Appendix 19: Effluent treatment plant, description baseline

BRIDGEND PAPER MILL

DOCUMENT STATUS RECORD

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DOCUMENT TITLE: Effluent Treatment Plant System Manual

ISSUE NUMBER	CHANGE DETAILS	ISSUE DATE	APPROVED BY
1	Creation of the Procedure	01.6.05	IG
2	Update consents & consents page added	26.6.06	IG
3	Hyperlinks Added	21.7.06	IG
4	High Sludge Blanket procedure added	24.7.06	IG
5	Procedure for start up after power dip added	25.9.06	IG
6	Security alarms added	24.10.06	IG
7	Emergency Power Supply added	02.11.06	IG
8	Mixing box high level added	18.01.08	IG
9	De-ink/Jonathan references voided. Bracket screen status updated. Molasses info added. PI references added. Responsibles/contacts updated.	18.08.08	DWL
10	All ETP test methods added	24.03.09	DWL
11	Tests updated	24.06.10	DWL
12	Sludge blanket lift procedure updated	09.02.12	RLM
13	Screw press inclusion, consents, links, ETP schematic, fire run-off updated.	14.11.12	RLM
14	ETM 007 updated, ammonia working range updated, responsible persons updated throughout.	22.10.13	RLM
15	Effluent Test Methods removed and referenced. Recycling of effluent flow chart updated	22.11.13	RLM
16	Appendix 8 updated	27.10.15	RLM
17	Updated: Pi monitoring, effluent & Nant Gwyn recycling, job titles.	30.11.16	RLM
18	Change of company name.	21.08.18	SDB
19	Review	May 2019	SDB
20	Review	Aug 2020	SDB

Contents

Introduction

The Effluent treatment system at Bridgend Paper Mills is described in detail below and is presented together with plant discharge records, performance charts versus consents and maintenance strategies.
The plant was commissioned in 1991 and remains a preferred effluent treatment process for Bridgend Paper Mills and the paper industry as a whole. The plant continuously produces a good quality effluent with few process problems.
It has built in systems to give maximum plant flexibility. The system was when designed, and continues to be, best practice for effluent treatment of a large paper mill.
Testing regimes are in place to ensure that all consents set out in our operating permit are met at all times.

Bridgend paper mills operates a two stage effluent treatment system, comprising of primary treatment via 2 Dorr Oliver clarifoculators and 1 aquascreen filter. Secondary treatment consists of a Biwater activated sludge plant and a final settlement clarifier.

System Overview

Pre-treatment

There are initially two effluent streams that flow into the effluent mixing and distribution box.
The main stream from Jupiter machine passes through an Aquascreen, which removes any solid material such as plastic and wood. There is a bypass around the screen in case of blockage. The second stream, which is the ex-Jonathan machinehouse drain, goes straight to the effluent plant via the mixing box, but has very little flow.

The effluent then carries forward to the mixing box.
The mixing box is a central collecting point for all mill effluent drains. A series of valves and slides allows the distribution of flow into the clarifloculators.
Effluent exiting the mixing and distribution box is then gravity fed to either or both Dorr Oliver Clarifloculators numbered 5 and 6.
Nos.1,2,3 and 4 clarifloculators are now redundant.

No. 5 & 6 are used to collect and treat the effluent distributed via the mixing box. No. 3 & 4 can be used in an emergency.

Effluent from the mixing box is further distributed prior to the clarifloculators at the inlet to inspection chambers 1 & 2.

Primary Treatment

Primary settlement tanks 2 off 3050m³ (5 & 6)

Dorr Oliver design clarifloculators using half bridge rotating outer scraper and central flocculation zone with inner rake and paddles.

Settled sludge removal is via 4 off Willet ram pumps

Supernatant liquor removal is via peripheral launder to manhole 1 collection chamber of concrete construction.

Balance tank

Concrete buffering tank collecting all effluent at start of secondary treatment.

Associated items:-

a. 1 off Archimedian Screw pump (M1), max flow - 316l/s, with screw failure alarm alarming at security gatehouse.
b. Penstock 4 effluent diversion valve.
c. Overflow mechanism to RAS pump station.
d. High level float alarm linked to the security gatehouse.

RAS pump station.

Receiving Return Activated Sludge via 825mm pipe into 730m3 collecting tank.

Associated items:-

a. 2 off Archimedian screw pumps (M10 & M11), max flow 475l/s, one duty and one standby working off--
b. High and low level float switches.
c. High sump level warning float alarm, alarming at security gatehouse.

Premix tank

Clarified primary effluent pumped via M1 screw pump is mixed with RAS pumped via M10 or M11 by the injection of air through 2 off aerators.

Oxidation Ditch.

Main aeration tanks 1 and 2 split into two by central separating wall with 2.5m x 2.5m linking hole.
Each tank is 55m long, 17.7m wide and has a depth of 3.5m, total volume of 6800m³.

Two 37kW mammoth brush rotor per ditch, with two rotors (M4 & M7) running constantly, drive the liquors around the tanks and introduce additional oxygen to liquors. M5 & M6 rotors are operated on oxygen concentration. Each rotor has a maximum oxygenation capacity of 9Kg O2/m of rotor length /hour. Dissolved oxygen is measured by Endress and Hauser Oxygen transmitter and recorded at the switch room recorder and on PI system.
Liquor level is controlled by a moveable weir system, which controls the oxygen input via the mammoth rotors.
Mixed liquor from the oxidation ditch flows over the weir and through a 900mm concrete pipeline to the centre of the final settlement tank.

Final Settlement Tank

45m diameter, 1591m² surface area, 6100m³ volume.
A sludge blanket clarifier with central skirt distribution. Full bridge scraper with standard trailing scraper arrangement. Continuous draw off from the clarifier from central hopper of tank via hydrostatic head. The sludge flow is manually controlled back to the RAS pump station by a telescopic valve fitted at end of draw off pipe.

Lower drain valve fitted to bottom of telescopic valve.

Sludge blanket level is monitored by Bestobell Mobrey sludge blanket detector, which alarms at the security gatehouse when sludge is detected.

The peripheral launder is cleaned by high pressure spray system attached to the circulator arm bridge and can be run off timer or continuously.

Clarified water passes over the peripheral launder V weir plates with facility for +/- 50mm adjustment and flows by gravity to the final effluent chamber.

Final Effluent Chamber

A distribution chamber for effluent and Nant Gwyn stream flows of concrete construction with a series of plastic penstock valves to adjust effluent and Nant Gwyn stream flows as desired and as dictated by stream and effluent conditions.

Sludge Handling (activated)

Surplus activated sludge (SAS) is removed from the RAS line at the surplus activated sludge pit by 2 off positive displacement pumps, (M3 & M4) 1 duty and 1 standby. Flowrate variable up to 20m ^{3}/hr
The SAS is pumped to the screw press.

Associated items:-

a. Low-level float switch in SAS pit connected to M3 & M4 SAS pumps.

Picket Fence Thickener (taken out of service)

Thickening tank for sludge received from RAS system at ~ 0.7% solids.

8m diameter, SWD 3.5m. Full diameter fixed access bridge, central drive tube, picket fence, scraper mechanism, tilting valve assembly and inlet deflector drum.

Drain and overflow mechanism to RAS line.

Sludge Handling (Primary)

Settled sludge collected in the primary clarifloculators is fed to the screw press at a consistency of approximately 4-5% via Willet reciprocating pumps (see above) and pressed to approximately 50% dryness.

The sludge collects in a holding tank and enters an integral flow distributor which directs it into the disc thickener. This raises the consistency to about 20%. Filtrate is returned to effluent drain.
This thickened sludge is fed into the screw press via an inlet chute. The screw then propels the material towards the pressing zone, which builds up a counterpressure and drives the free water of the material treated through the basket. Solids are retained and expelled by the screw through the press exit aperture at a consistency of about 50%. Filtrate from the press re-enters the sludge holding tank.

Sludge generated is collected from the floor below the drum by mechanical means, loaded onto open top truck and disposed of via land-spreading or animal bedding.

Responsibilities

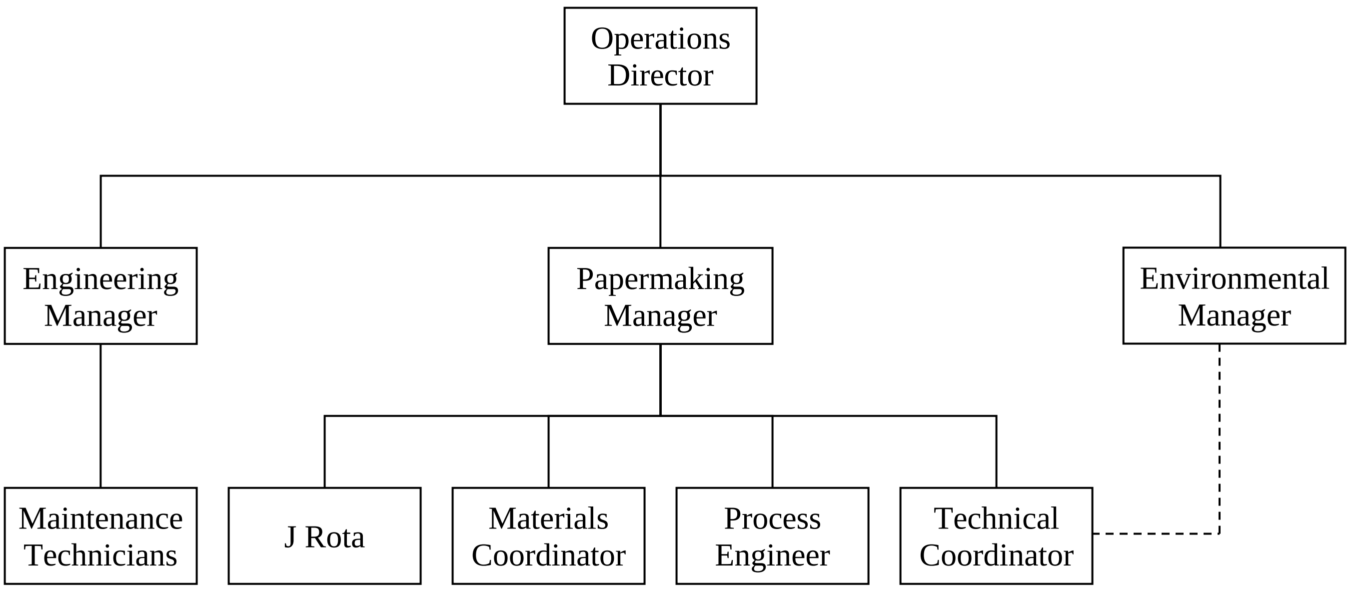
Senior Technologist – see current RR&Es

Mill Chemist - see current RR&Es & deputises for Technologist re effluent sampling

J Rota Operatives – see current RR&Es

Manning

<u>Organogram for effluent plant responsibility</u>



The effluent plant is continuously monitored by the PI system, which reports all major problems. Periodic manning is by 3 J Rota day operatives for the primary treatment system and screw press plant, and by the Technical Department for the secondary treatment. Plant inspection is performed at least once per day, every day.
Cover is provided 24hrs a day and 7 days per week. Out of normal hours cover is provided by the Shift Manager.

Chemical Addition

Nutromex

Nutrient addition, based upon a liquid mix, supplies nitrogen and phosphorus supplement to the activated sludge process.

Storage of the nutrient is in a bunded vented tank of 25m³ capacity.

Nutrient is pumped into the sewage stream to maintain predetermined nitrogen and phosphorus levels.

Adjustment is done manually under the direction of the Technical Department.

Sodium Hypochlorite

Used to control filamentous bulking. Fed from semi-bulk container by gravity into the RAS pit, the feed rate is varied according to the degree of bulking and plant viability.

Plant loading

Based on 917Kgs/ day BOD

0.11Kg BOD per m³ Aeration tank volume
0.03KgBOD per Kg Sludge Solids

Plant design capabilities

Average flowrate	-	18200m³/day
Maximum flowrate	-	27300m³/day
Peak hourly flowrate	-	1136m³/hr
Average BOD loading	-	1273Kg/day
Maximum BOD loading	-	3363Kg/day
Average Suspended Solids	-	546Kg/day

Current NRW consents (October 2018)

Maximum flow	**17500m³/day**
BOD	**10mg/l**
Suspended Solids	**25mg/l**
pH	**6.5 – 8.5**
Ammonia NH_3	**1.0mg/l**
Max Temp	**25°C**

Effluent Plant controls

Personnel - 24hr coverage via day operative, technical department and shift manager.

Flow Control

Flow into the plant is by gravity and buffered by the balance tank to maintain a constant flow to the oxidation ditch via the Archemedian screw pump.
Flows from the effluent treatment plant are monitored continuously by Endress and Hauser ultrasonic flow meter (Type. FMU 861). Flows are registered locally on the meter, logged on the Water Filtration Plant control computer and trended on the PI system.

Oxygen Level

Both oxidation ditches have Endress and Hauser DO transmitters linked to Mammoth Rotors M5 and M6 that bring in a rotor when the oxygen level falls below 1ppm.
DO level probes are set to control between 0.5 and 2ppm.

Sludge Blanket Level

Monitored by Bestobell Mobrey sludge blanket detector and set at 0.45m. Alarmed locally in the main switch room and at the security gatehouse.

Remote Monitoring

The BOD plant has a computer system dedicated to the monitoring of the plant remotely at the Jupiter machine control room.

The following pages are monitored:-

Plant Overview

Colour coded plan of plant that monitors plant status.
Green - running or okay
Yellow – warn
Red – Out of consent or pump/motor breakdown.

Level Alarms

Description of area of plant and status i.e.sump levels, DO (Dissolved Oxygen) levels, high sludge blanket, high RAS and high balance.

Trend Menu

Trends BOD, Suspended Solids, pH, Temperature, DO levels, Influent and Effluent flows.

Status Menu

All pump and motors electrical status.

In the event of total power failure to the system the system will require rebooting as described in effluent monitoring system start up procedure (appendix 1)
Response to active alarms is described in

Sampling regime

The following samples are taken as and when required:-

<u>Primary Outfall</u>

BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), Suspended Solids and nutrient levels.

<u>Secondary Aeration</u>

Mixed liquor solids
Stirred Settled Sludge Volume Index
Nutrient levels
Microscopic analysis of sludge

<u>Final Settlement Tank</u>

Sludge blanket level.
RAS solids
Nutrient levels

<u>Final Effluent Outfall</u>
Suspended Solids
pH
BOD
COD
Nutrient levels
Total N & P
AOX

<u>Primary Sludge</u>

Moisture
Ash
Fibre fractionation

Monthly Sampling Regime

Influent and Effluent samples are taken on a monthly basis for independent evaluation for the following determinands.

Mercury, Cadmium, pH, COD, BOD, AOX (Adsorbable Organic Halides), suspended solids, microtox, pentachlorophenol, tributyltin, triphenyltin, phosphate and Total nitrogen.

Plant Failure

All pumps are doubled up as Duty/Standby. Pumps are linked to level sensors that start the standby pump if levels increase in tanks due to pump failure.

Rotors for aeration are also Duty/Standby and are started when Oxygen concentration falls below 1mg/l.

