WASTEWATER SERVICES AND OPTIONS REPORT FOR THE CONSTRUCTION OF THE DAS STEEL MINI FOUNDRY

DAS Steel (Pty) Lt

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DAS Steel (Pty) Ltd

6/26/2012

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Table of Contents

1. Introduction

DAS Steel (Pty) Ltd (DAS) is proposing the construction and commencement of a foundry at Cato Ridge, on Eddie Hagen Drive. The project consists of a two phase implementation strategy; phase 1 the secondary steel foundry and phase 2 the hot rolling mill.
The proposed foundry and mill requires environmental authorisation through the Department of Agriculture and Environmental Affairs (DAEA). In addition, several Waste Management Activities (WMAs) require licensing through the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008).
This report provides specialist input into the sewage treatment options available on site and thereby providing succinct information in the Environmental Impact Assessment.

The proposed wastewater in this assessment is generated from the offices and ablutions on site. No industrial effluent has been stipulated within the proposed process although there is a wastewater stream that is produced from the treatment of incoming water through a reverse osmosis plant. This reject/brine stream has not been included in this report and is to be treated / disposed of separately.
The treated wastewater has no discharge point to either a natural water resource (e.g. river) or to a municipal sewer line. Accordingly, treated wastewater either needs to be re-used on site or transported off site to a suitable discharge point.

2. Wastewater Characterisation

2.1 HYDRAULIC LOAD

The total daily water demand for the site has not been specified at this preliminary stage of the assessment. 'The Process Design Manual for Small Wastewater Works; DJ Nozaic & SD; Table 2.3.3: Typical figures for daily sewage flow estimates for units other than households' has been used to estimate the daily hydraulic load for the site. A hydraulic load of 40 kl/d has been estimated as the design figure for the proposed site (Table 1).

Table 1: Estimated waste water flows for the site

Unit	Flow (l/d)	No. of workers	Total (l/d)
Factory Worker/shift	140	260	36 400
Office worker	90	40	3 600
Total		**300**	**40 000**

2.2 ORGANIC LOAD (CHEMICAL CHARACTER)

The proposed waste water in this assessment is of a domestic nature generated from the offices and ablutions on site. No industrial effluent has been stipulated within the proposed process although there is a waste water stream that is produced from the treatment of incoming water through a reverse osmosis plant. This reject/brine stream has not been included in this report and is to be treated / disposed of separately.

The most common parameters for measuring organic strength in waste water are:

- Chemical Oxygen Demand (COD); and
- Five-day Biochemical Oxygen Demand (BOD).

There is a fairly consistent COD/BOD ratio (2:1) in domestic sewages and therefore either parameter can be used for design. The selection of these depends largely on practical considerations such as treated effluent standards (discharge standards) and personal preference. There are more local accredited laboratories providing COD analysis methods than BOD analysis and COD testing is increasingly used in design of waste water processes. In this instance there is no actual waste water stream and the COD value has been used for design purposes.

Table 2 below shows typical domestic sewage strength. Lower income groups have higher strength sewage (e.g. COD 700 mg/l); conversely high income groups will be lower strength (e.g. COD 500 mg/l). For the factory workers on site it has been assumed that the sewage character is higher strength (COD 700 mg/l).

Table 2: Typical domestic sewage strength

Parameter	Value
BOD_5	250 – 350 mg/l
COD	500 – 700 mg/l
Settable solids	8-10 ml/l
Suspended solids	200 – 350 mg/l
TKN	60 – 85 mg/l
Ammonia	40 – 50 mg/l
Phosphate	10 – 13 mg/l

3. Treatment Process Options Identification

There are a multitude of suitable biological treatment processes documented for domestic and general industrial effluent. Biological treatment falls into two major categories:

- Anaerobic (Absence of oxygen); and,
- Aerobic (Presence of oxygen).

3.1 ANAEROBIC PROCESSES

The three primary anaerobic processes include:

- Septic tanks;
- Anaerobic ponds; and,
- Anaerobic digesters.

3.1.1 Septic Tank

Septic tanks are not considered a viable option for the on-site treatment works as the daily hydraulic and chemical load is too high for this particular technology. Furthermore, even when well-managed, septic tanks will not meet discharge standards without secondary treatment such as a soak away (French drain).

3.1.2 Anaerobic Pond

Anaerobic ponds require significant space requirements and are not recommended in close proximity to residential or industrial areas due to common odour concerns. This is therefore not considered a viable option for the site.

3.1.3 Anaerobic Digester

An anaerobic digester is not suited to domestic sewage treatment due to the relatively weak organic strength of the effluent. The anaerobic digester may be utilised in large municipal treatment works to digest primary sludge, but this site does not warrant this due to the relatively small daily discharge volumes.

3.2 AEROBIC PROCESSES

Common options for aerobic processes include:

- Conventional Activated Sludge Plant (AS);

- Aerated Lagoon (AL);
- Sequenced Batch Reactor (SBR);
- Membrane Bioreactor (MBR);
- Trickling Filters Plants (TF);
- Rotating Bio-contactors (Bio-Discs) Plants (RBC); and,
- Submerged Bio-Contactors (Bio-Reactors) Plants (BC).

