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## **Appendix 10:**

# **Additional Information**

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**Environmental Management Group (Pty) Ltd**

*Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment*

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Water User 

WSP - MAGARENG MUNICIPALITY-WARRENTON

Application 

WU46382 - Warrenton WWTW

Duration: Day 0 of 90  
Current Status Site Inspection Determinations

| # | Date               | Applicant                                          | Department                     | Duration in Days    |
|---|--------------------|----------------------------------------------------|--------------------------------|---------------------|
| 1 | May 22 2026 1:16PM |                                                    | Site Inspection Determinations | 12 Day(s) (Current) |
| 2 | Oct 9 2025 1:42AM  | Applicant: Prepares WUL Application for submission |                                | 148 Day(s)          |
| 3 | Oct 6 2025 1:39AM  |                                                    | Pre Application Enquiry        | 4 Day(s)            |
| 4 | Oct 6 2025 1:17AM  |                                                    | Pre Application Enquiry        | 1 Day(s)            |
| 5 | Sep 25 2025 8:07PM | Applicant: Prepares Pre-application for submission |                                | 8 Day(s)            |



## **Construction Method Statement for The Relocation of the Existing Warrenton Wastewater Treatment Works and Related Bulk Infrastructure**

**Prepared for: Magareng Local Municipality**

**18 May 2026**

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## Document Control

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## BVI APPROVAL

|                  |                                                                                     |                    |                                                                                       |
|------------------|-------------------------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------|
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## Amendment History

| Version | Date       | Issue to:                                | Amendments Section / Chapter / Page |
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| Glossary          |                                           |
|-------------------|-------------------------------------------|
| ADWF              | Average Dry Weather Flow                  |
| m <sup>3</sup> /s | Cubic meters per second                   |
| DWS               | Department of Water and Sanitation        |
| ECO               | Environmental Control Officer             |
| EMPr              | Environmental Management Programme        |
| FBDM              | Frances Baard District Municipality       |
| HDPE              | High-Density Polyethylene                 |
| HDD               | Horizontal Directional Drilling           |
| HRT               | Hydraulic Retention Time                  |
| IRS               | Implementation Readiness Study            |
| MLM               | Magareng Local Municipality               |
| MCC               | Motor Control Centre                      |
| m <sup>3</sup> /d | Cubic meters per day                      |
| NGL               | Natural ground level                      |
| NWA               | National Water Act, 1998 (Act 36 of 1998) |
| O&M               | Operation and Maintenance                 |
| p.a               | Per annum                                 |
| PDWF              | Peak Dry Weather Flow                     |
| PWWF              | Peak Wet Weather Flow                     |
| PPE               | Personal Protective Equipment             |
| PDR               | Preliminary Design Report                 |
| SABS              | South African Bureau of Standards         |
| uPVC              | Unplasticized polyvinylchloride           |
| VOCMA             | Vaal-Orange Catchment Management Agency   |
| WWTW              | Waste Water Treatment Works               |
| WULA              | Water Use Licence Application             |

# 1 INTRODUCTION

## 1.1 Purpose

This Method Statement describes the construction activities and controls relevant to the Water Use License Application (WULA) for the relocation of the existing Warrenton Wastewater Treatment Works (WWTW) and related bulk sewer infrastructure. It focuses on activities that may affect water resources, including earthworks, pond construction, liners and seepage control, pipeline crossings, stormwater management, wastewater containment, commissioning, decommissioning and rehabilitation.

The document is intended to support the WULA to the Department of Water and Sanitation (DWS) by demonstrating that the proposed works can be undertaken within the approved footprint and in a controlled manner that prevents or minimises impacts on water resources, watercourses, groundwater, stormwater pathways and surrounding land users.

## 1.2 Project Description

### 1.2.1 Project Location

Frances Baard District Municipality (FBDM) is one of five district Municipalities that make up the Northern Cape. FBDM is the smallest district in spatial terms of the five; however, it is the province's strongest economic region, accounting for 36% of the provincial gross domestic product (PGDP) and accommodating the largest proportion of the province's population.<sup>1</sup> FBDM comprises four local municipalities (LMs): Sol Plaatje, Dikgatlong, Magareng, and Phokwane. Figure 1 on the next page shows the local municipalities within FBDM.

