ESK SEWAGE TREATMENT PLANT
FUNCTIONAL SPECIFICATION

DOCUMENT APPROVAL			
TITLE	**NAME**	**SIGNATURE**	**DATE**
Author	Garry Henderson (KBR) reviewed by J Randall		25/3/15
Manager, Process Control and Efficiency	Zane Tomlins		30/3/15

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Stakeholder Review History

AREA	NAME	REV NO.	SENT	REQUESTED RETURN BY	RECEIVED	COMMENTS RECEIVED
T&EM _ Service Delivery Leader	Mike Oakey	3	25/3/15	31/3/15	N/A	Nil
Principal Process Engineer	Sonja Toft	3	25/3/15	31/3/15	N/A	Nil

TABLE OF CONTENTS

1 ESK STP OPERATING PRINCIPLE

1.1 Purpose of Esk STP

The key objective of Esk Sewage Treatment Plant (STP) is to treat sewage from the township of Esk.

Esk STP is operated in accordance with the Department of Environmental and Heritage Protection (DEHP) development approval number ENDC00464006.

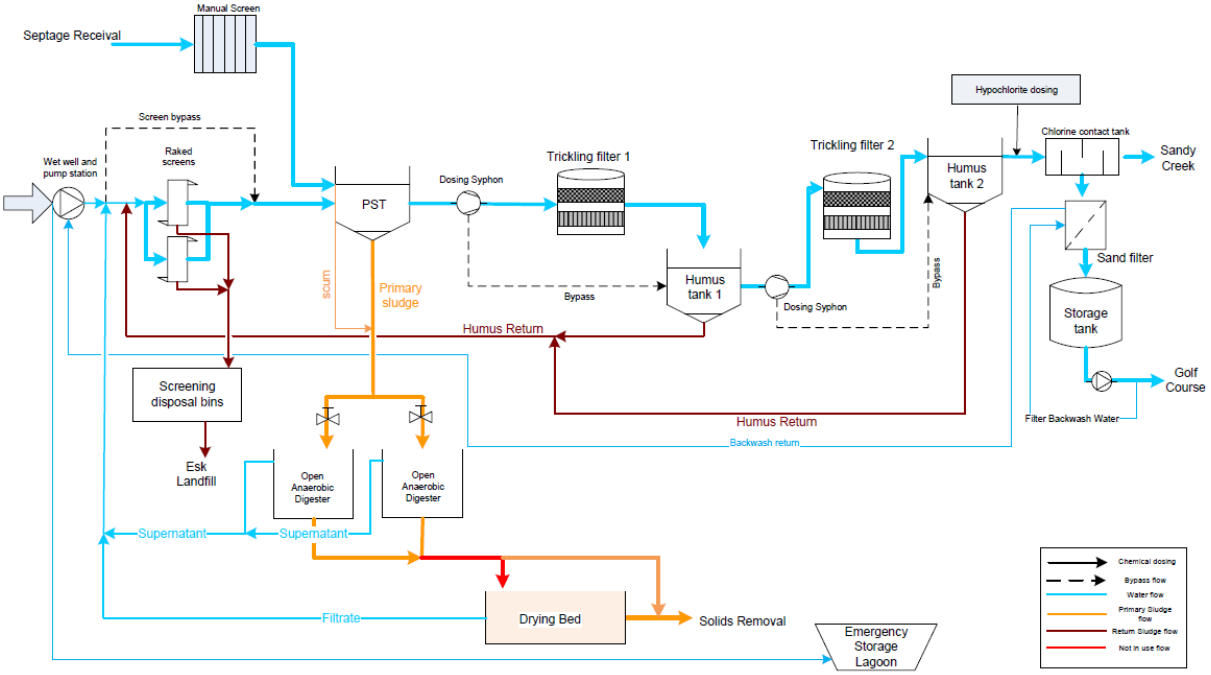
1.2 Existing Load and Design Information

Parameter	Existing	Design
ADWF	205 kL/d (2013/2014)	Unknown
PWWF	615 kL/d (3 x ADWF)	Unknown
Bypass Flow	N/A[1]	N/A[1]

1.3 System Overview

Esk STP consists of (also shown in the process flow diagram[2]):

- Inlet Works
- Primary Sedimentation Tank (PST)
- 2 Biological Trickling Filters (BTF)
- 2 Humus Tanks (HT)
- Chlorine Dosing and Contact Tank
- Effluent Discharge
- Recycled Water
- 2 Anaerobic Sludge Digesters



[1] There is no total plant bypass within Esk STP
[2] PFD taken from Q-Pulse Document PF26

Sewage enters the STP from the sewer network servicing the Esk township through a wet well and pump station on Esk STP site. There is a flow meter on the influent line. At present, tankered waste is also received at Esk STP. Septic waste arriving via tanker is received into the septage receival channel and flows by gravity through to the anaerobic digesters. Sullage waste arriving via tanker is received into the inlet channel prior to the first screen.

1.3.1 Inlet Works

The inlet works provide screening and grit removal for all pumped sewage flows. This minimises the risks associated with ragging and blocking of pumps, valves and trickling filter distributors.

The inlet channel is 0.5 m deep and 5 m long (approx. volume 0.5 m^3).

The inlet works splits into two channels to allow grit removal. Each channel has two bar screens in series (one after the other). The first screen has an average bar spacing of 38 mm, the second screen has an average bar spacing of 23 mm. Following the second screen each channel extends to allow grit to settle. The two channels then recombine to pass through a single third screen of average bar spacing of 12 mm. The screens are manually raked by the operator at least once per day. The screen design allows sewage to flow over the top of the screens when the screen is completely blocked. The over topping of the screen is most probable during high flows.

The deposited grit is removed manually from the channels by the operator during periods of low flow.

Screenings and grit collected from the inlet channel are transferred into 240 L bins for collection and transportation offsite via an external contractor.

