Article 12 (Part 3)
Section D.2: Operation &
Section F: Treatment, Abatement & Control

Note: All drawings referred to in this section of the response are included at the rear of this document, in the order in which they are referred to. However, drawings or attachments that may have been already referenced in Part 2 of the response, are included in Part 2 and not duplicated in this section

(a) For the Wastewater Treatment process, provide the following details:

(i) For each process step provide details of capacity and design criteria

The process steps for the wastewater treatment process are as follows (again, it should be noted that it is only the sludge treatment works (post Picket Fence Thickener) that is the licenceable activity and all other information given is for the purpose of providing a comprehensive overview of the overall WWTP operations):

Primary Treatment

- Flow (sewage) arrives to Works inlet building
- Sewage is screened automatic and manually raked screens prior to passing to grit traps
- Sewage passes to a distribution chamber where the flow is split between the two primary settlement tanks (PST)
- During storm conditions excess flow passes to the two storm tanks

Secondary Treatment

- Settled sewage flows to a selector tank and the Inclined Bubble Aeration (IBA) process
- Final settlement tanks separate the activated sludge flocs from the mixed liquor to produce settled effluent
- Settled effluent passes to the final effluent (FE) Sampling and Washwater Pumping Station prior to passing to outfall.
- Activated Sludge (RAS) is removed from the base of the Final Settlement Tanks (FST) and returned to the Selector Tank for mixing with the settled primary sewage
- This is introduced into the aeration tanks

Sludge Treatment

- The total sludge treated at the site consists of indigenous primary sludge from the Primary Settlement Tanks (PSTs) and surplus activated sludge from the Gravity Belt Thickener
- Primary sludge is thickened in a picket fence thickener and transferred to the sludge blending tank
- Activated sludge is thickened in the sludge building by a gravity belt thickener and transferred to the sludge blending tank
- Blended total sludge is pumped to the pasteurisation system
- Sludge is fed to the anaerobic digesters via the heat exchanger
- Sludge is transferred to sludge holding tanks
- Biogas generated within the digester is stored in a gas and is utilised to provide fuel to the boilers to heat the raw sludge

- The digested sludge flows by gravity to a digested sludge tank and pumped to sludge dewatering belt press streams
- Dewatered sludge cake is loaded into trailers/containers prior to being removed from site

Flow diagrams of the overall WWTP processes are shown in Drawings C1197-1001 and C1197-1005 and flow diagrams of the sludge treatment processes are shown in Drawings C1197-1002 and C1197-1006, as included with this response.

The capacity and design criteria are shown in the following Attachments for the sludge treatment part of the WWTP and for the non-licenceable section of the WWTP, for completeness:

Attachment C1197-8402	Screening and grit traps
Attachment C1197-8403	Primary Settlement Tank Design
Attachment C1197-8404	Activated Sludge Design (detailing the influent to the primary works and selector tank and IBA process)
Attachment C1197-8407	Settled Activated Sludge Production
Attachment C1197-8408	Picket Fence Thickener Design
Attachment C1197-8409	Gravity Belt Thickener Design
Attachment C1197-8420	Pasteuriser Design
Attachment C1197-8416	Heat Exchanger Design
Attachment C1197-8412/15	Anaerobic Digester Design (Sizing & Heat Loss)
Attachment C1197-8413/18	Biogas Equipment and Production
Attachment C1197-8410	Dewatering Belt Presses
Attachment C1197-8422	Liquor Return Sump

(ii) Provide details on influent monitoring, composite samplers and in-treatment monitoring required for management of the plant

The following areas/items of plant will be monitored (both flow and sampling unless shown otherwise) during the operation of the WWTP:

Primary Treatment

- Inlet channel & inlet works – raw sewage, screenings, grit (see Drawing C1197-2000)
- Inlet channel & post grit channel – screened sewage (see Drawing C1197-2000)

Secondary Treatment

- PST to Aeration chamber – settled sewage (see Drawing C1197-2006)
- Pre final effluent chamber & final effluent chamber – secondary effluent (see Drawing C1197-2020)
- Final effluent chamber – final effluent (see Drawing C1197-2000)
- At Selector tank – RAS to aeration selector tank (see Drawing C1197-3006)

Storm Flows

- After storm tanks – storm overflow to FE Chamber (see Drawing C1197-2002)

- At PST chamber – storm return (flow only) (see Drawing C1197-2004)

Sludge Treatment

- Settled sludge (PST to PFT)After primary pumps and at picket fence thickener (see Drawing C1197-3006)
- Emergency primary sludge holding tank – thickened primary sludge (see Drawing C1197-2008)
- Emergency secondary sludge holding tank – thickened secondary sludge (see Drawing C1197-2009)
- After dewaterer feed pump – stored digested sludge (see Drawing C1197-3006)
- Pasteuriser slab – pasteurised sludge and return from cooler (see Drawing C1197-3006)
- After PFT – Thickened primary sludge to sludge blending tank (see Drawing C1197-3006)
- Gravity Belt Thickener (GBT) – sludge blending tank (see Drawing C1197-3006)
- Pasteuriser Slab- blended sludge to pasteuriser (see Drawing C1197-2004)
- Digester to Digested sludge tank (see Drawing C1197-3006)
- Digested sludge tank to dewaterer (see Drawing C1197-2004)
- Sludge Cake Skip – final sludge product (see Drawing C1197-2011)
- Aeration tanks – mixed liquor (see Drawing C1197-1016)
- Sludge building – SAS to gravity belt thickeners, digested sludge to dewaterer, polymer use (see Drawing C1197-3006)

Other Flows

- Sludge building – liquor from gravity belt thickener (GBT) to Return Liquor chamber (see Drawing C1197-3006)
- Return liquor - at PST splitter (see Drawing C1197-2004)
- At liquor chamber – Return liquors (only sampling) (see Drawing C1197-1030)
- Inlet Works Building Odour Control Unit – inlet air and outlet air (see Drawing C1197-3006)
- Sludge Building Odour Control Unit – inlet air and outlet air (see Drawing C1197-3006)

Utilities

- Polymer dosing- sludge conditioning for dewatering- Sludge Building (see Drawing C1197-2011)
- Potable Water/Washwater (see Drawing C1197-2024)

Table 07_4084 3.a(ii) shows the monitoring and/or sampling that will be carried out during operation. The location of the monitoring is identified, with the measurement type, i.e. volumetric or flow rate, manual or auto-sampling for chemical or biological analysis. Also identified, where applicable, is the type of sampler to be used, size and equipment/sampler make or brand. The sampling interval for each one is given, ranging from continuous i.e. for volumetric measurements, flow rates at different parts of the plant, to daily or weekly, i.e. for chemical or biological analysis, to intermittently or spot checks.

In addition, the drawing reference for each drawing of where the sampling or monitoring point is located is provided in this table and the drawings showing these sampling/monitoring areas are included with this response.

(iii) Provide further details of sludge returns (SAS and RAS) including volume, removal rates, characteristics and controls

The sludge that will pass through the plant is as follows:

Sludge production is a percentage of the influent volume. The Plant is designed to cater for the maximum projected volume of influent in 25 years time.

Primary Sludge (as produced in the PST`s) - The projected maximum volume of primary (settled) sludge production is 6499 kg DS (Dry Solids)/day at a DS concentration of 3%, a density of 1009 kg/m^3 and a volume flow rate of 214.79 m^3/d. All based on the maximum projected inflow to the works in 25 years time.

Surplus Activated Sludge (SAS) - Sludge (activated sludge) produced in the final settlement tanks (part of the secondary treatment) is returned to the aeration tank inlet as it contains the bacteria for the aeration process. The rate of return of activated sludge (RAS) to the aeration tanks is determined by the dissolved oxygen demand of the settled sewage. Any activated sludge not required is therefore surplus (SAS) and is piped to the sludge treatment area where it is blended with the primary sludge and is therefore treated as part of the sludge treatment process.

The projected maximum volume of SAS production is 7748 kg DS/day at a DS concentration of 0.6%, a density of 1002 kg/m^3 and a volume flow rate of 1269 m^3/d.

Some details on RAS and SAS return can be seen in Attachment C1197-8404. However, these volumes and rates will not be available until the plant is commissioned as they are based on the quality of the sludges as settled in the Final Settlement Tanks (FST). These can be provided to the EPA as soon as they area available.

(iv) Provide further details of return liquors, including sources, volume, characteristics (including BOD load), return rates and controls. Provide details of the maximum volume and load to be returned to the WWTP

Return liquors arise from several discharge points within the works. Details of these return liquors are shown on Drawing C1197-1030, which is the P&ID for the liquor returns.

The liquor returns amount to an average of 185 m^3/hr for pump design purpose. This flow rate comprises the following:

- Odour control units 1 & 2 - indeterminate
- FST scum - 0.14m^3/hr
- Picket fence thickener - 29 m^3/hr
- Sludge tank overflows – as and when

- Gravity Belt Thickener - 111 m^3/hr max
- Digester holding tanks - as & when
- Gas condenser - 0.10 m^3/hr
- Polymer makeup overflow - 3.6m^3/hr
- Sludge dewatering - 58 m^3/hr

All these discharges are piped to (collected in) the Return Liquors pumping chamber tank (item 33 on Drawing No. C1197-3014). A duty pump (with standby) operates on float control to pump the contents to the splitter chamber at the inlet to the primary settlement tanks where they are mixed with the raw screened sewage for combined treatment in the PST`s .

The return liquors that are returned to the start of the wastewater treatment process, i.e. into the inlet works, are detailed in Attachment C1197-8404.

The return liquors load is as follows:

Return Liquors				
Load	**BOD kg/d**	**S.S kg/d**	**NH3**	**Flow l/s**
Average Load 2005	993	1153	135	21.3
Average Load 2025	1035	1127	135.0	28.0

(b) For the sludge treatment process, provide:

(i) Technical design specifications and operational details for each stage

The design specifications for the overall WWTP, including the sludge treatment, are detailed in Section 3.a(i). Please refer to this section for further information

(ii) Describe in more detail the AD process, operating conditions, throughput, retention time, heating mixing and cooling systems, quantities and characteristics of input and outputs, handling of digested sludge, and outputs other than digested sludge and biogas

The digestion process is working under mesophyllic conditions. Controls for the AD process are those relating to controlling the time and temperature; that is controls on the heating system and on the maximum flow rate through the system.

The Plant has been designed for a controlling temperature of 35 deg C in the digesters, and flow rate will be regulated accordingly and on production of sludges. Sludge arriving at the Digester (under pumping pressure against the head of the digester) is already heated (at 55 deg C) as a result of the pasteurization process and will enter the tank at 37 deg C. The pipework system is designed to enable heat to be lost before sludge enters the Digester. If there is insufficient heat loss (i.e. high ambient temperature) then a cooler heat exchanger is incorporated into the flow line which is fed by wash water, and if it is necessary the sludge can be diverted through this to provide cooling.

The flow into and out of the Digester is continuous but the `spot` retention time is 14 days.

The digester holding tank (of reinforced concrete) is designed to retain this temperature (35 deg C) over a specified temperature gradient of 1 deg C loss over one day when no heat is applied. Drawing No C1197-2019 shows the general arrangement of the Anaerobic Digesters and Drawing C1197-1021 shows the P&ID.

There are no other outputs from the digestion tanks other than digested sludge and biogas.

(iii) Provide further details on Biogas collection, storage and method of transfer. Provide details of any scrubbing, or moisture removal and details of the flare including location, design, temperature and residence time

As described in Part 2 Section D.1.i, biogas is produced as a product of digestion of the sludge in the digester tanks. This is utilised to provide the prime fuel source for the boilers, providing hot water for the pasteuriser system. Excess gas (or unused gas) is diverted to the waste gas flare for burning. Should there be insufficient gas available then the boiler system is designed to operate with gas oil. There is no provision for scrubbing.

The biogas collection system is located in the sludge treatment area, as shown in Drawing No. C1197-3006 (see attached). The pipework is shown, and the direction of flow of the biogas, from the 2 no. digesters to the biogas condensate holder, shown in Drawing No. C1197-2023 and Drawing No. C1197-1024.

Biogas from the Sludge Digesters flows to the flexible membrane gasholder. Water from the gas condenses in the gas pipework and gravitates forward to the condensate trap/chamber.

Gas is prevented from escaping from the condensate trap by means of a water trap, condensate discharges into a small pumping chamber for subsequent return to the liquors treatment plant. A system of valves in the condensate trap allows isolation of the gasholder if necessary. Low-pressure fans pressurising the space between the outer membrane of the gasholder and the internal membrane bag maintain gas pressure. Vacuum and pressure relief valves on the gasholder allow discharge under abnormal circumstances. The set pressures of the relief valves will be lower on top of the digesters than at the gas holder so that if there is a high gas pressure the relief will be at high level to make the best use of dispersion for safety and odour reasons.

The gas holder (Drawing No. C1197-1024) is a flexible membrane gas holder of 100m^3 capacity, which buffers the flow of biogas from the digesters and provides a reservoir of gas for semi-continuous operation of the boilers. The gas holder is constructed from two reinforced fabric membranes. The inner membrane is a hemispheric – cylindrical gas- holder, which is attached at its equator to the external, truncated spherical membrane, which is inflated by air pressure thus providing support to the inner membrane. The exterior membrane is inflated by two blowers, which maintain a constant air pressure in the outer membrane. The gas pressure is maintained by the exterior air pressure acting on the inner membrane.

The system operates at a working pressure of 200 mm wg. As the gas is utilised the inner membrane of the holder deflates under the constant pressure from the low-pressure fans. As the inner bag deflates an ultrasonic detector mounted in the top of the gasholder monitors the degree of deflation and computes a gas volume. Various set points will trigger various operations. As the inner membrane expands and fills with gas, the enclosed air volume between the inner and the outer membrane reduces, and to protect against this causing any excess air pressure, the air is automatically released through an air release valve mounted on the outer membrane. When gas consumption exceeds gas production the air blower provides air to replace the reducing gas volume whilst maintaining constant gas pressure.

Two air blowers configured as duty standby provide inflation air for the membrane Gasholder. These run continually in automatic and are rated for the maximum gas utilisation rate by the waste gas burner.

From the gas holder, the biogas is directed to the boilers, which are shown on Drawing No. C1197-3006. Gas is drawn from the gasholder via the condensate trap to the Boiler room for usage by the boilers (as the prime fuel source). The details of the gas use and flow rate for the boilers are shown in the P&ID for the boilers, included as Attachment C1197-8417.

A waste gas burner, located away from the gas holder, burns any excess Biogas, though as the hot water demand is high within the plant, use of this equipment will be limited and should be viewed as a standby route for the gas. This is shown in Drawing No. C1197-1024 and the P&ID sheet is included as Attachment C1197-8418, which gives further details on the capacity, retention time etc.

This low level waste gas burner operates under control of the SCADA (the operation control system). If the biogas level in the gasholder exceeds a set point the burner starts and biogas is drawn from the gasholder through a series of actuated valves and flame arrestors. In order that sufficient temperature is reached within the burner fresh air is added to the biogas at the burners to increase the oxygen/biogas mixture.

(c) For the odour handling units, provide further details including a list of air streams extracted, characteristics of extracted air, controls for emissions of methane. Describe any other odour abatement measures. Describe any proposed controls for pathogens.

Odour Abatement

The P&ID diagram for the odour control is included as Drawing No. C1197-1026 and the data associated with the design are included as Attachment C1197-8419. This shows the 2 no. odour units, and the streams extracted and the characteristics of the extracted air. As detailed in Part 2.h of this response, these include:

- Inlet Works
- Grit Classifier
- Screenings Wash
- Inlet Works Building
- Screen/Grit Skips
- Primary Settlement Tank

- Picket Fence Thickener
- Gravity Belt Thickeners
- Sludge Blending Tanks
- Emergency Sludge Holding Tanks (Primary and Secondary)
- Sludge Building
- Sludge Dewaterers and Dewaterers Skip
- Liquor Returns

The characteristic of the air streams extracted include - average and maximum odour concentrations for each source, the average and peak H_2S (hydrogen sulphide) concentrations, and the flow rate for the air from each source.

Further detail has been included on the odour abatement measures, which entail covering of potentially odorous tanks etc and the odour control units (OCU-1 and OCU-2) in Part 2.h.

Methane Emissions

The methane produced in the anaerobic digestion process will not be emitted to the atmosphere and therefore there will be no methane emissions from this part of the plant. The abatement control for this is the utilisation of the methane as a biogas fuel for the boilers. The boilers will use the biogas as described in Part 2(i) of this response. Any excess biogas will be burned off, again described in detail in Part 2(i).

Control for Destruction of Pathogens

The primary proposed control for pathogens that may be generated during the wastewater treatment process is the pasteurisation process. Detailed description of the pasteurisation process is included as Attachment 07_4084 3.c. Drawing C1197-1020 shows the P&ID for the process.

The thermal sludge pasteuriser is utilised to thermally pasteurise sewage sludge prior to sludge digestion in order to eliminate pathogens harmful to man from the sewage sludge and render it suitable for hygienic disposal as a Class `A` sludge.

The thermal pasteuriser operates on the basis of utilising heat to eradicate the pathogenic bacteria.

In the thermal pasteuriser, the sludge is held at a temperature of 55 deg C for a period of four hours after which, it can then be cooled to digester temperature and utilised as the sole source of digester heating.

The anaerobic digestion process also provides a control for pathogen destruction due to the retention time and temperature that the process is kept at. This is described in more detail in Part 3.c.

(d) Provide further details of process abatement and control for each stage of the wastewater treatment process, sludge treatment and odour control units. Submit Table F.1 for each stage

(i) Include details of the capacity, throughput and treatment efficiency, and waste products for each stage

Wastewater Treatment

The anticipated input to the wastewater treatment plant, in terms of the average and peak flows for both the current flows, and the predicted flows for the year 2025 (which is the maximum input for which the plant is designed) is shown in Attachment C1197-8404.

The expected average daily input for current situation (2005) is 277 l/s (average) and 611.3 l/s (max), and for the peak year (2025), the average flow is 441.3 l/s and the maximum is 981.7 l/s.

The loads for each year are shown in the Attachment C1197-8404. From the primary tanks, the removal efficiency rates for each parameter measured are as follows:

Suspended Solids (SS) (max.)	-	60%
Suspended Solids (SS) (min.)	-	55%
Biological Oxygen Demand (BOD) (max)	-	30%
Biological Oxygen Demand (BOD) (max)	-	25%

The percentage dry solids details are also included in Attachment C1197-8404. The loads to the secondary treatment are also shown in the attachment.

As discussed in the original application, until the plant is commissioned, the exact quality of the final treated effluent cannot be determined, as the exact nature of the raw sewage can only be predicted at present. At present, the sewage is discharging through a large number of outfalls into the River Suir, Suir Estuary and St. John's River, and therefore a composite quality and nature has been predicted for the design stage of the plant.

The commissioning phase will ensure that optimum efficiency rates of removal are achieved by adjusting and setting the controls/plant to achieve the required performance. More information can be provided as the commissioning phase is completed.

However, there are maximum limits that the WWTP are designed to meet in terms of the quality of the final treated effluent, which will be discharged to the Suir Estuary. These limits are as follows:

Parameter	Unit	Standard		Compliance Criteria	
		Target A	Target B	Target A	Target B
BOD	mg/l	25	50	No more than 3 daily samples per 60 days with a value for any one parameter or all parameters to be greater than the standards	No samples with a value for any one parameter to be greater than the standard
COD	mg/l	125	250		
Suspended Solids	mg/l	35	87.5		

Sludge Treatment

The sludge volumes that will be produced are identified in Section 3.a(iii) and Attachment C1197-8404.

As for secondary treatment, the plant design efficiency rate is to produce 23% dry solids sludge cake, which is the condition that the sludge cake will be in when it leaves the site for land spreading or landfilling. The efficiency rates in practice will be available once the plant is commissioned and can be supplied to the EPA if required.

Odour Control Units

Details of the odour control units are shown in Part 2(h) of this response. As described in the odour dispersion model, for OCU 1, which treats the inlet building, the hydrogen sulphide removal rate i.e. efficiency is 99% and this equates to an odour removal rate of 97%.

For OCU 2, which treats the sludge building, the hydrogen sulphide removal rate i.e. efficiency is 99% and this equates to an odour removal rate of 95% in this case. Attachment C1197-8419 (Odour Control Design), included with Part 2.h.

(ii) Include details of in-tank monitoring and control systems

Section 3.a(ii) details the monitoring for the operation of the WWTP, and Table 07_4083 shows all the parameters for each monitoring/sampling point.

In terms of the control systems, there will be in-tank monitoring in the digester tanks for level and temperature. The main control is that of temperature, which is described in Part 3.b(ii). All other monitoring is described in Table 07_4084 3.a(ii) and shown in the drawings identified in Part 3.a(ii).

(iii) Control parameters for the Anaerobic Digesters

Controls for the AD process are those relating to controlling the time and temperature; that is controls on the heating system and on the maximum flow rate through the system.

The Plant has been designed for a controlling temperature of 35 deg C in the digesters, and flow rate will be regulated accordingly and on production of sludges. Sludge arriving at the Digester (under pumping pressure against the head of the digester) is already heated (at 55 deg C) as a result of the pasteurization process and will enter the tank at 37 deg C. The pipework system is designed to enable heat to be lost before sludge enters the Digester. If there is insufficient heat loss (i.e. high ambient temperature) then a cooler heat exchanger is incorporated into the flow line which is fed by wash water, and if it is necessary the sludge can be diverted through this to provide cooling.

The flow into and out of the Digester is continuous but the `spot` retention time is 14 days.

The digester holding tank (of reinforced concrete) is designed to retain this temperature (35 deg C) over a specified temperature gradient of 1 deg C loss over one day when no heat is applied. The in-tank monitoring of temperature and level will monitor these parameters, whilst flow rates into and out of the tanks are measured on the pipework, see Part 3.a(ii).

(iv) For each item of control equipment provide details of maintenance and calibration

Details of maintenance and calibration will be determined prior to operation of the WWTP. As the WTTP is still under construction, many items of plant have not yet been installed, and therefore suppliers and manufacturers guidelines on maintenance and calibration are not available in some cases.

Once the WWTP is complete, and prior to operation, a full maintenance and calibration schedule will be available and submitted to the EPA, as per their requirements, and it will be part of the "standing" O&M (Operation and Maintenance) procedures for Waterford WWTP.

(e) Compare the abatement, treatment or recovery system with BAT Standards

The Integrated Pollution Prevention and Control (IPPC) Reference (Bref) Document on Best Available Techniques (BAT) for the Waste Treatments Industries (August 2006) [1] has been referred to in this section.

Specifically, the techniques to consider in biological treatment have been taken into consideration during the design phase of the WWTP.

Selection of the appropriate biological treatment was based on the need for the best treatment to carry out the processed within the WWTP that achieves the optimum operational performance and reduces environmental issues, as well as providing an opportunity to use waste gas as a fuel.

Specific Storage and Handling Techniques

There is no storage of the wastewater as it enters the treatment works, but it is directed into the inlet works. Technique (b), (e) and (f) of the Bref document [1], Section 4.2.2, have been employed for the WWTP by ensuring that the inlet works and primary settlement tanks are closed. The inlet works building is fully enclosed and under negative pressure and air from here, which may contain malodours, are sucked into the pipework to Odour Control Unit 1 (OCU 1), along with those from the primary settlement tanks.

Air exchanges of between 2 and 18.7 per hour are specified for different items of plant within the inlet works (2 air changes per hour for the overall building and for the primary settlement tank and between 8 and 19.7 for the individual items within the works building, including the pre-screen and post grit channel, the fine screens, the screenings compactors, the grit classifier and the grit channel).

The sludge works are also completely enclosed, in accordance with Technique (b) and (f), keeping all process within the structure. The building is under negative pressure and any malodourous air is sucked into OCU 2 from the building, which includes air from a number of items within the sludge works: the pasteurizer, picket fence thickener, the sludge tanks, the sludge dewaterer and the liquor returns. The air changes per hour for each item range from 2 – 6.

It should be noted that employees will not be routinely working in these areas, only for maintenance and monitoring purposes and therefore the air changes will be sufficient for these infrequent visits.

As all the waste entering the plant is via pipes, there will be no vehicle access to the inlet works delivering waste. In accordance with Technique (e) there is a roller shutter door for the inlet works building, which is electrically controlled to ensure the door opening is kept to a minimum and shut completely. Maintenance will be regular, and details will be included in the Operations Manual, which will be finalized prior to commencement of plant operation.

For the sludge works, there is no vehicle access, with only doors for employee access, which will be kept closed at all times. No air curtains are considered necessary as the risk of odour escaping is minimal (due to the building being under negative pressure, and also will not be significant as a result of the odour control programme.

Technique (d) has also been employed for the last steps of the biological treatment, concerning the storage of solid wastes produced, i.e. dewatered sludge cake, grit and screenings. The skips/containers will be enclosed and the dewatered sludge cake taken off-site every day, as waste storage on site will not be permitted. The grit and screenings will be taken off-site once the skips are almost full and replaced with empty ones.

Increase the Retention Time in the Anaerobic Digestion process

The required anaerobic digester operating temperature is 35 deg C with a 'spot' retention time of 14 days. These are the design criteria to ensure optimum digestion conditions, which allow the digestate to spend more time under degradation conditions, at the temperature that ensures maximum degradation. The temperature of the sludge fed forward to the digesters is controlled by the amount of cooling water used in the "cooler" heat exchanger. As a result of this process, maximum biogas is produced to fuel the boilers, providing a beneficial use from what was essentially a waste product.

In relation to the pasteurisation process, which is intrinsically linked with the Anaerobic Digestion process, there is increased retention time for this process. This is described in detail in Attachment 07_4084 3.c.

The relationship with the anaerobic digestion is that, having heated the sludge to a temperature up to 55 deg C (pasteurisation retention temperature), it can then be cooled to digester temperature and utilised as the sole source of digester heating. Hence, a control loop is established such that the digester is fed with pasteurised sludge either higher or lower than the required digester operating temperature of 35 deg C. Hence, in the summer months the temperature of the sludge going forward for digestion may be a little cooler than in the winter.

Techniques for the Reduction of Emissions when Biogas is used as Fuel

The biogas produced that is used as a fuel for the boilers, is methane, produced by the anaerobic digesters. The gas holder that will be part of the biogas system, will buffer out any peaks in production and therefore provide a steady supply of biogas to the boilers as and when it is required. This will ensure that the biogas is not wasted (by burning off excess during peak production times) and also reduces the need to use alternative fuel (diesel) for the boilers during times of low production.

Techniques a – d of the Bref document, Section 4.2.6 are not considered necessary for the WWTP, primarily because the gas produced is methane (CH_4) and not hydrogen sulphide (H_2S), which would required further abatement techniques.

In terms of the hydrogen suphide removal, there are activated carbon filters on each of the Odour Control Units (OCUs). The first step in the process, which is a biological media, strips the majority of the H_2S out of the gas, with the carbon filters acting as a polishing step, taking out the remainder of the H_2S (See Drawing C1197-1026) which is included with this response.

As the biogas is being used as a fuel, and the process is not a considerable source of fuel (only powering the boilers), it is not considered economically viable or environmentally justified for this plant.

Technique (e) has been employed by providing biogas storage and an emergency flare. Biogas is produced as a product of digestion of the sludge in the digester tanks. This is utilised to provide the prime fuel source for the boilers, providing hot water for the pasteuriser system. Excess gas (or unused gas) is diverted to the waste gas flare for burning. More details on the process are given in Section b(iii) of this section of the response (see above).

(f) Provide design details for the discharge outfall, and details of diffusers etc

Drawing No. 3126 shows the location and pathway of the final effluent discharge pipe and discharge point, which is marked on the drawing as a green line. The discharge point terminates in the centre of the Suir Estuary.

In summary, there will be three sections of the discharge pipeline, namely A. the land based section (227 metres), B. the section running parallel to the railway line above high water mark (399 metres), and C. the marine section (237 metres). Section C will have the diffusers, the pipe of which will be buried, and 20 diffuser ports, which will be exposed into the Estuary channel. Protection of these ports will be put in place.

See Attachment 07_4084 D.2(f) for more detail on the design details for the final effluent discharge outfall, including information on the diffusers.

(g) Provide details of final effluent wash water, including uses and volumes

Wash water is provided at the start of the operations at the WWTP from an adjacent source, which has been agreed. This will be the IDA borehole, located within the adjacent IDA Park, from which a spur will be directed to the WWTP facility. This source is considered to be only temporary, pending provision of a permanent supply from the public mains (which is not in place at present).

The quality can be deemed to be of potable standard but is not being used as a potable source and no special provision is made to keep it sterilized when on the site. Potable water will be brought on site from another source, in bottled form.

The quantities of wash water that are anticipated (volumes cannot be confirmed until the plant has been commissioned) are as follows:

For polymer make-up – SAS thickeners	9,821 l/d	- into sludge
For polymer make-up – Dewaterers	21,478 l/d	- into sludge
Boiler top up – as and when required		
Odour control unit – inlet	2,600 l/d	- keeping OCU moist
Odour control unit – sludge	1,500 l/d	- keeping OCU moist
Internal hose point	3,600 l/d	- into drainage system
Total	**39,000l/d**	

The system is designed to use 40000 l/day.

Drawing No. C1197-1027 shows the wash water flow diagram for the WWTP.

References

1. Integrated Pollution Prevention and Control (IPPC) Reference (Bref) Document on Best Available Techniques (BAT) for the Waste Treatments Industries, EPA, 2006

Table 07_4084 F.1 Rev.2

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Wastewater Treatment Stage – Inlet Works

Emission point reference number *: OCU-1 (Grid Ref:* E 264547 N 112429)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
Hydrogen Sulphide	Odour Control Unit 1	According to equipment specification	As recommended by supplier	None

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
Hydrogen Sulphide	Bi-annual Odour Survey at Determined Monitoring Points (closest receptors and boundary)	Hand held Jerome 631-X H_2S analyzer for odour surveys	In the field - Sensor calibration with Jerome H_2S functional test kit Also regular calibration by manufacturer approved facility

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Sludge Treatment Stage – Sludge Building

Emission point reference number *:* *OCU-2 (Grid Ref:* E 264624 N 112338)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
Hydrogen Sulphide	Odour Control Unit 2	According to equipment specification	As recommended by supplier	None

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
Hydrogen Sulphide	Bi-annual Odour Survey at Determined Monitoring Points (closest receptors and boundary)	Hand held Jerome 631-X H_2S analyser	In the field - Sensor calibration with Jerome H_2S functional test kit Also regular calibration by manufacturer approved facility

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Sludge Treatment Stage – Adjacent to Sludge Building

Emission point reference number *: A-01(a) Grid Ref:* E 264576 N 112295)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
NOx	None	None	None	None
CO	None	None	None	None

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
NOx	In-situ stack monitoring at Boiler stack A-01(a)	Testo 350 electrochemical analysis fitted with gas-drying unit (or similar)	As required by equipment manufacturer spec.
CO	In –situ stack monitoring at Boiler stack A-01(a)	Testo 350 electrochemical analysis fitted with gas-drying unit (or similar)	As required by equipment manufacturer spec.

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Sludge Treatment Stage – Adjacent to Sludge Building

Emission point reference number *: A-01(b) (Grid Ref:* E 264580 N 112295)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
NOx	None	None	None	None
CO	None	None	None	None

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
NOx	In-situ stack monitoring at Boiler stack A-01(b)	Testo 350 electrochemical analysis fitted with gas-drying unit (or similar)	As required by equipment manufacturer spec.
CO	In –situ stack monitoring at Boiler stack A-01(b)	Testo 350 electrochemical analysis fitted with gas-drying unit (or similar)	As required by equipment manufacturer spec.

