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25th May 2020

Baiada Poultry Pty Ltd
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Attention: Dean Kent
By Email: dean.kent@baiada.com.au
HY2989 Rev.2.3

Concept Process Design Report for Wastewater Treatment Plant, Advanced Water Treatment Plant,

Dear Dean,

Please see following the concept design report for Tamworth. The scope of this document includes:

- Calcuations confirming the capcity of the treatment plant
- A description of the flow and wastewater quality expected
- High-level design and description of the of the overall process
- Basic block diagram and mass balance of the process
- Estimated energy usage requirements of the process
- Basic Layout of the plant showing land required and elevations

This draft report describes a concept design for a wastewater treatment plant (WWTP) and advanced water treatment plant (AWTP). This document is provided to support Baiada's application for regulatory approval.

Please contact me if you have any queries.

Best Regards,

Andrew Miley | Director
Hydroflux Industrial

HYDROFLUX industrial

Sydney | Melbourne | Brisbane | Portsmouth | Suva | Auckland

BAIADA POULTRY

APRIL 2020

CONCEPT PROCESS DESIGN REPORT FOR WASTEWATER/ADVANCED WATER TREATMENT PLANT

HY2989 Rev.2.3

CONTENTS

1 Summary

- The system is designed based on the processing up to 3 million birds per week, with an associated wastewater volume of 8 ML/day.
- The Advanced Water Treatment Plant is designed to threat up to 8 million litres of water per day and allow recovery of up to 7.2 million litres (90%) for use as potable water.
- All wastewater from the adjacent rendering facility will be treated separately in the rendering plant wastewater treatment plant which is operational, and has been designed to accommodate additional volumes associated with the processing plant. Treated wastewater from the rendering plant wastewater treatment plant will continue to be discharged to sewer.
- Based on current estimates and processing technology, the facility will require up to 8 million litres of potable water per day, to at full capacity.
- Reuse of wastewater will have a significant impact on the water supply.
- The AWTP will generate a concentrate stream produced by the final process stages of disinfection and salt reduction.
- The Total Dissolved Solids (TDS) concentration at maximum recovery of water (i.e. 90%) will be approximately 13,550 mg/L, which at the full design flow, equates to 10,880 Kg TDS per day in 800 kL of water.
- The TDS mass discharged from the site will be same regardless of the flow treated in the AWTP.
- Accelerated evaporation is proposed to reduce the volume of brine by 90% to 80 kL/day.
- The advanced water treatment plant (AWTP) process is proven and has been operating successfully at two poultry processing plants in Australia for over 10 years.

1.1 Reference Attachments

HY2989-P000-F	WWTP, AWTP PROCESS DRAWING
19106_SK200_9_SITE PLANT	WWTP, AWTP GENERAL ARRANGEMENTS

2 Expected Influent

Baiada owns and operates a poultry processing facility with similar characteristics as those proposed in this concept design. The data available from his existing facility will be used to estimate the conceptual process design.

The average influent wastewater data from the Hanwood site is as follows:

Influent Waste Water Quality Data		
Average January 2017 – May 2018		
pH	6.59	units
Electrical Conductivity	1925	µS/cm
Chemical Oxygen Demand	3964	mg/L
Chemical Oxygen Demand (filtered)	1418	mg/L
Total Suspended Solids	1293	mg/L
Total Nitrogen	209	mg/L
Total Phosphorous	32	mg/L
Biological Oxygen Demand	2377	mg/L
Total Dissolved Solids	1167	mg/L

