CEDERBERG

Cederberg Municipality

# CEDERBERG LOCAL MUNICIPALITY

## TECHNICAL REPORT

**Revision 5 (Funding requirements updated)**

## REFURBISHMENT AND UPGRADE OF CLANWILLIAM WASTEWATER TREATMENT PLANT



**May 2024**

**CEDERBERG LOCAL MUNICIPALITY**

# REFURBISHMENT AND UPGRADE OF CLANWILLIAM WASTEWATER TREATMENT PLANT

## TECHNICAL REPORT

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# CLANWILLIAM WASTEWATER TREATMENT PLANT TECHNICAL REPORT

**ISSUE & REVISION RECORD**

**QUALITY APPROVAL**

| | Capacity | Name | Signature | Date |
|---|---|---|---|---|
| Author | Engineer | G.H. Meiring |  | 21 August 2024 |
| Client Approval | | | | |

This report has been prepared in accordance with BVi Consulting Engineers Quality Management System. BVi Consulting Engineers is ISO 9001: 2008 registered and certified by NQA Africa.

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# Acronyms

| | |
|---|---|
| ACIP | Accelerated Community Infrastructure Programme |
| ADWF | Average Dry Weather Flow |
| BEE | Black Economic Empowerment |
| CFO | Chief financial officer |
| CPI | Consumer price index |
| DM | District municipality |
| DWS | Department of Water and Sanitation |
| EIA | Environmental Impact Assessment |
| ES | Equitable share |
| FBS | Free basic services |
| GDP | Gross domestic product |
| GVA | Gross value added |
| I&AP | Interested and Affected Parties |
| IDP | Integrated Development Plan |
| IRS | Implementation readiness study |
| kℓ | Kilolitre = 1 000 ℓ = 1 m3 |
| KPI | Key performance indicator |
| kWh | Kilowatt hours |
| ℓ | Litre |
| ℓ/c/d | Litres per capita per day |
| ℓ/day | Litres per day |
| LM | Local municipality |
| $m^3/a$ | Cubic litres per annum |
| $m^6/m^3/a$ | Million cubic meters per annum |
| MIG | Municipality infrastructure grant |
| Mℓ | Mega litre = 1 000 kℓ = 1 000 m3 |
| MTREF | Medium Term Revenue and Expenditure Forecasts |
| MWIG | Municipal Water Infrastructure Grant |
| NRW | Non-revenue water |
| O&M | Operation and maintenance |
| p.a. | Per annum |
| p.m. | Per month |
| PDWF | Peak Dry Weather Flow |
| PGDS | Provincial Growth and Development Strategy |
| PMU | Project management unit |
| RBIG | Regional Bulk Infrastructure Grant |
| SALGA | South Africa Local Government Association |
| SDBIP | Service Delivery and Budget Implementation Plan |
| SMME | Small, Medium and Micro Enterprise |
| TOR | Terms of reference |
| VAT | Value Added Tax |
| WC DM | West Coast District Municipality |
| WSA | Water services authority |
| WSDP | Water services development plan |
| WSI | Water services institution |
| WSIG | Water Services Infrastructure Grant |
| WSP | Water services provider |
| WTW | Water treatment works |
| WWTW | Waste water treatment works |

# REFURBISHMENT AND UPGRADE OF THE CLANWILLIAM WASTEWATER TREATMENT PLANT

# TECHNICAL REPORT

## 1. INTRODUCTION

The town of Clanwilliam is administrated by the Cederberg Local Municipality with its administrative seat located in Clanwilliam. The Cederberg Municipality is located within the boundaries of the West Coast District Municipality.




*Figure 1: Cederberg Local Municipality in relation to the West Coast District Municipality*

Clanwilliam is situated at an elevation of 100 meters above mean sea level, between the western slopes of the Cederberg mountains and the east bank of the Olifants River, which is impounded nearby by the Clanwilliam Dam. It is situated at the foot of the Cederberg Range where the Jan Dissels River flows into the broad Olifants River. Clanwilliam is located just off the N7 national road, which runs from Cape Town to the Namibian border. Clanwilliam is 230 kilometers from Cape Town by road.

Clanwilliam has a population of approximately 7 674 persons and 2 363 households (Statistics SA: Census 2011). The town is primarily an agricultural service center with Rooibos tea and intensive citrus production being the predominant economic drivers for the town.

The Clanwilliam WWTP is currently equipped with two treatment modules, each comprising an oxidation ditch and a clarifier. The plant has a rated design capacity of 2400m$^3$/day according to the municipality.

High level capacity calculations indicate that the plant is able to cope with a flow of 2400m$^3$/day, but at a limited organic load, with COD concentrations not exceeding 580mg/l. **At a flow of 2100m$^3$/day, an organic concentration of 650mg/l could be managed.**

Currently, the plant is receiving in the order of 2200m$^3$/day (94% of rated maximum) with a very high organic concentration of **978mg/l COD**. The plant is **not** able to deal with this organic load for a variety of reasons, and this is reflected in the very poor Final Effluent analysis results. In the previous 15 months, the plant effluent did not comply with the General Limit values on even a single occasion.

| STANDARD | DETERMINANDS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MICROBIOLOGICAL | | PHYSICAL | | | | | | CHEMICAL | | | | | | | | | |
| | Faecal Coliforms | | pH | | EC | | SS | | COD | | $NH_3$-N | | NO3 | | NO2 | | PO4-P | |
| Gen. Limit Values | 1000 cfu/100ml | | 5.5-9.5 | | 70 above intake, max 150mS/m | | 25 mg/l | | 75 mg/l | | 6 mg/l | | 15 mg/l | | 15 mg/l | | 10 mg/l | |
| MONTH | MONTHLY AVERAGES | | | | | | | | | | | | | | | | | |
| Jan-20 | 2419.00 | NC | 7.40 | C | 84.00 | C | 77.00 | NC | 124.00 | NC | 39.30 | NC | 0.20 | C | 0.53 | C | 3.70 | C |
| Feb-20 | 2419.00 | NC | 7.00 | C | 102.00 | C | 143.00 | NC | 258.00 | NC | 45.40 | NC | 0.61 | C | 2.10 | C | 5.50 | C |
| Mar-20 | 2419.00 | NC | 7.07 | C | 85.00 | C | 145.00 | NC | 203.00 | NC | 43.00 | NC | 0.20 | C | 0.20 | C | 3.40 | C |
| Apr-20 | 2419.00 | NC | 6.79 | C | 79.00 | C | 12.00 | C | 157.00 | NC | 38.20 | NC | 0.20 | C | 0.20 | C | 5.00 | C |
| May-20 | 2419.00 | NC | 7.06 | C | 87.00 | C | 86.00 | NC | 145.00 | NC | 40.60 | NC | 0.20 | C | 0.20 | C | 4.70 | C |
| Jun-20 | 2419.00 | NC | 7.01 | C | 81.00 | C | 160.00 | NC | 291.00 | NC | 45.60 | NC | 0.20 | C | 0.20 | C | 3.10 | C |
| Jul-20 | 2419.00 | NC | 6.86 | C | 86.00 | C | 129.00 | NC | 189.00 | NC | 31.40 | NC | 9.80 | C | 1.30 | C | 12.40 | NC |
| Aug-20 | 2419.00 | NC | 7.10 | C | 75.00 | C | 65.00 | NC | 127.00 | NC | 21.80 | NC | 0.80 | C | 1.40 | C | 2.90 | C |
| Sep-20 | 2419.00 | NC | 6.85 | C | 92.00 | C | 261.00 | NC | 392.00 | NC | 45.70 | NC | 0.20 | C | 0.20 | C | 5.00 | C |
| Oct-20 | 2419.00 | NC | 6.89 | C | 120.00 | C | 333.00 | NC | 683.00 | NC | 71.00 | NC | 0.20 | C | 0.20 | C | 16.90 | NC |
| Nov-20 | 2419.00 | NC | 6.98 | C | 84.00 | C | 117.00 | NC | 211.00 | NC | 48.50 | NC | 0.20 | C | 0.20 | C | 7.00 | C |
| Dec-20 | 2419.00 | NC | 6.92 | C | 80.00 | C | 148.00 | NC | 221.00 | NC | 36.20 | NC | 0.20 | C | 0.20 | C | 4.90 | C |
| Jan-21 | 2419.00 | NC | 7.15 | C | 95.00 | C | 48.00 | NC | 129.00 | NC | 47.30 | NC | 0.20 | C | 0.20 | C | 7.50 | C |
| Feb-21 | 2419.00 | NC | 7.30 | C | 88.00 | C | 53.00 | NC | 183.00 | NC | 27.20 | NC | 0.93 | C | 1.60 | C | 1.10 | C |
| Mar-21 | 2419.00 | NC | 7.33 | C | 75.50 | C | 72.00 | NC | 148.00 | NC | 23.50 | NC | 0.78 | C | 0.30 | C | 5.70 | C |
| No. of samples complying: | | 0 | | 15 | | 15 | | 0 | | 0 | | 0 | | 15 | | 15 | | 13 |
| No.of samples taken: | | 15 | | 15 | | 15 | | 15 | | 15 | | 15 | | 15 | | 15 | | 15 |
| % Compliance of determinand: | | | | | | | | | | | | | | | | | | |
| | | 0% | | 100% | | 100% | | 0% | | 0% | | 0% | | 100% | | 100% | | 87% |
| % Compliance of Category: | | | | | | | | | | | | | | | | | | |
| MICROBIOLOGICAL: | | | PHYSICAL: | | | | | | CHEMICAL: | | | | | | | | | |
| 0% | | | 67% | | | | | | 57% | | | | | | | | | |
| % Compliance of Complete Treatment Plant: | | | | | | | | | | | | | | | | | | |
| 54% | | | | | | | | | | | | | | | | | | |

*Figure 2: Compliance record for Clanwilliam WWTP*

The Cederberg Local Municipality is desirous to develop an additional 1 158 stands in Clanwilliam, for low-cost housing. These stands will contribute an additional 579m$^3$/day to the current flow to Clanwilliam WWTP. Given the current condition of the Clanwilliam

WWTP, and the high strength sewage being received, the additional flow will not be able to be accommodated, unless funding is made available to repair and upgrade the existing works, to enable it to perform optimally.

