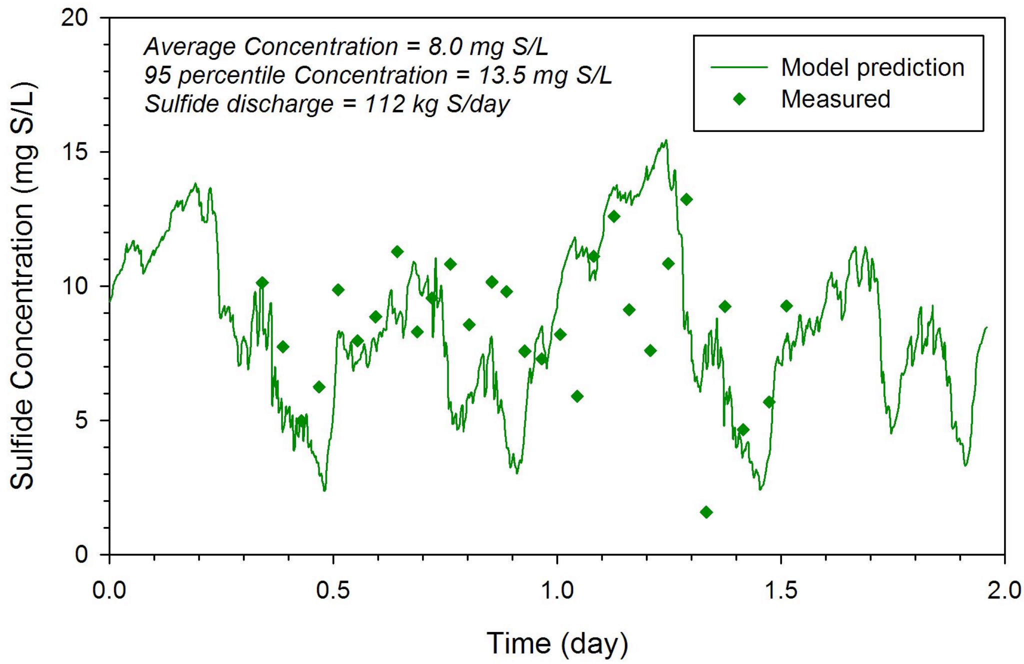


Figure 40. Comparison of simulated sulfide levels with measured values

3.1.1.3 Oxygen Injection

In our previous study, injection of oxygen at three locations located close to the treatment plant gave best results in terms of the control of sulfide discharge to Elanora WWTP (Please refer to PMSC 11 Report for details). This was reassessed using the updated model, and was still found to be the best suited. The optimal locations of oxygen injection determined by this simulation study are shown in Figure 41. The variation in sulfide concentration at the discharge point with oxygen supply rate of 178 kg O_2/day (oxygen actually dissolved in water, not what is supplied) is presented in Figure 42. This rate of oxygen supply was required to bring the average sulfide concentration to a level of 1 mg S/L. The results suggest that, with injection at three locations, oxygen injection was effective in controlling the sulfide generation/accumulation in the sewer line, and hence its discharge at Elanora WWTP.