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<sup>1</sup> FBDM – IDP 2017/18 – 2021/2022

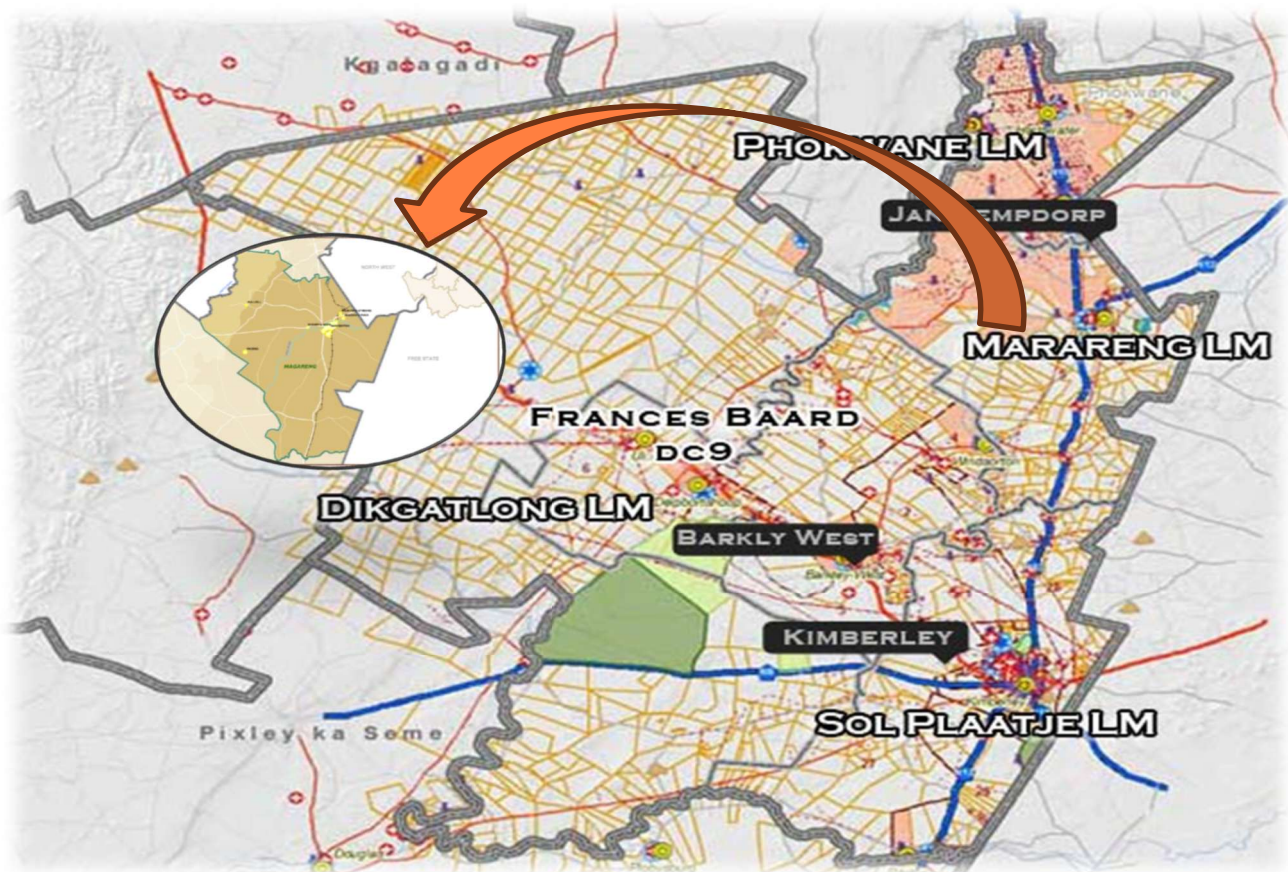


Figure 1: Locality Map Local Municipalities In FBDM

The Magareng Local Municipality is located approximately 75 km north-east of Kimberley and covers an area of approximately 1 541.6 km<sup>2</sup>. The Municipality has the smallest population in the Frances Baard District Municipality in Northern Cape province and is the smallest contributor to the regional GDP. Warrenton, the administrative centre of Magareng Municipality, is situated on the banks of the Vaal River. The N12 national road between Cape Town and Johannesburg forms a strategic T-junction with the N18 route to Mafikeng. The Railway line that connects Gauteng with the Northern and Western Cape Provinces runs through Magareng Municipality with a railway station at Warrenton. The railway line that connects the Northern Cape and Northwest provinces also passes through Warrenton.

The MLM comprises an urban node, villages and farms. The urban node consists of Warrenton, Warrenvale and Ikhutseng, while small agricultural villages have been established throughout the municipal area. The following figure shows the study area extents.