The inlet works contains a flow splitter which is controlled by manual stop logs. The flow splitter allows the bypassing of the primary tank if maintenance is required on the primary tank.

There is no plant bypass at Esk STP.

1.3.2 Primary Sedimentation Tank

The screened and de-gritted sewage gravity flows to the primary sedimentation tank (PST) which removes some suspended solids. The removal of suspended solids in the PST reduces organic load onto the biological filters downstream of the PST.

Solids removal is important to prevent blockage in the trickling filter media. Higher loads and solids cause biomass to accumulate quickly and this restricts or blocks the voids that allow water and air flow in the media. Therefore the correct operation of the PST is important for the overall performance of the plant.

The PST is a 5 m diameter tank with side wall height of 2.2 m. It is fitted with a sludge scraper and a scum harvester.

The settled sludge is drawn from the PST by manually opening a valve to release the solids into the sludge pit adjacent to the PST. This is done twice per day by the operator. The first time should be at least half an hour after the morning peak flow. The scum harvester on the PST pushes the scum into the sludge pit throughout the day each time the unit completes a rotation of the tank. The sludge pit drains to the anaerobic digesters by gravity.

The primary effluent flows continuously to the first dosing syphon under gravity.

As at November 2014 the primary tank receives underflow from the humus tanks via the inlet works on a near continuous basis. The flow rate is typically 4 L/s, however, this is expected to reduce to 3 L/s when the new pump is installed for this duty.

The recycle on a continuous basis returns nitrate to the primary tank. During hot weather the rate of denitrification is sufficient to cause solids to float. This in turn causes a high solids loading onto the trickling filters and reduces the plant performance.

To minimise this impact while retaining the benefit of continually wetting the trickling filters during hot weather, the timer for the humus pump should be set so that the humus pump does not start until at least half an hour after the morning peak flow and so that it does not operate during periods of peak flow.

1.3.3 First Biological Trickling Filter

The dosing syphon passes primary effluent to either the BTF or bypasses the BTF to the humus tank. The bypass generally occurs at flows in excess of 3 x ADWF.

The primary effluent flows via gravity to the four distribution arms of the rotating effluent distributor via the dosing syphon. Flow passes through the nozzles along each arm and onto the surface of the BTF. The primary effluent then percolates through the filter media. The settled sewage is treated in the BTF by aerobically converting the soluble and colloidal organic matter into settleable solids.

The BTF is an octagonal structure with a diameter of approximately 7 m (side width 3 m) filled with rock filter media to a depth of 2 m. There are ventilation ports at the base of the BTF. The filter media is rock (rock size is approx. 10cm across).

The biomass on the surface of the trickling filter needs to be controlled by washdown so that it does not become thick enough to cause blockages. When the biofilm has visibly become thick enough to cover more than ten percent (10%) of the spaces between the rock media at the surface, the surface will need to be washed down.

The nozzles on the distributor arms need to be kept clear and will require cleaning on an as needed basis as determined by regular inspection of the evenness of flows from the nozzles of the distributor arms.

1.3.4 First Humus Tank

Effluent from the BTF flows under gravity to the humus tank. The humus settles by gravity and the effluent flows over the weir into the launder. The humus tank has a diameter of 5 m and a depth of 2.2 m. The humus tank has internal sludge scrapers.

There is a line from the underflow of the humus tank to the humus pump. The humus pump is controlled by a timer and operates for 30 minutes every hour to remove humus from the humus tank. The humus is pumped into the inlet line: i.e. the discharge of the inlet pumps and the discharge of the humus pump share a common line to the inlet channel.

A humus tank while analogous, is not the same as a secondary clarifier on an activated sludge plant. It is not necessary to continually remove solids from the bottom. The solids should only require removal once or twice a day.

The purpose for the recycle from the underflow of the humus tanks is to keep the trickling filters wet during extended periods of no flow during hot weather and to capture the solids settled in the humus tank to send them to the digesters via the PST.

If the majority of the solids in the primary tank are removed prior to operating the humus return flow, then it is possible to also achieve a level of de-nitrification in the primary tank during those periods using the dissolved organics within the PST.

The total daily humus flow back to the inlet works should be restricted to 4 L/s with the larger pump and 3 L/s with the smaller pump when it is installed. This flow is controlled manually by restriction of the valves on the discharge of the humus pump.

1.3.5 Second BTF and HT

Effluent from the first humus tank flows into the second dosing syphon. The second syphon performs the same function as the first: it passes flow to either the second BTF, or bypasses the BTF and allows flow to the second humus tank. The second dosing syphon, BTF and humus tank dimensions are identical to the first. The purpose of the second BTF and humus tank is to provide further BOD reduction and SS removal. During warmer weather the second trickling filter is also able to provide ammonia oxidation due to the lower carbon loading compared to the first BTF.

The humus pump draws from the first humus tank for 24 hours, then from the second for the next 24 hours and so on. The flow path is changed manually (valve operation) every day by the operator. This method should be modified according to the weather and loading conditions. The second humus tank will contain nitrate during the warmer weather. Therefore the first humus tank should be the first tank to be drawn from each day. This will reduce the floating solids in the primary tank, allowing the solids to be cleared prior to using the nitrate containing underflow from the second humus tank. The timing should be adjusted such that the humus flow is intermittent and only sufficient to keep the trickling filter wet. The suggested starting regime is half an hour on each hour. The first humus tank should only be pumped once per day and the rest of the flow for the day from the second HT. If the issue of floating solids in the primary tank persists, then reverse the procedure for operating the humus tanks, and draw down the second humus tank half an hour prior to removing the solids from the primary tank.

1.3.6 Chlorine Dosing and Contact Tank

The effluent from the second humus tank flows under gravity to the chlorine contact tank. Sodium hypochlorite is added to the secondary treated effluent from the second humus tank at the head of the contact tank at an operator set constant dose rate. The contact tank contains baffles to provide adequate mixing as well as to provide a uniform contact time for effluent passing through the tank.

