Veolia Water Services (ANZ) Ltd

SEAVIEW WASTEWATER TREATMENT PLANT

BIOFILTER FLOW ASSESSMENT, JANUARY 2024

Issue II

March 2024

Veolia Water Services (ANZ) Ltd

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Executive Summary

Source Testing New Zealand (STNZ) was commissioned by Veolia Water Services (ANZ) Pty Ltd (Veolia) to conduct a flow assessment of the biofilter at the Seaview Wastewater Treatment Plant (WTP). The Seaview WTP's odour control system extracts foul air from the various odour sources on site which is treated via a six bed biofilter containing a bark composite media.

The following report has been amended to include the biofilter back pressure and Appendix A which identifies the cell numbers.

In December 2023, the biofilter underwent a partial refurbishment where the bark composite media in all six cells was completely replaced while the remediation of the granite flow distribution plenum was deferred which has the potential to adversely affect the odour removal efficiency of the biofilter. Hence, STNZ was requested to assess the biofilter discharge flow rates.

The Seaview WTP biofilter assessment was performed by Matthew Newby, Senior Air Quality Scientist at STNZ on 22 January 2024. The two ID fans at the inlet to the biofilters were found to be operating at 12,555 and 9,051 m^3/hr actual conditions for FN7001 and FN7002 respectively. Including the estimated flow from the sludge dryer measured in February 2023 (12,269 m^3/hr actual conditions) the total volumetric flow to the biofilter was 33,875 m^3/hr (9.41 m^3/s) actual conditions with a back pressure in the distribution channel of 4 mBar. The observed flow was approximately 20% lower than measured in 2021 and 2023 (42,461 m^3/hr actual conditions), potentially due to the ongoing degradation and binding of the granite plenum.

There was a good correlation between the inlet flow rate (9.41 m^3/s actual conditions) and discharge rate (9.21 m^3/s actual conditions) indicating the foul air is now passing through the bark composite media as opposed to prior to the refurbishment when significant short circuiting was occurring.

The averaged discharge rate for the individual cells were fairly consistent, ranging from 1.26 to 1.75 m^3/s actual conditions, with an average of 1.54 m^3/s actual conditions and there no significant difference between the cells at the inlet (Cells 1 & 4) and the far end of the biofilter (Cells 3 & 6).

However, the flow distribution of the individual cells was more significant, with two cells exhibiting over 100% difference between the minimum and maximum flow rates, with only Cell 5 less than 35%. Hence, the flow distribution of the induvial cells was not uniform as would be expected for a well performing biofilter.

The poor flow distribution will result is areas in the bed being subjected to higher odour loadings with the potentially for discharge of partially treated foul air. As the bark composite media is only a few months old, it appears not replacing the granite plenum has resulted in an uneven flow distribution which has the potential to adversely affect the odour removal efficiency and the condition of the bark composite media.

1. Introduction

Source Testing New Zealand (STNZ) was commissioned by Veolia Water Services (ANZ) Pty Ltd (Veolia) to conduct a flow assessment of the biofilter at the Seaview Wastewater Treatment Plant (WTP). The Seaview WTP's odour control system extracts foul air from the various odour sources on site which is treated via a six bed biofilter containing a bark composite media.

The following report has been amended to include the biofilter back pressure and Appendix A which identifies the cell numbers.

In December 2023, the biofilter underwent a partial refurbishment where the bark composite media in all six cells was completely replaced. While the granite flow distribution plenum was observed to be in a poor condition, the remediation of the plenum was deferred which has the potential to adversely affect the flow distribution through the biofilter and hence odour removal efficiency. In order to assess the impact of the old plenum in place on the flow distribution/efficiency, STNZ was requested to conduct an assessment of the biofilter discharge flow rates.

The Seaview WTP biofilter assessment was performed by Matthew Newby, Senior Air Quality Scientist at STNZ on 22 January 2024. Matthew has over 25 years of air quality monitoring and consulting services and is a Certified Air Quality Professional (CAQP) under the Clean Air Society of Australia and New Zealand (CASANZ) accreditation programme. Matthew also has extensive experience in the design, operation, and maintenance of biofilters throughout New Zealand and has been directly involved with the operation of the Seaview WTP biofilter for approaching 10 years.