In a status quo report (*Report No.34459-REP001*), commissioned by the Cederberg Municipality in May 2021, it was suggested that the Clanwilliam WWTP treatment capacity be extended. The correct long-term solution for the Clanwilliam WWTP being to add another module capable of treating wastewater for the expected 2030 population. This indicates an expansion capable to treat an additional 1 500m$^3$/day.

This technical report is therefore being submitted as motivation to obtain financial assistance to firstly address the repairs, and then upgrade the Clanwilliam Wastewater Treatment Plant to a new rated treatment capacity of 3 600m$^3$/day.

This project addresses the upgrade of both the future treatment capacity and the refurbishment of the existing mechanical and electrical equipment which have deteriorated over time due to age and normal wear and tear.

The project is already 78% funded by the Municipal Infrastructure Grant and the Water Services Infrastructure Grant combined. The Municipal Infrastructure Grant has financed the refurbishment of the wastewater treatment works while the Services Infrastructure Grant has committed to funding R 54 950 000.00 of the upgrading of the wastewater treatment works. The project budget is addressed in detail in Section 8 of this report.

## *1.1. Project Objective*

This project will aim to provide the residents of Clanwilliam, and the surrounding environment, with a wastewater treatment plant capable of producing a Treated Effluent that complies with the Special Limit Values, irrespective of the quality of raw sewage received.

The Clanwilliam WWTP discharges its effluent to the Jan Dissels River. Although the Jan Dissels River is not currently a Listed River, requiring discharge of Treated Effluent to meet the Special Limit Values, it is a tributary of the Olifants River, which is a Listed River.

The goal of all wastewater treatment facilities should be long-term sustainability and will include the following objectives:

- To provide unit processes which are capable of treating wastewater to the Special Limit Values irrespective of the incoming raw sewage quality in accordance with Section 21(f) and (h) of the National Water Act (Act 36 of 1998).

- To improve the plant hydraulics to a degree where the plant will be able to meet

the peak runoff of 3 600m$^3$/day as a minimum requirement.

- To deliver Treated Effluent to the Jan Dissels River that is fully compliant, aesthetically acceptable in terms of odour and colour, and has a COD concentration below 30mg/l, an Ammonia concentration below 2mg/l and a phosphate concentration below 1mg/l.

If wastewater treatment is to be sustainable in the long term, it means that, community needs must be addressed; resulting in customer satisfaction, which in turn enhances the level of cost recovery, which, in turn, enables ongoing wastewater treatment.

## 1.2. Community needs

The direct community needs are for low-cost housing, which is a serious and urgent need. In order to unlock funding for the construction of these houses, the Cederberg Municipality must be capable to deliver a long-term sustainable sanitation service for the new houses as well as the rest of the Clanwilliam residents. This project aims to put infrastructure in place, to allow Cederberg Municipality to provide this service, and in turn, address the needs of the community.

## 1.3. Project Description

This report proposes to describe the current constraints that prevent the existing infrastructure, at the Clanwilliam Wastewater Treatment Plant, from delivering Treated Effluent of acceptable quality, from being produced constantly. In addition, the report makes proposals as to possible solutions to address these constraints, and describes the infrastructure required to solve these problems. Further to this, a cost estimate will be provided to quantify these solutions in terms of funding required to address the needs.

## 1.4. Job creation and opportunity

- Local labour will be employed for all labour-intensive tasks in terms of EPWP guidelines although this is not an EPWP project;
- All locally employed labour will be selected in consultation with the local municipality ward councillors, community leaders and the Community Liaison Officer;
- Formal contracts of employment will be entered into for each local labourer employed;
- A Community Liaison Officer will be employed to facilitate employment of local labour and the facilitation of labour issues.

- In addition to the above, skills training will be undertaken to empower the incumbents with new skills such as carpentry for shutter erection, pipe laying and brick masonry work. Softer skills such as basic office administration and low-level accounting will also be incorporated to accommodate female employees.

## 1.5. Management Structure

**Project Steering Committee**

- A project steering committee will be established to facilitate community involvement at the project level;
- The PSC will include representation by Ward councillors, Community Leaders and other members of the community which may be nominated.

**Water Services Authority**

- The Cederberg Local Municipality is the Water Services Authority who is responsible for the Clanwilliam Wastewater Treatment Plant.

**Implementation Agent and Project Manager**

- Cederberg Local Municipality is the Implementing Agent for this project.
- The project manager for the Wastewater Treatment project is UDS Africa Consulting Engineers and Project Managers.

## 1.6. Project Details

### 1.6.1. Project description

| Project Name | Municipality | Budget (Estimated Cost) | Funding |
|---|---|---|---|
| Upgrade and Refurbishment of the Clanwilliam Wastewater Treatment Plant | Cederberg Local Municipality | R 78 885 958.74 | ***WSIG*** |

### 1.6.2. Project Location

Clanwilliam is situated in the West Coast District Municipality of the Western Cape Province. The town falls under the jurisdiction of the Cederberg Local Municipality for local government purposes. Clanwilliam is the largest town in the Cederberg Municipality.
Clanwilliam is situated at an elevation of 100 meters above mean sea level, between the western slopes of the Cederberg mountains and the east bank of the Olifants River, which is impounded nearby by the Clanwilliam Dam.

It is situated at the foot of the Cedarberg Range where the Jan Dissels River flows into the broad Olifants River. Clanwilliam is located just off the N7 national road, which runs from Cape Town to the Namibian border. Clanwilliam is 230 kilometres from Cape Town by road.

The approximate GPS coordinates for the project site are as follows:
Latitude: ***32°11'38.61"S*** Longitude: ***18°54'1.86"E***

The town is located in quaternary catchment **E10J**, but positioned close to the boundary with E10G (West) and E10H (East).

Treated Effluent will be discharged into the Jan Dissels River, which is a tributary of the Olifants River, with the confluence just north of Clanwilliam.

### 1.6.3. Project Objectives

- The primary aim of the Project is to provide the required infrastructure in the form of new unit processes at the Clanwilliam Wastewater Treatment Plant which will allow the production of Treated Effluent that will always be compliant with the General Limit Values, and also meet the Special Limit Values, irrespective of the quality of the raw sewage received.
- To provide a short-term increase in treatment capacity by creating a temporary storage facility in one of the existing Sludge Lagoons to store sewage in periods of peak flow, which can then be pumped back to the inlet works at night for treatment during off-peak times.
- To ensure that the hydraulic capacity of the Clanwilliam Wastewater Treatment Plant is capable of treating at least 3 600$m^3$/day on a constant basis during peak conditions.
- To involve the local community, through the Ward Councillors, to be responsible for the provision of local labour as well as skilled and semi-skilled labour as and when required.

### 1.6.4. Primary problems experienced at the Clanwilliam WWTP:

- The Clanwilliam WWTP is currently operating at **94%** of its rated design capacity.
- Based on measured flows, the plant is currently receiving an average of 2 257$m^3$/day, and has a stated design capacity of 2 400$m^3$/day.
- Using historical analysis results, the current organic load of the Clanwilliam WWTP is **1 187kg COD/day** measured as $O_2$. Given that the plant has a design load of only 971kg COD/day, it is clear why the plant is battling with compliance.
- Analysis of the Treated Effluent water quality analysis results of the previous 15 months, shows that the Clanwilliam WWTP has not complied with any of the General

Limit Value requirements in this period. The following parameters are of serious concern:

- ***Faecal Coliform counts,***
- ***Total Suspended Solids concentration,***
- ***Chemical Oxygen Demand concentration, and***
- ***Ammonia concentrations***

- The current condition of the mechanical equipment such as the aerators and the clarifiers, indicate that the plant is fast approaching a point where significant refurbishment will be required.
- This specific configuration of activated sludge plants, (oxidation ditches) is notorious for their high maintenance requirements on aerators, as well as their operational difficulties due to especially aeration problems.
- The Clanwilliam WWTP, in its current configuration **will not be able to cope** with the additional flow to be generated by the new housing development, unless some works are conducted in the short and medium term.