Figure 2: Locality Map the Study Area

### 1.2.2 Project Overview

The project entails the relocation of the existing Warrenton WWTW and the construction of a new WWTW with associated bulk sewer infrastructure. The existing WWTW and associated bulk sewer infrastructure are hydraulically and organically overloaded and do not provide sufficient long-term treatment capacity for Warrenton. The new system is intended to provide improved treatment capacity, reduce pollution risks, support future growth and facilitate the decommissioning of the existing works once the new facility is operational.

The preferred technology is a conventional oxidation pond system with horizontal-flow reed beds as a polishing stage and a downstream storage pond for storing treated final effluent and management of the reuse of the final treated effluent for irrigation purposes.

The proposed WWTW site is located on Portion 7/12 of Doornfonteyn Farm, approximately 3 km west of the Warrenton town centre, within the jurisdiction of Magareng Local Municipality. The site is situated just outside the urban edge and is currently undeveloped, with surrounding land uses including agriculture and a poultry farm. Access to the site is obtained via Erasmus Street.

The proposed bulk infrastructure includes the following:

Based on the Google Earth imagery figure on the next page, the red line represents the proposed new bulk gravity mains required to service the entire study area with waterborne sanitation. These gravity mains are designed to transport sewage to the wastewater treatment works (WWTW) efficiently.

The green line indicates the rising mains needed for the system. The existing Warrenvale rising main will be repurposed and redirected to a new lifting station. From the lifting station, the sewage will be pumped to a high point. Once at the high point, it will flow by gravity towards the WWTW.



Figure 3: Overall proposed bulk infrastructure and the WWTW



### 1.2.3 Applicable Water Uses

Based on the preliminary design information and the WULA context, the following Section 21 water uses are relevant to the construction and operation of the proposed works:

Table 1: Applicable Water Uses

| NWA Section 21 water use | Project relevance                                                                                                                                                                              | Construction method statement response                                                                                                                                                           |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Section 21(e)            | Controlled activity associated with irrigation of treated wastewater.                                                                                                                          | Storage, conveyance, pumping and irrigation infrastructure must be constructed and commissioned to prevent unauthorised discharge, overflow, leakage or irrigation outside approved areas.       |
| Section 21(g)            | Disposal of waste in a manner that may impact a water resource, including treatment ponds, sludge handling, emergency storage and associated infrastructure.                                   | Ponds, wet wells, sludge handling areas, storage infrastructure and wastewater conveyance systems must include seepage control, spill prevention, overflow protection and stormwater separation. |
| Section 21(c) and (i)    | Impeding/diverting flow or altering bed, banks, course or characteristics of a watercourse where sewer infrastructure, crossings or pump stations encroach near watercourses/floodplain areas. | Construction near watercourses or regulated areas must follow approved working limits, sediment controls, flow-maintenance measures, erosion protection and reinstatement requirements.          |



## 2 PRE-CONSTRUCTION REQUIREMENTS

### 2.1 Approvals and Authorisations

Before construction commences, the Contractor shall confirm that all approvals applicable to the relevant work area have been obtained. No construction shall commence in a watercourse, regulated area, floodplain, drainage line, riparian area, servitude, road reserve or sensitive area without the applicable approval, approved drawing and written instruction from the Engineer.

- Relevant environmental authorisations for all activities as identified in Listing Notices 1, 2 and 3 of the EIA regulations (GN R983 of 2014 as amended by GN R517 in 2021).
- Water Use Licence, General Authorisation or written DWS authorisation applicable to the works.
- Approved EMPr and specialist mitigation measures relevant to watercourses, wetlands, groundwater, stormwater, erosion, sedimentation and rehabilitation.

Approved drawings and coordinates showing the WWTW footprint, pipeline alignments, watercourse crossings, floodline constraints, buffers, servitudes and regulated areas.

- Approved site camp, access routes, stockpile areas, spoil areas, laydown areas, refuelling areas, waste storage areas and concrete washout areas.
- Signed-off method statement and any site-specific method statements for works within or near regulated areas.
- Confirmed lawful source and volume of construction water and confirmed controls for temporary sanitation, dewatering, waste handling and wastewater containment.

### 2.2 Pre-Construction Site Walkover

A pre-construction walkover must be undertaken with the Engineer, Contractor, ECO and relevant municipal representatives before site establishment. The walkover must verify the construction footprint, sensitive areas, access roads, watercourse buffers, floodline constraints, service crossings, existing fences, stockpile locations and environmental controls.

### 2.3 Demarcation

- Peg and clearly mark the approved construction footprint, WWTW site boundary, pipeline servitudes, lift station, access roads and stormwater structures.
- Demarcate no-go areas, riparian areas, wetlands, watercourses, sensitive vegetation, floodplain areas and areas outside the approved footprint.
- Install visible fencing, danger tape, droppers, bunting or shade cloth where required by the ECO.
- Maintain demarcation until the Engineer/ECO confirms that the area may be rehabilitated or opened.

