UP-FLO® FILTER

MEDIA EVALUATION

EAGLEBY FILTER SAND
LANGWARRIN FILTER SAND

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1.0 INTRODUCTION

The Up-Flo® Filter is a high rate, modular filtration system designed to meet the most stringent stormwater treatment regulations. It incorporates multiple elements of a treatment train design into a single, small-footprint device. The Up-Flo® Filter is engineered to remove over 80% of fine total suspended solids (TSS) and associated pollutants. Filter Media can be customized to target site-specific pollutants. This test evaluated removal of Sil-Co-Sil 106 for two sand media provided by Rocla Pty Ltd of Australia; Eagleby Filter Sand and Langwarrin Filter Sand.

2.0 THE UP-FLO® FILTER TEST FACILITY DESCRIPTION

2.1 LABORATORY SET UP

The Hydro International test facility contains an 85 cubic meter clean water storage reservoir equipped with a Flygt submersible pump to distribute feed water. The 75 mm Flygt pump delivers water to the Up-Flo® Filter through a 75 mm PVC pipe network that freely discharges into the open top of the test tank. The 75 mm PVC delivery line is equipped with a pinch valve used to adjust the flow to a desired rate. A Watson Marlow 704 S/R peristaltic pump conveys slurry from a slurry tank into the delivery line about 250 mm upstream of the Up-Flo® Filter.

2.2 UP-FLO® FILTER CONFIGURATION

The 1.2 m diameter concrete test tank stands 2.1 m high and houses from one (1) to six (6) Up-Flo® Filter Modules. The test tank has a 300 mm outlet pipe that discharges into a large underflow basin on the floor of the lab. A 50 mm Flygt pump sends water from the underflow basin back into the feed reservoir.

A Catch Basin configuration Up-Flo® Filter equipped with one Filter Module was used for testing. Two (2) media bags of the filtration media (Eagleby Filter Sand or Langwarrin Filter Sand) were inserted into the Filter Module and the module was latched shut. A schematic of the laboratory set-up can be seen in Appendix A.

2.3 FLOW RATE

The flow rate to the Up-Flo® Filter can be adjusted from 0 - 30 l/s (0 - 450 gpm) using the pinch valve fixed to the delivery pipework.

The filtration capacity of a Filter Module depends on the filter media housed within the module and the (height of water) driving head acting on the filter media. Tests with Eagleby Filter Sand evaluated the performance of a one-module set up with a flow capacity of 1.3 l/s (20 gpm) at 500 mm (20 inches) of driving head. To test the Filter Module under steady state conditions, the influent flow rate was set to 1.3 l/s. Tests with the more restrictive Langwarrin Filter Sand media evaluated the performance of a one-module set up with a flow capacity of 1.0 l/s (16 gpm) at 500 mm (20 inches) of driving head. To test the Filter Module under steady state conditions, the influent flow rate was set to 1.0 l/s.

2.4 INFLUENT FEED SAND GRADATION

The Up-Flo® Filter targets the removal of fine sediment. Commercially available feed sands of different grades are selected to best represent the sediment likely to be encountered at a project location. For this Up-Flo® Filter test, Sil-Co-Sil 106 (a ground silica gradation available from U.S. Silica, Inc.) was used as the feed pollutant. Sil-Co-Sil 106 has a particle size gradation with 100% of particles smaller than 212 microns in diameter, 75% of particles smaller than 45 microns in diameter and 50% less than 22 microns. The particle size distribution for Sil-Co-Sil 106 can be found in Appendix B.

2.5 SEDIMENT LOADING

These tests targeted sediment loading concentrations of 50, 100, and 200 mg/l. The tests required between 0.09 and 0.36 kg (0.2-0.8 lbs) of Sil-Co-Sil 106 to achieve the desired influent concentration.

3.0 TESTING PROCEDURE

3.1 PARTICLE SIZE DISTRIBUTION

Particle size analysis was performed on each blend to ensure that it conforms to the target gradation. The gradation of the filter sand and the hydraulic characterization of the media are discussed in a different report. Because Sil-Co-Sil 106 is composed of very fine particles, the particle size distribution was tested according to ASTM D422 (AASHTO T88).