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Surface Water Runoff

Emission point reference number *:* *SW-1 (Grid Ref:* 265022 112153)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
BOD	None	Not Applicable	Not Applicable	Not Applicable
COD	None	Not Applicable	Not Applicable	Not Applicable
Suspended Solids	None	Not Applicable	Not Applicable	Not Applicable
pH	None	Not Applicable	Not Applicable	Not Applicable
Hydrocarbons	Hydrocarbon Interceptors	Regular Inspection of interceptors	Not Applicable	Not Applicable

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
BOD	Manually taken samples will be analysed by an external accredited laboratory, approved by the Agency	Standard Laboratory	Standard Laboratory
COD	As Above	As Above	As Above
Suspended Solids	As Above	As Above	As Above
pH	On-Site pH meter	WTW-Water Meter or similar	As per manufacturers recommendations

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE F.1: ABATEMENT / TREATMENT CONTROL

Final Treated Effluent Stage – Discharge Point

Emission point reference number *:* *SW-2 (Grid Ref:* 265602 112078)

Control[1] parameter	Equipment [2]	Equipment maintenance	Equipment calibration	Equipment back-up
BOD	The WWTP, which is described in Section D.2 performs the abatement function –	As required by supplier/manufacturer specification	As required by supplier/manufacturer specification	Manually sampling at three-hourly intervals - results weighted according to flow to establish the equivalent daily total load
COD	As Above	As Above	As Above	As Above
Suspended Solids	As Above	As Above	As Above	As Above
pH	As Above	As Above	As Above	On-Site pH meter
Flow	As Above	As Above	As Above	Not Specified
Temperature	As Above	As Above	As Above	On-site temperature meter

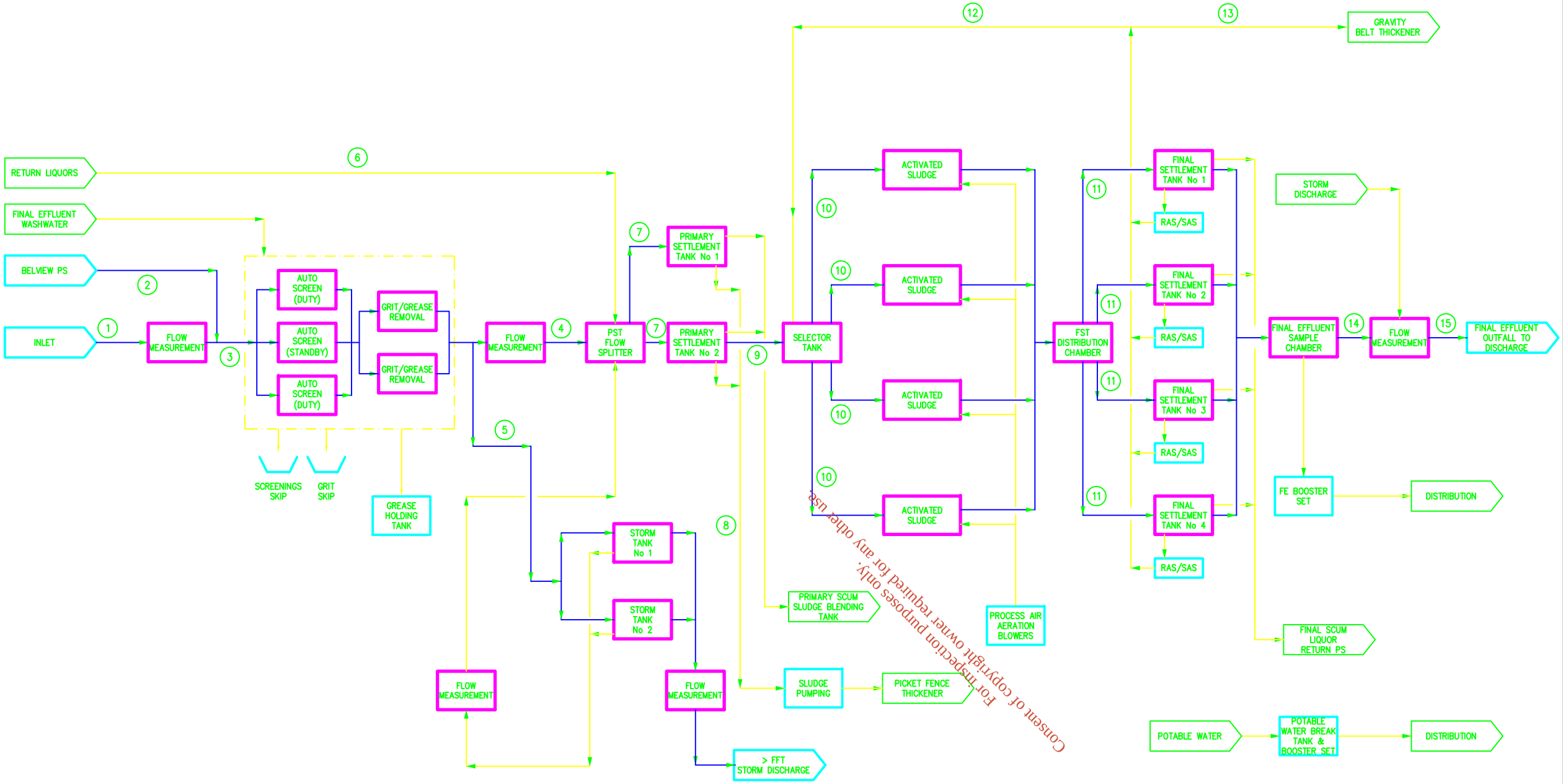
Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
BOD	Composite samples will be analysed by an external accredited laboratory, approved by the Agency	Standard Laboratory	Standard Laboratory
COD	As Above	As Above	As Above
Suspended Solids	As Above	As Above	As Above
pH	Ongoing pH monitoring	On-Site pH meter	As per manufacturers recommendations
Flow	On-Site flow monitoring	Open channel flumes fitted with ultrasonic level device	As specified by equipment manufacturer
Temperature	On-Site temperature	On-Site temperature probe	As specified by equipment manufacturer

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

DO NOT SCALE - IF IN DOUBT ASK

Rev. E

Drg. No. C1197-1001



DESCRIPTION	INLET SCREENS	GRIT REMOVAL	GREASE REMOVAL	PRIMARY SETTLING TANK DISTRIBUTION	PRIMARY SETTLEMENT	NEW PRIMARY SLUDGE PUMPS	SECONDARY TREATMENT DISTRIBUTION CHAMBER	ACTIVATED SLUDGE PLANT	PROCESS AIR AERATION BLOWERS	FST DISTRIBUTION CHAMBER	NEW FINAL SETTLEMENT TANKS	FINAL EFFLUENT SAMPLING CHAMBER	FINAL EFFLUENT BOOSTER SET	POTABLE WATER BREAK TANK & BOOSTER SET
NUMBER	3 SCREENS	2	2	1	2	3	1	4	5	1	4	1	2	2
DUTY	2	1	1	\	2	2	\	4	4	\	4	\	1	1
STANDBY	1	1	1	\	0	1	\	0	1	\	0	\	1	1
SIZE				\	32m DIA	29m³/h	\	10760m³ TOTAL	XXXm³/h	\	36	\	XXXm³/h	XXXm³/h
CAPACITY (EACH)	–	–	–			–		2690m³						
NOTES					CAN OPERATE WITH ONE PST OUT OF SERVICE			CAN OPERATE WITH ONE LANE OUT OF SERVICE			CAN OPERATE WITH ONE FST OUT OF SERVICE			

STREAM NUMBER COMPONENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DESCRIPTION	RAW SEWAGE	BELVIEW PS	COMBINED RAW SEWAGE	FFT RAW SEWAGE	STORM FLOW	RETURN LIQUORS	RAW SEWAGE	PRIMARY SLUDGE	SETTLED SEWAGE	MIXED LIQUOR	MIXED LIQUOR	RETURN ACTIVATED SLUDGE	SURPLUS ACTIVATED SLUDGE	FINAL EFFLUENT	DISCHARGE TO OUTFALL
FLOW M³/d DWF	24594	2870	27465	27465	–	–	29884	–	29716	54676	54676	24960	–	27465	27465
AVE	32834	2870	35704	35704	–	1628	38123	168	37955	71171	71171	33216	1089	35704	35704
MAX	136059	9504	145563	82394	63169	2419	84813	–	84645	133509	133509	48864	–	82394	145563
B.O.D. kg/d (AVERAGE)	–	–	11436	–	–	1035	12471	3741	8730	–	–	–	–	–	–
S.S. kg/d (AVERAGE)	–	–	8005	–	–	1227	9232	5078	4154	–	–	–	6547	–	–
kg/d (AVE)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SOLIDS CONTENT (% DS)	–	–	–	–	–	–	–	3	–	0.35	0.35	–	0.6	–	–

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
E	04/05/2007	DRAWING BORDER REVISED.	DDF

NOTES

1. LOADS STATED ARE FOR YEAR 2025 ALTHOUGH PLANT DESIGNED TO ACCOMMODATE INCREASED LOADINGS OF UP TO 20% EXTRA.
2. DRAWING PREVIOUSLY E8374–1001
3. EXPANDED TO INCLUDE MASS AND FLOW BALANCE TABLE.

CHECKED		APPROVED	
	PROCESS ENG.		PROCESS TECH SPECIALIST.
	PROJECT ENG.		PROJECT MAN.
	LEAD MECH ENG.		MECH ENG MAN.
	LEAD ELEC ENG.		ELEC ENG MAN.

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
SEWAGE TREATMENT
PROCESS FLOW DIAGRAM
WATERFORD WWTW

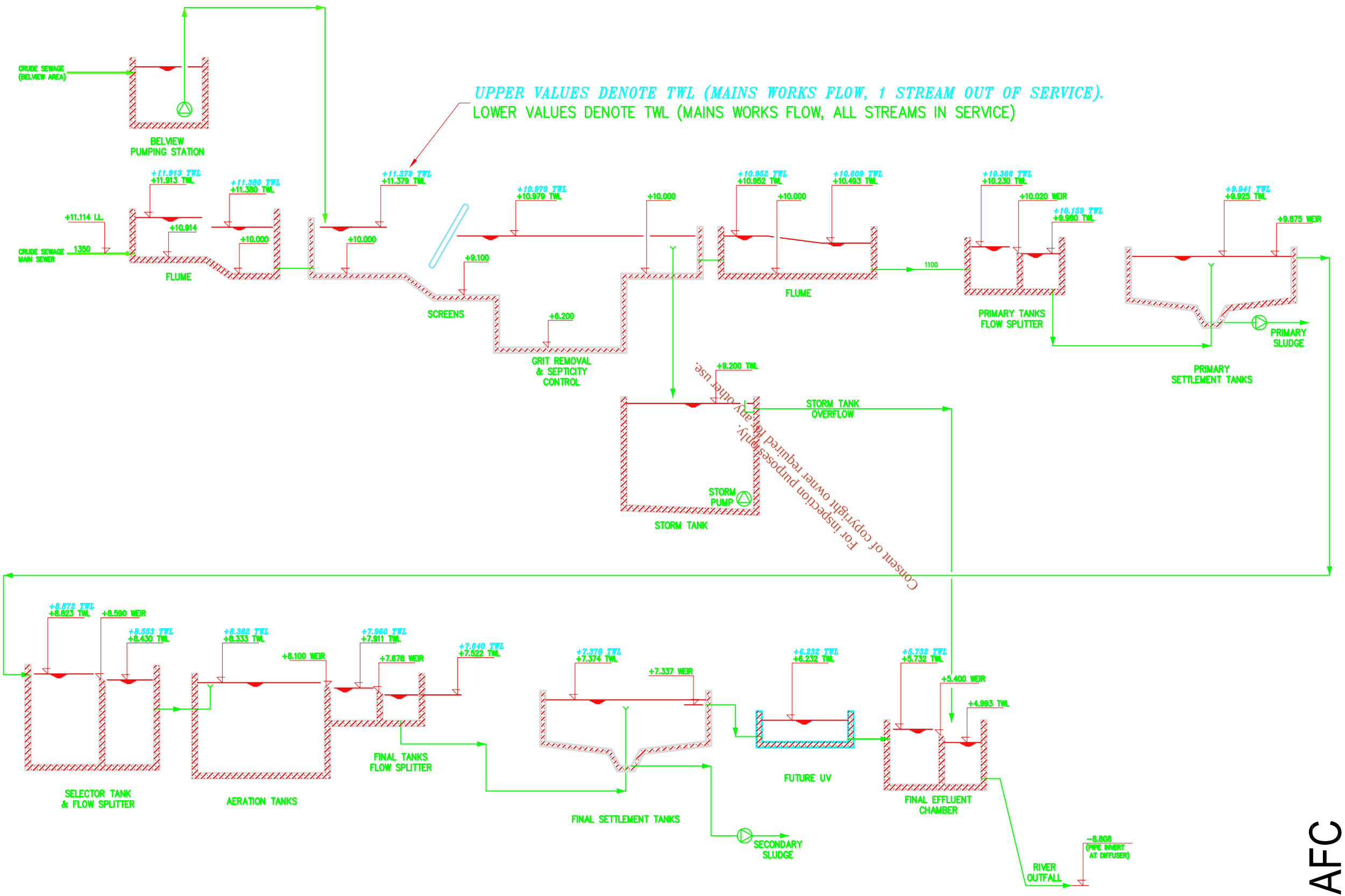
Drawn	Checked	Approved	Original Sheet Size
DJTildesley	DGHemmings	JMorton	A1
Date 20/10/2006	Date 04/05/2007	Date 04/05/2007	Original Scale NTS
Drg. No. C1197-1001			Rev. E

DESIGN ISSUE

DO NOT SCALE - IF IN DOUBT ASK

Rev. 1

Drg. No. C1197-1005



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	17/12/2007	LEVELS REVISED IN LINE WITH AS BUILT WEIRS.	DDF

NOTES

1. DRAWING PREVIOUSLY E8374-1005
2. LEVELS REVISED IN-LINE WITH HYDRAULIC CALCULATIONS.

ISSUED AFC

CHECKED			APPROVED	
	PROCESS ENG.	DGH		PROCESS TECH SPECIALIST.
	PROJECT ENG.	JMN		PROJECT MAN. CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN. ADG
	LEAD ELEC ENG.			ELEC ENG MAN.

A.W.I. CONTRACT No 1002

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Title
HYDRAULIC PROFILE
SEWAGE SYSTEM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMiller	CGPage	A1
Date 20/10/2006	Date 17/12/2007	Date 17/12/2007	Original Scale NTS
Drg. No. C1197-1005			Rev. 1

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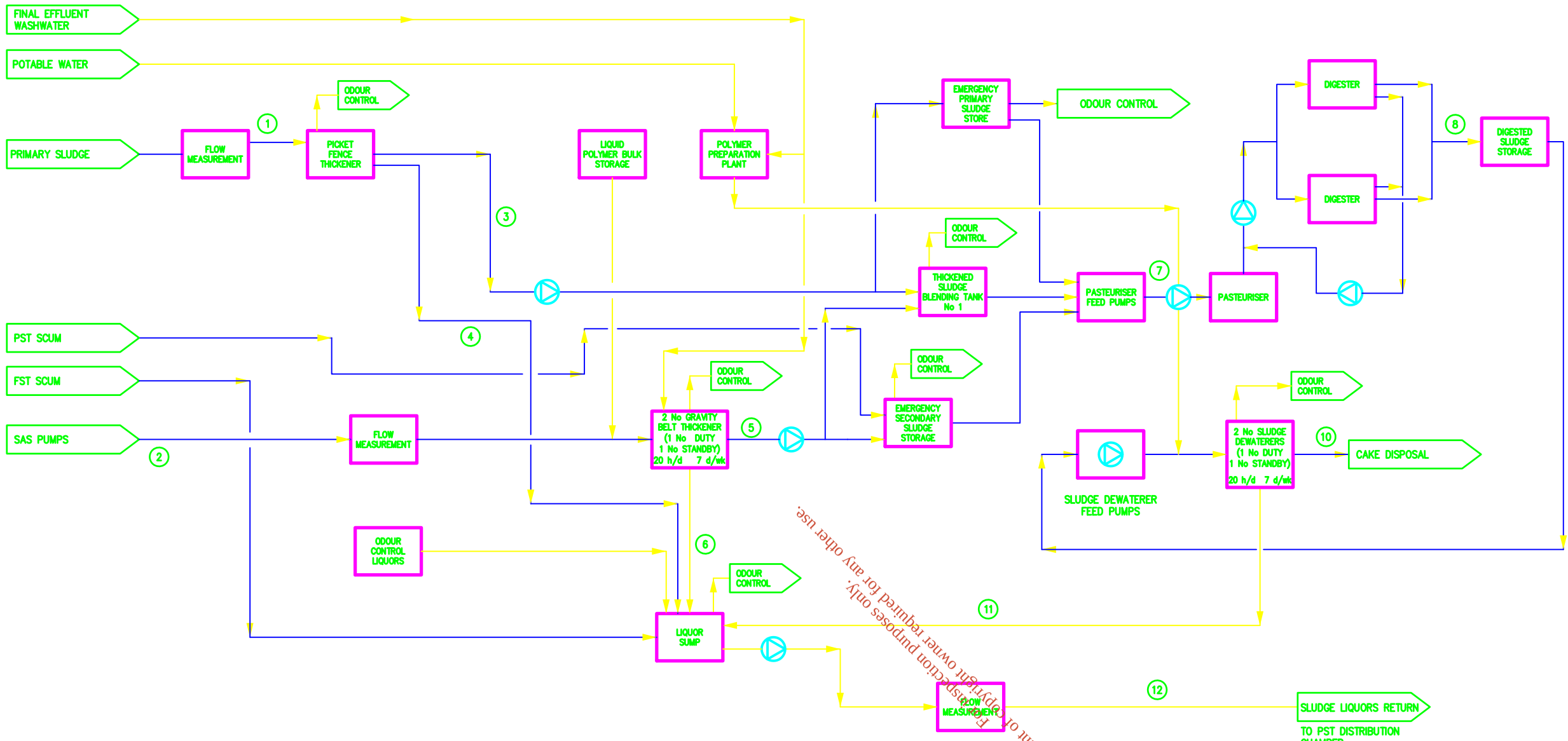
Rev. C

Drg. No. C1197-1002



DESCRIPTION	PRIMARY SLUDGE FEED PUMPS	PICKET FENCE THICKENER	THICKENED PRIMARY SLUDGE PUMPS	SECONDARY SLUDGE FEED PUMP	GRAVITY BELT THICKENER	POLYMER PREPERATION PLANT	THICKENED SECONDARY SLUDGE PUMPS	THICKENED SLUDGE BLENDING TANKS	EMERGENCY PRIMARY SLUDGE STORAGETANK	EMERGENCY SECONDARY SLUDGE STORAGE TANK	PASTEURISER FEED PUMPS	PASTEURISER TANKS	DIGESTERS	DIGESTED SLUDGE STORAGE TANK	DEWATERER SLUDGE FEED PUMPS	SLUDGE DEWATERER	POLYMER PREP PLANT	SLUDGE LIQUORS RETURN PUMPS
NUMBER	2	1	2	2	2	1	2	1	–	–	2	3	2	1	2	2	–	2
DUTY	1	1	1	1	1	1	1	1	–	–	1	3	2	1	1	1	–	1
STANDBY	1	–	1	1	1	0	1	–	–	–	1	0	0	0	1	1	–	1
SIZE	–	⌀8.7m	–	–	–	–	–	–	–	–	15m³/h	–	–	–	–	–	–	–
CAPACITY (EACH)	29 m³/h	–	29 m³/h	55 m³/h	–	–	XXm³/h	41 m³	318m³	422m³	–	41m³	1721m³	1221m³	11m³/h	–	–	m³/h
NOTES	–	–	–	–	CAPABLE OF OPERATING BOTH UNITS AS DUTY	–	–	–	–	–	–	–	–	–	–	CAPABLE OF OPERATING BOTH UNITS AS DUTY	–	–

STREAM No	1	2	3	4	5	6	7	8	9	10	11	12
COMPONENT												
DESCRIPTION	PRIMARY SLUDGE	SURPLUS ACTIVATED SLUDGE	THICKENED PRIMARY SLUDGE	PRIMARY THICKENER FILTRATE	THICKENED SECONDARY SLUDGE	SECONDARY THICKENER FILTRATE	SLUDGE FEED TO PASTEURISER	SLUDGE FROM DIGESTER	SLUDGE FEED TO DEWATERER	DEWATERED SLUDGE	DEWATERER FILTRATE INC WASHING	DEWATERER FILTRATE
FLOW M³/d DWF	–	–	–	–	–	–	–	–	–	–	–	–
AVE	168	1089	83	85	119	970	202	199	199	31	573	1628
MAX	–	–	–	–	–	–	–	–	–	–	–	2419
B.O.D. Kg/d (AVERAGE)	–	–	–	–	–	–	–	–	–	–	–	1035
S.S. Kg/d (AVERAGE)	5078	6547	5052	26	6023	524	11075	8268	8268	7606	661	1227
SOLIDS CONTENT (% DS)	3	0.6	6	–	5	< 0.1	5.5	4	4	23	0.4	–
NOTES	–	–	–	–	–	–			–	–	–	–

DESIGN ISSUE

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
C	23/04/2007	41m³ VALUE ADDED TO PASTEURISER TANK COLUMN.	DDF

NOTES

1. LOADS STATED ARE FOR YEAR 2025 ALTHOUGH PLANT DESIGNED TO ACCOMMODATE INCREASED LOADINGS OF UP TO 20% EXTRA.
2. DRAWING PREVIOUSLY E8374–1002
3. EXPANDED TO INCLUDE MASS AND FLOW BALANCE TABLE.

CHECKED		APPROVED	
	PROCESS ENG.		PROCESS TECH SPECIALIST.
	PROJECT ENG.		PROJECT MAN.
	LEAD MECH ENG.		MECH ENG MAN.
	LEAD ELEC ENG.		ELEC ENG MAN.

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
SLUDGE TREATMENT
PROCESS FLOW DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DDFudger	DGHemmings	CGPage	A1
Date	Date	Date	Original Scale
21/11/2006	23/04/2007	23/04/2007	NTS
Drg. No. C1197-1002			Rev. C

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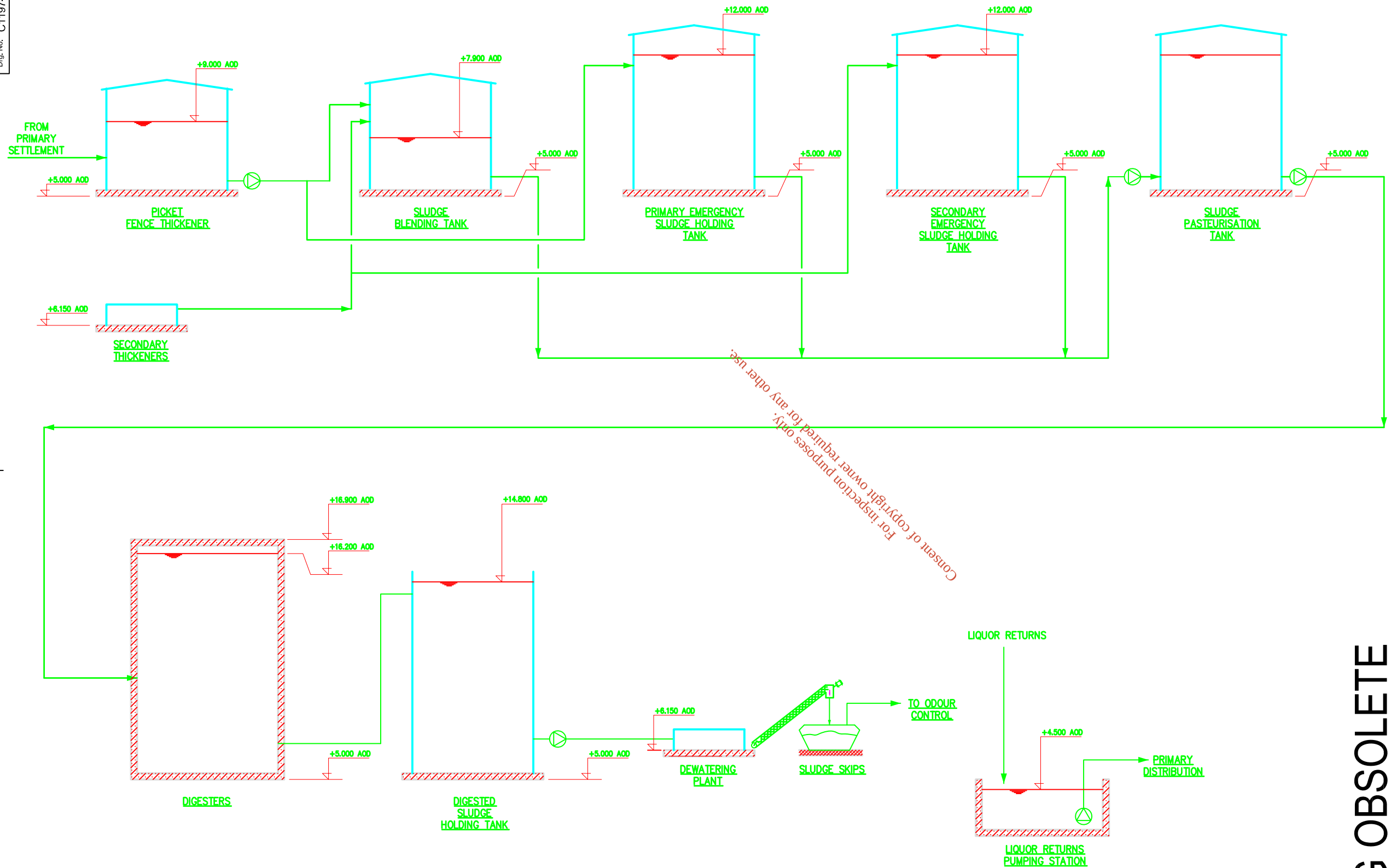
Rev. A

Drg. No. C1197-1006



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
A	07/08/2007	NOTES ADDED.	

NOTES

1. DRAWING PREVIOUSLY E8374-1006
2. EPS TO ADVISE ON LEVELS.

LEGEND:

NEW PIPEWORK/CHANNEL BY CIVILS CONTRACTOR.

NEW PIPEWORK BY M&E CONTRACTOR.

EXISTING PIPEWORK/EQPT.

CHECKED		APPROVED	
	PROCESS ENG.		PROCESS TECH SPECIALIST.
	PROJECT ENG.		PROJECT MAN.
	LEAD MECH ENG.		MECH ENG MAN.
	LEAD ELEC ENG.		ELEC ENG MAN.

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
HYDRAULIC PROFILE
SLUDGE SYSTEM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RAdams	RAdams	A1
Date 20/10/2006	Date 07/08/2007	Date 07/08/2007	Original Scale NTS
Drg. No. C1197-1006			Rev. A

DRAWING OBSOLETE

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8402 **Title :** Grit and Grease Removal

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	2		Contract Issue	DGH		

PURAC Grit / Grease Removal				Project-Specific Data	
				Document Ref	8402
Standard Process Calculation: Project-specific data input is permitted to highlighted areas only.				Project No	C1197
				Project Name	Waterford
Calc Ref:	PCS001	Rev 1	Page 1	Process area code	
Author	D Garnett	Refer to PCS index for full details		Tag No(s)	
Calculation status:				Process Engineer	D. Hemmings
				Date	21-Nov-06

Description

Two longitudinal, spiral flow type aerated grit and grease removal tanks are to be utilised. A bypass channel capable of taking 50% of the flow is also included should one lane be out of service.

Plant Flows				
Peak flow		1.685	m3/s	
Mean flow		0.413	Cumecs	
Minimum flow		0.318	Cumecs	
Design parameters				
Detention time				
At **maximum flow**		3.0	Mins	Ref: Metcalf and Eddy 4th Edition page 389
Adopt maximum flow		1.685	Cumecs	
No. of channels	Select	2	No.	Ref: Vol 4 section 7.3.2
No. of channels as standby	Select	0	No.	
No. of operational channels		2	No.	
Total volume required		303	m3	
Volume per channel		152	m3	
Detention time				
At **average flow**		12.2	Mins	
Channel cross section - see also sketch				
D1 : Depth of channel	Select	4.00	m	Ref: Metcalf and Eddy 4th Edition page 389
W1 : Width of Grit channel		3.40	m	
W2 : Width of grease channel		1.70	m	
W1 approx 0.85*D				
W2 approx W1/2 and between 1 - 2m				
W4 Width : Wall to grit sump	Select	0.75	m	
W3 Width of grit sump	Select	0.75	m	
D2 Depth of grit sump	Select	0.85	m	
Angle A of benching	Select	60		
Angle B of channel floor	Select	45		
Area a		20.4	m2	
Area b		0.5	m2	
Area c		4.8	m2	
Cross sectional area of channel		15.1	m2	
Length of channel		10.01	m	
Actual Length	Rounded	10.00	m	
Actual W1	Rounded	3.40	m	
Actual W2	Rounded	1.70	m	
Total channel width		5.10	m	
Check hydraulic rate at maximum flow		59.5	m/h	Note: don't consider surface
		0.017	m/s	of grease removal normally.
Check hydraulic rate in non-aerated section		178.39	m/h	

Purac AB design notes:

Take cross section area around	10 and 15	m2
Take typical airflow as	40	m3/hr

The airflow will be set on site.

Use one Saunders valves per down comer and perforated stainless steel pipes DN40-50 as aerators.

Fat removal zone width between	1 and 2	m
Retention time at maximum flow	3 to 5	min
Hydraulic load in non aerated zone	25	m/hr

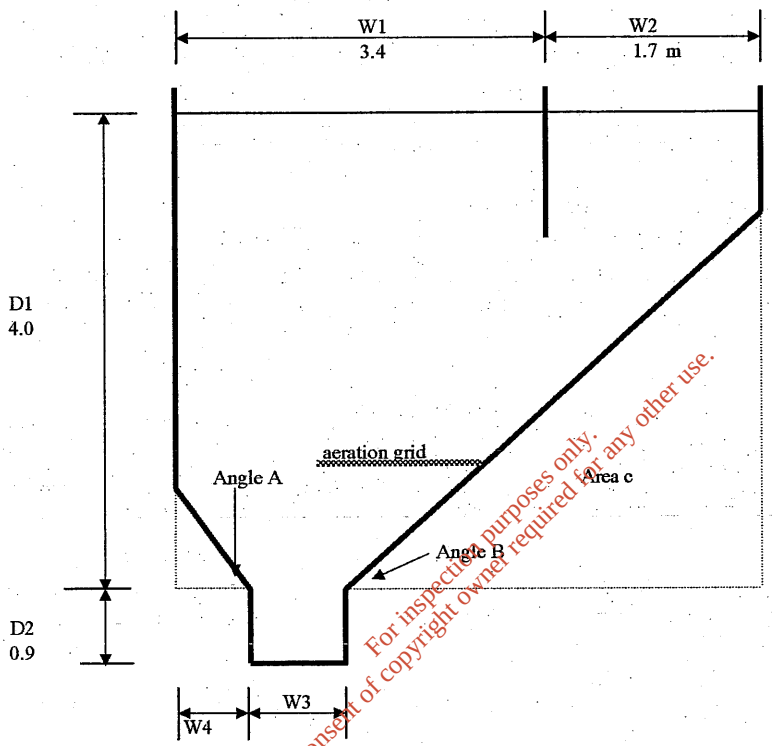
Air Requirement

Metcalf and Eddy states that an airflow of between 12 and 30 m3/h per m length of tank is required.

Nm3/h of air per m length of tank	Nm3/h	20.0
Air Requirement	Nm3/h	200.0

Expected grit quantities	m3/1000 m3	0.0150	Ref: Metcalf and Eddy 4th Edition page 389
Grit quantities @ average flow	m3/d	0.54	

Cross Section - Grit and Grease Channel



PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Ref: 8403 **Title :** PST Design

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
				DGH		
1	2	30 OCT 06	Contract Issue	DGH	[illegible]	[illegible]

PURAC					
Primary Settlement Tank Design: Radial Flow				Project-Specific Data	
				Document Ref	8403
Standard Process Calculation: Project-specific data input is permitted to highlighted areas only.				Project No	C1197
				Project Name	Waterford
Calc Ref:		Rev	Page 1	Process area code	
Author	D Garnett	Refer to PCS index for full details		Tag No(s)	
Calculation status:		CHECKED M HARPHAM		Process Engineer	D.Hemmings
				Date	30/10/2006

APPLICATION **References**

Provides guidance in design of radial flow (circular) tanks for primary sedimentation of municipal wastewaters.

INTRODUCTION

Sedimentation tank design is not a precise science; judgement and experience are required. USA practice specifies tank depths as a design criteria whereas UK practice tends to ignore this parameter. The calculation below is based on UK practice where the surface loading does not exceed 45 $m^3/m^2.day$.

INPUTS

		Maximum	Minimum	Average	
Inflow to Primary Tanks	(m^3/h)	3534	1221	1564	From 8000-Design Basis
	lps	982	339	435	
Liquor returns	(m^3/h)	101	77	77	
Required No. Tanks		2			

SURFACE LOADING

Recommended Surface Loading

Radial Flow Tanks	45	m^3/m^2d	all tanks in service
	< 80	m^3/m^2d	1 tank out of service
Upward Flow Tanks	28.8 - 43	m^3/m^2d	

References: - Manual of British Practice in Water Pollution Control 'Primary Sedimentation'

TANK DESIGN

Design Loading	m^3/m^2d	45.0		
Minimum tank diameter	(m)	34.6		
Actual Tank Diameter		32.0		
Tank Gross Surface Area - per tank	(m^2)	804.2		
Minimum stilling well diameter	(m)	4.800	at 15 % of tank diameter	(normal range 15-20%)
Actual stilling well diameter	(m)	5.20	Vol 4 section 7.6 states 10% liquid surface area	
Stilling well surface area	(m^2)	21.24		
Velocity in Stilling Well	(m/s)	0.02		
Stilling Well :Tank Diameter	%	16.3		
Stilling Well Area:Tank Area	%	2.64		
Tank nett surface - per tank	(m^2)	802		

		Maximum Flow		Min Flow	Average Flow	
No. tanks in operation		2	1	2	2	1
Tank Surface Gross Loading	($m^3/m^2.day$)	52.7	105.5	18.2	23.3	46.7
Tank Surface Nett Loading	($m^3/m^2.day$)	52.9	105.8	18.3	23.4	46.8
(allowing for inlet diffuser drum)	m/h	2.20	4.41	0.76	0.98	1.95

SIDE WALL DEPTH

Tank geometry is important for good performance since interference can occur between the incoming high velocity diffuser zone and the sludge zone (particularly in final settlement tanks) when tanks are too shallow. Note that primary tanks where activated and primary sludge are cosettled have a higher minimum sidewall height. The values calculated below are based on a floor slope of 7.5 degrees. Should the floor slope be steeper lower values may be acceptable.

	Minimum	Preferred
Primary Sidewall Depth	2.10	3
Primary Sidewall Depth (Cosettled)	2.40	3
Actual Sidewall Depth	2.50	

DIFFUSER DRUM SIZING

Tank Diameter	(m)	32.00		
		Minimum	**Maximum**	
Primary Drum Diameter	(m)	4.80	6.40	
Storm Drum Diameter	(m)	4.80	6.40	
Drum Immersion	(m)	0.300	1.500	Should be at least 1m
Height above TWL	mm	300	300	

FLOOR SLOPE (Exception cone bottomed tanks [no sludge scrapers] typically 60 degrees)

Minimum floor slope is 7.5 degrees, preferred floor slope is 11 degrees.

Floor Slope Selected	degrees	7.5	
Depth due to slope	m	2.11	Vol 4 sect. 7.6 minimum specified wall height 2.5 m
Volume of cone	m3	22	

SCRAPER SPEED

Number of scraper blades	2	
Efficiency of Scraper	1.3	Note : Efficiency is 1.3 for scraper system, 1.0 for suction lift system.

		Minimum	Maximum	Selected	
Peripheral scraper speed	m/min	1.2	1.5	1.5	Vol 4 sect. 7.6 maximum speed 2.5 m/min
Circumference of tank	m	100.5			
Time Period Between Blade	mins	54.5	43.6	43.6	

NUMBER OF SCRAPERS IS SATISFACTORY

Preferred scraper speed is 1.5 m/min for primary tanks. Note for large tanks (>30m) this can be increased to 1.8 to 2m/min.

RETENTION TIME

Capacity of tank	m3	2033

		Maximum	Minimum	Average
Inflow to each Primary Tank	(m^3/h)	1767	611	782
Sewage retention time	hrs	1.2	3.3	2.6

Note that this is not a critical parameter but in order to prevent septicity the follwing guidelines should be adhered to where possible: -
Retention period should not exceed 8 hours at DWF.
retention time at maximum flow shouldn't greatly exceed 2 hours.

SLUDGE HOPPER

Where automatic or frequent manual desludging is employed, it is recommended that the hopper should have a nominal size based on a depth of approximately 1.5m. This provides for sludge thickening within the hopper. The hopper should have sloping sides not less than 60 degrees to the horizontal and the base of the hopper should have a diameter not greatly exceeding 1m.

Diameter of hopper base	m	1.5	
Depth Of Hopper	m	1.5	
Volume of sludge hopper	m3	0.86	

Weir Loading Criteria

Primary Tanks	Must be greater than 100 m^3/md to prevent surface effects. Preferred value of around 300 m^3/md Maximum allowable 450 m^3/md

V NOTCH WEIR SIZING (90° NOTCHES)

Max Notch Discharge	(m3/d)	30.0	Maximum discharge per notch is 30-40 m^3/d.
Min Number of Notches per tank		1414	
Circumference	m	101	

Based on 2m long boards the maximum number of V notches per board is:-

Required No. V notches per 2m plate is	28	and since the maximum number of V notches in a 2m long plate is 19, a double sided weir is required
Actual No. V notches per 2m long plate	2	

Actual No Notches		200	
Act Notch Discharge	(m3/d)	212.0	
Vert Head Thro Notch	(mm)	80.7	(normally around 30 to 35mm)
Effective Weir Length	(m)	32.3	for a 45 degree V notch weir.
Weir Loading	(m3/md)	1313	(all tanks in operation)
		2627	(1 tank out of service)

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Ref: 8404 **Title :** Activated Sludge Design

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator DGH	Checked	Approved
1	4	30 Oct 06	Contract Issue	DGH		

PURAC
IBA Plant Design

Standard Process Calculation: Project-specific data input is permitted to highlighted areas only.				Project-Specific Data	
				Document Ref	8405
				Project No	C1197
				Project Name	Waterford
Calc Ref:	PCS001	Rev	Page 1	Process area code	
Author	D Garnett	Refer to PCS index for full details		Tag No(s)	
Calculation status:				Process Engineer	Dave Hemmings
				Date	13th July 2005

Inlet Data

Year 2005

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	196.7	12.3	209.0	From 8000-Design Basis +
Average Daily Flow, l/s	255.7	21.3	277.0	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	590.0	21.3	611.3	

Year 2025 (Tender)

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	317.9	28.0	345.9	From 8000-Design Basis +
Average Daily Flow, l/s	413.2	28.0	441.3	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	953.6	28.0	981.7	

Year 2025

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	317.9	28.0	345.9	From 8000-Design Basis +
Average Daily Flow, l/s	413.2	28.0	441.3	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	953.6	28.0	981.7	

DGHemmings: +20% extra load

DGHemmings: +20% extra load

DGHemmings: +20% extra load

	Raw Load kg/d	RL's kg/d	Load to PST kg/d	Concentration, mg/l Raw @DWF	Concentration, mg/l Raw+RLs @DWF
Average Daily BOD5 Load 2005	6654	993.0	7647	346	320
Average Daily BOD5 Load 2025	11436	1035.0	12471	349	327
Average Daily BOD5 Load 2025	13724	1035.0	14759	413	387
Average Daily SS Load 2005	4378	1153.0	5531	250	231
Average Daily SS Load 2025	8005	1227.0	9232	259	242
Average Daily SS Load 2025	9606	1227.0	10833	303	284
Average Daily TKN Load 2005			0	0	0
Average Daily TKN Load 2025			0	0	0
Average Daily TKN Load 2025			0	0	0
Average Daily TN Load 2005			0	0	0
Average Daily TN Load 2025			0	0	0
Average Daily TN Load 2025			0	0	0
Average Daily NH3 Load 2005	1066	135.0	1201	54	50
Average Daily NH3 Load 2025	1217	135.0	1352	38	35
Average Daily NH3 Load 2025	1461	135.0	1596	45	42
Average Daily TP Load 2005			0	0	0
Average Daily TP Load 2025			0	0	0
Average Daily TP Load 2025			0	0	0

Percentage Volatile Solids	%	70
Percentage Volatile Solids in settled sewage	%	80
Percentage Soluble BOD in raw sewage	%	30
Percentage Soluble BOD in return liquors	%	80
TKN:BOD Ratio		0.0

Are return liquors sent to ASP or inlet: Inlet

Effluent Consent Standard			Average	95 % 'ile
COD	From 8000-Design Basis	mg/l	62.5	125
BOD	From 8000-Design Basis	mg/l	12.5	25
SS	From 8000-Design Basis	mg/l	17.5	35
NH3		mg/l	N/A	#VALUE!
TN			N/A	#VALUE!
P			N/A	#VALUE!

