KANTEY & TEMPLER
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ASSMANG CATO RIDGE WWTW

PRELIMINARY DESIGN REPORT

DRAFT

OCTOBER 2022

K&T PROJECT REFERENCE: 20207 - 01

REVISION 0

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Details of this report

Client Name	Assmang
Document Title	ASSMANG CATO RIDGE WWTW PRELIMINARY DESIGN REPORT
K&T Project Reference	K&T Job No: 20207
File Name	Doc No: 20207 - 01
Prepared by	K. E. Hohls / R Keppler

Report Revision Record

Revision	Date	Description
0	03/10/2022	ASSMANG CATO RIDGE WWTW PRELIMINARY DESIGN REPORT

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For and on behalf of

Kantey & Templer (Pty) Ltd

Approved by: K. E. Hohls

Signed: ______________________

Position: Structural Engineer

Date: 03/10/2022

1. CONCEPT DESIGN

The concept covered in this report is for the design and construction of a "mini wastewater treatment works" as opposed to a "package plant".
The differences between the two are:

- A mini works has each unit process specifically designed and tailored to suit the unique circumstances applicable to the site and is not simply a catalogue selection from a standard range of models. This is especially important when considering the unique hydraulic and process requirements of specific works.

- The equipment supplied and installed in a mini works is of a generic nature and is specified on a performance basis by the designer. As such, it is possible for the equipment and the structures to be costed and selected on a conventional tender basis. This is due to the fact that the design is supplied by the designer who acts on behalf of the client and is not subject to "black box" technology or patented systems. Spares and service may thus be readily obtained directly from the local agent of the equipment in question and not necessarily from the original installer.

- Package plants, by definition are constructed off site, from catalogue designs which do not readily allow for variation between the various unit processes. This can lead to dangerous imbalances in certain circumstances. Naturally, these plants are designed to cater for size ranges and not necessarily specific to the actual needs of the site.

- Package plants are usually designed to produce an effluent complying with the General Limit Values of the Water Act and can be difficult to tailor for higher effluent standards (as in this case).

- In general, package plants are designed in low volume modules, often necessitating a multiplicity of units to cater for the design flows and loads. This leads to complexity of flow division, operation and maintenance.

- Package plants are often constructed of lightweight materials and some do not have the longevity required of a permanent works.

In general, the design concept adopted embodies the following principles:

a) Each unit process is sized specifically for the requirements of this site
b) The units process design factors into account the specific sewage characteristics
c) The units are designed for economy of construction, longevity, ease of operation and economy of operation
d) The units are designed using generic equipment, all of which may be supplied and installed by a number of suppliers and contractors.
e) A minimum number of units are employed, simplifying flow balancing, operation and maintenance.
f) In common with most commercial developments, the project is likely to be phased in stages that are developed as the market demand requires. This phasing will determine the module size and for the purposes of this report it is assumed that each module will be capable of treating 250 Kld. This results in a total of 8 modules to treat the ultimate capacity of 2 Mld. This is considered to be the minimum module size. For ease of

operation, module sizes should be equal and in this instance, may be either 250 Kld, 500 Kld or 1 000 Kld

g) In the past, eThekwini Metro has not permitted the construction and operation of private wastewater treatment works with a capacity in excess of 2 000 Kld. For this reason and coupled with the more stringent Water Licencing requirements for plant larger than 2 000 Kld,, it is assumed that the maximum size of the plant will be 2 000 Kld

h) It is further understood that the Hammarsdale WWTW (owned and operated by eThekwini Metro) is expected to be in a position to accept sewage from the Cato Ridge area within the next 10 years. For this reason, the works in question is considered to be of a temporary nature and wherever possible the process units will be constructed from reusable or resaleable materials.

2. DESIGN PARAMETERS

2.1 Potable Water Supply

Potable water is supplied to this area from Umgeni Water sources, via eThekwini Metro and is via a metered connection. This potable water is used for domestic purposes only and is not used to dilute sewage or added in significant amounts to the process.

2.2 Nature of the Sewage

The sewage entering this treatment works will be confined to domestic sewage only, no industrial effluent will be permitted to enter the system.