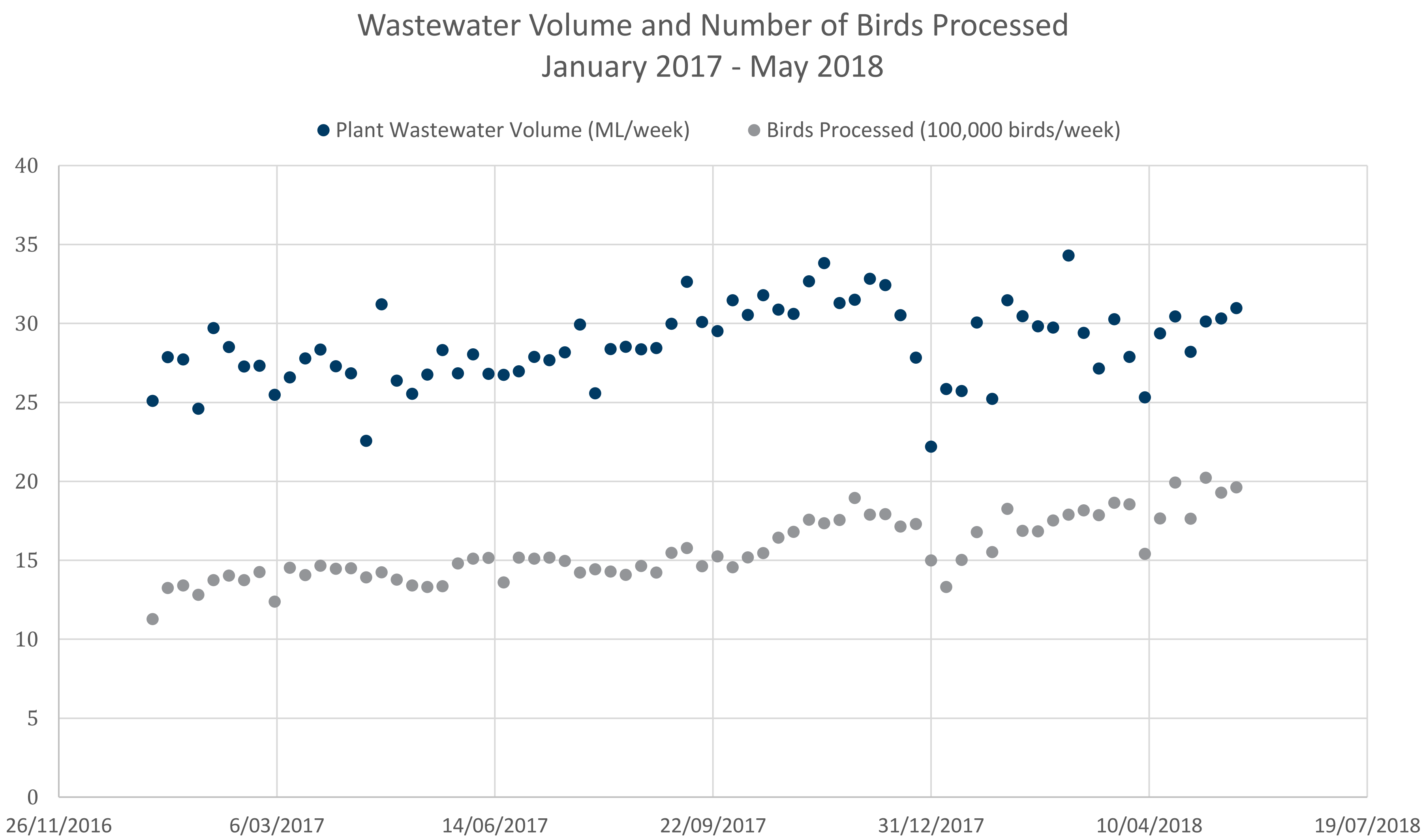
Additionally, the wastewater flows and the number of birds over this period has been recorded:

Influent Water Volume Data		
Average January 2017 – May 2018		
Incoming Water	23.51	ML/week
Birds Processed	1,562,165	birds/ week

From these figures, we can determine a mass loading and wastewater volume per bird processed:

Specific Wastewater Load per Bird Processed		
Average January 2017 – May 2018		
Chemical Oxygen Demand	60.38	g / bird
Chemical Oxygen Demand (filtered)	21.6	g / bird
Total Suspended Solids	19.7	g / bird
Total Nitrogen	3.18	g / bird
Total Phosphorous	0.49	g / bird
Biological Oxygen Demand	36.21	g / bird
Total Dissolved Solids	17.78	g / bird
Water Use	15.23	L / bird

The proposed facility will have the capacity for up to 3 million birds per week. A wastewater flow of 8 ML/day equates to a daily processing capacity of 525,000 birds/day. The wastewater system is thus designed for a total production of up to 3.6 million birds per week, allowing for some contingency.


Wastewater Volume and Number of Birds Processed
January 2017 - May 2018
Plant Wastewater Volume (ML/week)
Birds Processed (100,000 birds/week)
40
35
30
25
20
15
10
5
0
26/11/2016
6/03/2017
14/06/2017
22/09/2017
31/12/2017
10/04/2018
19/07/2018

3 Conceptual Process Design

3.1 Summary

This concept design is for a Wastewater Treatment Plant (WWTP) followed by Advanced Water Treatment Plant (AWTP).

The wastewater from the poultry processing facility will first be treated in a conventional manner, with primary and secondary treatment processes. This will reduce the concentrations of primary suspended solids, organics and nutrients.