Primary Tanks

No. of Tanks		2	
SS Removal Efficiency (max)	%	60	From 8403-PST
SS Removal Efficiency (min)	%	55	From 8403-PST
BOD5 Removal Efficiency (max)	%	30	From 8403-PST
BOD5 Removal Efficiency (min)	%	25	From 8403-PST
TKN/TN Removal Efficiency (max)	%	0	
TKN/TN Removal Efficiency (min)	%	0	
N-NH4 Removal Efficiency (max)	%	0	
N-NH4 Removal Efficiency (min)	%	0	

Primary Sludge Production

			Sludge Production, m3/d			
Percentage Dry Solids		%	1.5	2	3	5
Max Removal in year 2005	kg/d	3318	221	166	111	66
Min Removal in year 2005	kg/d	3042	203	152	101	61
Max Removal in year 2025	kg/d	5539	369	277	185	111
Min Removal in year 2025	kg/d	5078	339	254	169	102
Max Removal in year 2025	kg/d	6500	433	325	217	130
Min Removal in year 2025	kg/d	5958	397	298	199	119

SECONDARY TREATMENT

		Yr 2005		Yr 2025		Yr 2025 + 20%	
		Max	Min	Max	Min	Max	Min
BOD Load To Secondary Stage	kg/d	5736	5353	9353	8730	11069	10331
Soluble BOD Component	kg/d	2791	2791	4259	4259	4945	4945
Percentage Soluble BOD	%	49	52	46	49	45	48
TKN Load To Secondary Treatment	kg/d	0	0	0	0	0	0
SS To Secondary Treatment Stage	kg/d	2489	2212	4155	3693	4875	4333
Volatile SS Component	%	80					
Volatile SS Component	kg/d	1991	1770	3324	2954	3900	3467
Inorganic SS Component	kg/d	498	442	831	739	975	867
NH4-N Load	kg/d	1201	1201	1352	1352	1596	1596
TN Load	kg/d	0	0	0	0	0	0

Concentrations at DWF

	Yr 2005		Yr 2025		Yr 2025 + 20%	
	Max	Min	Max	Min	Max	Min
BOD concentration To Secondary Stage	318	296	313	292	370	346
Soluble BOD Component	155	155	143	143	165	165
Percentage Soluble BOD						
TKN concentration To Secondary Treatment	0	0	0	0	0	0
SS To Secondary Treatment Stage	138	123	139	124	163	145
Volatile SS Component						
Volatile SS Component	110	98	111	99	130	116
Inorganic SS Component	28	25	28	25	33	29
NH4-N concentration	67	67	45	45	53	53

Concentrations at Average Flow

	Yr 2005		Yr 2025		Yr 2025 + 20%	
	Max	Min	Max	Min	Max	Min
BOD concentration To Secondary Stage	240	224	245	229	290	271
Soluble BOD Component	117	117	112	112	130	130
Percentage Soluble BOD						
COD concentration To Secondary Treatment	0	0	0	0	0	0
SS To Secondary Treatment Stage	104	92	109	97	128	114
Volatile SS Component						
Volatile SS Component	83	74	87	77	102	91
Inorganic SS Component	21	18	22	19	26	23
NH4-N concentration	50	50	35	35	42	42

SLUDGE PRODUCTION

Extended Aeration Not used in design

Note : This equation applies where primary tanks are not utilised and where extended aeration is practiced.
It should not be used if trade effluents containing non-degradable or slowly biodegradable solids are present.
For a more detailed calculation see spreadsheet entitled 'SAS Production Rate'.

Sludge Loading (F/M Ratio)	kgBOD/kgTSSd	0.3			
Temperature	degrees C	8	10	12	20
Ratio of non biodegradable solids in raw sewage / total SS in raw sewage.		0.2	0.2	0.2	0.2
Ratio of total raw sewage SS to raw sewage BOD (Fallback value =1.2)		0.72			
Temperature	degrees C	8	10	12	20
Sludge Yield		0.79	0.79	0.78	0.73
Max Sludge Production (Yr 2005)	kg/d	4556	4514	4466	4194
Min Sludge Production (Yr 2005)	kg/d	4252	4213	4168	3915
Max Sludge Production (Yr 2025)	kg/d	7139	7061	7000	6618
Min Sludge Production (Yr 2025)	kg/d	6934	6871	6798	6384
Max Sludge Production (Yr 2025)	kg/d	8792	8712	8619	8095
Min Sludge Production (Yr 2025)	kg/d	8206	8131	8045	7555

Conventional Aeration

For well settled sewage the following equation can be used. This applies for a temperature range of 7 to 25 C

Sludge Loading (F/M Ratio)	kgBOD/kgTSSd	0.27			
Temperature	degrees C	8	10	12	20
0.75 used in tender design					
SludgeYield		**1.01**	0.75	0.80	0.51
Max Sludge Production (Yr 2005)	kg/d	**5810**	4302	4569	2899
Min Sludge Production (Yr 2005)	kg/d	**5423**	4015	4264	2706
Max Sludge Production (Yr 2025)	kg/d	**9475**	7015	7451	4727
Min Sludge Production (Yr 2025)	kg/d	**8844**	6547	6954	4412
Max Sludge Production (Yr 2025)	kg/d	**11213**	8302	8817	5594
Min Sludge Production (Yr 2025)	kg/d	**10466**	7748	8229	5221

Selector Tank Volume

Design Basis : minimum of 30 mins at DWF plus RAS or 10 mins at max flow plus RAS

Assuming RAS remains constant for both flows.

		Yr 2005	Yr 2025	Yr 2025 + 20%
RAS Flow	m3/h	752	2036	2036
30 mins at DWF plus RAS	m3	730	1590	1590
10 mins at max flow plus RAS	m3	479	912	912
30 mins at DWF		354	572	572
Selector Zone Volume	**m3**	730	1590	**1590**

MLSS	kg/m3	3.5	
Number of selector tanks		1	
Water Depth	m	5	
Tank Length	m	12	
Tank Width	m	10	
Actual Volume per tank	m3	600	
Proposed Selector Tank Volume	**m3**	**600**	Selected to give floc loading >2.3

		DWF	Average	Peak
Actual Retention Time	mins	51	39	17
Actual Retention Time (inc RAS)	mins	25	22	13
Floc Loading (>2.3)		**4.5**	(BOD kg/d /Mixed Liquor Mass in Selector)	

Note: The Floc Loading should be greater than 2.3 to encourage the growth of floc forming bacteria.
This can be increased by lowering the selector volume or mixed liquor suspended solids.

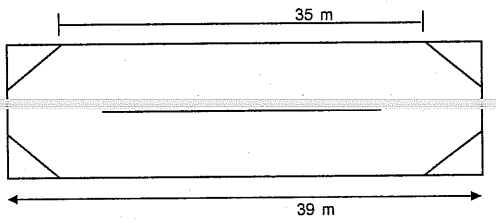
Selected F/M ratio	0.3		
Operating MLSS	3.5		
Volume Required	10542	m^3	Based upon 2025 load with 20% extra
Volume Selected	10600		as requirement to meet consent with one lane out of service.

Inclined Bubble Aeration Ditch

Selector Volume Required	m3	600	
Total Volume For Oxidation ditch	m3	10600	
			Tender drawing shows tank
Number of streams	m3	4	
Volume Per stream	m3	2650	
Minimum Sewage Depth	m	5	5
Width of each lane	m	7	7
Straight Length of each tank	m	38	48.5
Actual Volume Per Tank	m3	2660	3395
Recycle Ratio (FST to ditch)		1	

Ref: Vol 4 section 7.7.1 minimum sludge 5 days @ 10 deg C

Inclined Bubble Aeration Ditch - Tapered Ends



Area taken by corner baffles	8 m^2
total length required	38.0 m
actual total tank length	39 m
Actual Volume	2690 m^3 per ditch
	10760 m^3 total

DGHemmings: Includes 20% extra load

Actual F/M Ratio

		Average 2005		Max Year 2025		Max Year 2025		
		Max	Min	Max	Min	Max	Min	
MLSS in ASP	kg/m3	3.0	3.0	3.5	3.5	3.5	3.5	
Actual F/M Ratio		0.18	0.17	0.25	0.23	0.29	0.27	
SRT	d	8	8	5	6	5	5	SRT = Vol x MLSS/sludge prod
SRT	d	8	8	5	6	5	5	SRT = 1/(yield x F:M)

Operation With One Tank Out Of Service

MLSS in ASP	kg/m3	3.0	3.0	4.0	4.0	4.8	4.8	
Actual F/M Ratio		0.24	0.22	0.29	0.27	0.29	0.27	
SRT	d	6	6	5	5	5	5	SRT = Vol x MLSS/sludge prod
SRT	d	6	6	5	5	5	5	SRT = 1/(yield x F:M)

assumes all FST's will be in service when one activated sludge lane is taken out of service.

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8407 **Title :** SAS Sludge Production

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	3	10/11/2006	Contract Issue	DGH	RJW	RJW
2	3	16/11/06	Revised maximum sludge load	DGH		

PURAC

Sludge Production in Conventional Aeration Plants

Standard Process Calculation: *Project-specific data input is permitted to highlighted areas only.*

Calc Ref:		Rev	Page 1
Author		Refer to PCS index for full de	
Calculation status:		**CHECKED**	

Project-Specific Data

Document Ref	8407
Project No	C1197
Project Name	Waterford STW
Process area code	
Tag No(s)	TBC
Process Engineer	D. Hemmings
Date	01/11/2006

Application

Provides guidance in the calculation of the quantity of WAS produced for conventional aeration plants which utilise primary tanks.

Introduction

The calculation below can be used for a well settled sewage treating domestic sewage.

Sludge Load Produced (Average) 2005

BOD in settled sewage feed	kg/d	5353	From 8404 Activated Sludge Design
SS in settled sewage feed	kg/d	2212	From 8404 Activated Sludge Design
Temperature of sewage	degrees C	10	Ref: Vol 4 section 7.7.1
F/M Ratio		0.17	From 8404 Activated Sludge Design

Temperature of sewage	degrees C	8	10	12	20	
Yield Coefficient	kgTS/kgBOD	**0.91**	0.75	**0.72**	**0.46**	note: 0.75 in tender
Sludge Production	kgDS/d	**4883**	**4015**	**3852**	**2466**	
	tDS/yr	**1782**	**1465**	**1406**	**900**	

Sludge Dry Solids	%	Temperature	0.4	0.5	0.6
Sludge Density	kg/m3		**1001**	**1001**	**1002**
Sludge Volume	m3/d	**8**	**1219**	**975**	**813**
		10	**1003**	**802**	**668**
		12	**962**	**769**	**641**
		20	**616**	**492**	**410**

Sludge Load Produced (Average) 2025

BOD in settled sewage feed	kg/d	8730	From 8404 Activated Sludge Design
SS in settled sewage feed	kg/d	3693	From 8404 Activated Sludge Design
Temperature of sewage	degrees C	10	Vol 4 section 7.7.1
F/M Ratio		0.23	From 8404 Activated Sludge Design

Temperature of sewage	degrees C	8	10	12	20	
Yield Coefficient	kgTS/kgBOD	0.98	0.75	0.77	0.49	note: 0.75 in tender
Sludge Production	kgDS/d	8557	6547	6735	4285	
	tDS/yr	3123	2390	2458	1564	

Sludge Dry Solids	%	Temperature	0.4	0.5	0.6
Sludge Density	kg/m3		1001	1001	1002
Sludge Volume	m3/d	8	2137	1709	1424
		10	1635	1308	1089
		12	1682	1345	1121
		20	1070	856	713

dghemmings:
Only 30% BOD removal across PST

Sludge Load Produced (Maximum 20% extra) 2025

BOD in settled sewage feed	kg/d	10331	From 8404 Activated Sludge Design
SS in settled sewage feed	kg/d	4875	From 8404 Activated Sludge Design
Temperature of sewage	degrees C	10	Vol 4 section 7.7.1
F/M Ratio		0.27	From 8404 Activated Sludge Design

Temperature of sewage	degrees C	8	10	15	20	
Yield Coefficient	kgTS/kgBOD	1.02	0.75	0.67	0.51	note: 0.75 in tender
Sludge Production	kgDS/d	10502	7748	6930	5237	
	tDS/yr	3833	2828	2529	1912	

Sludge Dry Solids	%	Temperature	0.4	0.5	0.6
Sludge Density	kg/m3		1001	1001	1002
Sludge Volume	m3/d	8	2622	2097	1747
		10	1935	1547	1289
		12	1730	1384	1153
		20	1308	1046	871

PURAC

IBA Design: SAS Pumps

Standard Process Calculation: Project-specific data input is permitted to highlighted areas only.

Calc Ref:		Rev 0	Page 1
Author	D Garnett	Refer to PCS index for full details	
Calculation status:		UNCHECKED	

Project-Specific Data	
Document Ref	8407
Project No	C1197
Project Name	Waterford
Process area code	
Tag No(s)	
Process Engineer	D Hemmings
Date	01-Nov-06

APPLICATION

Provides guidance in the calculation of the sludge pump capacity required for SAS desludging.

INTRODUCTION

SAS sludge pumps are normally run on a timer basis.
The calculation below allows an estimate of the sludge pump capacity

INPUTS

		Average	Maximum
SS Load	kg/d	6547	7748
No. duty pumps per tank		1	
Pump run time	mins/hr	60	

AVERAGE SLUDGE QUANTITY REMOVED

Dry Solids Content	%	0.6	0.6	0.7	0.8
Sludge Density	kg/m3	1002	1002	1002	1002
Sludge Removed	kgDS/d	6547	6547	6547	6547
	m3/d	1089	1089	933	817

SLUDGE PUMP DUTY

Feeding 1 GBT thickener 20 h day 7 d/wk (ref: 8409 Secondary Sludge Thickener)

Hours operated per day	hr/d	20	20	20	20
Duty GBT		1	1	1	1
Pump flowrate required	m3/h	54	54	47	41
Selected Flowrate	m3/h	60			per duty pump.
Actual run time	mins/hr	54	54	47	41

MAXIMUM SLUDGE QUANTITY REMOVED

Feeding 2 GBT thickener 12.6 h day 7 d/wk (ref: 8409 Secondary Sludge Thickener)

Dry Solids Content	%	0.6	0.6	0.7	0.8
Sludge Density	kg/m3	1002	1002	1002	1002
Sludge Removed	kgDS/d	7748	7748	7748	7748
	m3/d	1289	1289	1105	966
Hours operated per day	hr/d	12.6	12.6	12.6	12.6
Duty GBT		2	2	2	2
Time to remove sludge	mins/hr	51	51	44	38

Pipe diameter	0.15	m
CSA	0.018	m2
Pump Flowrate	60	m3/h
Velocity	0.943	m/s

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8408 **Title :** Picket Fence Thickener

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	3	10/11/06	Contract Issue	DGH DGH	RJW	RJW

1. SCOPE

To calculate the WRc thickener size for the Waterford WwTW.

2. SUMMARY

No. of WRc thickeners =	1	
WRc thickener diameter =	8.700	m
Total depth =	4.000	m
Supernatant depth =	0.660	m
Launder width =	0.870	m
Launder TWL =	0.109	m below O/F

3. REFERENCES

01. Ref 1 for wastewater is Guidelines for design and operation of sewage sludge consolidation tanks WRc 1994

Design the picket fence thickener to operate in continuous mode on primary sludge only.
Assume that the primary tanks will be provided with an auto desludging system, which will operate on a semi-continuous basis for 24 hours per day, 7 days per week.
Auto desludge regime is 24 desludges per day per PST (2 PSTs). 20 minutes per desludge.
Therefore desludging for 20 min x 24 x 2 = 16 hours per day.

4. CALCULATION

4.1. Design Basis

4.1.1. Sludge Production

	Min.	Avg.	Max.		
Sludge production =	3041.94	5077.79	6500.05	kg d^{-1}	From 8404-Activated Sludge
≡	126.7	211.6	270.8	kg h^{-1}	
Primary tank removal =	55.0	55.0	60.0	%	Assumed
Solids concentration =	3.0%	3.0%	3.0%	by wt	Assumed
Sludge density =	1008.6	1008.6	1008.6	kg m^{-3}	
Sludge =	4.19	6.99	8.95	m^3 h^{-1}	

4.1.2. Thickener Design

	Min.	Avg.	Max.
No. of duty thickeners =	1	1	1
No. of standby thickeners =	0	0	0

Max. hydraulic loading rate =	0.5	m^3 m^{-2} h^{-1} … [Ref. 01]
Max. solids loading rate =	4.6	kg m^{-2} h^{-1} … Ref: Vol 4 section 7.9.1
	110.0	kg m^{-2} d^{-1} … Ref: Vol 4 section 7.9.1

4.2. WRc Thickener

4.2.1. Thickener Feed Rate

	Min.	Avg.	Max.		
Days operation =	7.0	7.0	7.0	d week^{-1}	
Hours operation =	24.0	24.0	24.0	h d^{-1}	
No. of duty units =	1	1	1		
Thickener unit feed flow =	4.19	6.99	8.95	m^3 h^{-1}	
Solids concentration =	3.0%	3.0%	3.0%	by wt	
Sludge density =	1008.6	1008.6	1008.6	kg m^{-3}	
Thickener block feed solids =	126.7	211.6	270.8	kg h^{-1}	
Maximum allowable thickener unit feed flow =	29.72	29.72	29.72	m^3 h^{-1}	
			29.00	m^3 h^{-1}	Chosen max instanteous pump rate

4.2.2. Thickened Solids

	Min.	Avg.	Max.		
Thickener recovery =	99.5%	99.5%	99.5%	by wt of inlet solids	Assumed
Cake solids =	126.1	210.5	269.5	kg h^{-1}	
Solids concentration =	*6.0%*	*6.0%*	*6.0%*	by wt	Ref: Vol 4 section 7.9.1
Sludge density =	1017.4	1017.4	1017.4	kg m^{-3}	
Thickened sludge volume =	*2.07*	*3.45*	*4.41*	m^3 h^{-1}	
			29.00	m^3 h^{-1}	Chosen max instanteous pump rate

4.2.3. Thickener Filtrate

	Min.	Avg.	Max.		
Filtrate solids =	0.6	1.1	1.4	kg h^{-1}	
Approx. centrate density =	1000.0	1000.0	1000.0	kg m^{-3}	Assumed
Average Filtrate flow =	*2.12*	*3.54*	*4.54*	m^3 h^{-1}	
			29.00	m^3 h^{-1}	Max instanteous discharge rate
Filtrate solids concentration =	*0.30*	*0.30*	*0.30*	kg m^{-3}	
≡	*299*	*299*	*299*	mg L^{-1}	WRc guidelines for sewage sludge consolidation tanks
Solids concentration =	0.03%	0.03%	0.03%	by wt	140 mg/l
Load =	15.2	25.4	32.5	kg/d	

4.2.4. Thickened Sludge Storage (Emergency)

	Min.	Avg.	Max.		
Days operation =	3.0	3.0	3.0	d	Ref: Vol 4 section 7.9.3 storage of 3 days
Hours production =	24.0	24.0	24.0	h d^{-1}	production of thickened primary sludge
No. of duty tanks =	1	1	1		
Sludge storage volume =	148.74	248.29	317.83	m^3	

4.2.5. Thickener Diameter

	Min.	Avg.	Max.	
Hydraulic load =	4.2	7.0	29.0	m^3 m^{-1}
Solids load =	*126.7*	*211.6*	*270.8*	kg h^{-1}
No. of thickeners =	1	1	1	
Unit hydraulic load =	4.2	7.0	29.0	m^3 h^{-1} $thickener^{-1}$
Unit solids load =	126.7	*211.6*	*270.8*	kg h^{-1} $thickener^{-1}$
Hydraulic diameter =	3.266	4.220	8.593	m
Solids diameter =	5.934	*7.666*	*8.674*	m

Thickener is	Solids limited	
Diameter selected =	*8.700*	m
Diameter selected from Permastore Range =	*8.530*	m

4.2.6. Depths

Total depth =	*4.000*	m	Ref: Vol 4 section 7.9.1; Needs to be at least 4m process depth
Supernatant depth =	*0.660*	m	… Ref. 01

4.2.7. Launder

Launder width =	*0.870*	m	… Ref. 01
Liquid depth =	*0.109*	m below thickener O/F	… Ref. 01

4.2.8. Sludge Retention

Chosen capacity =	*237.000*	m^3	
Sludge volume =	*190.869*	m^3	
Sludge depth =	*3.340*	m	
Hydraulic retention @ max sludge flow =	*1.802*	d	Ref: Vol 4 section 7.9.1; minimum 1 d

PERMASTORE STANDARD DIMENSIONS FOR A PICKET FENCE THICKENER

Model Reference (Height)				5	10	15	20	25	30	35	40	45	50
Actual Height (m)				1.47	2.867	4.264	5.661	7.058	8.455	9.852	11.249	12.846	14.043
Number of rings				1	2	3	4	5	6	7	8	9	10
Model Ref	Actual Diameter	Floor Area m2	Sheets Per Ring	NOMINAL CAPACITY (m3)									
8	2.56	5.14	3	7	14	21	28	36	43	50	57	64	72
11	3.41	9.14	4	12	25	38	51	63	76	89	102	115	127
14	4.27	14.29	5	19	39	59	79	99	119	139	159	179	199
17	5.12	20.58	6	28	56	85	114	143	171	200	229	258	286
20	5.97	28.01	7	38	77	116	155	194	233	2782	312	351	390
22	6.82	36.58	8	49	100	151	203	254	305	356	407	458	509
25	7.68	46.3	9	62	127	192	256	321	386	450	515	580	644
28	**8.53**	**57.16**	**10**	77	157	**237**	316	396	476	556	636	716	795
30	9.38	69.16	11	93	190	286	383	479	576	673	769	866	963
33	10.24	82.3	12	111	226	341	456	571	686	801	916	1031	1146
36	11.09	96.59	13	130	265	400	535	670	805	940	1075	1209	1344
39	11.94	112.03	14	151	307	464	620	777	933	1090	1246	1403	1559
42	12.8	128.6	15	173	353	532	712	892	1071	1251	1431	1610	1790
45	13.65	146.32	16	197	401	606	810	1014	1219	1423	1628	1832	2036
47	14.5	185.18	17	222	453	684	914	1145	1376	1607	1837	2068	2299
50	15.36	185.18	18	249	508	766	1025	1284	1543	1801	2060	2319	
53	16.21	206.33	19	278	566	854	1142	1431	1719	2007	2295	2583	
56	17.06	228.62	20	307	627	946	1266	1585	1904	2224	2543		
59	17.91	252.06	21	339	691	1043	1395	1748	2100	2452	2804		
62	18.77	276.63	22	372	759	1145	1531	1918	2304	2691	3077		
64	19.62	302.35	23	407	829	1251	1674	2096	2519	2941	3363		
67	20.47	329.22	24	443	903	1363	1823	2282	2742	3202	3662		
70	21.33	357.22	25	480	980	1479	1976	2477	2976	3475	3974		
73	22.18	386.37	26	520	1059	1599	2139	2679	3218	3758			
76	23.03	416.67	27	560	1142	1725	2307	2889	3471	4053			
78	23.89	448.1	28	603	1229	1855	2481	3107	3733	4359			
81	24.74	480.68	29	647	1318	1990	2661	3333	4004	4676			
84	25.59	514.4	30	692	1410	2129	2848	3566	4285				
86	26.45	549.27	31	739	1506	2273	3041	3808	4575				
89	27.3	585.27	32	787	1605	2422	3240	4058	4875				
92	28.15	622.43	33	837	1707	2576	3446	4315	5185				
95	29	680.72	34	889	1812	2735	3658	4581	5504				
98	29.88	700.16	35	942	1920	2898	3876	4854	5832				
101	30.71	740.74	36	996	2031	3066	4101	5136					
103	31.56	782.46	37	1052	2146	3239	4332	5425					
106	32.42	825.33	38	1110	2263	3416	4589	5722					
109	33.27	869.34	39	1169	2384	3598	4813	6027					
112	34.12	914.49	40	1230	2508	3785	5063	6340					
115	34.98	960.79	41	1292	2634	3977	5319	6661					
118	35.83	1008.23	42	1356	2765	4173	5582	6990					
120	36.68	1056.81	43	1421	2898	4374	5850	7327					
123	37.54	1106.53	44	1488	3034	4580	6126	7672					
126	38.39	1157.4	45	1557	3174	4790	6407						
129	39.24	1209.42	46	1627	3316	5005	6695						
131	40.09	1262.57	47	1698	3462	5226	6990						
134	40.95	1316.87	48	1771	3611	5451	7290						
137	41.8	1372.31	49	1848	3763	5680	7597						
140	42.65	1428.89	50	1922	3918	5914	7910						
143	43.51	1486.62	51	2000	4076	6153	8230						
145	44.38	1545.49	52	2079	4238	6397	8556						
148	45.21	1605.5	53	2159	4402	6645	8888						

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8409 **Title :** GBT Design

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	2	10/11/2006	Contract Issue	DGH	RJW	RJW
2	2	16/11/06	Revised 2 machine operating hours	DGH		

1. SCOPE

To calculate the thickener duties for the Waterford WwTW

2. SUMMARY

2.1. Scheme [Thickeners]

	Min.	Avg.	Max.		
No. of duty units =	1	1	2		
Thickener feed flow =	40.09	54.47	55.00	$m^3 h^{-1}$	per machine
Thickener feed solids =	0.5%	0.6%	0.6%	by wt	
≡	200.7	327.4	330.6	$kg h^{-1}$	per machine
Thickened solids =	***5.0%***	***5.0%***	***5.0%***	by wt	
Filtrate solids consent =	441	540	540	$mg L^{-1}$	

3. REFERENCES

3.1. Duty [From AS Plant]

DGHemmings:
Includes 20% extra load at only 30%BOD removal across PST

3.1.1. SAS Sludge Feed

	Min.	Avg.	Max.	
Sludge production =	4014.89	6547.43	7748.24	$kg d^{-1}$
≡	167.3	272.8	322.8	$kg h^{-1}$
Solids concentration =	0.5%	0.6%	0.6%	by wt
Sludge density =	1001.4	1001.7	1001.7	$kg m^{-3}$
Sludge =	33.41	45.39	53.72	$m^3 h^{-1}$

3.1.2. SAS Buffer Tank

	Min.	Avg.	Max.	
Days operation =	1.0	1.0	1.0	d
Hours production =	0.0	0.0	0.0	$h d^{-1}$
No. of duty tanks =	1	1	1	
Sludge storage volume =	0.00	0.00	0.00	m^3

3.1.2. Thickener Feed Rate

	Min.	Avg.	Max.		
Days operation =	7.0	7.0	7.0	d week^{-1}	
Hours operation =	20.0	20.0	11.7	h d^{-1}	Vol 4 section 7.9.7 treat average sludge load in < 20 hours
No. of duty units =	1	1	2		
Thickener unit feed flow =	40.09	54.47	55.00	m^3 h^{-1}	
Solids concentration =	0.5%	0.6%	0.6%	by wt	
Sludge density =	1001.4	1001.7	1001.7	kg m^{-3}	
Thickener block feed solids =	200.7	327.4	330.6	kg h^{-1}	per machine

3.1.3. Thickened Solids

	Min.	Avg.	Max.		
Thickener recovery =	92.0%	92.0%	92.0%	by wt of inlet solids	
Cake solids =	184.7	301.2	304.1	kg h^{-1}	per machine
Solids concentration =	***5.0%***	***5.0%***	***5.0%***	by wt	
Sludge density =	1014.5	1014.5	1014.5	kg m^{-3}	
Thickened sludge volume =	***3.64***	***5.94***	***6.00***	m^3 h^{-1}	per machine

3.1.4. Thickener Filtrate

	Min.	Avg.	Max.		
Filtrate solids =	16.1	26.2	26.4	kg h^{-1}	
Approx. centrate density =	1000.0	1000.0	1000.0	kg m^{-3}	
Filtrate flow =	***36.46***	***48.54***	***49.01***	m^3 h^{-1}	per machine
Filtrate solids concentration =	***0.44***	***0.54***	***0.54***	kg m^{-3}	
≡	***441***	***540***	***540***	mg L^{-1}	
Solids concentration =	0.04%	0.05%	0.05%	by wt	
Return Load =	321.2	523.8	619.9	kg/d	
Wash water and make-up consumption =	6.5	6.5	6.5	m^3 h^{-1}	Sernagiotto Literature (1200N)
Total filtrate return =	43.0	55.0	111.0	m^3 h^{-1}	

3.1.5. Thickened Filter Sludge Storage

	Min.	Avg.	Max.		
Days operation =	3.0	3.0	3.0	d	Vol 4 section 7.9.3 storage of 3 days
Hours production =	20.0	20.0	11.7	h d^{-1}	production of thickened secondary sludge
No. of duty tanks =	1	1	1		
Sludge storage volume =	218.46	356.26	421.59	m^3	

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8420 **Title :** Pasteurisier

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	6	04/06/2007	Contract Issue	DGH		

DESIGN BASIS FOR WATERFORD STW

1. Indigenous sludge production

Yearly sludge production 0 tDS/year
0 kgDS/day

Primary sludge thickness	6	6	6	%DS by means of new Picket Fence Thickeners (EPS)
Density	1017	1017	1017	kg/m3
Secondary sludge thickness	5	5	5	%DS by means of a new SAS thickener (EPS)
Density	1014	1014	1014	kg/m3

	Minimum	Average	Maximum		
Primary sludge production	3041	5078	6499	kgDS/day	From 8408 Primary Sludge Thickening
Primary sludge volume	50	83	106	m3/day	
Secondary sludge production	3694	6024	7116	kgDS/day	From 8409 Secondary Sludge Thickening
Secondary sludge volume	73	119	140	m3/day	
Total indigenous sludge volume	**122.6**	**201.9**	**246.7**	m3/day	
Percentage dry solids of the blend	5.4	5.4	5.5	%DS	

2. Imported sludge

Type of imported sludge Unknown
In the future, the sludge will be imported in consolidation tanks prior to digestion. Imported sludge will not be thickened.

	Minimum	Average	Maximum	
Yearly import	0	0	0	tDS/year
Import 5 days a week	0	0	0	kgDS/day
Thickness of imported sludge	3.0	3.0	3.0	%DS
Density	1009	1009	1009	kg/m3
Volume	**0.0**	**0.0**	**0.0**	m3/day

3. Total sludge throughput

PASTEURISATION PLANT DESIGN BASIS

	Minimum	Average	Maximum	
Total sludge production	0	0	0	tDS/year
	6735	11102	13615	kgDS/day
Total volume	**123**	**202**	**247**	m3/day
Total percentage dry solids	5.41	5.42	5.41	%DS
	Normally at maximum flow:		5.44	%DS

4. Check retention time in the digesters

No off digesters	2			
Individual volume	1721	m3		8412 Digester design sheet
Volume	3442	m3		
Retention time	28.1	17.0	13.9	days

5. Biogas production

Average gas production 3776 m3/day 8413 Gas production sheet

PASTEURISATION PLANT DESIGN BASIS

Sludge Input criteria

	Max	Avg	Min	
Sludge Make	13615	11102	6735	kg DS/d
Flowrate	10.3	8.4	5.1	m3/h
Thickness	5.4%	5.4%	5.4%	% DS
Density	1016	1016	1016	kg/m3
Viscosity at 10 degC For an upper bound sludge	35.12	23.32	14.6	Nm2/s CHECK WITH LOWESTOFT DE

	Summer	Winter	
Sludge Temp	15	5	degrees C Assumed

Enter Installed Digester Capacity: 3442 m3

Specific Heat Capacity: 4.186 kJ/kg.K

For the purpose of the heat requirement calculations, winter and summer conditions will be defined using maximum operational conditions (sludge throughput and %DS) for summer and minimal operational conditions for winter.

Operational Requirements

Pasteurisation Temp: 55 degrees (70 degrees min recommended)

Pasteurisation Time: 240 minutes as a minimum (35 minutes minimum recommended)

Hrs of Operation: 20 hrs per day to make allowance for down time (22 hrs recommended)
Ref: Vol 4 section 7.9.5 (average daily load treated in 20 hours)

Range of flowrate	12.3	10.1	5.1	m3/h

	Option 1		Option 2	
Digestion Temp	35	Mesophilic	-	Thermophilic

Digesters heat losses

The design of the heat exchangers is based on the maximum and minimum sludge flows, i.e.

15.0 m3/hr. 5.1 m3/hr

See spreadsheet "Digester heat losses".

Note: This includes the heat losses in the pipelines.

	Maximum flow		Minimum flow		
	Summer	Winter	Summer	Winter	
Heat losses	95.4	206.1	47.7	103.1	kW

The corresponding rise in temperature is:

$$\text{Temp (deg C)} = \frac{\text{Energy (kW)} \times 3600}{\text{Heat Capacity(kJ/kg.K)} \times \text{Flow (m3/hr)} \times \text{Density (kg/m3)}}$$

Temperature rise	6.5	14.1	7.9	17.1	deg C
Final temperature	41.5	49.1	42.9	52.1	deg C

SIZING OF THE PASTEURISATION UNIT

Sludge Input criteria

	Max	Avg	Min	
Sludge Make	13615	11102	6735	kg DS/d
Flowrate	10.3	8.4	5.1	15.0 m3/h
Thickness	5.4%	5.4%	5%	% DS
Density	1016	1016	1016	kg/m3
Viscosity at 10 degC For an upper bound sludge	35.12	23.32	14.6	Nm2/s

Operational Requirements

Pasteurisation Temp	55	degrees (70 degrees min recommended)
Pasteurisation Time	240	min as a minimum (35 minutes minimum recommended)
Hrs of Operation	20	hrs per day to make allowance for down time (22 hrs recommended)

			Alfa Laval		
Actual Flowrate	**12.3**	**10.1**	**5.1**	**15.0**	m3/h

Channel (0.018m x 0.25m)
SA = 0.0045 m2
velocity = 0.925926 m/s

0

2 cycles per day option

Number of tanks	**3**				
Number of complete cyles per day	**2**		Therefore number of tank empties per day		6
Time of cycle	720	min	720	720	
	Max		15	15	
Duration of fill stage	280	min			
Duration of pasteurise stage	**240**	min	**240**	**240**	
Duration of empty stage	200	min	**CHECK**		
			Avg	**Min**	
Volume of sludge	41.1	m3	33.7	20.4	
Discharge rate	12.3	m3/h			
Fill time @ chosen tank size	164	min	135	82	
Discharge rate @ chosen tank size	15.0	m3/h	15.0	12.0	
Discharge time @ chosen tank size	164.0	min	134.6	102.2	
Total cycle time	732.0	min	643.9	485.3	min
Volume of sludge discharged	246.0	m3/d	201.9	122.6	m3/d OK
Idle time	-12.0		76.1	234.7	min

Pasteurisation tank unit

				Chosen	
Volume of the bottom section			**49.3**	**41.0**	m3
	Min	Average	Max		
Retention time	240	293	579	199	min
Time allowed for filling bottom section			**0**	**0**	min
Real retention time	240	293	579	199	min
Internal diameter of the unit			3.5	3.5	m
Wall thickness			0.005	0.005	m
Lagging thickness			0.05	0.05	m
External diameter of the unit			3.61	3.61	m
Minimum sludge water depth in top tank			**0.000**	**0.000**	mm N/A

(Note: the sludge water depth is measured from the top of the truncated section of the upper tank)

Volume in the top tank	49.3	41.0	m3	
Freeboard in top tank	**0.500**	**0.500**	m	
Minimum lagging under the tank	**0.200**	**0.200**	m	
Partition between top and bottom tanks	**60**	**60**	degrees inc	Chosen for sizing
Maximum height of the top tank	**7.150**	**6.282**	m	6.250 m
Total heigth of the pasteurisation unit	**7.850**	**6.982**	m	6.750 m

Sludge inlet pipe diameter	**0.150**	**0.200**	m
Sludge inlet pipe level	11.47	9.73	m
Sludge outlet pipe top section diameter			m
Sludge outlet pipe top section level	10.509	8.773	m
Sludge inlet pipe bottom section level			m
Sludge outlet pipe diameter	**0.150**	**0.150**	m
Sludge outlet pipe level	0.325	0.350	m

Note: level 0.00 is taken as being at the bottom of the pasteurisation tank, including the bottom insulation.
The level of pipes is the level of the center section of the pipes.