The volume of the contact tank is 19.5 m^3, providing an average contact time of 3 hours .

The contact tank is cleaned 3 times per week by the plant operator by hosing. During cleaning the discharge of the contact tank can be directed to the inlet wet well.

Effluent flow is measured by a v-notch weir and ultrasonic level detector. The ultrasonic level detector area should be kept clear of return flows from the sensors. These flows can cause false reading for the flow measurement.

1.3.7 Recycled Water

Recycled water is removed from the contact tank immediately prior to the V-notch weir (there is a pump in the contact tank). Sodium hypochlorite is added to the recycled water on removal from the contact tank. The sodium hypochlorite flow rate is set by the operator and only operates on the start of the reuse pump. The recycled water is pressure filtered through a sand filter and then stored in three 20 kL tanks. The recycled water is pumped from the storage tanks to the recycled water customer (Esk Golf Course). The recycle water pump is used to backwash the sand filter. The sand filter backwash discharges into the inlet wet well.

1.3.8 Effluent Discharge

Treated effluent is released from Esk STP to Sandy Creek.

1.3.9 Anaerobic Sludge Digesters

There are two open-top anaerobic sludge digesters at Esk STP. Settled sludge and scum from the PST are collected in the sludge pit adjacent to the PST. The sludge pit drains to the anaerobic digesters by gravity. The sludge and scum are directed to a single digester for a week, then to the other digester the following week and so on. The operator changes the line-up via manual valves.

When the solids are released to the anaerobic digesters, the mixer in the anaerobic digester to which the solids have been added should be turned on for twenty minutes following the addition and then turned off. This is to provide contact between the new solids and the digesting solids. This will aid settling of the new solids. Supernatant can be decanted from the digester an hour after the mixing is complete.

Each digester has a diameter of 4 m and a volume of approximately 40 m^3. The anaerobic digester is not provided with heating facilities. Each digester has a submerged mixer. Hence, it provides only limited sludge stabilisation.

Supernatant drawn from the digester to the inlet wet well periodically via the manual decant valves on each digester.

Digested sludge is removed by tanker approximately once every 4 weeks when arranged by the plant operator. The sludge is transported by road tankers to Bundamba STP.

1.4 Main Site Considerations

The main considerations for the site are:

- Sodium Hypochlorite dosing – there is no redundancy in this system, i.e. there is only a single dosing pump to each dosing point with no standby.
- The humus pump is oversized and flow has to be controlled manually by the site operator restricting the valve on the discharge of the pump. This causes damage to the valve and uses excess power.
- Operator safety:
    - screens are manually raked, increasing the risk of operator contact with raw sewage

- operator often works alone
- high levels of H_2S are released when sludge is removed from the PST. The valve is manually operated and requires the operator to lean over the well, resulting in exposure of the operator to high levels of H_2S.

1.5 Daily Inspections

The following activities are carried out by the plant operator on a regular basis.

1.5.1 Inlet Screens

Esk STP inlet works currently consists of an inlet channel containing manually raked screens. As the screens are not automatic, they require raking by the plant operator.

1.5.2 Daily Readings

As there is no SCADA system at Esk, any recording of data is done manually by the operator. On a daily basis the operator records the following in the Excel Log Sheet for Esk STP:

- Influent flow rates
- Effluent flow rates
- Volume of tankered waste received
- Recycled water flow to on site storage
- Influent and humus pump run hours
- Humus pump flow
- Recycled water pump flow to customer and pump run hours
- Volume of sludge removed
- Electricity Consumption
- Volume of sodium hypochlorite consumed
- Effluent pH, DO and free Chlorine
- Weekly tests of effluent SS, Ammonia, Nitrates and Phosphates

1.5.3 Equipment Condition

The operator walks the plant and visually inspects all equipment daily. Including:

- All pumps to ensure they are running without fault
- Integrity of all tanks, channel and pipework to ensure there are no leaks
- Condition/movement of trickling filter arms

1.5.4 Sodium Hypochlorite Inventory

The operator checks the volume of sodium hypochlorite on site and re-orders as required.

1.5.5 Sludge Removal

The operator monitors the condition of the digester by visual observation of tank level and supernatant appearance. The operator organises tankers to remove sludge from the site as required.

2 ESK STP FUNCTIONAL SPECIFICATION

2.1 Preliminary Treatment Area

2.1.1 Process Description

The sewage from the catchment is received at site in the inlet pump station wet well. The sewage or influent is then pumped to the inlet works where the flow is treated by a series of manually raked screens of reducing aperture.

Prior to the first screens the flow splits into two channels. Each channel has the first manually raked screen with an average aperture of 38 mm followed soon after by the second manually raked screen with an average aperture of 23 mm. The channels then continue and act as grit channels to settle grit from the influent.

Following the grit removal, the channels combine again and pass through a single manual screen with an average aperture of 12 mm.

Tanker deliveries of sullage waste are received at the inlet channel prior to the first screens.

Tanker deliveries of septic waste are received at the inlet works in a separate manually screened receival facility. The tanker is connected by a flexible pipe with a camlock connection. The tanker pump empties the tanker into the receival facility.

There are two manually raked screens in series in the tanker receival facility. The first has an average aperture of approximately 50 mm for the first and 38 mm for the second screen.

The septic tanker receival facility discharges directly into the well which gravitates to the anaerobic digesters.

2.1.2 Reference Drawings

2.1.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.1.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.1.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.1.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION DIAGRAM (GENERAL)

2.1.3 Equipment

Equipment listed for the humus de-sludge pump is listed in section 3.4.3.