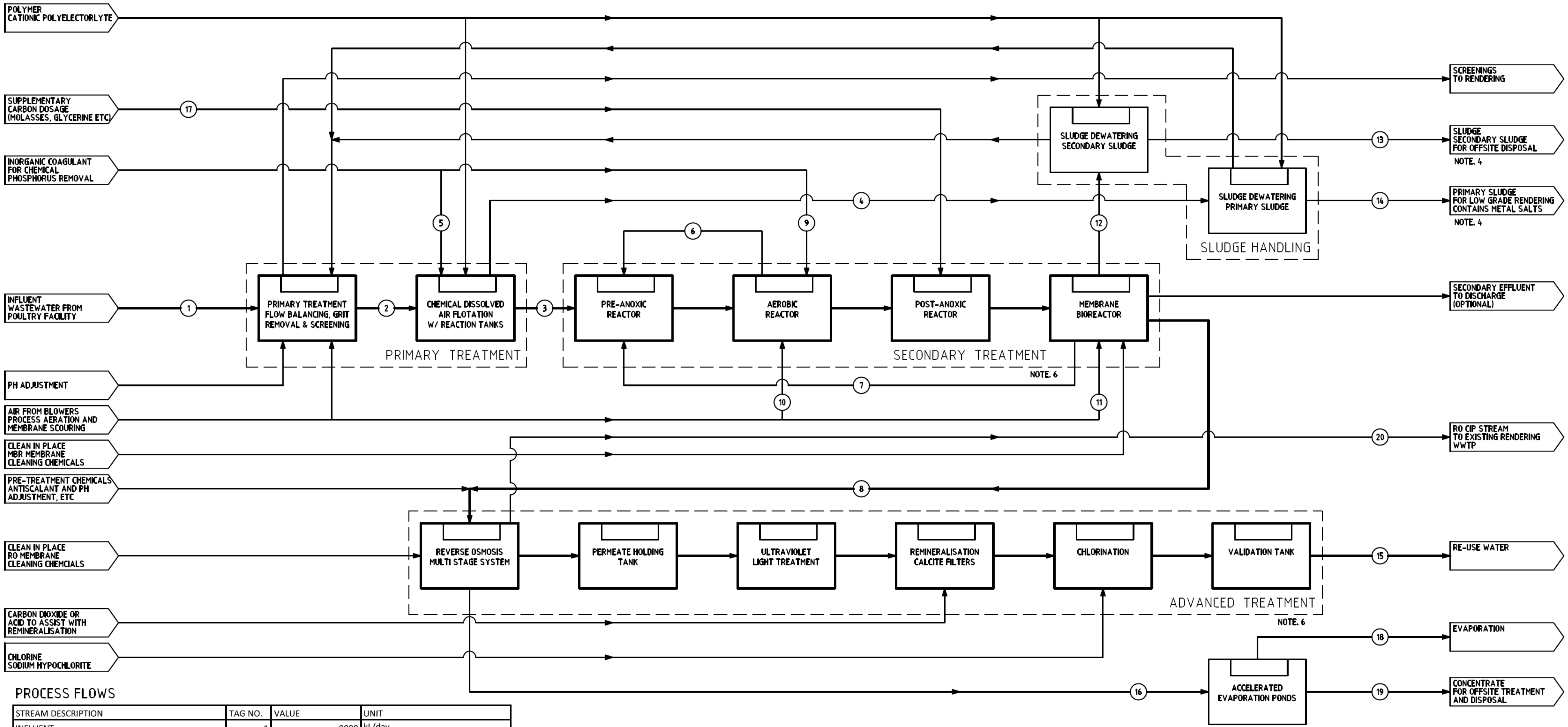
The proposed technology is dissolved air flotation (DAF) to remove fats, oils and grease (FOG) and suspended solids (TSS). Followed by a membrane bioreactor (MBR) designed to remove organics and nutrients such as nitrogen and phosphorus to target levels. The membrane bioreactor combines the features of a conventional bioreactor, combined with the water quality of an ultrafiltration membrane. Chemical phosphorus removal will be employed in both the primary and secondary treatment with the addition of an inorganic coagulant.

The effluent from the MBR will then be suitable for discharge, irrigation and or further treatment for re-use. The effluent intended for re-use will then be treated by Reverse Osmosis (RO) to reduce the levels of dissolved solids. Following additional treatment, the RO permeate will be suitable for re-use. Additional treatment will consist of: chlorination, ultraviolet light and remineralisation. This system will be designed to meet and exceed the re-use water quality standards including the log reduction values (LVR) of pathogens, as laid out in:

- NSW Food Authority – Water Reuse Guideline – May 2008
- NSW Government – Management of private recycle water schemes – May 2008
- NSW Department of Primary Industries – Recycled Water Management Systems – May 2015
- Australian Government – NHMRC – NRMMC – Australian Drinking Water Guidelines 6 - 2011

A RO concentrate stream will also be produced, this stream will have a high concentration of dissolved salts and is intended to be further treated via accelerated evaporation and with final disposal offsite as a concentrated brine.