2.3 Flows

The design flows to this works are predicted to be as follows:

Average dry weather flow	2 000 Kld (23 l/s)
Peak factor	2.65
Peak dry weather flow	61 l/s
Peak wet weather flow	70 l/s

2.4 Load and Chemical Parameters

Chemical Oxygen Demand (COD)	1 504 kg COD/d (752 mg/l)
Biological Oxygen Demand (BOD)	752 kg BOD/d (376 mg/l)
COD: BOD Ratio	2:1
Total Kjeldahl Nitrogen (TKN)	115 Kg/d (58 mg/l)
Suspended Solids (SS)	340 Kg/d
SS Concentration	170/l

2.5 Effluent Targets

The effluent quality targets assumed for this works is assumed to be the General Limit Values as laid down in the Water Act.
The works has been designed to produce an effluent complying with this requirement as reflected in the following table.

Determinand	**GLV Limits**
pH	5.5 - 9.5
Conductivity (mS/m)	+ 70 max <150 max T
COD (mg/l)	<75
Ammonia as N (mg/l)	<6.0
Nitrate as N (mg/l)	15
Phosphate (mg/l)	<10
Suspended solids (mg/l)	<25
E.Coli (CFU/100 ml)	<1000

3. SITE CONSTRAINTS

3.1 Wetland Buffers

The allocated site is possibly constrained by wetland buffers and this will need clarification before detail design.

3.2 Development Potential

The developable area is reflected on Drg No 20207-XX-01 rev B and the sewage demand table reflects the following:

Priority	Sewage Generation (Kl/d)	Accumulative Sewage (Kl/d)
1		
2		
3		
4		

Previously, the Department of Water and Sanitation have resisted developments that produce sewage flows in excess of 80% of the design capacity of the treatment works. If such restrictions are applied, then it is apparent that the extent of development that will be allowed (using the temporary treatment works) will be such as to generate 1 600 Kld of sewage.

Therefore, Priority 1 and a portion of the future Priority 2 will be catered for.

4. PROCESS TRAINS (refer to process flow diagram and site layout drawing)

4.1 BNR Extended Aeration Activated Sludge by Sequencing Bioreactors

The process train for this option consists of:

1) Inlet works consisting:
    - Coarse hand raked bar screen
    - Fine hand raked bar screen (standby)
    - Fine mechanically raked bar screen
    - Screenings washing, dewatering and compaction
    - Vortex grit removal with air lift
    - Grit classifier
    - Flow measurement
2) Sequencing batch reactors consisting of circular steel tanks, HDPE lined, equipped with external venturi type aerators.
3) Reinforced concrete emergency storage / inlet pump station.
4) Disinfection by chlorination
5) Sludge wasting and disposal by mechanical means.
6) Siteworks, roads and fencing
7) A control building with ablutions
8) A second- class water supply for site washing and irrigation.
9) A standby diesel generating set.

5. MATERIALS BALANCE

5.1 Liquid Balance

Inputs

Raw sewage	2 000 000 l/d
Potable water	2 000 l/d
Sodium hypochlorite solution	1 500l/d
Total	2 003 500 l/d

Outputs

Final effluent	2 002 000l/d
Liquid in sludge cake	1 500 l/d
Total	2 003 500 l/d

5.2 Solids Balance

Inputs

Screenings (0.008 m^3/Mld)	0.016m^3/d
Grit (0.034m^3/Mld)	0.068m^3/d
Activated sludge production	220 kg/d

Outputs

Screenings	0.016m^3/d
Grit	0.068m^3/d
Waste sludge	220/d

6. FUNCTIONAL DESIGN SPECIFICATION

The sewage arrives at the site and flows into the inlet works.

<u>Inlet Works (IW)</u>

A coarse hand raked screen is situated in the screen channel at the head of the inlet works. This screen has 40mm gaps and is designed to protect the fine screen from heavy foreign objects. This screen is cleared by hand and the screenings placed in a bin for later removal.

From the hand raked screen channel, the sewage flows to a further set of screens (duty / standby), placed in two parallel channels.

The flow to these channels is controlled by handstops.

The duty channel is equipped with a mechanically raked screen This screen operates on a differential level basis to initiate the screening process. This is controlled by a level switch, monitoring the upstream sewage level in the screen channel.