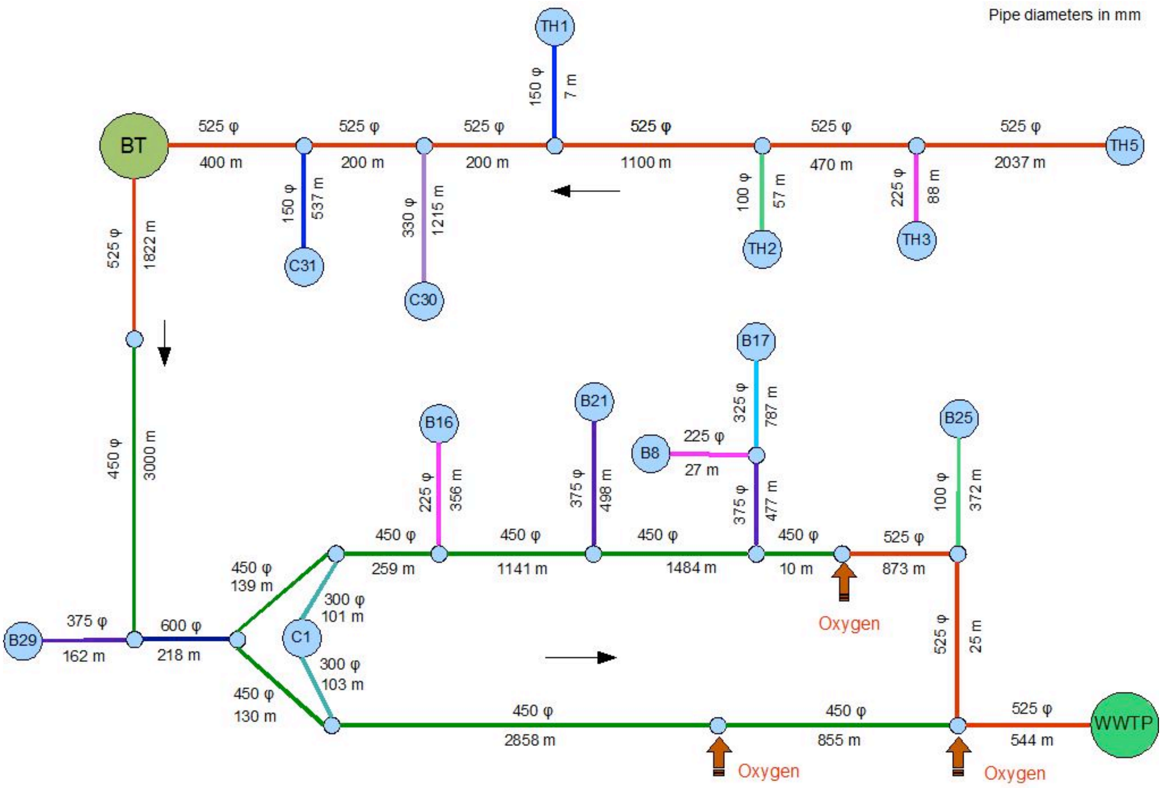


Figure 41. Proposed locations of oxygen injection

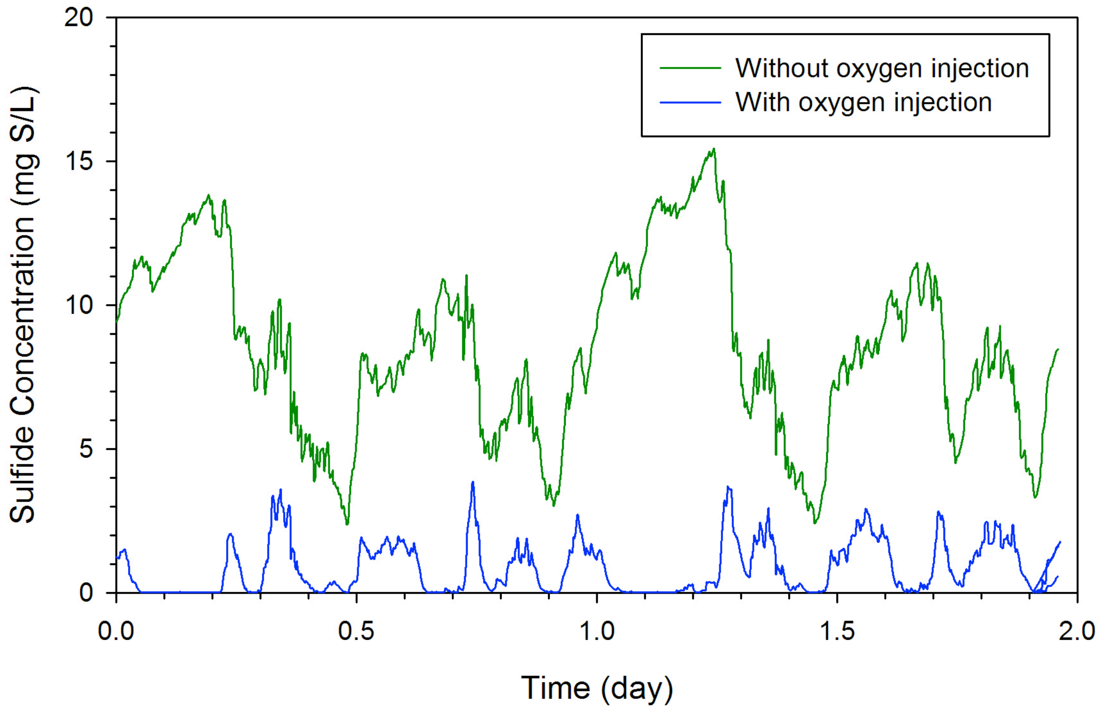


Figure 42. Sulfide concentration with oxygen injection at proposed 3 locations

Simulations were done for a series of oxygen supply rate ranging from 0 - 178 kg O_2/day to investigate the effect of variation in oxygen supply rate on overall sulfide control. The results of these simulations are summarized in

Figure 43 and

Figure 44. A decrease in average and 95 percentile sulfide concentrations is observed with the increase in oxygen supply rate and vice versa. Much more additional oxygen is required to achieve a small decrease in the sulfide level once the sulfide reaches a level of about 2 mg S/L. The same applies to sulfide discharge load. As a consequence of oxygen injection, VFA discharge to the WWTP decreases with increase in oxygen supply rate. This will have significant impact on nutrient removal in downstream treatment plant. Sulfide level can be brought down to a lower level at the expense of higher oxygen supply incurring higher VFA consumption. Considering the negative impact it would have, a very careful consideration should be given in establishing a target sulfide level.