2.1.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
PU-2000-001	Influent pump number 1
PU-2000-002	Influent pump number 2

2.1.3.2 Uncontrolled Equipment

TAG NAME	DESCRIPTION
PK-2000-001	Primary tank desludging penstock
SC-2000-001	Inlet screen 1 [38 mm]
SC-2000-002	Inlet screen 2 [38 mm]
SC-2000-003	Inlet screen 3 [23 mm]
SC-2000-004	Inlet screen 4 [23 mm]
SC-2000-005	Inlet screen 5 [12 mm]
SC-2000-006	Inlet screen 6 [~ 50 mm]
SC-2000-007	Inlet screen 7 [~ 38 mm]

2.1.4 Instrumentation

TAG NAME	DESCRIPTION
LS-2000-001	Influent pump wet well multitrode level switch
PE-2000-001	Influent pump number 1 pressure gauge
PE-2000-002	Influent pump number 2 pressure gauge
FM-2000-002	Influent flow meter

2.1.5 Data Recording

Not applicable

2.1.6 Operation in Local Control Mode

Local control is selected at the Motor Control Centre (MCC) via a selector switch on the starter cell door located in the Inlet pump station. In this mode, pump operation is enabled via a Local Control Station (LCS) adjacent to the equipment using start and stop push buttons. All process interlocks are disabled in this mode. Only hard wired interlocks are still active. Local control status alarm will be indicated on the SCADA when this mode is selected.

2.1.6.1 Manual Mode

Both pumps PU-2000-001 and PU-2000-002 can be individually switched to manual mode by individual switches on the door of the MCC.

In manual mode each pump is controlled by separate on and off switches for each pump.

When a pump is turned on by pressing its on switch, the pump will run until its stop switch is pressed.

When the stop switch is pressed the related pump is to stop.

The pump selected in auto mode on the MCC panel is to start when the level switch LS-2000-001 registers a high level.

The pump runs at a constant speed until the level switch LS-2000-002 registers a low level and then the pump stops.

2.1.7 Operation in Remote Manual Control Mode

Not applicable

2.1.8 Operation in Auto

2.1.8.1 Inlet Pump Station - inlet pumps

There are ten levels on the multitrode level switch LS-2000-001 in the inlet pump station wet well which control the operation of the inlet pumps. The duty inlet pump may be selected manually on the MCC panel in the inlet pump station. The duty pump is rotated on a daily basis. Alternatively, the duty alternate switch on the switchboard may be used to cause the duty pump to alternate after each run.

Currently only three levels are used within the pump control. When the level in the wet well rises to activate the high level on level switch LS-2000-001, the duty pump starts and runs until the level in the wet well drops sufficiently to activate the low level on level switch LS-2000-001 to stop the duty pump. If during the operation of the single pump, the level in the inlet wet well continues to rise until it reaches the assist level, the second pump will start and both pumps run until the wet well drops sufficiently to activate the low level on level switch LS-2000-001 to stop both pumps.

The plant is typically set to operate in single pump mode as the flow rate with both pumps operating exceeds the hydraulic capacity of the plant.

The levels for the control can be set between the multitrode levels. The levels are believed to be 150 mm apart.

2.1.8.2 Inlet Pump Station - humus de-sludge pump

The humus de-sludging pump operates on a timer control TS-2000-001 which can be set to time intervals from 15 minutes. The timer is to be set for time period on and time period off. The operation of this pump is described in section 2.3.1.

2.1.9 SCADA Operator Adjustable Setpoints

Not applicable.

2.1.10 PLC Adjustable Parameters

Not applicable.

2.1.11 Interlocks

Not applicable.

2.1.12 SCADA Alarms

Not applicable.

2.1.13 History

Not applicable.

2.1.14 Start-up, Operation and Shutdown

2.1.14.1 Start up

To start the inlet works section all the plant must be available or the unavailable units bypass manually set.

The selected duty pump is switched to auto.

2.1.14.2 Operation

The duty pump is to be rotated periodically.

2.1.14.3 Shutdown

Prior to shutting down the preliminary treatment area, the pump wet well must be isolated and all flows into the wet well from the catchment diverted to the emergency storage. Once the wet well is isolated, turn all pumps to off.

2.2 Primary and Sludge Treatment

2.2.1 Process Description

Screened raw sewage from the preliminary treatment area flows to the primary settlement tank (PST) CLF-2000-001 under gravity. The sewage discharges into a small stilling chamber in the centre of the PST prior to flowing downwards into the clarification zone.

The clarified liquid phase becomes the primary settled sewage and passes over the overflow weir into the collection launder. Primary settled sewage in the collection launder flows to a discharge point from where it gravitates to the dosing syphon SYP-3000-001 for trickling filter RCT-3000-001.

The heavy solids settle to the bottom of the PST where they are scraped by the scraper into the central sludge hopper. The primary solids are drained when the timer switch TS-2000-001 on the actuator on penstock PK-2000-001 opens the penstock to allow the solids to flow by gravity to the selected anaerobic digester, either RCT-6000-001 or RCT-6000-002. The timer on the actuator on the penstock PK-2000-001 has two (2) functions. When the penstock closes, the timer starts and runs for an operator set duration. If no flow signal is received from flow meter FIT-4000-001 before it expires, the timer will expire and cause the actuator on the penstock to open the penstock. The second function of the timer is activated and the timer will then run for an operator set period. When the timer expires it causes the penstock to be closed. If a flow signal is received from flowmeter FIT-4000-001 during the running of the first function of the timer, the timer will stop and reset. The timer will start again when a zero flow signal is received from flowmeter FIT-4000-001. The operator set period for the first function should be sufficiently long so that it is longer than the period typically required for the inlet wet well to fill to a pump start level during a peak flow period. Alternatively, the actuator on the penstock PK-2000-001 can be set to operate at set times of the day for set intervals, both of which are to be set and controlled through the PLC and timer TS-2000-001.

The duty anaerobic digester is selected by manual operation of the three way valve V-6000-007. The duty anaerobic digester is changed over once per week by the operator.