## 3 CONSTRUCTION METHODOLOGY

### 3.1 General Construction Sequence

1. Confirm approvals, drawings, wayleaves, construction programmes and site-specific method statements.
2. Demarcate work areas, no-go areas, access routes, stockpiles, hazardous substance areas and waste storage areas.
3. Install temporary erosion, sediment, stormwater and pollution-control measures before earthworks commence.
4. Establish site camp, laydown areas, welfare facilities, access control and approved traffic-management measures.
5. Strip and stockpile topsoil separately from subsoil, spoil and contaminated material.
6. Construct temporary and permanent stormwater diversion measures to keep clean stormwater away from active works.
7. Undertake bulk earthworks for ponds, reed beds, storage pond, access roads, lift station, inlet works and pipelines.
8. Construct pipelines, manholes, rising mains, crossings, terminal structures, lift station, inlet works, ponds, reed beds and storage pond.
9. Install mechanical, electrical, instrumentation, telemetry, flow monitoring, standby power and control systems.
10. Conduct quality-control testing, water-tightness testing, liner testing, pressure testing, electrical testing and mechanical testing.
11. Commission the works in a controlled sequence approved by the Engineer.
12. Decommission the existing WWTW **only after** the new WWTW has been commissioned, tested, confirmed operational and authorised for use.
13. Remove temporary facilities and rehabilitate disturbed areas.

### 3.2 Site Establishment

The site camp, laydown areas and contractor facilities shall be located outside watercourses, wetlands, riparian areas, flood-prone areas and sensitive habitats unless otherwise approved. Refuelling, hazardous substance storage and concrete washout areas shall be located at approved positions only and shall include bunding, spill kits and runoff controls.

### 3.3 Clearing, Grubbing and Topsoil Management

- Clear vegetation only within the approved footprint and only after the ECO has confirmed the area may be cleared.
- Strip topsoil before bulk earthworks and store it separately from subsoil, spoil, rubble and contaminated material.
- Do not stockpile topsoil in drainage paths, watercourses, wetlands, riparian buffers or flood-prone areas.
- Stabilise stockpiles against wind and water erosion, using silt fences, berms or covering where required.
- Reuse clean topsoil during rehabilitation of disturbed areas.

### 3.4 Bulk Earthworks and Pond Construction

Bulk earthworks will include excavation, filling, shaping, compaction and embankment construction for the new WWTW ponds, reed beds, storage pond, platforms, access roads and associated structures. Pond embankments and floors shall be constructed to the final approved slopes, levels, freeboard and compaction specifications.

- Remove unsuitable materials such as topsoil, organic material, collapsible material and highly unsuitable soils from engineered areas.
- Place approved fill in controlled layers not exceeding the specified layer thickness, with moisture conditioning and compaction to design requirements.
- Pond embankments must be constructed to the approved slopes, crest levels, freeboard and compaction specifications.
- Compaction testing, material classification and moisture-density testing must be undertaken as specified by the Engineer.
- Prevent clean stormwater from entering pond excavations and prevent sediment-laden water from leaving construction areas.
- Temporary drains, cut-off berms, silt fences and sediment traps must be installed before and during earthworks.
- Pond floors and embankments must be trimmed and inspected before lining or concrete work commences.

#### 3.4.1 Anaerobic, Facultative and Maturation Ponds

- Construct pond embankments, floors, inlet structures, outlet structures, division structures and interconnecting pipework in accordance with approved drawings.
- Maintain the hydraulic sequence: inlet works -> anaerobic ponds -> facultative ponds -> aerobic maturation ponds -> reed beds -> storage pond.
- Construct inlets and outlets to minimise short-circuiting, erosion, dead zones and uncontrolled overtopping.
- Complete liner testing, embankment testing, concrete testing and water-tightness testing before introducing wastewater.
- Protect embankments against erosion and animal damage during and after construction.

#### 3.4.2 Reed Beds and Storage Pond

- Construct reed bed cells with approved liner, media, distribution pipework, collection pipework and outlet level-control structures.
- Place media in accordance with the final grading specified by the Engineer; media shall be clean and free from fines, clay contamination, hydrocarbons and construction waste.
- Plant reeds or approved wetland vegetation in accordance with the approved planting specification and timing.
- Maintain outlet levels to ensure subsurface flow through the horizontal-flow reed beds.
- Construct the storage pond downstream of reed beds and provide approved outlet, pumping, flow-monitoring and effluent reuse/discharge controls.