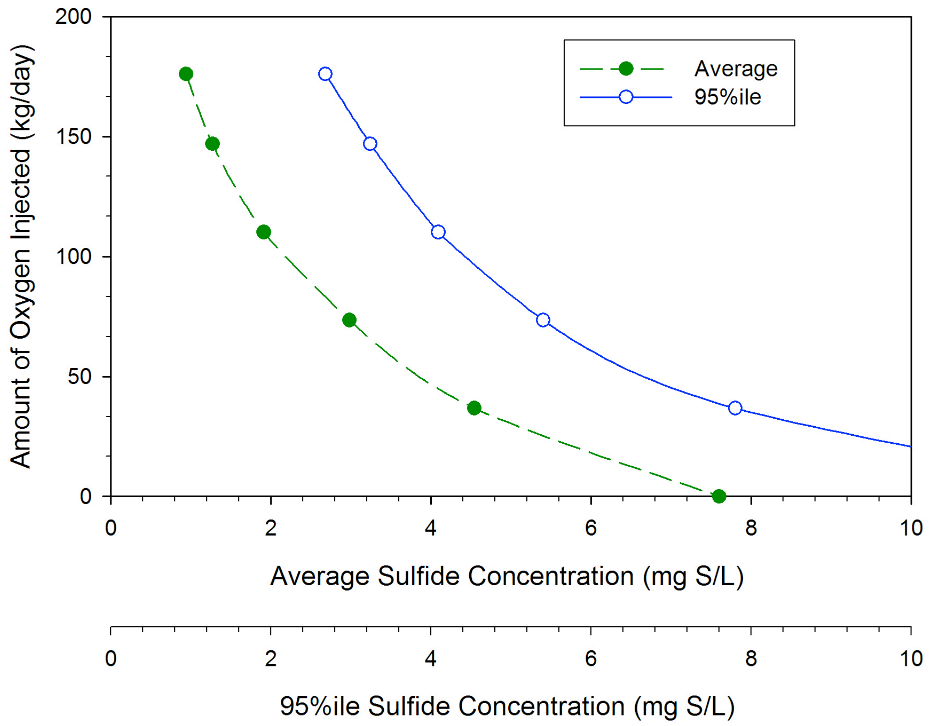


Figure 43. Effect of the amount of oxygen dosed on sulfide levels

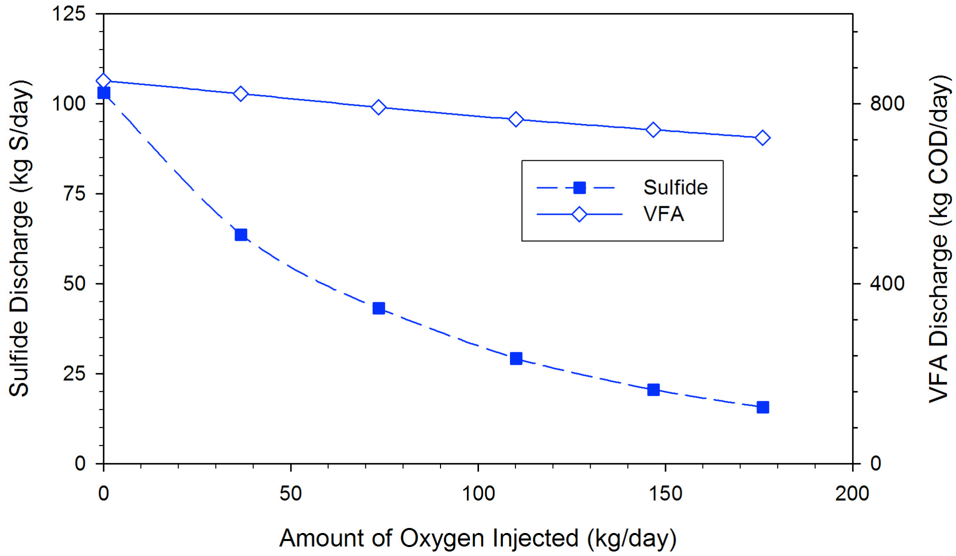


Figure 44. Effect of the amount of oxygen dosed on sulfide and VFA discharge

To examine the sensitivity of shifting the location of oxygen injection on overall control of sulfide accumulation, further simulations were done making changes in the injection locations. For this, one location was shifted upstream or downstream at one time, and the results were compared. The effects of changing location for Injection Point 1 (873 m upstream of the point where feeder from B25 enters the trunk) are shown in Figure 45. The same for Injection Point 2 (855 m upstream of the point where two parallel sewer lines meet, on second sewer line) are shown in Figure 46.