PASTEURISATION TANK HEAT LOSSES Rev 1

Reason for revision:
Heat losses for the three tanks configuration (previous calculations were for one tank).

Drawing ref:

		Minimum	Average	Maximum	
Temperatures					
Heated raw sludge in	^{0}C	57	57	57	
Inside Pasteuriser	^{0}C	55	55	55	
Air	^{0}C	-10	-10	-10	
Ground	^{0}C	0	0	0	
Sludge					
Specific Heat	kJ/kg.^{0}C	4.186	4.186	4.186	
Feedrate	m^3/h	5.1	10.1	12.3	
Solids concentration	% w/w	5.4	5.4	5.4	
Density	kg/m^3	1015.7	1015.7	1015.7	
Pasteuriser					
Retention time	mins	481.4	243.6	199.4	
Total retention volume Selected	m^3	41.000	41.000	41.000	
Number of tanks	m^3	1	1	1	
Thermal conductivities					
Steel Wall	W/m.^{0}C	45.000	45.000	45.000	45.000
Steel Floor	W/m.^{0}C	45.000	45.000	45.000	45.000
Concrete roof	W/m.^{0}C	1.500	1.500	1.500	1.500
Steel roof	W/m.^{0}C	45.000	45.000	45.000	45.000
Roof/wall insulation	W/m.^{0}C	0.037	0.037	0.037	0.037
Wet soil	W/m.^{0}C	0.700	0.700	0.700	0.700
Film coefficients					
Sludge	W/m^2.^{0}C	1000.000	1000.000	1000.000	1000.000
Gas / air	W/m^2.^{0}C	50.000	50.000	50.000	50.000
Thickness of soil heated by Pasteuriser	m	1.000	1.000	1.000	1.000
Pasteuriser dimensions		Steel Roof	Steel Roof with lagging and cladding	Steel Roof	Steel Roof
Inner diameter	m	3.500	3.500	3.500	3.500
Overall height of Pasteuriser, roof & motor above ground	m	6.750	6.750	6.750	6.750
Overall height of Pasteuriser, floor & base below ground	m	0.000	0.000	0.000	0.000
Side wall					
Below ground	m	0.000	0.000	0.000	0.000
Above ground	m	6.750	6.750	6.750	6.750
Total height	m	6.750	6.750	6.750	6.750
Wetted wall height	m	6.250	6.250	6.250	6.250
Wetted roof depth	m	0.000	0.000	0.000	0.000
Sludge freeboard	m	0.500	0.500	0.500	0.500
Height of gear box & motor	m				
Floor					
Slope	^{0}	60.000	60.000	60.000	60.000
Depth	m	3.031	3.031	3.031	3.031
Roof					
Slope	^{0}	0.000	0.000	0.000	0.000
Height	m	0.000	0.000	0.000	0.000
Pasteuriser sludge volume	m^3	41.000	41.000	41.000	0.000
Wall thickness	m	0.005	0.005	0.005	0.005
Floor thickness	m	0.005	0.005	0.005	0.005
Roof thickness	m	0.005	0.005	0.005	0.005
Wall insulation thickness	m	0.050	0.050	0.050	0.050
Floor insulation thickness	m	0.050	0.050	0.050	0.050
Roof insulation thickness	m	0.050	0.050	0.050	0.050

Surface areas

Pasteuriser base					
Inner surface area	m^2	33.501	33.501	33.501	33.501
Outer surface area	m^2	33.741	33.741	33.741	33.741
Log mean suface area	m^2	33.621	33.621	33.621	33.621
Pasteuriser base insulation in contact with air					
Inner surface area	m^2	33.741	33.741	33.741	33.741
Outer surface area	m^2	36.203	36.203	36.203	36.203
Log mean suface area	m^2	34.958	34.958	34.958	34.958
Wetted Pasteuriser wall in contact with soil					
Inner surface area	m^2	0.000	0.000	0.000	0.000
Outer surface area	m^2	0.000	0.000	0.000	0.000
Log mean suface area	m^2	0.000	0.000	0.000	0.000
Wetted Pasteuriser wall insulation in contact with soil					
Inner surface area	m^2	0.000	0.000	0.000	0.000
Outer surface area	m^2	0.000	0.000	0.000	0.000
Log mean suface area	m^2	0.000	0.000	0.000	0.000
Wetted Pasteuriser wall above ground level					
Inner surface area	m^2	68.722	68.722	68.722	68.722
Outer surface area	m^2	68.919	68.919	68.919	68.919
Log mean suface area	m^2	68.820	68.820	68.820	68.820
Wetted Pasteuriser wall insulation in contact with air					
Inner surface area	m^2	68.919	68.919	68.919	68.919
Outer surface area	m^2	70.882	70.882	70.882	70.882
Log mean suface area	m^2	69.896	69.896	69.896	69.896
Dry Pasteuriser wall above ground					
Inner surface area	m^2	5.498	5.498	5.498	5.498
Outer surface area	m^2	5.513	5.513	5.513	5.513
Log mean suface area	m^2	5.506	5.506	5.506	5.506
Dry Pasteuriser wall insulation in contact with air					
Inner surface area	m^2	5.513	5.513	5.513	5.513
Outer surface area	m^2	5.671	5.671	5.671	5.671
Log mean suface area	m^2	5.592	5.592	5.592	5.592
Dry Pasteuriser roof					
Inner surface area	m^2	16.837	16.837	16.837	16.837
Outer surface area	m^2	16.982	16.982	16.982	16.982
Log mean suface area	m^2	16.909	16.909	16.909	16.909
Dry Pasteuriser roof insulation in contact with air					
Inner surface area	m^2	16.982	16.982	16.982	16.982
Outer surface area	m^2	18.475	18.475	18.475	18.475
Log mean suface area	m^2	17.718	17.718	17.718	17.718

Heating requirements

Heat losses from pasteurisation tank

$$\text{Heat losses} = \frac{\text{Tin-Tout}}{\frac{1}{\text{Sludge film coef x SA in}} + \frac{\text{Wall thickness}}{\text{Therm.cond x SAmean}} + \frac{\text{Insulation thick}}{\text{Therm.cond x SAmean}} + \frac{1}{\text{Air film coef x SA out}}}$$

Note: The air film coefficient insulation has not been taken into account in the following calculations.

Pasteuriser floor	kW	1.680	1.680	1.680	0.000
Wetted Pasteuriser wall in contact with soil	kW	0.000	0.000	0.000	0.000
Wetted Pasteuriser wall in contact with air	kW	3.362	3.362	3.362	0.000
Dry Pasteuriser wall in contact with air	kW	0.269	0.269	0.269	0.000
Dry Pasteuriser Roof in contact with air	kW	0.852	0.852	0.852	0.000
Sub - total	kW	**6.16**	**6.16**	**6.16**	**0.00**
Assuming the three tanks are full	kW	**6.16**	**6.16**	**6.16**	**0.00**
Heat required by feed sludge	kW	0.000	0.000	0.000	0.000
Miscellaneous losses (pipes etc)	kW	0.616	0.616	0.616	0.000

Note: there is no heat losses in the heat exchangers.

TOTAL HEAT REQUIRED FOR SITE	kW	**6.8**	**6.8**	**6.8**	**0.0**
Equivalent temperature drop based on feed rate only	d°C	**1.1**	**0.6**	**0.5**	**#DIV/0!**
Equivalent temperature drop	d°C	**3.4**	**1.7**	**1.4**	**#DIV/0!**

In reality, the sludge spend three time the amount of time needed for filling only as a batch will then be pasteurised and emptied.
This is taken into account in the equivalent temperature drop calculation cells.

The temperature depletion has been calculated using the following formulas.

Energy (kW) = Sludge Specific Heat x Mass Flux x (Tin-Tout)

Sludge Specific Heat = 4.186 kJ/kg/dK

Mass Flux (kg/s)= Sludge Flow (m3/hr) x density (kg/m3) / 3600

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8416 **Title :** Heat Exchanger

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	2	04/06/2007	Contract Issue	DGH		

HEAT EXCHANGER DESIGN

2. DESIGN WITH INCREASED FLOW (for AL)

The minimum sludge flow through the heat exchangers will be advised by Alfa Laval. It is usually 15m3/hr

Feed flow through the heat exchangers | 15 | m/hr

Recirculation around the hot water heat exchangers

Say recirculation around the hot water HE is | 15 | m3/hr minimum

Temperature at inlet of heat recovery	15	5	15	5	deg C

The maximum percentage dry solids that will be recirculated is 6%DS.
The minimum is still 5%DS.

Mass Flux	**4.23**	**4.23**	**4.23**	**4.23**	kg/s
Energy	**443**	**620**	**443**	**620**	kW
Temperature rise	**25**	**35**	**25**	**35**	deg C
Sludge temperature out	**40**	**40**	**40**	**40**	deg C

Heat Exchanger No.2 (Hot water)

Raw sludge

Sludge temperature in	40	40	40	40	deg C

Allowance must be made for the heat losses in the pasteurisation tank and such determining the temperature of the sludge after the hot water heat exchangers.

Heat losses	6.8	6.8	6.8	6.8	kW (see calcs. Pasteurisation Tank Heat Losses)
Rise in temperature	0.47	0.47	1.12	1.12	deg Celsius
Sludge temperature out	55	55	56	56	deg C
Chosen temperature	**57.0**	**57.0**	**57.0**	**57.0**	deg C

The energy (kW) needed to heat the raw sludge is:

Energy (kW) = Specific Heat x Mass Flux x (Tin-Tout)

Specific Heat = 4.186 kJ/kg/dK
Mass Flux (kg/s)= Sludge Flow (m3/hr) x density (kg/m3) / 3600

Mass Flux	4.23	4.23	4.23	4.23	kg/s
Energy	**301**	**301**	**301**	**301**	kW

The equivalent energy will have to be provided using Hot Water.
Maximum acceptable temperature for the hot water | 70 | deg C

Total energy requirement	**744**	**921**	**744**	**921**	kW

3. ENERGY NEEDED AT PLANT START UP

There is no heat recovery when the plant is starting up and the sludge will be heated by means of the hot water heat exchangers only.

	Maximum flow		**Minimum flow**	
	Summer	**Winter**	**Summer**	**Winter**
Temperature in	15	5	15	5
Flowrate	15.0	15.0	5.1	5.1

Temperature needed	57	57	57	57	
Flowrate	**15.0**	**15.0**	**5.1**	**5.1**	m3/hr
Mass flux	4.23	4.23	1.44	1.44	kg/s
Energy needed	744.1	921.2	253.5	313.8	kW

Purchase 2 new boilers operating as duty/assist.

Each will be rated at	500	kW	
Duty/assist	1000	kW	okay for normal operation

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8412 **Title :** Digester Sizing

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	20/11/2006	Contract Issue	DGH DAH		

DIGESTER SIZING

		Case 1	Case 2	Case 3	Case 4	
Number of Digesters		2	**2**	2	2	
Total Feed Volumetric Flowrate	m^3/d	246.47	**209.04**	201.52	122.39	
All Digesters in Service						
Flowrate per Digester	m^3/d	123.24	**104.52**	100.76	61.20	Check against pasteurisation design sheets 8420
Retention Time Required	d	14.0	**14.0**	14.0	14.0	Ref: Vol 4 scetion 7.9.6
Minimum Digester Capacity Required	m^3	1725	**1463**	1411	857	
Allowance for Grit build-up	%	1.0	**5.0**	5.0	5.0	
Design Capacity	m^3	1743	**1536**	1481	900	
Capacity Selected	m^3	1700	**1700**	1700	1700	
Ratio of Diameter to Height (h=nxd)		0.90	**0.90**	0.90	0.90	
Floor Slope Selected	degrees	10.00	**10.00**	10.00	10.00	
Calculated Diameter	m	13.255	**13.255**	13.255	13.255	
Calculated Height	m	11.930	**11.930**	11.930	11.930	
Selected Diameter	m	13.300	**13.300**	13.300	13.300	
Selected Height	m	12.000	**12.000**	12.000	12.000	Height restriction of 16.9m AOD, GL = 5m AOD
Volume of Selected Tank	m^3	1721	**1721**	1721	1721	Note: Tendered volume 1660 m3
Retention Time in Selected Tank	d	14.0	**16.5**	17.1	28.1	
Some Digesters Out of Service						
Number of Digesters Out of Service		1	**1**	1	1	
Number of Digesters Remaining		1	**1**	1	1	
Flowrate per Digester	m^3/d	246.47	**209.04**	201.52	122.39	
Retention Time Required	d	14.00	**14.00**	14.00	14.00	
Minimum Digester Capacity Required	m^3	3451	**2927**	2821	1713	
Allowance for Grit build-up	%	1.0	**5.0**	5.0	5.0	
Design Capacity	m^3	3485	**3073**	2962	1799	
Capacity Selected	m^3	1600	**1600**	1600	1600	
Ratio of Diameter to Height (h=nxd)		0.90	**0.90**	0.90	0.90	
Floor Slope Selected	degrees	10.00	**10.00**	10.00	10.00	
Calculated Diameter	m	12.990	**12.990**	12.990	12.990	
Calculated Height	m	11.691	**11.691**	11.691	11.691	
Selected Diameter	m	13.300	13.300	13.300	13.300	
Selected Height	m	12.000	12.000	12.000	12.000	
Volume of Selected Tank	m^3	1721	**1721**	1721	1721	
Retention Time in Selected Tank	d	7.0	**8.2**	8.5	14.1	

Digester Size Selection Summary

Selected Diameter	m	13.300	13.300	13.300	13.300
Selected Height	m	12.000	12.000	12.000	12.000
Volume of Selected Tank	m^3	1721	**1721**	1721	1721

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8415 **Title :** Digester Heat Loss

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	3	04/06/2007	Contract Issue	DGH		

DIGESTERS HEAT LOSSES - Mesophilic operation

Drawing references:

		Maximum flow		Minimum flow		
Temperatures		Summer	Winter	Summer	Winter	
Operation of digestion		**Mesophilic**				
Raw sludge in	^{0}C	37	39	37	40	Indicative values, not used in ca
Inside Digester	^{0}C	35	35	35	35	Average
Air	^{0}C	15	-10	15	-10	To allow for windchill
Ground	^{0}C	0	0	0	0	
Sludge						
Specific Heat	kJ/kg.^{0}C	4.186	4.186	4.186	4.186	
Feedrate	m^3/h	12.34	12.34	5.11	5.11	
Solids concentration	% w/w	5.41%	5.41%	5.41%	5.41%	
Density	kg/m^3	1015.7	1015.7	1015.7	1015.7	
Digester						
Retention time *	days	**13.9**	**13.9**	**14.0**	**14.0**	
(with 1 digester in service only)		6.97	6.97	7.02	7.02	
Total retention volume Selected	m^3	3442	3442	1721	1721	
No digesters		2	2	1	1	
Retention volume of each digester	m^3	1721	1721	1721	1721	
Maximum permitted heatlosses						
Temperature drop	^{0}C	1.00	1.00	1.00	1.00	
Time	h	24	24	24	24	
Energy	kJ	7.317E+06	7.317E+06	7.317E+06	7.317E+06	
Rate of heat loss per digester	**kW**	**84.69**	**84.69**	**84.69**	**84.69**	
Thermal conductivities						
Steel Wall	W/m.^{0}C	45	45	45	45	
Steel Floor	W/m.^{0}C	45	45	45	45	
Concrete wall	W/m.^{0}C	1.5	1.5	1.5	1.5	
Concrete floor	W/m.^{0}C	1.5	1.5	1.5	1.5	
Concrete roof	W/m.^{0}C	1.5	1.5	1.5	1.5	
Steel roof	W/m.^{0}C	45	45	45	45	
GRP roof	W/m.^{0}C	1.5	1.5	1.5	1.5	
Roof/wall insulation	W/m.^{0}C	0.037	0.037	0.037	0.037	
Wet soil	W/m.^{0}C	0.7	0.7	0.7	0.7	
Film coefficients						
Sludge	W/m^2.^{0}C	1000	1000	1000	1000	
Gas and external air	W/m^2.^{0}C	50	50	50	50	
Thickness of soil heated by digester	m	1	1	1	1	
Primary digester dimensions						
NB area sums will need to be changed if different		**Concrete Roof**	Concrete Roof	Concrete Roof	Concrete Roof	
Inner diameter	m	14.25	14.25	14.25	14.25	
Overall height of digester, roof & motor above ground	m	12.30	12.3	12.3	12.3	
Overall height of digester, floor & base below ground	m	1.356	1.356329738	1.356329738	1.356329738	
Side wall						
Below ground	m	0.1	0.1	0.1	0.1	
Above ground	m	11.650	11.650	11.650	11.650	
Total height	m	11.750	11.750	11.750	11.750	
Wetted wall height	m	10.750	10.750	10.750	10.750	
Wetted roof depth	m	0.000	0.000	0.000	0.000	
Sludge freeboard	m	1.000	1.0	1.0	1.0	
Height of gear box & motor	m					
Floor						
Slope	^{0}	10.0	10.00	10.00	10.00	
Depth	m	1.256	1.256	1.256	1.256	
Roof						
Slope	^{0}	0.0	0.0	0.0	0.0	
Height	m	0.00	0.0	0.0	0.0	
Total digester sludge volume	m^3	3442	3442	3442	3442	
Wall thickness (average)	m	0.500	0.500	0.500	0.500	

Floor thickness	m	0.5	0.500	0.500	0.500
Roof thickness	m	0.300	0.300	0.300	0.300
Wall insulation thickness	m	0	0.000	0.000	0.000
Floor insulation thickness	m	0	0.000	0.000	0.000
Roof insulation thickness	m	0	0.000	0.000	0.000
Surface areas					
Digester base					
Inner surface area	m^2	161.9	161.9	161.9	161.9
Outer surface area	m^2	167.6	167.6	167.6	167.6
Log mean suface area	m^2	**164.8**	**164.8**	**164.8**	**164.8**
Wetted digester base insulation in contact with air					
Inner surface area	m^2	0.0	0.0	0.0	0.0
Outer surface area	m^2	0.0	0.0	0.0	0.0
Log mean suface area	m^2	0	0	0	0
Wetted digester wall in contact with soil					
Inner surface area	m^2	4.8	4.8	4.8	4.8
Outer surface area	m^2	5.4	5.4	5.4	5.4
Log mean suface area	m^2	**5.1**	**5.1**	**5.1**	**5.1**
Wetted digester insulation wall / soil					
Inner surface area	m^2	0.0	0.0	0.0	0.0
Outer surface area	m^2	0.0	0.0	0.0	0.0
Log mean suface area	m^2	**0.0**	**0.0**	**0.0**	**0.0**
Wetted digester wall above ground					
Inner surface area	m^2	476.8	476.8	476.8	476.8
Outer surface area	m^2	510.2	510.2	510.2	510.2
Log mean suface area	m^2	**493.3**	**493.3**	**493.3**	**493.3**
Wetted digester wall insulation in contact with air					
Inner surface area	m^2	0.0	0.0	0.0	0.0
Outer surface area	m^2	0.0	0.0	0.0	0.0
Log mean suface area	m^2	**0.0**	**0.0**	**0.0**	**0.0**
Dry digester wall above ground					
Inner surface area	m^2	44.8	44.8	44.8	44.8
Outer surface area	m^2	47.9	47.9	47.9	47.9
Log mean suface area	m^2	**46.3**	**46.3**	**46.3**	**46.3**
Dry digester wall insulation in contact with air					
Inner surface area	m^2	0.0	0.0	0.0	0.0
Outer surface area	m^2	0.0	0.0	0.0	0.0
Log mean suface area	m^2	**0.0**	**0.0**	**0.0**	**0.0**
Dry digester roof in contact with air					
Inner surface area	m^2	159.5	159.5	159.5	159.5
Outer Surface area	m^2	166.3	166.3	166.3	166.3
Log mean suface area	m^2	**162.9**	**162.9**	**162.9**	**162.9**
Roof insulation in contact with air					
Inner surface area	m^2	0.0	0.0	0.0	0.0
Outer Surface area	m^2	0.0	0.0	0.0	0.0
Log mean suface area	m^2	0.0	0.0	0.0	0.0

Heating requirements

The typical equation for the Heat losses for wetted wall is

$$\text{Heat losses} = \frac{\text{Tin-Tout}}{\frac{1}{\text{Sludge film coef x SA in}} + \frac{\text{Wall thickness}}{\text{Therm.cond x SAmean}} + \frac{\text{Insulation thick}}{\text{Therm.cond x SAmean}} + \frac{1}{\text{4ir film coef x SA out}}}$$

(this later is not taken into accounts in calcs)

Notes: In the following calculations, this formula is corrected for dry surfaces and includes a Gas film coefficient instead of the sludge film coefficient.
It is also corrected if there is no insulation.
The heat losses from digester floor consider that there is 1 meter thickness of wetted ground below the digester.
However, CHANGE FORMULA ACCORDING TO THE MATERIAL USED.

Heat losses from digesters

Digester floor	kW	3.3	3.3	3.3	3.3	
Wetted digester wall in contact with soil	kW	0.1	0.1	0.1	0.1	
Wetted digester wall in contact with air	kW	29.5	66.4	29.5	66.4	
Dry Digester wall in contact with air (gas space)	kW	0.0	0.0	0.0	0.0	
Dry Digester Roof in contact with air	kW	14.8	33.2	14.8	33.2	
Sub - total	kW	**47.7**	**103.1**	47.7	103.1	
Heat required by feed sludge	kW	0.0	0.0	0.0	0.0	
Miscellaneous losses (pipes etc)	kW	9.5	20.6	4.8	10.3	(Estimate)
TOTAL HEAT REQUIRED FOR SITE	kW	**95.4**	**206.1**	**47.7**	**103.1**	
TOTAL HEAT REQUIRED PER DIGESTER		47.7	103.1	47.7	103.1	

Quick heat losses estimation

Assuming that a digester has been designed to loose not more than 1 degrees C per m3 per day in winter;

$$\text{Heat Loss (kW)} = \frac{\text{Specific Heat x Digester Volume (m3) x Density x 1 deg C}}{24 \times 3600}$$

In summer, the heat losses are half the winter heatlosses (approximatively).

	Maximum flow		Minimum flow		
	Summer	**Winter**	**Summer**	**Winter**	
kW	**97.4**	**194.9**	**97.4**	**194.9**	
			48.7	**97.4**	single digester

The estimated values are very close from the calculated values. The calculations will take into account the calculated values.

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8413 **Title :** Gas Production

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	20/11/2006	Contract Issue	DGH DGH		

DIGESTER GAS PRODUCTION					
		Case 1	Case 2	Case 3	Case 4
Total Sludge Volatile Solids	kg VS/d	10298	8737	8391	5091
Specific Gas Yield	m^3/kg VS	1.00	1.00	1.00	1.00
Net Gas Calorific Value	MJ/m^3	22.50	22.50	22.50	22.50
Minimum Volatile Solids Destruction					
Minimum Volatile Solids Reduction	%	40	40	40	40
Minimum Volatile Solids Destroyed	kg VS/d	4119	3495	3357	2037
Minimum Gas Yield (Total)	m^3/d	4119	3495	3357	2037
Minimum Net Gas Fuel Value (Total)	kW	1073	910	874	530
Average Volatile Solids Destruction					
Average Volatile Solids Reduction	%	45	45	45	45
Average Volatile Solids Destroyed	kg VS/d	4634	3932	3776	2291
Average Gas Yield (Total)	m^3/d	4634	3932	3776	2291
Average Net Gas Fuel Value (Total)	kW	1207	1024	983	597
Maximum Volatile Solids Destruction					
Maximum Volatile Solids Reduction	%	50	50	50	50
Maximum Volatile Solids Destroyed	kg VS/d	5149	4369	4196	2546
Maximum Gas Yield (Total)	m^3/d	5149	4369	4196	2546
Maximum Net Gas Fuel Value (Total)	kW	1341	1138	1093	663
Gas Production Per Digester (All Digesters in Service)					
Minimum Gas Production	m^3/d	2060	1747	1678	1018
Average Gas Production	m^3/d	2317	1966	1888	1146
Maximum Gas Production	m^3/d	2574	2184	2098	1273
Gas Production Per Digester (Some Digesters Out of Service)					
Minimum Gas Production	m^3/d	4119	3495	3357	2037
Average Gas Production	m^3/d	4634	3932	3776	2291
Maximum Gas Production	m^3/d	5149	4369	4196	2546
Digester Outlet Solids Concentration					
Digesters Feed Volume	m^3/d	246.47	209.04	201.52	122.39
Digesters Feed Dry Solids	kg DS/d	14247	12086	11625	7056
Digesters Feed Volatile Solids	kg VS/d	10298	8737	8391	5091
Reduction of Volatile Solids	%	40	40	40	40
Volatile Solids Destroyed	kg VS/d	4119	3495	3357	2037
Volatile Solids in Digesters Outlet	kg VS/d	6179	5242	5035	3055
Dry Solids in Digester Outlet	kg DS/d	10128	8591	8268	5019
Digester Outlet Dry Solids Concentration	% DS	4.11	4.11	4.10	4.10
Reduction of Volatile Solids	%	45	45	45	45
Volatile Solids Destroyed	kg VS/d	4634	3932	3776	2291
Volatile Solids in Digesters Outlet	kg VS/d	5664	4805	4615	2800
Dry Solids in Digester Outlet	kg DS/d	9613	8154	7849	4765
Digester Outlet Dry Solids Concentration	% DS	3.90	3.90	3.89	3.89
Reduction of Volatile Solids	%	50	50	50	50
Volatile Solids Destroyed	kg VS/d	5149	4369	4196	2546
Volatile Solids in Digesters Outlet	kg VS/d	5149	4369	4196	2546
Dry Solids in Digester Outlet	kg DS/d	9098	7717	7429	4510
Digester Outlet Dry Solids Concentration	% DS	3.69	3.69	3.69	3.69

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8418 **Title :** Gas System Equipment

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	20/11/2006	Contract Issue	DGH	DG	DG
2	1	16/04/2007	Whessoe valve information changed	DGH	RJM	DG
3	1	07/01/2008	Gas holder sized to give 1 hours retention	RJM		

GAS HOLDER, EXCESS GAS BURNER AND DIGESTER PRESSURE/VACUUM RELIEF VALVES SIZING

		Case 1	Case 2	Case 3	Case 4	
Gas Holder						
Number of Gas Holders		1	1	1	1	
Average Gas Production Rate	m^3/h	193	164	157	95	
Retention Time in each Gas Holder	min	60	60	60	60	
Capacity of each Gas Holder	m^3	193	164	157	95	
Selected Capacity of each Gas Holder	m^3	200	200	200	200	
Retention Time at Minimum Production Rate	min	70	82	86	141	
Retention Time at Average Production Rate	min	62	73	76	126	
Retention Time at Maximum Production Rate	min	56	66	69	113	
Excess Gas Burner						
Maximum Gas Production Rate	m^3/h	215	182	175	106	
Gas Burner Oversizing Margin	%	25	25	25	25	
Gas Burner Capacity Required	m^3/h	268	228	219	133	
Digester Pressure/Vacuum Relief Valve - Pressure Relief Condition						
Maximum Gas Production Rate	m^3/h	107	91	87	53	
Mixing Compressor Flowrate	m^3/h	0	0	0	0	Mechanical Mixing
Digester Feed Volume	m^3/h	15	15	15	15	Ref: Pasteurisation design sheets 8420
Pressure Relief Rate Required	m^3/h	122	106	102	68	
Digester Pressure/Vacuum Relief Valve - Vacuum Relief Condition						
Digester Height (Centre of Cone to TWL)	m	13.173	13.173	13.173	13.173	
Drain Pipe Diameter (ID)	m	0.20	0.20	0.20	0.20	
Drain Pipe Length	m	10.0	15.0	18.0	20.0	
Roughness	mm	0.5	0.5	0.5	0.5	
Fittings K_T		2	2	2	2	

Maximum vacuum relief rate will occur when the friction loss in the outlet line is equal to the static head above the outlet. To evaluate this, the flowrate at which the static head is equal to the friction loss must be determined. Note that the friction factor and hence the friction loss is dependent on the flowrate so the equations must be solved by iteration.

To solve, use the following procedure :

From "Tools" menu choose "Goal Seek"
In "Set cell" box enter "C64", "D64", "E64", "F64"
In "To value" box enter number contained in cell C39, D39, E39, F39
In "By changing cell" box enter "C56", "D56", "E56", "F56"

Maximum Flowrate	m^3/h	882	824	794	776
Water Temperature for Design	°C	35.0	35.0	35.0	35.0
Water Density	kg/m^3	994	994	994	994
Water Viscosity	mNs/m^2	0.7204	0.7204	0.7204	0.7204
Velocity	m/s	7.80	7.28	7.02	6.86
Reynolds Number		2152745	2010124	1937033	1892508
Friction Factor	f us	0.02495	0.02495	0.02496	0.02496
Dynamic Head Loss	m H_2O	13.17	13.17	13.17	13.17
Vacuum Relief Flowrate Required	m^3/h	882	824	794	776

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8410 **Title :** Digested Sludge Dewaterer

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	2	22 NOV 06	Contract Issue	DGH DGH	[illegible]	[illegible]

1. SCOPE

To calculate the dewaterer duties for the Waterford scheme

2. SUMMARY

2.1. Scheme [Thickeners]

	Min.	Avg.	Max.	
No. of duty units =	1	1	2	
Thickener feed flow =	6.04	10.35	10.35	$m^3 h^{-1}$
Thickener feed solids =	3.9%	4.1%	4.1%	by wt
≡	238.3	429.6	429.4	$kg h^{-1}$
Thickened solids =	*23.0%*	*23.0%*	*23.0%*	by wt
Filtrate solids consent =	3697	3923	3923	$mg L^{-1}$

3. REFERENCES

3.1. Duty [From Digester]

3.1.1. Sludge Feed

	Min.	Avg.	Max.		
Sludge production =	4765.00	8591.00	10128.00	$kg d^{-1}$	Ref: 8413 Sludge Digestion Gas Production
≡	198.5	358.0	422.0	$kg h^{-1}$	
Solids concentration =	3.9%	4.1%	4.1%	by wt	
Sludge density =	1011.3	1011.9	1011.9	$kg m^{-3}$	
Sludge =	5.03	8.63	10.17	$m^3 h^{-1}$	

3.1.2. Digested Sludge Buffer Tank

	Min.	Avg.	Max.		
Days operation =	5.0	5.0	5.0	d	Ref: Vol 4 section 7.9.3
Hours production =	24.0	24.0	24.0	$h d^{-1}$	
No. of duty tanks =	1	1	1		
Sludge storage volume =	604.09	1035.41	1220.65	m^3	

3.1.2. Dewaterer Feed Rate

	Min.	Avg.	Max.		
Days operation =	7.0	7.0	7.0	$d week^{-1}$	
Hours operation =	20.0	20.0	11.8	$h d^{-1}$	Clause 7.9.7 treat average sludge load in < 20 hours
No. of duty units =	1	1	2		
Thickener unit feed flow =	6.04	10.35	10.35	$m^3 h^{-1}$	per machine
Solids concentration =	3.9%	4.1%	4.1%	by wt	
Sludge density =	1011.3	1011.9	1011.9	$kg m^{-3}$	
Thickener block feed solids =	238.3	429.6	429.4	$kg h^{-1}$	

3.1.3. Thickened Solids

	Min.	Avg.	Max.		
Thickener recovery =	92.0%	92.0%	92.0%	by wt of inlet solids	
Cake solids =	219.2	395.2	395.0	kg h^{-1}	per machine
Solids concentration =	***23.0%***	***23.0%***	***23.0%***	by wt	
Sludge density =	1070.3	1070.3	1070.3	kg m^{-3}	
Thickened sludge volume =	***0.89***	***1.61***	***1.60***	m^3 h^{-1}	per machine

3.1.4. Thickener Filtrate

	Min.	Avg.	Max.		
Filtrate solids =	19.1	34.4	34.4	kg h^{-1}	
Approx. centrate density =	1000.0	1000.0	1000.0	kg m^{-3}	
Filtrate flow =	***5.16***	***8.76***	***8.76***	m^3 h^{-1}	per machine
Filtrate solids concentration =	***3.70***	***3.92***	***3.92***	kg m^{-3}	
≡	***3697***	***3923***	***3923***	mg L^{-1}	
Solids concentration =	0.37%	0.39%	0.39%	by wt	
Return Load =	381.2	687.3	810.2	kg/d	
Wash water and make-up consumption =	20.3	20.3	20.3		Sernagiotto Literature (BPF 2000)
Total filtrate return =	25.4	29.0	58.0	m^3 h^{-1}	

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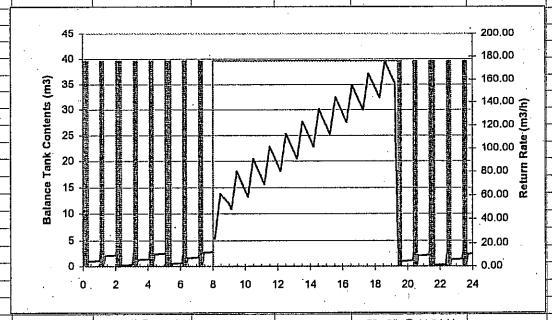
PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8422 **Title :** Return Liquor Tank

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	01/02/2007	Contract Issue	DGH		

Time	Starts per hour	Sources	Instantaneous Flow m3/h	
		FST Scum	0.14	Est
1	4.0	PFT Supernatent	29	Ref:8408
2	3.0	GBT Filtrate	111	Ref:8409
3	4.0	Sludge Tank Overflow	0	Est
4	3.0	Pasteuriser Cooler	0	Est
5	3.0	Sludge Dewaterer Filtrate	58	Ref:8410
6	4.0	Gas Condensate	0.10	Est
7	3.0	Poly Make-up Area	3.6	Est
8	3.0			
9	1.0			
10	0.0	***Liquor Holding Tanks***		
11	0.0	Start Volume	3.0	m3
12	0.0	Tank Volume	39.6	m3
13	0.0	Stops Volume	2	m3
14	0.0	Return Rate to PST	176.40	m3/h
15	0.0		2.94	m3/min
16	0.0		49.00	l/s
17	0.0	Return Time	12.11	hr
18	0.0			
19	0.0			
20	2.0			