- Do not commission reed beds or the storage pond until lining, media, vegetation and hydraulic controls have been inspected and approved.

### 3.5 Pond Lining, Seepage Control and Water-Retaining Structures

Final lining type and specification must be confirmed by the Engineer before installation. Where compacted clay is specified, the material must be tested for permeability and compacted to specification. Where a geomembrane is specified, installation must follow the manufacturer's and the engineer's requirements.

- Prepare subgrade free of sharp stones, roots, debris, organic matter and protrusions before liner installation.
- Test liner panels, welds, seams, anchor trenches and penetrations before wastewater is introduced.
- The anaerobic ponds are indicated in the preliminary design as having a 125 mm reinforced concrete lining; final lining details will be confirmed in the detailed design.
- Water-retaining concrete structures shall include approved construction joints, water stops, curing, crack-control measures and water-tightness testing.
- Failed liner or water-tightness tests shall be repaired and retested before commissioning.

### 3.6 Inlet Works

- Collect screenings and grit in contained receptacles and dispose of them at an approved facility.
- No screenings, grit, sewage, wash water or contaminated material may be discharged to the environment.
- Calibrate flow-measurement equipment and link it to the monitoring system where required.

### 3.7 Bulk Sewer Pipelines and Manholes

- Locate and protect existing services before excavation; trial holes shall be used where required.
- Excavate trenches to the required width, depth, gradient and alignment shown on approved drawings.
- Provide trench shoring, battering, barricading and safe access where required by ground conditions and safety regulations.
- Prepare bedding, lay pipes to line and level, inspect joints, and install selected fill in accordance with pipe manufacturer and SANS requirements.
- Construct manholes at changes in direction, changes in grade, junctions and specified intervals.
- Backfill in layers and compact to the specified density with testing where required.
- Undertake pressure/leakage testing, CCTV inspection and/or mandrel testing where specified before final acceptance.
- Reinstate roads, fences, services, accesses, drainage lines and disturbed areas after testing and backfilling.

### 3.8 Rising Mains

- Install rising mains to the approved alignment, pipe class, pressure rating and cover depth.
- Install bends, thrust blocks, anchor blocks, air valves, scour valves, isolating valves, flow meters and chambers as appropriate and as shown on approved drawings.
- Pressure test rising mains to the specified pressure and duration before commissioning.
- Flush and clean pipelines before connecting them to live wastewater flow.
- Provide scour arrangements that prevent uncontrolled release of sewage or contaminated water to the environment.
- Record pipe material, diameter, class, chainage, coordinates, invert levels and test results for as-built documentation.

### 3.9 Watercourse, Floodplain and Regulated Area Crossings

Where pipeline routes, pump stations, stormwater structures or access roads enter a watercourse, floodplain, riparian area or regulated area, the following method must be applied in addition to the site-specific method approved by the Engineer and ECO:

- Construct crossings during the dry season as far as practicable.
- Minimise working width and duration of disturbance within the watercourse or regulated area.
- Maintain stream flow at all times; if flow is present, use approved diversion, cofferdam and over-pumping measures with sediment control.
- Keep excavated material, topsoil, bedding, spoil and construction waste outside the active channel and outside buffer areas unless specifically approved.
- Pump sediment-laden water to a settlement/silt trap before release; turbid water may not be released directly into a watercourse.
- Do not refuel, store fuel, batch concrete, undertake cement washout or store hazardous substances within 50 m of a watercourse unless specifically approved with additional protection.
- Reinststate bed, banks, channel profile, topsoil and vegetation to match pre-construction conditions as far as practicable.
- Install erosion protection such as gabions, reno mattresses, stone pitching, geotextiles or vegetation where required by the final design.



### 3.10 Road, Rail and Service Crossings, including HDD

Where bulk sewer pipelines, rising mains or associated infrastructure require road, rail or service crossings, the works shall be undertaken in accordance with the approved engineering drawings, authority approvals and Engineer's instructions.

For the purposes of this Method Statement and the WULA, this section applies only to crossings that may affect water resources, including crossings located within or near watercourses, drainage lines, floodplain areas, stormwater pathways or other regulated areas.

Where horizontal directional drilling or open-cut construction is required, the Contractor shall implement controls to prevent drilling fluid, slurry, spoil, sediment-laden water, contaminated runoff or construction waste from entering stormwater systems, drainage lines, watercourses or open ground.

Launch and reception pits, stockpiles, spoil areas, refuelling areas and concrete washout areas shall be located outside sensitive areas as far as practicable. Where dewatering is required, water shall be managed through suitable sediment and pollution-control measures before reuse or authorised discharge.