3.2.1 Conventional Activated Sludge Plant

Raw sewage/effluent runs through primary treatment consisting of screens into an aeration basin where it is aerated. The effluent is passed from the aeration basin to a clarifier where the sludge is settled from the mixed liquor and returned to the aeration tank with a daily volume pumped to drying beds. The effluent is passed through the clarifier, disinfected and discharged (Figure 1).

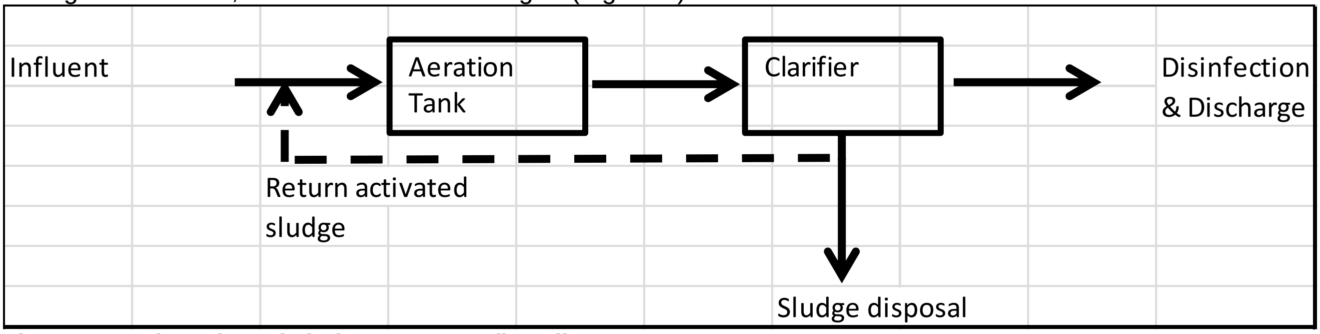

Figure 1: Basic activated sludge treatment flow diagram

The activated sludge process is considered a viable option for the site due to the following advantages:

- High quality final effluent (90%-95% COD removal, 90-95% solids removal);
- Robust process capable of varying influent character (volume & strength);
- Robust mechanical and structural equipment, and simple to maintain;
- Small footprint requirement;
- Suited to small and large communities;
- Well suited to disinfection of final effluent; and,
- Phosphate and nitrogen removal possible through the process.

The activated sludge process has the following disadvantages:

- High capital cost;
- Requires manpower to operate;
- Requires regular sludge removal; and
- High energy requirement.

3.2.2 Activated Lagoon

Raw sewage runs through primary treatment consisting of screens into an aerated lagoon where it is aerated. The effluent passes through the lagoon and flows either into a secondary lagoon or is disinfected and discharged. Aerated lagoons are activated sludge units operated without sludge return (Figure 2).

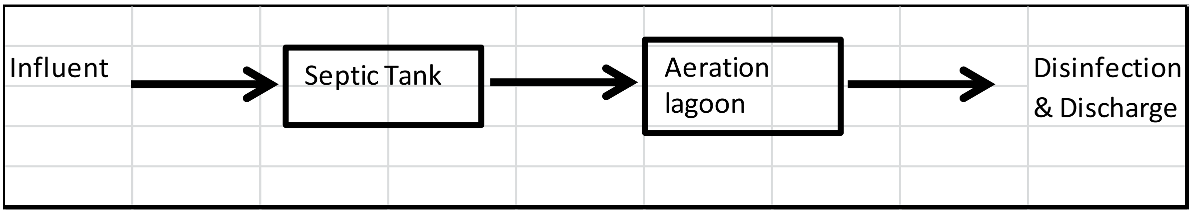

Figure 2: Basic aerated lagoon treatment flow diagram

The activated lagoon process has the following advantages:

- Robust process capable of varying influent character (volume & strength);
- Robust mechanical and structural equipment, simple to maintain;
- Medium space requirement; and,
- Low manpower requirement.

The activated lagoon process is not considered a viable option for the site due to the following disadvantages:

- Large footprint;
- Poor quality effluent in terms of suspended solids content and chlorine contact (*E-coli*);
- High costs associated with disinfection due to quality of effluent (solids prevent adequate contact with the chlorine);
- Significant civil construction; and,
- High energy requirement.

3.2.3 Sequence Batch Reactor (SBR)

Raw sewage runs through primary treatment consisting of screens into one of two tanks (may be more depending on design). While the one tank is being filled it is aerated. The other tank is not aerated and the mixed liquor (sludge) settles. The supernatant is decanted off, disinfected and discharged into the receiving watercourse. The decanted tank is then filled with incoming effluent and aerated while the other tank settles and decants. The SBR continues to operate by a period of cycles consisting of fill, react (aerate), settle, decant and idle (Figure 3).