3.1.1 Process Flow Diagram



PROCESS FLOWS

STREAM DESCRIPTION	TAG NO.	VALUE	UNIT
INFLUENT	1	8000	kL/day
BALANCED FEED TO DAF	2	8000	kL/day
FEED TO SECONDARY TREATMENT	3	8000	kL/day
PRIMARY SLUDGE TO DEWATERING - NOTE 1	4	10502.4	kg TSS/day
COAGULANT TO DAF - NOTE. 2	5	4998.2	kg/day Ferric Chloride 42%
MIXED LIQUOR RETURN	6	32,000 - 64,000	kL/day
RETURN ACTIVATED SLUDGE	7	8000	kL/day
MEMBRANE BIOREACTOR EFFLUENT	8	7943.2	kL/day
COAGULANT TO SECONDARY TREATMENT - NOTE. 2	9	1249.6	kg/day Ferric Chloride 42%
AERATION FOR AEROBIC REACTOR	10	31960	Nm3/hr @ 620 mBar.g
AERATION FOR MEMBRANE SCOUR	11	13000	Nm3/hr @ 570 mBar.g
WASTE ACTIVATED SLUDGE - NOTE. 1	12	3077.6	kg TSS/day
DEWATERED SECONDARY SLUDGE	13	2923.7	kg TSS/day
DEWATED PRIMARY SLUDGE	14	9977.3	kg TSS/day
TREATED WATER FOR RECYCLING	15	7200	kL/day
RESERVE OSMOSIS CONCENTRATE	16	800	kL/day
SUPPLEMENTARY CARBON - NOTE 3.	17	AS REQUIRED FOR DENITRIFICATION PERFORMANCE.	
EVAPORATION OF CONCENTRATE	18	720	kL/day
CONCENTRATE POST EVAPORATION	19	80	kL/day
REVERSE OSMOSIS CIP STREAM TO EXISTING WWTP	20	40	kL/month

WATER QUALITY ESTIMATES

STREAM DESCRIPTION	TAG NO.	VOLUMETRIC FLOW	COD	BOD	TN	TKN	TP	PO4-P	TS	TSS	TDS
-	#	kL/day	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
INFLUENT	1	8000	3970	2380	210	210	40	36	2700	1300	1400
FEED TO SECONDARY TREATMENT	3	8000	1500	899	210	210	10	10	1600	200	1400
MEMBRANE BIOREACTOR EFFLUENT	8	8000	50	20	21	15	1	1	1405	5	1400
TREATED WATER FOR RECYCLING	15	7200	-	-	-	-	-	-	50 - 200	-	50 - 200
RESERVE OSMOSIS CONCENTRATE	16	800	250	200	210	150	312	272	13600	50	13550
CONCENTRATE POST EVAPORATION	19	80	2500	2000	2100	1500	3120	2720	136000	500	135500

NOTE. 5

NOTES:

1. PRELIMINARY CALCULATIONS SUGGEST 1,041 KG TSS IS PRECIPITATED DUE TO CHEMICAL P REMOVAL. FOR DESIGN PURPOSES IT HAS BEEN ASSUMED THAT 80% OF THIS SLUDGE IS PRODUCED DURING PRIMARY TREATMENT, WITH THE RESIDUAL PRODUCED IN THE SECONDARY TREATMENT PROCESS.
2. ESTIMATED FERRIC CHLORIDE DOSAGE IS 3,123.9 KG/DAY AS 42% SOLUTION. ASSUMPTION HAS BEEN MADE THAT THIS IS DOSED 4:1 INTO PRIMARY AND SECONDARY TREATMENT STAGES. MOLAR RATIO OF 2:1 [METAL]:[PHOSPHATE] USED FOR CALCULATIONS.
3. SUPPLEMENTARY CARBON DOSAGE MAY BE REQUIRED TO ACHIEVE TARGET TOTAL NITROGEN VALUES IN THE EFFLUENT.
4. WATER CONTENT OF DEWATERED SLUDGE HAS NOT BEEN CONSIDERED IN THE MASS BALANCE.
5. IMPACT OF CHEMICAL DOSING FOR PH CORRECTION, DISINFECTION AND CLEANING HAS NOT BEEN CONSIDERED IN THIS MASS BALANCE.
6. SECONDARY AND ADVANCED TREATMENT SPLIT INTO TWO PARALLEL TREATMENT TRAINS

3.2 Primary Treatment

The balancing tanks will ensure that the flows are hydraulically managed from the processing facility, this will serve to equalise the effluent concentrations and mitigate swings in pH that may be caused by clean in place (CIP) waste streams.

The primary treatment shall be designed to protect downstream processes from solids, and fats oil and grease (FOG). Large solids may cause mechanical issues with downstream processes, and FOG can upset the biological process when introduced in high concentrations.

The physical treatment processes (screens, grit removal and dissolved air flotation) are designed on the basis that the wastewater treatment plant is operated on a 14-hour per day.

3.2.1 Balance Tank

Objectives of this process unit:

- Ensure the flow from the plant can be adequately pumped to the WWTP
- Provide a balancing volume, such that spikes in pH and concentration may be effectively mitigated

Our recommendation is for a balance tank with a volume of 2000 m^3, this allows for 6 hours hydraulic retention time. Our experience with industrial wastewater shows that this volume will be adequate for balancing pump flows to primary treatment.