On completion of the crossing works, disturbed areas shall be reinstated, stabilised and rehabilitated to prevent erosion, sedimentation, ponding or altered runoff patterns.

The Contractor shall retain records of relevant approvals, inspections, incidents, corrective actions and rehabilitation completed for each crossing, where applicable.

### 3.11 New Sewer Lift Station

- Excavate the wet well, pump house, valve chambers and related structures to approved founding levels and provide temporary support/dewatering where required.
- Construct reinforced concrete wet well, emergency storage, valve chambers and pump house in accordance with approved structural drawings and water-retaining structure requirements.
- Install duty/standby self-priming pumps, suction and delivery pipework, valves, non-return valves, flow meter, level sensors, MCC, telemetry, generator/backup systems and security systems.
- Test pumps, alarms, level controls, flow meters, standby power, telemetry and emergency response systems before the lift station receives live sewage.
- Confirm emergency storage, bypass arrangements and overflow-prevention measures before commissioning.
- No uncontrolled overflow from the lift station may be allowed during construction, testing or commissioning.

### 3.12 Access Roads, Internal Roads and Security Fencing

- Construct access roads and internal roads to the approved alignment, width, layer works and stormwater design.
- Provide clean stormwater cut-off drains, side drains and energy dissipation where runoff could erode embankments or discharge into sensitive areas.
- Final road surfacing should be undertaken at a stage that avoids damage by heavy construction traffic, unless otherwise instructed by the Engineer.
- Install perimeter security fencing, gates, access control, lighting and security systems to final approved layout.
- Maintain access for emergency vehicles, operation and maintenance vehicles where required.

### 3.13 Decommissioning of the Existing WWTW

The existing Warrenton WWTW must only be decommissioned after the new WWTW has been commissioned, tested, confirmed operational and authorised for use. A separate detailed decommissioning method statement may be required before this work commences.

- Isolate influent, effluent, sludge return, electrical and mechanical systems under Engineer supervision.
- Remove, classify and lawfully dispose of sludge, screenings, grit and contaminated material.
- Dewater process units in a controlled manner; contaminated water must be returned to treatment or disposed of as authorised.
- Remove redundant mechanical and electrical equipment for reuse, recycling or lawful disposal.
- Demolish or make safe redundant structures only in accordance with approved demolition and waste plans.
- Backfill voids, shape the area to drain safely, stabilise exposed soils and rehabilitate disturbed land.
- Retain waste manifests, sludge disposal records, photographs and close-out certification.

## 4 WATER RESOURCE PROTECTION AND ENVIRONMENTAL CONTROLS

### 4.1 Stormwater and Erosion Control

- Separate clean and dirty water throughout construction.
- Divert clean stormwater around active construction areas using berms, diversion drains and cut-off channels.
- Capture dirty water from disturbed areas in sediment traps, silt fences, check dams or settlement areas before discharge.
- Inspect erosion and sediment controls before forecast rainfall and after rainfall events.
- Repair gullies, rills, failed berms and damaged silt fences immediately.
- Do not allow stormwater to enter pond excavations, wet wells, pipeline trenches or concrete works where it can become contaminated.
- Permanent stormwater controls must be completed before the ponds are commissioned.

### 4.2 Pollution Prevention and Spill Control

- Store fuels, oils, chemicals and hazardous substances in bunded areas with adequate capacity and signage.
- Use drip trays under stationary equipment, generators, pumps, compressors and parked plant.
- Refuel only in approved areas, using spill trays and trained personnel.
- Keep spill kits at refuelling areas, stores, site camp, concrete works and active work fronts.
- Repair leaking plant immediately or remove it from site.
- Report all spills to the Engineer and ECO immediately and clean up contaminated material for lawful disposal.
- No oil, fuel, cement, sewage, sludge, screenings, grit, chemicals or contaminated water may enter soil, stormwater systems or water resources.

### 4.3 Groundwater and Seepage Protection

- Construct all ponds, wet wells, sludge areas and storage ponds with approved seepage-control measures.
- Do not introduce wastewater until liner integrity and watertightness have been verified.
- Protect monitoring boreholes, if required by the geohydrologist or WUL conditions, and keep them accessible for sampling.
- Report any evidence of seepage, leakage, unexpected groundwater inflow, settlement or liner damage to the Engineer/ECO immediately.
- Assess temporary dewatering water for turbidity and contamination before reuse or discharge.