If the level switch in the duty anaerobic digester, either LS-6000-001 or LS-6000-002, registers a H2 high level, an alarm is raised. If both LS-6000-001 and LS-6000-002 register H2 high levels, then the operation of PK-2000-001 is inhibited. The activation of H1 high level switch on either anaerobic digester level switch enables the operation of PK-2000-001 the next time it is called to operate by the timer TS-2000-001.

The operator is to manually operate the anaerobic digester mixer, either MX-6000-001 or MX-6000-002, in the duty anaerobic digester for twenty minutes per day. The mixer is then to be manually turned off. The solids are to be allowed to settle for at least one hour prior to decanting the supernatant.

The supernatant from the anaerobic digesters is decanted using the manually operated decant valves V-6000-001, V-6000-002, V-6000-003, V-6000-004, V-6000-005, V-6000-006. The decanting should be conducted from the highest submerged valve. The operator should avoid using a decanting valve submerged by high solids content liquor where practical. The decanting is to continue until most of the clarified liquid above a valve not contacting solids has been removed.

2.2.2 Reference Drawings

2.2.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.2.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.2.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.2.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION DIAGRAM (GENERAL Proposed)

2.2.3 Equipment

2.2.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
PK-2000-001	PST Sludge Penstock

2.2.3.2 Uncontrolled Equipment

TAG NAME	DESCRIPTION
V-6000-007	Digester selection 3 way valve
MX-6000-001	Anaerobic digester 1 mixer
MX-6000-002	Anaerobic digester 2 mixer
V-6000-001	Decant valve digester 1
V-6000-002	Decant valve digester 1
V-6000-003	Decant valve digester 1
V-6000-004	Decant valve digester 2
V-6000-005	Decant valve digester 2
V-6000-006	Decant valve digester 2

2.2.4 Instrumentation

TAG NAME	DESCRIPTION
FIT-4000-001	Flow meter (ultrasonic + weir) in chlorine contact tank overflow
TS-2000-001	Timer switch controlling PK-2000-001
LS-6000-001	Anaerobic digester 1 level switch pump
LS-6000-002	Anaerobic digester 2 level switch pump

2.2.5 Data Recording

Not applicable.

2.2.6 Operation in Local Control Mode

The actuator on the penstock PK-2000-001 can be set to manual on the local control panel.

When the actuator is set to manual, the penstock PK-2000-001 can be opened using the local control panel.

When the actuator is set to manual, the penstock PK-2000-001 can be closed using the local control panel.

2.2.7 Operation in Remote Manual Control Mode

There is no remote manual controlled equipment in this area.

2.2.8 Operation in Automatic

The removal of the solids from the bottom of the primary settlement tank CLF-2000-001 is controlled by operation of the penstock PK-2000-001. This penstock is controlled by the timer switch TS-2000-001and the flow signal from FIT-4000-001. The operation of the penstock can be inhibited by level switches LS-6000-001 and LS-6000-002.

If both the anaerobic digester level switches LS-6000-001 and LS-6000-002 register a H2 high level, the operation of the penstock PK-2000-001 is inhibited. The operation

of the penstock PK-2000-001 is inhibited until either LS-6000-001 or LS-6000-002 registers a H1 high level. The levels H1 and H2 are to be operator adjustable, however, the input interface is to ensure that H1 is lower than H2.

There are to be two methods of operating in auto:

1. The signal to open the penstock actuator is taken from the PLC by measuring flow at flow meter FIT-4000-001. When flow is measured by FIT-4000-001 the PLC checks for when the flow stops. When the flow at FIT-4000-001 is detected to be zero, PLC programmed time switch TS-2000-001 is activated for an operator set interval between zero and two hundred and forty (240) minutes. If the timer expires without a new flow event being registered by FIT-4000-001, then a signal is generated to open the penstock PK-2000-001. If a flow event is recorded before the timer is expired, then the timer TS-2000-001 is stopped and reset to zero when the flow at FIT-4000-001 is detected to be zero.
2. Alternatively, the actuator on the penstock PK-2000-001 can be set to operate at set times of the day for set intervals, both of which are to be set and controlled through the PLC and timer TS-2000-001, independent of any flow signal received from FIT-4000-001.

The duration of the opening of penstock PK-2000-001 is controlled by the timer TS-2000-001 which has an operator set duration from zero to twenty minutes in intervals that allow for durations to be set in minutes and seconds.

2.2.9 SCADA Operator Adjustable Setpoints

Not applicable.

2.2.10 PLC Adjustable Parameters

PARAMETER			ADJUSTABLE RANGE		INITIAL VALUE	ACCESS LEVEL
Tag	Descriptor	Unit	Min	Max		
T1	Time before PK-2000-001 operation	min	0	240	60	
T2	Duration of PK-2000-001 opening	min	0	20	5	
H1	Clear anaerobic digester high level inhibit	mm	2m from top of tank	1m from top of tank	1.5m from top of tank	
H2	Anaerobic digester high level inhibit	mm	1.5m from top of tank	0.5m from top of tank	1m from top of tank	

2.2.11 Interlocks

RELATED PROCESS	EVENT	ACTION
Opening penstock PK-2000-001	High level H2 in both digesters	Stop penstock PK-2000-001 from opening

2.2.12 Alarms

TAG NAME	DESCRIPTION	SCADA PRIORITY
RCT-6000-001 on LS-6000-001	High level H2	N/A
RCT-6000-002 on LS-6000-002	High level H2	N/A

2.2.13 History

Not applicable.

2.2.14 Start-up, Operation and Shutdown

Not applicable

2.3 Biological Treatment

2.3.1 Process Description

Primary effluent from the primary settlement tank flows to dosing syphon SYP-3000-001 which causes a set volume of primary effluent to accumulate in the syphon chamber prior to causing the syphon chamber to empty to the trickling filter distribution arm TFA-3000-001 for distribution.