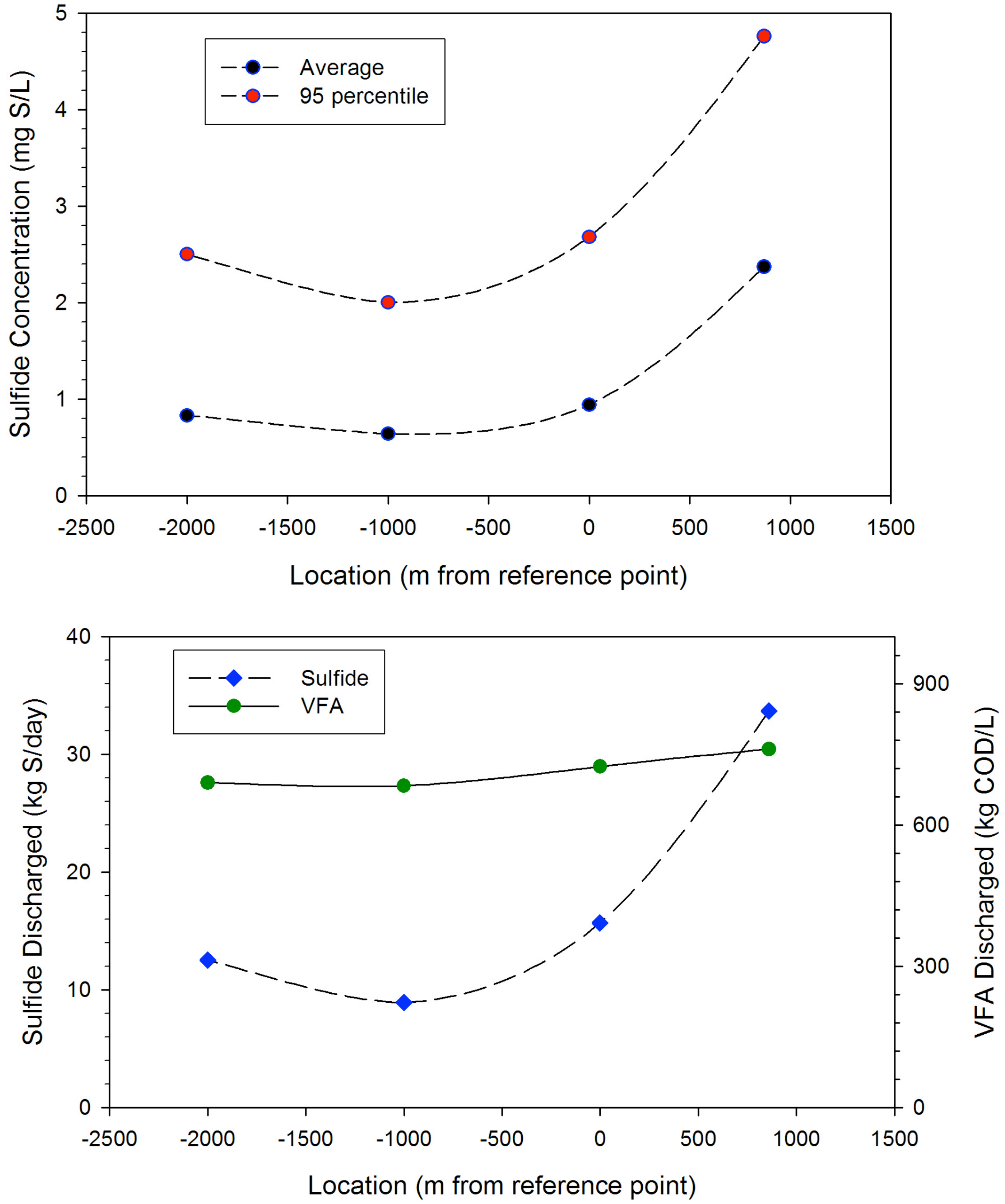
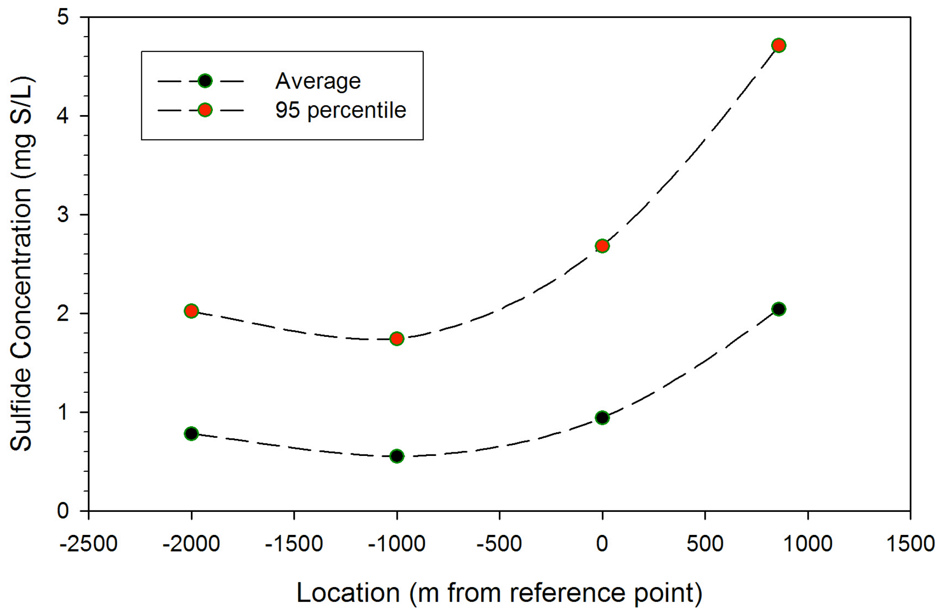