In the event of a total power failure to the plant, there is a backup ‘House Set’ that can be activated to provide power to essential plant and prevent spill of untreated effluent to river. Indication of power failure is registered at the security gatehouse alarm panel and relayed via radio to all relevant personnel.

In the event of effluent being below discharge specification, there is a facility on site to recycle all effluent generated by the mill, via a series of penstocks situated at the final distribution box.
Effluent is returned to the Water Filtration Plant via the River Pump House and all water is retained within the mill water courses.
Isolation of the River Pump House from the river is also possible by the closing of valves situated within the pump house.

In the event of a total plant failure due to power, mechanical breakdown or biomass problems, there is facility to bypass the BOD plant and recycle primary treated effluent back to the mill.

Abnormal working

Abnormal working occurs during mill cleaning operations or at shut periods.
Highly alkaline liquors flushed through the papermaking system as a cleaner are segregated from all other effluent streams and collected in a previously prepared clarifloculator.
Effluent held in this tank is pH adjusted to neutral by manual addition of an acid solution.

Once neutralisation has been achieved the effluent is discharged into the main effluent stream.
There is a procedure for total mill periods to run the BOD plant on oxygen and level controls only, to maintain a viable biomass for mill start up.

Effluent Recycle

Treated effluent from the mill can be either discharged to the River Llynfi or recycled by gravity to the River Pump House and pumped to the Water Filtration Plant, where it is reused in the process.
Generally the mill runs with a recycle flow of ~40%, though this can range from 0 – 100% dictated by process conditions and River Llynfi flow and effluent quality.

Responsibility for recycle/discharge flows is taken by the technical department or day operator. Out of hours responsibility is assumed by the shift manager.
Flow through the recycle channel is monitored using a Endress and Hauser ultrasonic flow meter and recorded locally on the meter and also at the Water Filtration Plant.

Maintenance

The design of the plant allows minimal regular maintenance due to the flexibility of the plant. Generally, the plant can be allowed to run to failure because of the back up systems. There are however, regular lubrication regimes in place to ensure that all critical plant is kept in optimum condition.
The EAM system produces a job ticket at set intervals to ensure that the routine lubrication takes place. Records of lubrication are maintained on the EAM system database.
Visual integrity checks are carried out as part of the daily routines on the plant and faults or concerns logged on the BOD plant log and acted upon using the EAM system.
For general repairs an EAM Request is submitted and scheduled for repair at the earliest opportunity.
Records of general repair maintenance are maintained on the mills EAM maintenance system.
Instrumentation maintenance is carried out on a weekly basis in accordance to a (PWR) ticket being produced. Records of instrument repair and calibration are maintained for inspection at the BOD plant 'Biox' cabin.
There is an ongoing programme to replace original plant equipment with equipment of improved design and capability. This is done when failure of existing plant occurs.

Measurement

All measurements on consents are monitored continuously and the instruments used are serviced and calibrated according to the manufacturers recommendations.
Records of servicing and calibration are maintained at the BOD plant cabin.
Flow monitoring equipment and methodologies of discharge and recycle flows are MCERTS accredited and subject to independent audits every 2 years.
Continuous BOD measurement instrument BIOX 1010 is serviced and calibrated to manufacturer's guidelines. These records are maintained in the wet laboratory IPPC file.

Environmental Benchmarks

Substance	**Benchmark** mg/l
Mercury	0.0001
Phosphorous	0.065
Cadmium	0.005
Pentachlorophenol	0.002
Tributyltin	0.00002
Triphenyltin	0.00002
BOD 5	3.0

Operating Procedures

The first stage of the effluent treatment at Bridgend is by physical means, the second stage effluent treatment utilises both physical separation and conversion processes.

Operating procedure for BOD plant

Biological Controls

There are several elements to the correct and proper operation of the activated sludge Biochemical Oxygen Demand (BOD) plant, each of which interrelates with the other. Due to these interactions reference must be made to the other prior to making any decision to make changes to the plant.

The sections of the BOD plant have been described in detail earlier in the overview of the plant.

The primary design of the plant is to remove soluble organic biodegradable compounds that remain after the primary settlement treatment stage.

The plant relies on two main elements:

1. Water loading (referred to as Hydraulic load)
2. BOD load (the dissolved organics in the water)

The plant which is made up of several tanks is filled with aerobic bacteria which uses the BOD content as a source of food, the water phase effectively being the transportation for the food, so in simple terms it's a balancing act between the amount of load (food) entering the plant and the mass of the solids (activated sludge in the plant). Maintaining a proportionate balance will give good conversion:-

Effluent (soluble organics) + Oxygen → Bio-conversion = Extra Biomass + Carbon Dioxide

It is important to maintain a constant flow with as few spikes or surges of flow as possible and a constant BOD loading.

The feed of organics to the plant is supplemented by a dose of nutrient that contains nitrogen and phosphorus, this is added to promote biomass growth.

F/M Ratio

The biological loading for the plant is expressed as:

Activated sludge loading or Food to Biomass F/M ratio

$$F = Kg\ BOD\ fed\ to\ plant\ per\ day = \frac{BOD(mg/l)\ x\ flow\ (m^3/d)}{1000}$$

$$M = Kg\ Biomass\ in\ the\ bioplant = \frac{MLSS\ (mg/l)\ x\ V(m^3)}{1000}$$

where V = *volume of oxidation ditch (6800m³).*

Typically activated sludge plants would run at an F/M ratio of 0.2 – 0.4

Bridgend mill activated sludge plant typically runs on a ratio 0.005 to 0.012

The plant will run efficiently at what would be seen as a critically low F/M ratio, but biomass growth is much slower than if F/M was higher

Sludge Production

As the activated sludge is a living plant, the plant will continually produce sludge due to the conversion processes involved

Higher sludge production occurs at high f/m rations and conversely low sludge production occurs when the F/M ratio is low.

To maintain sludge levels in the plant consistent with the loading of the effluent entering the plant (F/M ratio) the sludge is 'wasted' when the levels reach a point where the plant is either saturated (too much sludge) or if the loading on the plant reduces (not enough food). These results are obtained from weekly measurements of the solids content of the MLSS (mixed liquor suspended solids) and RAS (return activated sludge).

Biomass wasting is done via P3 or P4 SAS (surplus activated sludge) pumps. Sludge is pumped off the plant until the sludge levels reduce enough to achieve a suitable F/M ratio.

The sludge ratio is traditionally maintained between the RAS and MLSS with a ratio of 2:1 being ideal for a good plant balance. Plant design is for RAS 0.8% and MLSS 0.4%, though typical results would be 0.45 and 0.35 (1.3:1) respectively.

The ratio between RAS and MLSS is controlled via the telescopic valve (Bellmouth) at the top of the FST (final settlement tank) draw off chamber. The rate of return is approximately equal to the flow into the plant.
It is important that the rate of RAS return from the FST is sufficient as not to hinder the settlement of sludge in the tank and not too high as to disintegrate the sludge blanket in the tank.

Sludge Settlement

The sludge within the FST must settle to produce a clear supernatant liquor or final effluent.

Settlement varies and is dependent on a number of factors.

1. Concentration of the sludge.
2. Biological make up of the sludge
3. Hydraulic load on the plant
4. Rate of RAS draw off from The FST
5. Nutrient level
6. Sludge age

There are three stages to sludge settlement:

1. Free settlement. - Initial settlement where sludge particles/flocs are free to settle easily
2. Hindered settlement. – As the flocs get closer and the sludge thickens, they interfere with each other and slow down the rate of settlement.
3. Compaction. – When flocs are clumped with little space between them they continue to concentrate slowly.

Controlling the level of the sludge blanket in the FST is crucial to prevent the solids building up to a point where the blanket could rise to the top of the FST and overflow to river. The blanket is continually monitored by the HSB probe which will alarm at the security gatehouse at 0.45 metres below the surface of the water.

Very high residence time in the FST can lead to the sludge becoming anaerobic. This should be avoided as this sludge will eventually rise to the surface of the clarifier and potentially break suspended solids consents.

A typical reason for poor settlement could be 'Bulking'. This must be closely monitored by regular microscopic evaluation of the sludge.

Determination of settlement is by SSD or Stirred Sludge Density (see test methods).

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Nutrient Dosing

Macronutrients in effluent will vary due to activities in the mill (chemicals/furnish etc), the effluent process conditions and the operation of the effluent treatment plant. Nutrient addition has to overcome these variations so control is necessary. Deficiencies can lead to an overall reduction in plant performance and undesirable changes in the bacterial ecosystem as more adaptable species dominate e.g. Filamentous bacteria

Rule of thumb for dosing of nutrients to an activated sludge plant is a ratio of:

100 BOD: 5 Nitrogen : 1 Phosphorous

Bridgend mill uses Omex Nutromex P as a source of nitrogen and phosphorus.

The majority of the nutrient will be taken up by the biomass and is so removed from the system in the surplus sludge.

Excess nutrient can lead to breach of ammonia consent and denitrification at the FST, which can lead to nitrogen build up in the flocs of the blanket, which will in turn cause the flocs to rise to the surface of the FST.

Dosage is via P1 or P2 nutrient dosing pump and is increased or decreased according to laboratory results of primary and final effluent testing.

Increase and decreases in nutrient addition should be done in small steps of 5 – 10% of existing dose, as small changes to dosing can lead to significant changes in residual levels

A small residual of Ammonia is required in the final effluent test to ensure that the biomass is receiving enough supplements ~0.01 – 0.1Mg/l

Consent on Ammonia is 1.0mg/l

Action should be taken to reduce dosage at 0.6mg/l

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A N A L Y T I C A L   T E S T   M E T H O D S

The following test methods are available in ***S:\Environmental\Environmental Mgt System (EMS)\4.4 Implementation and Operation\4.4.6 Operational Control\Effluent Test Methods***

- **ETM001** – Ammonia concentration
- **ETM002** – Nitrate concentration
- **ETM003** – Phosphate concentration
- **ETM004** – Iodine concentration
- **ETM005** – Bromine concentration
- **ETM006** – Free Chlorine conentration
- **ETM007** – Oil & Grease contamination of watercourses
- **ETM008** – Stirred Specific Volume (SSV)
- **ETM009** – Mixed Liquor Suspended Solids (MLSS)
- **ETM010** – Free Halogen concentration
- **ETM011** – Determination of suspended solids in effluent

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Ammonia

To comply with the variation to our IPPC permit No. BJ5805 Bridgend paper mill is required under the amended permit (commencing 02.11.11) to conduct a daily test on the final effluent from the plant to ascertain ammonia concentration (in the form ammoniacal nitrogen). Maximum values are reported to the EA within the quarterly returns report.

Note

The permit has a consent level of **1.0mg/l**.

The operating levels are set between 0.01mg/l and 0.6mg/l

The laboratory normally takes care of ammonia testing and controlling, but in the event of the results being higher than 0.6mg/l at weekends, inform the mill manager, who will take measures to reduce the ammonia levels to normal operating range.

Check List

Check the ammonia level of the incoming waters i.e. River Llynfi at the abstraction point and Nant Gwyn (if it is being used).

Measure the Nutromex (nutrient) dosing

Check the BOD plant for any pump and or motor malfunction

Check the MLSS (mixed liquor suspended solids) and RAS (return activated sludge levels

Current and historic results are stored on the mill computer system:
S:\Green Dragon\Supereffluent (year)

Microbiology of the BOD plant

The microbes that make up the activated sludge are too small to be seen with the naked eye and must be viewed using a microscope. The organisms used at the BOD plant are mainly Bacteria (bugs) they are widespread and diverse and are the ‘workhorse’ of biological wastewater (effluent) treatment.

Activated sludge organisms derive both their energy and carbon from food i.e. organic contaminant of the effluent.

Microbes grow very quickly if conditions are correct. They reproduce by binary fission i.e. they split in half and make two identical copies. The time taken to grow then split into two identical copies under good conditions is usually around 15-45 minutes. One of the factors constraining this exponential growth is source of food. If the food is scarce growth slows (f/m ratio).

The condition of activated sludge can be established my simple microscopic investigation. To investigate sludge floc structure a microscopic magnification of 100x or 200x is adequate. The characterisation of sludge tends to be subjective, so regular microscopic investigations are important to become familiar with the microbiology of the plant and become receptive to subtle changes within the system.

Information obtained from such investigation can be:-

Form and structure of flocs
Type and quantity of filamentous organisms
Number and type of protozoa and higher life forms

Activated sludge floc comprises of:-

Living organisms (mainly bacteria)
Dead cells
Undigested large organic fragments e.g. paper fibres trapped in the flocs
Inorganic materials – grit, chalk, clays etc.

A good sludge would have a diverse life forms with a mixture of protozoa and metazoa with a variety of filamentous bacteria that will effectively bind the floc structure.

For microbial identification refer to appendix 3.

Mechanical and Electrical controls

PROCEDURE BOD PLANT SHUT DOWN AND START UP

The BOD plant normally operates in full automatic mode. Each major function has back-up facility to preclude, as far as possible, the accidental shut down of the plant. However, the plant requires an orderly shut down for extended periods of zero effluent flow e.g. holidays of more than 7 days. During such times it is important that the activated sludge is kept 'healthy'.

SHUT DOWN PROCEDURE

1 Switch the Main inlet screw pump M1 to AUTO for the duration of the shut. This will ensure that any extraneous waters entering the system will not overflow the default level and discharge to river via the ditch bypass.

2. Switch off the two duty rotors and switch on the two standby rotors to keep the sludge mixed and aerated.

3. Switch of Blowers.

4 Leave RAS pumps in Auto Mode –M10 and M11.

5. Leave Final settlement tank bridge running – M8 and M9.

6 Turn off the nutrient pumps -PI and P2.

7. Switch off SAS pumps, Pumps 3,4

8. Switch off any other chemical dosages to plant (if being used)

The Biox will continue to run until the final effluent chamber is empty whereupon the low water protection switch will trip the unit.

NB
When the plant is shut, ensure that the effluent is switched to 100%recycle at the effluent distribution box

START UP PROCEDURE

1. Allow mill effluent to flow through the plant.

2. Return MI to 'MANUAL' operation.

3. Return rotors M4 and M7 to ‘Manual’ and M5 and M6 to 'AUTO' mode.

4. Restart air blowers

5. Switch on Nutrient pumps PI or P2. (Manual Mode).

6. Start up the BIOX 1010 unit

7 Restart chemical dosing if necessary

Leave the effluent on 100% recycle until the plant has settled and all parameter are within consents
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Procedure For Recycling Effluent at Bridgend Paper Mill ETP

Bridgend Paper Mill aims to reduce overall water use at the mill.
To keep in line with the IPPC (Integrated Pollution Prevention and Control) guidelines and a benchmark of 20m3/te, (based on effluent discharged to the river Llynfi), the recycling or closing up the water system is the simplest way of reducing water figures to within the benchmark figure.

Reasons for recycling

There are two main reasons for recycling;

1. To reduce overall water consumption
2. To protect the river from contamination when the effluent is out of consent, set out in our licence to discharge.

Recycling more than 50% for prolonged periods can cause process issues within the plant and must be monitored closely.