3.2 FLOW RATE CALIBRATION

A 75 mm, non-variable Flygt pump delivered flows at a constant rate of 30 l/s (450 gpm). A pinch valve was used to adjust the flow to the desired influent flow rate of 1.3 l/s (1.0 l/s for Langwarrin Filter Sand). The flow rate was calibrated using a V-notch weir in the underflow basin.

3.3 TSS PERFORMANCE TESTING

The following sampling procedure was used:

1. Accurately weigh out a bulk sample of the influent feed sand based on the target influent concentration and mix with clean water to form the influent slurry.
2. Start the 75 mm submersible pump and allow it to pump water into the Up-Flo® Filter test tank until there is enough driving head to start conveying water up through the Filter. Continue to pump flows into the tank until the desired operating head of 500 mm is reached and the system is in steady state.
3. Start the stopwatch and switch on the Watson Marlow peristaltic pump to begin feeding the influent feed slurry into the upstream piping to the Up-Flo® Filter at a constant rate.
4. Take the first influent sample two minutes following slurry introduction and take four more samples at two minute intervals.
5. While the slurry is being fed, watch the water level in the test chamber at regular intervals. Be sure that the water level in the chamber is not rising or falling below 500 mm of operating head.
6. Take the first effluent sample after one volume exchange within the chamber and take four more samples at two minute intervals.
7. Stop the sampling and test. Stop the pumps, stirring motor and peristaltic pump.

3.4 INFUENT AND EFFLUENT ANALYSIS

Analyze samples using the Suspended Sediment Concentration (SSC) method in ASTM, 1999, D 3977-97.

3.5 AVERAGE REMOVAL EFFICIENCY CALCULATION

Calculate the average percent removal by using the following calculation:

$$\text{Average \% Removal} = 100 \times ([SSC]_{\text{Mean inflow}} - [SSC]_{\text{Mean outflow}}) / [SSC]_{\text{Mean inflow}}$$

Photographs of the test unit and the media material are shown in Appendix A.

4.0 RESULTS AND DISCUSSION

Six (6) full-scale tests were performed during the testing for each media mix. All tests for one media mix were completed at the same flow rate (either 1.3 of 1.0 l/s) with a target influent concentration (two tests per concentration) of 50, 100 and 200 mg/l. Influent and effluent concentrations determined using the SSC method are plotted in Figures 1 through 3. The plots show the individual grab samples from all of the tests.

From Figure 1, it can be seen that the effluent concentration was consistently below 10 mg/l for both media types indicating good sediment control at the targeted influent concentration of 50 mg/l. Influent concentrations ranged from 42 – 65 mg/l with an average of 53 mg/l. The effluent concentrations ranged from 2-12 mg/l with an average of 7 mg/l. The average removal efficiency was 87%.