The following document briefly describes the Seaview WTP biofilter and the methodology used to assess the volumetric flow rates. The observed flow conditions and presented and discussed.

2. Odour Control System Biofilter

The Seaview WTP odour control system extracts foul air from various odorous processes around the plant, including the sludge drier, which is treated by a six-bed biofilter containing a bark composite media prior to discharging to atmosphere. Appendix A depicts the biofilter with the cell numbers. Foul air is extracted from the plant via two ID fans at the inlet to the biofilter, aided by two fans in the milliscreening plant. A separate system ventilates the sludge dryer with the gas stream through a rudimentary water spray to minimise the level particulates carried over from the dryer and reduce the temperature and moisture content of the gas stream before entering the biofilter.

The flow is distributed to the individual cells via a 2 x 2 m channel where the foul air is discharged to the cells via nine inlet points linked to lines of perforated crates to distribute the gas stream evenly across the base of the biofilter. The biofilter has a total surface area of 750 m^2 and a bed depth of 1.2 m. It is designed to treat a total volumetric flow rate of 43,000 m^3/hr with a 90 second retention time. While the biofilter itself was designed to treat a maximum of 43,000 m^3/hr, the odour control model design flow rate is only 26,000 m^3/hr (refer to the Operations Manual) as the plant was designed to with duty and stand by fans at the inlet to the biofilter and in the milliscreening plant.

In December 2023, the bark composite media in all six cells was replaced with new media consisting of 85% bark nuggets, 7.5% compost and 7.5% Agro-lime chip.

3. Biofilter Flow Monitoring Methodology

The Seaview WTP biofilter flow assessment involved the measurement of the total flows entering and exiting the biofilter and a review of the surface flow distribution. The total flow to the biofilter consists of the two inlet ID fans (FN7001 & FN7002) and the discharge from the sludge dryer. Measuring the flows from the inlet fans is straight forward with reasonable sampling ports and ambient gas conditions. However, the flow from the dryer is more problematic due to the elevated temperature/moisture content and the build-up of sludge carried over from the dryer which discharges from the sampling port and is highly odorous. Hence, the flow from the sludge dryer was based on the most current measurements conducted in February 2023.

The discharge from the biofilter was measured using a purpose, built biofilter sampling hood (See Figure 1). Due to the large surface area of biofilters, the discharge rate at the surface is very low and easily adversely affected by the wind speed. To account for the low discharge velocity the sampling hood captures the flow from an area of 0.785 m^2 and reduces to 0.00785 m^2 concentrating the air volume to measurable level. An extension placed on the outlet of the hood allows laminar flow to develop and reduce the impact of any wind.

To ensure the data collected was representative of the total surface area of the biofilter, the flow rate for each cell was measured on a 3 x 4 grid for a total 72 sampling points. Prior to recording the velocity, the sampling hood was sealed at the base with media and allowed to equilibrate for approximately 5-minutes. The velocity was then observed over several minutes prior to recording the data to account for any fluctuations associated with the wind speed. On the day of the assessment, relatively calm conditions persisted which limited the impact on the observed velocities.

To determine the discharge rate at the surface of the biofilter using the biofilter sampling hood requires the velocities measured to be converted to the volumetric flow through the hood, which is then used to back calculate the velocity at the surface of the biofilter based on the different diameters/areas of the inlet and outlet of the hood. The surface velocity was then used to determine the volumetric flow for each cell and the biofilter.

As the volume of gas is dependent on temperature and pressure, air discharge monitoring data is generally adjusted to standard conditions of 0°C and 101.3 kPa. In addition, as the discharge of moisture into the to the atmosphere has no significant environmental impacts, gas volumes are reported on a dry gas basis. However, as the objective of the monitoring was to assess the variability in the flow distribution, the data has been reported at actual conditions. Furthermore, engineering ventilation models such as the Seaview WTP odour control model, present actual flows with no correction factors.

- **Figure 1: Biofilter Sampling Hood, 23 January 2024**

4. Biofilter Flow Monitoring Results

The results of the Seaview WTP biofilter flow assessment conducted on 22 January 2024 are detailed below. Table 1 presents the results of the inlet flow monitoring and showed the inlet fans to be operating at 12,555 and 9,051 m^3/hr actual conditions for FN7001 and FN7002 respectively. It is worth noting that FN7001 generally operates at a higher flow rate than FN7002. The total flow from the two inlet fans plus the estimated flow from the sludge dryer measured in February 2023 (12,269 m^3/hr actual conditions) results in a total volumetric flow entering the biofilter of 33,875 m^3/hr (9.41 m^3/s) actual conditions with a back pressure in the distribution channel of 4 mBar.