Restrictions

Closing the system (recycling) increases the demand on the disinfection systems and extra vigilance is required to ensure that biocide residual levels are maintained within the set limits. Conductivity, hardness, alkalinity and COD of mill water are likely to increase and should be monitored frequently.

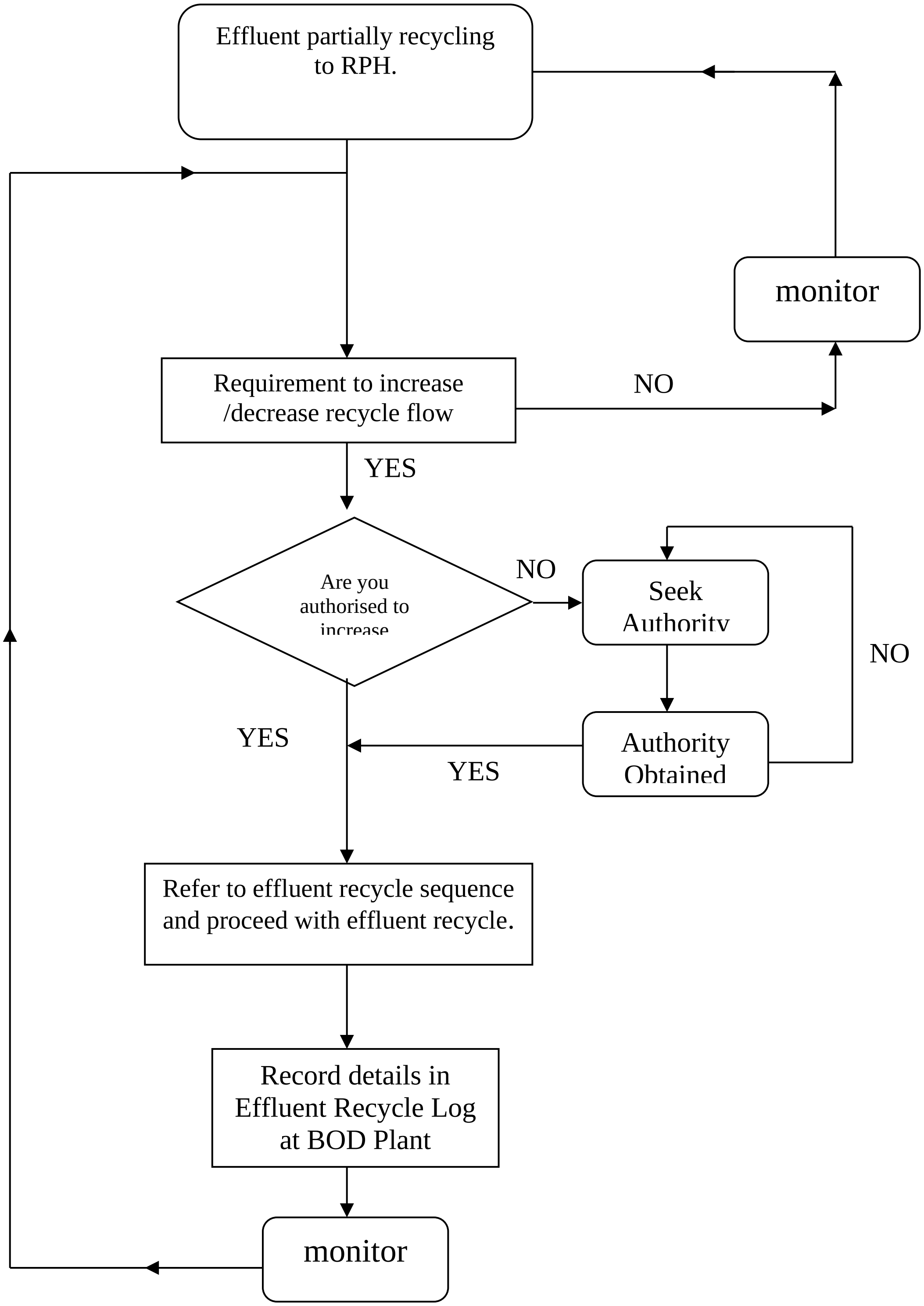
Normal running

During ‘normal’ running, effluent should be recycled back to the River Pump House at a rate that ensures that:

The overall discharge from the plant to the river Llynfi does not exceed the 17500m^3/day i.e. average flow of 730m^3/hour

Procedure
Refer to flow chart.

EFFLUENT RECYCLE FLOW CHART

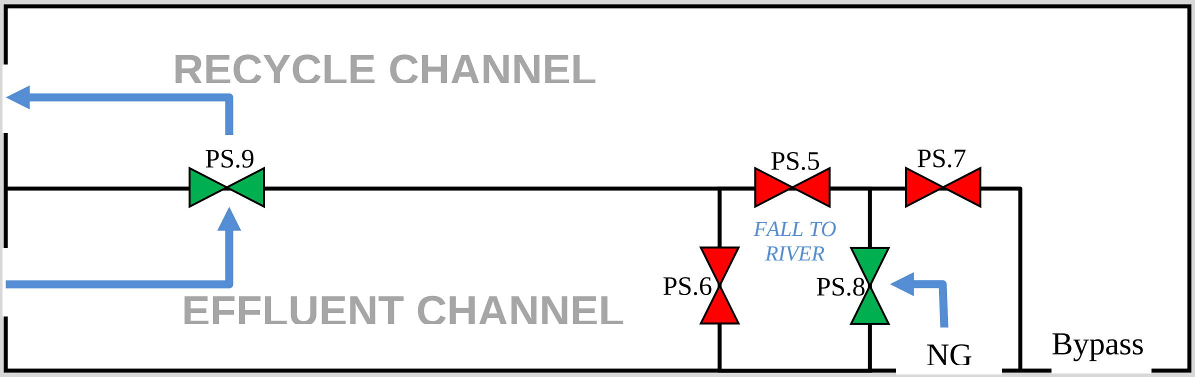


Authorised Personnel
Papermaking manager
Technical Coordinator
Mill chemist
Process engineer
Shift manager
Water filtration plant operators

VALVE SEQUENCE FOR EFFLUENT RECYCLE AND DISCHARGE

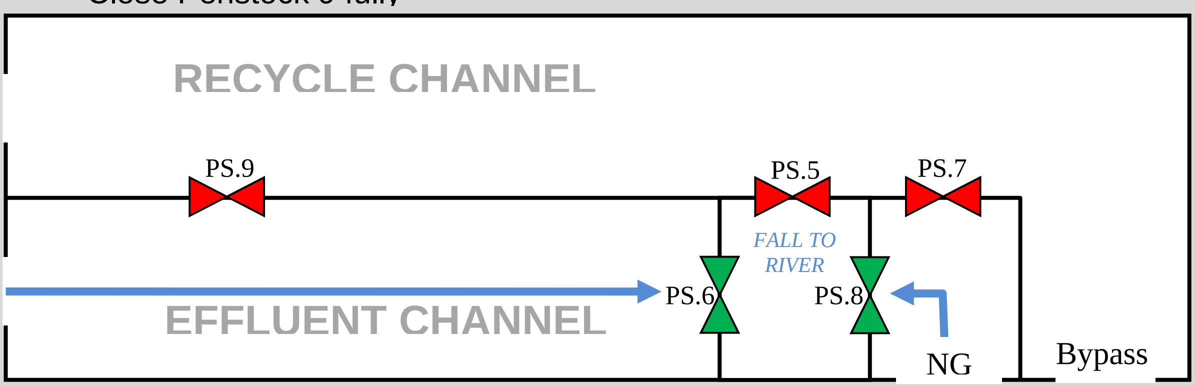
Sequence for 100% effluent recycle (0% discharge)

- Open Penstock 9 fully
- Close Penstock 6 fully



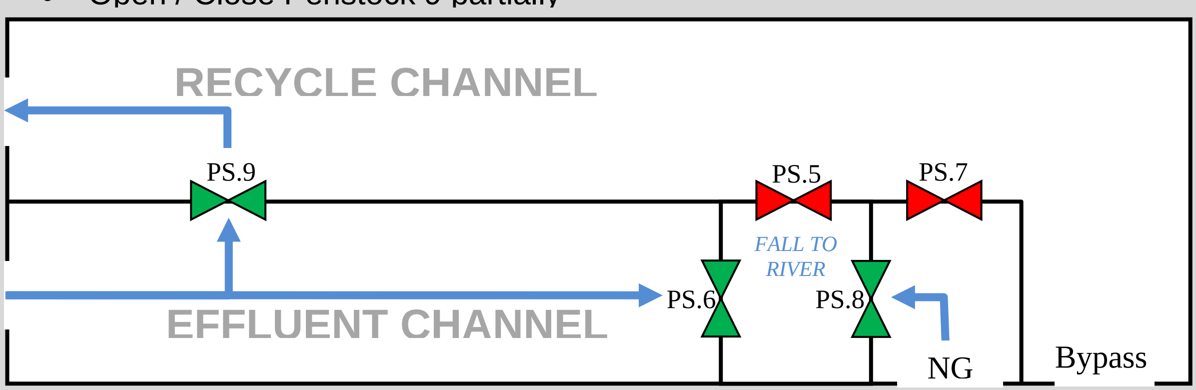
Sequence for 0% effluent recycle (100% discharge)

- Open Penstock 6 fully
- Close Penstock 9 fully



Sequence for increasing / decreasing effluent recycle

- Open Penstock 6 fully
- Open / Close Penstock 9 partially



At the River Pump House

The 2014 pump house renovation ensures that no recycled water / Nant Gwyn water backflows into the river but if the flow is greater than mill requirements, the level in the pump house chambers will rise and stop the flow through the recycle line. The effluent chamber will then overflow into the discharge outfall. To make sure this does not happen when recycling effluent or Nant Gwyn 100%:

Check, via PI or flow meter readings, that the recycle flow is less than the river pump flow. If not, increase flow from P3 by the following method (filtration plant computer):

Override inverter-driven river pump P3

1. Select Main menu
2. Select F2 – River Pump House
3. Select F1 Pump control
4. Select Pump P3, Click MANUAL
5. Increase set point (S/P) to 100% using the + icon

Monitor evacuation of water from river pump house. If insufficient, start river pump P2:

Start river pump P2

1. Select Main menu
2. Select F2 – River Pump House
3. Select Pump P2
4. Click START (The RUNNING box will flash red).

Pump P2 is not inverter-driven and pulls a fixed flow of 6000 l/m. Pump P3 may need its set-point lowered after starting P2. Monitor and adjust regularly throughout the incident.

Emergency Procedure

In the event of a major spillage, or when effluent is out of consent, e.g. sludge blanket lift, high or low pH or high suspended solids and high BOD, the priority is to contain the effluent within the mill regardless of conditions at the mill.

Emergency Procedure

BOD PLANT BLANKET LIFT PROCEDURE

If a HSB (High Sludge Blanket) alarm is activated at the security gatehouse, a visual inspection of the BOD plant is necessary to determine whether the clarifier sludge blanket has lifted.

Security officers must contact one the following:

Between 08:30 and 16:30

	Extension	Mobile
Technical Coordinator	4519	07891 537 190
Day operator	4584	07967 886 139
Mill chemist	4615	07968 086 834
Technical manager	4595	07967 124 572

Outside these hours, the shift manager is responsible for the operation of the plant

If on inspection from the FST bridge, no blanket is visible, remove and clean the sensor in the clarifier then reset the HSB warning light in the switch room. No other action is required. However if the blanket has lifted significantly or indeed has overflowed the clarifier launder and is being discharged to river, then the following procedure should be implemented **immediately**, as our priority in this situation is to protect the river from pollution.

1. Recycle final effluent 100%, ensuring that the river is isolated. Make sure Nant Gwyn discharges to river as normal. These actions will protect against polluting the river.

2. Stop the flow into the balance tank at MH1, this will automatically start the primary effluent bypassing the plant and in turn recycling via the recycle channel.

3. For reducing the level in the oxidation ditches quickly, shut off M1. Be aware that M1 can only remain off until the balance tank is full to ground level.

4. If necessary, increase the RAS flow by opening the bell mouth.

5. Isolate the RPH from the river to prevent unauthorised discharge from the mill at the RPH.

6. A detailed inspection of the plant is now required, to ascertain the cause of the blanket lift before any remedial action can be taken as there can be several causes of blanket lift.

PARAMETERS TO CONSIDER WHEN ASSESSING PLANT

1. Flow – has the plant become unstable due to excessive hydraulic load
2. Nutrient levels – Is the clarifier denitrifying and causing the sludge to lift with the gas
3. MLSS/RAS ratio / concentration – Is the plant overloaded with sludge or is there enough sludge to form a blanket?
4. Sludge make up – What type of bacteria is the sludge made up of ? Is there an excess of filamentous?
5. DO levels. What is the oxygen concentration of the oxidation ditch?
6. Toxic shock – Has anything been released to drain from the mill that may have killed off the plant or caused the sludge to rise
7. F/M ratio – Is the plant being underfed or overfed?
8. Mechanical / electrical breakdown.- Is there a breakdown or malfunction of any part of the plant that may give rise to the poor settlement?
9. Recent historical data – what has been happening on the plant during the past month?

Home

Standard Procedure for Control of Run off Waters from a Major Fire at Bridgend Paper Mill

1. **INTRODUCTION**
   In the event of a major fire, it is imperative that the watercourses within the mill and its immediate boundaries are protected from contamination by the run off water from fire fighting.
   All steps must be taken to ensure that run off waters are contained within the mill effluent system.
   In the event of there being a risk of run off water contaminating the Nant Gwyn, the following two stage procedure must be implemented.

2. **SCOPE**
   This procedure covers any such incident within the Bridgend Mill site.

3. **RESPONSIBILITY.**
   The Mill Controller (Normally the Shift Manager) is responsible for ensuring that this procedure is followed. He will call for the support of other personnel as required.

4. **PROCEDURE**
   Procedure 1 - Amber Alert

1.a. The mill controller will monitor the run off water from fire-fighting activities.

b. If after assessment there is a risk of contamination.

2. Inform the Environment Agency of the situation (EA incident hotline 0800 807060). Inform Technical Manager, Effluent Plant Supervisor and J Rota operatives (if incident occurs during the day).

4. Instruct the shift technician to divert the Nant Gwyn flows to the River Pump House, using the following method: -

At the diversion box at the BOD Plant. (diag.1)

i. Shut Penstock 9
ii. Open Penstock 6
iii. Shut Penstock 8
iv. Open Penstock 7

(All effluent will now be discharged leaving higher capacity for capturing total Nant Gwyn flow)

Flows to be monitored at the final effluent outfall and River Pump House abstraction grid.

Procedure 2 must be implemented if: -

i. The fire is deemed to be major and fire fighting extensive with risk of contamination of both Nant Gwyn and River Llynfi.

ii. After procedure 1, there is further risk of contamination of the River Llynfi by fugitive emissions.

