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Dear Rick

Results of Odour Extraction system Inspection

This email summarises results from our inspection of the Rendering Plant air extraction system at the Imlay meat works on 16 March 2015.

1 Background and Objective

Previous inspection of the Imlay Rendering Plant air extraction system occurred on 12 December 2013 after fire had propagated through drier exhaust air ducting, incinerating the Tellerettes packing in the scrubber/humidifier. Prior to that, a normal inspection had occurred on 24 April 2013. The objective of these inspections has been to independently check that the system is operating as it should be to meet air discharge Consent obligations.

2 Assessment of Extraction System Performance

2.1 Figures and Tables

Figure 1 in Appendix A provides a schematic of the Dry Side, Wet side and Drier air extraction system feeding the biofilters.

Table 1 in Appendix A summarises the measured data for the Drier to Covered Biofilter in Fig 1.

Table 2 in Appendix A summarises measured data for the Wet Side to Uncovered Biofilter in Fig 1.

Table 3 in Appendix A provides an overview of measured data since 2008 for comparison.

2.2 System Description

With reference to Figure 1:

a) Dry Side gas passes through a spray tower (known as the Dry Process heat exchanger or Dry Process Humidifier in Fig 1) to a common induced draught fan (ID1) which discharges into the uncovered biofilter. The primary function of the spray tower is the humidification of the Dry Side gas flow that might otherwise dehydrate the biofilter and reduce biological activity.

b) Wet Side gas and vapour is cooled in the Wet Process heat exchangers; i.e. Wet Process HX1, HX2 and HX3. After cooling and some water removal, the Wet Side gas passes to the common ID1 fan which discharges into the uncovered biofilter.

c) Drier gas and vapour passes through the Drier Trash Vessel which removes entrained water and then to a newly installed stickwater waste heat evaporator. The cooled Drier gases and non-condensable gases from the evaporator vacuum pump then pass through two heat exchangers

(Gardiner HX and Potter HX) which further cool the gas and vapour and remove condensed water from the gas stream. After cooling and water removal the Drier gas passes to induced draught fan ID2 which discharges to the covered biofilter. As pressure in the evaporator non-condensable gas discharge duct is to be -10 to -20mm wg an orifice plate OP has been inserted in the duct exiting the Potter heat exchanger to moderate the vacuum.

d) Water in the Dry Process humidifier (previously called the Dry Process heat exchanger) is recirculated by a pump (P1) with water make up from the adjacent pond.

2.3 Process Measurements

The biofilter gas and vapour systems were characterised by: thermocouple readings and pitot tube gas velocity readings taken by removing plugs and inserting instruments at:

- The outlet from the Drier gas fan, ID2.
- The gas ductwork inlet to the Dry Process humidifier.
- The gas outlet ductwork from Wet Process Heat Exchangers HX1, HX2 and HX3, prior to the connection with ductwork from the Dry Process humidifier and prior to the ID1 fan.
- The gas duct outlet ductwork from the ID1 fan static pressure measurements made at the covered biofilter distributor ducting inlet and end.
- Temperature and pH spot measurement of the biofilter media.
- Infiltration airflow into the wet processing area measured when the roller door was open.

2.4 Comments on Flowrates, Pressure and Temperatures

Table 1 shows the results of flowrate and temperature measurements taken during the day of 16 March 2015 which was characterised by warm temperatures and moderate south-east wind.

From the data in Figure 1 and Tables 1 and 2:

2.4.1 Covered Biofilter Airflow

The air flow to the covered biofilter was 1,070 – 1,670 m^3/h or 1.2 – 1.9 tonnes/hour (tph). This was based on measurements taken over a 6 hour period at the thermowell six metres downstream of the ID2 fan. This was the only readily available access into the duct. The measured flow was half that measured in previous years. This was plainly due to the orifice plate (OP in Fig 1) having been inserted into the line upstream of fan ID1. No biofilter performance issue is seen to arise from the reduced airflow. The loading on the biofilter is reduced and the further cooling of drier air which occurs in the evaporator heat exchanger will further reduce any tendency for smoke to break out of the biofilter.