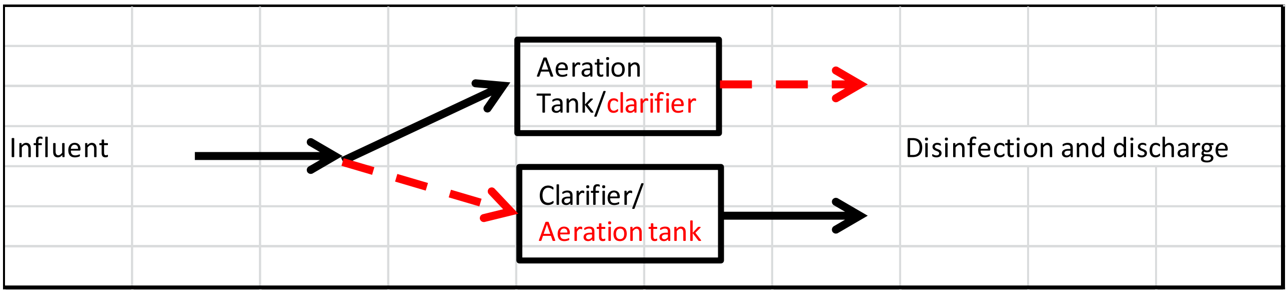

Figure 3: Basic sequence batch reactor treatment flow diagram

The sequence batch reactor has the following advantages and is considered as a potential option for the site:

- Simplicity, aeration, settling, decanting and sludge wasting all take place in one tank;
- Robust process capable of varying influent character (volume & strength);
- Small footprint requirement;
- Suited to small and large communities;
- Modular for easy expansion;
- Well suited to disinfection of final effluent; and,

- Phosphate and nitrogen removal possible through the process.

The sequence batch reactor has the following disadvantages:

- High energy requirement (higher than AS);
- High level of automatic PLC programming required;
- Requires skilled manpower to operate;
- High capital cost;
- Maintenance requires skilled manpower; and,
- Requires regular sludge removal.

3.2.4 Membrane Bioreactor Reactor (MBR)

Raw sewage/effluent runs through primary treatment consisting of screens into an aeration basin where it is aerated. The effluent is passed from the aeration basin through a membrane where the sludge is returned to the aeration tank, drying beds. The effluent (filtrate through membrane) is passed through the clarifier then disinfected and discharged. The membrane is typically an ultrafiltration membrane which provides a high quality treated effluent (see Figure 4).