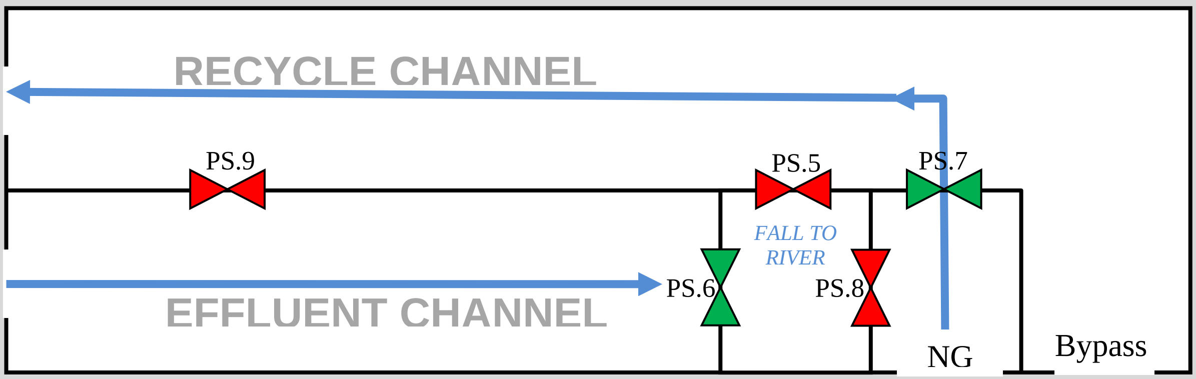
Procedure 2 – Red Alert

1. Switch the river pumps to manual control to override level controllers (see river pump override procedure below)
2. Ensure that all Nant Gwyn water is pumped through the mill influent and effluent systems
3. Monitor flows until fire fighting has ceased and all risk of contamination has subsided.

Diag.1

Sequence for 100% Nant Gwyn recycle

- Open Penstock 7 fully
- Close Penstock 8 fully
- Close Penstock 9 fully



River pump override procedure

Override inverter-driven river pump P3

6. Select Main menu
7. Select F2 – River Pump House
8. Select F1 Pump control
9. Select Pump P3, Click MANUAL
10. Increase set point (S/P) to 100% using the + icon

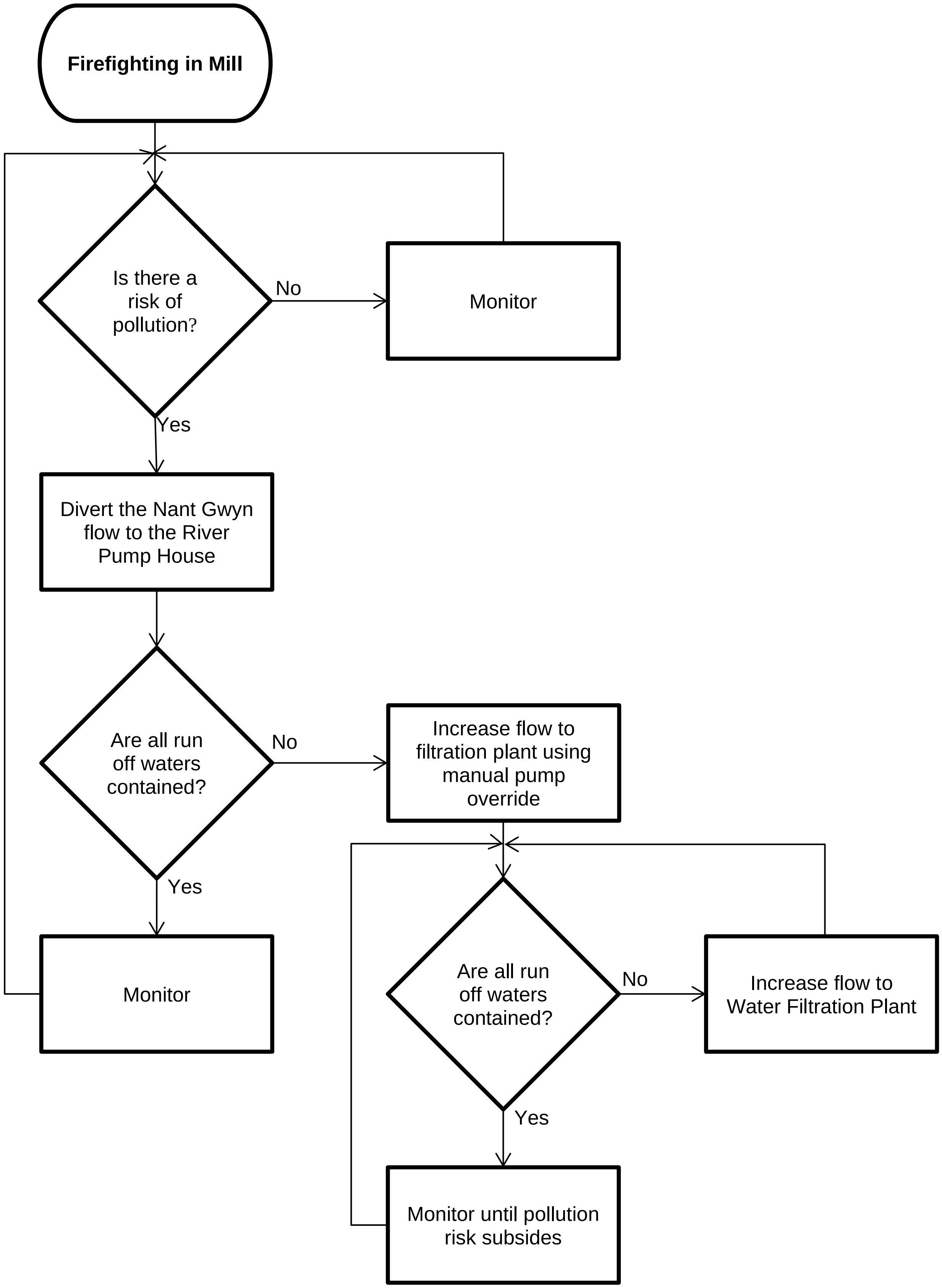
Monitor evacuation of water from river pump house. If insufficient, start river pump P2:

Start river pump P2

5. Select Main menu
6. Select F2 – River Pump House
7. Select Pump P2
8. Click START (The RUNNING box will flash red).

Pump P2 is not inverter-driven and pulls a fixed flow of 6000 l/m. Pump P3 may need its set-point lowered after starting P2. Monitor and adjust regularly throughout the incident.

9. Procedure in event of Firefighting



Problem Solving

What can go wrong?

Since the BOD plant is a dynamic living system, there can be a delay from the initial cause to seeing an effect and consequences within the plant. The time delay can be as long as a few weeks, with a gradual change in mixed liquor populations or as sudden as when the plant is subject to toxic shock.

Problems on the plant follow the path:

Cause → Effect → Consequences

If the plant performs badly, the final effluent will eventually suffer. BOD, Suspended Solids, pH and Ammonia levels are all likely to be affected.

If poor performance is noticed, the effluent must be put onto 100% recycle until such time that the effluent is within consents and settled

Toxic Shock

Some chemicals used in the papermaking process could have a serious effect on the activated sludge plant if they were released to drain in large quantities or even at a lower release rate over a longer time, though the latter is unusual.

There is potential for the biomass of the plant to be either inhibited or even killed off. In either case the final effluent quality is likely to suffer. If the biomass is inhibited BOD removal decreases with a subsequent effect on effluent quality. In the event of a total kill of the plant, the plant would require reseeding with activated sludge.

Accidental spills in the mill will cause problems at the plant and all steps must be taken to ensure tat any such spill is cleaned up and disposed of in a correct manner and not washed to drain.

If poor performance is noticed due to toxic shock, the effluent must be put onto 100% recycle until such time that the effluent is within consents and settled

Foaming

Two types of foam can occur at the BOD plant:-

1. Foaming caused by chemical applications at the mill
2. Biological foaming caused by the growth of certain filamentous micro-organisms.

Chemical foaming caused by process activities can be controlled by the use of defoamers at the balance tank that will suppress foam production and dissipate any foam that may have built up.

Foams are generally chemical initiated and foam up as a white froth at the balance tank and in severe cases at the final effluent.
Slight foaming on the river is normal. This is due to the mixing effect as the effluent hits the river. Normally this will dissipate at 20 – 30metres downstream of the discharge. If foaming becomes more severe defoamer must be used (described below).

If foaming is left untreated the foam becomes brown in colour as the activated sludge organisms become trapped. This can stabilise the foam and lead to significant problems. It is possible for filamentous organisms to grow in the foam and could lead to high suspended solids as the foam breaks up in the final effluent.

Defoamer Use

To add defoamer to the ETP, an IBC of suitable defoamer is set up on a bund near the ditch weir. There are 110v power sockets at that location for a small, outdoor chemical pump. Defoamer is pumped into the weir.
The defoamer pump should be started at a low setting and adjusted accordingly based on the status of the foam.

Denitrification

Can be caused when too much Nitrogen is present in the waste water or produced from ammonia by nitrifying bacteria.

Denitrification can occur in the FST. The Nitrogen gas bubbles become attached to the biomass and can cause the sludge to rise. This can give rise to pinfloccing in the final effluent or worse can cause the biomass to lift in the FST.

Control of Denitrification

1. Control of nutrient addition
2. Maintain a good oxygen level in the mixed liquor flow to the FST

Filamentous Bulking

The most troublesome microbial problem for the BOD plant is filamentous bulking. Filamentous bulking is a gross change in the bacterial ecology of the plant whereby the filamentous bacteria dominate such as Mithothrix parvicella, Sphaerotilus natans and Halocomenabacter hydrosis.

These types of bacteria prevent the usual floc forming. As a result, the sludge becomes difficult to settle and ‘bulks’. This is seen in very high SSVI levels and ultimately the FST blanket can reach the top of the tank and can potentially overflow to the final effluent.

There are several causes of filamentous bulking, but it generally occurs when conditions in the plant are poor. The shape of the floc, long and thin (like cotton) and has a large surface area. This large surface area enables it to absorb food and nutrient much easier than protozoa and metazoa or round floc forming bacteria. In poor conditions the filaments will grow and multiply at a faster rate changing the ecology of the plant.

Some common causes of increased filamentous growth:-

1. Nutrient imbalance – Nitrogen and phosphorous deficiencies
2. Low dissolved oxygen – Oxygen is a vital nutrient and should be maintained at 1 – 2mg/l
3. Slow degrading carbon sources – e.g. starch or paper fibres. High starch uses at the mill could lead to a carry over into effluent streams. Inefficient sludge removal at the primary treatment stage could again lead to carry-over into the BOD oxidation ditch.
4. Intermittent flow and load– If the load varies to the plant it could lead to periods of overloading or under-loading.

Remedial Actions and Controls in the event of filamentous bulking

Long term control of filamentous bulking can be achieved if the cause is identified, but shot term control can be gained by the following:

1. Lower the mixed liquor suspended solids to achieve more settlement in the FST
2. Treat the plant with sodium hypochlorite, as the filamentous are primary feeders and more exposed the kill can be effective
3. Treat plant with selective biocides i.e. biocides that will only kill the filamentous.
4. Dose with coagulants such as PAC (Polyaluminiumchloride) to increase settlement.
5. Bio-augmentation

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Troubleshooting: Effluent Treatment Monitoring System

If the power is lost to the monitoring system, the system should auto-restart, but in case of loss of Pi data, check the following components of the signal path.

- PLC (Programmable Logic Computer) in effluent plant switch room.
- Computer in corner of effluent plant switch room.
- Wireless transceiver connected to above computer.
- Wireless receiver at top of office block (attic of board room).
- Network switch box in corner of Jupiter control room.
- Pi computer in far corner of Jupiter ABB room.

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Appendix 2

Procedure for Responding to Effluent Monitoring System Alarms

The effluent monitoring system situated at Jupiter machine control room is a comprehensive monitoring system for overseeing the process activities. There are several pages that show Plant overview, process trends, plant status and plant alarms. In addition to this, all trends and alarms are captured in the PI system.

In order to comply with the IPPC permit No. BJ5805ix, Bridgend Paper Mill **must** monitor the effluent treatment plant 24 hours a day seven days a week. During normal working hours this is overseen by day personnel. Out of hours monitoring is done by shift personnel. **All** problems with the system must be reported immediately

Records of alarms are automatically recorded in PI.
Note - Alarms are stored on the PC, but **do not** alert the user to an active alarm**.**

Procedure

1. F12 main menu

2. Scroll through Trends, Status and Alarm pages noting any alarms or high/low levels, trips or adverse trends

3. If an alarm, tripped motor is identified, or a trend is nearing consent, visit effluent treatment plant and take appropriate action.

4. Make notes of alarm and action taken in the monitoring log

5. If further action/backup is required, contact day personnel on emergency contact numbers (These numbers are held by the mill shift manager).

Permitted levels

	Minimum	Maximum	95%ile
BOD mg/l	n/a	10mg/l	5mg/l
Suspended Solids mg/l	n/a	40mg/l	25mg/l
pH	6.5	8.5	n/a
Temperature ° C	n/a	25	Daily Average
Discharge Flow m^3/day	n/a	17500	n/a
Ammonia mg/l	n/a	1.0	n/a

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Sludge Identification

6 Protozoa and metazoa

Protozoa, and frequently also metazoa, are almost always present in activated sludge. Some species are attached to the flocs whereas others are free in the water between the flocs. These organisms are (much) larger than bacteria, their 'length' varying from 10 to 10,000 µm (table 2). In addition, they also possess a characteristic shape. On account of the combination of characteristics, they are very conspicuous on a microscopic slide.

Table 2 *Order of magnitude of(micro-)organisms in activated sludge*

Group	Cell length (µm)	Remarks
bacteria	1–5	occasional colonies or filaments
protozoa		
-flagellates	10–30	occasional colonies
-amoeba	30–400	
-testate amoeba	30–200	
-heliozoa	40–200	
-ciliates	25–400 [1]	occasional colonies
metazoa		
-rotifers	100–500	
-nematodes	500–3,000	
-tardigrades	200–1,200	
-worms	3,000–10,000	

1) A few species are much longer (up to 1000 µm)

Many protozoa/metazoa mainly feed on bacterial cells which are present free in the liquid or at the edges of the flocs. In this manner they remove many bacterial cells that are not firmly bound to the flocs. Free bacterial cells cannot be separated from the treated water through settling in the final clarifier. Protozoa are also indispensable for a far-reaching COD reduction, viz. a clear effluent.

Furthermore, protozoa/metazoa that consume sludge flocs (~ reduction of the sludge production) or consume other protozoa also exist.

The presence of certain species is relevant for the process conditions in the treatment plant. Assessing the composition of the population is, therefore, an important aspect of microscopic sludge investigation. This indicator function is further referred to in paragraph 6.3.

More than 200 different strains can be observed in activated sludge. Identification of these organisms is not really very easy and requires specialist knowledge. It is also unnecessary to identify all of these species for the purpose of process monitoring, distinguishing the most important main groups is sufficient. The following paragraphs contain a short description of these main groups, referring to several species that are regularly observed in activated sludge.

6.1 Protozoa

Like bacteria, protozoa are single celled organisms. As long as the sludge loading level is not extremely high, they are present in practically every activated sludge. Their population is always much smaller than that of the bacteria. The biomass of protozoa present in the treatment plant comprises, at most, a few percent of the total biomass.

Protozoa are divided into four groups:
- ciliates
- flagellates
- amoeba;
- testate amoeba;
- heliozoa

6.1.1 Ciliates

Ciliates are characterised by the presence of cilia (= vibrating hairs) on their cell surfaces. For some ciliates, the surface is completely covered with cilia whereas other species are only partly covered. Ciliates also exist which cilia are only present during a certain phase of their lives.