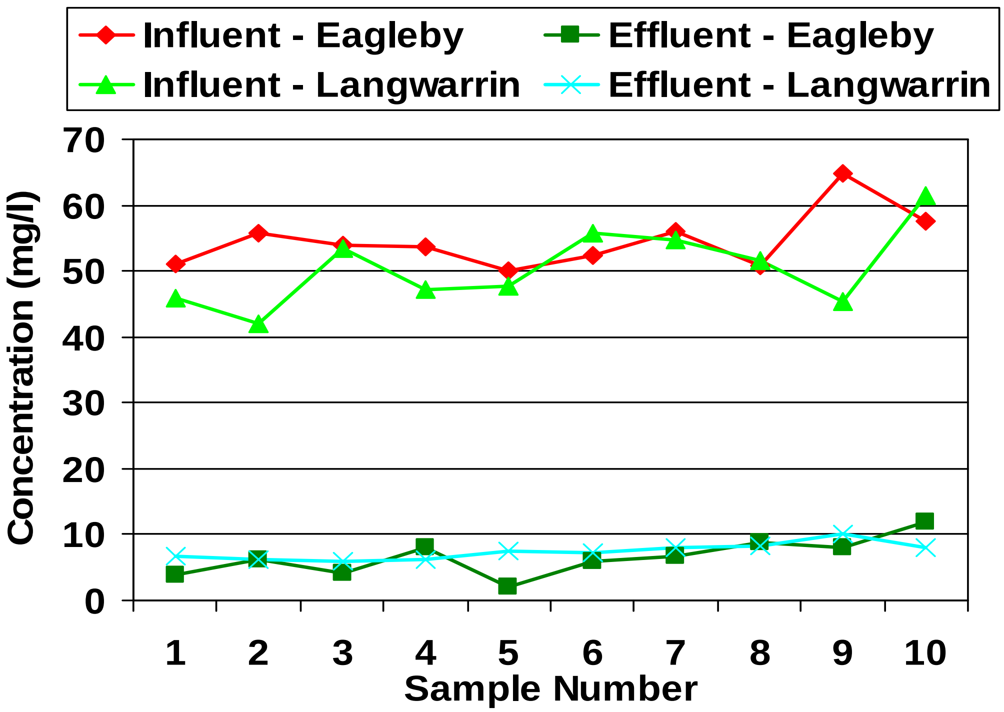


Figure 1: SSC analysis results of tests targeting 50 mg/l influent concentration.

The pattern of effluent control in Figure 2 below is similar to the results from Figure 1. For the targeted influent concentration of 100 mg/l, the effluent concentration was around 20 mg/l or below for all the ten samples collected. Influent concentrations ranged from 88 - 108 mg/l with an average of 97 mg/l. The effluent concentrations ranged from 11 - 22 mg/l with an average of 17 mg/l. The average removal efficiency was 83%.

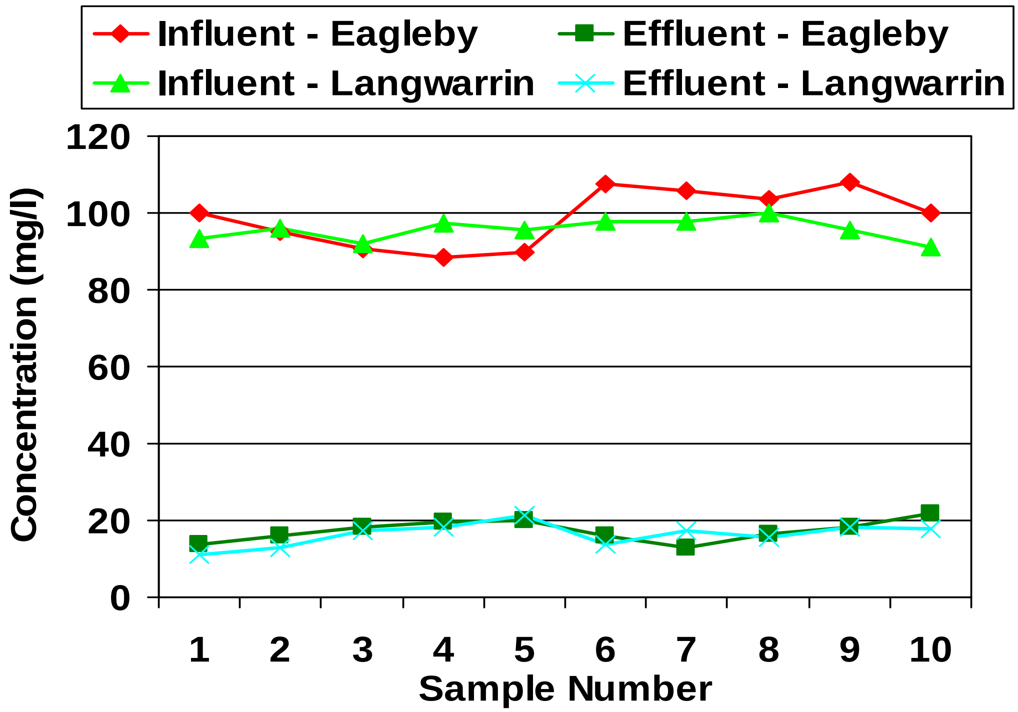


Figure 2: SSC analysis results of tests targeting 100 mg/l influent concentration.

The plot in Figure 3 also shows good effluent control for the target influent concentration of 200 mg/l. The range of influent concentrations was 168-241 mg/l with an average of 196 mg/l and the range of effluent concentrations between 31- 44 mg/l with an average of 36 mg/l. The average removal efficiency was 82%.