### 1.6.5. Project Scope of Works Summary

- Upgrade the Inlet Works flow measurement facility.
- Remedial works on the existing WWTP equipment are as follows:
  - Repair and service 6 x horizontal brush aerators inclusive of shafts, bearings, gearboxes and motors, or replace with submersible jet aerators
  - Repair 2 x outlet weirs c/w servicing of spindles, bevel gearboxes and handwheels
  - Repair and service Clarifier bridge drive geared motors x 2
  - Clarifier suction lift equipment: - check integrity, sluice plugs and air-tightness
  - Repair and service Archimedean screw pumps inclusive of lower bearings, gearboxes and flights
  - Service and cleaning of submersible transfer pumps
  - Check condition of switchgear and repair if needed
- Installation of a small Lime dosing facility to do pH correction at the Inlet Works
- Convert one of the existing Sludge Lagoons into a Night Storage Pond by trimming the existing earthworks, and fitting the pond with a 0.5mm thick HDPE lining. This will provide a storage volume of approximately 1500m3, or 16 hours of peak flow.
- Construct a temporary overflow weir at the Inlet Works to divert excess peak flow to the proposed Night Storage Pond through a 250mm dia gravity pipeline approximately 75m in length.
- Install a temporary submersible pump, complete with switchgear, in the Night Storage Pond with a duty point of 45 l/s at a total head of 10m, to return the sewage to the Inlet Works during off-peak periods. Flow to be pumped to the Inlet Works through a temporary 160mm dia Rising Main 75m in length.

- Construction of a new 1 500m$^3$/day Reactor and Clarifier based on the UCT process configuration, to cater for the new 1 158-House project as well as to provide future treatment capacity for Clanwilliam.

- <u>This phase to consist of:</u>
  - Anaerobic Tank with a volume of 225m$^3$ with 2 x 5kW mixers.
  - Anoxic Tank with a volume of 400m$^3$ with 4 x 5kW mixers.
  - Aerobic Aeration Tank with a volume of 584m$^3$ with 3 x 15kW Aerators
  - Return Activated Sludge Pump Station with Duty & Standby pumps
  - A-Recycle Pump Station with Duty & Standby pumps
  - R-Recycle Pump Station with Duty & Standby pumps
  - Single 18m diameter Suction Lift Clarifier
  - New Chlorine Contact Tank with a contact period of 60 minutes
  - New Chlorine Dosing Facility (either $Cl_2$ gas or HTH dosing)

# 2. STATUS QUO

## 2.1. Community Profile

### 2.1.1. Population

| Town | Population (Census 2011) | Population (2022) | Households (Census 2011) | Households (2022) |
|---|---|---|---|---|
| Clanwilliam | 7 674 | 12 279 | 2 363 | 3 781 |

### 2.1.2. Income level and sources of income

| Area | % Indigent household | % Household that can afford the service |
|---|---|---|
| Cederberg Municipality | 80.0% | 20.0% |

## 2.2. Institutional Profile

- Water Services Authorities (WSA)
  - Cederberg Local Municipality is the Water Services Authority in the area of jurisdiction.
  - The councillors and officials will play an active part in the implementation of the Wastewater project.
- Water Services Providers (WSP)
  - Cederberg Local Municipality.

# 3. EXISTING BULK WASTEWATER ENGINEERING SERVICES

## *3.1. Clanwilliam Wastewater Treatment Plant*

The town is currently equipped with an activated sludge wastewater treatment plant for treatment and safe disposal of the town's wastewater.

The Clanwilliam wastewater treatment plant is provided with two distinct units of the oxidation ditch type of wastewater treatment plant. Typical oxidation ditch treatment systems consist of a single or multichannel configuration within a ring, oval, or horseshoe-shaped basin. As a result, oxidation ditches are often referred to as "raceway type" reactors.

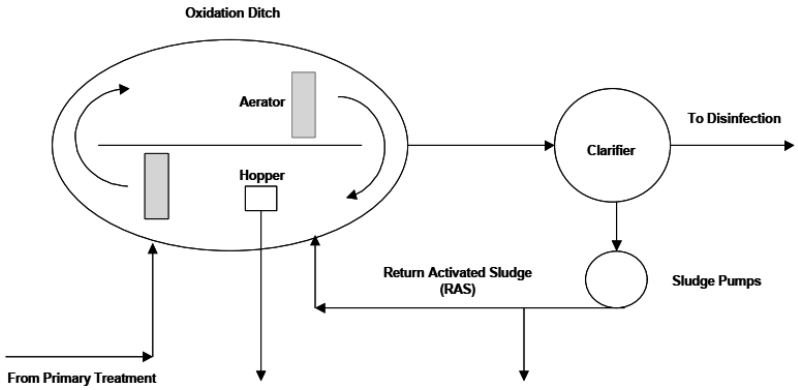


*Figure 3: Typical Process Flow Diagram for an Oxidation Ditch type wastewater plant*

An oxidation ditch is effectively a variant of what is known as an ***extended aeration activated sludge*** type plant. The term "extended aeration" indicates that there is no primary sedimentation and that the plant receives screened sewage directly from the Inlet Works of the plant.

Surface aerators, such as horizontal brush rotors or disc aerators, are used to circulate the mixed liquor. The mixing process entrains oxygen into the mixed liquor to foster microbial growth, and the motive velocity ensures contact of microorganisms with the incoming wastewater. The aeration sharply increases the dissolved oxygen (DO) concentration, but decreases as biomass takes up oxygen, as the mixed liquor travels through the ditch. Solids are maintained in suspension as the mixed liquor circulates around the ditch.

If design Solids Retention Times are selected for nitrification, a high degree of nitrification will occur. Oxidation ditch effluent is usually settled in a separate secondary clarifier, where the biomass and the treated effluent are separated.

### 2.1.1 Inlet Works: (common to both reactor sets)

- Course hand-raked screens
- Grit channels
- Flow measurement by means of a flume fitted with an ultrasonic level sensor (not functional)
- Division Box, where the flow is divided into a fixed ratio by means of different sized openings to each of the reactors.



*Figure 4: Clanwilliam WWTP Inlet Works*

### 2.1.2 Reactor 1:

- Oxidation ditch – typically a long continuous channel, oval in shape with two horizontal surface rotors placed across the channel.
- Equipped with 2 number Horizontal Brush Aerators powered by electrical motors through a reduction gearbox.
- Adjustable Outlet Weir used to regulate the depth of immersion of the aerators. This weir was broken and could not be adjusted.
- Estimated process volume = 14m x 34m x 1.20m = 571m$^3$.
- Very little evidence of sludge, also sludge is very thin.



*Figure 5: Old Reactor at Clanwilliam WWTP*

### 2.1.3 Clarifier 1:

- Hydrostatic Suction Lift type flat-bottom Clarifier with diameter of 14.5m
- Fitted with rotating half-bridge and annular sludge collection hopper fed by a siphon arrangement between the bridge and the sludge hopper.
- The rotating bridge is driven by a geared motor driving a wheel which runs on the outer concrete wall of the clarifier.
- The sludge removed from the clarifier is directed to the Return Activated Sludge Pump Station, from where it is recycled back to the Old Reactor.
- This clarifier appears to be fully functional and operational.
- The supernatant was not very clear, indicating a problem with the sludge settleability.



*Figure 6: 14.5m diameter Suction Lift Clarifier*

### 2.1.4 Return Activated Sludge Pump Station 1:

- Consists of 2 x Archimedean Screw Pumps to recycle the Clarifier underflow back to the old Reactor to maintain the active sludge population.
- Only one of the screw pumps was operational during our visit.
- The flow of these pumps is given as 4 liters per second. Typically, the Return Sludge rate should be a minimum of 1 to 1.5 times the maximum inflow to the plant. It is unsure whether the given flow of 4 liters per second is for one pump, or for both pumps when operating simultaneously.



*Figure 7: RAS Pump Station 1*



*Figure 8: Clanwilliam WWTP New Reactor*

### 2.1.5 Reactor 2:

- Oxidation ditch – a long continuous channel, oval in shape with four surface rotors placed across the channel.
- Equipped with 4 number 22kW Horizontal Brush Aerators powered by electrical motors through a reduction gearbox.
- Adjustable Outlet Weir used to adjust the depth of immersion of the aerators, and to regulate the flow to the clarifiers.
- Estimated process volume = 15m x 75m x 1.20m = 1 350m$^3$.
- Almost no visible sludge in the process, contents of the reactor is essentially just water.

### 2.1.6 Clarifier 2:

- Suction Lift type flat-bottom Clarifier with diameter of 12.5m
- Fitted with rotating half-bridge and annular sludge collection hopper fed by a siphon arrangement
- The rotating bridge is driven by a geared motor driving a wheel which runs on the outer concrete wall of the clarifier.
- The sludge removed from the clarifier is directed to the adjacent Return Activated Sludge Pump Station, from where it is recycled back to the New Reactor.
- This clarifier appears to be fully functional and operational.
- The supernatant was not clear, with evidence of sludge on the surface, indicating a problem with the sludge settleability.
- Also, the color of the sludge was a yellowish-brown color instead of a rich, dark brown color as is normal with activated sludge.



*Figure 9: 12.5m diameter Clarifier*

### 2.1.7 Return Activated Sludge Pump Station 2:

- Consists of a concrete sump fitted with 2 x Submersible Pumps to recycle the Clarifier underflow back to the new Reactor to maintain the active sludge population.
- The flow of these pumps is given as 9 liters per second. Typically, the Return Sludge rate should be a minimum of 1 to 1.5 times the maximum inflow to the plant. It is unsure whether the given flow of 9 liters per second is for one pump, or for both pumps when operating simultaneously.
- When switched on, the RAS pumps where essentially pumping water, with almost no evidence of sludge emanating from Clarifier 2 underflow.

### 2.1.8 Waste Activated Sludge:

- As the sludge concentration in the reactors increase, sludge needs to be wasted to maintain the sludge at optimum concentration in each reactor.
- The sludge concentration should be measured daily in each reactor using the half hour settling test to determine the sludge concentration. Typically, the sludge concentration should be maintained at a reading of 450 to 600 ml/liter. If the reading is higher, sludge should be wasted.
- Sludge is wasted by withdrawing sludge from the either the clarifiers or the reactors and discharging it to the Sludge Lagoons for drying.