For many species, the cilia are arranged in a certain manner around the mouth openings. As a result, these cilia make the water flow in their vicinity. They fan, as it were, the food towards their mouth openings. These nutrient particles are subsequently taken up from the water by filtration. In addition, cilia contribute to the locomotion of several species.

Ciliates take in food particles by means of their mouth openings. According to the type of organism, this food can comprise organic fragments as well as bacterial cells or other protozoa. Therefore, predation plays an important part within such a mixed population. Some examples are given below:

- ciliates that mainly eat bacteria: *Aspidisca, Blepharisma, Carchesium, Colpidium, Chilodonella, Epistylis, Opercularia, Vorticella;*
- omnivorous species that consume bacteria as well as flagellates and small ciliates: *Euplotes, Stentor;*
- carnivorous species that mainly eat other ciliates: *Litonotus, Trachelophyllum, Hemiophrys, Suctorea.*

Bacterial cells transported with the influent form an important source of nourishment for ciliates. Sewage contains some tens of mg/l of bacterial cell material, a level that can also vary markedly according to the type of sewer, the weather conditions, the time of year, etc. The number of cells that are consumed is closely linked to the format of the organism. In this manner, small ciliates consume ca. 10 cells/min., larger ones *(e.g.'Opercularia)* more than 10 times as much whereas some nematode strains consume 5000 cells/min. Ciliates mainly exploit their food for the production of new cells. Movement costs little energy. As a rule of thumb, it is reckoned that 50% of the available food is used for cell synthesis.

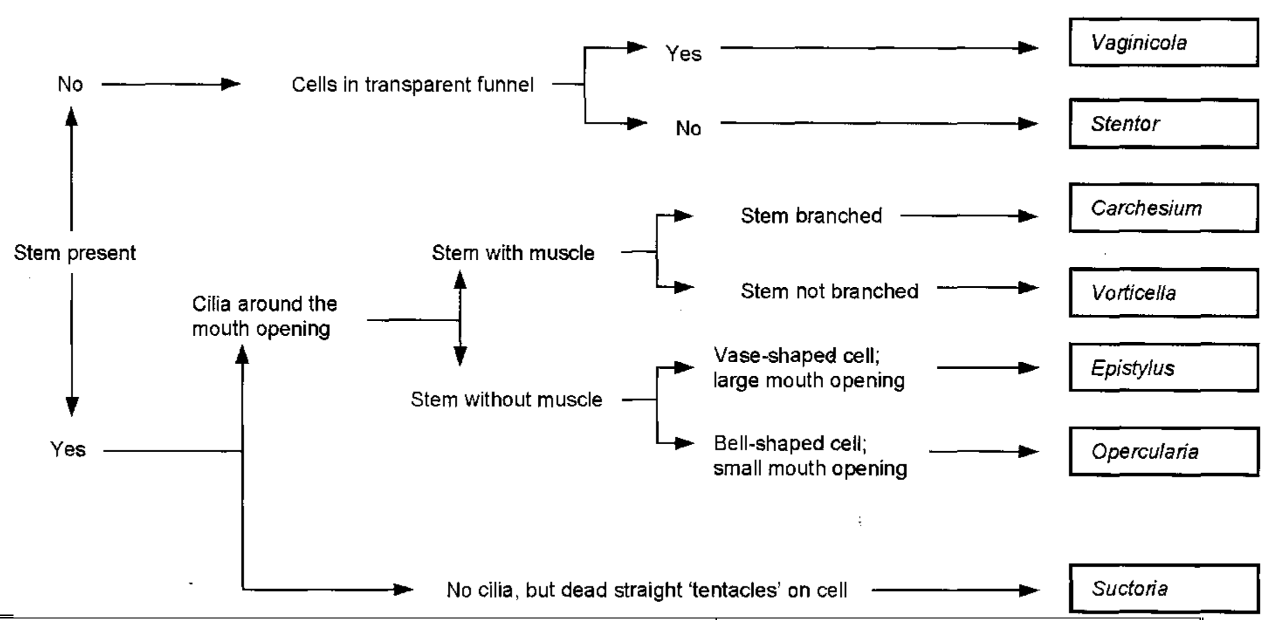
If the oxygen concentration is adequate, the size of the population is principally determined by the sludge load applied and the related sludge age. The population is at its maximum at a sludge load of ca. 0.3 kg BOO/kg MLSS.day (order of magnitude: 10^3-10^4 cells per ml). Fewer bacterial cells are available at lower sludge loading levels (floc more robust and relatively less transport with the influent), leading to a smaller ciliate population. At higher sludge loading levels, the sludge age is so short that the relatively slow-growing ciliates cannot be maintained in the sludge any more.

Quantities of thousands of specimens per millilitre are very suggestive of, and lead easily to, an over-estimation of the contribution of the ciliates to the total treatment process. The influence of a given group of organisms is not actually determined by quantity, but in terms of its contribution to the total amount of biomass in the treatment plant. The mass of several strains that frequently occur in activated sludge can vary from 0.1 ng to 10 ng, with peaks to 80 ng for *Stentor roesili,* a 'giant' among the ciliates. With 1 ng and 5000 specimens/ml and a total sludge concentration of 4 g/l, only 0.5% of the total biomass will comprise ciliates. The actual contribution of ciliates (and that of the other protozoa) to the total treatment performance is consequently very subordinate to that of bacteria.

Ciliates are subdivided into sessile (= attached), crawling and free-living species.

6.1.1.1 Sessile ciliates

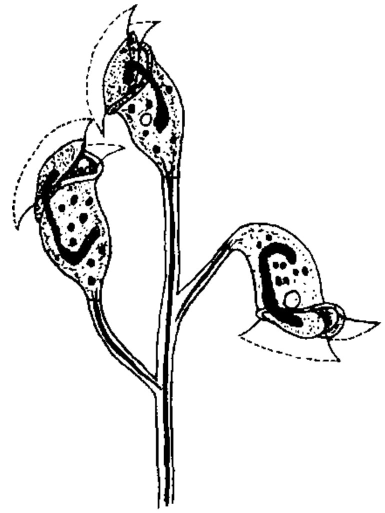
The cells of sessile ciliates are usually positioned on a stem which is often attached to a sludge floc. The stems are branched in some strains, through which colonies of sometimes numerous cells arise. Fig. 68 represents an identification key for distinguishing sessile ciliates commonly occurring in activated sludge.



Carchesium

Carchesium is a sessile ciliate with bell-shaped cells. These cells have a diameter of 50-125 µm. There is a wreath/ring of cilia around the mouth opening and the rest of the cell surface is bare. The stem contains a contracting 'muscle'. The stems are mostly branched, thereby creating colonies. These colonies can reach a diameter of a few mm. The 'muscle' in the stem is interrupted at the points where branching occurs.

Carchesium sp. commonly occur in activated sludge at a sludge load less than ca. 0.2 kg BOD/kg MLSS.day.



Epistylis

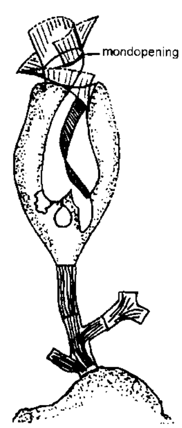
Epistylis has somewhat 'vase' -shaped cells. They have a diameter of 70-100 µm. The stem is usually branched, which causes colonies to arise, but does not contain a 'muscle'. Therefore, the stems cannot contract (the cell actually does). The colonies can reach macroscopic dimensions (mm).

Epistylis sp. occur commonly in activated sludge, especially at sludge loading levels of 0.1 to 0.2 kg BOD/kg MLSS.day.

Opercularia

Opercularia has somewhat bell-shaped cells. The cell diameter is approximately 140 µm. The stems are branched, causing colonies to form. A non-contracting 'muscle' is present in the stem. In comparison with the other sessile ciliates, *Opercularia* has a small mouth opening.

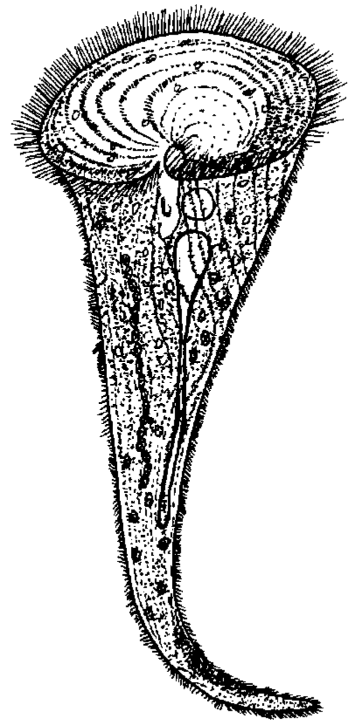
Opercularia sp. mainly occur at higher sludge loading levels (0.2 to 0.3 kg BaD/kg MLSS.day).



Stentor

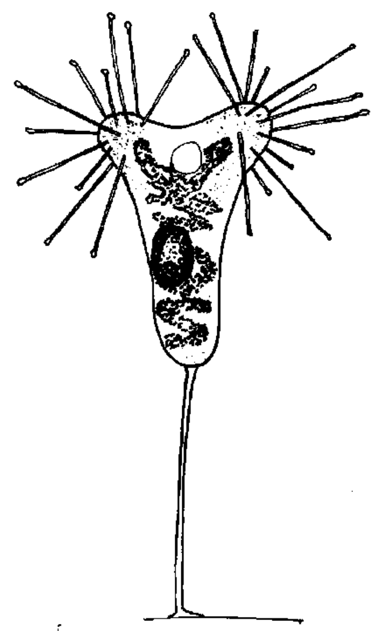
Stentor is a ciliate with a very characteristic trumpet-shaped cell. It is usually, but not always, attached to a sludge floc. A wreath of cilia for transporting water and nutrient particles to the mouth opening is present at the broad extremity. The cell length can vary from 150 to 500 µm. It is, therefore, a large ciliate. *Stentor* does not possess a stem.

Stentor is chiefly observed in low-loaded treatment plants.



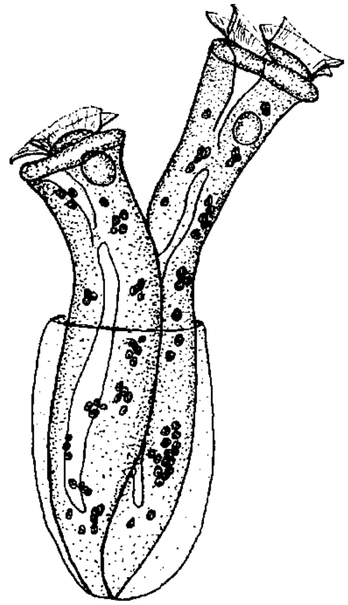
Suctoreans

Suctoreans are ciliates, although cilia are absent on adult cells. The cilia disappear when the cell forms a stem with which the organism can attach itself to a surface, e.g. an activated sludge floc. Adults are therefore sessile. Some very characteristic, dead straight tentacles are present on the cell surface. These tentacles are thicker than the straight pseudopoda of the heliozoa. For most suctoreans, a small knob is present at the extremities of all the tentacles. This is a type of mouth for catching protozoa, which are sucked empty. Protozoa form the most important source of food for suctoreans. Depending upon the strain, both round and vase shaped cells can be observed in activated sludge. The cells in activated sludge usually measure 50-100 µm in length.



Suctoreans are regularly observed in activated sludge. The population is generally always small.

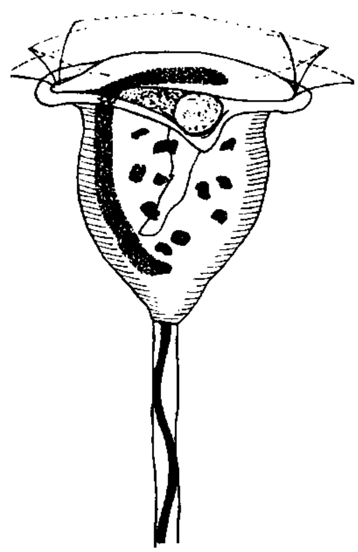
Vaginicola



Vaginicola is a sessile ciliate with a trumpet shaped cell. The cell is contained in a distinctly transparent funnel. Two cells are often present in this funnel. The cell can contract, meaning that it can disappear completely into the funnel. A wreath of cilia, which transports water and nutrient particles to the mouth opening, is present on the 'head' of the cell. The cell measures approximately 100 µm in length.

Vaginicola is chiefly observed in low loaded plants (oxidation ditch conditions).

Vorticella



Vorticella is a sessile ciliate whose cells measure 50-150 µm. These are somewhat bell shaped. A wreath of cilia is present around the mouth opening by which the organism directs water (containing nutrients) towards the mouth opening. The stem is never branched, meaning that *Vorticella* is a solitary organism. A contracting muscle is present in the stem.

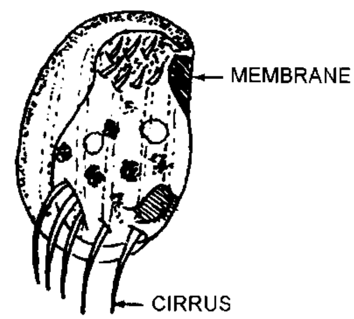
Vorticella sp. commonly occur at sludge loading levels < ca. 0.4 kg BOD/kg MLSS.day.

6.1.1.2 Crawling ciliates

The representatives of this group 'crawl' over the sludge floes and graze their surfaces. Bacterial cells that are not firmly attached to the floes are removed in this manner.

Aspidisca

Aspidisca is a ciliate that crawls, often at a high speed, over the floes. Seen from above, the cell is round whereas the side view is more oval shaped. A distinct mouth opening is absent. Five ridges are present on the 'back'. The cilia are not individually implanted on the body but are present as cirri. Cirri are small bundles of cilia that come to a point and look like small feet. There are seven cirri on the front ventral side and five or more on the back of the cell. The cilia also form a membrane! ('strips' of cilia that are stuck together).



Onderkant


Zij-aanzicht

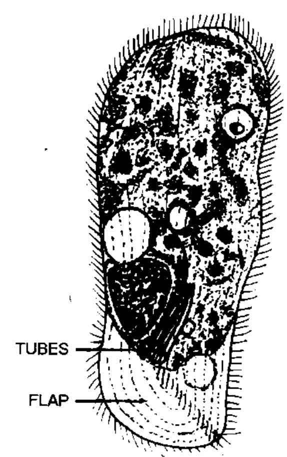
The sizes of the different Aspidisca strains can vary from 30 to 50 µm. The very common species Aspidisca costata has a diameter of 30µm. Aspidisca resembles Euplotes, which is larger (30-1 00 µm) and does not crawl over the floes.

Aspidisca occurs very frequently. As long as the sludge load is not too high <ca. 0.4 kg BOD/kg MLSS.day), this ciliate can be observed in almost every activated sludge.