The flow of the primary effluent from the dosing syphon causes the distributor arm TFA-3000-001 to rotate by hydraulic mechanical drive. The rotating distributor arm distributes the primary effluent across the top of the trickling filter via nozzles in the distributor arms.

The primary effluent flows down through the media of the trickling filter RCT-3000-001. The flow wets a biofilm that grows on the media, providing nutrients to the biofilm which converts the carbon for energy and biomass as well as taking up nutrients for growth. Excess biofilm is washed off (usually referred to as sloughing off) as the biomass becomes too thick and an anaerobic layer forms.

The solids are washed into the humus tank CLF-3000-001 where they settle and are separated from the treated liquid flow.

The action of the water passing through the media causes a temperature difference in the air voids and hence causes an air flow from the spaces at the bottom of the trickling filter which allows the air to escape through the top surface.

Both these actions are impaired by excess biomass build up on the surface of the trickling filter media. When the biofilm has visibly become thick enough to cover more than ten percent (10%) of the spaces between the rock media at the surface, the surface will need to be washed down.

The stage one treated secondary effluent from humus tank CLF-3000-001 flows to dosing syphon SYP-3000-002 which causes a set volume of stage one treated secondary effluent to accumulate in the syphon chamber prior to causing the syphon chamber to empty to the trickling filter distribution arm TFA-3000-002 for distribution.

The flow of the stage one treated secondary effluent from the dosing syphon causes the distributor arm to rotate by hydraulic mechanical drive. The rotating distributor arm distributes the stage one treated secondary effluent across the top of the trickling filter via nozzles in the distributor arms.

The stage one treated secondary effluent flows down through the media of the trickling filter RCT-3000-002. The flow wets a biofilm that grows on the media, providing nutrients to the biofilm which converts the carbon for energy and biomass as well as taking up nutrients for growth. The stage one treated secondary effluent has a lower carbon content than the primary effluent. Therefore nitrifying organisms are able to compete with carbon oxidising bacteria where the carbon concentration becomes sufficiently low. This allows the nitrifying organism to convert some of the ammonia to nitrate. This is more active during warm weather when all the biomass including the nitrifying bacteria grow faster.

Excess biofilm is washed off (usually referred to as sloughing off) as the biomass becomes too thick and an anaerobic layer forms.

The solids are washed into the humus tank CLF-3000-002 where they settle and are separated from the treated liquid flow.

The solids from both humus tanks CLF-3000-001 and CLF-3000-002 are returned to the inlet works by manual selection of each humus tank using V-2000-009 and timer control of the humus pump PU-2000-003. The selection of the duty humus tank is changed every 24 hours.

The humus tank underflow from humus tank CLF-3000-002 will contain nitrate during warm weather. The nitrate in the humus tank underflow will denitrify in the primary tank. If the primary tank contains significant solids, the nitrogen formed during de-nitrification will form bubbles on the solids and cause them to float to the surface. If this is allowed to happen, the solids can overflow the weir and cause overloading of the first trickling filter. If this becomes a problem, the trickling filters should be kept moist using the underflow of the first humus tank CLF-3000-001 during the hottest parts of the day.

The clarified effluent from the humus tank CLF-3000-002 overflows the weir and flows by gravity to the chlorine contact tank TK-4000-003.

2.3.2 Reference Drawings

2.3.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.3.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.3.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.3.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION

	DIAGRAM (GENERAL)

2.3.3 Equipment

2.3.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
PU-2000-003	Humus tank de-sludging pump

2.3.3.2 Uncontrolled Equipment

TAG NAME	DESCRIPTION
RCT-3000-001	Trickling filter 1 [distribution arm]
CLF-3000-001	Humus tank 1 [scraper]
RCT-3000-002	Trickling filter 2 [distribution arm]
CLF-3000-002	Humus tank 2 [scraper]

2.3.4 Instrumentation

TAG NAME	DESCRIPTION
PE-2000-003	Humus tank de-sludging pump pressure gauge
FIT-2000-001	Humus tank de-sludging pump flow meter
TS-2000-002	Humus tank de-sludging pump timer switch

2.3.5 Data Recording

Not applicable

2.3.6 Operation in Local Control Mode

The Humus tank de-sludging pump can be selected into local mode on the MCC panel in the inlet pump station building. The pump can be set to on and will run continuously.

The humus tank being de-sludged is manually selected by valve V-2000-005.

2.3.7 Operation in Remote Manual Control Mode

Not applicable

2.3.8 Operation in Auto

The humus tank de-sludging pump PU-2000-003 is controlled to turn on and off by the timer switch TS-2000-002.

Timer switch TS-2000-002 is a twenty four hour timer which is separated into fifteen minute intervals. Each separate fifteen minute interval can be manually set to either allow the pump to run or cause it to stop for that 15 minute interval (see existing timer switch for existing humus pump).

The flow rate F1 as measured by the flow meter FIT-2000-001 can be set in the PLC. The flow rate range available is determined by the pump and the variable speed drive (VSD) supplied. The flow rate is set by the operator to match the requirements of the plant. It is anticipated that a flow rate of the average dry weather flow should be sufficient for all purposes.

The operator manually selects the humus tank being de-sludged by operating valve V-2000-005. The humus tank selected is changed on a 24 hour basis.

2.3.9 SCADA Operator Adjustable Setpoints

Not applicable.

2.3.10 PLC Adjustable Parameters

PARAMETER			ADJUSTABLE RANGE		INITIAL VALUE	ACCESS LEVEL
Tag	Descriptor	Unit	Min	Max		
F1	Humus Flow set point	L/s	1	12	4	

2.3.11 Interlocks

Not applicable.

2.3.12 SCADA Alarms

TAG NAME	DESCRIPTION	SCADA PRIORITY
Not applicable		

2.3.13 History

TAG NAME	DESCRIPTION	SAMPLE TIME
Not applicable		

2.3.14 Start-up, Operation and Shutdown

Not applicable

2.4 Disinfection System

2.4.1 Process Description

The disinfection system consists of a sodium hypochlorite storage tank TK-4000-001 within a bund TK-4000-002, two dosing pumps PU-4000-001 and PU-4000-002 and a chlorine analyser ACT-4000-001. The two pumps are both duty only and dose to different points.