*Figure 10: Sludge Lagoons*

### 2.1.9 Chlorine Dosing Facility

- Chlorine is dosed by means of a gas chlorination system. The plant is fitted with a single 68kg Chlorine cylinder equipped with a gas regulator.
- Motive water is provided by means of a small pump, which pumps clean water through a venturi, which essentially sucks chlorine gas into the water, creating a chlorine solution, which is then dosed into the treated effluent stream upstream of the Maturation River.
- Chlorine is also added by means of a chip doser, whereby Calcium Hypochlorite chips are dissolved with water, and the resulting solution is dosed into the final effluent, as back-up system when the chlorine gas runs out.
- The latter is not an ideal setup, as it is very difficult to control the dosing rate to effective levels.

### 2.1.10 Maturation Pond/River:

- The Treated Effluent is discharged to a large maturation pond with approximate dimensions of 15m x 75m x 1.0m deep. This provides 1125m$^3$ of storage space with approximately 10 to 12 hours hydraulic retention.
- The Maturation Pond is divided into channels with internal division walls creating a plug flow through the pond, and serves as chlorine contact tank, as well as increasing retention with the aim of increasing bacterial die-off in the Final Effluent.

- The pond is fitted with vibercrete dividing walls, which are supposed to direct water to flow slowly back and forth before exiting the pond. There are however several broken panels, which leads to short circuiting and defies the purpose of the original design.
- The Final Effluent is discharged from the Maturation Pond over a weir, which regulates the depth of the water in the pond, into a gravity pipeline which discharges the final effluent into the Jan Dissels River approximately 350m southeast of the plant.



*Figure 11: Clanwilliam WWTP Chlorine Dosing Facility*

### 2.1.11 Final Disposal:

- As far as we could ascertain, a large portion of the Treated Effluent is used to irrigate the adjacent golf course, and the remaining water is discharged into the Jan Dissels River which is located 350m from the Clanwilliam WWTP.

### 2.1.12 General Condition of Infrastructure:

- The housekeeping at the Clanwilliam Plant is generally good. The plant is clean and relatively tidy.
- The Inlet Works is clean and tidy and appears to be fairly well operated.
- The flow measurement system is partially functional, as only the Plant Outlet Flowmeter appears to be functional. The Inlet Works Flowmeter is not functional. The Process Controllers do record readings once every 24 hours, albeit manually on paper.
- 50% of the aerators were in a state of disrepair, and not functioning.
- The level control sluice at Reactor 1 was not adjustable, as one of the spindles had broken off. This means that the aerators' depth of immersion could not be adjusted, affecting oxygen transfer.
- The consistency of the activated sludge appeared very thin, indicating that the recycle rate may be too slow. Sludge should typically have the consistency of wet paint, while the sludge at Clanwilliam was very watery or thin. In addition, the color of the activated sludge indicated that something was amiss, being a yellowish-brown color instead of a rich chocolate brown color as healthy sludge should be.

- Only one of the Return Activated Sludge screw pumps was operational during our visit.
- The clarifiers were fairly well kept, with overflow weirs and launders relatively clean.
- The Chlorine Dosing system, although being operational, left much to be desired. Especially the electrical switchgear inside the chlorine room is in a very poor state.
- The electrical switchgear located in the main building on site, appeared to be quite well kept and is clean, neat and according to the Process Controller, still fully functional.
- In general, the plant appears to be functional, with some repairs needed here and there.



*Figure 12: Clanwilliam WWTP Electrical Switchgear*



*Figure 12: Maturation Pond / River*

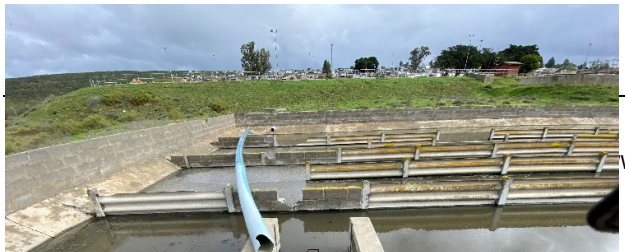



*Figure 13: Maturation Pond outlet showing poor quality of the Final effluent being discharged*

## 3.2. Bulk Pipelines and Pump systems

The town of Clanwilliam is almost fully reticulated with waterborne sewers. Due to the topography, there are two wastewater pump stations located at low points, where the sewage from the older part of town collects, and is then pumped to the WWTP through a rising main.

This infrastructure is still in a fair to good condition and fully functional at this point in time.

The exception to the above, is the southern area directly adjacent to the WWTP. This area is not reticulated, and currently served by blocks of communal toilets, which are connected to the WWTP, and the sewage flows by gravity, being located higher than the WWTP. There is currently a housing project being planned for the area directly west and directly north of the existing WWTP, where a further 1 158 homes are to be constructed, complete with wastewater reticulation.

## 3.3. Legal

*The existing Clanwilliam WWTP does **NOT** have a valid Water Use License. A Water Use Licence Application (WULA) process needs to be embarked upon as soon as possible to legalize the Clanwilliam WWTP.*

*It is envisaged that an application in terms of:*

***Section 21(e) -*** ***Engaging in a controlled activity**, such as irrigation of any land with waste, or water containing waste generated through any industrial activity or by a sewerage treatment works;*

***Section 21(f) -*** ***Discharging waste or water containing waste into a water resource** through a pipe, canal, sewer or other conduit;*

***Section 21(g) -*** ***Disposing of waste in a manner which may detrimentally impact on a water resource***

*be applied for as soon as possible to ensure compliance with the National Water Act.*

# 4. EIA, SURVEY, GEOHYDROLOGICAL AND GEOTECHNICAL INVESTIGATIONS

- EIA investigation will be not be required for this project, as the proposed extensions will be conducted on the same site as the existing works.
- A topographical survey of the existing wastewater treatment plant site is already available and can be used for design purposes.
- Geotechnical investigations will be conducted just prior to the design phase and will be included in the cost estimate.
- There is more than sufficient land available on the existing site, being part of the municipal commonage.

# 5. MAPS AND LAYOUT DRAWINGS

The Google image of the Clanwilliam Wastewater Treatment Plant is found below as well as a detailed layout plan of the existing works.