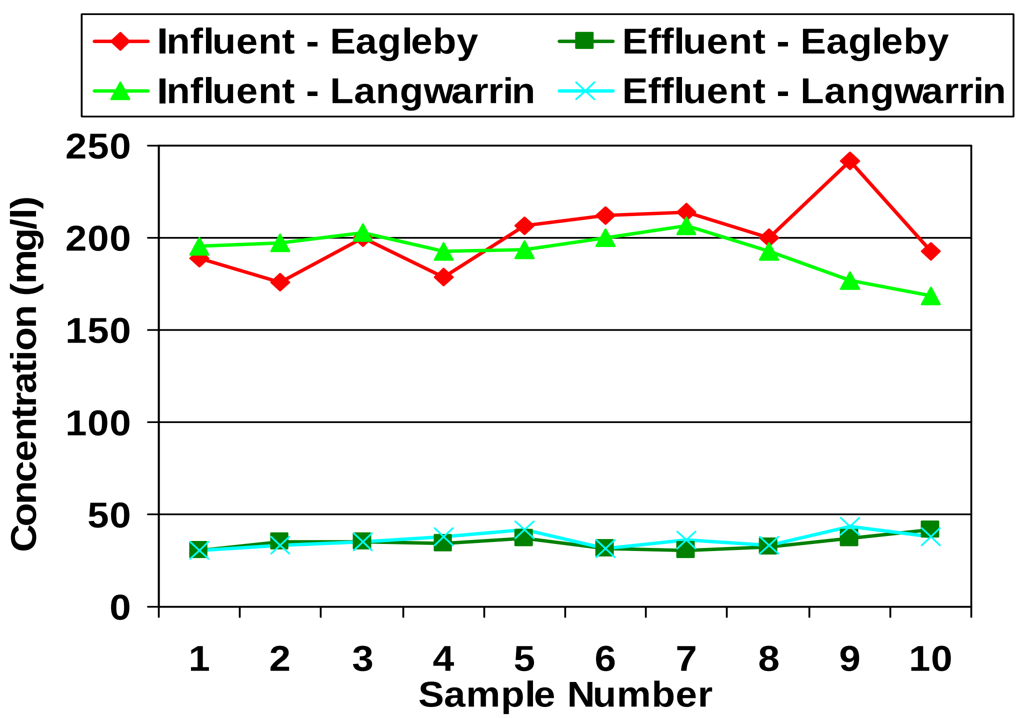


Figure 3: SSC analysis results of tests targeting 200 mg/l influent concentration.

Figures 4 and 5 show the paired sample of influents and effluents plotted for the two media types used for sediment control. These plots highlight the ability of the Up-Flo Filter using the Eagleby Filter Sand and the Langwarrin Filter Sand to control effluent concentrations to very low levels. Overall the performance of the two media types tested is very similar to results obtained from testing the Hydro Filter Sand (test results in different document). The Hydro Filter Sand is one of the media types used in the Up-Flo Filter in the US to remove small particulates from stormwater runoff.