3.2.2 Grit Removal

Objectives of this process unit:

- Protect downstream equipment from readily settleable solids.

Grit removal is important to remove readily settleable particles such as sand from the process to protect downstream equipment.

3.2.3 Screening

Objectives of this process unit:

- Protect downstream equipment from large solids.

Coarse screening should be provided to protect downstream equipment, such as pumps and instruments. At a minimum, this should include screening to < 3mm. Hydroflux proposes an automatic bar screen or drum screen (or similar) for this purpose.

The screening details will need to be confirmed during detailed design to ensure they are compliant with the membrane bioreactor (MBR) pre-treatment requirements. This is a requirement of the specific membrane elements used and varies from manufacturer to manufacturer.

3.2.4 Primary Dissolved Air Flotation

Objectives of this process unit:

- Reduce levels of FOG.
- Recover valuable proteins, fats and oils for rendering.
- Remove precipitates from chemical phosphorus removal

A dissolved air flotation (DAF) unit, creates a stream of microbubbles which attach to solids and FOG, causing them to float. This allows for the separation of solids and FOG from a wastewater stream.

Aerobic treatment systems are generally not tolerant to high - moderate levels of FOG, typically aerobic reactors will start to be adversely impacted when fed wastewaters with a higher concentration than 30 mg/L. The FOG will interfere with the aeration processes and thus starve the biomass of the required oxygen.

This DAF is intended to run with both inorganic coagulant and polymer. As such the for concept design an influent hydraulic loading rate of between 6.5m³/m².hr has been selected. This corresponds to a minimum surface area requirement of 88 square metres. The calculated minimum recycle flow is 20% to meet a recommended air: solids ratio of 0.01 (kg Air/kg Solids).

Hydroflux suggests that three units with a third the rated capacity be put in parallel for maintenance and operation reasons.

Chemical DAF units can typically be expected to remove 85-95% of the total suspended solids (TSS) and fat oils and grease (FOG).

Table 1 - Concept design calculations: Primary Dissolved Air Flotation

Parameters	Value	Units
Influent Bypass to SBR Design Flow	8,000	m³/day
Design Flow	571.4	m³/h
Design Influent Hydraulic Loading	6.5	m³/m².h
Required Surface Area	87.9	m²
Design Solids and FOG Concentration	1500	mg/L
Solids Loading	857.1	kg/h
Design Air: Solids Ratio	0.01	kg Air/kg Solids
Required Air Flow	8.57	kg Air/hr
Air Solubility @ 450kPa, 20°C	95.9	g/m³
Nominal Saturator Efficiency	80%	
Required Recycle Flow	111.7	m³/h
Recycle Ratio	20%	-
Actual Hydraulic Loading	7.8	m³/m².h

3.3 Secondary Treatment

Secondary treatment is required to remove the soluble nutrients and organics. Poultry processing wastewater is readily biodegradable and has a high concentration of organic compounds and nutrients such as nitrogen and phosphorus. As such, it well suited for biological treatment.

As the effluent is destined for re-use, a membrane bioreactor (MBR) has the benefit that it produces a very high-water quality effluent, that can be paired with reverse osmosis without significant pre-treatment. Other potential technologies will normally require additional pre-treatment including a combination of the following: multimedia filtration, cartridge filtration and or micro/ultrafiltration.

3.3.1 Aerobic Treatment – Membrane Bioreactor

Design Objective for this process unit:

- Remove residual organic carbon compounds
- Nutrient removal of nitrogen compounds
- Retain secondary solids
- Remove Colloidal Solids
- Remove Turbidity
- Contribute to log removal of pathogens for re-use
- Meet pre-treatment requirements for Reverse Osmosis

The membrane bioreactor (MBR) is an activated sludge treatment process, combined with membrane treatment process. Activated sludge processes are a suspended growth biological treatment process which conventionally relies on settling for biomass removal. In an MBR the separation is achieved using a microfiltration (MF) or ultrafiltration (UF) membrane. For this design Hydroflux suggests the use of a submerged flat sheet ultrafiltration membrane.

The secondary treatment process has been designed based on the following requirements:

Table 2 - Concept design: MBR Influent Design Parameters

Parameters	Inlet	Outlet	Unit
Influent Volumetric Flow	8000		m^3/day
COD	1500	50	mg/L
TN	210	20	mg/L
TKN	210	15	mg/L
NH4-N	190	1	mg/L
NO2-N	N/A	1	mg/L
NO3-N	N/A	10	mg/L
TP	10	1*	mg/L
PO4-P	9.8	1*	mg/L
TSS	200	5	mg/L

Note: *Requires chemical phosphorus removal.