The screenings from the mechanically raked screen are discharged into a screenings washer / compactor. This device washes organics from the screenings and these organics return to the sewage flow for further treatment. The washed screenings are compressed to reduce the water content and are then bagged for later removal. The bags are fitted and removed manually from the bagging device.

The standby channel is fitted with a hand raked screen. This screen is manually raked, and the screenings are placed in the screening's washer / compactor for disposal.

The exists to the screening channels are controlled by hand stops.

From the screenings channel, the screened sewage flow to the detritor. The flow to this detritor is controlled by hand stops.

The detritor settles grit contained in the sewage and this is removed via an airlift pump and flows to the grit classifier

The airlift pump is powered by air from an air blower and this is manually controlled.

The detritor is equipped with a rotating paddle driven by an electric motor and gearbox. This paddle keeps organics in suspension during periods of low flow and is operated manually.

The detritor is also fitted with a high-pressure water lance which is fed with high pressure water from the second-class water system. This lance is manually controlled and is used to break up any dense accumulation of grit in the hopper of the detritor.

The grit classifier removes any remaining organics from the grit and returns these to the system for treatment. The cleaned grit is elevated by s screw conveyor and discharged into a grit hopper for later disposal. The classifier is manually operated.

From the detritor, the screened, degritted sewage enters the delivery pipe to the recycle / feed pump station which is fitted with the inlet flow recorder (FR1) where the instantaneous flow rate and accumulated flow rates are measured and recorded by the flow recorder.

<u>Feed Pump Station</u>

The sewage enters the feed pump station.

The sump is equipped with a submersible mixer to keep solids in suspension and ensure homogeneity of contents.

The mixers are manually operated.

Sequencing Batch Reactors

The treatment process is explained below. Each of the SBR's will operate independently of each other, running a full batch treatment from start to finish before receiving any additional wastewater flow. The batch treatment volume, tank sizes and cycle time has been designed to ensure that each SBR will operate out of phase with the others and one tank will always be ready to accept sewage when the buffer storage in the recycle / feed sump reaches high level.

Flow into the tanks will be controlled by actuated valves and flow out of the tanks by actuated valves. These are actuated via signals from the PLC.

Manually operated valves are provided upstream of the actuated valves to facilitate fine tuning and maintenance.

Stage 1 – Fill

The treatment cycle starts at time T=0. It is assumed that the SBR has recently completed a treatment cycle so the volume is at low level, inlet valve and decant valve are closed and that the aerators are either off or in mixing mode.

When the duty feed pump starts, the actuator fitted to the inlet valve opens and the SBR starts to fill. The aerator continues to operate in mixing mode.

When the level indicator in the SBR reads HIGH the feed pump stops and the inlet valve is closed.

Stage 2 – Aeration

The treatment cycle is now at time T=+1 hour. SBR1 is at high level and inlet and decant valves are closed. The venturi aerator starts and commences the four hour aeration period. At this stage the SBR is operating as a conventional aeration tank. During the aeration cycle it is possible to use the aerator in a mixing mode for a selected period.

Stage 3- Settlement

The treatment cycle is now at time T= +5 hours. The aeration / mixing cycle is now complete and the auto timer switches off the venturi aerator Inlet and decant valves remain closed. At this stage the SBR is operating as a settlement tank to allow separation of solid and liquid phases.

Stage 4 – Decant

The treatment cycle is now at time T = +6 hours. During the preceding hour, the sludge has settled to the lower part of the SBR (importantly to below the level of the decant bellmouth) and clear treated effluent occupies the upper portion of the tank. The auto timer sends a signal to the actuator controlling the decant valve which opens. Simultaneously, the sodium hypochlorite dosing pump starts and runs until the decant valve closes. The level in the SBR starts to drop and treated effluent flows from the tank until the level recorded by reads LOW at which time the decant valve closes.

At the end of the decant stage the treatment cycle is complete and time is now at T= +7 hours. SBR is now ready to restart at stage 1, once sufficient wastewater has been collected in the sump of the feed / recycle pump station.