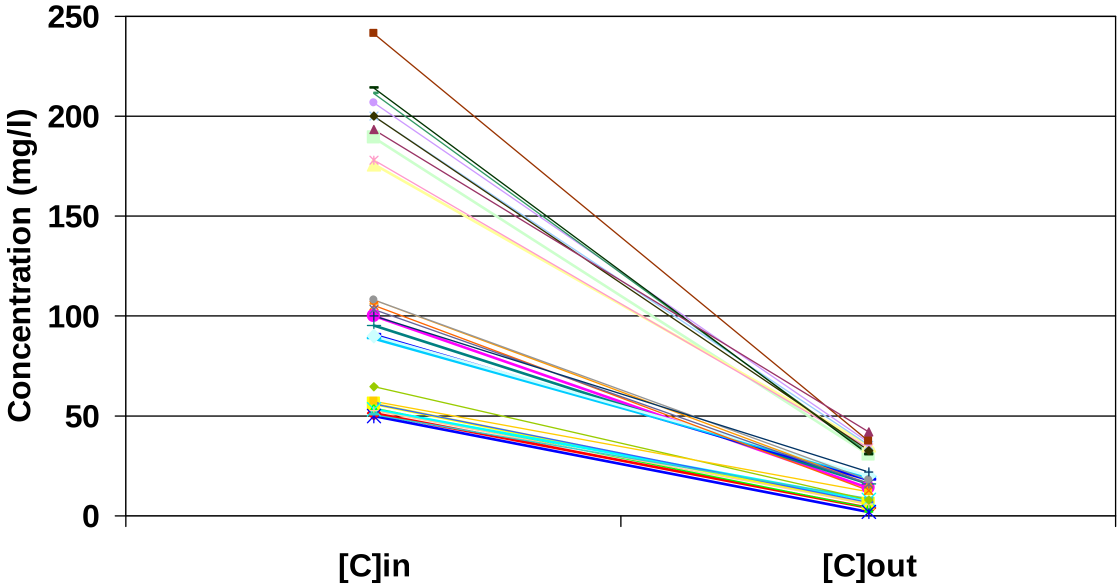


Figure 4: Plot showing the drop from influent to effluent concentration for Eagleby Filter Sand for a wide range of influent concentrations.

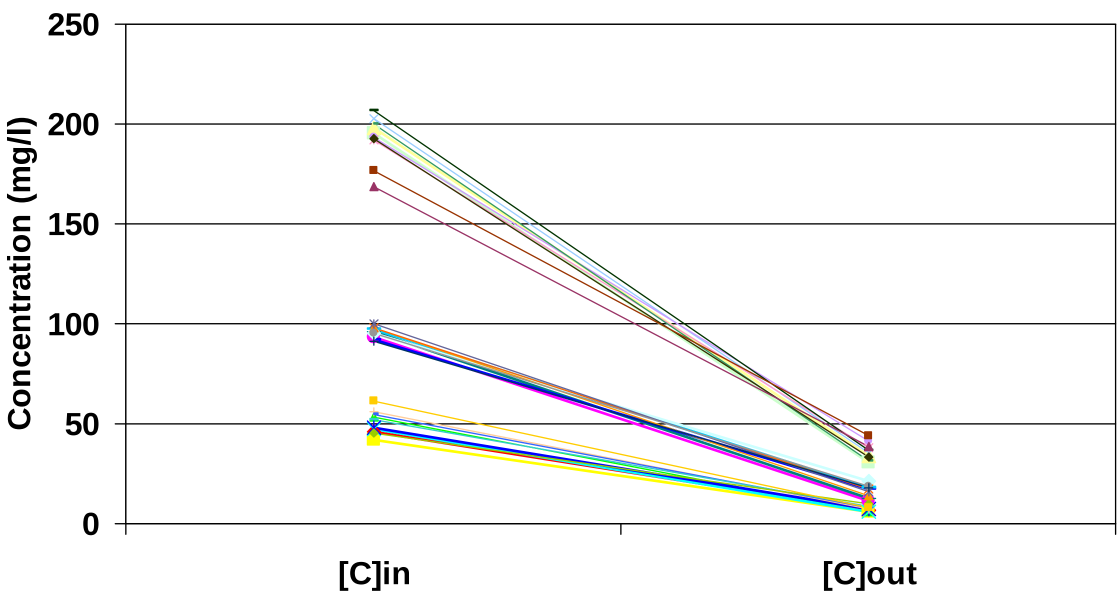


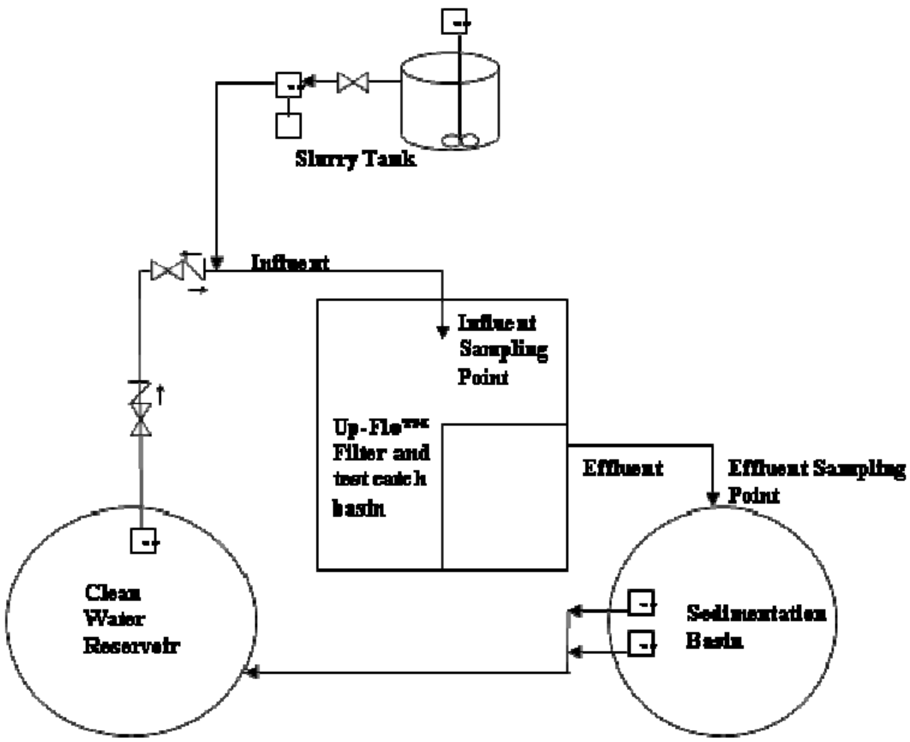
Figure 5: Plot showing the drop from influent to effluent concentration fro Langwarrin Filter Sand for a wide range of influent concentrations.