*Figure 14: Aerial photograph of the Clanwilliam Wastewater Treatment Plant*



*Figure 15: Layout drawing of existing Clanwilliam Wastewater Treatment Plant*

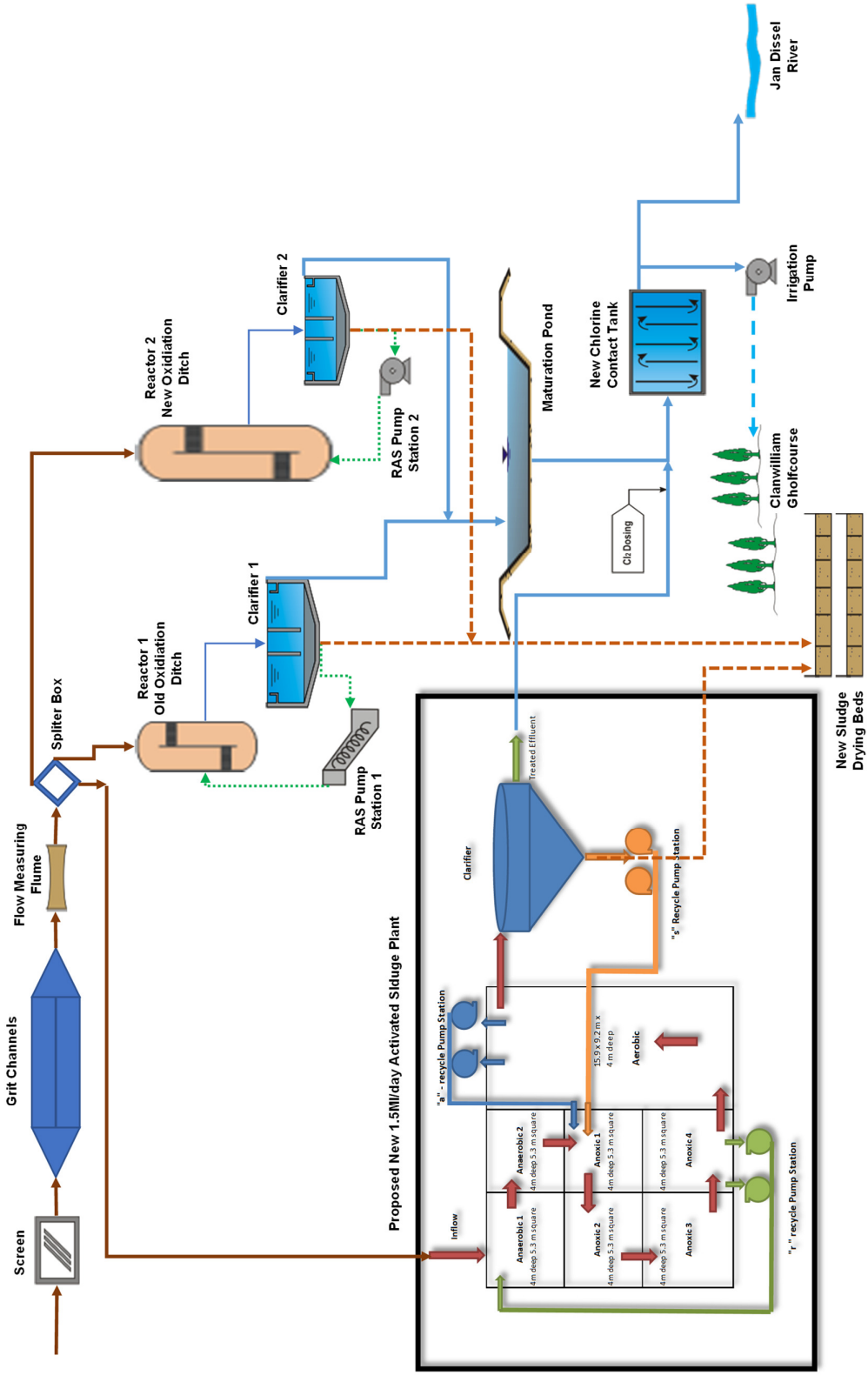


*Figure 16: Schematic Layout of Existing and proposed new works*

# 6. SCOPE OF WORK

## 6.1. Inlet Works

- The existing inlet channel has a calculated hydraulic capacity of 3 980m$^3$/day.
- Subsequently, only minor works will be required, such as the modification of the division box downstream of the measuring flume, where provision must be made to split the flow into three streams, as opposed to the current two streams.
- Replacement of the open channel flowmeter complete with a dedicated datalogger to record incoming flows.
- Clean up building, repaint and repair roof leaks.
- Provide facilities for Lime Dosing to correct the pH of the incoming water.
- Provide an inline pH meter to facilitate automatic lime dosing and pH correction, to maintain a pH of 7.5 to 7.8.

## 6.2. Refurbishment of the existing Aeration Tank mechanical equipment

- The existing horizontal brush aerators to be removed and replaced with submersible jet aerators.
- Reactor 1 will require two no jet aerators of 15kW each complete with mounting equipment and Variable Speed Drive switchgear.
- Installation of an online Dissolved Oxygen probe, which will be used to regulate the rotational speed of the jet aerator motors to maintain a DO concentration of 2mg/l.
- Replace the existing outlet weir at Reactor 1 with a new Gr 316 Stainless Steel downward opening Weir Gate complete with gearbox and manual adjustment by handwheel.
- Reactor 2 will require 4 x 22kW jet aerators each complete with mounting equipment and Variable Speed Drive switchgear.
- Installation of an online Dissolved Oxygen probe, which will be used to regulate the rotational speed of the jet aerator motors to maintain a DO concentration of 2mg/l.
- Replace the existing outlet weir at Reactor 2 with a new Gr 316 Stainless Steel downward opening Weir Gate complete with gearbox and manual adjustment by handwheel.

## 6.3. Refurbishment of the existing Clarifier mechanical equipment

- Empty Clarifier 1 and clean out all debris and sludge.
- Inspection of sludge scraper rubbers and hoods, repair, and reinstall as before.
- Strip out and clean central inlet chamber and annular sludge collection hopper, sandblast, paint with Copon or similar and reinstall as before.
- Strip out and clean the suction lift piping, sandblast, paint with Copon or similar, and reinstall as before.
- Supply and installation of new aluminum sludge flow plugs x 3 complete with handles and locating pins.
- Inspection of rotating half bridge geared motor drive, check alignment of drive wheels, clean, service and reinstall.

- Recommissioning of Clarifier 1 to active service.
- Empty Clarifier 2 and clean out all debris and sludge.
- Inspection of sludge scraper rubbers and hoods, repair, and reinstall as before.
- Strip out and clean central inlet chamber and annular sludge collection hopper, sandblast, paint with Copon or similar and reinstall as before.
- Strip out and clean the suction lift piping, sandblast, paint with Copon or similar, and reinstall as before.
- Supply and installation of new aluminum sludge flow plugs x 3 complete with handles and locating pins.
- Inspection of rotating half bridge geared motor drive, check alignment of drive wheels, clean, service and reinstall.
- Recommissioning of Clarifier 2 to active service.

### *6.4. Return Activated Sludge Pump Stations*

- Strip out Archimedes Screw Pump No 1, inspect for corrosion, welding up of worn flights, replace lower bearings with “sealed for life” Eco Bearing.
- Strip out drive-end coupling, clean, inspect and reinstall.
- Strip out drive gearbox and electrical motor, clean, inspect, replace oil and leaking seals and reinstall.
- Recommission Screw Pump No.1
- Strip out Archimedes Screw Pump No 2, inspect for corrosion, welding up of worn flights, replace lower bearings with “sealed for life” Eco Bearing.
- Strip out drive-end coupling, clean, inspect and reinstall.
- Strip out drive gearbox and electrical motor, clean, inspect, replace oil and leaking seals and reinstall.
- Recommission Screw Pump No.2
- Service Sluice Gates and Headstocks at RAS Pump Station 1 inlet.
- Remove Submersible RAS Pump No.1 at Clarifier 2, clean, inspect, change oil and reinstall.
- Remove Submersible RAS Pump No.2 at Clarifier 2, clean, inspect, change oil and reinstall.

### *6.5. Construction of Temporary Works to provide 500m$^3$/day short-term increase in capacity*

- *Convert one of the existing Sludge Lagoons into a Night Storage Pond by trimming the existing earthworks, and fitting the pond with a 0.5mm thick HDPE lining.*
- *This could provide a temporary storage volume of approximately 1500m$^3$, or the equivalent of 16 hours of peak flow storage.*
- *Construct a temporary overflow weir at the Inlet Works to divert the excess peak flow to the proposed Night Storage Pond through a 250mm dia gravity pipeline approximately 75m in length.*

- *Install a temporary hand-operated submersible pump, complete with switchgear, in the Night Storage Pond with a duty point of 45 l/s at a total head of 10m, to return the stored sewage to the Inlet Works during off-peak periods.*
- *Flow to be pumped to the Inlet Works through a temporary 160mm dia Rising Main 75m in length.*
- *This measure will allow the treatment of flow in excess of the current plant capacity to be treated during periods of off-peak flow at night, when the normal flows drop to below the total available treatment capacity of the plant.*
- *Although not actually creating additional capacity, this measure will fully utilize the available treatment capacity of the plant, and provide some time in the short-term to effectively deal with excess flows. A minimum of 500m3 could be dealt with in the short-term in this fashion without creating new infrastructure immediately.*

### *6.6. Construction of a New 1.5 Ml/day Activated Sludge Reactor*

- The proposed new Reactor 3 will be a single, reinforced concrete tank structure with a water depth of 4m, and a total depth of 5m, comprising the following units:
  - Aerobic Tank with an area of 56.25m$^2$.
  - Anoxic Tank with an area of 100m$^2$.
  - Aerobic Aeration Tank with an area of 146m$^2$.
  - Construction of walkways and mounting platforms for mixers and aerators.
  - Construction of a cantilevered RAS Canal between the Aeration basin and the Anoxic Basin.
  - Each Zone or Basin to be separated from the other by means of a concrete weir, with each consecutive weir being 100mm lower than the previous weir. This arrangement will prevent mixing or backflow between the contents of the various basins and ensure process integrity.
- Construction of the “S-Recycle” pump station, typically 2 or 3 Archimedean screw pumps, to circulate the settled sludge from the Clarifier underflow back to the Anoxic Zone inlet.
- Construction of the “A-Recycle” pump station, comprising two Gorman-Rupp self-priming centrifugal pumps, which recycles nitrified sludge from the Aerobic Aeration Tank back to the Anoxic Tank.
- Construction of the “R-Recycle” pump station, comprising two Gorman-Rupp self-priming centrifugal pumps, which recycles denitrified sludge from the outlet of the Anoxic Basin back to the inlet of the Anaerobic Basin.
- Connector piping between the Clarifier and Reactor No.3, and connector piping between the various pump stations and Reactor No.3.
- Bulk Earthworks to backfill the area around Reactor No.3 to bring the ground level to approximately the same level at Reactor No.2.
- The installation of 6 x 5kW slow-speed mixers to keep the sludge in suspension in the Anaerobic and the Anoxic Zones. These items to be mounted on the provided concrete platforms above each basin.
- The installation of 3 x 15kW Surface Aerators, each comprising a Hansen P4 reduction gearbox mated to a shaft and impellor suitable for introducing oxygen into the sludge. The Aerators to be mounted on galvanized mild steel baseplates,

which will be fixed to the concrete platforms by means of jacking bolts to allow accurate levelling.

- A Dissolved Oxygen Probe to be fitted at the Aerobic Aeration Basin outlet to monitor the oxygen levels, and control the rotational speed of the aerators to allow automatic control of the DO level at 2mg/l.
- The outlet of the Aeration Basin to be fitted with a Gr316 Stainless Steel Tilting Weir complete with reduction gearbox and electrical actuator.
- A new Switchgear Room will be constructed from brick masonry to house the Motor Control Centre panels, instrumentation and control equipment for the various mechanical items.