Chlorine Dosing

Sodium hypochlorite is dosed into the decant tank during the decant cycle to disinfect the effluent. This is done by sodium hypochlorite dosing pumps (duty / standby) interlocked with the decant vale operating cycle.

Waste Activated Sludge System

Excess activated sludge is wasted from the independent sequencing batch reactors when required. This is achieved by the manual operation of the waste activated sludge outlet valve on the SBR and then the waste activated sludge in admixture with the polyelectrolyte flows by gravity to the thin sludge holding tank.

The mechanical dewatering system is operated when the thin sludge holding tank is full and this system operates automatically, controlled by a PLC. The dewatered sludge is deposited into a skip for later removal. The filtrate from the dewatering process is returned to the feed pump station for further processing.

Final Effluent Flow Recorder

A final effluent flow recorder is provided to record instantaneous flow and total flow released to the environment.

7. WORKS RATING AND STAFFING REQUIREMENTS

7.1 Works Rating

Water and wastewater treatment works are subject to rating by DWS as laid down by the regulations published in the Government Gazette (Regulation No R 2834 dated 27 December 1985).

In terms of this, we are of the opinion that this works will be rated as a Class C works.

7.2 Staffing Requirements

The same regulations define the staffing requirements for each class of works.

In the case of a Class C works, the requirements are:

1 x	Trainee
2 x	Class I operators
1 x	Class II operator
1 x	Class IV person as supervisor
1 x	Class V person to carry out weekly inspections

8. MANAGEMENT SYSTEMS

8.1 Water Services Provider

The sewage treatment works is managed by a grouping of the contributors, which body is a designated water services provider, in terms of an agreement with eThekwini Municipality.

All of the functions and responsibilities of a water services provided are the responsibility of this group.

8.2 Description and Hierarchy of Operating Staff

The hierarchy of the operating staff is as follows:

- Water Services Provider Responsible Person
- Plant operator
- Works staff

These persons are supported by :

- Consulting Chemical Engineer
- Consulting Design Engineer
- SANAS accredited laboratory
- Mechanical and electrical service provider
- Sludge, screening and grit removal service providers.

8.3 Availability of Mechanical Maintenance Staff

The Water Service Provider has a term contract with a service provider for routine mechanical maintenance and breakdown interventions on the plant.

8.4 Availability of Electrical Maintenance Staff

The Water Service Provider has a term contract with a service provider for routine electrical maintenance and breakdown interventions on the plant.

8.5 Availability of Process Control Staff and Process Consultants

The Water Services Provider has a term contract with a firm of Consulting Engineers to provide this assistance to the staff employed.

8.6 Drainage By Laws

A set of drainage by laws is in place and is administered by the Water Services Provider, in conjunction with the Consulting Engineers.

9. IS THE WASTE TREATMENT PROCESS THE BEST OPTION

It is contended that the treatment process employed is the best option in this case for the following reasons:

- The ability to produce the required effluent standard
- The ease of constructing the plant in a modular fashion
- The small footprint of the plant
- The absence of fly breeding and odours applicable to this process
- The production of a mineralised, stable sludge within the process by aerobic means
- The ability of the process to denitrify and reduce nitrates as well as to recover alkalinity lost in the process.

10. IS THE BEST TECHNOLOGY IN USE

It is contended that the best technology is in use as all items of equipment employed are generic and may thus be replaced at any stage with similar equipment, without being beholden to any one original equipment suppliers.

11. WHAT ARE THE ALTERNATIVE OPTIONS FOR SEWAGE TREATMENT

Alternative options for treatment and disposal are:

- Biological filtration
- Rotating biological contactors
- Submerged fixed film reactors.

12. WHY WAS THIS OPTION CHOSEN

This option was chosen for the following reasons:

- Effluent quality produced
- Ease of extension
- Small footprint
- Low nuisance
- Ease of removal when main drainage connection is available.

13. OPERATIONAL MANAGEMENT PLAN

13.1 What are the Chances of System Failure

System failure can be attributed to the following causes:

- Mechanical breakdown
- Electrical breakdown
- Electrical outage
- Process poisoning
- Operator actions

In the event of a mechanical breakdown, all essential items of equipment are provided with a standby to assume duty in the event of a failure.