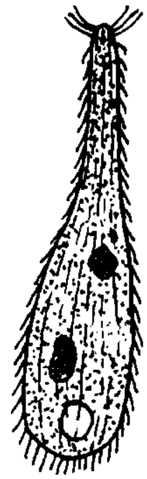
Chilodonella

Chilodonella is a crawling/grazing ciliate whose most important characteristic is an almost transparent flap on the front side. This flap often curls up when the organism crawls over the floc. Seen from the side, this flattened flap is also clearly recognisable. The mouth opening is surrounded by a bulge in the shape of a short tube. The cell length can vary from 40 to 125 µm.

Chilodonella commonly occurs in activated sludge if the sludge load is < ca. 0.2 kg BOD/kg MLSS.day.



Trachelophyllum



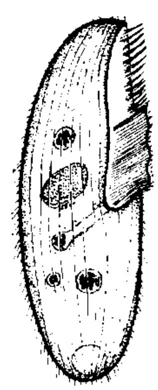
Trachelophyllum species are characterised by their flat, elongated cells, which are completely covered with cilia. The cilia are longer around the mouth opening and are ordered in a characteristic manner (bowed 'moustache hairs'). *Trachelophyllum* usually move rapidly through the water between the floes, but can also be observed crawling over them. The most common representative of this strain is *Trachelophyllum pusillum,* which has a cell length of 30 to 50 µm.

Trachelophyllum is a very commonly occurring ciliate at sludge loading levels less than ca. 0.4 kg BOD/kg MLSS.day.

6.1.1.3 Free-living ciliates

As the name suggests, these ciliates move freely in the water between the floes. The speed at which they move is highly variable.

Blepharisma



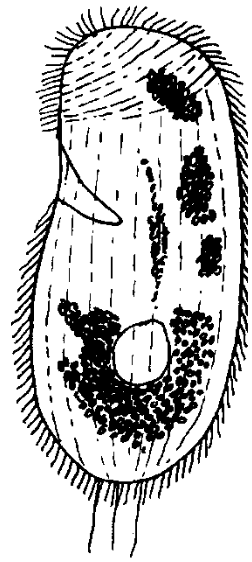
The (light) pink cells of *Blepharisma* are very characteristic. These free moving ciliates have somewhat oval cells of 200 µm in length. A zone with strips of relatively long cilia is present near the mouth opening. The cilia transport water, containing nutrients, to the mouth opening.

Blepharisma is mainly observed at some higher sludge loading levels (0.1-0.4 kg BOD/kg MLSS.day).

Colpidium

Colpidium is a free-moving ciliate possessing a kidney-shaped cell. The cell surface is covered with cilia. A few long vibrating hairs are present on the back of the cell. The zone around the mouth opening is dented inwards. The most usual species *(Colpidium colpoda)* has a cell length of ca. 100 µm.

Colpidium is less frequently observed than the other free-moving ciliates. This ciliate probably occurs most commonly at sludge loading levels of 0.1-0.4 kg BOD/kg MLSS.day.



Euplotes

Euplotes is a free-swimming ciliate with oval cells. The cilia are stuck together as cirri. There are nine cirri present on the front side and five on the back. These cirri function as pseudopoda. There is also a characteristic strip of joined cilia present on the cell, which transports nutrients to the mouth opening. Six ridges are present on the upper surface of the cell. The sizes of the different strains can vary from 30 to 100µm.

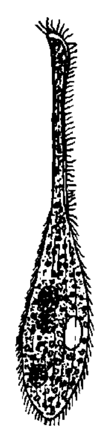
Euplotes resembles *Aspidisca*, but is usually bigger and is free swimming.

Euplotes commonly occurs in activated sludge, principally at sludge loading levels of 0.1-0.2 kg BOD/kg MLSS.day.

Litonotus (Lionotus)

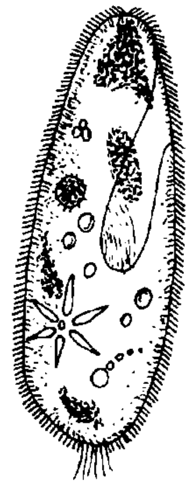
The cells of *Litonotus* are shaped like a bottle (amphora). The neck, which is almost as long as the rest of the cell, is slightly bowed. The total length of the cell is ca. 100 µm.. The cilia on the outside of the neck are longer than those on the remainder of the cell surface. *Litonotus* usually moves through the water in an 'elegant' manner.

Litonotus commonly occurs in sludge loading levels lower than ca. 0.4 kg BOD/kg MLSS.day.



Paramecium

Paramecium is a free-moving ciliate whose cells slightly resemble slippers. It is a large ciliate. Cell length can vary from 180 to 300 µm. The cell surface is covered with cilia. The nucleus of the cell is large and usually clearly visible. The contractible star-shaped vacuole is very characteristic.



Paramecium is primarily observed at sludge loading levels of 0.1-0.3 kg BOD/kg MLSS.day.

Spirostomum

Spirostomum has a markedly elongated, flexible cell covered with cilia, with a characteristic vacuole present at the extremity. *Spirostomum* usually moves quickly through the liquid between the flocs. It is the largest ciliate present in activated sludge, the cell length varying from 500 to 900 µm.

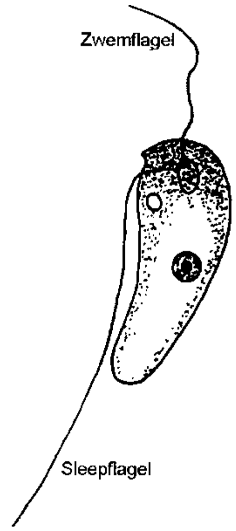
Spirostomum commonly occurs in activated sludge, particularly in treatment plants with sludge loading levels less than ca. 0.2 kg BaD/kg MLSS.day.

6.1.2 Flagellates

Flagellates derive their name from the fact that they possess one or more (usually no more than eight) flagella. The flagella are longer than the cilia of ciliates. On account of their rapid movement, the flagella are quite often not clearly visible. The flagella assist the movement of the cell. Some species have a mouth opening with which they can consume nutrient particles such as bacteria cells. Other strains absorb dissolved nutrients through their cell walls. Because of their diameters of 10-30 µm, flagellates are noticeably smaller than ciliates. Therefore, a 40x objective should be used for microscopic viewing.

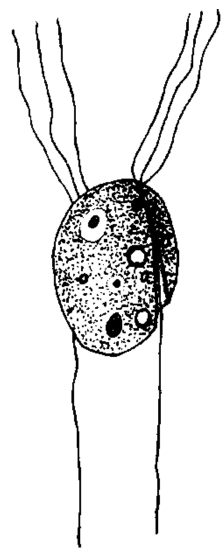
Bodo

Bodo is a free-swimming flagellate, which propels itself with a characteristic jerky movement. There are two flagella present, one swimming flagellum and one trailing flagellum at the rear. The flagella are longer than the oval cell. The cell wall is dented at the point where the flagella are implanted. The flagella are not always clearly visible. The cells are approximately 15 µm in length.



The presence of *Bodo* sp. indicates a high sludge load (> ca. 0.4 kg BOD/kg MLSS.day) and/or a lack of oxygen.

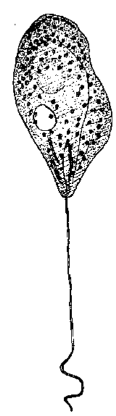
Hexamitus



Hexamitus is a free-swimming flagellate which moves rapidly in a straight line through the water (but does not rotate like *Trepomonas).* There are two groups of three flagella on the front side and two trailing flagella behind. The cell is somewhat oval-shaped and has a diameter of approximately 20 /lm.

The presence of *Hexamitus* indicates a high sludge load (>ca. 0.4 kg BOD/kg MLSS.day) an/or a lack of oxygen.

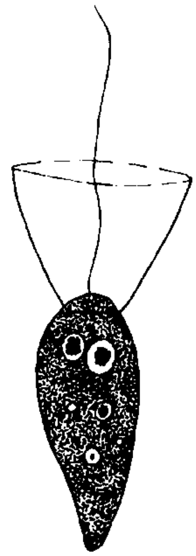
Peranema



Peranema is a free-swimming flagellate with a very characteristic, long, thick flagellum. A second much thinner (trailing) flagellum is also present, but this is hardly ever visible. Only the tip of the flagellum moves when the cell is in motion. The cell is usually 20-30 µm long.

This flagellate is regularly observed in activated sludge. In contrast to most other flagellates, the presence of *Peranema* is not indicative of specific process conditions such as a high sludge load or a lack of oxygen.

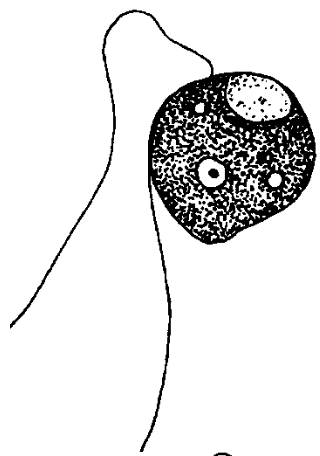
Monosiga



The cell is spherical to oval. A collar is present on its 'top' through which the flagellum emerges. *Monosiga* is usually fixed to a sludge floc. The cells are 1-15 µm in length.

The presence of *Monosiga* indicates a high sludge load (> ca. 0.4 kg BOD/kg MLSS.day) and/or a shortage of oxygen

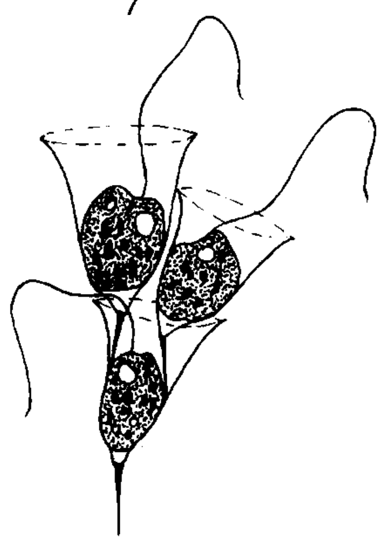
Pleuromonas



Pleuromonas is a flagellate that moves in a characteristically rapid and jumpy manner. The cells are usually not free-living in the water but are attached t2 the floes. *Pleuromonas,* like *Bodo,* has two flagella. The cell is attached to the floc by the longest flagellum. Cell diameter is 5-10 µm.

The presence of *Pleuromonas* indicates a high sludge load (> ca. 0.4 kg BOD/kg MLSS.day) and/or a shortage of oxygen.

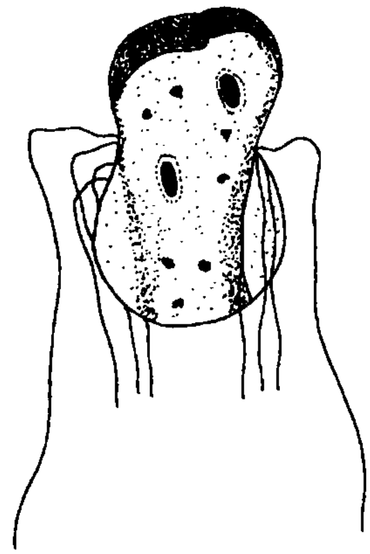
Poteriodendron



Poteriodendron is a flagellate whose most important characteristic is that it forms colonies of cells. The cells are contained in transparent funnels. These funnels are joined together into colonies by stems on their undersides. The diameters of the individual cells are ca. 20 µm. The cells have a flagellum which allows them to move inside the funnel but they cannot leave it.

Poteriodendron colonies are regularly observed in activated sludge. It is not known if this flagellate can be used as an indicator organism.

Trepomonas



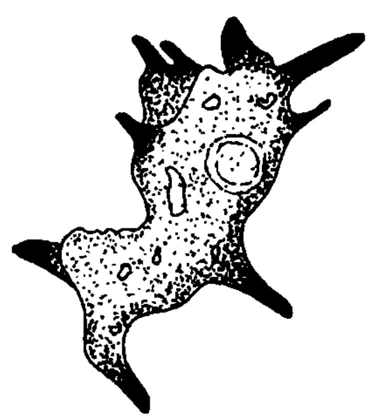
Trepomonas is a free-swimming flagellate which moves through the water in a characteristic rotating manner. Seen from above, the cell is oval and from the underside it is spherical. The cells measure approximately 20 µm in length. *Trepomonas* possesses two groups of four flagella which are implanted on the side of the cell. Besides two long (20 µm).flagella, six short (8 /lm) ones are also present

The presence of *Trepomonas* indicates a high sludge load (> ca. 0.4 kg BOD/kg MLSS.day) and/or a lack of oxygen.

6.1.3 Amoeba, testate amoeba and heliozoa

These organisms have in common that they can form pseudopoda. These pseudopoda are temporary extensions of the cell content.

Amoeba



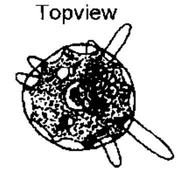
Amoeba are single-celled organisms possessing a flexible cell membrane which allows the shape of the cell to constantly change. They absorb nutrient particles (bacteria cells, other protozoa, etc.) by engulfing them. This resembles the uptake of food by a mouth opening. The sizes of the various strains range from 50 to 400 µm. Amoeba can be as big as a sludge floc and their particular structure sometimes resemble sludge floes. Apart from the odd exception, amoeba move extremely slowly (by means of the pseudopoda).

Amoeba are characteristic of somewhat higher sludge loading levels (0.1-0.4 kg BOD/kg MLSS.day) and/or shortages of oxygen. They are seldom observed in low loaded nutrient removal plants.

Testate amoeba

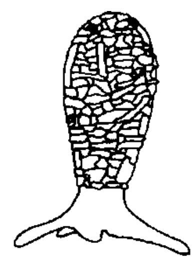
In this group of amoeba, the cell is surrounded by a type of shell. There is an opening in the shell through which the pseudopoda can protrude. These pseudopoda are seldom visible on a microscopic slide. The cell form (round, beaker shaped, etc.) depends on the species in question.

ARCELLA
Topview



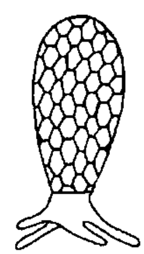
ARCELLA
Sideview

Arcella is a testate amoeba with a shell which, when seen from above, is round. The side view resembles the top of a toadstool. The shell has a clearly observable structure. In general, the shells are practically transparent, but in activated sludge they are usually coloured yellow-brown on account of the precipitation of iron compounds on their surfaces. The round opening on the underside of the shell is very characteristic.



DIFFLUGIA

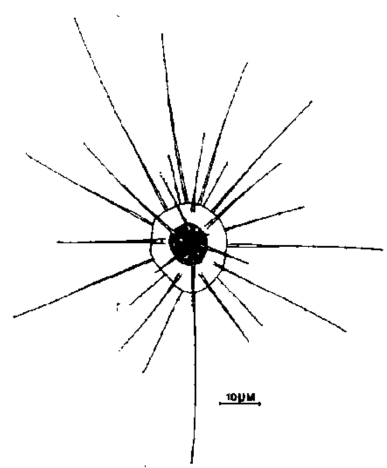
The structure of *Euglypha* shells largely resembles that of a honeycomb. The sizes of the various testate amoeba can vary from 30 to 200 µm.



EUGLYPHA

Testate amoeba are almost always present, and often in large numbers, in low-loaded activated sludge plants. *Arcella* is the most commonly occurring species. It mainly occurs under nitrifying conditions.