As greater than 90% nitrogen removal is required, the conventional pre-anoxic (or Modified Ludzack-Ettinger) process is not suitable to meet the process requirements. As such Hydroflux suggests the application of the 4 stage Bardenpho process (pre and post-anoxic process). The Bardenpho process splits the biological treatment into four stages:

- Pre-anoxic
- Aerobic
- Post-anoxic
- Re-aeration (in this case the Membrane Bioreactor Tank)

Bardenpho process can be configured to remove greater than 95% of the nitrogen in the wastewater. However, depending on influent characteristics, carbon dosage may be required in the post-anoxic reactor. At this stage Hydroflux expects that whilst the influent is ratio of COD:TN is correctly balanced; it will be likely that some carbon dosing will be required to meet downstream process requirements.

Hydroflux is also suggesting that the system be split into two parallel process trains for operational redundancy.

Table 3 - Concept design calculations: Membrane Bioreactor

Parameters	Value	Units
Influent Flow to MBR	8,000	m^3/day
Design Influent COD Concentration	1,500	mg/L
Design COD Loading	12,000	kg/day
Design Influent TKN Loading	210	mg/L
Design TKN Loading	1,680	kg/day
COD Specific Oxygen Demand	1.3	kg O_2 / kg COD
TKN Specific Oxygen Demand	4.3	kg O_2 / kg TKN
COD Oxygen Demand	15,600	kg O_2/day
TKN Oxygen Demand	7,224	kg O_2/day
Assumed Aeration Efficiency	1.2	kg O_2/kWh
Total Oxygen Demand	22,824	kg O_2/day
Total Aeration Energy Required	19,020	kWh/day
Reactor Volume Selection		
Reactor Trains	2	-
Food to Micro-organism Ratio	0.18	kg COD/kg MLSS.day
Mixed Liquor Suspended Solids	6,500	mg/L
Biomass Required	66,667	kg MLSS
Total Reactor Volume	10,256	m^3
Individual Reactor Train Volume	5,128	m^3
Overall Hydraulic Retention Time	1.28	days
Blower Indicative Sizing		
Daily Aeration Hours	22	h/day
Rated Blower Power Per Reactor Train	432	kW
Total Blower Rated Power	865	kW

The flux and trans-membrane pressure (TMP) of the membrane modules will be monitored to ensure correct control can be achieved. The submerged membrane modules will require suction pumps, and air scouring.

Additionally, the system will include provision for clean in place (CIP) chemical treatment which is required to maintain membrane performance. Typical CIP chemicals used to clean the membrane elements include hypochlorite for organic scaling, and citric acid for inorganic scaling.

Hydroflux has calculated the membrane area requirements as follows:

Table 4 – Membrane Area Requirements for MBR

Parameter	Value	Unit
Operational Hours	14	h/day
Volumetric Capacity Required	8,000	kL/day
Hourly Capacity	571	kL/h
Design Flux	10	$L/m^2.h$
Required Membrane Surface Area	57,143	m^2

For concept design purposes Hydroflux has considered the usage of a Toray membrane module, each module offers 600 m^2, which translates to a minimum requirement of 138 modules. For this number of modules, the recommended aeration flowrate is approximately 13,000 Nm^3/h, this value has been used for energy estimation.

3.4 Advanced Water Treatment

The advanced water treatment plant main purpose is to produce a very high-quality water for re-use purposes. As well as the water quality requirements, there is also be a requirement for the development and implementation of a HACCP (Hazard Analysis and Critical Control Points) plan.

This plan will be developed specifically for the plant based on input and consultation from key stakeholders. Hydroflux's staff have previously been involved in the design and development of successful AWTP projects and have a clear understanding of the required process.

Essentially, the plan provides a systemic approach for operation, monitoring and decision making to ensure that the water produced from the plant is safe for it's intended usage.

3.4.1 Pathogen Removal Summary

The effluent from the MBR will require additional treatment prior to reuse. This is required to satisfy the log reduction of pathogens, ensuring the water will exceed the applicable guidelines. The following table provides an overview of the expected log removal of different type of pathogens.

Table 5 - Concept design calculations: Log Reduction Values of Pathogens

Process	Protozoa Log Reduction	Virus Log Reduction	Bacteria Log Reduction
Ultra-filtration (MBR)	3	2.5	3
Reverse Osmosis	5	4	5
Ultraviolet Light Irradiation	3	3	3
Chlorination (minimum 30 minutes contact)	2	2	2
Total	**13**	**11.5**	**13**

3.4.2 Reverse Osmosis (RO)

Objectives of this process unit:

- Contribute to log removal of pathogens for re-use water.
- Concentrate stream produced at total dissolved solids (TDS) concentrations of approx. 13,600 mg/L
- Reduce TDS concentrations in permeate to less than 100 mg/L
- Recover up to 90% of input wastewater for re-use

This system will use both low-pressure RO membranes, which typically allow for concentrate TDS concentrations of up to 10,000 – 12,000 mg/L TDS, and high-pressure RO membranes which can be used up to and exceeding concentrations of 50,000 mg/L TDS.