111m3/h @ 11.7 h/d

58m3/h @ 11.8 h/d

Information Required

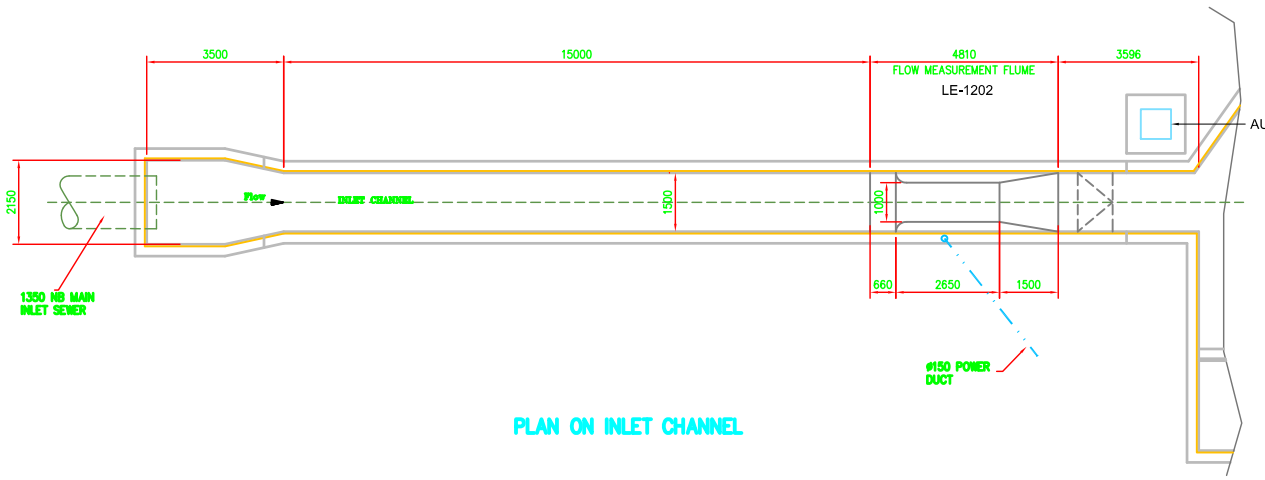
No. of Pumps	1				
Individual Pump Flow Rate	176.40	m3/h			
Max. No. of Starts per hour	8	h-1			
Sump Volume to Overflow	39.6	m3			
Sump Volume Check	5.51	m3	Diam		
Sump Area	9.62	m2	3.5	m	
Minimum Sump Volume	5.51	m3			
Sump Depth to Overflow	4.12	m			
BWL	3.62	m			
Minimum Sump Level	1	m			
Overflow Level	5.12	m			

				Flow (m3/min													Graph		
		Time (hours)	Time (mins)	FST Scum	PFT Supernatent	GBT Filtrate	Sludge Tank Overflow	Pasteuriser Cooler	Sludge Dewaterer Filtrate	Gas Condensate	Poly Make-up Area	Total Flow Into Liquor Tank	Flow Out Of Tank	Cumulative Volume	Tank Contents			Tank Contents	Discharge Rate (m3/h)	
21	3.0	0.00	0.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	3.0	3.0		0.0	3.0	0.00	A
22	3.0	0.02	1.0	0.0	0.5		0.0	0.0		0.0		0.5	2.94	3.5	3.5		0.0	3.5	176.40	1
23	4.0	0.03	2.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	4.0	1.0		0.0	1.0	0.00	A
24	3.0	0.05	3.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	4.5	1.5		0.1	1.5	0.00	A
		0.07	4.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	4.9	2.0		0.1	2.0	0.00	A
		0.08	5.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	5.4	2.5		0.1	2.5	0.00	A
		0.10	6.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	5.9	3.0		0.1	3.0	0.00	A
		0.12	7.0	0.0	0.5		0.0	0.0		0.0		0.5	2.94	6.4	3.5		0.1	3.5	176.40	1
		0.13	8.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	6.9	1.0		0.1	1.0	0.00	A
		0.15	9.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	7.4	1.5		0.2	1.5	0.00	A
		0.17	10.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	7.9	2.0		0.2	2.0	0.00	A
		0.18	11.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	8.4	2.5		0.2	2.5	0.00	A
		0.20	12.0	0.0	0.5		0.0	0.0		0.0		0.5	0.00	8.8	3.0		0.2	3.0	0.00	A
		0.22	13.0	0.0	0.5		0.0	0.0		0.0		0.5	2.94	9.3	3.5		0.2	3.5	176.40	1

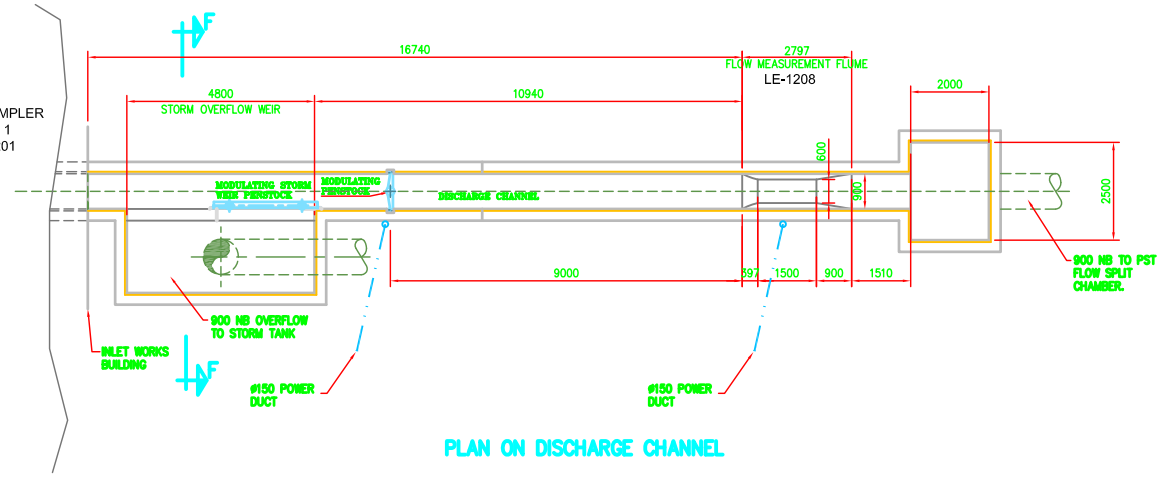
DO NOT SCALE - IF IN DOUBT ASK

Drg. No. C1197-2000

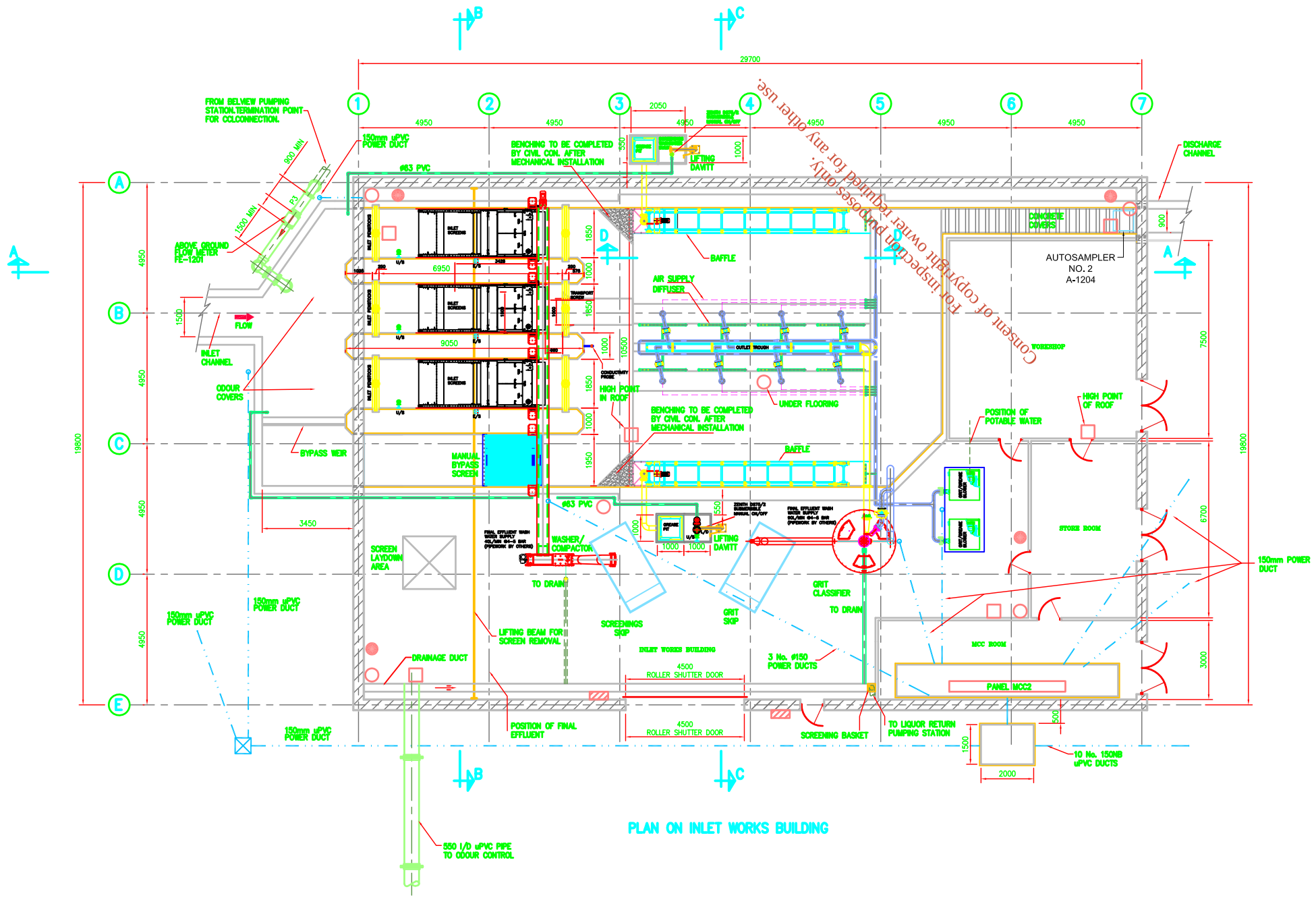
Rev. 9



PLAN ON INLET CHANNEL



PLAN ON DISCHARGE CHANNEL



PLAN ON INLET WORKS BUILDING

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
9		GAS DETECTION SYSTEM ADDED.	

NOTES

1. SEE DRAWING No C1197-9403 FOR DUCT SIZING AND ROUTING INFORMATION.

- ○ H_2S (LOW LEVEL)
- ● O_2 (1.5 – 1.8m)
- □ CH_4 (HIGH LEVEL)
- ▨ STATUS INDICATOR

APPROVED FOR CIVIL DESIGN
REV. 6 DATE 03/07/2007
SIGNATURE JMNORTON

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW COMPLETED
DATE: 08/03/2007 SIGNATURE: JMNorton

A.W.I. CONTRACT No 1002

..\03 Title Blocks\Coffey Logo.JPG enpure

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Customer: WATERFORD CITY COUNCIL

Title: INLET WORKS
GENERAL ARRANGEMENT - PLAN
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
07/11/2006			1:100
Drg. No. C1197-2000			Rev. 9

AFC UNDER REVISION

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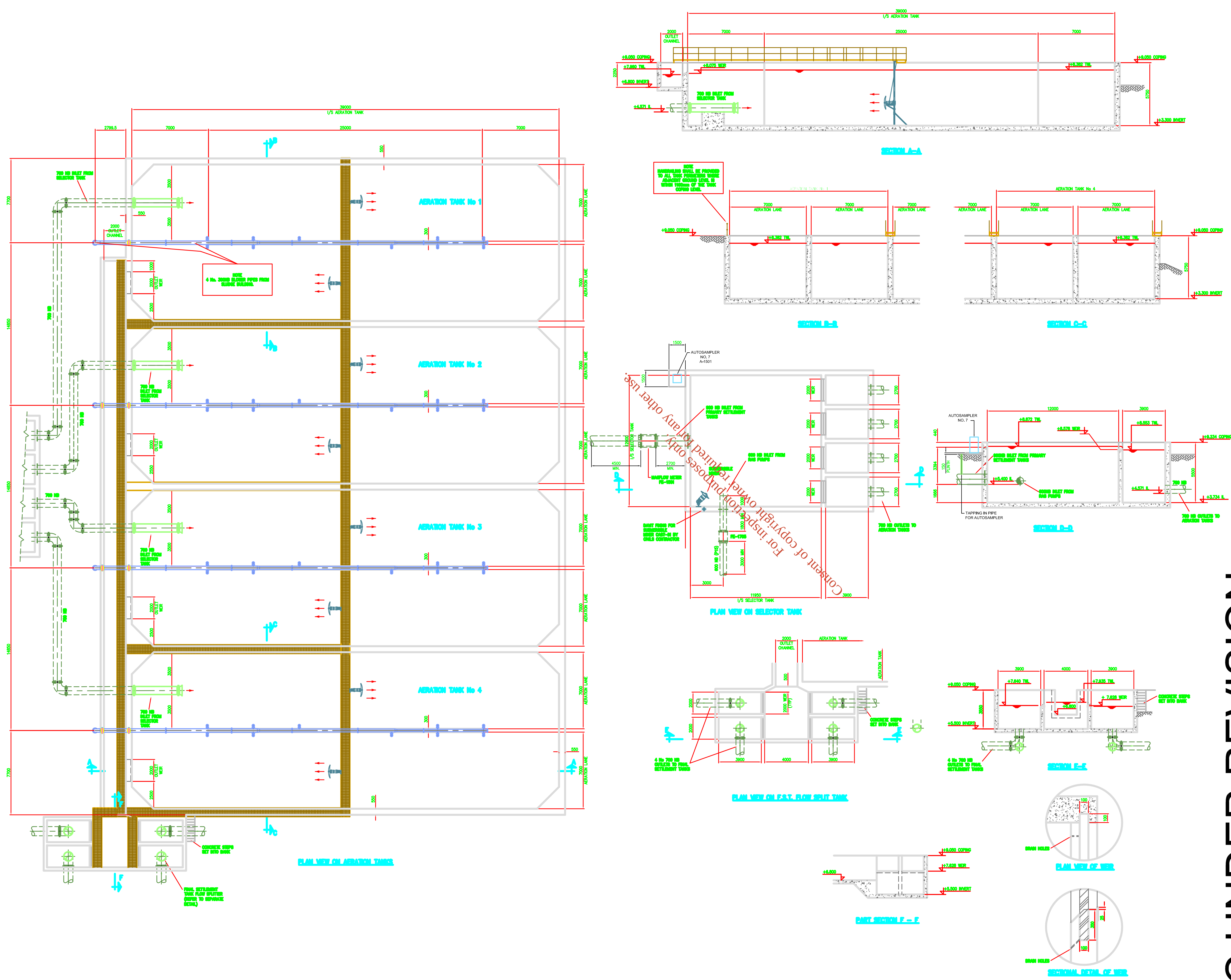

AFC UNDER REVISION

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
5		TWL 7.960 WAS 7.935, TWL 8.872 WAS 8.885, TWL 7.640 WAS 7.553	

APPROVED FOR CIVIL DESIGN
REV. 5 DATE
SIGNATURE

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW
COMPLETED
A.W.I. CONTRACT No 1002
DATE: 03/07/2007 SIGNATURE: DJTildesley

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Customer: WATERFORD CITY COUNCIL

Title: SELECTOR AND AERATION TANKS GENERAL ARRANGEMENTS WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date 07/11/2006	Date	Date	Original Scale 1:175

Drg. No. C1197-2006 Rev. 5

DO NOT SCALE - IF IN DOUBT ASK

Rev. C
Drg. No. C1197-2020

+6.200
+5.732 TWL
+5.400 WEIR
+4.993 TWL
5200
IL +3.400
IL +3.100
EL +3.000
FLOWMETER FE2703
STORM IL +1.900
IL +1.100
(RYAN HANLEY TO CONFIRM) IL +1.000
NB 900
2700 MIN

SECTIONAL ELEVATION A-A

AUTO SAMPLER A-2705
AUTO SAMPLER A-2702
+6.200
PRESSURE VESSEL
AUTOMATIC STRAINER
GV
GV
NRV
NRV
TAPER 80/150
EL +3.000

ELEVATION B-B

GV
GV
ACT.GV
GV
GV
PRESSURE VESSEL
3200
3800
203
525
900 NB FROM STORM TANK OVERFLOWS (DUCTILE IRON)
1200 NB TO RIVER OUTFALL (CONCRETE) (RYAN HANLEY TO CONFIRM)
2600
900 NB FROM FINAL SETTLEMENT TANKS (DUCTILE IRON)
FLOWMETER FE2703
AUTO SAMPLER A-2705
NB 900
1200
600
300
2100
3800
AUTO SAMPLER A-2702
BY

PLAN VIEW ON F.E. WASHWATER PUMPING CHAMBER

IN REVIEW

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
C		DRAWING UPDATED.	

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

Title: FINAL EFFLUENT WASHWATER PUMPING CHAMBER
GENERAL ARRANGEMENTS
WATERFORD WWTW

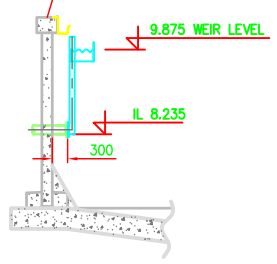
Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
07/11/2006			1:25
Drg. No. C1197-2020			Rev. C

DO NOT SCALE - IF IN DOUBT ASK

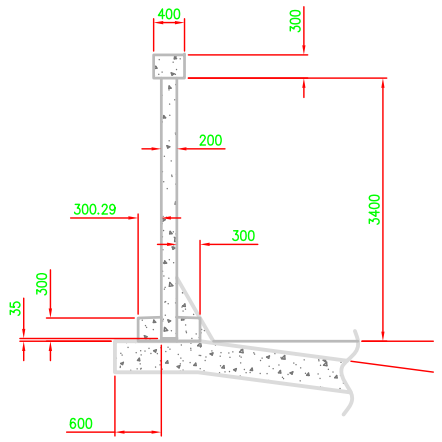
Rev. 3

Drg. No. C1197-2004

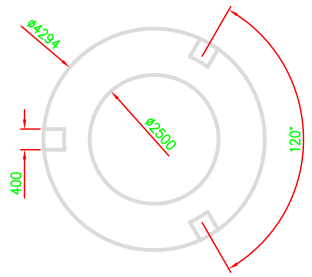
NOTE:
NO SUDDEN STEPS BETWEEN CAPPING, SURFACE PERIMETER LEVEL TO WITHIN ± 5mm



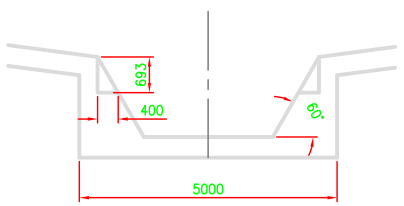
ODOUR OUTLET SECTION



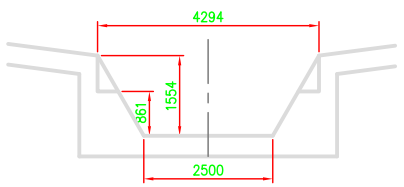
WALL TO BASE CONNECTION
(SCALE 1:50)



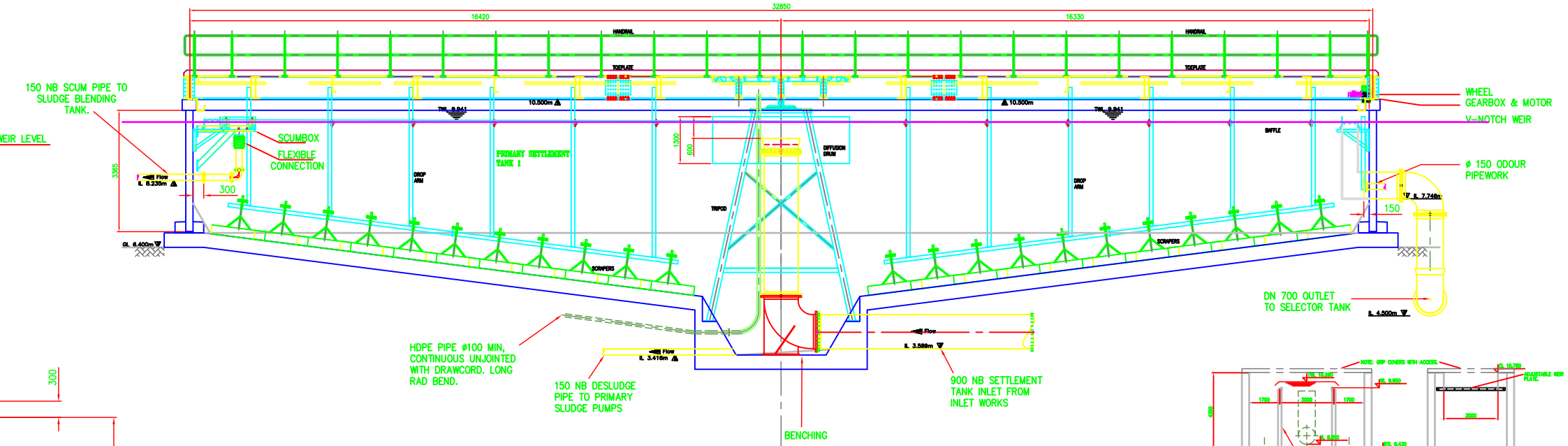
PLAN ON HOPPER



SECTION A-A

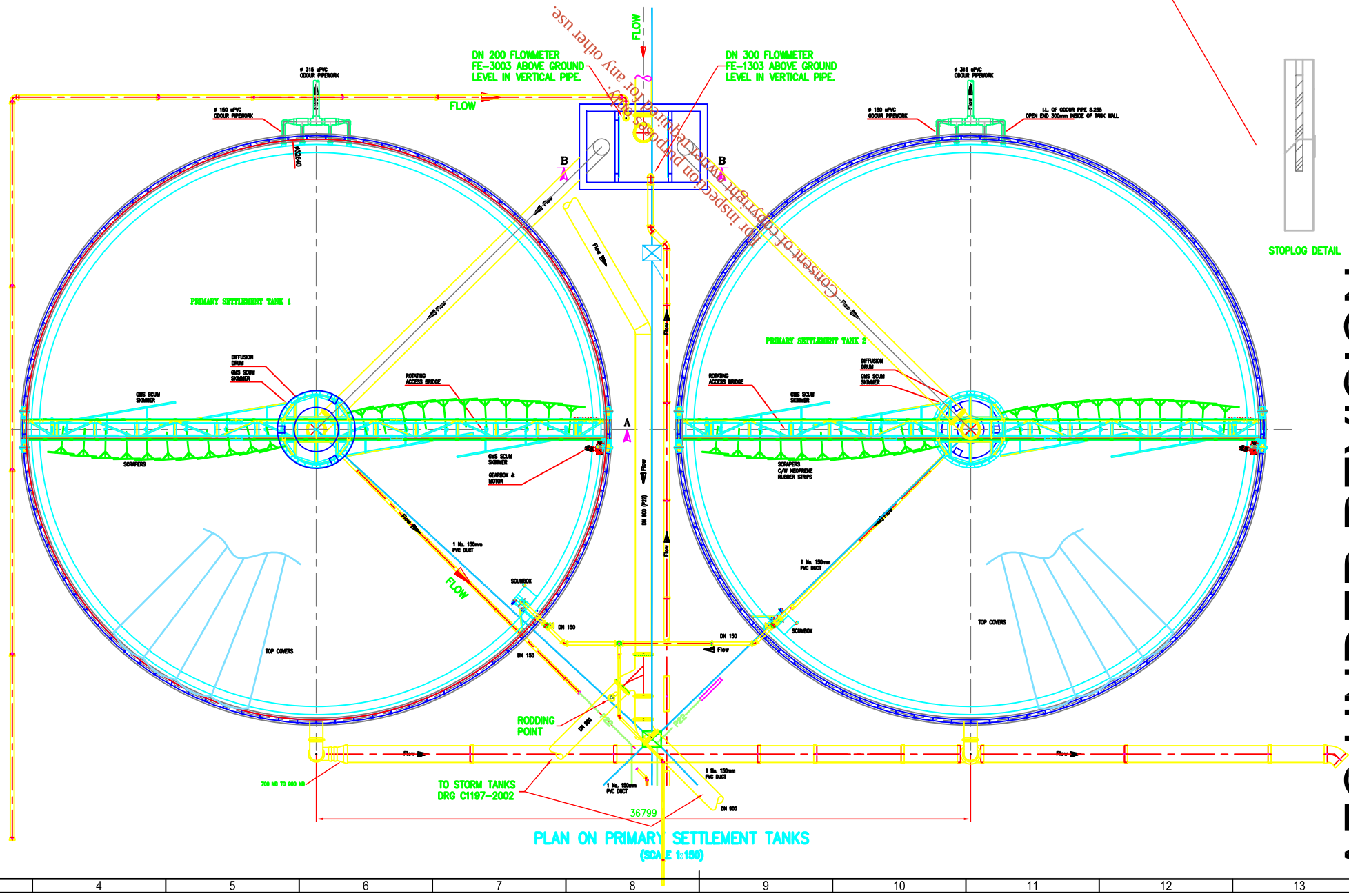


SECTION B-B



TYPICAL SECTION THROUGH PRIMARY SETTLEMENT TANK
(2 TANKS REQUIRED TOTAL)

SECTIONAL VIEWS OF P.S.T SPLITTER BOX
(SCALE 1:100)



PLAN ON PRIMARY SETTLEMENT TANKS
(SCALE 1:150)

STOPLOG DETAIL

AFC UNDER REVISION

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
3		TWL 9.941 WAS 9.909	

APPROVED FOR CIVIL DESIGN
REV. 3 DATE
SIGNATURE

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW COMPLETED
DATE: 05/11/2007 SIGNATURE: JMNorton

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

Title: PRIMARY SETTLEMENT TANKS
GENERAL ARRANGEMENTS
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
07/11/2006			1:75
Drg. No. C1197-2004			Rev. 3

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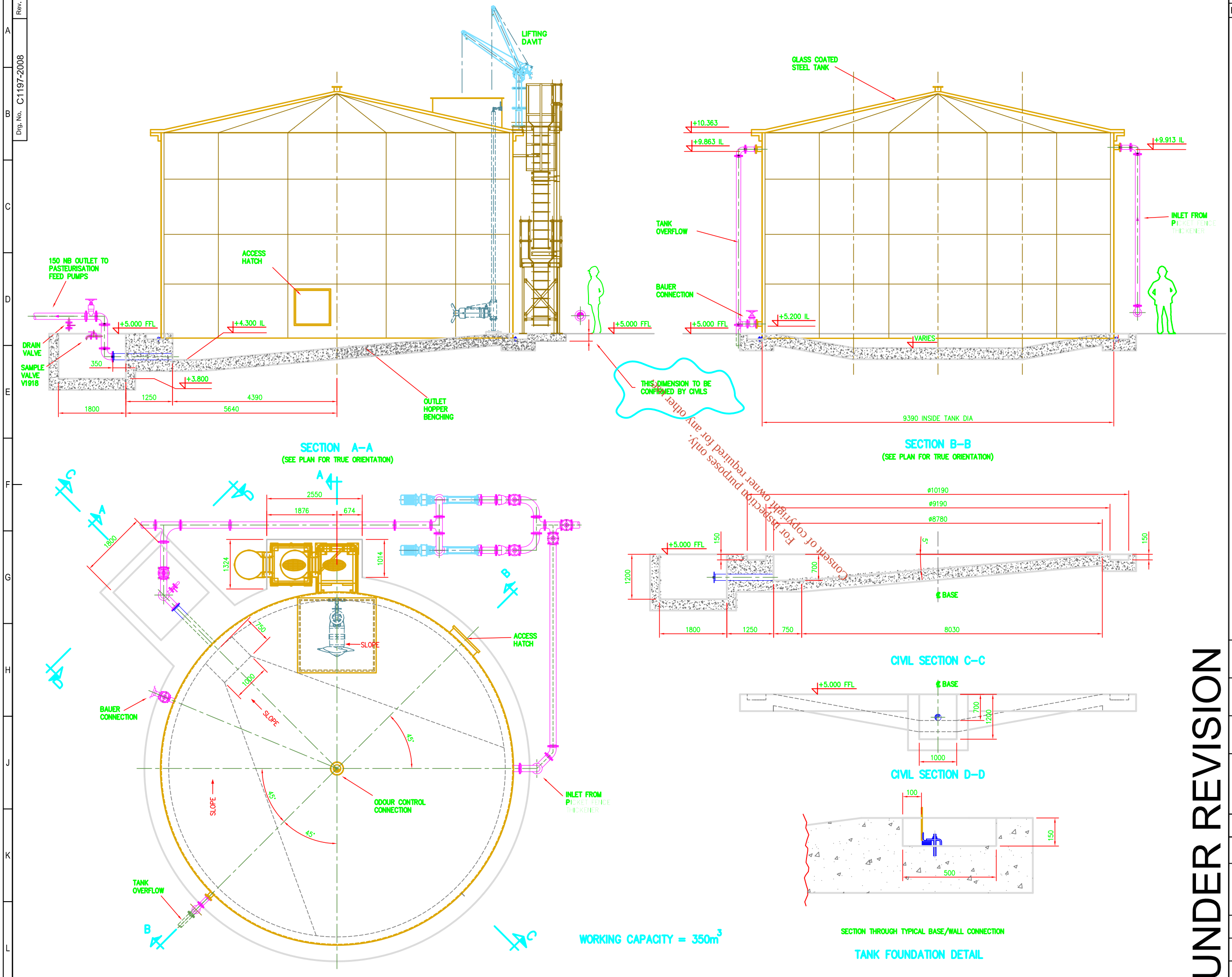
Rev. G

Drg. No. C1197-2008



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
G		SAMPLE VALVE TAG No. ADDED	

APPROVED FOR CIVIL DESIGN
REV. G DATE
SIGNATURE

UNDER REVISION

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
EMERGENCY PRIMARY SLUDGE HOLDING TANK (T1903)
GENERAL ARRANGEMENTS
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
07/11/2006			1:50
Drg. No. C1197-2008			Rev. G

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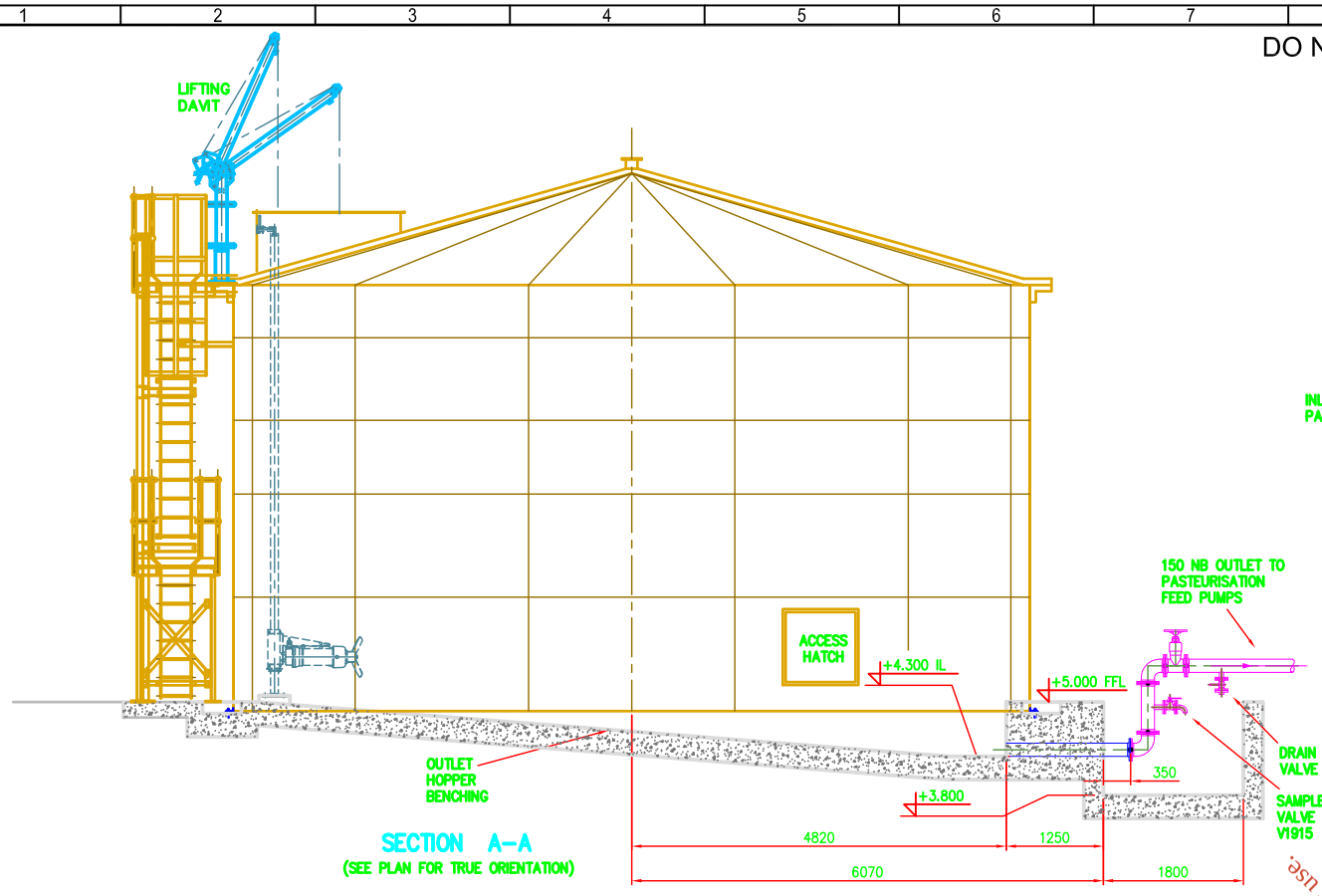
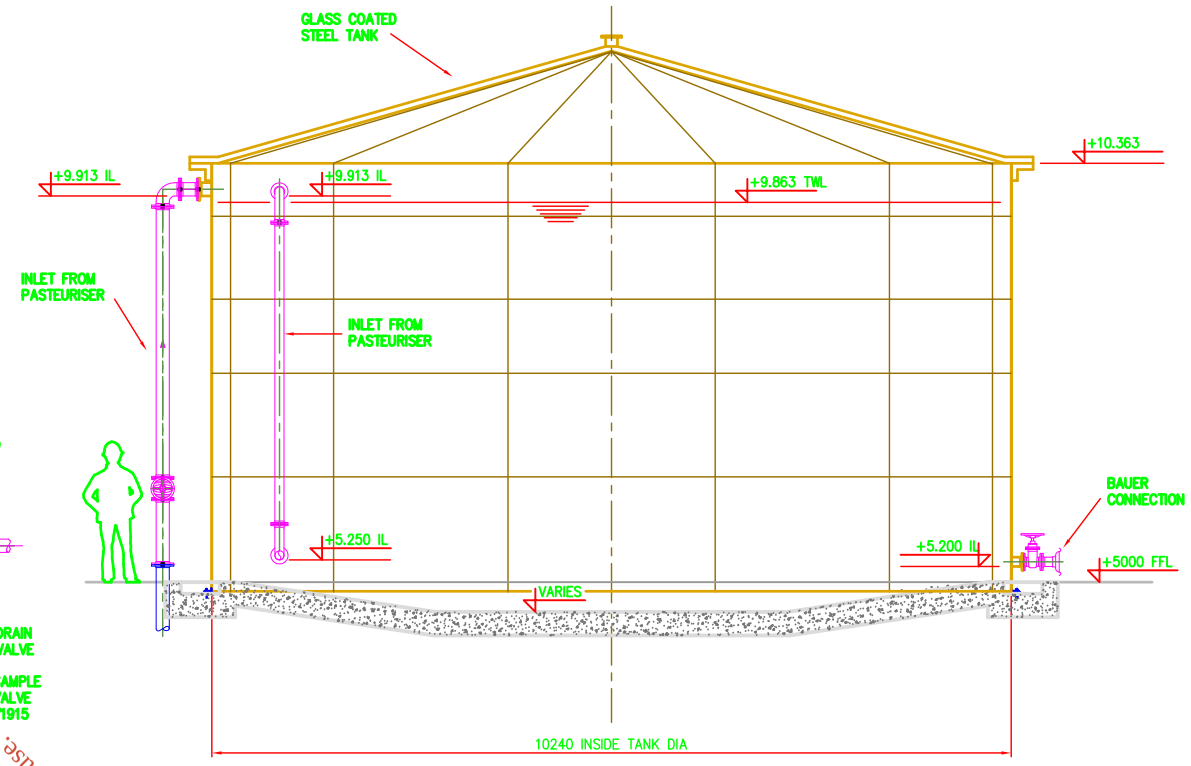
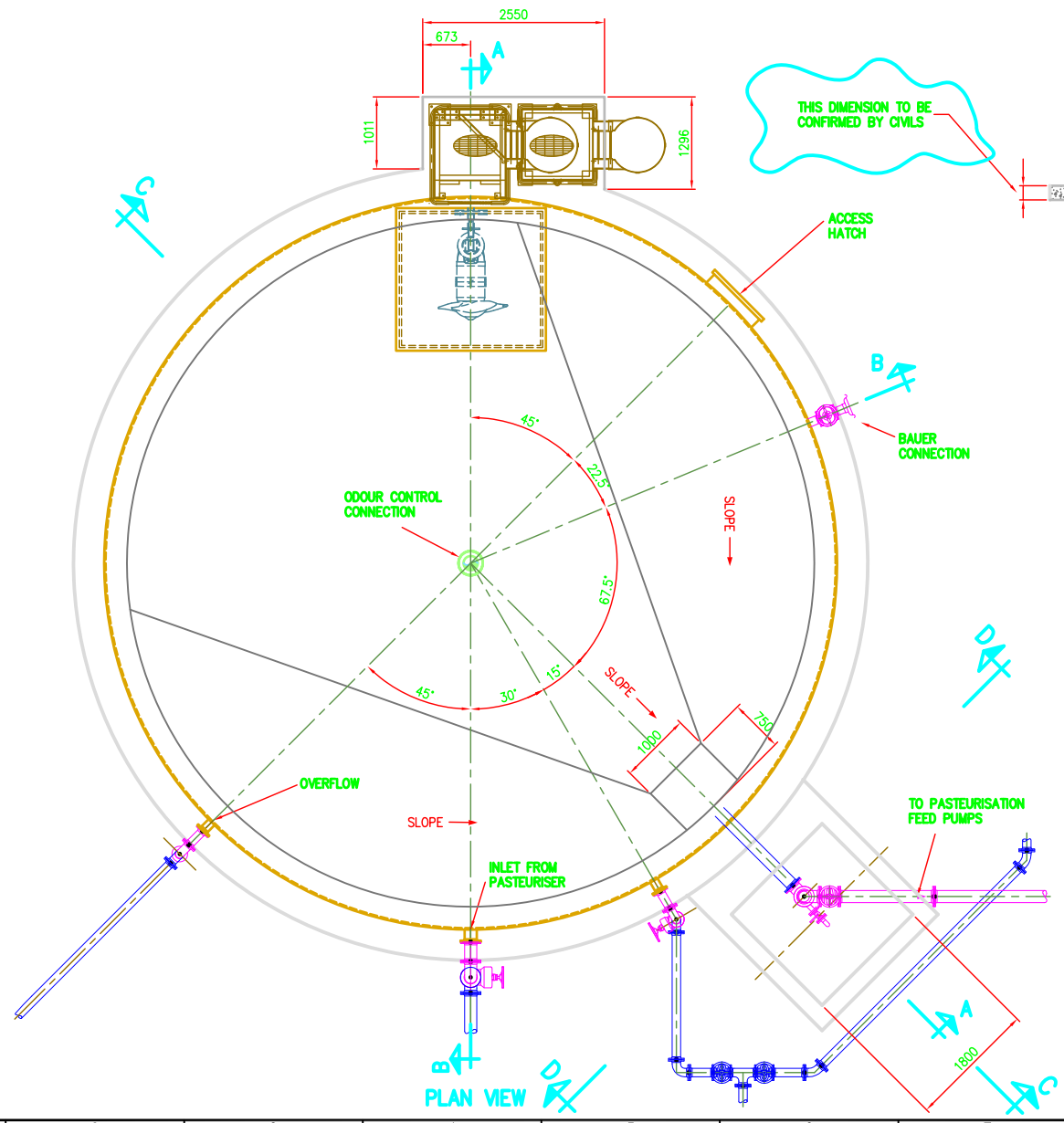
Rev. G
Drg. No. C1197-2009