Figure 45. Effect of changing injection location for Location 1

Shifting the injection location upstream by 2 km doesn't show any significant impact on the overall sulfide control. On the other hand, moving the location downstream showed negative impact as both the sulfide level and the load increased rapidly. The VFA discharge load decreased in the former case, and increased in the latter. The results indicated a window of about 2 km in the upstream side of the proposed injection locations along which actual injection sites could be located without affecting the effectiveness of controlling sulfide discharge. This provides a greater flexibility in implementation of the strategy.



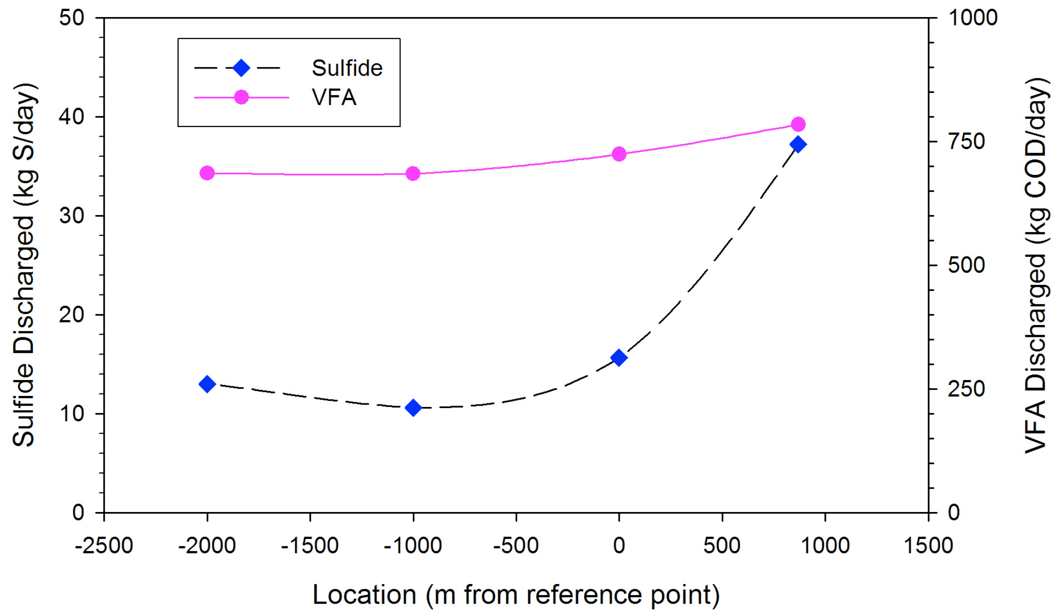


Figure 46. Effect of changing injection location for Location 2