### *6.7. Construct a new 18m diameter Flat Bottom Clarifier to separate the biomass from the water*

- It is proposed that a new circular clarifier, with a side depth of 4m and a diameter of 18m be constructed from reinforced concrete.
- The structure comprises a circular concrete tank with a concrete radial overflow weir and a launder constructed on the perimeter of the tank in which the overflowing supernatant will be collected.
- The clarifier will be equipped with a Copon coated mild steel central inlet pipe, which is to be constructed before construction of the concrete tank floor commences.
- A Copon coated mild steel Sludge Outlet pipe will be similarly constructed, but will be offset from the center of the tank to accommodate sludge from the central sludge hopper.
- The Clarifier is to be fitted with a rotating half bridge, of which the pivot point will be the central inlet pipe. The bridge to be driven by a geared motor, powering a wheel running on the outside wall of the clarifier launder.
- The rotating half bridge is to be fitted with a hydrostatic suction lift sludge removal system. This system comprises a series of vertical suction pipes with their inlets just above the floor of the clarifier. Each pipe inlet to be fitted with a scraper and hood to facilitate sludge collection. Each of the lift pipes are connected to a sludge collection box fitted to the bridge structure. With the surface of the water in the clarifier being higher than the surface of the water in the sludge box. This difference in pressure head forces sludge from the bottom of the clarifier to flow through pipes to the sludge box.
- At the center of the clarifier, a GRP Sludge Hopper will be fitted around the Inlet Pipe. A siphon pipe arrangement is then used to transfer the sludge from the bridge-mounted sludge box to the central collection hopper. This arrangement allows the bridge to rotate freely around the central sludge hopper, whilst continuously transferring sludge collected from the floor of the clarifier. The sludge collected in the hopper, then flows out of the clarifier through the Sludge Outlet Pipe below the clarifier floor.
- The removed sludge is then directed to the “S-Recycle” , or Return Activated Sludge Pump Station sump, from where it is returned to the Reactor inlet.

### 6.8. Upgrade the Disinfection dosing system

- The most effective means of disinfection for large quantities of wastewater remains chlorine gas. The problem with chlorine gas is that it is dangerous to handle and one requires special facilities for the storage of both full and empty gas cylinders. Although the Clanwilliam WWTP is currently equipped with a Chlorine Gas dosing system, it is in very poor condition.
- Subsequently, it is advised that the existing system be totally replaced with a new Chlorine Gas dosing system, or as alternative, a new Calcium Hypochlorite dosing facility.
- Typically for a Calcium Hypochlorite dosing installation one would require a bulk make-up tank of say 3 000 liters in which a 20% concentration of water and Calcium Hypochlorite are made up in. The solution is mixed aggressively by means of a wall mounted mixer, and then allowed to settle. The clear settled solution is then dosed with a conventional dosing pump system just prior to entering the chlorine contact tank.
- The Dosing of Calcium Hypochlorite serves to kill off any bacteria and pathogens rendering the Treated Effluent disinfected and safe for disposal.

### 6.9. Chlorine Contact Tank

- Currently, the Clanwilliam WWTP does not have a Chlorine Contact Tank. Chlorine is dosed prior to the existing Maturation Pond, the latter being equipped with vibercrete baffles, which are severely damaged, causing short circuiting of the flow.
- It is therefore suggested that a new Chlorine Contact Tank be constructed directly downstream of the existing Maturation Pond in order to disinfect the Final Effluent prior to discharge into the Jan Dissels River.
- The goal of water disinfection is to remove or inactivate pathogenic micro-organisms. Disinfection is not synonymous with the sterilization of water, in which all organisms are killed. In disinfection, the primary pathogenic micro-organisms targeted for inactivation include bacteria, viruses and protozoan cysts.
- Chlorination may be carried out by direct use of gaseous chlorine obtained from cylinders via purpose designed chlorinators, or by dosage of hypochlorite solution which contains chlorine. Normally the dosage equipment would be sized for a maximum dosage of about 10 mg/l with normal dosage levels being about 3 to 5 mg/l.
- Chlorine disinfection is not instantaneous and can take tens of minutes or even several hours, depending on various factors such as pH and ammonia concentration. When ammonia is present, chlorine reacts to form chloramines, which are slow disinfectants and can take up to 24 hours to react to completion. It is therefore, normal when disinfecting with chlorine to provide contact tanks for the disinfection reactions to take place. The contact time criteria range from 20 minutes' contact at peak flow up to 24 hours' storage.
- Chlorine contact tanks are sized with the following considerations in mind:
  - Design E. Coli concentration
  - Required effluent standard to be achieved by the Final Effluent
  - Chlorine demand of the final effluent

- Required chlorine residual in the Final Effluent
- Optimum chlorine contact time

- From the calculations, the optimum tank will have a contact time in the order of 120 minutes to 140 minutes in order to meet the legal requirements and get sufficient disinfection. This translates to a tank size with an area of approximately 40 m2 and a tank depth of 4m.
- Chlorine Contact Tanks are typically constructed from reinforced concrete in a configuration that ensures plug flow through the structure. It is typically equipped with over-and-under baffles to ensure effective mixing of the chlorinated water.

## *6.10. Improve sludge management*

- The Clanwilliam WWTP is currently equipped with two Sludge Lagoons. Sludge Lagoons typically comprise a shallow reservoir with a “sealed base” to prevent ingress of the sludge water into groundwater, aquifers or other environmental water bodies.
  The lagoon is then filled with sludge, and the solids allowed to settle. Over the drying/dewatering operational cycle, which is in the region of several months, water is lost through evaporation while the solids form a thick layer at the base of the lagoon, stabilized by anaerobic biological processes.
- Usually, a supernatant water layer of more than 0.5 m is maintained over the digesting sludge layer. This layer allows the oxidation of odorous compounds generated by, and released from, the sludge layer during anaerobic digestion. Once the dewatered sludge reaches the desired solids concentration of 25–30% DS, the dried sludge is removed.
- A typical operational cycle of a sludge-drying lagoon is usually more than one year depending on the local climate.
- The Clanwilliam Sludge Lagoons are not sealed, and basically just earthen basins. If Sludge Lagoons do not have concrete linings, the removal of sludge is always problematic, as it cannot be done mechanically. In addition to the above, there is a risk of groundwater pollution due to seepage.
- The alternatives for Sludge Lagoons, are either Sludge Drying Beds, or mechanical dewatering by means of a belt press or a centrifuge. The latter options requiring a high level of operational input, and a high degree of mechanical and electrical maintenance, which is not available.
- Subsequently, it is suggested that the existing Sludge Lagoons be replaced with a series of Drying Beds with dimensions of 5.50m wide x 25.0m in length.
- The concrete floor of each drying bed is fitted with a slotted drainage pipe which has been covered with a filter media. The filter media comprises a layer of 19mm crushed stone, overlain with a 150mm thick layer of course sand.
- The inlet of each drying bed is fitted with either a valve or an aluminium hand-stop which allows sludge to be diverted into the drying bed. The incoming stream of sludge lands on a concrete splash plate, to prevent erosion of the filter material by the incoming stream of liquid sludge.

- The outlet-end of each drying bed is fitted with a decanting device. It consists of a series of aluminium angles with a height of 50mm each. They are fitted into a recessed guide in the wall to a maximum height of 650mm above the drying bed media level.
- The 50mm angles are then removed sequentially as the water and sludge settle and separate, allowing the water to be decanted off the top.
- Simultaneously, water passes through the filter media and drains out of the under drain. After a few hours, only the solid fraction remains settled on the drying bed media. The solid fraction then dries out by means of evaporation to form a layer of stable, dried sludge cakes.
- Drying time of the sludge varies considerably with seasonal changes and weather. In summer it is seldom longer than 10 days and during winter, or periods of excess rainfall, it may take up to 20 days to reach a moisture content suitable for removal.
- Once dry, sludge is removed by hand, using rakes and long-tined ballast forks. The sludge is lifted and carried to the open side of the drying bed where it is discharged in a windrow for collection and loading with a front-end loader.
- The dried sludge is then stockpiled at a designated and fenced off site at the plant for sales or disposal at a solid waste disposal site.
- If each drying bed is filled to a depth of 650mm, it equates to a volume of 90 $m^3$ of wet sludge which can be discharged into each drying bed.
- It is proposed that the Clanwilliam WWTP be fitted with 20 number Sludge Drying beds, each with dimensions of 5.50m x 25.0m x 0.65m deep.

## *6.11. Cost Recovery Plan*

For this project, it is envisaged that the refurbishment and upgrade of the Clanwilliam Wastewater Treatment Plant will be fully funded from a grant.

This project will however have an enormously positive impact on the quality of the Treated Effluent produced, which should lead to a far lower impact on the Jan Dissels River's ecology, and in addition provide significant future treatment capacity for Clanwilliam.

Wastewater treatment is typically not a service on which municipalities make significant profits, as it is meant to be a zero-based service for which only the cost is to be recovered from residents.

Each municipality, does however have both legal, and environmental obligations, which must be complied with. This project therefore serves to achieve this compliance, although cost recovery will probably take a decade or more to recover.

## *6.12. Design Norms and Standards*

Design standards to employed for this contract include:

- SABS 0100 : Design of Reinforced Concrete Structures
- Standard Specifications for Civil Engineering Construction: SABS 1200 series
- Guidelines for Human Settlement Planning and Design: CSIR 2000
- General Conditions of Contract for use in connection with Works of Civil Engineering Construction: SAICE 201
- National Building Regulations: Act 29 of 1996
- National Water Act(Act No.36 of 1998), and related Regulations
- Occupational Health and Safety Act 1993, and Regulations
- Specifications which are project specific

The Clanwilliam Wastewater Treatment Plant must be capable of treating the incoming wastewater to such a degree, that the Final Effluent complies with the Special Limit Values as determined by the Department of Water and Sanitation.

For the design of activated sludge wastewater treatment plants, the South African guidelines, published by the Water Research Commission under ***Report No TT16 / 84 "Theory, design and operation of Nutrient Removal Activated Sludge Processes"*** *by Messrs.' GA Ekama, GVR Marais, IP Siebritz, AR Pitman, GFP Keay, L Buchanan, A Gerber and M Smollen* is generally used as source document.