The addition of the new orifice plate to limit drier gas vacuum in the evaporator will have an effect on the operating efficiency of fan ID2. Driving the fan at a lower speed with less orifice constriction, to achieve the same evaporator pressure sink needed, may give a worthwhile energy saving.

2.4.2 Uncovered Biofilter Airflow

The air flow to the uncovered biofilter was 39,600 – 41,800 m^3/h or 43.7 – 46.2 tph and was based on measurements taken over a 6 hour period at a removable plug eight metres downstream of the ID1 fan. The measured flow matches that of the average flow for the previous six years. As seen in

Figure 1 an average total flow of around 47 tph was made up of 20 tph of Wet Side vapour and 27 tph of Dry Side Gas. The Wet Side vapour flow is similar to what it was in May 2013 as also was the Dry Side Gas. After the fire (December 2013) some of the ducting had distorted resulting in ambient air being drawn into the ducting upstream of the ID1 fan. With the ducting now fixed some airflow reduction would be expected and this perhaps is the reason for the slightly reduced total airflow to the uncovered biofilter compared to the previous two measurements. This slight reduction in total gas airflow is not thought to have contributed to any of the recent odour issues. No change to the total airflow is needed nor any change in the airflow split between dry and wet side.

2.4.3 Covered Biofilter Media

The moisture content of the bark media in the covered biofilter at 100mm below the surface was found to be between 51 and 64% w/w (wet basis). This is a good consistent result over the bed area. The air loading on the biofilter of 19 m^3/h of air per m^3 of media is at the low end of the recommended range for the type of air. No traces of smoke were observed at any time. An indicative test of media pH gave a result of 5.0 – 6.0. The temperatures in the bed at 200mm depth ranged from 21°C to 25°C and indicated even gas distribution. The pressure drop across the bed was found to have fallen from 84 mm wg at the last inspection to 8 mm wg which is near what it was when the media was last replaced. In the previous inspection report, addition of lime and tillage was recommended. Tillage would account for a reduction in bed pressure drop but the most likely cause is the greatly reduced airflow arising from the insertion of the orifice plate between the evaporator and ID1 fan.

Previous reports have commented on the presence of compacted clay in the biofilter bed particularly in the south-west quarter. Attempts have been made to modify this by lime addition and tillage but it is noted that this compacted clay mass is still there. As discussed at the time of the inspection the existing media should be dug out and replaced rather than attempting to renovate it.

With the airflow to the covered biofilter being greatly reduced over what it was, due to installation of the stickwater evaporator, it should be possible to replace one half at a time while the other half still operates as a working biofilter. The central distribution pipe is large diameter concrete drainage pipe running the length of the biofilter to the manhole. Biofilter laterals are perforated soil drainage tubes which are inserted into holes at 3 o'clock and 9 o'clock in the concrete pipe. Hence temporarily plugging the holes on one side of the concrete pipe would allow work on that side of the biofilter to be carried out.

Another reason for doing half the biofilter at one time would be to test whether only half the biofilter area is needed with the reduced airflow and the extra cooling given to the airstream by the evaporator.

One further point noted is that the mortar sealing of the manhole provided at the west end of the covered biofilter has progressively disintegrated over the years. Leakage is occurring at the manhole. Replacement of the broken mortar would minimise this.

Suggested Remedial Action:

a) Replace the media in the southern half of the covered biofilter to get rid of the compacted clay. Clean free flowing bark that is easily separated from the compacted clay mass may be reused with new bark.

b) Replace the perforated lateral distributor tubes if they are significantly blocked by fat.

c) If no stone has previously been used immediately around the lateral distributors, cover the distributors with coarse bark (25 to 75mm particle size) to give a depth of 120 -150mm above the distributor tubes (likely volume needed 15 – 20 m^3 for half the biofilter area). If stone (washed river pebbles 20 – 40mm) has been used this should be dug out and washed to get rid of built up fat and dirt and replaced around the distributor tubes. The stone should normally rise to a depth of around 50mm above the distributor tubes. The coarse bark is then laid over the pebbles.

d) Add around 40 m^3 of graded bark having a particle size range 3 to 10 mm to give a bed depth around 500mm).

e) Upon completion, check the bed moisture content. If it is less than 40% moisture, add over days, small amounts of water from the sprays to bring the moisture content up to around 40 – 50%.

f) Block off the distributors on the north side of the concrete pipe to test whether the half biofilter with the new media is capable of handling the drier gases alone.

g) Repair the mortar on the covered biofilter manhole to stop air leakage.