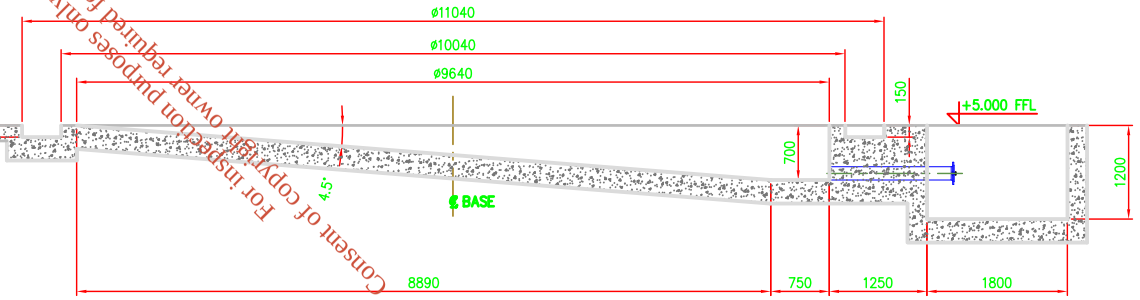
SECTION A–A
(SEE PLAN FOR TRUE ORIENTATION)



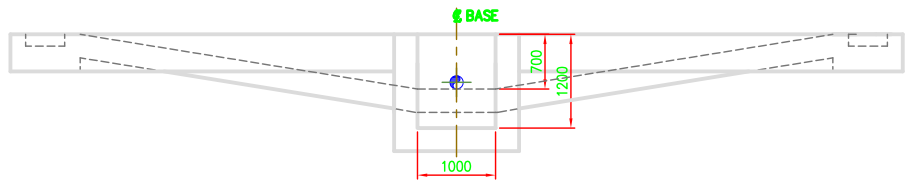


PLAN VIEW

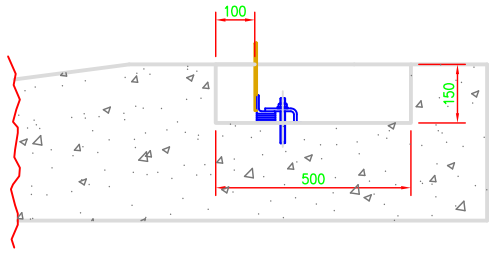
SECTION B–B
(SEE PLAN FOR TRUE ORIENTATION)



CIVIL SECTION C–C



CIVIL SECTION D–D



SECTION THROUGH TYPICAL BASE/WALL CONNECTION

TANK FOUNDATION DETAIL

WORKING CAPACITY = 422m³

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
G		SAMPLE VALVE TAG No. ADDED	PW

APPROVED FOR CIVIL DESIGN
REV. G DATE
SIGNATURE

UNDER REVISION

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

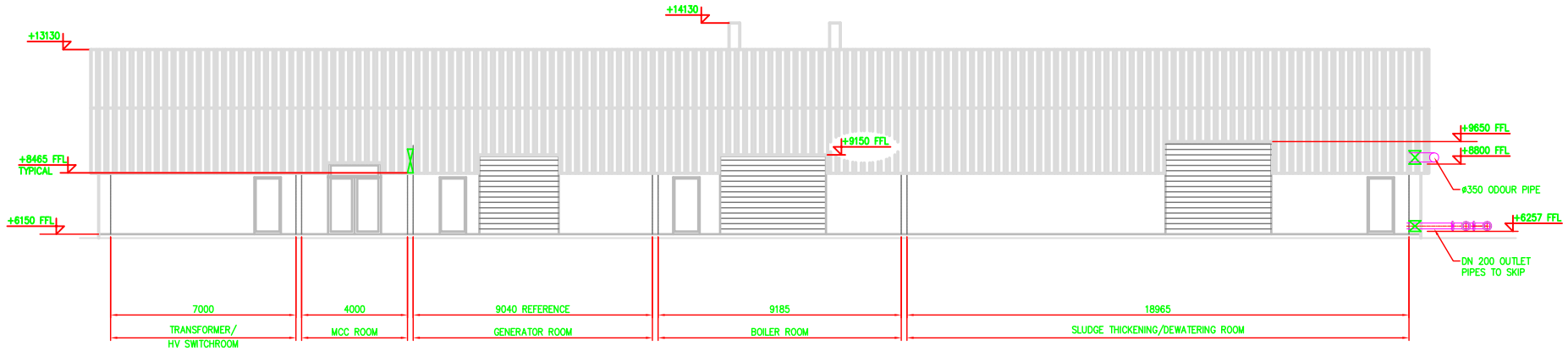
Title: EMERGENCY SECONDARY SLUDGE HOLDING TANK (T1902) GENERAL ARRANGEMENTS WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
07/11/2006			1:50
Drg. No. C1197-2009			Rev. G

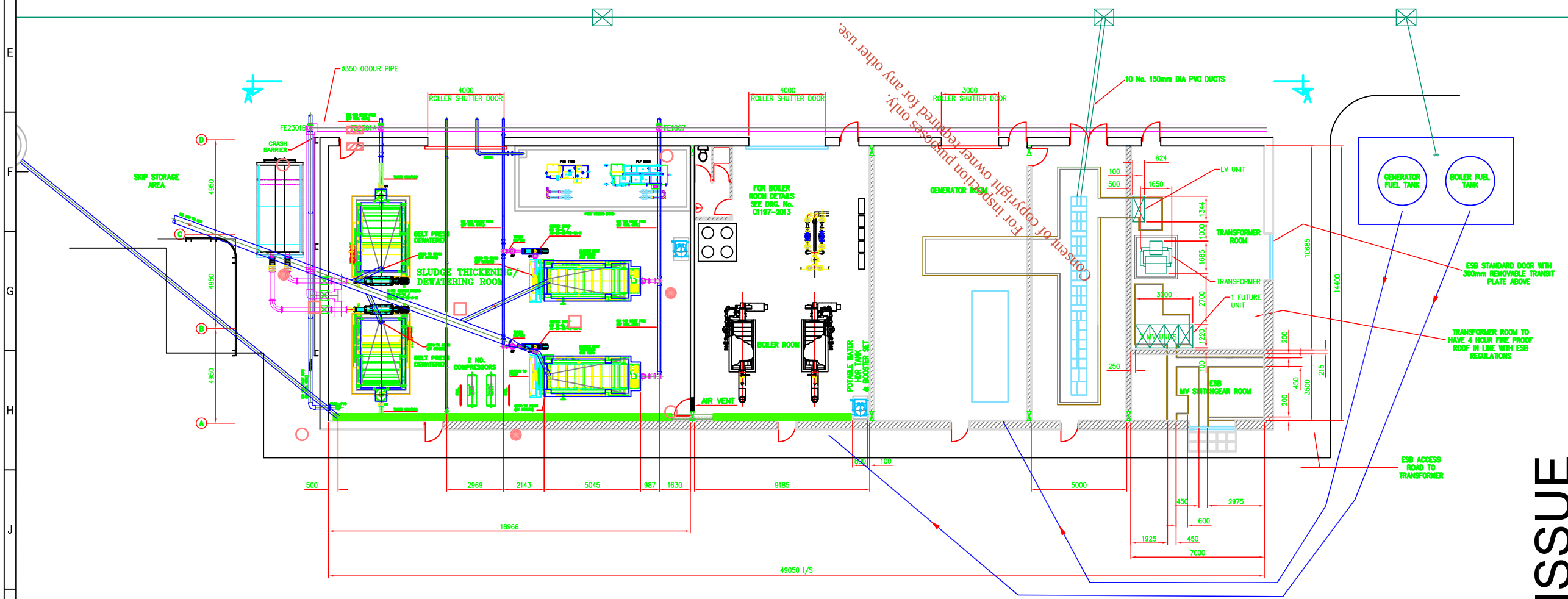
DO NOT SCALE - IF IN DOUBT ASK

Rev. P

Dg. No. C1197-2011



ELEVATION A-A Scale 1:200



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
P	01/09/2008	GENERATOR & BOILER FUEL TANKS ADDED.	

- H_2S (LOW LEVEL)
- O_2 (1.5 – 1.8m)
- CH_4 (HIGH LEVEL)
- STATUS INDICATOR

SCHEDULE OF BUILDERSWORK OPES & LEVELS.

Centerline of Ope on plan equals centerline of corresponding pipe passing through unless noted otherwise.

Ref:	Pipeø	Size (W x H)	Invert Level	Qty.
1	TRAY	500x900	8.465m	7
2	200	550x550	6.257m	2
3	ODOUR	500x500	8.800m	1

APPROVED FOR CIVIL DESIGN
REV. P DATE 01/09/2008
SIGNATURE CGPage

DESIGN ISSUE

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

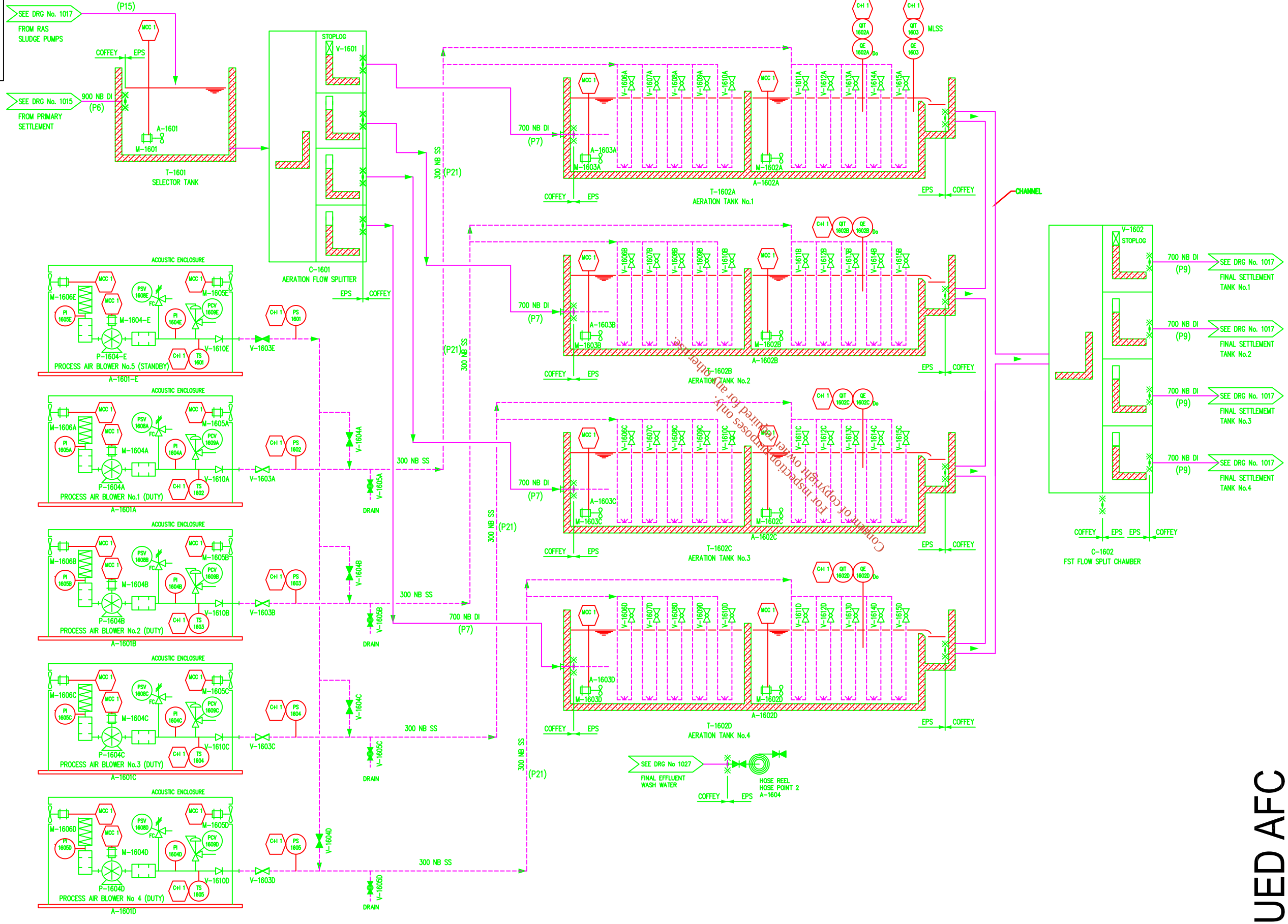
Title: SLUDGE THICKENING/DEWATERING BUILDING
GENERAL ARRANGEMENT
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMeakin	CGPage	A1
Date 15/11/2006	Date 21/08/2008	Date 01/09/2008	Original Scale 1:125
Drg. No. C1197-2011			Rev. P

DO NOT SCALE - IF IN DOUBT ASK

Ref.

Drg. No. C1197-1016



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	27/06/2008	TS-1601 to 5 & PS-1601 to 5 ADDED	

NOTES

1. REMOVED
2. REMOVED
3. REMOVED

LEGEND:

NEW PIPEWORK /CHANNEL BY CIVILS CONTRACTOR. ———

NEW PIPEWORK BY M&E CONTRACTOR. - - - - -

CHECKED			APPROVED		
	PROCESS ENG.	DGH		PROCESS TECH SPECIALIST.	DGG
	PROJECT ENG.	JMN		PROJECT MAN.	CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN.	BM
	LEAD ELEC ENG.	AMT		ELEC ENG MAN.	JL

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
AERATION TANKS
P & I DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMiller	RJMeakin	A1
Date 20/10/2006	Date 26/06/2008	Date 27/06/2008	Original Scale NTS
Drg. No. C1197-1016			Rev. 1

ISSUED AFC

DO NOT SCALE - IF IN DOUBT ASK

Rev. 2

Drg. No. C1197-1030

SEE DRG No. 1026
ODOUR CONTROL No1

SEE DRG No. 1017
FINAL SETTLEMENT
TANK SCUM

SEE DRG No. 1018 (P26)
PICKET FENCE THICKENER

SEE DRG No. 1018
GRAVITY BELT THICKENERS

SEE DRG No. 1019 (P26)
SLUDGE TANK OVERFLOWS

SEE DRG No. 1022 (P26)
DIGESTED SLUDGE
HOLDING TANK

SEE DRG No. 1023 (P26)
SLUDGE DEWATERERS

SEE DRG No.1024 HOLD (P26)
GAS CONDENSATE

SEE DRG No. 1025
POLY MAKE-UP AREA

SEE DRG No. 1026 (P26)
ODOUR CONTROL No2

SEE DRG No. 1026
ODOUR

C+I 1
FIQT 3003
FE 3003

EPS COFFEY

(P28)

SEE DRG No. 1015
PRIMARY SETTLEMENT
FLOW SPLIT CHAMBER

200 NB DI
V-3001A
V-3002A

200 NB DI
V-3001B
V-3002A

C+I 1 | MCC 1
AUTO SAMPLER

C+I 1
LIT 3001
LE 3001

C+I 1
LSL 3002
LE 3002

A-3001

150 x 200

MCC 1
M-3001A
P-3001A PUMP

MCC 1
M-3001B
P-3001B PUMP

C-3001
LIQUOR RETURNS PUMPING STATION

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
2		ODOUR CONTROL LINE REMOVED	

NOTES
1. REMOVED
2. REMOVED

LEGEND:
NEW PIPEWORK/CHANNEL BY CIVILS CONTRACTOR.
NEW PIPEWORK BY M&E CONTRACTOR.

CHECKED			APPROVED		
	PROCESS ENG.	DGH		PROCESS TECH SPECIALIST.	DGG
	PROJECT ENG.	JMN		PROJECT MAN.	CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN.	BM
	LEAD ELEC ENG.	AMT		ELEC ENG MAN.	JL

A.W.I. CONTRACT No 1002

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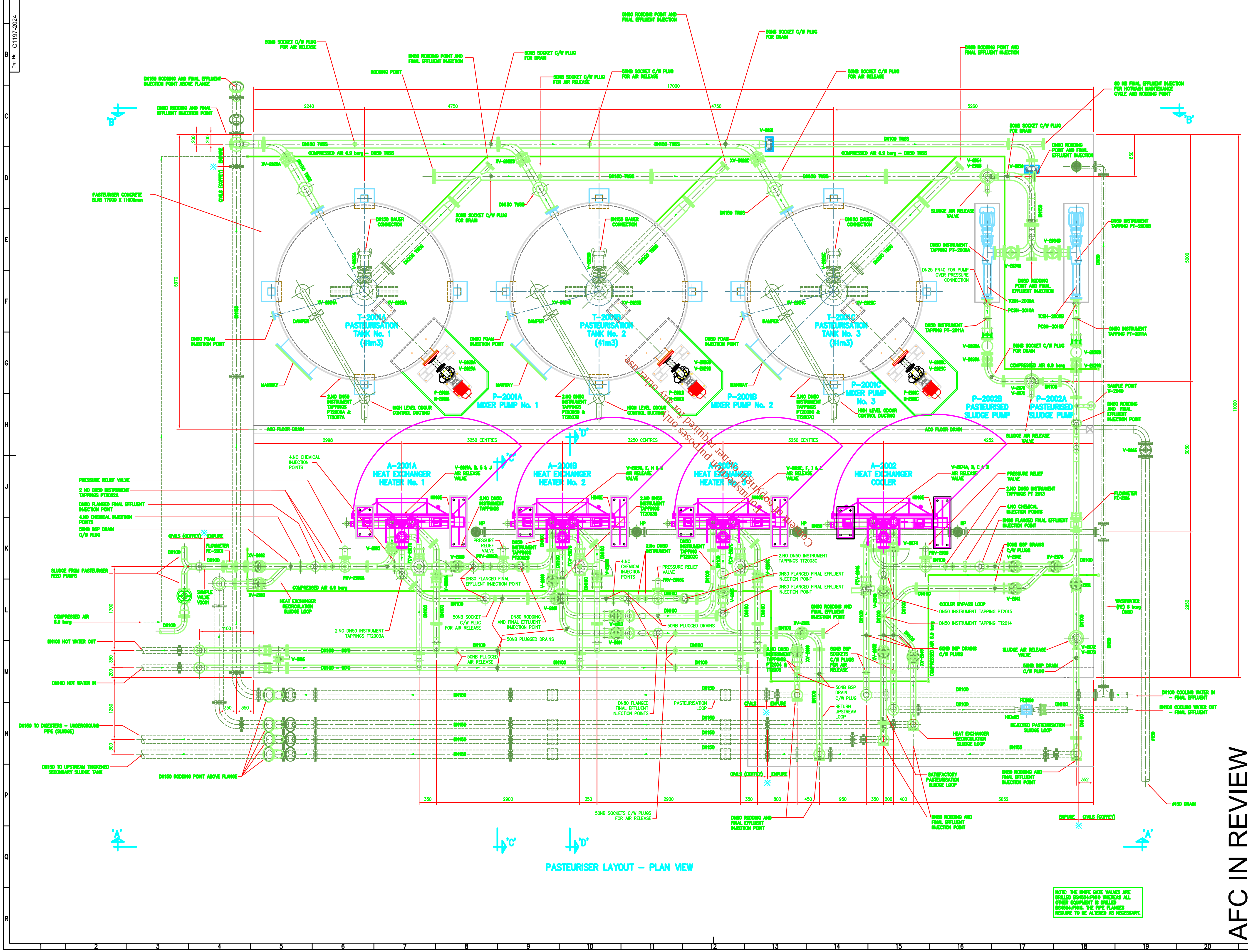
Customer
WATERFORD CITY COUNCIL

Title
LIQUOR RETURNS
P & I DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley			A1
Date	Date	Date	Original Scale
20/10/2006			NTS
Drg. No. C1197-1030			Rev. 2

AFC UNDER REVISION

DO NOT SCALE - IF IN DOUBT ASK



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
3		FLOW METER FE2020 ADDED. SAMPLE VALVE TAG No. ADDED.	

NOTES

1. ALL PASTEURISER FLANGES BS4504 NP16
2. HEAT EXCHANGERS TO INCLUDE AIR RELEASE PORTS AT THE HIGHEST POINT ON SLUDGE AND WATER SIDE
3. PRESSURE RELIEF VALVE DISCHARGE PIPE TO BE FLOOR LEVEL WITH 60° CHAMFER TO PREFERRED SIDE
4. PNEUMATICALLY OPERATED KNIFE GATE VALVES TO HAVE A SOLENOID AT EACH END OF THE DIRECTIONAL CONTROL VALVE TO FAIL IN THEIR LAST POSITION ON POWER 'OFF'. IF THE PASTEURISER IS TO BE LEFT FOR VERY LONG PERIODS OF INACTIVITY THEN ALL KNIFE GATE VALVES SHOULD BE LEFT IN THE 'OPEN' POSITION TO ALLOW GASSING OFF TO OCCUR VIA THE AUTOMATIC AIR RELEASE VALVES ON THE TOP OF EACH HEAT EXCHANGER
5. GRAVITY FED MACERATORS AND PASTUERISER FEED PUMPS TO BE POSITIONED VERY CLOSE TO THE UPSTREAM SLUDGE TANKS IN ORDER TO ACHIEVE MINIMUM LOSSES IN THE SUCTION PIPE PRIOR TO ENTRY INTO THE MACERATOR / PUMPS
7. THE KNIFE GATE VALVES MAY REQUIRE WELD NECK FLANGES IN ORDER FOR THEM TO FIT CORRECTLY AND HAVE A SUITABLE WIDTH GASKET SEALING FACE.
8. CHEMICAL INJECTION TAPPINGS REQUIRED ON EACH HEAT EXCHANGER SLUDGE INLET PIPE, AND ON 'COOLER' HEAT EXCHANGER ON THE INLETS OF BOTH SIDES
9. ALL PIPEWORK TO BE SUITABLE FOR SLUDGE. I.E. 3D BENDS, SWEPT Y's & T's, RODDING POINTS AND FINAL EFFLUENT INJECTION POINTS ETC.
10. THE THREE 'HEATER' HEAT EXCHANGERS TO BE IDENTICAL. THIS WILL ALLOW OPERATION OF ANY TWO OF THE UNITS (AS PRIMARY AND SECONDARY SLUDGE HEATERS) IN ORDER TO ACHIEVE THE REQUIRED TEMPERATURE FOR SLUDGE PASTEURISATION. HENCE, THERE WILL ALWAYS BE ONE 'HEATER' HEAT EXCHANGER OUT OF SERVICE AND THEREFORE AVAILABLE FOR MANUAL MAINTENANCE
11. DURING PRIMING CONDITIONS THE HEAT EXCHANGER AIR RELEASE VALVES WILL OPERATE AS TO EXCLUDE AIR AND THEREBY PRIME THE SYSTEM READY FOR USE
12. ALL SLUDGE PUMPS TO HAVE BALL TYPE NON RETURN VALVES & PUMP SUCTION & DELIVERY ISOLATION VALVES TO BE VITON SEATED ECCENTRIC PLUG VALVES.
13. THE PASTEURISER FEED PUMPS AND THE PASTEURISED SLUDGE PUMPS WILL BE TWO STAGED TO OVERCOME THE PRESSURE LOSSES IN CLEAN AND 'FOULED' HEAT EXCHANGER CONDITIONS.
14. ENPURE TO THERMALLY LAG ALL ABOVE GROUND PIPEWORK - 50mm ROCKWOOL & STAINLESS STEEL, STUCCO ALUMINIUM OR RUBBER SHEET CLADDING.
15. ALL PUMPS & VALVES TO BE LAGGED WITH FABRIC THERMAL JACKETS WITH VELCRO FASTENERS.
16. THE PASTEURISER GENERAL ARRANGEMENT DRAWINGS SHOW ADDITIONAL PIPEWORK APPENDAGES, WHEN COMPARED AGAINST THE P&D. THESE ADDITIONAL ITEMS COMPRISE, PLUGGED DRAIN POINTS, TEMPERATURE & TRANSMITTER TAPPINGS, CHEMICAL INJECTION POINTS, RODDING POINTS, PLUGGED AIR RELEASE POINTS, BRANCHES WITH BLANKING FLANGES BOLTED ON, ETC. THE PIPEWORK & MECHANICAL INSTALLATION TENDERER(S) SHALL INCLUDE IN THEIR PRICINGS FOR ALL ITEMS SHOWN ON GA's & P&ID's COLLECTIVELY. THE ADDITIONAL APPENDAGES SHOWN ON THE GA ARE TO FACILITATE FUTURE ADDITIONAL INSTRUMENTATION, DEVIATIONS FROM THE P&ID AND FOR OPERATIONAL AND INVESTIGATIVE CAPABILITIES.
17. ALL THREADED SOCKETS FOR INSTRUMENTS, PLUGGED AIR RELEASES AND DRAINS TO BE BSP.

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW COMPLETED
DATE: 06/12/2007 SIGNATURE: CGPage

AFC IN REVIEW

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

Title: PASTEURISER LAYOUT MARK 2 PLAN VIEW WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
APatel			A0
Date 12/06/2007	Date	Date	Original Scale 1:25

Drg. No. C1197-2024 Rev. 3

Table 07_4084 3.a(iii) Monitoring, Measuring & Sampling Information Sheet **Rev 4 09.09.08**

	Measuring	Location	Measurement Type	Description	Size	Type	Pipe Ref	Drawing Ref.	P & ID Ref	Sampling Interval
	Primary Treatment									
1A	Raw Sewage	Inlet Channel	Volumetric	Open Flume	1m throat	Arkon	n/a	C1197-2000	C1197-1012	Continuous
1C	Screened Sewage	Inlet Channel	Flow Rate	Flume	0.6m throat	Arkon	n/a	C1197-2000	C1197-1012	Continuous
1B	Raw Sewage	Inlet Works	Flow Rate	Flowmeter	300 NB	Siemans	P3	C1197-2000	C1197-1012	Continuous
1A/1B	Raw Sewage	Inlet Works	Temperature BOD COD ph SS	Auto Sampler			n/a		C1197-1012	Weekly Monthly Weekly Weekly Weekly
17	Screenings	Inlet Works	% TDS							Spot
18	Grit	Inlet Works	% TDS % VS							Spot Spot
28	Inlet air	Inlet Works OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
29	Outlet air	Inlet Works OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
1C	Screened Sewage	Post Grit channel	Temperature BOD COD SS	Auto Sampler			n/a	C1197- 2000	C1197-1012	Twice weekly Weekly 5 times/week (reducing) Weekly
	Secondary Treatment									
4A	Storm Return	At PST chamber	Flow Rate	Flowmeter	300 NB	Siemans	P27	C1197-2004	C1197-1013	Continuous
6	Storm Overflow	After Storm tanks	Flow Rate	Flowmeter	900 NB	Siemans	P8	C1197-2002	C1197-1013	Continuous
6	Storm Overflow	After Storm tanks	BOD	Auto Sampler			P8	C1197-2002	C1197-1013	Intermittent
4	Flow to Storm	Not measured. Calc. will be made be deducting storm overflow from flow to storm to give storm return for treatment								
			SS							Intermittent
7	Settled Sludge (PST to PFT)	After Primary Pumps	Flow Rate	Flowmeter	150 NB	Siemans	P22	C1197-3006	C1197-1018	Continuous
7	Settled Sludge (PST to PFT)	At PFT	% TDS	Manual Sample	25 NB	B/valve	P22	C1197-3006	C1197-1018	Intermittent
5	Settled Sewage	At Aeration chamber	Flow Rate	Flowmeter	900 NB	Siemans	P6	C1197-2006	C1197-1015	Continuous
5	Settled Sewage	At Aeration chamber	BOD COD ph SS	Auto Sampler			P6	C1197-2006	C1197-1015	Intermittent Intermittent Intermittent Intermittent
8	RAS to Aeration Selector Tank	At Selector Tank	Flow Rate	Flowmeter	600 NB	Siemans	P15	C1197-2006	C1197-1017	Continuous
21	Mixed Liquor	On aeration tanks	DO	DO meter		Siemans			C1197-1016	Continuous
21	Mixed Liquor	On aeration tanks	DO	DO meter		Siemans			C1197-1016	Continuous
21	Mixed Liquor	On aeration tanks	DO	DO meter		Siemans			C1197-1016	Continuous
21	Mixed Liquor	On aeration tanks	DO	DO meter		Siemans			C1197-1016	Continuous
21	Mixed Liquor	On aeration tanks	ph							Weekly
21	Mixed Liquor	On aeration tanks	SS							5 times per week
21	Mixed Liquor	On aeration tanks	SSV							Twice Weekly
21	Mixed Liquor	On aeration tanks	SSI							Twice Weekly
21	Mixed Liquor	On aeration tanks	Microspic Exam							Weekly
22	Aerated sewage	On aeration tanks	MLSS	MLSS meter		Siemans			C1197-1016	Continuous
2	Secondary Effluent	Pre. FE Chamber	Flow Rate	Flowmeter	900 NB	Siemans	P12	C1197-2020	C1197-1027	Continuous
2	Secondary Effluent	FE Chamber	BOD COD ph SS	Auto Sampler			n/a	C1197-2020	C1197-1027	Weekly 5 times/week (reducing) 5 times/week (reducing)
	Sludge Treatment									
9	SAS To Gravity Belt Thickeners	Sludge Building	Flow Rate	Flowmeter	150 NB	Siemans	P16	C1197-3006	C1197-1018	Continuous
9	SAS To Gravity Belt Thickeners	Sludge Building	% TDS	Manual Sample	25NB	B/valve	P16	C1197-3006	C1197-1018	Intermittent
10	GBT to Sludge Blend Tank	At S/Blend Tank	Flow Rate	Flowmeter	100 NB	Siemans	P19	C1197-3006	C1197-1018	Continuous

10	GBT to Sludge Blend Tank	At S/Blend Tank	% TDS	Manual Sample	25NB	B/valve	P19	C1197-2010	C1197-1019	Intermittent
23	Thickened Secondary Sludge	Outlet of emergency secondary sludge holding tank	As Required	Manual Sample	50 NB	B/valve		C1197-2009	C1197-1019	Spot
24	Thickened Primary Sludge	Outlet of emergency primary sludge holding tank	As Required	Manual Sample	50 NB	B/valve		C1197-2008	C1197-1019	Spot
25	Thckened Primary Sludge	After PFT	% TDS	Manual Sample	50 NB	B/valve	P25	C1197-2007	C1197-1018	Spot
11	RTN Liquor to PST Splitter	At Splitter	Flow Rate	Flowmeter	200 NB	Siemans	P28	C1197-2004	C1197-1030	Intermittent
11	Return Liquors	At liquor chamber	BOD COD SS	Manual Sample			n/a	C1197-2018	C1197-1030	Intermittent Intermittent Intermittent
12	Blended Sludge to Pasteuriser	P/riser Skid	Flow Rate	Flowmeter	100 NB	Siemans	P40	C1197-2024	C1197-1020	Continuous
12	Blended Sludge to Pasteuriser	P/riser Skid	ph Alk (mg CaCO3/l) % TDS % VS	Manual Sample	50mm	B/valve	P40	C1197-2010	C1197-1019	Monthly Monthly Weekly Monthly
32	Return from Cooler	Pasteuriser slab	Flow rate	Flow meter	65 NB	Siemans	P32	C1197-2024	C1197-1020	Continuous
33	Pasteurised Sludge	Pasteuriser slab	ph Alkalinity % TDS % VS	Manual Sample	50 NB	B/valve	P41	C1197-2024	C1197-1020	Spot Spot Spot Spot
13	Digested Sludge to Dewaterer	Sludge Building	Flow Rate	Flowmeter	150 NB	Siemans	P46	C1197-3006	C1197-1023	Intermittent
13	Digested Sludge to Dewaterer	Sludge Building	Flow Rate	Flowmeter	150 NB	Siemans	P46	C1197-3006	C1197-1023	Intermittent
13	Digested Sludge to Dewaterer	Digested Sludge Tank Outlet	% TDS % VS	Manual Sample	50 NB	B/valve	P20	C1197-2014	C1197-1022	Intermittent Intermittent
26	Stored Digested Sludge to Dewaterer 1	After dewaterer feed pump 1	As Required	Manual Sample	50 NB	B/valve	P46	C1197-2014	C1197-1022	Spot
27	Stored Digested Sludge to dewaterer 2	After dewaterer feed pump 2	As Required	Manual Sample	50 NB	B/valve	P46	C1197-2014	C1197-1022	Spot
30	Inlet air	Sludge OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
31	Outlet air	Sludge OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
34	Liquor from GBT 1	Sludge Building	pH	Manual Sample	25 NB	B/valve			C1197-1018	Spot
35	Liquor from GBT 1	Sludge Building	pH	Manual Sample	25 NB	B/valve			C1197-1018	Spot
20	Potable Water	Pre Site Storage	Flow Rate	Flowmeter						Continuous
3	Final Effluent		Flow Rate							Continuous
3	Final Effluent	FE Chamber	BOD COD ph SS	Auto Sampler			n/a	C1197-2020	C1197-1027	Intermittent Intermittent Intermittent Intermittent
14	Final Sludge Product	access road	Weight	Weighbridge				C1197-3002	C1197-1023	Intermittent
14	Final Sludge Product	Discharge to skip	Nitrogen Phosphorous Potassium Temperature % TDS % VS Dry Solids Heavy Metals Faecal Coliforms	Manual Sample	150 NB	B/valve		C1197-2011	C1197-1023	Occasional Occasional Occasional 5 times per week 5 times per week Weekly 5 times per week Occasional 5 times per week
14	Final Sludge Product	Discharge to skip	Nitrogen Phosphorous Potassium	Manual Sample	150 NB	B/valve		C1197-2011	C1197-1023	Occasional Occasional Occasional

			Temperature % TDS % VS Dry Solids Heavy Metals Faecal Coliforms							5 times per week 5 times per week Weekly 5 times per week Occasional 5 times per week
30	Inlet air	Sludge OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
31	Outlet air	Sludge OCU	H2S	Gas monitor	TBC	TBC			C1197-1026	Continuous
32	Return from Cooler	Pasteuriser slab	Flow rate	Flow meter	65 NB	Siemans	P32	C1197-2024	C1197-1020	Continuous
33	Pasteurised Sludge	Pasteuriser slab	ph Alkalinity % TDS % VS	Manual Sample	50 NB	B/valve	P41	C1197-2024	C1197-1020	Spot Spot Spot Spot
	Utilities									
19	Polymer Usage	Sludge Building								Intermittent
19A	Mixed Polymer to GBT 1802A	Sludge Building	Flow Rate	Flowmeter	50 NB			C1197-2011	C1197-1018	Continuous
19A	Mixed Polymer to GBT 1802B	Sludge Building	Flow Rate	Flowmeter	50 NB			C1197-2011	C1197-1018	Continuous
19B	Mixed Polymer to dewaterer 1	Sludge Building	Flow Rate	Flowmeter				C1197-2011	C1197-1023	Continuous
19B	Mixed Polymer to dewaterer 2	Sludge Building	Flow Rate	Flowmeter				C1197-2011	C1197-1023	Continuous

PURAC

PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Ref: 8404 **Title :** Activated Sludge Design

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator DGH	Checked	Approved
1	4	30 Oct 06	Contract Issue	DGH		

PURAC
IBA Plant Design

Standard Process Calculation: Project-specific data input is permitted to highlighted areas only.