The feed water is sent to pressure vessels containing semi-permeable reverse osmosis membrane elements. The membranes allow the passage of the water molecule but reject a portion of the dissolved solids. This creates a concentrate stream and permeate stream (treated water). This separation is driven by the pressure gradient generated by the feed pumps.

As the permeate (treated water) is produced, the concentration of the remaining water (concentrate) increases. This increase in concentration, results in an increase in the osmotic pressure of the concentrate, and thus the pressure required to overcome this. Thus, as higher water recoveries are targeted, there is an increase in the required driving pressure and energy usage.

The sustainable level of water recovery will depend on the composition and ionic balance of the feedwater and may be limited by the presence of sparingly soluble salts and other potential foulants including silica. pH correction and antiscalants may be required to maximise the water recovery in this process.

The performance of up-stream processes such as the secondary treatment and chemical phosphorus removal have the potential to increase rates of scaling and fouling. As such, performance of upstream processes will need to be considered when evaluating RO performance.

Balance tanks are required for the feed water, permeate and concentrate streams, such that the dynamics of the system can be adjusted without knock-on effects throughout the process. In addition, a clean in place system will be required to periodically treat the membrane units to restore capacity due to fouling.

3.4.3 Ultraviolet Light Treatment

Objectives of this process unit:

- Achieve 3 log reductions of protozoa, viruses and bacteria

Ultraviolet light is an effective way to achieve disinfection of water, it is well suited to permeate and distillate treatment due to the favourable UV transmittance of the water source. The UV dosage required for disinfection is linked to the turbidity and colour of the water, as such a relatively low dosage is required for this application.

The required dosage would be assessed during detailed design.

3.4.4 Remineralisation

Objectives of this process unit:

- Add Hardness and Alkalinity to the water.

Reverse osmosis removes such a large amount of the dissolved solids from water, that the permeate ends up corrosive. To mitigate this hardness and alkalinity are added to protect pipes and equipment in contact with the re-use water.

Remineralisation filters containing calcite are used for this purpose. The permeate will require the addition of carbon dioxide gas (or acid) prior to introduction to the remineralisation filter to improve the process.

3.4.5 Chlorination

Objectives of this process unit:

- Achieve target log removal of protozoa, viruses and bacteria
- Provide free chlorine residual for ongoing disinfection of water

Dosing levels and contact time to be considered during detailed design and would be subject to HACCP approval. Typical values are a minimum of 30 minutes contact time, and 1 mg/L free chlorine residual.

3.5 Reject Streams to Existing Wastewater Treatment Plant

Both the membrane bioreactor and reverse osmosis systems will need to undergo cleaning to maintain efficient operation. The clean in place (CIP) waste streams generated by the reverse osmosis system is proposed to be sent to the existing rendering wastewater treatment system, and ultimately be discharged to trade waste.

For the reverse osmosis system, a typical clean in place schedule would include inorganic acid and organic acid wash, non-oxidising biocide wash, and an alkaline and surfactant wash. Each reverse osmosis train is required to be cleaned quarterly (3 months) with an expected production CIP waste stream of 20 kL/cycle. The 8 ML/day design is expected to contain 5 membrane trains; thus, the total expected CIP wastage volume is 100 kL/quarter.

The cleaning of the individual trains would be on a rotating schedule, where roughly two trains would be cleaned each month generating, a total CIP volume of 40 kL/month. As the existing plant is designed to treat up to 4 ML/week or 16 ML/month, the addition of 40 kL/month of CIP waste will not make any significant impact to existing wastewater treatment systems performance.

The CIP streams from the membrane bioreactor, will be self-contained in the new proposed system. These streams will not need to be sent to the existing treatment plant. A typical clean in place schedule would be monthly cleaning with chlorine, caustic and organic acids.

3.6 Accelerated Evaporation Ponds

In order to minimise the volume of reverse osmosis brine for off-site disposal, Hydroflux is proposing the use of accelerated evaporation ponds.

Accelerated evaporation is the process of mechanically spraying the wastewater into the atmosphere, enhancing the surface area for evaporation. The key design parameter for this kind of unit is the evaporation efficiency, which is the percentage of the sprayed wastewater that will evaporate. The evaporation efficiency typically ranges between 20-80%, depending on a range of factors, including wind speed, temperature, humidity, etc.

Figure 1 - Images of Typical Accelerated Evaporation Processes

Hydroflux has contacted two suppliers for conceptual design information. It has been indicated that we can expect an average of 30-50% evaporation efficiency in the Tamworth location.

The required land use for accelerated evaporation, is dictated by the minimum distance between units and potential for overspray. Overspray occurs when a droplet travels outside the pond surface, and the droplet ends up in an unintended location.

Accelerated evaporation systems can be implemented with inbuilt weather monitoring. A control system can adjust the operation to reduce or eliminate overspray, by controlling droplet size and or stopping/reducing spray flow. In addition, the installation of overspray curtains or an earth berm is typically recommended around the periphery of the pond, especially with reference to the prevailing wind direction. In this instance, Hydroflux suggest that an overspray curtain should be considered, and combined with a weather-based control system.