2.4.4 Un-covered Biofilter Media

The moisture content measurements in the uncovered biofilter ranged from 20 to 52% moisture w/w wet basis. Measurements were made near the end of a long spell of dry weather. Also it was noted that samples from the north-east corner had a proportion of stone in the media compared to all the other samples which did not. As the stone changes little in weight on drying, the moisture content of the non-stone media in the samples tested would likely have been above 40%. Hence considering the dry weather and the stone, the biofilter moisture is around the low end of the acceptable range.

The temperatures measured in the bed ranged from 22°C to 25°C indicating acceptably uniform distribution. A bed permeability check was also made at the time of temperature measurement. There was evidence of upward gas flow in all parts of the biofilter. It was noted that much of the biofilter looked like normal earth at the surface but aged graded bark was found below the surface – it was later learned that a contractor had dumped earth on the biofilter thinking it was a disposal site – most of the earth had been removed but some residue remained. The biofilter loading at 59 m^3/h of air per m^3 of media is within the recommended range for the type of air. The media pH was found to be 5.5 - 6.5 in an indicative test. This is satisfactory. The distributor and media pressure drop (as measured at the test point downstream of the fan) has decreased slightly over the last 15 months from 52 mm wg to 45 mm wg. It is understood that tillage had occurred prior to the inspection. Bed pressure drop was 20mm wg as measured at the north-east and north-west manometers. Most of the uncovered biofilter manometers are not working, probably due to solids blockage. The two working manometers appear to be giving an accurate indication of bed pressure drop.

Current air flow through the bed is good and evenly distributed with the pressure drop in the distributors and the bed being much the same as what it was in 2008. The highest measured static pressure downstream of ID1 was 138 mm wg in 2011 but as recent maintenance has shown, tillage of the top part of the bed is still capable of keeping bed pressure drop near to what it was when the media was last renewed.

If it was desired to have the biofilter in top working order, all of the media would be removed and stored in piles according to its nature i.e. stone in one place, coarse bark in another and fine bark in another. From memory there is not much coarse bark in the uncovered biofilter, but with the finer bark removed the media near the distributor pipes can be easily loosened. The material along with new bark can then be returned to the biofilter. This work is labour intensive and good practice but may not give a noticeable difference.

The media is currently still in satisfactory working condition and no immediate further action beyond the recent tillage is recommended.

Suggested Remedial Action:

Renewal in-part of the fixed manometer tubing is recommended. This has not been commented on in the past, as the ultra-violet light quickly degrades the tubing - unless the manometers are being regularly monitored there did not seem to be any point in regular replacement. For monitoring inspections a portable manometer in good condition has always been used. However now that most manometer tubes for the uncovered biofilter appear blocked (except the north-east and north west ones) it is time to get some back in good working order. If the inlet tubes cannot be readily unblocked, it may be that some distributors are partially blocked and should be cleaned out. Accurate working manometers will guide the need for such action. Essentially only one good working manometer at the end of the distributor (where there is no more air flow) is all that is needed for measurement of bed pressure drop. However two or three in good working order, say the north west, centre north and north east ones are useful for ensuring consistency of reading.

2.4.5 Rendering Plant Wet Processing Area Ventilation

At the time of inspection it was understood that complaints had been made about odour from the plant having been transported beyond the Imlay site boundaries. Hence some measurement was made of airflows into the system.

The air flow into the Wet Processing Area from outside when the north roller door was open was found to be low compared to what had been measured in previous years. A zone on a 2/3 west side of the opening had a velocity in which was well above the 0.3 to 0.5 m/s minimum capture velocity needed to prevent escape of odour out through the open door. However there was a zone on the east side of the opening where occasional drifts of wet side ambient air could have been discharged. This may have related to the moderate SE wind conditions on the day.