## 4.4 Concrete, Cement and Washout Control

- Use prefabricated concrete alternatives to on-site construction where possible.
- Use ready-mix concrete where practical to reduce on-site batching impacts.
- Concrete washout may only occur in designated lined washout areas approved by the ECO.
- Contain cement bags, slurry, grout and wash water and dispose of them lawfully.
- Do not wash chutes, pumps or tools into drainage lines, watercourses, open ground or trenches.
- Clean up concrete spills before hardening and dispose of them at an approved facility.

## 4.5 Waste, Spoil, Sludge, Screenings and Grit

- Segregate general waste, recyclable waste, hazardous waste, rubble, spoil, sludge, screenings, grit and contaminated material.
- Waste storage areas shall be clearly marked, contained and managed to prevent windblown litter or polluted runoff.
- Spoil may only be placed at approved spoil areas and may not be placed in watercourses, wetlands, drainage lines or flood-prone areas.
- Screenings and grit from commissioning or temporary operations shall be handled as contaminated waste and disposed of lawfully.
- Sludge from the existing WWTW or any temporary treatment structures shall be classified, transported and disposed of in accordance with applicable legislation and approval conditions.
- Retain waste disposal slips and manifests for close-out reporting.

## 4.6 Construction Water and Temporary Sanitation

- Confirm the source, volume and lawful authorisation for construction water before use.
- Water abstraction from any water resource may only occur if authorised.
- Provide adequate chemical toilets or temporary ablution facilities for workers.
- Service toilets through an approved contractor and locate them away from watercourses and drainage paths.
- No sewage from temporary facilities may be discharged to the environment.

## 4.7 Environmental Incident Response

- Stop the activity causing the incident, where safe to do so.
- Contain the spill, sediment release, overflow, wastewater release or erosion failure immediately.
- Notify the Site Agent, Engineer, ECO and Client representative.
- Clean up contaminated soil, water, waste or affected material and dispose of it lawfully.
- Record the incident, cause, corrective action, photographs and prevention measures.
- Report to DWS or other authorities where required by the WUL, EMP or legislation.

## 5 QUALITY ASSURANCE, TESTING AND COMMISSIONING

### 5.1 Quality Control Plan

The Contractor must prepare and implement a Quality Control Plan. The plan must include hold points for the Engineer's inspection and approval before works are covered, backfilled, commissioned or handed over.

### 5.2 Testing Requirements

- Pipeline pressure/leakage testing before commissioning.
- Manhole leakage testing where specified.
- Water-tightness testing of water-retaining concrete structures.
- Liner integrity testing for ponds and reed beds.
- Compaction testing for embankments, roads, platforms and trench backfill.
- Flow-meter calibration and telemetry verification.
- Pump duty testing and standby pump changeover testing.
- Generator/backup power testing and mains-failure simulation.
- Stormwater infrastructure inspection before the first major rainfall after construction.

### 5.3 Commissioning

- No wastewater may be introduced into incomplete, untested or unapproved structures.
- Commission the treatment train progressively and maintain sufficient monitoring to prevent overflow, bypassing or unauthorised discharge.
- Confirm emergency storage, pump controls, alarms, standby power and flow measurement before live sewage is accepted.
- Provide operator training, O&M manuals, as-built drawings and equipment warranties before handover.
- The new WWTW must be operational before the existing WWTW is decommissioned.



## 6 REHABILITATION REQUIREMENTS

- Remove temporary infrastructure, rubble, waste, excess material, redundant fencing and contractor equipment.
- Rip compacted temporary work areas and reshape to free-draining profiles.
- Replace stockpiled topsoil on disturbed areas and lightly scarify to assist revegetation.
- Stabilise slopes, embankments, drainage lines and exposed soils using vegetation, erosion blankets, geotextiles, stone pitching or gabions, where required.
- Reinstate fences, access roads, gates, road shoulders, servitudes and property access to the same or better condition.
- Revegetate using approved indigenous or suitable grass/plant species in accordance with the EMPr and specialist recommendations.
- Monitor rehabilitated areas after rainfall and repair erosion, settlement or failed vegetation establishment.
- Keep livestock and unauthorised traffic out of rehabilitated areas until vegetation is established, where applicable.