Calc Ref:	PCS001	Rev	Page 1
Author	D Garnett	Refer to PCS index for full details	
Calculation status:			

Project-Specific Data

Document Ref	8405
Project No	C1197
Project Name	Waterford
Process area code	
Tag No(s)	
Process Engineer	Dave Hemmings
Date	13th July 2005

Inlet Data

Year 2005

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	196.7	12.3	209.0	From 8000-Design Basis +
Average Daily Flow, l/s	255.7	21.3	277.0	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	590.0	21.3	611.3	

Year 2025 (Tender)

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	317.9	28.0	345.9	From 8000-Design Basis +
Average Daily Flow, l/s	413.2	28.0	441.3	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	953.6	28.0	981.7	

Year 2025

	Raw Sewage	Return Liquors	Total Flow	
Dry Weather Flow, l/s	317.9	28.0	345.9	From 8000-Design Basis +
Average Daily Flow, l/s	413.2	28.0	441.3	8050 Flow Diagram
Peak Flow For Biological Treatment, l/s	953.6	28.0	981.7	

DGHemmings: +20% extra load

DGHemmings: +20% extra load

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	Raw Load kg/d	RL's kg/d	Load to PST kg/d	Concentration, mg/l Raw @DWF	Concentration, mg/l Raw+RLs @DWF
Average Daily BOD5 Load 2005	6654	993.0	7647	346	320
Average Daily BOD5 Load 2025	11436	1035.0	12471	349	327
Average Daily BOD5 Load 2025	13724	1035.0	14759	413	387
Average Daily SS Load 2005	4378	1153.0	5531	250	231
Average Daily SS Load 2025	8005	1227.0	9232	259	242
Average Daily SS Load 2025	9606	1227.0	10833	303	284
Average Daily TKN Load 2005			0	0	0
Average Daily TKN Load 2025			0	0	0
Average Daily TKN Load 2025			0	0	0
Average Daily TN Load 2005			0	0	0
Average Daily TN Load 2025			0	0	0
Average Daily TN Load 2025			0	0	0
Average Daily NH3 Load 2005	1066	135.0	1201	54	50
Average Daily NH3 Load 2025	1217	135.0	1352	38	35
Average Daily NH3 Load 2025	1461	135.0	1596	45	42
Average Daily TP Load 2005			0	0	0
Average Daily TP Load 2025			0	0	0
Average Daily TP Load 2025			0	0	0

Percentage Volatile Solids	%	70
Percentage Volatile Solids in settled sewage	%	80
Percentage Soluble BOD in raw sewage	%	30
Percentage Soluble BOD in return liquors	%	80
TKN:BOD Ratio		0.0

Are return liquors sent to ASP or inlet: Inlet

Effluent Consent Standard			Average	95 % 'ile
COD	From 8000-Design Basis	mg/l	62.5	125
BOD	From 8000-Design Basis	mg/l	12.5	25
SS	From 8000-Design Basis	mg/l	17.5	35
NH3		mg/l	N/A	#VALUE!
TN			N/A	#VALUE!
P			N/A	#VALUE!

Primary Tanks

No. of Tanks		2	
SS Removal Efficiency (max)	%	60	From 8403-PST
SS Removal Efficiency (min)	%	55	From 8403-PST
BOD5 Removal Efficiency (max)	%	30	From 8403-PST
BOD5 Removal Efficiency (min)	%	25	From 8403-PST
TKN/TN Removal Efficiency (max)	%	0	
TKN/TN Removal Efficiency (min)	%	0	
N-NH4 Removal Efficiency (max)	%	0	
N-NH4 Removal Efficiency (min)	%	0	

Primary Sludge Production

			Sludge Production, m3/d			
Percentage Dry Solids		%	1.5	2	3	5
Max Removal in year 2005	kg/d	3318	221	166	111	66
Min Removal in year 2005	kg/d	3042	203	152	101	61
Max Removal in year 2025	kg/d	5539	369	277	185	111
Min Removal in year 2025	kg/d	5078	339	254	169	102
Max Removal in year 2025	kg/d	6500	433	325	217	130
Min Removal in year 2025	kg/d	5958	397	298	199	119

SECONDARY TREATMENT

		Yr 2005		Yr 2025		Yr 2025 + 20%	
		Max	Min	Max	Min	Max	Min
BOD Load To Secondary Stage	kg/d	5736	5353	9353	8730	11069	10331
Soluble BOD Component	kg/d	2791	2791	4259	4259	4945	4945
Percentage Soluble BOD	%	49	52	46	49	45	48
TKN Load To Secondary Treatment	kg/d	0	0	0	0	0	0
SS To Secondary Treatment Stage	kg/d	2489	2212	4155	3693	4875	4333
Volatile SS Component	%	80					
Volatile SS Component	kg/d	1991	1770	3324	2954	3900	3467
Inorganic SS Component	kg/d	498	442	831	739	975	867
NH4-N Load	kg/d	1201	1201	1352	1352	1596	1596
TN Load	kg/d	0	0	0	0	0	0

Concentrations at DWF

	Yr 2005		Yr 2025		Yr 2025 + 20%	
	Max	Min	Max	Min	Max	Min
BOD concentration To Secondary Stage	318	296	313	292	370	346
Soluble BOD Component	155	155	143	143	165	165
Percentage Soluble BOD						
TKN concentration To Secondary Treatment	0	0	0	0	0	0
SS To Secondary Treatment Stage	138	123	139	124	163	145
Volatile SS Component						
Volatile SS Component	110	98	111	99	130	116
Inorganic SS Component	28	25	28	25	33	29
NH4-N concentration	67	67	45	45	53	53

Concentrations at Average Flow

	Yr 2005		Yr 2025		Yr 2025 + 20%	
	Max	Min	Max	Min	Max	Min
BOD concentration To Secondary Stage	240	224	245	229	290	271
Soluble BOD Component	117	117	112	112	130	130
Percentage Soluble BOD						
COD concentration To Secondary Treatment	0	0	0	0	0	0
SS To Secondary Treatment Stage	104	92	109	97	128	114
Volatile SS Component						
Volatile SS Component	83	74	87	77	102	91
Inorganic SS Component	21	18	22	19	26	23
NH4-N concentration	50	50	35	35	42	42

SLUDGE PRODUCTION

Extended Aeration Not used in design

Note : This equation applies where primary tanks are not utilised and where extended aeration is practiced.
It should not be used if trade effluents containing non-degradable or slowly biodegradable solids are present.
For a more detailed calculation see spreadsheet entitled 'SAS Production Rate'.

Sludge Loading (F/M Ratio)	kgBOD/kgTSSd	0.3			
Temperature	degrees C	8	10	12	20
Ratio of non biodegradable solids in raw sewage / total SS in raw sewage.		0.2	0.2	0.2	0.2
Ratio of total raw sewage SS to raw sewage BOD (Fallback value =1.2)		0.72			
Temperature	degrees C	8	10	12	20
Sludge Yield		0.79	0.79	0.78	0.73
Max Sludge Production (Yr 2005)	kg/d	4556	4514	4466	4194
Min Sludge Production (Yr 2005)	kg/d	4252	4213	4168	3915
Max Sludge Production (Yr 2025)	kg/d	7139	7061	7000	6618
Min Sludge Production (Yr 2025)	kg/d	6934	6871	6798	6384
Max Sludge Production (Yr 2025)	kg/d	8792	8712	8619	8095
Min Sludge Production (Yr 2025)	kg/d	8206	8131	8045	7555

Conventional Aeration

For well settled sewage the following equation can be used. This applies for a temperature range of 7 to 25 C

Sludge Loading (F/M Ratio)	kgBOD/kgTSSd	0.27			
Temperature	degrees C	8	10	12	20
0.75 used in tender design					
SludgeYield		**1.01**	0.75	0.80	0.51
Max Sludge Production (Yr 2005)	kg/d	**5810**	4302	4569	2899
Min Sludge Production (Yr 2005)	kg/d	**5423**	4015	4264	2706
Max Sludge Production (Yr 2025)	kg/d	**9475**	7015	7451	4727
Min Sludge Production (Yr 2025)	kg/d	**8844**	6547	6954	4412
Max Sludge Production (Yr 2025)	kg/d	**11213**	8302	8817	5594
Min Sludge Production (Yr 2025)	kg/d	**10466**	7748	8229	5221

Selector Tank Volume

Design Basis : minimum of 30 mins at DWF plus RAS or 10 mins at max flow plus RAS

Assuming RAS remains constant for both flows.

		Yr 2005	Yr 2025	Yr 2025 + 20%
RAS Flow	m3/h	752	2036	2036
30 mins at DWF plus RAS	m3	730	1590	1590
10 mins at max flow plus RAS	m3	479	912	912
30 mins at DWF		354	572	572
Selector Zone Volume	**m3**	730	1590	**1590**

MLSS	kg/m3	3.5	
Number of selector tanks		1	
Water Depth	m	5	
Tank Length	m	12	
Tank Width	m	10	
Actual Volume per tank	m3	600	
Proposed Selector Tank Volume	**m3**	**600**	Selected to give floc loading >2.3

		DWF	Average	Peak
Actual Retention Time	mins	51	39	17
Actual Retention Time (inc RAS)	mins	25	22	13
Floc Loading (>2.3)		**4.5**	(BOD kg/d /Mixed Liquor Mass in Selector)	

Note: The Floc Loading should be greater than 2.3 to encourage the growth of floc forming bacteria.
This can be increased by lowering the selector volume or mixed liquor suspended solids.

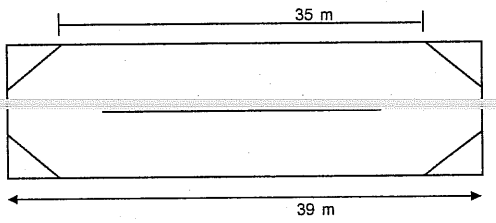
Selected F/M ratio	0.3		
Operating MLSS	3.5		
Volume Required	10542	m^3	Based upon 2025 load with 20% extra
Volume Selected	10600		as requirement to meet consent with one lane out of service.

Inclined Bubble Aeration Ditch

Selector Volume Required	m3	600	
Total Volume For Oxidation ditch	m3	10600	
			Tender drawing shows tank
Number of streams	m3	4	
Volume Per stream	m3	2650	
Minimum Sewage Depth	m	5	5
Width of each lane	m	7	7
Straight Length of each tank	m	38	48.5
Actual Volume Per Tank	m3	2660	3395
Recycle Ratio (FST to ditch)		1	

Ref: Vol 4 section 7.7.1 minimum sludge 5 days @ 10 deg C

Inclined Bubble Aeration Ditch - Tapered Ends



Area taken by corner baffles	8 m^2
total length required	38.0 m
actual total tank length	39 m
Actual Volume	2690 m^3 per ditch
	10760 m^3 total

DGHemmings: Includes 20% extra load

Actual F/M Ratio

		Average 2005		Max Year 2025		Max Year 2025		
		Max	Min	Max	Min	Max	Min	
MLSS in ASP	kg/m3	3.0	3.0	3.5	3.5	3.5	3.5	
Actual F/M Ratio		0.18	0.17	0.25	0.23	0.29	0.27	
SRT	d	8	8	5	6	5	5	SRT = Vol x MLSS/sludge prod
SRT	d	8	8	5	6	5	5	SRT = 1/(yield x F:M)

Operation With One Tank Out Of Service

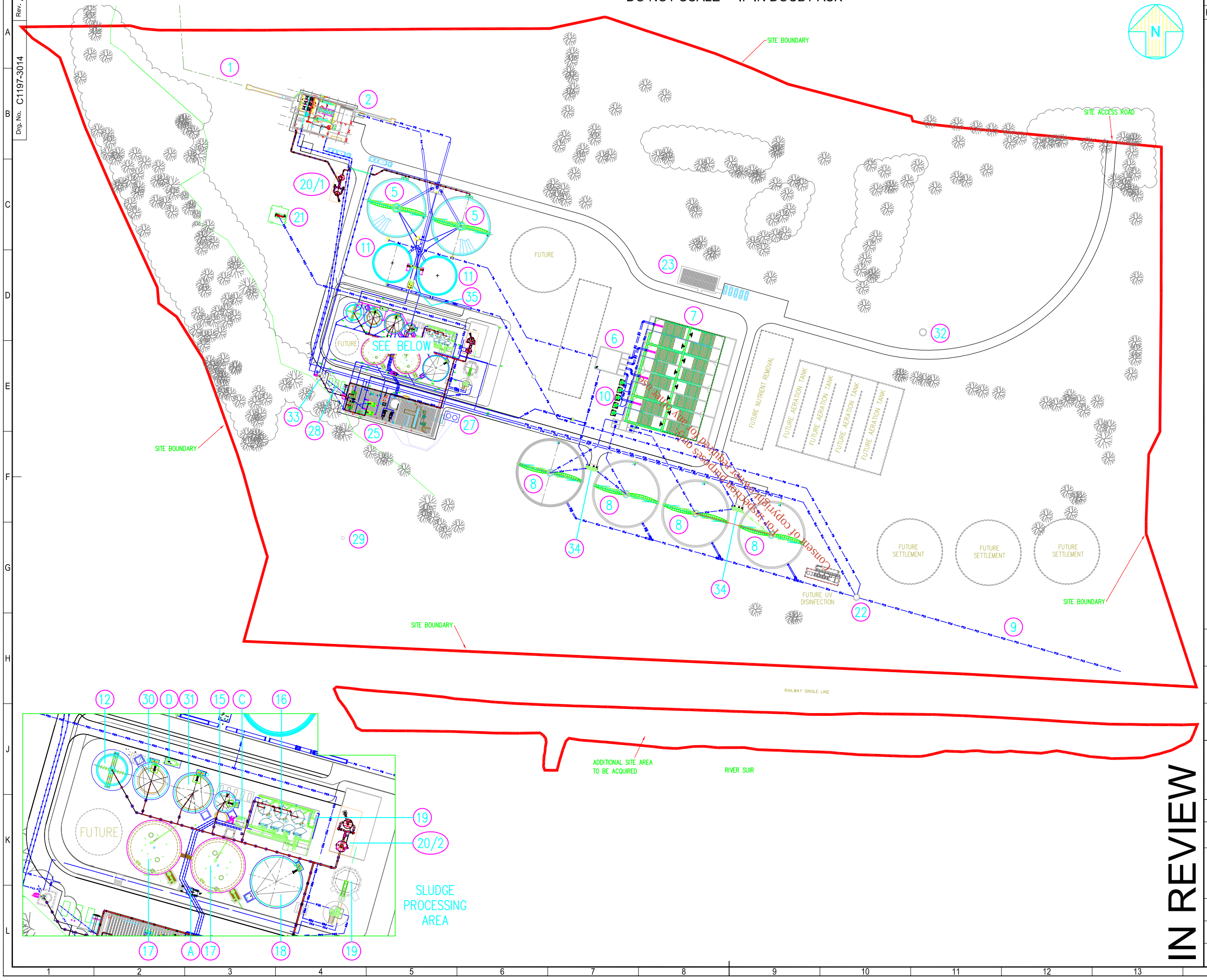
MLSS in ASP	kg/m3	3.0	3.0	4.0	4.0	4.8	4.8	
Actual F/M Ratio		0.24	0.22	0.29	0.27	0.29	0.27	
SRT	d	6	6	5	5	5	5	SRT = Vol x MLSS/sludge prod
SRT	d	6	6	5	5	5	5	SRT = 1/(yield x F:M)

assumes all FST's will be in service when one activated sludge lane is taken out of service.

DO NOT SCALE - IF IN DOUBT ASK

Rev. A

Drg. No. C1197-3014



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
A		FIRST ISSUE	

NOTE

TREES INDICATED ARE TO BE RETAINED

THIS DRAWING TO BE READ IN CONJUNCTION WITH TEXT OF 3 a) (i) WATER LICENCE

PLANT LEGEND:

1. INLET CHANNEL
2. SCREENING & GRIT REMOVAL BUILDING
5. PRIMARY SETTLEMENT TANK
6. SELECTOR TANK
7. AERATION TANK
8. FINAL SETTLEMENT TANK
9. OUTFALL
10. AERATION BLOWERS (5 No.)
11. STORMWATER TANK
12. PICKET FENCE THICKENER
15. SLUDGE BLENDING TANK
16. SLUDGE PASTEURISATION
17. SLUDGE DIGESTER
18. DIGESTED SLUDGE TANK
19. GAS HOLDING TANK
20. ODOUR CONTROL UNIT
20/1. ODOUR CONTROL UNIT – INLET
20/2. ODOUR CONTROL UNIT – SLUDGE
21. WASTE GAS BURNER
22. DISCHARGE MONITORING CHAMBER
23. ADMINISTRATION BUILDING
25. SLUDGE THICKENING, DEWATERING & DIGESTION CONTROL BUILDING
27. FUEL TANK
28. SKIP HOLDING AREA
29. SURFACE WATER MONITORING CHAMBER
30. THICKENED PRIMARY SLUDGE TANK
31. THICKENED SECONDARY SLUDGE TANK
32. BELVIEW SEWER PUMPING STATION
33. RETURN LIQUORS PUMPING CHAMBER
34. RAS PUMPS (6 No TOTAL)
35. PRIMARY SLUDGE PUMPS (3 No)

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

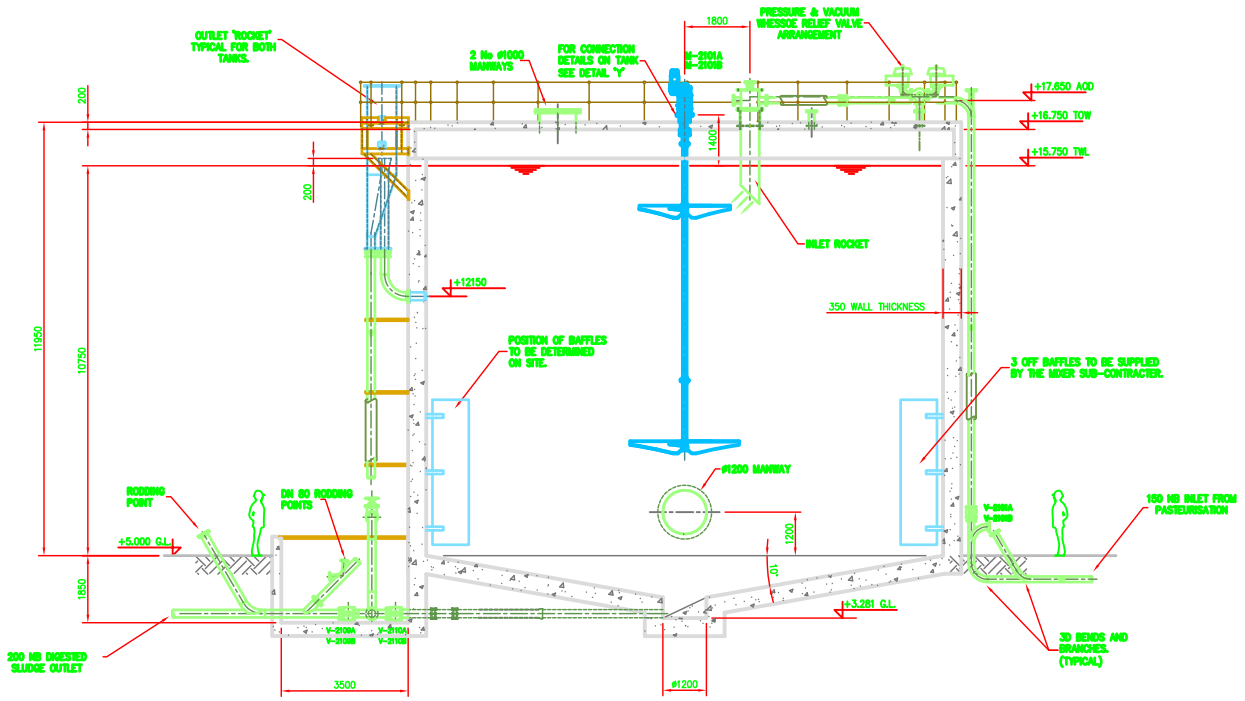
Title: SITE LAYOUT
MAIN FEATURES
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
PWhite			A1
Date: 23/09/2008	Date	Date	Original Scale
Drg. No. C1197-3014			Rev. A

IN REVIEW

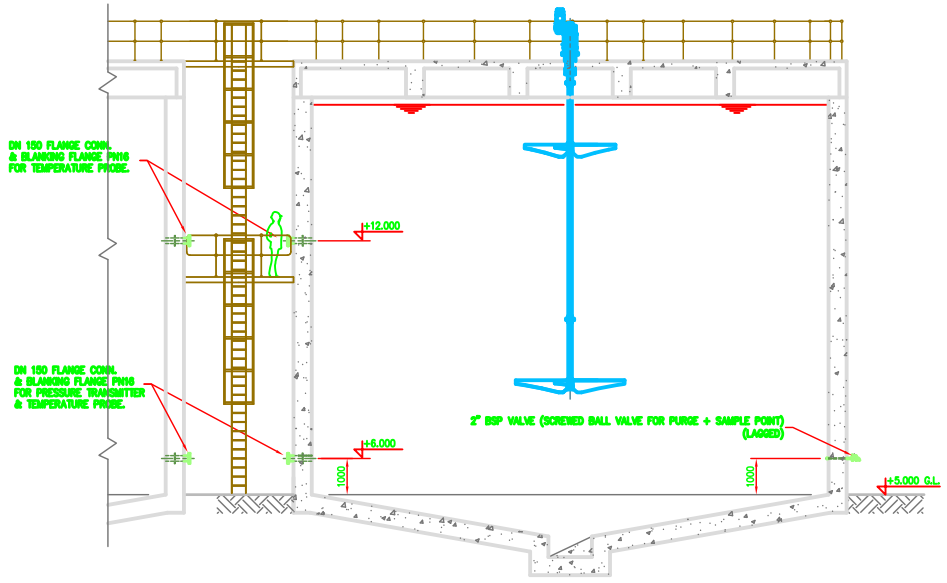
DO NOT SCALE – IF IN DOUBT ASK

Rev. I
Dng No. C1197-2019



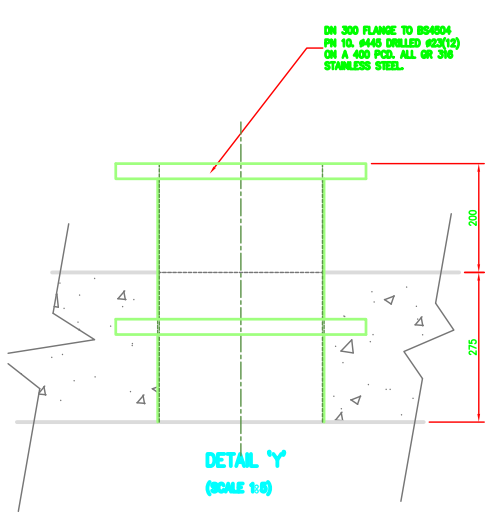
SECTIONAL ELEVATION A–A

(FOR TRUE ORIENTATION OF PIPEWORK AND CONNECTION POSITIONS SEE PLAN BELOW)



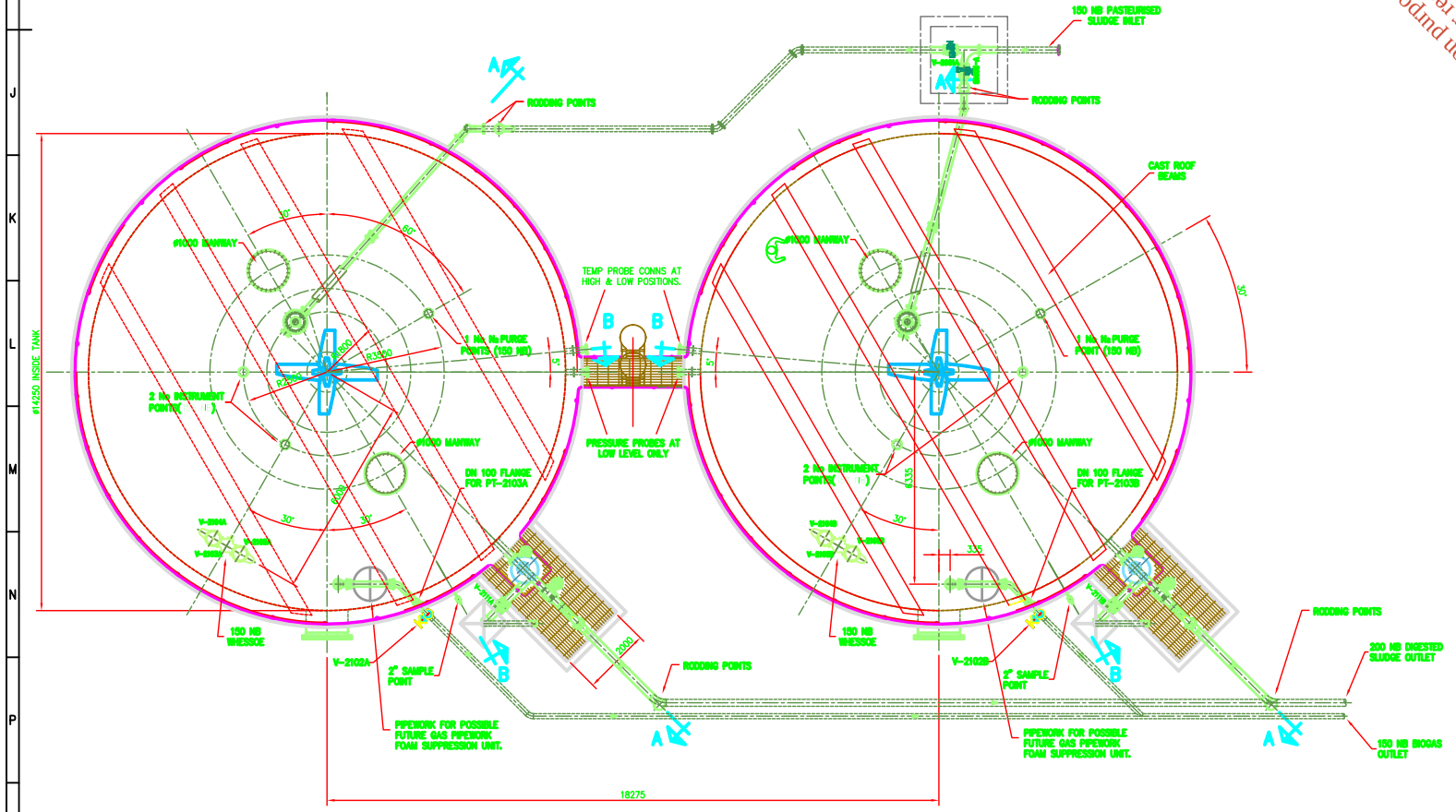
SECTIONAL ELEVATION B–B

(FOR TRUE ORIENTATION OF PIPEWORK AND CONNECTION POSITIONS SEE PLAN BELOW)

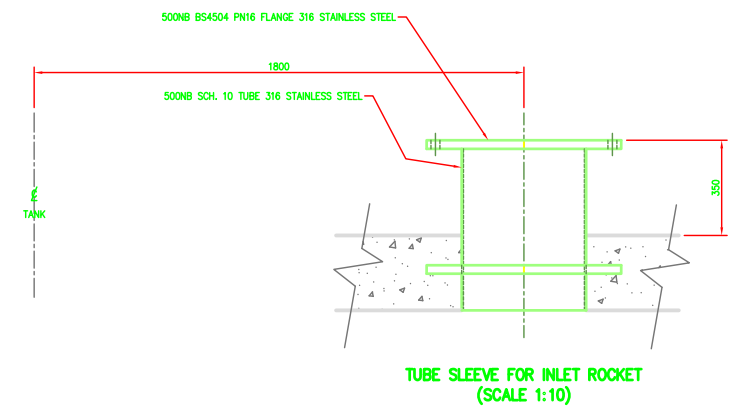


DETAIL 'Y'

(SCALE 1:5)

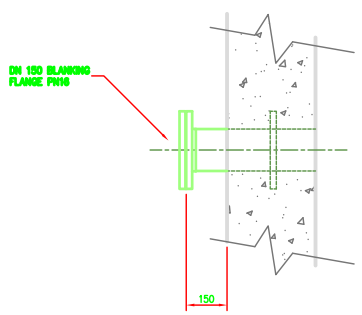


SLUDGE DIGESTER No.1 — PLAN VIEW ON DIGESTERS — SLUDGE DIGESTER No.2



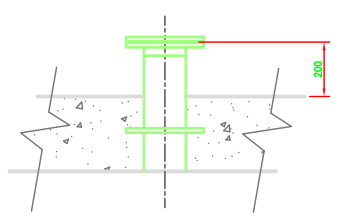
TUBE SLEEVE FOR INLET ROCKET

(SCALE 1:10)



TYPICAL CONNECTION FOR PRESSURE TRANSMITTER AND TEMPERATURE PROBE.

(SCALE 1:10)



TYPICAL UPSTAND FOR ROOF MOUNTED BIOGAS & WHESSOE VALVE CONNECTIONS. N_2 PURGE POINT & INSTRUMENTATION. DN150 BS4504 NP16

(SCALE 1:10)

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
I	08/07/2008	350 WALL THICKNESS ADDED (AS BUILT).	JPF

APPROVED FOR CIVIL DESIGN
REV. I DATE 08/07/2008
SIGNATURE CGPage

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW COMPLETED
DATE: 31/07/2007 SIGNATURE: CGPage

DESIGN ISSUE

A.W.I. CONTRACT No 1002

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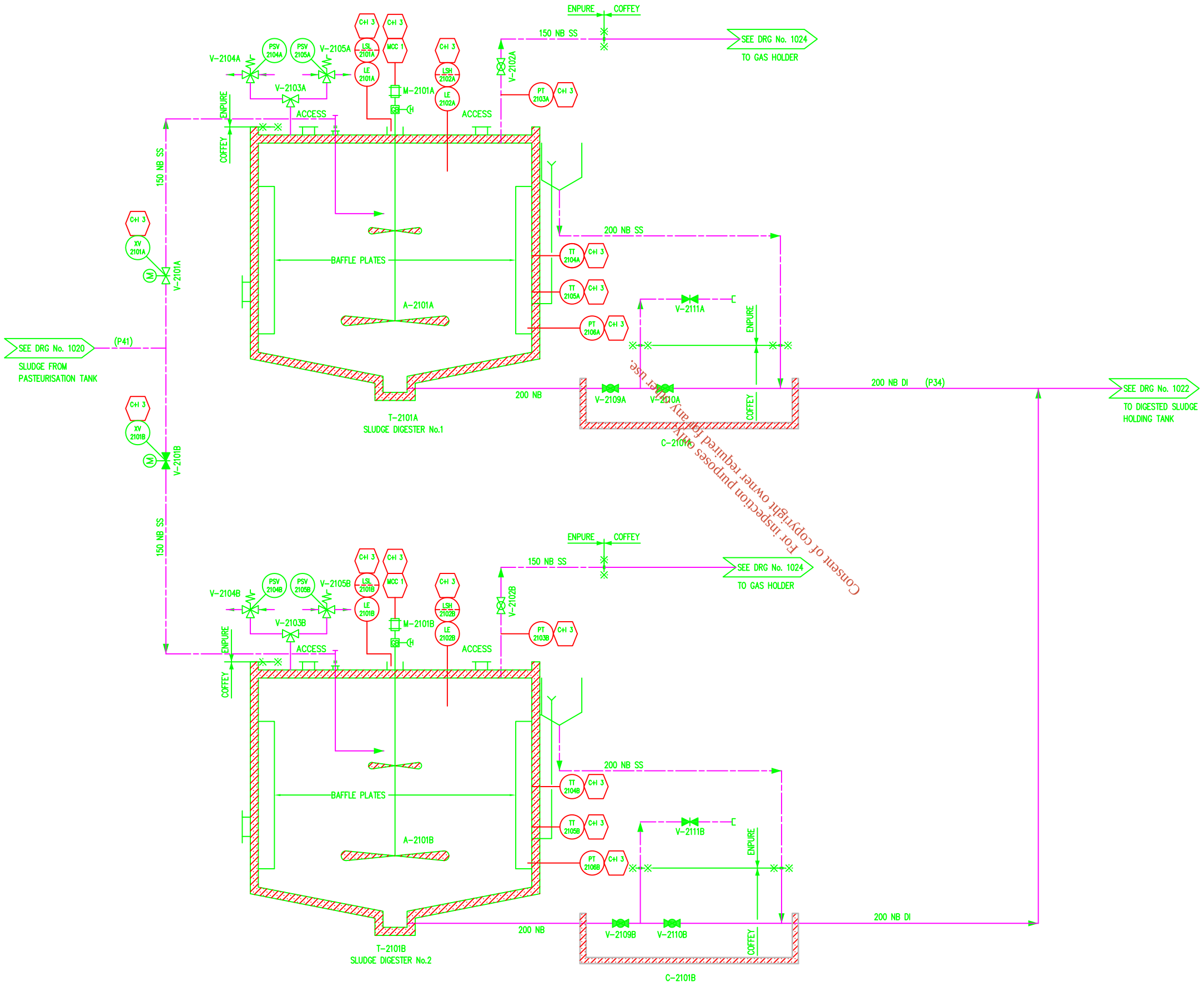
Customer: WATERFORD CITY COUNCIL

Title: SLUDGE DIGESTERS
GENERAL ARRANGEMENTS
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMeakin	CGPage	A0
Date 07/11/2006	Date 12/05/2008	Date 08/07/2008	Original Scale 1:75
Drg. No. C1197-2019			Rev. I

DO NOT SCALE - IF IN DOUBT ASK

Ref.
Drg. No. C1197-1021



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	27/06/2008	GENERAL MODS	

NOTES
1. REMOVED

HOLDS
1. ENPURE TO CONFIRM.