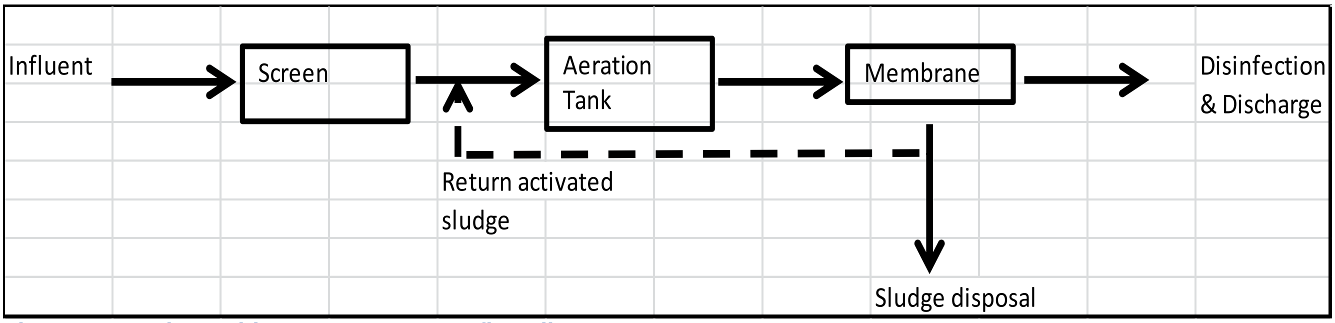

Figure 4: Membrane bioreactor treatment flow diagram

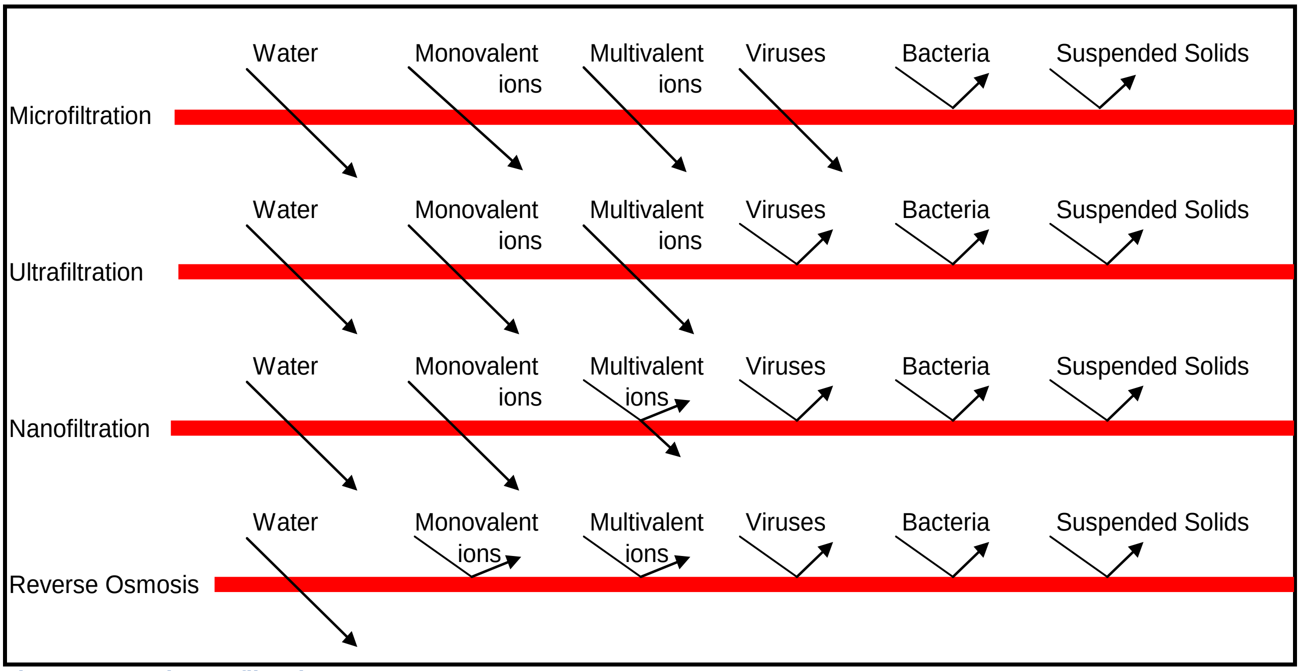

Figure 5: Membrane filtration

The membrane bioreactor reactor has the following advantages and is considered a potential option due to water reclamation opportunity:

- Highest quality effluent (90%-98% COD removal, 95-98% solids removal);
- Robust process capable of varying influent character (Volume & strength);
- Physical barrier to viruses and bacteria.
- Small footprint requirement;
- Suited to small and large communities;
- Modular for easy expansion;
- Well suited to disinfection of final effluent;
- Phosphate and nitrogen removal possible through the process; and,
- Well suited for water recovery secondary treatment such as reverse osmosis.

However the membrane bioreactor reactor has the following disadvantages:

- High capital cost (Highest capital cost of all technologies);
- High operating cost (membrane replacement);
- High energy requirement;
- High level of automatic PLC programming required (manual aeration operation not recommended);
- Maintenance requires skilled manpower;
- Requires skilled manpower to operate; and
- Requires regular sludge removal.

MBR's are increasingly being implemented in areas where the waste water is being re-used (especially as drinking water).

Figures 6 & 7 below highlight the difference between the treatment train requirements for a reverse osmosis (RO) post AS (or SBR) and a MBR process.

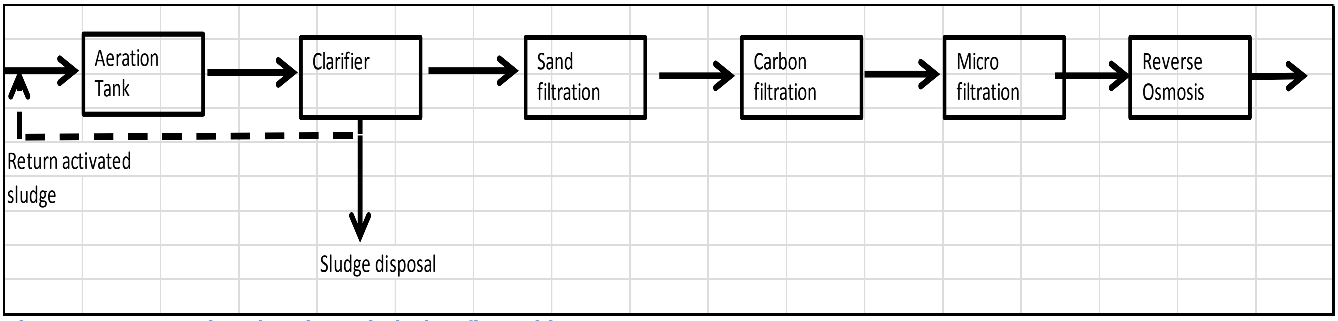

Figure 6: Conventional activated sludge flowed by RO

AS followed by RO requires long and complicated treatment trains as the RO process requires pre-treatment steps.