The total flow in January 2024 was approximately 20% lower than measured in 2021 and 2023 (average 42,461 m^3/hr actual conditions), with the reduction potentially due to the ongoing degradation and binding of the granite plenum.

- **Table 1: Seaview WTP Biofilter Inlet Flow Data, 22 January 2024**

Parameter	Biofilter Fan (FN7001)	Biofilter Fan (FN7002)	Sludge Dryer	Total Flow
Date	22/01/2024	22/01/2024	24/02/2023	
Fan Speed	100%	100%	NA	
Velocity (m/s)	11.0	7.9	10.0	
Temperature (°C)	25.5	25.9	45.4	
Duct Diameter (mm)	635	635	660	
Volumetric Flow (m^3/hr)	12,555	9,051	12,269	33,875
Volumetric Flow (m^3/s)	3.49	2.51	3.41	9.41

1. Actual Conditions.

The results of the biofilter discharge flow rates measured on 22 January 2024 are presented in Tables 2 through 7 for Cells 1 through 6 respectively and has been summarised in Table 8. There was a good correlation between the inlet flow rate (9.41 m^3/s actual conditions) and discharge rate (9.21 m^3/s actual conditions) indicating the majority of the air is now passing through the bark composite media as opposed to prior to the refurbishment when significant short circuiting was occurring.

Reviewing the averaged discharge rate showed the flow through the different cells to range from 1.26 to 1.75 m^3/s actual conditions, with an average of 1.54 m^3/s actual conditions with an observed variability of approximately 30 %. There also did not appear to be a significant difference in the flow between the cells with similar flow rates observed at the inlet (Cells 1 & 4) and the far end of the biofilter (Cells 3 & 6).

Table 2: Cell 1 Discharge Flow Data, 22 January 2024

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	0.98	31.4	0.0098	1.23
	2	1.38	31.1	0.0138	1.73
	3	1.38	30.6	0.0138	1.73
2	1	1.4	30.4	0.0140	1.75
	2	1.83	30.0	0.0183	2.29
	3	1.13	29.1	0.0113	1.41
3	1	1.12	28.6	0.0112	1.40
	2	1.17	28.5	0.0117	1.46
	3	1.13	29.2	0.0113	1.41
4	1	1.4	30.3	0.0140	1.75
	2	0.87	27.9	0.0087	1.09
	3	1.43	27	0.0143	1.79
Average		1.27	29.5	0.0127	1.59
Minium		0.87	27.0	0.0087	1.09
Maximum		1.83	31.4	0.0183	2.29

1. Actual Conditions.

Table 3: Cell 2 Discharge Flow Data, 22 January 2024

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	1.53	27.6	0.0153	1.91
	2	1.28	27.3	0.0128	1.60
	3	1.18	27.1	0.0118	1.48
2	1	1.12	27.1	0.0112	1.40
	2	0.69	27.1	0.0069	0.86
	3	1.06	26.9	0.0106	1.33
3	1	2.24	26.9	0.0224	2.80
	2	1.56	26.6	0.0156	1.95
	3	0.89	26.7	0.0089	1.11
4	1	1.7	26.8	0.0170	2.13
	2	0.98	26.9	0.0098	1.23
	3	1.23	26.9	0.0123	1.54
Average		1.29	27.0	0.0129	1.61
Minium		0.69	26.6	0.0069	0.86
Maximum		2.24	27.6	0.0224	2.80

1. Actual Conditions.

- **Table 4: Cell 3 Discharge Flow Data, 22 January 2024**

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	1.51	26.8	0.0151	1.89
	2	1.06	26.3	0.0106	1.33
	3	1.14	26.1	0.0114	1.43
2	1	1.15	26.1	0.0115	1.44
	2	0.87	26.0	0.0087	1.09
	3	1.94	26.1	0.0194	2.43
3	1	0.93	25.9	0.0093	1.16
	2	1.16	25.9	0.0116	1.45
	3	1.26	25.8	0.0126	1.58
4	1	1.37	25.1	0.0137	1.71
	2	1.24	25.9	0.0124	1.55
	3	0.91	25.8	0.0091	1.14
Average		1.21	26.0	0.0121	1.51
Minium		0.87	25.1	0.0087	1.09
Maximum		1.94	26.8	0.0194	2.43