Dosing pump PU-4000-001 doses at a constant rate to the inlet of the chlorine contact tank. The dosing rate is manually adjusted by the operator to maintain a chlorine residual greater than 0.1 mg/L and less than 0.7 mg/L as free chlorine measured by the chlorine analyser ACT-4000-001.

Dosing pump PU-4000-002 doses at a constant rate to the inlet of the sand filter and starts on the start signal for the sand filter feed pump PU-4000-003. The pumping rate of dosing pump PU-4000-002 is manually adjusted by the operator.

The chlorine contact tank has a v-notch weir and ultrasonic level device to measure the flow from the plant to the discharge to Sandy Creek. The instantaneous flow is recorded at 15 minute intervals.

The effluent is sampled from the chlorine contact tank by auto-sampler AS-4000-001. The auto-sampler has its own control unit that takes samples based on a timer control and a self-contained sampling pump.

Deliveries of sodium hypochlorite are requested by the operator when the reading in the sight glass for tank TK-4000-001 reaches a defined low level which may vary from time to time depending upon season demand and delivery timing.

2.4.2 Reference Drawings

2.4.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.4.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.4.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.4.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION DIAGRAM (GENERAL)

2.4.3 Equipment

2.4.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
AS-4000-001	Auto-sampler for effluent sampling

2.4.4 Uncontrolled Equipment

TAG NAME	DESCRIPTION
PU-4000-001	Chlorine tank dosing pump
PU-4000-002	Sand filter chlorine dosing pump

2.4.5 Instrumentation

TAG NAME	DESCRIPTION
ACT-4000-001	Chlorine analyser in chlorine contact tank
FM-4000-001	Flow meter (ultrasonic + weir) in chlorine contact tank overflow

2.4.6 Data Recording

The instantaneous flow measurement is recorded from flow meter FIT-4000-001 at 15 minute intervals to the RTU.

The free chlorine level at the end of the chlorine contact tank is measured continuously by the chlorine analyser ACT-4000-001 and displayed on the interface in the inlet pump station as well as recorded to the RTU at 15 minute intervals.

The auto-sampler AS-4000-001 operates on a timer with its own sampling pump. The pump starts at fifteen minute intervals and runs for an operator set time to transfer a set volume of effluent to the sample bottle.

2.4.7 Operation in Local Control Mode

Not applicable

2.4.8 Operation in Remote Manual Control Mode

Not applicable

2.4.9 Operation in Auto

Not applicable

2.4.10 Start-up, Operation and Shutdown

Not applicable

2.5 Recycled Water Systems

2.5.1 Process Description

Recycled water is supplied to a holding tank at the golf course by the reuse water transfer pump PU-5000-001, or to tankers via a camlock pipe connection at the reuse water storage tank.

Recycled water is taken from the end of the chlorine contact tank and pumped to a sand filter. The feed to the sand filter is dosed with sodium hypochlorite prior to the sand filter. The filtered water is then delivered to the recycled water storage tank TK-5000-001 without further pumping.

The recycled water is operated on level switches in the chlorine contact tank TK-4000-003 and in the recycled water storage tank TK-5000-001 and a timer.

The hypochlorite dosing pump PU-4000-002 dosing sodium hypochlorite to the sand filter is linked to the sand filter feed pump PU-4000-003 and only operates when the sand filter feed pump is operating.

The recycled water pump PU-5000-001 operates on a timer and level switches in the holding tank at the golf course and the recycled water storage tank TK-5000-001. The pump is inhibited from operating on a low level switch in the recycled water storage tank or a flow switch in the pump feed line.

The recycled water pump PU-5000-001 also acts as the sand filter FLT-5000-001 backwash pump. Backwash is instigated by a differential pressure reaching a set value by comparing the readings of pressure sensor PIT-5000-001 and pressure sensor PIT-5000-002.

The recycled water is tested in the laboratory for total and free chlorine levels, E.Coli and Faecal coliform counts once per week. The results are used by the operator to make a judgement on the dose rate of sodium hypochlorite to the sand filter feed line.

2.5.2 Reference Drawings

2.5.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.5.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.5.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.5.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION DIAGRAM (GENERAL)

2.5.3 Equipment

2.5.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
PU-4000-003	Sand filter feed pump
PU-5000-001	Reuse water transfer pump

2.5.3.2 Uncontrolled Equipment

TAG NAME	DESCRIPTION
FLT-5000-001	Reuse water sand filter

2.5.4 Instrumentation

TAG NAME	DESCRIPTION
FI-5000-001	Flow meter reuse water to dam
FI-5000-002	Flow meter reuse water to tankers
FS-5000-001	Flow switch protection on reuse water pump
LS-5000-002	Level switch in reuse water tank TK-5000-001

2.5.5 Data Recording

Not applicable.

2.5.6 Operation in Local Control Mode

The sand filter is manually backwashed by manually stopping the sand filter feed pump PU-4000-003 and operating the recycled water pump PU-5000-001 in manual mode after closing valve V-5000-003 and opening valve V-5000-004. The sand filter is returned to service by returning the recycled water pump to automatic control, closing valve V-5000-004 and opening valve V-5000-003, then returning pump PU-4000-003 to automatic control.

2.5.6.1 Manual Operation Actions

The sand filter feed pump PU-5000-001 can be selected into manual mode by the switch on the local panel.

In manual mode the sand filter feed pump PU-5000-001 starts when the start button on the local panel is pressed then continues to run.

In manual mode the sand filter feed pump PU-5000-001 stops when the stop button on the local panel is pressed.

In manual mode the sand filter feed pump PU-5000-001 stops when the flow switch FS-5000-001 detects no flow.