Heliozoa



Heliozoa belong to the amoeba. They have spherical cells which are surrounded by needle thin, dead straight, retractable pseudopoda. The pseudopoda are not used for propelling the cell but for catching bacteria and protozoa. Organisms that come into contact with the pseudopoda are 'paralysed' after which they are consumed by the heliozoa. The cell diameter can vary from 40 to 100 µm.

Heliozoa are principally observed in low-loaded activated plants. The population is usually small.

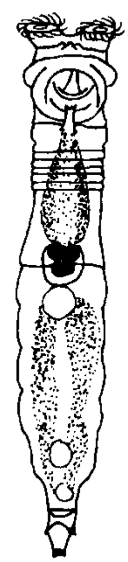
6.2 Metazoa

In contrast to bacteria and protozoa, metazoa are multi-cellular micro-organisms, meaning that they are 'higher' organisms. The sizes of the different species can vary from 100 µm to sometimes as much as 1-2 cm. Most metazoa feed on free-living bacteria cells or on very small floc particles. Species also exist that can consume whole sludge flocs.

The following metazoan groups can be present in activated sludge:
- Rotifers
- Nematodes
- Worms
- Tardigrades

Apart from exceptional cases, metazoa play a subsidiary role in activated sludge treatment plants. They are mainly observed at sludge loading levels lower than ca. 0.15 kg BOD/kg MLSS.day. To register the number of metazoa, a scale varying from 0 (= absent) to 3 (= numerous organisms/slide) is used.

6.2.1 Rotifers



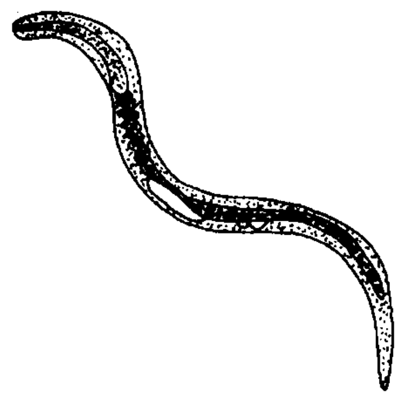
Rotifers are relatively large, distinctly mobile and elongated multi-celled organisms. The body length can vary from 100 to 500 µm and is surrounded by a type of armour into which the head and tail can be withdrawn. A few bunches of cilia are present on the head of the organism. These cilia can create a current in the direction of the mouth opening. They have a set of 'jaws' around their mouth openings by which they can crack particles filtered from the water. Particles larger than about 10 µm cannot actually fit in this mouth opening. Rotifers, therefore, principally consume free-living bacteria cells and small floc particles.

The tail is branched in a characteristic manner and is important to the movement of the organism. With this, a rotifer first attaches itself, after which the body is stretched. The tail is subsequently released, the head stays in place and the abdomen is drawn up. This manner of propulsion resembles the manner in which a slug moves.

Rotifers commonly occur in activated sludge with low loading levels. The size of the population is nearly always very limited in domestic treatment plants. Large numbers of rotifers are sometimes present in plants treating waste water from the agro- industry.

6.2.2 Nematodes

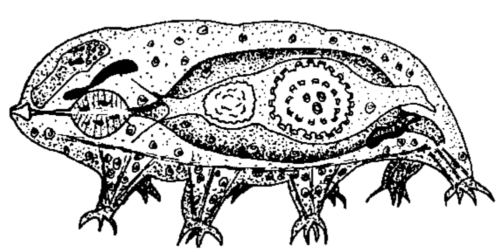
Nematodes have elongated, cylindrical and very flexible bodies. The extremities of this multicelled micro-organism are thinner than its central section. The cell length can vary from 0.5 mm to 3 mm. They are larger than most protozoa. They principally consume free-living bacteria cells and very small floc particles. They swallow/engulf food particles by contraction of the oesophagus. Owing to the fact that they do not possess 'jaws' and that their mouth openings are small, they cannot consume intact flocs. These exceptionally mobile animals are sometimes difficult to keep in focus during microscopic investigation. In addition, nematodes often 'crawl away' into the flocs and it can be a while before they reappear.



Nematodes are regularly observed in activated sludge with a low loading level, but they are almost never present in large numbers. It is not known if nematodes can be used as indicators for given process conditions.

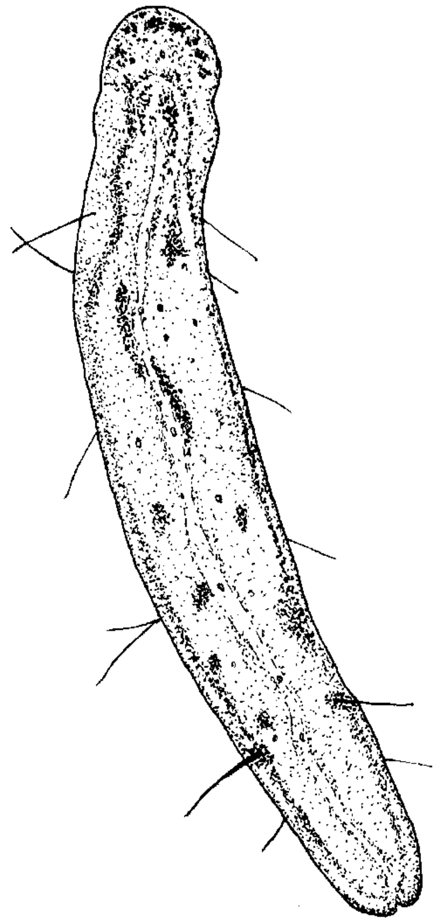
6.2.3 Tardigrades

This is a multi-celled organism with a very striking form. A tardigade, sometimes known familiarly (to the experts) as a water bear, has pseudopoda with small claws, with which it crawls over the flocs and grazes them. This organism moves around somewhat awkwardly when free in the water. The size can vary from 200 to 1200 µm.



Tardigrades are occasionally observed at sludge loading levels of < 0.1 kg BaD/kg MLSS.day.

6.2.4 Worms



Worms are the largest organisms observed during the microscopic investigation of activated sludge. With diameters of approximately 0.1 mm and lengths to a maximum of 10 mm, their presence is very apparent on a wet slide. Oligochaeta are almost always involved, often *Nais elingius* and *Aelosoma* spp. Worms are able to consume sludge flocs or particles of flocs. A worm bloom (ca. 10^5 worms/I) is also connected with a reduction in sludge production.

Little is known about the growth of worms in activated sludge plants. They do not grow particularly slowly. Under the best of conditions they have a generation time of a few days. More than enough nutrients, in the form of sludge flocs, seem to be present. Consequently, one would expect worms to be present in virtually all treatment plants. However, they are not often observed at low sludge loading levels (oxidation ditch conditions). Sludges containing many worms usually originate from treatment plants with a sludge load of ca. 0.1 kg BOD/kg MLSS.day and in which the influent is pre-settled. A definite connection between their presence or absence and the process conditions is usually missing.

6.3 Indicator function

A new activated sludge plant can be started by opening the sewage supply and switching on the aeration system. Sludge flocs subsequently arise spontaneously in the aeration tank. These are removed in the final clarifier and recycled into the aeration tank. By constantly adding fresh sewage, without withdrawing the sludge from the system, the desired biomass concentration can be cultivated within a few weeks. During the start phase, the sludge loading level is constantly reduced and the treatment performance is increased.

A shift within the protozoa population takes place simultaneously, which is actually a characteristic succession of species. Many free-living bacteria cells (> 10^8 cells/ml) are present during the first days and the compounds, which have been transported with the sewage, are not yet fully processed by the bacterial biomass. An excess of food for flagellates and amoeba is created, and they also develop *en masse.* After a few days also free swimming ciliates appear. The numbers of flagellates and amoeba are reduced considerably thereafter. Because of the increase in the sludge concentration, the sludge load decreases constantly during such an initial phase. A subsequent scarcity of nutrients automatically results in a decrease in the growth rate of the free-living ciliates.

Many species disappear as soon as their population doubling rate exceeds the hydraulic retention time in the aeration tank. At this stage, the ciliates that are attached to the sludge flocs (e.g. *Vorticella),* or those that crawl over them (e.g. *Aspidisca),* appear and, therefore, are not easily washed out. This explains the domination of attached and crawling species at low sludge loading levels. Thecamoeba, and sometimes metazoa, also eventually appear with long sludge ages. By this time, a high level of treatment performance, including extensive nitrification, takes place; the number of bacterial cells that are not bound to the flocs is less than 10^6/ml.

Therefore, other strains grow as the treatment performance rises. This fact can also be used in the opposite sense: the presence of certain strains says something about the treatment results and the process conditions.

The connection between the sludge load and the composition of the population is shown systematically in Fig. 69. During the microscopic investigation of the sludge, it should be checked that the species present are characteristic for the load applied in the treatment plant. If the sludge load is not too high, mainly ciliates, testate amoeba and occasionally some metazoa should be present. A shortage of oxygen in a low loaded plant results in a decline of the COD removal rate and causes, therefore, a shift towards flagellates and amoeba within the population

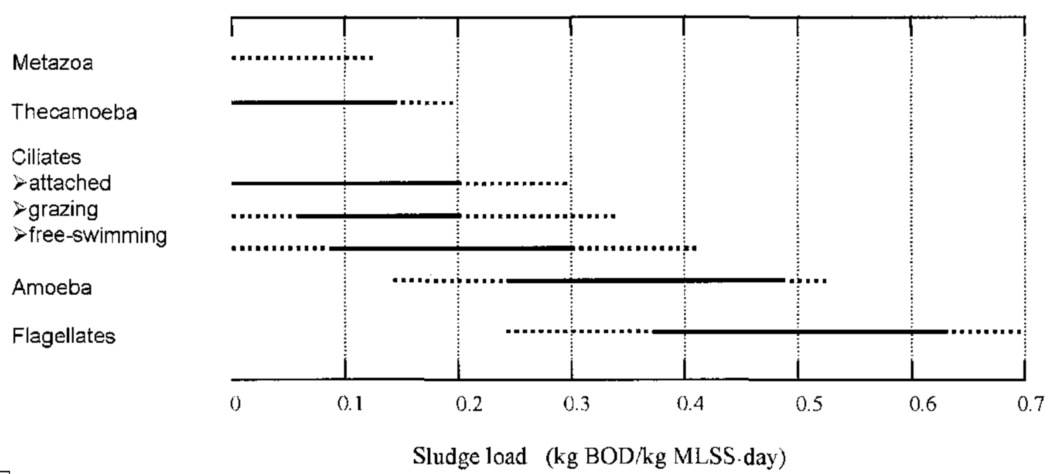
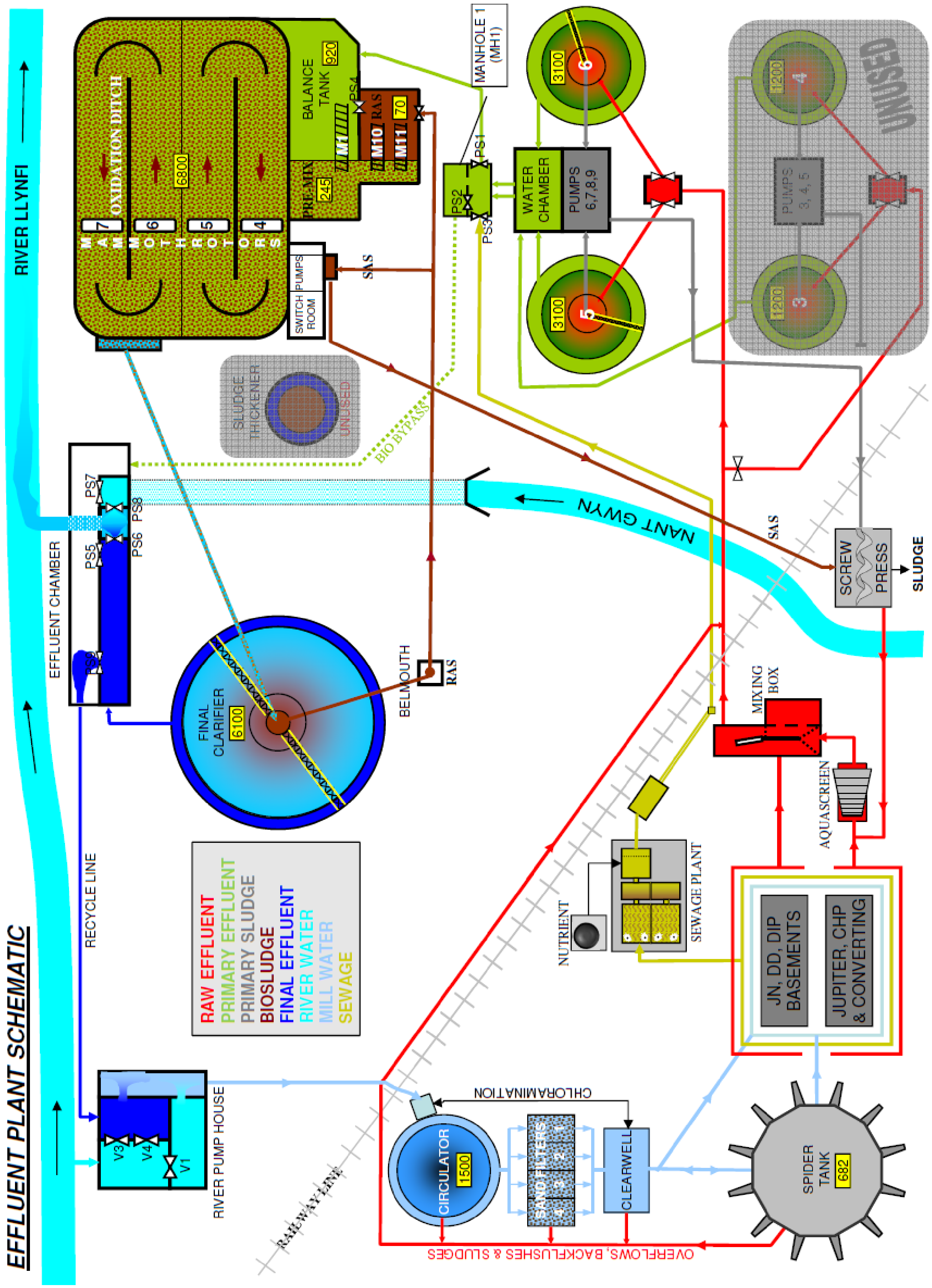


Figure 69 Effect of the sludge load on the occurrence of protozoa and metazoa (no lack of oxygen).

If protozoa and metazoa suddenly disappear, then toxic components are present in the influent. This can be followed within a few days by an explosive increase in the number of protozoa, because the number of free-living bacterial cells has considerably increased during their absence.