Figure 2 - Example Image of spray curtain design to mitigate overspray in accelerated evaporation

The proposed system relies on the extraction of the residual brine in order to avoid the ongoing accumulation of dissolved salts in the pond. To this effect Hydroflux is recommended that the 80 kL/day of the residual concentrate is extracted, at equilibrium this would result in a pond concentration of 136,000 mg/L TDS, slightly below the expected solubility limits of many sparingly soluble salts (~150,000 mg/L).

As way of concept design Hydroflux is proposing the installation of three 10,000 m^2 lagoons, with a minimum depth of 1.5 m. This includes a minimum freeboard of 500mm in order to accommodate the 7-day RDRD (rare design rainfall depth) for a 1 in 2000-year event, of approximately 480mm. The ponds will require raised banks to avoid ingress of stormwaters which fall outside the pond footprint.

The following concept design calculations have been used to determine the appropriate pond area sizing and for production of power consumption estimates.

Table 6 - Pond Sizing as per provided supplier information

Parameter	Value	Unit
Concentrate Flow	800	kL/day
Brine Concentration	13,550	mg/L
Target Concentration	135,500	mg/L
Residual Concentrate	80	kL/day
Evaporation Required	720	kL/day
Unit Evaporation Rate*	65	LPM/unit
	3.9	kL/hr.unit
Operating Hours	12	hr/day
Unit Evaporation	46.8	kL/day.unit
Required Units	15.4	units
Suggested Unit Spacing**	900	m2/unit
Total Pond Area for Unit Spacing	14,400	m2
Pond Area Safety Factor	2	-
Total Pond Area with Safety Factor	28,800	m2
Nominal Suggested Area	**30,000**	**m2**
Unit Power	21	kW
Total Power	336	kW
Total Energy Consumption	4032	kWh/day
Notes: **Preliminary estimate provided by supplier* ***Suggested spacing for specific unit provided by supplier is for 30 m by 30 m*		

3.6.1 Pond de-sludging

The ponds are designed as accelerated evaporation ponds which limits the capacity of the ponds to the theoretical solubility limit to avoid precipitation of sparingly soluble salts that will result in scaling and issues.

To avoid the precipitation of sparingly soluble salts, the theoretical capacity of the 1.5 m deep ponds is 1.7 years for total system and 0.6 years for single pond based on a flow of 8 ML/day. The values are linear so a 3 m pond will provide double the retention time.

If sparingly soluble salts are allowed to precipitate, then the ponds will require attention after approximately 4.2 years for the total pond system, and 1.4 years for a single pond.

Calculations are based on 8 ML of wastewater being discharged per day.

Parameter	Value	Unit
Daily Salt Mass	10,840	kg/day
Pond Depth	1.5	m
Total Pond Volume	45,000	m3
Solubility Limit	365	g/L
Capacity of Pond (Solubility Limit)	16,425,000	kg
Time to Total Pond Capacity Reached	1515	days
	4.2	years
Approx. Sparingly Soluble Limit*	150	g/L
Capacity of Pond (Precipitation Limit)	6,750,000	kg
Time to Total Pond Capacity Reached	623	days
	1.7	years

*Approximately solubility limit for sparingly soluble salts. This is indicative only, and other salts may precipitate prior to this limit.

The concentrated salt waste will be disposed of via a licenced disposal facility.

4 Estimated Energy Usage

The following table contains estimates for the energy usage of the plant.

Table 7 - Concept Design - Estimated Energy Usage

Flow	Power	Energy	Cost @ 20c/kWh	Cost/Year
	kW	kWh/day	$AUD/day	$AUD
Primary Dissolved Air Flotation	29	684	$136.80	$49,932
Aerobic Reactor	865	9510	$1,902.00	$694,230
MBR Air Scour	339	7331	$1,466.21	$535,166
RAS, MLR, WAS Pumps, and Anoxic Mixing	220	5280	$1,056.00	$385,440
Low Pressure Reverse Osmosis*	1429	20000	$4,000.00	$1,460,000
High Pressure Reverse Osmosis*	857	12000	$2,400.00	$876,000
Remineralisation Filters	103	1440	$288.00	$105,120
Ultraviolet Irradiation	51	720	$144.00	$52,560
Accelerated Evaporation	336	4032	$806.40	$294,336
Allowance for Transfer Pumps and Misc.	200	4800	$960.00	$350,400
Allowance for Screens and Sludge Handling	100	2400	$480.00	$175,200
Total	**4529**	**68197**	**$13,639.41**	**$4,978,384**

Notes: There are several components including: sludge handling, transfer pumps, and screening for which an allowance has been made without any calculations. The overall estimate should only be considered as a guide, actual energy usage is subject to detailed design.