1. Actual Conditions.

- **Table 5: Cell 4 Discharge Flow Data, 22 January 2024**

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	2.38	26.8	0.0238	2.98
	2	1.54	26.3	0.0154	1.93
	3	1.10	26.4	0.0110	1.38
2	1	1.62	27.1	0.0162	2.03
	2	1.29	26.8	0.0129	1.61
	3	1.04	26.6	0.0104	1.30
3	1	1.17	27.4	0.0117	1.46
	2	1.54	27.7	0.0154	1.93
	3	1.16	28.3	0.0116	1.45
4	1	1.22	30.3	0.0122	1.53
	2	1.78	30.0	0.0178	2.23
	3	0.93	29.000	0.0093	1.16
Average		1.40	27.7	0.0140	1.75
Minium		0.93	26.3	0.0093	1.16
Maximum		2.38	30.3	0.0238	2.98

1. Actual Conditions.

Table 6: Cell 5 Discharge Flow Data, 22 January 2024

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	0.95	27.4	0.0095	1.19
	2	1.06	27.4	0.0106	1.33
	3	0.97	26.8	0.0097	1.21
2	1	0.9	24.7	0.0090	1.13
	2	0.82	25.3	0.0082	1.03
	3	0.86	26.2	0.0086	1.08
3	1	1.05	24.5	0.0105	1.31
	2	1.15	24.3	0.0115	1.44
	3	1.12	24.2	0.0112	1.40
4	1	0.96	23.9	0.0096	1.20
	2	1.1	23.8	0.0110	1.38
	3	1.12	24	0.0112	1.40
Average		1.01	25.2	0.0101	1.26
Minium		0.82	23.8	0.0082	1.03
Maximum		1.15	27.4	0.0115	1.44

1. Actual Conditions.

Table 7: Cell 6 Discharge Flow Data, 22 January 2024

Grid Line	Line Point	Sampling Hood Outlet Velocity (m/s)	Temperature (°C)	Sampling Hood Inlet Velocity (m/s)	Cell Discharge Flow Rate (m^3/s)
1	1	0.98	23.1	0.0098	1.23
	2	1.17	23.2	0.0117	1.46
	3	0.78	23.3	0.0078	0.98
2	1	1.13	23.4	0.0113	1.41
	2	1.39	23.3	0.0139	1.74
	3	0.86	23.3	0.0086	1.08
3	1	1.69	23.8	0.0169	2.11
	2	1.27	24.0	0.0127	1.59
	3	1.58	24.3	0.0158	1.98
4	1	1.02	24.3	0.0102	1.28
	2	1.04	24.6	0.0104	1.30
	3	1.48	24.6	0.0148	1.85
Average		1.20	23.8	0.0120	1.50
Minium		0.78	23.1	0.0078	0.98
Maximum		1.69	24.6	0.0169	2.11

1. Actual Conditions.

- **Table 8: Seaview WTP Biofilter Flow Rate Summary, 22 January 2024**

Cell	Cell Flow Rate (m^3/s)		
	Range	Average	Deviation (%)
1	1.09 – 2.29	1.59	75.7%
2	0.86 – 2.80	1.61	120.3%
3	1.09 – 2.43	1.51	88.3%
4	1.16 – 2.98	1.75	103.8%
5	1.03 – 1.44	1.26	32.8%
6	0.98 – 2.11	1.50	75.9%
Total		9.21	