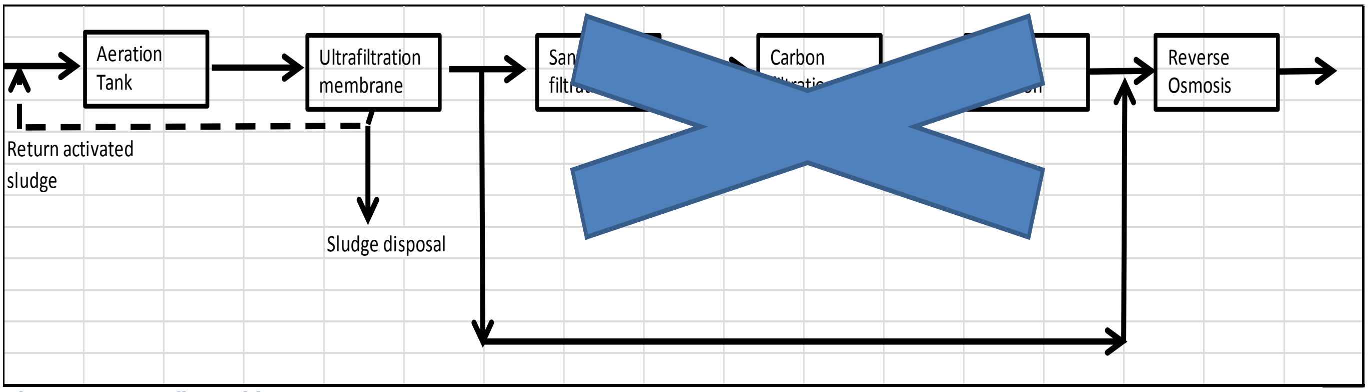

Figure 7: MBR flowed by RO

3.2.5 Rotating Bio-Contactors (Bio-Disc) Plants (RBC)

Raw sewage runs through a primary treatment consisting of a septic tank before passing through troughs containing rotating discs that are partially submerged in the sewage. A film of biomass grows on the discs and flakes off as the layer grows too thick. As the disc rotates the biomass is exposed to air resulting in aeration of the biofilm. After sedimentation in a humus tank the final effluent is disinfected and discharged into the receiving watercourse (see Figure 8).

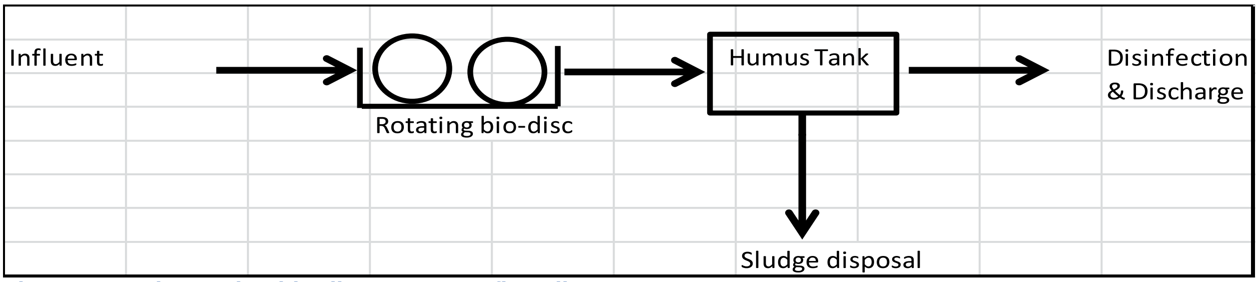

Figure 8: Basic rotating bio-disc treatment flow diagram

The rotating bio-disc process has the following advantages and is considered an option for this site:

- Robust mechanical and structural equipment;
- Simple maintenance and operational control;
- Low energy requirement; and,
- Available in package plants.

The rotating bio-disc process has the following disadvantages:

- Susceptible to load variation in terms of hydraulic and chemical character (e.g. food waste);
- Generally requires a septic tank as a primary treatment phase;
- Final effluent quality poor with COD removal of 65% – 80% (COD 500mg/l @ 80% reduction = 100 mg/l);
- High strength effluent (food waste) difficult to treat to specified standards; and,
- Process not as robust as other aerobic options.

3.2.6 Submerged Bio-Contactors Plants

Raw sewage runs through a primary treatment consisting of a septic tank before being pumped into the bottom of a bio-contactor which is packed full of media on which biomass grows. The liquid is then treated aerobically with the introduction of air at the base of the bio-contactor. The effluent then passes through a clarifier before being disinfected and discharged (see Figure 9).

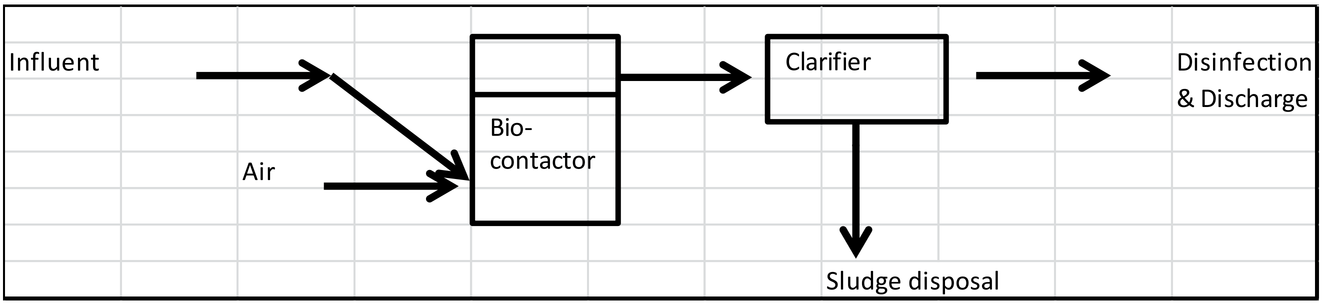

Figure 9: Basic submerged bio-contactor treatment flow diagram

The submerged bio-reactor has the following advantages is considered an option for this site, although process better suited to individual households:

- Robust mechanical and structural equipment;
- Simple maintenance and operational control;
- Low energy requirement; and,
- Available in package plants (short delivery time).