2.5.7 Operation in Remote Manual Control Mode

Not applicable.

2.5.8 Operation in Auto

2.5.8.1 Recycled Water

The sand filter feed pump PU-4000-003 is controlled by two level switches, being the level switch LS-5000-001 in the recycled water tank TK-5000-001 and the level switch LS-4000-001 in the chlorine contact tank TK-4000-003.

The sand filter feed pump runs in automatic mode until it is inhibited by either the high level switch in the recycled water tank or the low level switch in the chlorine contact tank. The pump commences running when the low level on LS-5000-001 is active and the high level on LS-4000-001 is active.

The recycled water pump PU-5000-001 operates when the timer TS-5000-001 allows pumping, the low level switch in the holding tank at the golf course is active and it is not inhibited by the low level switch LS-5000-002 in the recycled water holding tank TK-5000-001. The recycled water pump operates until either the high level switch in the holding tank at the golf course is activated, the low level switch in the recycled water tank is activated or the timer expires.

The recycled water pump PU-5000-001 operates as the sand filter backwash pump when the pressure differential between pressure sensors PIT-5000-001 and PIT-5000-002 reaches an operator set difference.

2.5.8.1.1 Auto Operation Actions

The timer TS-5000-001 is set to enable QUU to take advantage of the night time power tariff for the pumping of the recycled water.

The sand filter feed pump PU-4000-003 can be selected into auto mode by the switch on the local panel.

When the sand filter feed pump PU-4000-003 is in auto mode it is controlled by two level switches LS-4000-001 and LS-5000-001.

If level switch LS-4000-001 low level has not been activated and level switch LS-5000-001 high level has not been activated, then the sand filter feed pump PU-4000-003 pumps to the sand filter FLT-5000-001.

If level switch LS-4000-001 low level is activated or if level switch LS-5000-001 high level is activated then the sand filter feed pump PU-5000-001 stops.

The sand filter feed pump PU-4000-003 is prevented from restarting once it has been stopped until

- if level switch LS-4000-001 low level has been activated, when level switch LS-4000-001 high level is activated and level switch LS-5000-001 high level is not activated
- if level switch LS-5000-001 high level is activated, when level switch LS-5000-001 low level is activated and level switch LS-4000-001 low level is not activated

If the differential between the pressure sensors PIT-5000-001 and PIT-5000-002 reaches an operator set difference the sand filter feed pump PU-4000-003 is to stop. The recycled water pump PU-5000-001 is to be stopped. Motorised valves V-5000-001 and V-5000-003 are to close. Motorised valves V-5000-004 and V-5000-005 are to be opened. The recycled water pump PU-5000-001 is to restart and provide backwash flow to the sand filter for an operator set time.

2.5.9 SCADA Operator Adjustable Setpoints

Not applicable.

2.5.10 PLC Adjustable Parameters

Not applicable.

2.5.11 Interlocks

RELATED PROCESS	EVENT	ACTION
Sand filter backwash	No flow	Stop pump PU-5000-001

2.5.12 SCADA Alarms

TAG NAME	DESCRIPTION	SCADA PRIORITY
Not applicable		

2.5.13 History

TAG NAME	DESCRIPTION	SAMPLE TIME
Not applicable		

2.5.14 Start-up, Operation and Shutdown

2.5.14.1 Start up

On start up the integrity of the tanks and manual valve positions must be checked to ensure they are correctly aligned and the tank integrity is sound.

When valves are confirmed as correctly aligned, switch the sand filter feed pump PU-5000-001 to auto on the MCC panel.

2.5.14.2 Operation

Follow description of operation for filter backwash described in section 2.5.4. For normal operation the system is to remain in automatic operation.

2.5.14.3 Shutdown

To shutdown the reuse water plant, set the sand filter feed pump PU-5000-001 to off at the MCC panel.

2.6 Outfall

2.6.1 Process Description

Under normal operating conditions, Esk STP discharges excess water that is not required for recycling to the Sandy Creek Discharge.

2.6.2 Reference Drawings

2.6.2.1 Civil Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.6.2.2 Mechanical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.6.2.3 Electrical Drawings

DRAWING NUMBER	DESCRIPTION
No reference available	

2.6.2.4 Process and Instrumentation Drawings

DRAWING NUMBER	DESCRIPTION
	ESK STP PIPING & INSTRUMENTATION DIAGRAM (GENERAL)

2.6.3 Equipment

2.6.3.1 Controlled Equipment

TAG NAME	DESCRIPTION
Not applicable	

2.6.3.2 Uncontrolled Equipment

TAG NAME	DESCRIPTION
Not applicable	

2.6.4 Instrumentation

TAG NAME	DESCRIPTION
FIT-4000-001	Chlorine contact tank overflow Flow Indicating Transmitter

2.6.5 Data Recording

Not applicable

2.6.6 Operation in Local Control Mode

Not applicable

2.6.7 Operation in Remote Manual Control Mode

Not applicable

2.6.8 Operation in Auto

Not applicable

2.6.9 SCADA Operator Adjustable Setpoints

PARAMETER			ADJUSTABLE RANGE		INITIAL VALUE	ACCESS LEVEL
Tag	Descriptor	Unit	Min	Max		

2.6.10 PLC Adjustable Parameters

PARAMETER			ADJUSTABLE RANGE		INITIAL VALUE	ACCESS LEVEL
Tag	Descriptor	Unit	Min	Max		

2.6.11 Interlocks

RELATED PROCESS	EVENT	ACTION
Not applicable		

2.6.12 SCADA Alarms

TAG NAME	DESCRIPTION	SCADA PRIORITY
Not applicable		

2.6.13 History

TAG NAME	DESCRIPTION	SAMPLE TIME
Not applicable		

2.6.14 Start-up, Operation and Shutdown

Not applicable

APPENDIX A
P&ID GENERAL