In looking at the system with Mr. Te Weri a duct opening which should have been capped in the dry area was found. This was allowing around 1,800 m^3/h of dry area air into the system at the expense of wet area extraction draw. It is understood this has now been capped.

Air flows into items of processing equipment in the wet area were also looked at. All the equipment accessed and measured were working well with the exception of the day bin conveyors which did not have any measureable inward air flows. The day bin itself was no problem as there was 0.48 – 0.57 m/s inward air flow when the north top hatch door was open.

In the past material to be rendered has been fresh. Regular processing and good housekeeping has ensured that there has been little time for material to decay. In February / March when there was a long spell of hot weather it is understood that some large consignments of matter to be rendered were received where there was no guarantee that what was conveyed to the day bin was processed sequentially. It is possible that odour from ripe material which had been caught in a pocket in the day bin for several days was omitting offensive odour which then entered the wet process area airspace from the conveyors, then in turn this Wet Area air then left the rendering plant through the roof vents or other wall openings.

In relation to the odour complaints there seemed to be varying views on the nature of the odour i.e. whether it was a wet area raw odour or a wet area raw rotten odour or a wet area cooked odour or a dry area meal type odour. In the past fresh wet area odours and dry meal type odours have rarely given rise to complaint. Cooked odours from the Wet Area appeared to be being effectively drawn into the Uncovered Biofilter extraction system. Can the possibility of raw rotten odour emission be eliminated?

We trust that the above information is of assistance.

Regards

John Vickerman
Mechanical Engineer.