The submerged bio-reactor process has the following disadvantages:

- Not suited to high hydraulic load (more commonly implemented as a small package plant for individual household or building);
- Susceptible to load variation (e.g. food waste);
- Requires a septic tank as a primary treatment phase;
- Final effluent quality poor with COD removal of 75% – 85%;
- High strength effluent difficult to treat to specified standards (COD 700mg/l @ 85% reduction = 105 mg/l); and,
- Process not as robust as other aerobic options.

3.2.7 Process Selection Matrix

To provide a preliminary comparison between the treatment processes, a selection matrix in Table 3 has been drafted. The primary constraint on site is the cost associated with transporting the waste water off site to a suitable treatment works or disposal point. The cost of disposal is not dependent on the quality of the waste water, but rather the volume required for transport. Therefore any waste water reuse would result in a reduced volume for transport and potential for water reclamation has been listed as the primary driver within the comparison matrix and therefore weighted by a factor of two (x2).

The high level comparison between the treatment processes, indicates that conventional activated sludge (AS), sequence batch reactor (SBR), Membrane Bio-reactor (MBR), rotating bio-disc and submerged bio-contactors are all considered viable process options for the site. Due to the fact that there is a limited area on site for irrigation, the quality of the treated waste water needs to be in line with the municipal water supply quality. Only the MBR produces treated waste water of the highest quality which is suitable for reverse osmosis (RO) treatment. AS and SBR produce good quality waste water and with additional polishing through sand filtration produces similar quality to the MBR, however this waste water is not suited to further treatment through RO and there is no physical barrier for viruses and human pathogens as is the case with the MBR. The bio contactors and rotating discs treated waste water is only suitable for irrigation purposes.

Table 3: Technology comparison for sewage treatment works

Technology	Water Reclamation	Effluent Quality	Footprint	Flexibility (Modular)	Simplicity	Robust	CAPEX	OPEX	Total
Septic Tank	F	F	3	1	3	3	3	3	F
Anaerobic Pond	F	F	F	0	3	2	2	3	F
Anaerobic digester	F	F	2	1	2	1	1	3	F
Activated sludge (AS)	1(x2)	2	2	2	2	3	1	1	15
Aerated lagoon	1(x2)	1	F	1	3	3	2	2	F
Sequence batch reactor	1(x2)	2	2	3	1	3	1	1	15
Membrane bioreacter	3(x2)	3	3	2	0	2	0	0	16
Trickling filter	F	F	2	0	2	0	2	3	F
Rotating Bio-disc	0(x2)	1	3	3	3	1	3	2	16
Submerged bio-contactor	0(x2)	1	3	3	3	1	3	3	16

Key

3 = Excellent (low cost)
2 = Good
1 = Average
0 = Poor
F = Fail (technology not suited to site)

4. Process Design (Guidelines)

The following design guidelines for an MBR waste water treatment plant have been made with the objective of treating 40 m^3/d of waste water to a quality that is suitable for re-use within the site process and in particular as a RO feed stream. As stated earlier these figures are to be used as a preliminary estimate to model the final effluent quality, sludge production, WWTW footprint, order of magnitude cost and environmental impacts.

4.1 BASIC DESIGN DATA

Table 4: Influent character (Design guidelines as estimated in section 3 above)

Parameter	Phase 1
Flow	40 m^3/d
BOD	350 mg/l
COD[1]	700 mg/l
Settable solids[2]	8-10 ml/l
Suspended solids[2]	200 – 350 mg/l
TKN[2]	60 – 85 mg/l
Ammonia[2]	40 – 50 mg/l
Phosphate[2]	10 – 13 mg/l

[1]*Using the ratio of 2:1 vs. BOD (typical of domestic waste water)*
[2]*Typical range for domestic waste water*

Table 5: General and Special Limits for treated effluent discharge to water course *(WRC Report No. TT389/09)* (Department of Water Affairs General limits for discharge to watercourse) and drinking water standards SANS 241

	Wastewater discharge		Drinking Standards	
Parameter	**General limit (GLV)**	**Special limit (SLV)**	**Class I**	**Class II**
Faecal Coliforms (per 100 ml)	1000	0	0	0
Chemical Oxygen Demand (mg/l)	75	30	N/A	N/A
pH	5.5-9.5	5.5-7.5	5.5-9.5	4.0-10.0
Chlorine as Free Chlorine (mg/l)	0.25	0	N/A	N/A
Ammonia as nitrogen	3	2	1	2
Nitrate/Nitrite as nitrogen (mg/l)	15	1.5	10	20
Suspended Solids (mg/l)	25	10	N/A	N/A
Electrical Conductivity (mS/m) 70 mS/m above intake to a max	70 mS/m above intake to a max of 150mS/m	50 mS/m above intake to a max of 100mS/m	150	370
Orthophosphate (mg/l)	10	1	N/A	N/A
Fluoride (mg/l)	1	1	1	1.5
Soap, oil and grease (mg/l)	2.5	0	N/A	N/A
Arsenic (mg/l)	0.02	0.01	0.01	0.05
Cadmium (mg/l)	0.005	0.001	0.005	0.01
Chromium (VI) (mg/l)	0.05	0.02	0.1	0.5
Copper (mg/l)	0.01	0.002	1	2
Cyanide (mg/l)	0.02	0.01	0.05	0.07
Iron (mg/l)	0.3	0.3	0.2	2
lead (mg/l)	0.01	0.006	0.02	0.05
Manganese (mg/l)	0.1	0.1	0.1	1
Mercury (mg/l)	0.005	0.001	0.001	0.005
Selenium (mg/l)	0.02	0.02	0.02	0.05
Zinc (mg/l)	0.1	0.04	5	10
Boron (mg/l)	1	0.5	N/A	N/A