The research done by especially GA Ekama and GVR Marais over a period of 35 years on wastewater process design in South Africa, is internationally recognized as accepted method used for the process design of such treatment plants.

The existing Clanwilliam Wastewater Treatment Plant has a rated design capacity of 2.10 Megalitre/day according to the available data from the municipality.

Their current request is to upgrade this plants' capacity to at least 3.5 Megalitre per day, which will be sufficient to accommodate the proposed new Subeconomic Housing Project of 1 158 new homes, as well as provide some future capacity for a period of at least 15 to 20 years into the future.

# 7. DEVELOPMENTAL ASPECTS

## 7.1. Project Management

The project team to be as follows:

| | |
|---|---|
| Implementation Agent: | Cederberg Municipality |
| Project Management: | UDS Consulting Engineers |
| Engineering Design: | BVi Consulting Engineers |
| Client Representative: | Director: Infrastructure Services |

## 7.2. Community Participation and Empowerment

All labour for the construction of the works will be sourced locally. Accredited training will be provided for Carpentry, Brick laying and pipe fitting during the contract. At least 30 to 40 persons will be employed for the duration of the contract.

## 7.3. Training and Capacity Building

Training and Capacity Building will be addressed by providing accredited training in several trades during the contract.

## 7.4. Labour Intensive Methods

With the exception of the bulk earthworks and the specialist disciplines of mechanical installations and electrical switchgear and instrumentation, the nature of this contract is labour intensive.

Large numbers of skilled, and semi-skilled people, will be employed for especially the civil works, where shutters for reinforced concrete structures, brick masonry and the laying of pipes are involved. Due to their nature, these activities are labour intensive.

## 7.5. Employment Policy

All labour for this contract in the semi-skilled and unskilled categories will be sourced locally from Clanwilliam in cooperation with the local Ward Councillors and the Community Liaison Officer.

## 7.6. Wages and Labour standards

Normal rates as determined by the Bargaining Council for the Civil Engineering Industry for the Western Cape province will be applicable. Semi-skilled labour to be paid in accordance with the applicable Task Grade rates.

## 7.7. Consultants and other Service Providers

To be appointed as and when required.

## 7.8. Tender Procedure

The tender procedure will be followed as laid out by Cederberg Local Municipality Supply Chain policy, based on the standard CIDB documentation format.

# 8. COST ESTIMATE

## *8.1. Project Costing*

Since the refurbishment of the wastewater treatment works has already been financed by the Municipal Infrastructure Grant, and the repairs are being implemented, the table below will address the funding required for the upgrading of the wastewater treatment works only. It should be noted that the figures below are estimates of a similar project completed during the inception of this report. Allowance for escalation of the rates have been included, but **final funding requirements will be determined by a formal tender process.**

| Item | Description | Unit | Qty | Rate | Cost | Total |
|---|---|---|---|---|---|---|
| **1** | **Preliminary & General Charges** | | | | | |
| | P&Gs | Sum | 1 | R 5 552 803.96 | R 5 552 803.96 | **R 5 552 803.96** |
| **5** | **Construction of 1.5 Ml/day Activated Sludge Plant** | | | | | R 26 852 779.59 |
| 5.1 | Earthworks (Create platforms, backfilling, trenches) | $m^3$ | 6470 | R 95.00 | R 614 650.00 | |
| 5.2 | Modifications to inlet works | Sum | 1 | R 278 585.00 | R 278 585.00 | |
| **5.3** | **Biological Reactor** | | | | | |
| | Civil Works | Sum | 1 | R 9 086 265.00 | R 9 086 265.00 | |
| | Mechanical Works | Sum | 1 | R 4 164 452.15 | R 4 164 452.15 | |
| | Electrical Works | Sum | 1 | R 1 531 688.71 | R 1 531 688.71 | |
| **5.4** | **Clarifier** | | | | | |
| | Civil Works | Sum | 1 | R 4 552 696.43 | R 4 552 696.43 | |
| | Mechanical Works | Sum | 1 | R 1 403 489.65 | R 1 403 489.65 | |
| | Electrical Works | Sum | 1 | R 405 843.98 | R 405 843.98 | |
| **5.5** | **Chlorine Contact Tank** | | | | | |
| | Civil Works | Sum | 1 | R 846 540.38 | R 846 540.38 | |
| | Mechanical Works | Sum | 1 | R 387 419.34 | R 387 419.34 | |
| | Electrical Works | Sum | 1 | R 220 583.95 | R 220 583.95 | |
| **5.6** | **Connector Piping** | | | | | |
| | From inlet works splitter to Reactor 3 inlet | m | 170 | R 1 550.00 | R 263 500.00 | |
| | From Reactor 3 outlet to clarifier | m | 25 | R 1 750.00 | R 43 750.00 | |
| | From Reactor 3 to sludge drying beds | m | 125 | R 1 450.00 | R 181 250.00 | |
| | From Recycle pump stations to reactor 3 inlet | m | 75 | R 2 500.00 | R 187 500.00 | |
| **5.7** | **Sludge Drying Beds x 20** | | | | | |
| | Civil Works | Sum | 1 | R 2 323 875.00 | R 2 323 875.00 | |
| | Mechanical Works | Sum | 1 | R 48 190.00 | R 48 190.00 | |
| **5.8** | **Electrical Switchgear room for reactor 3** | Sum | 1 | R 312 500.00 | R 312 500.00 | |
| **6** | **Bulk Earthworks & Fencing** | Sum | 1 | R 6 289 522.00 | R 6 289 522.00 | R 6 289 522.00 |
| **7** | **Miscellaneous Items** | | | | | R 425 626.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7.1 | Handheld DO Meter | No | 1 | R | 27 436.00 | R | 27 436.00 | |
| 7.2 | Handheld pH Meter | No | 1 | R | 15 600.00 | R | 15 600.00 | |
| 7.3 | Handheld Conductivity Meter | No | 1 | R | 14 850.00 | R | 14 850.00 | |
| 7.4 | Handheld Free Ammonia Meter | No | 1 | R | 15 450.00 | R | 15 450.00 | |
| 7.5 | Handheld Free Chlorine Meter | No | 1 | R | 16 810.00 | R | 16 810.00 | |
| 7.6 | Imhoff Cones | No | 6 | R | 1 600.00 | R | 9 600.00 | |
| 7.7 | 1000ml Measuring Cylinders | No | 6 | R | 655.00 | R | 3 930.00 | |
| 7.8 | Water distiller and storage drums | No | 1 | R | 21 950.00 | R | 21 950.00 | |
| 7.9 | Tractor with FEL + trailer combination for transport of sludge | No | 1 | R | 300 000.00 | R | 300 000.00 | |
| **8** | **Legal Requirements** | | | | | | | R 250 000.00 |
| **9** | **Training** | | | | | | | R 60 000.00 |
| | Sub-Total | | | | | | | R 39 430 731.55 |
| | Add 10% Contingencies | | | | | | | R 3 943 073.16 |
| | Sub-Total | | | | | | | R 43 373 804.71 |
| | Add 8% CPA per year over 4 years | | | | | | | R 15 635 777.75 |
| | **Sub-Total: Direct Costs** | | | | | | | **R 59 009 582.46** |
| | Professional Fee (ECSA 2021 Including 10% Discount) | | | | | | | R 6 770 463.40 |
| | Supervision & Travelling | | | | | | | R 2 499 840.00 |
| | Health and Safety/ECO | | | | | | | R 246 600.00 |
| | Disbursements | | | | | | | R 70 000.00 |
| | **Sub-Total: In-Direct Costs** | | | | | | | **R 9 586 903.40** |
| | PROJECT SUB-TOTAL | | | | | | | R 68 596 485.86 |
| | ADD 15% VAT | | | | | | | R 10 289 472.88 |
| | **ESTIMATED TOTAL PROJECT COST** | | | | | | | **R 78 885 958.74** |

Of the R 78 885 958.74, the Services Infrastructure Grant has already committed to funding R 54 950 000.00. A cashflow in Section 8.2 details the planned implementation of funding for the upgrading of the wastewater treatment works.