Appendix A
Figures & Tables

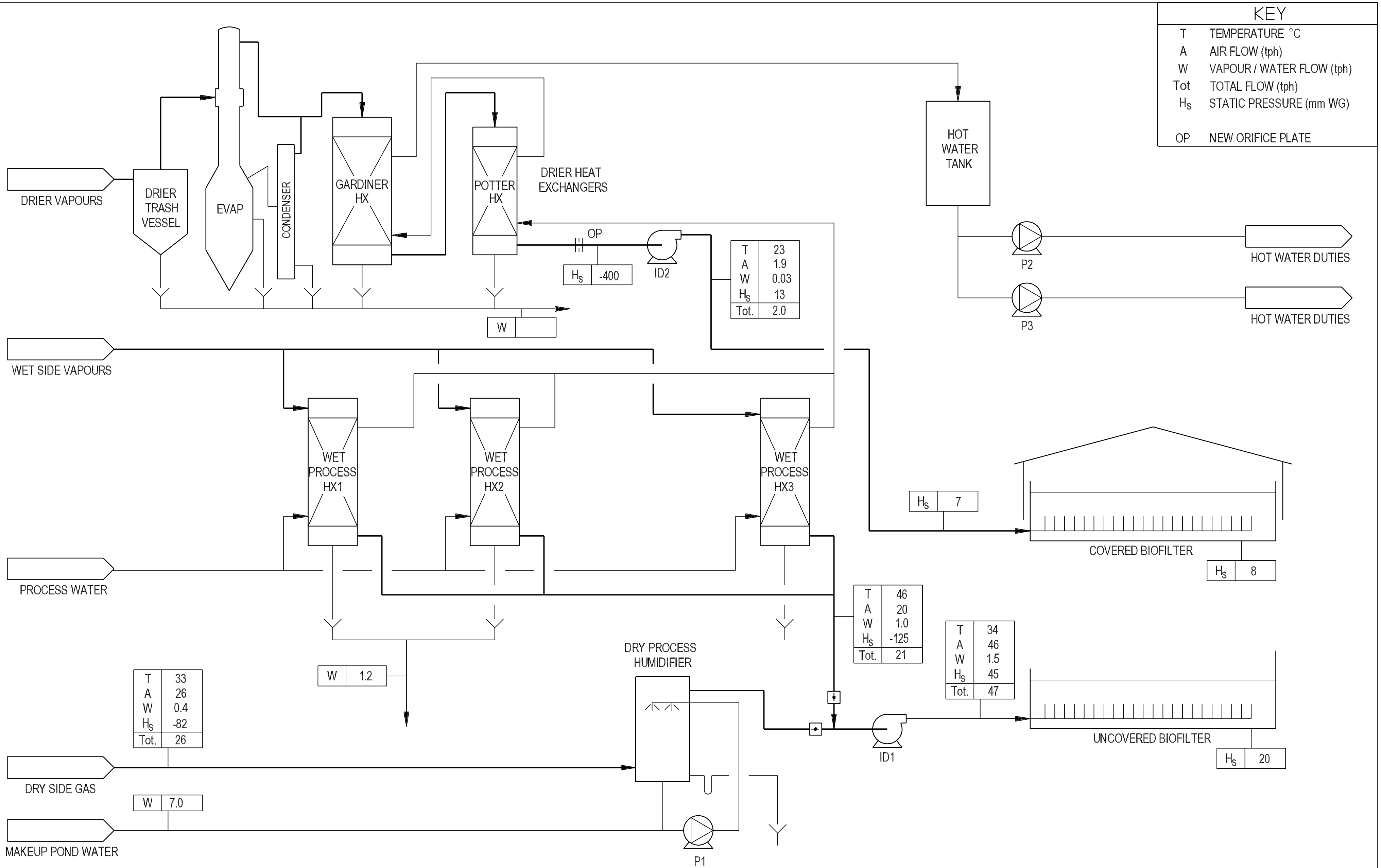

Fig 1. Biofilter Systems at AFFCO Imlay Plant March 2015

Table 1: AFFCO Imlay - Covered Biofilter

Performance Assessment 16 March 2015
Data gathered between 1240h and 1905h 16/03/15

A **Ambient Conditions**

On site temperatures (open air)	19	to	21	°C
Humidity (site open air)	70	to	87	%RH
Atmospheric pressure	99.5	to	99.6	kPa
Wind - Moderate SE generally	5	to	7	m/s
Occasional wind gust to 10 m/s around 1330h				

B **Measured Air Flow to Covered Biofilter**

(at thermowell approx 6m downstream of ID2 fan)

	Duct Diameter mm	Static Head mm wg	Dynamic Head pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	302	13	2.5	21.2	21	99.5	1.00	1.16	6.5	1,677	0.54	1.9
Min Air Flow	302	13	1.0	26.6	21	99.5	1.00	1.14	4.1	1,069	0.34	1.2

C **Covered Biofilter Characteristics**

Length	14.8	m
Width	13.0	m
Min media depth	0.45	m
Media bed area	192	m^2
Media volume	87	m^3

Media Moisture Analysis

%w/w (wet basis)

NW	51.1	64.0	NE
	54.3	59.9	
SW	*River Side*		SE

Media Temperature

°C at 200 mm depth

NW	20.7	20.8	22.9	22.7	22.8
	21.9	25.0	23.9	23.5	22.6
	21.7	21.2	21.8	23.0	22.5
	20.9	20.9	20.7	22.3	22.0
	21.2	23.2	23.3	22.0	22.2
SW			*River Side*		

Media pH 5.0 - 6.0

D **Biofilter Loading**

19 m^3/h air per m^3 media

E **Duct Static Pressure**

ID2 Fan Inlet static head	-400	mm wg
ID2 Fan Outlet static head	13	mm wg
Biofilter end manhole static head	8	mm wg

Table 2: AFFCO Imlay - Uncovered Biofilter

Performance Assessment 16 March 2015

Data gathered between 1220h and 1840h 16/03/15

A **Ambient Conditions**

On site temperatures (open air)	19	to	21	°C
Humidity (site open air)	70	to	87	%RH
Atmospheric pressure	99.5	to	99.6	kPa
Wind - Moderate SE generally	5	to	7	m/s
Occasional wind gust to 10 m/s around 1330h				

B **Measured Air Flow to Uncovered Biofilter**

At removable plug 8m downstream of fan

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	898	45	19	34.2	21	99.5	1.00	1.11	18.3	41,815	12.85	46.2
Min Air Flow	898	48	17	33.9	21	99.5	1.00	1.11	17.3	39,553	12.15	43.7