Red print indicating where drinking water standards are stricter than waste water discharge standards

Table 6: Design parameters

PARAMETER	Phase 1
Incoming COD load	40 m^3/d at 700 mg/l = 28 kg/d average
Incoming BOD (COD : BOD = 2 : 1)	40 m^3/d at 350 mg/l = 14 kg/d average
Effluent COD value	<75 mg/l
Corresponding COD removal efficiency	>88%
Sludge loading rate selected	0.104 kg BOD/kgMLSS.d
Sludge Age	20 days
Aeration basin sludge concentration	5 kg/m^3 MLSS
Aerator requirement (blower diffussers)	1 kW
MBR configuration	External side stream
Membrane type	UF external[1]

[1] Depends on supplier preference (external require more electricity)

4.2 MEMBRANE BIOREACTOR PROCESS DESCRIPTION (GUIDELINES ONLY)

Screening:
The effluent will flow through the flat bar screen where coarse solids will be retained on the bars of the screen, manually raked, collected and disposed of by burial on site. Alternatively, the solids can be bagged and disposed to landfill.

Main treatment – Aeration and MBR:
This activated sludge system consists of a de-nitrification tank, an aeration basin and membrane separation of the sludge from the mother liquor. Organic pollutants (COD, BOD) are further reduced. Ammonia nitrogen is oxidised to nitrate, which is partially removed by simultaneous de-nitrification in the aeration basin. Aeration is achieved by submersible diffusers and a set of blowers. A dissolved oxygen probe controls the aerator operation, in order to maintain a low but sufficient oxygen supply. The mixed liquor separation of the sludge from the mother liquor is done by a set of ultrafiltration membranes. The mixed liquor is pumped through the external tubular UF membranes. The retentate represents the return activated sludge and is returned to the aeration basin. The filtered stream is collected in a treated water break tank. Excess sludge is drawn from the sludge return on a daily basis. The treated effluent (filtrate) from the membrane unit is discharged under gravity from the overflow tank to the RO or incoming water break tank.
The MBR is equipped with a CIP station for the regular cleaning of the membranes as required. The CIP station caters for cleaning with caustic, sodium hypochlorite and citric acid.

Disinfection:
The clarified water will pass into the disinfection channel. The hydraulic retention time in the disinfection will be in the order of 15 minutes to allow adequate contact.

Sludge handling and disposal:
Excess aerobic sludge is drawn from the aeration tanks periodically, and pumped to drying beds. An estimated 7 kg DS/d or approximately 1.3 m^3 (0.5% solids) of waste activated sludge is expected to be produced. The waste activated sludge will be disposed of either to: land application; sludge lagoon (pit); dewatering belt press or; sludge drying beds.

Disposal of final effluent:
From the disinfection tank the treated sewage will be stored in an incoming water tank where it is available to be used throughout the site process (e.g. RO treatment)

4.3 SCOPE OF SUPPLY (GUIDELINES ONLY)

Inlet works:
- Bar screen (manually raked)
- Screening bin

- Flow meter

Aeration basin:
- Aeration tank (approx. 30 m^3)
- Aerators (1 kW total required) for diffusers and blower
- All interconnecting pipework
- Hand rails

Ultrafiltration membrane:
- Membrane chamber
- Membrane cassettes
- Coarse air scouring (Blower)
- Cross flow pump
- CIP station
- Backwash pump
- Waste activated sludge pump
- All interconnecting pipe work

Sludge wasting:
- 7 x drying beds (2m^2) – mass concrete or brick

Disinfection:
- Sodium hypochlorite dosing tank (dosing pump + standby) – contact chamber 15 minute retention

Instrumentation:
- All instrumentation requires – (DO meter, pH, Flow, temp, pressure)

Electrical:
- Motor Control Cabinet (MCC) and small PLC
- Remote isolator stations
- All cables and racking

Civil:
- Slabs, aeration and MBR basin, roofed structure for the MCC

5. Order of Magnitude (OOM +-20%) Costing

The design, supply, installation and commissioning of one MBR treatment plant based on a full turnkey supply as per the scope of supply guidelines stipulated in Section 5 of this report has been estimated at **R2.5 million** (Two million five hundred thousand Rand) excluding VAT, taxes or other duties.