## 8.2. Project Cashflow

Below a projected cashflow with actual expenditure to date included.

| | Upgrading of Clanwilliam WWTW | | |
|---|---|---|---|
| | INCLUSIVE OF VAT, CONTINGENCIES & RETENTION | | |
| | Direct | In-Direct | Total |
| **Jul-23** | R - | R - | R - |
| **Aug-23** | R - | R 811 005.15 | R 811 005.15 |
| **Sep-23** | R - | R - | R - |
| **Oct-23** | R - | R 579 232.49 | R 579 232.49 |
| **Nov-23** | R - | R - | R - |
| **Dec-23** | R - | R - | R - |
| **Jan-24** | R - | R - | R - |
| **Feb-24** | R - | R - | R - |
| **Mar-24** | R 347 305.76 | R - | R 347 305.76 |
| **Apr-24** | R 560 753.69 | R - | R 560 753.69 |
| **May-24** | R 595 966.06 | R - | R 595 966.06 |
| **Jun-24** | R 1 279 151.61 | R 326 585.23 | R 1 605 736.84 |
| **2023/2024 FY Expenditure** | R 2 783 177.12 | R 1 716 822.87 | **R 4 499 999.99** |
| **2023/2024 FY Budget** | R 2 783 177.10 | R 1 716 822.90 | R 4 500 000.00 |
| **Jul-24** | R - | R - | R - |
| **Aug-24** | R - | R - | R - |
| **Sep-24** | R - | R 132 463.35 | R 132 463.35 |
| **Oct-24** | R - | R - | R - |
| **Nov-24** | R - | R 500 000.00 | R 500 000.00 |
| **Dec-24** | R - | R - | R - |
| **Jan-25** | R - | R 100 000.00 | R 100 000.00 |
| **Feb-25** | R 1 200 000.00 | R - | R 1 200 000.00 |
| **Mar-25** | R 1 500 000.00 | R 200 000.00 | R 1 700 000.00 |
| **Apr-25** | R 2 000 000.00 | R - | R 2 000 000.00 |
| **May-25** | R 2 500 000.00 | R - | R 2 500 000.00 |
| **Jun-25** | R 1 450 000.00 | R 867 536.65 | R 2 317 536.65 |
| **2024/2025 FY Expenditure** | R 8 650 000.00 | R 1 800 000.00 | **R 10 450 000.00** |
| **2024/2025 FY Budget** | R 8 650 000.00 | R 1 800 000.00 | R 10 450 000.00 |
| **Jul-25** | R 2 000 000.00 | R 500 000.00 | R 2 500 000.00 |
| **Aug-25** | R 3 000 000.00 | R 250 000.00 | R 3 250 000.00 |
| **Sep-25** | R 3 000 000.00 | R 500 000.00 | R 3 500 000.00 |
| **Oct-25** | R 3 000 000.00 | R 500 000.00 | R 3 500 000.00 |
| **Nov-25** | R 3 500 000.00 | R 250 000.00 | R 3 750 000.00 |
| **Dec-25** | R 3 000 000.00 | R 500 000.00 | R 3 500 000.00 |
| **Jan-26** | R 3 500 000.00 | R 250 000.00 | R 3 750 000.00 |
| **Feb-26** | R 3 000 000.00 | R 500 000.00 | R 3 500 000.00 |
| **Mar-26** | R 3 500 000.00 | R 250 000.00 | R 3 750 000.00 |
| **Apr-26** | R 3 000 000.00 | R 500 000.00 | R 3 500 000.00 |
| **May-26** | R 3 000 000.00 | R 250 000.00 | R 3 250 000.00 |
| **Jun-26** | R 3 968 366.78 | R 1 258 116.01 | R 5 226 482.79 |

| | | | |
|---|---|---|---|
| **2025/2026 FY Expenditure** | R 37 468 366.78 | R 5 508 116.01 | **R 42 976 482.79** |
| **2025/2026 FY Budget** | R 37 468 366.78 | R 5 508 116.01 | R 42 976 482.79 |
| **Jul-26** | R 3 000 000.00 | R 250 000.00 | R 3 250 000.00 |
| **Aug-26** | R 2 000 000.00 | R 250 000.00 | R 2 250 000.00 |
| **Sep-26** | R 2 000 000.00 | R - | R 2 000 000.00 |
| **Oct-26** | R 2 000 000.00 | R 250 000.00 | R 2 250 000.00 |
| **Nov-26** | R 2 000 000.00 | R 250 000.00 | R 2 250 000.00 |
| **Dec-26** | R 2 000 000.00 | R - | R 2 000 000.00 |
| **Jan-27** | R 2 000 000.00 | R 250 000.00 | R 2 250 000.00 |
| **Feb-27** | R 1 000 000.00 | R 250 000.00 | R 1 250 000.00 |
| **Mar-27** | R 1 000 000.00 | R 250 000.00 | R 1 250 000.00 |
| **Apr-27** | R 1 000 000.00 | R 250 000.00 | R 1 250 000.00 |
| **May-27** | R 259 475.95 | R - | R 259 475.95 |
| **Jun-27** | R 700 000.00 | R - | R 700 000.00 |
| **2026/2027 FY Expenditure** | R 18 959 475.95 | R 2 000 000.00 | **R 20 959 475.95** |
| **2026/2027 FY Budget** | R 18 959 475.95 | R 2 000 000.00 | R 20 959 475.95 |
| **Total Budget** | R 67 861 019.83 | R 11 024 938.91 | R 78 885 958.74 |
| **Total Expenditure** | **R 67 861 019.85** | **R 11 024 938.88** | **R 78 885 958.73** |
| **WSIG Funding** | **R 67 861 019.83** | **R 11 024 938.91** | **R 78 885 958.74** |
| Round 1 | **R 11 433 177.10** | **R 3 516 822.90** | **R 14 950 000.00** |
| Round 2 | **R 37 468 366.78** | **R 5 508 116.01** | **R 42 976 482.79** |
| Round 3 | **R 18 959 475.95** | **R 2 000 000.00** | **R 20 959 475.95** |

From the above, an additional R 20 959 475.95 is required in the 2026/2027 financial year with confirmation of the availability of the R 42 976 482.79 in the 2025/2026 financial year.

## 8.3. Summary of Total Estimated Cost

The table below will address the funding required for the upgrading of the wastewater treatment works only.

| Item | Description | Total | |
|---|---|---|---|
| 1 | Preliminary & General Charges | R 5 552 803.96 | |
| 5 | Construction of 1.5 Ml/day Activated Sludge Plant | R 26 852 779.59 | |
| 6 | Bulk Earthworks & Fencing | R 6 289 522.00 | |
| 7 | Miscellaneous Items | R 425 626.00 | |
| 8 | Legal Requirements | R 250 000.00 | |
| 9 | Training | R 60 000.00 | |
| | Sub-Total | R 39 430 731.55 | |
| | Add 10% Contingencies | R 3 943 073.16 | |
| | Sub-Total | R 43 373 804.71 | |
| | Add 8% CPA per year over 4 years | R 15 635 777.75 | |
| | **Sub-Total: Direct Costs** | | **R 59 009 582.46** |
| | Professional Fee (ECSA 2021 Including 10% Discount) | R 6 770 463.40 | |
| | Supervision & Travelling | R 2 499 840.00 | |
| | Health and Safety/ECO | R 246 600.00 | |
| | Disbursements | R 70 000.00 | |
| | **Sub-Total: In-Direct Costs** | | **R 9 586 903.40** |
| | PROJECT SUB-TOTAL | | R 68 596 485.86 |
| | ADD 15% VAT | | R 10 289 472.88 |
| | **ESTIMATED TOTAL PROJECT COST** | | **R 78 885 958.74** |

The cost estimates provided above are based on current rates for similar projects older than 4 years. Care must be taken with especially the mechanical equipment, which has a significant imported component, and is very susceptible to exchange rate fluctuations.

The final cost of this project can only be determined once a procurement process has been done, and the market has responded to such a process.

The professional fees are based on the 2021 Guidelines for Professional Fees for Persons registered in terms of the Engineering Professions Act (Act 46 of 2000), as published in Government Gazette No.44333 of 26 March 2021.

It is envisaged that the construction of this project will take in excess of 2 years, it will subsequently include a clause for Contract Price Adjustment over the period of construction.

Of the R 74 132 014.99 project cost, R 14 950 000.00 has been funded by the Water Services Infrastructure Grant. A further R 40 000 000.00 has been committed by the Water Services Infrastructure Grant but needs to be confirmed again. This application is for the outstanding R 19 182 014.99 (Including 15% VAT) required to complete the project.

# 9. CONCLUSION

The existing Clanwilliam Wastewater Treatment Plant is in excess of 30 years old. Due to the substantial increase in the town's population over the past 15 years, wastewater flows have now increased to 94% of the plant's rated design capacity. The current quality and quantity of raw sewage received for treatment has reached the limits of the Clanwilliam WWTP's current capacity of 2.10 Megalitres per day.

The Cederberg Municipality is desirous to construct an additional 1 158 subeconomic houses at Clanwilliam to address a serious housing need of the community. If this project is not executed, the existing WWTP will NOT be able to deal with the additional flow from the proposed housing project. Temporary works can be constructed to improve the utilization of the Clanwilliam WWTP capacity in off-peak periods, thereby freeing up limited capacity for the short-term. It is possible to treat an additional 500m$^3$ per day in this manner over the short-term, but will not be sustainable for the longer term.

In addition to the above, it is always pertinent to provide sufficient spare capacity for future growth of the town over the next 5 to 10 years.

Currently the Clanwilliam WWTP is NOT complying with the legally required Water Quality Objectives, and substandard effluent has been discharged to the Jan Dissels River during the preceding 24 months.

This Technical Report, and accompanying Business Plan, has the aim of addressing the shortcomings in the Clanwilliam WWTP process train, and correcting those processes and providing additional processes to deal with the expected future flows in a sustainable manner.

It is of utmost importance that the Cederberg Municipality commence with a process to legalize the operations as well as the discharge from the Clanwilliam WWTP, as it is currently operated without a Water Use Licence.

The Cederberg Municipality and the community of Clanwilliam wish to thank you in anticipation for your willingness to consider this application and hopefully a positive decision in this regard as result.

The Cederberg Municipality and its consultants have already started with the implementation of the project with the confirmation of the outstanding funding required to finalise the project.



**GH MEIRING Pr TECH Eng**
**obo CEDERBERG LOCAL MUNICIPALITY**

**This business plan is endorsed by the council of the Cederberg Municipality:**

**Name:** **Date**

**MUNICIPAL MANAGER : CEDERBERG LOCAL MUNICIPALITY**

# ANNEXURE A
# PROPOSED LAYOUT OF NEW EXTENSIONS


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