C **Uncovered Biofilter Characteristics**

Length	36.0	m
Width	35.7	m
Min media depth	0.55	m
Media bed area	1285	m^2
Media volume	707	m^3

Media Moisture Analysis

%w/w (wet basis)

	NW	NE	
NW	40.4	20.1	NE
SW	52.4	35.8	SE

SW — *River Side* — SE

Media Temperature

°C at 200 mm depth

22.8	23.6	24.6	25.1	22.6
24.0	22.6	23.5	24.3	23.3
23.2	23.4	22.7	25.1	22.9
24.1	22.2	22.1	24.2	23.4
22.9	23.4	22.1	22.1	25.8

NW (top left), NE (top right), SW (bottom left), SE (bottom right) — *River Side*

Media pH 5.0 - 6.5

D **Biofilter Loading**

59 m^3/h air per m^3 media

Table 2 continued: AFFCO Imlay - Uncovered Biofilter

E **Measured Air flow from Wet Process Heat Exchangers**

	Duct Size W x H mm		Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	645	790	-125	6	45.8	21	99.5	1.00	1.05	10.6	19,439	5.65	20.3
Min Air Flow	645	790	-123	5	38.9	21	99.5	1.00	1.10	9.4	17,308	5.29	19.0

F **Measured Air Flow into Dry Gas Scrubber**

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Air Flow	702	-78	16	33.1	21	99.5	1.00	1.17	16.4	22,848	7.39	26.6
	702	-82	14	31.1	21	99.5	1.00	1.17	15.3	21,372	6.92	24.9

E **Duct Static Pressure**

ID1 Fan Inlet static head	-125	mm wg
ID1 Fan Outlet static head	48	mm wg
Biofilter end static head (NW)	20	mm wg
Biofilter end static head (NE)	19	mm wg

Table 3: AFFCO Imlay - Rendering Plant Historical Air Extraction Data

	2008	2010	2011	2012	May-13	Dec-13	2015
Drier Vapours							
Fan ID2 inlet static pressure (mm wg)	-312	-302	-290	-285	-228	-201	-400
Fan ID2 outlet static pressure (mm wg)	83	80	101	123	140	136	13
Fan ID2 outlet air temperature (°C)	27	28	29	22	26	26	23
Covered Biofilter inlet total pressure (mm wg)	4	13	37	59	97	84	8
Flow to Covered Biofilter (m^3/h)	3,600	3,700	3,500	3,800	3,000	3,100	1,600
Mass flow to Covered Biofilter (tonnes/h)	4.3	4.3	4.1	4.5	3.5	3.6	1.9
Biofilter Loading (m^3/h air per m^3 media)	47	42	40	40	35	33	19
Non-Drier Vapours							
Dry Side Air							
Humidifier Inlet Static Pressure	-83	-83	-77	-95	-98	-88	-79
Humidifier Inlet Temperature (°C)	32	35.1	30.4	24.1	27	30	31
Inflow to Humidifier (m^3/h)	24,900	20,300	20,700	22,100	22,800	28,000	19,400
Mass flow to Humidifier (tonnes/h)	29.2	22.5	23.9	25.9	26.6	31.7	20.3
Wet Side Vapours from HX1 - HX3							
Static pressure (mm wg)	-123	-119	-93	-118	-131	-108	-125
Temperature (°C)	35	46.1	43.7	37.5	41	39	46
Flow (m^3/h)	20,400	20,800	16,600	15,100	19,100	14,400	19,400
Mass flow (tonnes/h)	22.5	19.4	17.8	16.6	20.7	15.8	20.3
Uncovered Biofilter							
Fan ID1 outlet static pressure (mm wg)	40	56	138	68	58	52	45
Air temperature to Uncovered Biofilter (°C)	33	22.5	31.5	26.6	32.4	31.2	34
Flow to Uncovered Biofilter (m^3/h)	44,800	41,300	37,500	39,900	43,500	43,200	41,800
Mass flow to Uncovered Biofilter (tonnes/h)	51.7	44.3	43.5	46	49	49	46
Biofilter Loading (m^3/h air per m^3 media)	63	58	53	56	62	62	59