LEGEND:
NEW PIPEWORK/CHANNEL BY CIVILS CONTRACTOR.
NEW PIPEWORK BY M&E CONTRACTOR.
ENPURE PIPEWORK

CHECKED			APPROVED		
	PROCESS ENG.	RJM		PROCESS TECH SPECIALIST.	DGG
	PROJECT ENG.	JMN		PROJECT MAN.	CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN.	BM
	LEAD ELEC ENG.	AMT		ELEC ENG MAN.	JL

A.W.I. CONTRACT No 1002

coffey enpure

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Customer
WATERFORD CITY COUNCIL

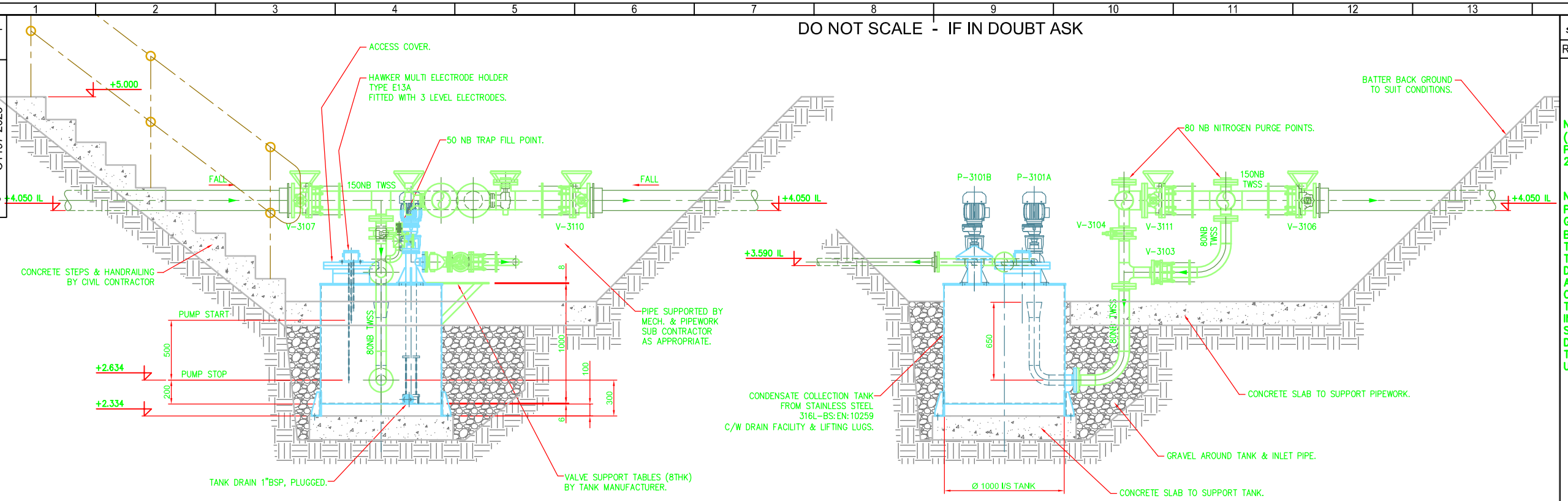
Title
SLUDGE DIGESTERS
P & I DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMiller	RJMeakin	A1
Date 20/10/2006	Date 26/06/2008	Date 27/06/2008	Original Scale NTS
Drg. No. C1197-1021			Rev. 1

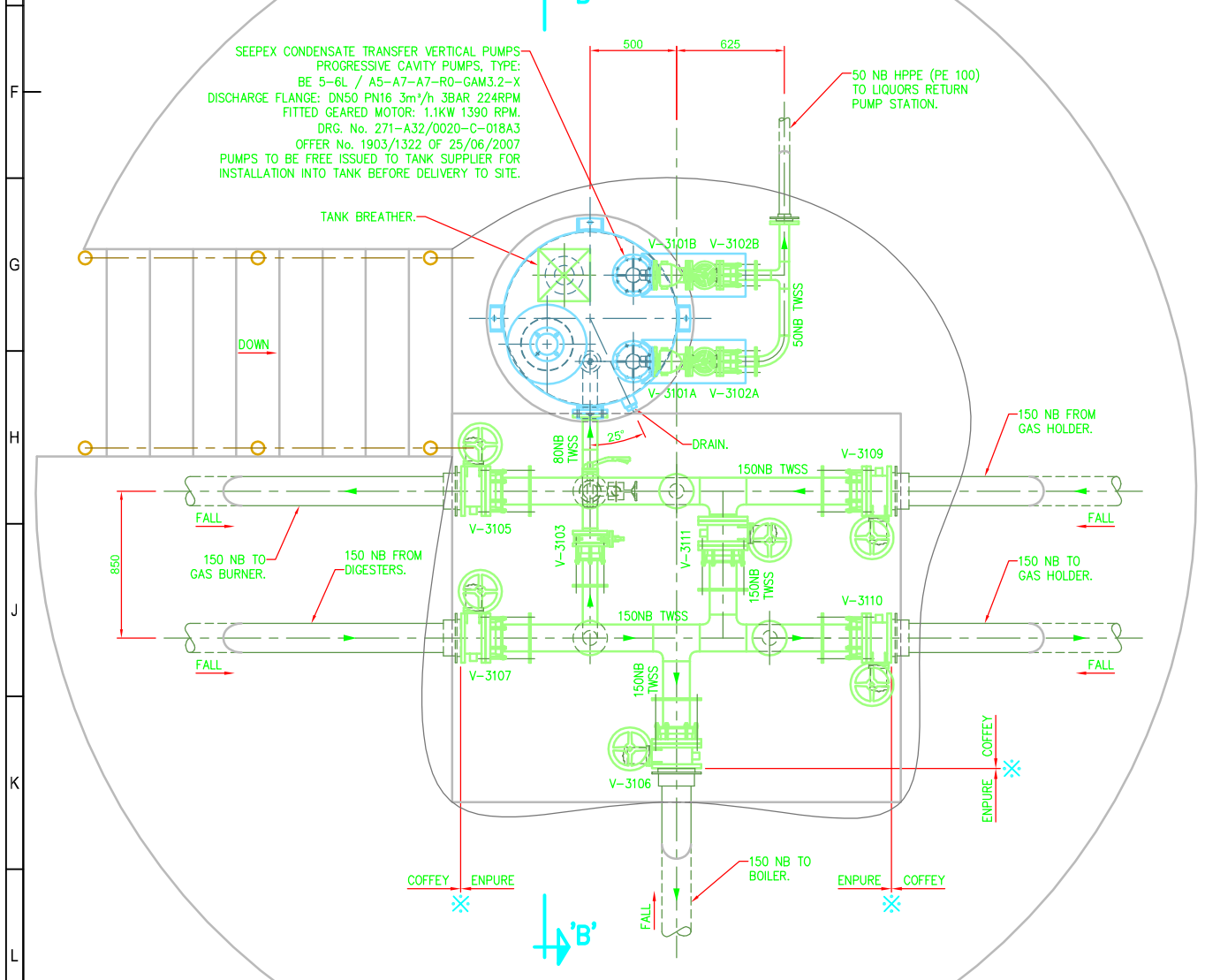
ISSUED AFC

DO NOT SCALE - IF IN DOUBT ASK

Rev. 1
Drg. No. C1197-2023



SECTION B-B



See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	24/09/2007	REDRAWN, WAS IN ROUND CHAMBER.	

NOTE : THE DIGESTER BIOGAS IS AT A PRESSURE OF 200mm Wg (20 mBAR) ABOVE ATMOSPHERIC CONDITIONS AND THE DIGESTER PRESSURE RELIEF VALVES WILL BE SET TO DISCHARGE AT 275mm Wg.

NOTE : IT IS OF PARAMOUNT IMPORTANCE THAT THE BIOGAS PIPEWORK BETWEEN DIGESTERS AND CONDENSATE TRAP (CT); GROUND FLARE AND CT; GAS HOLDER AND CT AND HOT WATER BOILERS AND CT; ALL SLOPE, WITH CONSTANT GRADIENT "DOWN", TOWARDS THE PIPEWORK ABOVE THE CONDENSATE TRAP. TYPICAL CONSTANT GRADIENT 1:100.
DIGESTER BIOGAS AT 36°C IS SATURATED WITH WATER VAPOUR AND ANY COOLING OF THE GAS WILL RESULT IN CONDENSATE CONTAINING SULPHUR. THIS LIQUOR MUST FLOW DOWNHILL TO THE CONDENSATE TRAP, ANY DIP IN THE GRADIENT MAY RESULT IN THE GAS FLOWRATES BEING THROTTLED OR COMPLETELY STOPPED, DUE TO THE LIQUOR FORMING IN THE PIPELINE DEPRESSION. THE PURPOSE OF THE CT IS TO FULLY REMOVE THE LIQUOR FROM THE SYSTEM AND THEREBY ALLOW THE UNRESTRICTED FLOW OF BIOGAS THROUGH THE SYSTEM.

ISSUED AFC

ISSUED APPROVED for CONSTRUCTION / SHE 2 REVIEW COMPLETED
DATE: 02/11/2007 SIGNATURE: JMNorton

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

Title: CONDENSATE TRAP
GENERAL ARRANGEMENTS
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
CWThomas	RJMeakin	CGPage	A1
Date 12/02/2007	Date 19/09/2007	Date 24/09/2007	Original Scale 1:20
Drg. No. C1197-2023			Rev. 1

DO NOT SCALE - IF IN DOUBT ASK

Ref.
Drg. No. C1197-1024

GAS HOLDER PACKAGE
A-2401

SEE KIRK LMS DRAWING
C1197-1611

C+I 3 | MCC 1 | LCP 1

(P17) 50nb. HPPE → SEE DRG No. 1030
LIQUORS RETURN PUMPING STATION

150nb. HPPE (P33)
150nb. HPPE (P23)
50nb.

ENPURE | COFFEY

FRESH AIR INLET

V-2409
V-2410
V-2411
V-2407

150nb. SS (P29) → SEE DRG No. 1028
TO BOILER

150nb.
150nb.SS

C+I 3 | LSHH 2403 | LSL 2403 | LE 2403
C+I 3 | MCC 1 | M-2401A | V-2402A | V-2401A
C+I 3 | MCC 1 | M-2401B | V-2402B | V-2401B
FRESH AIR INLET

CONDENSATE PUMP P-2401A
CONDENSATE PUMP P-2401B

80nb. SS — V-2404 — 80nb. SS

V-2405

CONDENSATE COLLECTION TANK

T-2401

(P23)

EXCESS GAS BURNER
A-2402

SEE EUROGRADE DRAWING
C1197-1211

LCP 2 | MCC 1 | C+I 3

COFFEY | ENPURE

150nb. HPPE

(P33) HOLD 1

COFFEY | ENPURE
SEE DRG No. 1021 → 150nb. HPPE
DIGESTOR No. 1

COFFEY | ENPURE
SEE DRG No. 1021 → 150nb. HPPE
DIGESTOR No. 2

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	27/06/2008	ELEC TAGS UPDATED AND GAS HOLDER REVISED.	

NOTES
1. DRAWING PREVIOUSLY E8374-1024

LEGEND:
NEW PIPEWORK/CHANNEL BY CIVILS CONTRACTOR.
NEW PIPEWORK BY M&E CONTRACTOR.
ENPURE PIPEWORK

CHECKED			APPROVED		
	PROCESS ENG.	DGH		PROCESS TECH SPECIALIST.	DGG
	PROJECT ENG.	JMN		PROJECT MAN.	CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN.	BM
	LEAD ELEC ENG.	AMT		ELEC ENG MAN.	JL

A.W.I. CONTRACT No 1002

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Customer: WATERFORD CITY COUNCIL

Title: GAS HOLDING SYSTEM
P & I DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMiller	RJMeakin	A1
Date 20/10/2006	Date 26/06/2008	Date 27/06/2008	Original Scale NTS
Drg. No. C1197-1024			Rev. 1

ISSUED AFC

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8417 **Title :** Bolier

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	04/06/2007	Contract Issue	DGH		

BOILER SIZING								
		Case 1	Case 2	Case 3	Case 4			
Total Heat Required by all Digesters	kW	253	314	744	921	Ref: 8416 Heat Exchanger Design		
Number of Duty Boilers Selected		1	1	2	2			
Output Required by Each Boiler	kW	253	314	372	461			
Boiler output required to be specified to suppliers. Suppliers to select actual boiler model to meet the required output and advise actual output, efficiency and fuel input requirements. Calculation given below is for preliminary assessment purposes only.								
Boiler Output Selected (Each)	kW	500	500	500	500			
Boiler Efficiency (Assumed)	%	80	80	80	80			
Estimated Fuel Input Required (Each)	kW	625	625	625	625			
Sludge Gas Usage								
Gas Net Calorific Value	MJ/Nm^3	22.5	22.5	22.5	22.5			
Approximate Gas Flowrate (Each)	Nm^3/h	100	100	100	100			
Approximate Gas Flowrate (Total)	Nm^3/h	100	100	200	200			
Minimum Gas Yield (Total)	m^3/d	2291	2291	3776	3776	8413 Gas Production		
Proportion of Minimum Gas Yield Consumed by all Boilers	%	105	105	127	127			
Standby Fuels								
Fuel Oil Net Calorific Value	MJ/m^3	36900.00	36900.00	36900.00	36900.00			
Fuel Oil Flowrate (approx)	m^3/h	0.06	0.06	0.06	0.06			
	l/h	61	61	61	61			
LPG Net Calorific Value	MJ/m^3	93.90	93.90	93.90	93.90			
LPG Flowrate (approx)	Nm^3/h	23.96	23.96	23.96	23.96			
Natural Gas Net Calorific Value	MJ/Nm^3	38.62	38.62	38.62	38.62			
Natural Gas Flowrate (approx)	Nm^3/h	58.26	58.26	58.26	58.26			

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8418 **Title :** Gas System Equipment

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	1	20/11/2006	Contract Issue	DGH	DG	DG
2	1	16/04/2007	Whessoe valve information changed	DGH		

GAS HOLDER, EXCESS GAS BURNER AND DIGESTER PRESSURE/VACUUM RELIEF VALVES SIZING

		Case 1	Case 2	Case 3	Case 4	
Gas Holder						
Number of Gas Holders		1	1	1	1	
Average Gas Production Rate	m^3/h	193	164	157	95	
Retention Time in each Gas Holder	min	20	20	20	20	
Capacity of each Gas Holder	m^3	64	55	52	32	
Selected Capacity of each Gas Holder	m^3	65	65	65	65	
Retention Time at Minimum Production Rate	min	23	27	28	46	
Retention Time at Average Production Rate	min	20	24	25	41	
Retention Time at Maximum Production Rate	min	18	21	22	37	
Excess Gas Burner						
Maximum Gas Production Rate	m^3/h	215	182	175	106	
Gas Burner Oversizing Margin	%	25	25	25	25	
Gas Burner Capacity Required	m^3/h	268	228	219	133	
Digester Pressure/Vacuum Relief Valve - Pressure Relief Condition						
Maximum Gas Production Rate	m^3/h	107	91	87	53	
Mixing Compressor Flowrate	m^3/h	0	0	0	0	Mechanical Mixing
Digester Feed Volume	m^3/h	15	15	15	15	Ref: Pasteurisation design sheets 8420
Pressure Relief Rate Required	m^3/h	122	106	102	68	
Digester Pressure/Vacuum Relief Valve - Vacuum Relief Condition						
Digester Height (Centre of Cone to TWL)	m	13.173	13.173	13.173	13.173	
Drain Pipe Diameter (ID)	m	0.20	0.20	0.20	0.20	
Drain Pipe Length	m	10.0	15.0	18.0	20.0	
Roughness	mm	0.5	0.5	0.5	0.5	
Fittings K_T		2	2	2	2	

Maximum vacuum relief rate will occur when the friction loss in the outlet line is equal to the static head above the outlet. To evaluate this, the flowrate at which the static head is equal to the friction loss must be determined. Note that the friction factor and hence the friction loss is dependent on the flowrate so the equations must be solved by iteration.

To solve, use the following procedure :

From "Tools" menu choose "Goal Seek"
In "Set cell" box enter "C64", "D64", "E64", "F64"
In "To value" box enter number contained in cell C39, D39, E39, F39
In "By changing cell" box enter "C56", "D56", "E56", "F56"

Maximum Flowrate	m^3/h	882	824	794	776
Water Temperature for Design	°C	35.0	35.0	35.0	35.0
Water Density	kg/m^3	994	994	994	994
Water Viscosity	mNs/m^2	0.7204	0.7204	0.7204	0.7204
Velocity	m/s	7.80	7.28	7.02	6.86
Reynolds Number		2152745	2010124	1937033	1892508
Friction Factor	f us	0.02495	0.02495	0.02496	0.02496
Dynamic Head Loss	m H_2O	13.17	13.17	13.17	13.17
Vacuum Relief Flowrate Required	m^3/h	882	824	794	776

DO NOT SCALE - IF IN DOUBT ASK

Ref.
Drg. No. C1197-1026

SEE DRG No. 1027
FINAL EFFLUENT WASHWATER
(P31)
COFFEY
EPS
V-2601A
V-2602A
C+I 2
SOV 2603A

SEE DRG No. 1015
PRIMARY SETTLEMENT TANKS

SEE DRG No. 1014
SCREEN/GRIT SKIPS

SEE DRG No. 1011
INLET WORKS BUILDING

SEE DRG No. 1014
SCREENINGS WASHER/COMPACTOR

SEE DRG No. 1014
GRIT CLASSIFIER

SEE DRG No. 1012
INLET WORKS

C+I 2
QIT 2601
QE 2601
H_2S MONITOR

ODOUR UNIT BIOFILTER

H_2S MONITOR
C+I 2
QIT 2605
QE 2605

EPS
COFFEY

SEE DRG No. 1030
LIQUOR SUMP
(P43)

DROPLET ELIMINATOR

LCP
LCP
2 No. EXHAUST FANS

CARBON FILTER

H_2S MONITOR
C+I 2
QIT 2602
QE 2602

C+I 2
QIT 2606
QE 2606
DUST

CLEANED AIR TO ATMOSPHERE VIA VENT STACK

A-2601
ODOUR CONTROL PLANT No1

SEE DRG No. 1018
PICKET FENCE THICKENER

SEE DRG No. 1018
GRAVITY BELT THICKENERS

SEE DRG No. 1019
SLUDGE BLENDING TANK

SEE DRG No. 1019
PRIMARY EMERGENCY SLUDGE HOLDING TANK

SEE DRG No. 1019
SECONDARY EMERGENCY SLUDGE HOLDING TANK

SEE DRG No. 1023
SLUDGE BUILDING

SEE DRG No. 1023
SLUDGE DEWATERERS

SEE DRG No. 1023
SLUDGE DEWATERER SKIP

SEE DRG No. 1030
LIQUOR RETURNS P.S.

SEE DRG No. 1027
FINAL EFFLUENT WASHWATER
(P31)
COFFEY
EPS
V-2601B
V-2602B
C+I 1
SOV 2603B

2603 QE
2603 QIT
C+I 1
H^2S MONITOR

ODOUR UNIT

DROPLET ELIMINATOR

LCP
LCP
2 No. EXHAUST FANS

CARBON FILTER

H_2S MONITOR
C+I 1
QIT 2604
QE 2604

C+I 1
QIT 2607
QE 2607
DUST

CLEANED AIR TO ATMOSPHERE VIA VENT STACK

EPS
COFFEY

SEE DRG No. 1030
LIQUOR SUMP
(P26)

A-2602
ODOUR CONTROL PLANT No2

LCP
MCC 2

LCP
MCC 1

ISSUED AFC

See Previous Issues For Past Revision Details

Rev.	Date	Description	Drawn
1	27/06/2008	UPDATED TO SUPPLIERS INFORMATION	

NOTES
1. REMOVED

LEGEND:
NEW PIPEWORK/CHANNEL BY CIVILS CONTRACTOR. ———
NEW PIPEWORK BY M&E CONTRACTOR. - - - - -

CHECKED			APPROVED		
	PROCESS ENG.	DGH		PROCESS TECH SPECIALIST.	DGG
	PROJECT ENG.	JMN		PROJECT MAN.	CGP
	LEAD MECH ENG.	JAM		MECH ENG MAN.	BM
	LEAD ELEC ENG.	AMT		ELEC ENG MAN.	JL

A.W.I. CONTRACT No 1002

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Customer
WATERFORD CITY COUNCIL

Title
ODOUR CONTROL
P & I DIAGRAM
WATERFORD WWTW

Drawn	Checked	Approved	Original Sheet Size
DJTildesley	RJMiller	RJMeakin	A1
Date	Date	Date	Original Scale
20/10/2006	26/06/2008	27/06/2008	NTS

Drg. No. C1197-1026 Rev. 1

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PROCESS DESIGN CALCULATION

Contract Name : Waterford **Contract No:** C1197

Document Reference: 8419 **Title :** Odour Control Design

Revision	No. of Pages (Excluding Cover)	Date of Issue	Purpose of Issue	Originator	Checked	Approved
1	4	23/01/2007	Draft Issue	DGH	PB	
2	4	09/02/2007	Contract Issue	DGH		

PURAC Contract No.	C1197
Contract Title	Waterford WwTW
PURAC Document No.	8419
Date	09/02/07
Revision	2

List Odour Control Unit Names	P&ID no.	Tag No.	Ave Odour concentration (OU_E/m^3)	Max Odour concentration (OU_E/m^3)	Ave H_2S conc (ppm)	Peak H_2S conc (ppm)	Air flowrate (m^3/hr)
Combined Treatment OCU	C1197-1026	TBC	0	0	0.0	0.0	0
			0	0	0.0	0.0	0
			0	0	0.0	0.0	0
Inlet Treatment OCU	C1197-1026	TBC	63533	63533	19.2	19.2	13815
Sludge Treatment OCU	C1197-1026	TBC	97976	97976	49.0	49.0	5042
			0	0	0.0	0.0	0
Other discharges			0	0	0.0	0.0	0
			72743	72743	27.1	27.1	18857
Check calc integrity			OK	OK	OK	OK	OK

Areas to be odour controlled Orange cells require input

Process Area	Process Fluid	P&ID no. & GA no.	No.	Tag No(s):	Air extracted to:	Ave Odour concentration (OU_E/m^3)	Max Odour concentration (OU_E/m^3)	Converted average H_2S conc. (ppm)	Converted peak H_2S conc. (ppm)	Air flowrate (m^3/hr)
Pre-screen and post-grit channels	Raw Sewage	C1197-1012 & 2000/1	1	T-1201	Inlet Treatment OCU	131243	131243	39	39	388
Fine Screens including bypass	Raw Sewage	C1197-1012 & 2000/1	4	A-1201A/B/C & A-1202	Inlet Treatment OCU	81000	81000	24	24	704
Screenings Compactors	Raw Sewage	C1197-1014 & 2000/1	1	A-1401	Inlet Treatment OCU	80000	80000	40	40	32
Grit Classifier	Grit	C1197-1014 & 2000/1	1	A-1402	Inlet Treatment OCU	160000	160000	80	80	32
Grit Channel	Raw Sewage	C1197-1012 & 2000/1	2	T-1202A/B	Inlet Treatment OCU	65833	65833	20	20	1004
Preliminary Treatment Building	N/A	C1197-1012 & 2000/1	1		Inlet Treatment OCU	150	150	0	0	7247
Primary Sedimentation Tank	Screened Sewage	C1197-1015 & 2004	2	T-1501A/B	Inlet Treatment OCU	157664	157664	47	47	4407
Pasteuriser	Sludge	C1197-1020	3	T-2001A/B/C	Sludge Treatment OCU	630000	630000	315	315	246
Picket Fence Thickener	Primary Sludge	C1197-1018	1	T-1801	Sludge Treatment OCU	420000	420000	210	210	178
Secondary Sludge Thickener	Secondary Sludge	C1197-1018 & 2011	2	A-1802A/B	Sludge Treatment OCU	280000	280000	140	140	60
Sludge Building	N/A	C1197-1018 & 2011	1		Sludge Treatment OCU	800	800	0	0	3580
Emergency Primary Sludge Tank	Primary Sludge	C1197-1019	1	T-1903	Sludge Treatment OCU	315000	315000	158	158	276
Emergency Secondary Sludge Tank	Secondary Sludge	C1197-1019	1	T-1902	Sludge Treatment OCU	315000	315000	158	158	329
Sludge Blending Tank	Sludge	C1197-1019	1	T-1901	Sludge Treatment OCU	630000	630000	315	315	41
Sludge Dewaterer	Sludge	C1197-1023 & 2011	2	A-2301A/B	Sludge Treatment OCU	96000	96000	48	48	90
						0	0	0	0	0
Liquor Return PS	Sludge Liquors	C1197-1030	1	C-3001	Sludge Treatment OCU	78750	78750	39	39	240

C1197 - Waterford WwTW

Ventilation, Odour Control and Declassification of Zoned Areas Calculations

PURAC Document No. 8419

Date 09/02/2007

Revision 2

Orange cells require input

Process Area	Process fluid	No.	Vessel Shape	Working Dimensions / Details						Headspace / Gross Vessel Dimensions / Details						Process volume (per unit) m^3	Headspace / Gross volume m^3	Tank Perimeter (per unit) m	Cover Perimeter m	Actual Perimeter	Max fill rate or specified (per unit) m^3/hr
Pre-screen and post-grit channe	Raw Sewage	1	Rectangular	52.4	m length	1.8	m deep	1.5	m width	52.4	m length	0.5	m deep	1.5	m width	141.5	39.3	107.8		Perimeter	
Fine Screens including bypass	Raw Sewage	4	Rectangular	10	m length	2.2	m deep	2.2	m width	10	m length	1	m deep	2.2	m width	48.4	22.0	24.4		Perimeter	
Screenings Compactors	Raw Sewage	1	Other	4	m3 volume											4.0	4.0	N/A		N/A	
Grit Classifier	Grit	1	Other	4	m3 volume											4.0	4.0	N/A		N/A	
Grit Channel	Raw Sewage	2	Rectangular	10	m length	2.2	m deep	5.1	m width	10	m length	0.5	m deep	5.1	m width	112.2	25.5	30.2		Perimeter	400
Preliminary Treatment Building	N/A	1	Rectangular	29.3	m length	6.38	m deep	19.4	m width	29.3	m length	6.38	m deep	19.4	m width	3623.7	3623.7	97.4		N/A	
Primary Sedimentation Tank	Screened Sewage	2	Circular	32	m diam	3	m deep			32	m diam	1.37	m deep			2412.7	1101.8	100.5		Perimeter	
Pasteuriser	Sludge	3	Other	41	m3 volume											41.0	41.0	N/A		N/A	
Picket Fence Thickener	Primary Sludge	1	Circular	8.7	m diam	4.5	m deep			8.7	m diam	0.5	m deep			267.5	29.7	27.3		Perimeter	8
Secondary Sludge Thickener	Secondary Sludge	2	Rectangular	5.6	m length	0.75	m deep	1.2	m width	5.6	m length	0.75	m deep	1.2	m width	5.0	5.0	13.6		Cover	
Sludge Building	N/A	1	Rectangular	19.5	m length	6.38	m deep	14.4	m width	19.5	m length	6.38	m deep	14.4	m width	1790.1	1790.1	67.8		N/A	2
Emergency Primary Sludge Tan	Primary Sludge	1	Circular	9.38	m diam	5.6	m deep			9.38	m diam	2	m deep			387.0	138.2	29.5		Cover	
Emergency Secondary Sludge T	Secondary Sludge	1	Circular	10.2	m diam	5.6	m deep			10.2	m diam	2	m deep			461.2	164.7	32.2		Cover	
Sludge Blending Tank	Sludge	1	Circular	5.12	m diam	2.9	m deep			5.12	m diam	1	m deep			59.7	20.6	16.1		Cover	
Sludge Dewaterer	Sludge	2	Rectangular	5	m length	0.75	m deep	2	m width	5	m length	0.75	m deep	2	m width	7.5	7.5	14.0		Cover	
0	0	0	Rectangular		m length		m deep		m width		m length		m deep		m width	0.0	0.0	0.0		N/A	
Liquor Return PS	Sludge Liquors	1	Rectangular	3	m length	4	m deep	5	m width	3	m length	4	m deep	5	m width	60.0	60.0	16.0		Perimeter	240

C1197 - Waterford WwTW

Ventilation, Odour Control and Declassification of Zoned Areas Calculations

PURAC Document No. 8419

Date 09/02/2007

Revision 2

	Calculations for zoning declassification ventilation rate																			
Process Area	CH_4 rate of emission $m^3m^{-3}sec^{-1} \times 10^{-9}$	Air changes per hour	Temp °C	LEL %	Density kg / m^3	Grade of release	BS safety factor k	Gas production rate kg/s	Temperature corrected rate kg/s	Actual gas production rate kg/s	Ventilation rates per unit m^3/hr Rate 1	Rate 2	Rate 3	Rate 4	Safety Factor	Final rate per unit (Max X SF) m^3/hr	Choose flowrate per unit	Actual flowrate per unit m^3/hr	Actual air changes per hour (based on headspace)
Pre-screen and post-grit channel	6.9	8.0	20	5.3	0.72	Secondary	0.5	7.03E-06	5.35E-06	Corrected	388.1	1.1	N/A	314.4	0%	388.1	Max xSF	388.1	9.9
Fine Screens including bypass	6.9	8.0	20	5.3	0.72	Secondary	0.5	2.40E-06	1.83E-06	Corrected	87.8	0.4	N/A	176.0	0%	176.0	Max xSF	176.0	8.0
Screenings Compactors	0.0	8.0	20	5.3	0.72	Secondary	0.5	0.00E+00	0.00E+00	Corrected	N/A	0.0	N/A	32.0	0%	32.0	Max xSF	32.0	8.0
Grit Classifier	0.0	8.0	20	5.3	0.72	Secondary	0.5	0.00E+00	0.00E+00	Corrected	N/A	0.0	N/A	32.0	0%	32.0	Max xSF	32.0	8.0
Grit Channel	6.9	4.0	20	5.3	0.72	Secondary	0.5	5.57E-06	4.25E-06	Corrected	108.7	0.9	400.0	102.0	26%	502.0	Max xSF	502.0	19.7
Preliminary Treatment Building	0.0	2.0	20	5.3	0.72	Secondary	0.5	0.00E+00	0.00E+00	Corrected	N/A	0.0	N/A	7247.4	0%	7247.4	Max xSF	7247.4	2.0
Primary Sedimentation Tank	6.9	2.0	20	5.3	0.72	Secondary	0.5	1.20E-04	9.13E-05	Corrected	361.9	18.6	N/A	2203.6	0%	2203.6	Max xSF	2203.6	2.0
Pasteuriser	163.0	2.0	55	5.3	0.72	Secondary	0.5	4.81E-05	6.07E-05	Corrected	N/A	13.9	N/A	82.0	0%	82.0	Max xSF	82.0	2.0
Picket Fence Thickener	289.0	6.0	20	5.3	0.72	Secondary	0.5	5.57E-04	4.24E-04	Corrected	98.4	86.5	8.0	178.3	0%	178.3	Max xSF	178.3	6.0
Secondary Sludge Thickener	163.0	6.0	20	5.3	0.72	Secondary	0.5	5.91E-06	4.50E-06	Corrected	0.0	0.9	N/A	30.2	0%	30.2	Max xSF	30.2	6.0
Sludge Building	0.0	2.0	20	5.3	0.72	Secondary	0.5	0.00E+00	0.00E+00	Corrected	N/A	0.0	2.0	3580.2	0%	3580.2	Max xSF	3580.2	2.0
Emergency Primary Sludge Tank	289.0	2.0	20	5.3	0.72	Secondary	0.5	8.05E-04	6.13E-04	Corrected	0.0	125.2	N/A	276.4	0%	276.4	Max xSF	276.4	2.0
Emergency Secondary Sludge T	163.0	2.0	20	5.3	0.72	Secondary	0.5	5.41E-04	4.12E-04	Corrected	0.0	84.1	N/A	329.4	0%	329.4	Max xSF	329.4	2.0
Sludge Blending Tank	289.0	2.0	20	5.3	0.72	Secondary	0.5	1.24E-04	9.46E-05	Corrected	0.0	19.3	N/A	41.2	0%	41.2	Max xSF	41.2	2.0
Sludge Dewaterer	110.0	6.0	20	5.3	0.72	Secondary	0.5	5.94E-06	4.52E-06	Corrected	0.0	0.9	N/A	45.0	0%	45.0	Max xSF	45.0	6.0
0	0.0	2.0	20	5.3	0.72	Secondary	0.5	0.00E+00	0.00E+00	Corrected	N/A	0.0	N/A	0.0	0%	0.0	Max xSF	0.0	#DIV/0!
Liquor Return PS	110.0	2.0	20	5.3	0.72	Secondary	0.5	4.75E-05	3.62E-05	Corrected	57.6	7.4	240.0	120.0	0%	240.0	Max xSF	240.0	4.0

C1197 - Waterford WwTW

Ventilation, Odour Control and Declassification of Zoned Areas Calculations

PURAC Document No. 8419

Date 09/02/2007

Revision 2

	OU concentration calculation						Final Calculated Odour, H_2S and airflow rates							
Process Area	Frechen data E_f (OU / s /m^2)	North data E_n (OU / s /m^2)	UKWIR value $OU_E.s^{-1}.m^{-2}$	Surface area per tank A (m^2)	Superficial air velocity V (m / s)	Emission rate E_{out} (OU / s)	Specified Odour concentration (OU_E / m^3)	Odour concentration (OU_E / m^3)	Chosen H_2S correlation factor ppb H_2S/OU_E	Direct H_2S correlation (ppm)	Factor of safety (peaking factor)	Odour concentration using SF (OU_E / m^3)	Estimated H_2S conc. using SF (ppm)	Total flow m^3/hr
Pre-screen and post-grit channels			180	78.6	0.001	14148		131243	0.3	39.4	1.0	131243	39.4	388
Fine Screens including bypass			180	22.0	0.002	3960		81000	0.3	24.3	1.0	81000	24.3	704
Screenings Compactors			180	N/A	N/A	N/A	80000	80000	0.5	40.0	1.0	80000	40.0	32
Grit Classifier			360	N/A	N/A	N/A	160000	160000	0.5	80.0	1.0	160000	80.0	32
Grit Channel			180	51.0	0.003	9180		65833	0.3	19.7	1.0	65833	19.7	1004
Preliminary Treatment Building				568.4	0.004	0	150	150	0.3	0.05	1.0	150	0.05	7247
Primary Sedimentation Tank			120	804.2	0.001	96510		157664	0.3	47.3	1.0	157664	47.3	4407
Pasteuriser			480	N/A	N/A	N/A	630000	630000	0.5	315.0	1.0	630000	315.0	246
Picket Fence Thickener			350	59.4	0.001	20806		420000	0.5	210.0	1.0	420000	210.0	178
Secondary Sludge Thickener			350	6.7	0.001	2352		280000	0.5	140.0	1.0	280000	140.0	60
Sludge Building				280.8	0.004	0	800	800	0.5	0.4	1.0	800	0.4	3580
Emergency Primary Sludge Tank			350	69.1	0.001	24186		315000	0.5	157.5	1.0	315000	157.5	276
Emergency Secondary Sludge Tank			350	82.4	0.001	28824		315000	0.5	157.5	1.0	315000	157.5	329
Sludge Blending Tank			350	20.6	0.001	7206		630000	0.5	315.0	1.0	630000	315.0	41
Sludge Dewaterer			120	10.0	0.001	1200		96000	0.5	48.0	1.0	96000	48.0	90
0.0				0.0	0.000	0		0	0.2	0.0	1.0	0	0.0	0
Liquor Return PS			350	15.0	0.004	5250		78750	0.5	39.4	1.0	78750	39.4	240
								72742.7		27.1		72742.7	27.1	18857