Similarly, all electrical switchgear (excepting the transformer) is duplicated with the mechanical plant.

In the event of an electrical outage, the plant is provided with a diesel driven standby generator. Process poisoning can occur if poisons find their way into the sewer system. This is unlikely as the system is for domestic sewage only and not for industrial effluents. Diligent application of the drainage by laws will also mitigate against this.

If the operation of the works is not diligent, then process failure can result. The Water Services Provider has an obligation to ensure that all routine and intervention actions are carried out by the operational staff.
Overall, the chances of a significant system failure are seen as being low.

13.2 What are the Implications of Such a Failure

The implications of such failure will be the loss of final effluent quality. This will result in an additional load being placed on the purification capacity of the adjacent wetland. If this capacity is ever exceeded, then pollution and nuisance will result.

13.3 What Safety Factors Have Been Used

As described earlier in this report, the following safety factors have been used:

- Conservative design criteria
- Generic equipment employed that can be replaced at short notice
- Domestic sewage only to be treated
- Professional process advice and monitoring
- Preventative maintenance of plant and equipment
- Standby equipment provided

13.4 What are the Management and Maintenance Plans

The day- to- day management of the works rests with the Water Service Provider who manages and guides the following;

- Finance and budgets
- Personnel and training plans
- Process and monitoring plans
- Mechanical and electrical maintenance plans
- Applications for new connections
- Compliance planning

13.5 Availability of Standby / Spare Equipment

All mechanical and electrical equipment is provided in a duty / standby configuration.
A standby generator is provided.
All equipment is generic and spares are readily available.

13.6 What are the Accident and Emergency Plans:

In the event of an accident, first aid is available from Administration / Control building on the plant. First aid facilities are provided at this point.
Emergency services are available from various service providers in the vicinity.
Emergency breakdowns are handled by the contracted maintenance service providers.
Process emergencies are handled by the Consulting Engineers.

13.7 What Plans are there to Minimise the Pollution Hazard / Potential

Daily plant inspections by operating and supervisory staff.
Weekly plant inspections by maintenance service providers.
Monthly plant inspections by Consulting Engineers.

13.8 Are there Alarm Systems in All Pump Stations?

Alarm systems are provided.

13.9 Are there Notification Procedures for Downstream Users

These are in place.

14. DISPOSAL OF SOLID WASTE AND SLUDGES

14.1 Description of Solid Waste

Solid waste emanating from this works will be:

- Washed grit from the inlet works
- Washed and bagged screenings from the mechanical screen
- Dewatered waste activated sludge.

14.2 Quantity

The grit output is calculated to be	0.068 m³/d or 95 kg/d or35t/annum
The screenings output is calculated as	0,016 m³/d or 10kg/d or 3 650 kg/annum
The waste activated sludge output is	120kg dry solids / day or 44t per annum

14.3 Analyses of Sludges

No sludge analyses are currently available as the works have yet to be constructed.

14.4 Classification of Sludges

No classification of sludge is as yet available.

14.5 Method of Disposal

The waste sludge is taken to a designated eThekwini Metro works for final disposal.

14.6 Description of Contract for Removal of Sludges

A service provider is contracted to transport the waste sludge to the designated eThekwini Metro works.

15 METRO APPROVAL

eThekwini Metro have, in the past, applied Guideline 12 as a means of controlling the design, construction and operation of privately owned wastewater treatment works. *Inter alia* this guideline demands the following:

a) Sewage shall only be from residential areas with a maximum of 20% being generated by commercial sources. Clearly, this development does not fall within the appropriate category and relief will have to be sought from this requirement
b) The works shall be designed by an experienced professional who shall be responsible for overseeing operation and maintenance for a period of 5 years after commissioning
c) The works shall be monitored monthly with reporting to EWS. Analyses to be undertaken by a SANAS accredited laboratory.
d) Application to construct and operate such a works shall be made to EWS in due form.
e) A guarantee amounting to 250% (2,5 times) the cost of the works (including VAT and Professional fees) shall be lodged with EWS on commissioning of the plant. The duration of this guarantee is for 5 years and is refundable if the works performance is satisfactory. If the works performance is unsatisfactory, then the guarantee monies may be used for rectification.