1. Actual Conditions.

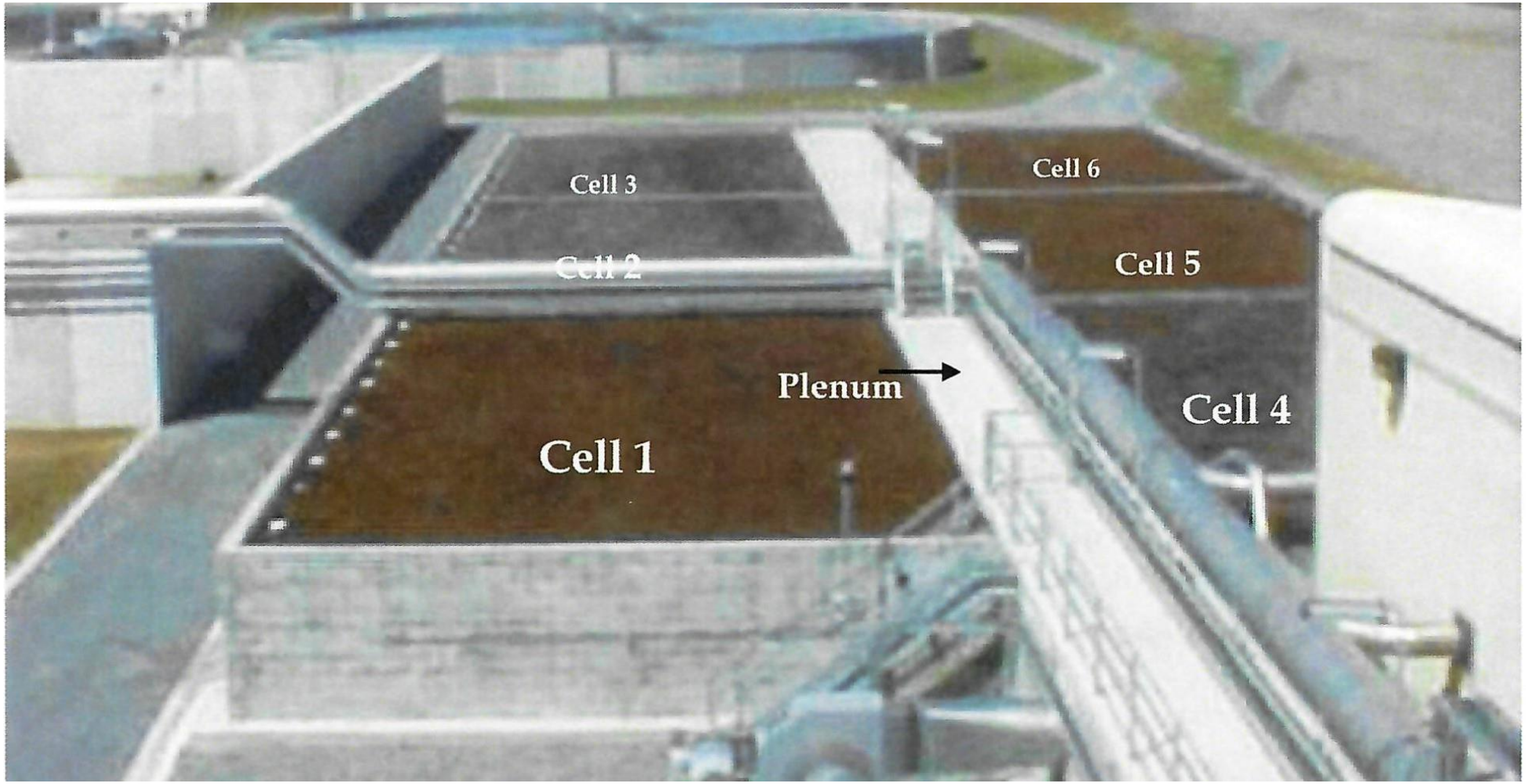
While the average flow from each of the cells showed limited variability, the flow distribution of the individual cells was more significant with Cels 2 and 4 exhibiting over 100% difference between the minimum and maximum flows, with only Cell 5 less than 35% variability, indicating the flow distributions of the induvial cells was poor when compared to a well performing biofilter.

The poor flow distribution would result is areas in the bed being subjected to higher odour loadings with the potentially for discharge of partially treated foul air. As the bark composite media used in the refurbishment was uniform and the installation process the same, it is unlikely that variability is associated with the new media. Hence, delaying the replacing the granite plenum appears to have adversely affected the flow distribution, which has the potential to reduce the odour removal efficiency and increase the rate of degradation of the bark composite media.

Appendix A Seaview WTP Biofilter Cell Numbers

This Appendix contains 2 pages including cover.

- **Seaview WTP Biofilter Cell Numbers**



Source: Hutt Valley Water Services Operations Manual Vol II Odour Control HVOPS UPCP-70 Issue 3: February 2019