The costing is to be used as a preliminary figure for financial projections and is not an offer of sale. A detailed design and costing from a supplier would need to be carried out to finalise this figure.

The expected delivery is 30 weeks for cold commission

6. Conclusion and Recommendations

The high level comparison between the treatment processes indicates that conventional activated sludge (AS), sequence batch reactor (SBR), Membrane Bio-reactor (MBR), rotating bio-disc and submerged bio-contactors are all considered viable process options for the site. Considering that the treated waste water has no discharge point to either a natural water resource (e.g. river) or to a municipal sewer line treated waste water either needs to be re-used on site or transported off site to a suitable discharge point. The following three recommendations have been proposed:

1. No treatment of waste water – collection in conservancy tanks and then transported to closest waste water treatment works.
   Advantages:
   - The only capital cost would be the conservancy tanks sized to store 5 days average flow (40 x 5 = 200 m3).
   - No on site management of treatment – simple solution

   Disadvantages:
   - Operational cost of waste water transport and discharge of R85/m^3 and R10/m^3 respectively (municipal cost provided by Jeffares & Green). The cost estimate is R115 583 per month ((40 x 95 x 365)/12).
   - No recovered water for use on site
2. Treatment through rotating bio-disc plant – an option if available land for irrigation can be obtained or a discharge route to a natural water course identified in the foreseeable future.
   Advantages:
   - Lowest relative capital cost (OOM +- 20% R1 million full turnkey supply) of the viable options compared in Table 3.
   - Can meet irrigation specifications which would allow re-use through irrigation
   - Simple and low cost operation (no on-site operator)

   Disadvantages:
   - The quality of the waste water is only suitable for irrigation standards (general limits Table 5). The proposed site footprint does not have the required area on site to irrigate 40 m^3/d.
   - Operational cost of treated waste water transport is R85/m3 (municipal cost provided by Jeffares & Green). The cost estimate is R103 417 per month ((40 x 85 x 365)/12).
3. Treatment through an MBR with water reclamation – only option available to ensure process water quality.
   Advantages:
   - High quality treated water that is available for reuse within the site's process (within drinking water specification)
   - Treated water suitable as a RO feed stream
   - No transport cost off site so a minimum saving of R103 417 per month
   - A water saving of 40 m^3/d which relates to R13 992 per month at R11.5/m^3 (municipal price)
   - Sustainability in terms of water consumption (Drought or insufficient municipal supply)

   Disadvantages:
   - High capital cost (R2.5 million)
   - Operational cost associated with operation in terms of man power, electricity and membrane replacement (Estimated cost R20 000 per month excluding electricity)
   - Require trained operational staff

The MBR treatment option is regarded as the optimum solution to the site in terms of operational cost, long term sustainability and water recovery (at high quality). The MBR capital cost is the highest of the options, however if irrigation is not an option due to lack of footprint then the capital payback is less than 3 years. It should be noted that this option is only recommended if the water is re-used within the process and in particular if the major point of use is as a RO feed stream. <u>If irrigation is viable in terms of footprint then this option is no longer the preferred option.</u>

Below are additional environmental considerations for the recommended WWTW design as stipulated in Section 4 of this report.

- Effluent discharge quality:

The expected quality of the final treated effluent will meet the special standards for discharge to watercourse and/or irrigation stipulated in Table 5, Section 4.

- Visual aesthetics:

The treatment works should be buffered from sight by vegetation planted once construction is complete. A covered structure could be constructed if required.

- Sludge:

The dewatered waste activated sludge will be disposed of either as land application[1], to a sludge pit on site, or to landfill.

- Odour:

Correct management of the sewage works will ensure the odour is not an issue of concern. In particular the raked screenings at the head of the works needs to be regularly disposed of. If left to stand, the screenings will result in an odour nuisance.

- Life span:

MBR can be constructed from steel or concrete and with proper maintenance are expected to last for more than 25 years

- Foot Print:

Aeration basin	10 m^2
Membrane basin	5 m^2
Sludge drying beds	15 m^2
General Miscellaneous	30 m^2
Total footprint	60 m^2

- Monitoring discharge limits:

The volume of sewage entering the treatment works should be recorded on a daily basis. The treated sewage should be sampled on a monthly basis to provide a database on the plant performance in meeting the general discharge limits. The following table indicates the monitoring requirements. The proposed treatment works falls into the 10 to 100 cubic metre category as stipulated by Department of Water Affairs (DWA).

Table 7: Monitoring requirements for domestic waste water discharges (DWA)

Discharge volume on any given day	Monitoring Requirements
< 10 cubic metres	None
10 to 100 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml)
100 to 1000 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml) Chemical Oxygen Demand (mg/l) Ammonia as Nitrogen (mg/l) Suspended Solids (mg/l)
1000 to 2000 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml) Chemical Oxygen Demand (mg/l) Ammonia as Nitrogen (mg/l) Suspended Solids (mg/l) Nitrate/Nitrite as Nitrogen (mg/l) Free Chlorine (mg/l) Ortho-Phosphate as Phosphate (mg/l)

[1] Application for permit required

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