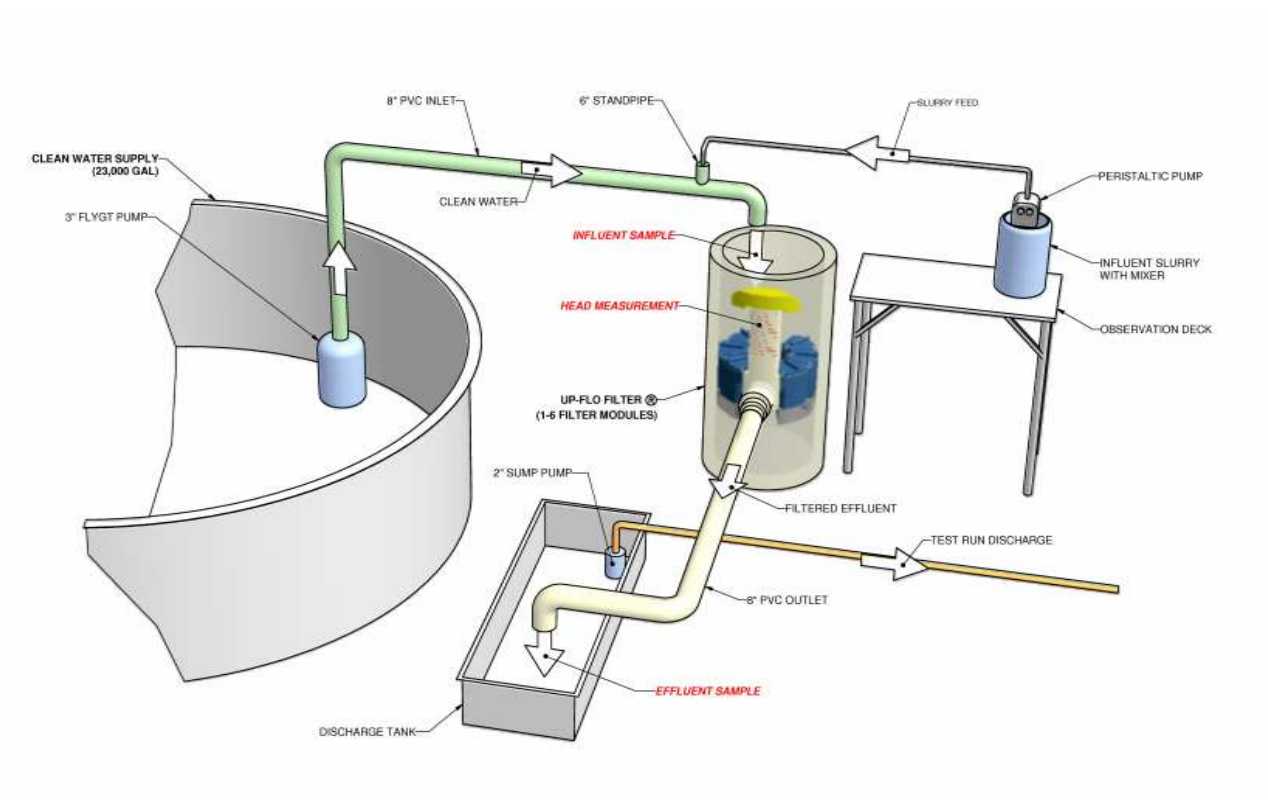
5.0 CONCLUSIONS

The removal efficiency for both media mixes were greater than 80% irrespective of the influent concentration. Performance was slightly higher at lower concentrations, which is likely due to both influent and effluent concentrations falling within a smaller range at the lower concentrations. The Eagleby Filter Sand had a higher hydraulic capacity than the Langwarrin Filter Sand and as such can accommodate more flow before bypassing and still maintain effluent control comparable to the Langwarrin Filter Sand. Physical observations of the media packs did not show any clogging or blockage of the filter media and the hydraulic profile did not change over the course of testing.