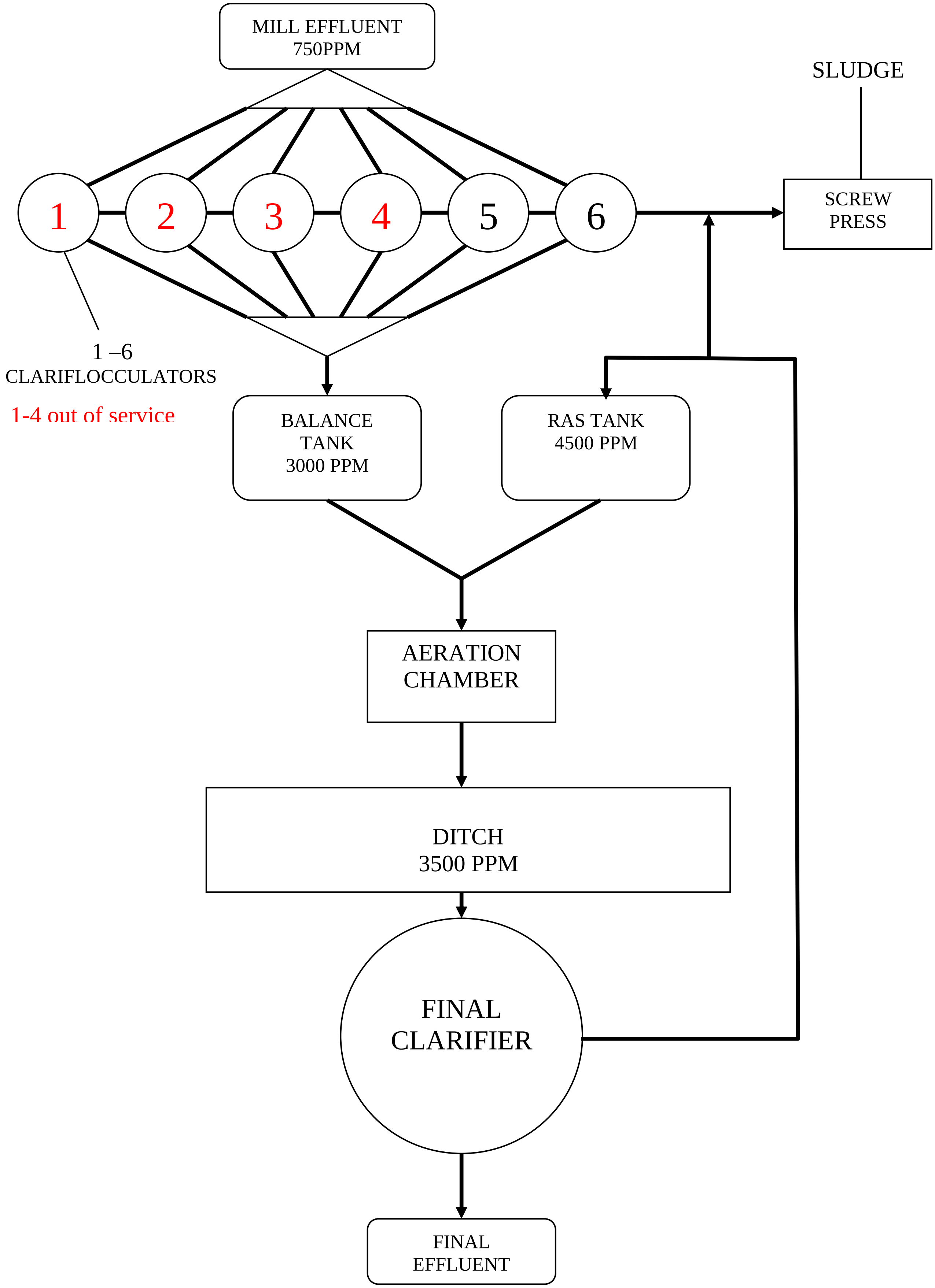
A strong increase in the number of worms in activated sludge can cause a decrease in the production of surplus sludge (see paragraph 9.7).

Appendix 4


EFFLUENT PLANT SCHEMATIC
RIVER LLYNFI
NANT GWYN
OXIDATION DITCH
6800
MAMMOTH ROTORS
7
6
5
4
BALANCE TANK
920
PREMIX
245
M1
M10 RAS
M11
70
PS4
SWITCH ROOM
PUMPS
SAS
MANHOLE 1 (MH1)
PS1
PS2
PS3
WATER CHAMBER
PUMPS 6,7,8,9
3100
6
5
1200
4
3
PUMPS 3, 4, 5
UNUSED
SLUDGE THICKENER
UNUSED
BIO BYPASS
EFFLUENT CHAMBER
PS7
PS8
PS5
PS6
FINAL CLARIFIER
6100
BELMOUTH
RAS
SCREW PRESS
SLUDGE
MIXING BOX
AQUASCREEN
SEWAGE PLANT
NUTRIENT
JN, DD, DIP BASEMENTS
JUPITER, CHP & CONVERTING
RECYCLE LINE
RAW EFFLUENT
PRIMARY EFFLUENT
PRIMARY SLUDGE
BIOSLUDGE
FINAL EFFLUENT
RIVER WATER
MILL WATER
SEWAGE
RIVER PUMP HOUSE
V3
V4
V1
RAILWAY LINE
CHLORAMINATION
CIRCULATOR
1500
SANDFILTERS
CLEARWELL
SPIDER TANK
682
OVERFLOWS, BACKFLUSHES & SLUDGES

Appendix 5

Effluent Treatment



Appendix 6

Procedure for Restarting BOD Plant After Power Dip or Power Loss

On loss of power to the effluent treatment plant, the plant must be checked to ascertain what parts of the plant require resetting and or restarting. Refer to the table below for normal process running conditions.

Pump/Motor	Status	Mode
M1	Run	Manual
M10	Run	Manual
M11	Standby	Auto
M4	Run	Manual
M5	Standby	Auto
M6	Standby	Auto
M7	Run	Manual
M8&M9	Run	Manual
P1	Run	Manual
P2	Off	Off
P3	Off	Manual
P4	Off	Manual
FST Spray	Run	Manual
Biox 1010	Run	
Flow meters	Display value	
Turbidity meter	Display value	
Temperature monitors	Display value	
pH	Display value	
Effluent monitoring system	Reboot	
Aquacell sampler	Run	
Ammonia meter	Run	

All pumps and motors are fitted with a black reset button.
Ensure these buttons are depressed before pressing the start buttons.

On restarting the plant, monitor the Final Settlement Tank sludge blanket level as increased hydraulic load at start up can destabilise the plant.

In the event of a prolonged power loss (if known) refer to Emergency Power Supply Procedure. **Emergency_Power_Supply_Procedure**

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Appendix 7

Security Gatehouse Alarm Summary

Bridgend Paper Mill security gatehouse is the designated area for critical alarms from the effluent treatment plant to alarm to. The alarms are monitored on the GENT system.

All alarms activated on this system must be reported to the duty shift manager immediately for further investigation and remedial action(s).

Below is a list of items from the effluent treatment plant that will alarm on the GENT system:-

HSB – High Sludge Blanket **blanket_lift**
M1 – M1 Archimedes Screw Pump failure
RAS Sump – High Level in RAS sump indicating potential failure of M10/M11

	Alarm level	Max permitted	
BOD- High BOD level	5mg/l	10mg/l	**Quick guide**
Suspended Solids – High SS	25mg/l	25mg/l	Quick Guide
PH – High/Low pH	6.6 – 7.9	6.5 – 8.0	**Quick Guide**
High Discharge flow	15000m ^{3}	17500m^3	Quick Guide
High Discharge Temp	24°	25°	Quick Guide

Index

Procedure for Running the BOD plant from Emergency Generator Supply (House Set)

1. INTRODUCTION

In the event of a major power outage, it is imperative that the effluent treatment plant (BOD) is maintained in a running condition to ensure that no overflows occur direct to river.

It must be the first priority to go direct to the plant and establish whether the electrically driven equipment is still operating.

If the equipment has stopped then it must be restarted after the auxiliary power supply is switched over.

2. SCOPE

This procedure covers any such incident within the Bridgend Mill site.

3. RESPONSIBILITY

The Mill Controller (Normally the Shift Manager) is responsible for ensuring that this procedure is followed. He will call for the support of other personnel as required.

4. PROCEDURE

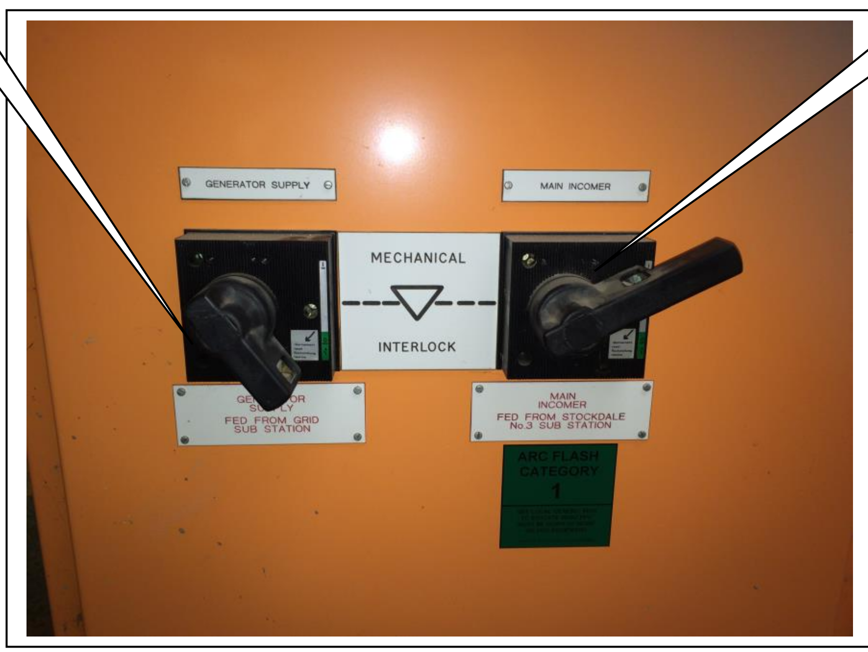
1. The mill controller will establish that the House Set generator is running. If not it will need to be started before checking the BOD plant.

2. The mill controller will then go directly to the BOD plant together with a competent electrical technician.

3. On entering the switch room at the BOD plant, check all drives to ensure that they are operational.

4. If the equipment has stopped and supply has been lost, then instruct a competent electrical person to switch in the auxiliary power supply identified below. (This is fed from the House Set generator which should be running in the event of a power failure).


Isolator set


House set infeed
Main incomer
GENERATOR SUPPLY
MAIN INCOMER
MECHANICAL
INTERLOCK
FED FROM GRID SUB STATION
MAIN INCOMER FED FROM STOCKDALE No.3 SUB STATION
ARC FLASH CATEGORY 1

5. Please note that the auxiliary power supply is 100 amps and will only provide enough power to run the equipment specified below. Restart the following equipment <u>one at a time</u>.

Note: All pumps and motors are fitted with a black reset button. Ensure these buttons are depressed before pressing the start buttons.

a. One mammoth rota only, either no 4 or no 5

b. Either M10 or M11 screw pump

c. Final settlement tank bridge drive

6. Check to ensure that the equipment starts correctly and that all flows through the plant are restored.

7. Check the Effluent Chamber/Discharge Point and Manhole 1 to ensure that no overflow has occurred. If it has then contact the Environment Manager immediately.

8. Once mains power is restored then visit the BOD plant and switch the mains power back on.

9. THIS MUST BE DONE AS SOON AS THE HOUSE SET SWITCHES OFF AS OTHERWISE NO POWER WILL BE SUPPLIED TO THE BOD PLANT.

10. To switch back to mains power, visit the BOD switch room and reverse the position of the switches so that the main incomer is now live and the auxiliary incomer is switched off.

11. Then restart the following equipment <u>one at a time</u>:
    a. Both M10 and M11 Archimedes screws.
    b. M4 or M5 plus M6 or M7 mammoth rotors (2 running)
    c. Final clarifier bridge drive
    d. PI computer in corner of switch room.

12. Check to ensure that the equipment starts correctly and that all flows through the plant are restored.

When power is re-established the power switch over must be reversed and plant started as per normal running **(Start up procedure)**

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BOD

Check trends on the Effluent monitoring system at Jupiter control room, or via PI.
Do Trends show high BOD value?
NO.
The problem is probably the signalling between the two systems. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.
YES
Check Biox 1010 unit at the BOD plant.

Is the display showing a high value i.e.>5mg/l
YES
Action: Monitor the trend. If the BOD approached 10mg/l put the Effluent to 100% recycle whilst the issue is investigated, call out if necessary and report via environmental near miss reporting system.
NO
The problem lies in the communication between the BIOX 1010 and the Effluent monitoring system. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.

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Suspended Solids

Check SS trends within PI system (or the Effluent monitoring system at Jupiter control room)

Do Trends show high SS value?

NO
The problem is probably the signalling between the two systems. **Action**: Request further investigation from engineering department and report via environmental near miss system.
Yes
Action: Check the probe in the discharge channel for debris (algae/plastics). If debris is found around the probe, remove and replace probe and wait for alarm to reset.

If no debris is found, check the channel for water quality. Remove a sample and examine visually.
If the sample is turbid or contains higher than normal concentrations of suspended solids, **Action:** Put the effluent to 100% recycle while the issue is investigated further and call out if necessary and report via environmental near miss reporting system.

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PH High/Low

Check pH trends with PI system (or the Effluent monitoring system at Jupiter control room)

Do Trends show high or low pH value?

NO
The problem is probably the signalling between the two systems. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.
YES
Check the pH meter at the BOD plant.

Does the meter at the BOD plant show a high or low pH value?
NO
The problem lies in the communication between the pH meter and the Effluent monitoring system. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.
YES
Action: Take a sample and check with hand held pH meter (available from Lab)

Is pH outside consent limits? 6.5 & 8.0

YES
Action: Put effluent to 100% recycle, call out if necessary, report via environmental near miss reporting system.
NO
Action: Request further investigation from engineering department and report via environmental near miss reporting system

The pH meter probes have pre-determined shelf lives so holding spares can be an issue. The same type of pH meter is used on the incoming river water. If issues are detected with the effluent pH meter then the incoming water meter can be used.

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High Discharge flow

Check trends within PI system (or the Effluent monitoring system at Jupiter control room)

Do Trends show high discharge flow value?

NO
The problem is probably the signalling between the two systems. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.

YES
Action:
1.Increase recycle rates so that the discharge flow reduces to within acceptable limits and monitor.

1. Check for excessive flows on machines and reduce as far as practicably possible.
2. Check for overflows etc from water filtration plant.
3. Report via environmental near miss reporting system

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High Discharge Temperature

Check trends via PI system (or the Effluent monitoring system at Jupiter control room)

Do Trends show high Temperature value?

NO
The problem is probably the signalling between the two systems. **Action**: Request further investigation from engineering department and report via environmental near miss reporting system.

YES

Action:
1. Reduce the discharge flow to a level that the Nant Gwyn is effectively cooling the effluent to within consented limit (currently 25°C)
2. Check for sources of heat through machine systems.
3. Report via environmental near miss reporting system.

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High Mixing Box level

When the high mixing box level alarms at the security gatehouse, the shift manager must **immediately** visit the mixing box to confirm the alarm.

If the level is high, there is a danger that the mixing box could overflow to the Nant Gwyn stream.

Immediate action should be taken to reduce flows to the mill and on machine to prevent overflow.
Inspections must be made to check there are no fugitive overflows and close any drains that may be open. This includes water and stock. Index