APPENDIX A - TEST UNIT AND FACILITY DETAILS

Schematic of Laboratory Set-Up





Laboratory Setup

Overhead view showing inlet and outlet piping

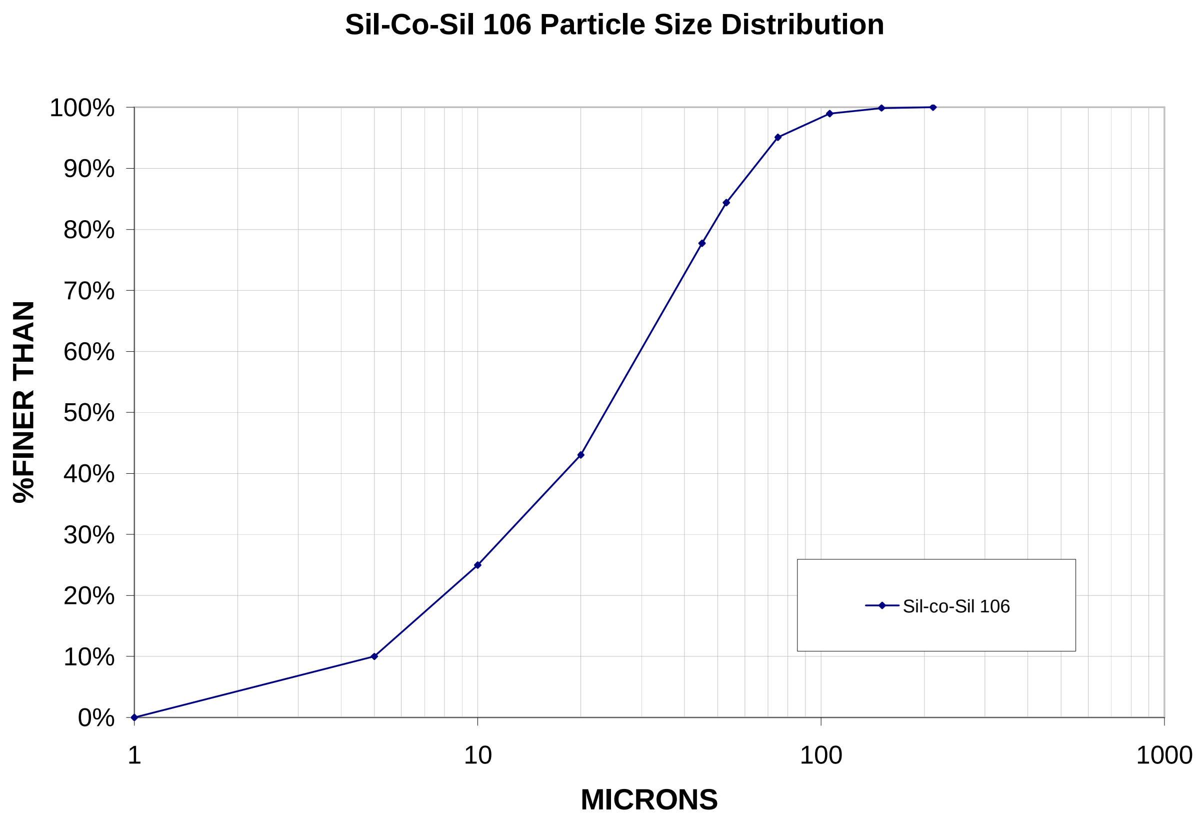
Two Filter Modules

Used media bags

Eagleby Filter Sand

Langwarrin Filter Sand

APPENDIX B – PARTICLE SIZE DISTRIBUTION OF SIL-CO-SIL 106



Particle Size Distribution of Sil-Co-Sil 106