## **Sludge Management Plan Report for The Relocation of the Existing Warrenton Wastewater Treatment Works and Related Bulk Infrastructure**

**Prepared for: Magareng Local Municipality**

**14 May 2026**

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| Glossary          |                                     |
|-------------------|-------------------------------------|
| m <sup>3</sup> /s | Cubic meters per second             |
| DWS               | Department of Water and Sanitation  |
| FBDM              | Frances Baard District Municipality |
| h                 | Hour                                |
| IRS               | Implementation Readiness Study      |
| km                | Kilometre                           |
| ℓ                 | Litre                               |
| ℓ/s               | Litres per second                   |
| m                 | Metre                               |
| MLM               | Magareng Local Municipality         |
| mamsl             | Meters above sea level              |
| mbgl              | Meters below ground level           |
| m/s               | Metres per second                   |
| mm                | Millimetre                          |
| m <sup>3</sup> /d | Cubic meters per day                |
| NGL               | Natural ground level                |
| O&M               | Operation and Maintenance           |
| p.a               | Per annum                           |
| PFR               | Peak Flow Rate                      |
| s                 | Second                              |
| SABS              | South African Bureau of Standards   |
| uPVC              | Unplasticized polyvinylchloride     |
| v                 | Flow velocity (in m/s)              |
| WSA               | Water Services Authority            |
| WSP               | Water Services Provider             |
| WWTW              | Waste Water Treatment Works         |

# 1 SLUDGE MANAGEMENT PLAN REPORT FOR WARRENTON WWTW

## 1.1 Introduction

This Sludge Management Plan has been prepared in support of the Water Use Licence Application (WULA) for the proposed relocation of the Warrenton Wastewater Treatment Works (WWTW), in Warrenton, within the Magareng Local Municipality.

The proposed treatment works will utilise an oxidation pond system comprising anaerobic, facultative and maturation ponds. During operation, settleable and biological solids will accumulate gradually within the ponds and undergo partial stabilisation through anaerobic digestion. Over time, the accumulated sludge must be monitored, periodically removed, and managed in an environmentally responsible manner to ensure continued treatment performance and compliance with regulatory requirements.

This Sludge Management Plan outlines the anticipated sludge generation, monitoring requirements, desludging criteria, handling procedures, temporary storage arrangements, and final disposal or beneficial use options for sludge generated by the proposed WWTW. The plan also addresses the management of the sludge removed from the existing WWTW during decommissioning. Decommissioning, while considered in this sludge management plan, will only take place after the new WWTW and associated bulk infrastructure are fully operational and will thus only take place after the appropriate environmental impact assessment and licensing processes have been completed.

The plan has been developed to demonstrate that adequate provisions will be implemented to:

- Maintain treatment capacity and hydraulic retention times.
- Protect the quality of the receiving environment.
- Prevent nuisance conditions such as odours and vector attraction.
- Ensure safe handling and transport of sludge.
- Comply with applicable South African legislation and licence conditions.

The objective of this plan is to ensure that sludge is handled, dried, temporarily stored, classified, transported and disposed of in a controlled manner that prevents pollution of soil, groundwater, stormwater systems, the Vaal River and surrounding water resources.

## 1.2 Applicable Legislation and Guidelines

Sludge generated at the proposed Warrenton WWTW will be managed in accordance with the following legislation and guidance documents:

- National Water Act, 1998 (Act No. 36 of 1998)
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
- Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)
- Department of Water and Sanitation licence conditions and sludge management requirements.
- Water Research Commission guidelines for the beneficial use and disposal of wastewater sludge.
- Applicable waste classification and disposal requirements issued by the Department of Forestry, Fisheries and the Environment.

## 1.3 Project Context

The proposed WWTW site is located on Portion 7/12 of Doornfonteyn Farm, approximately 3 km west of the Warrenton town centre, within the jurisdiction of Magareng Local Municipality. The site is situated just outside the urban edge and is currently undeveloped, with surrounding land uses including agriculture and a poultry farm. Access to the site is obtained via Erasmus Street.

The proposed treatment technology is a conventional oxidation pond system with horizontal-flow reed beds as a polishing stage and a downstream treated effluent storage pond for the management and reuse of final treated effluent for irrigation purposes.



Figure 1: WWTW overall treatment sequence

The existing Warrenton WWTW will only be decommissioned once the new WWTW has been commissioned, tested, confirmed operational and authorised for use. Decommissioning of the existing WWTW will thus not form part of the current project scope and will take place following a separate environmental assessment process. Sludge, screenings, grit and contaminated material removed from the existing WWTW during decommissioning must be classified and lawfully disposed of.

## 1.4 Sludge Sources

Sludge and sludge-related waste may originate from the following sources:

Table 1: Sludge Sources

| Source                   | Description                                                                               | Management requirement                                                               |
|--------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Anaerobic ponds          | Main sludge accumulation area due to the settlement of solids and anaerobic stabilisation | Periodic desludging, drying and classification                                       |
| Facultative ponds        | Secondary sludge accumulation over time                                                   | Desludging when required, based on monitoring                                        |
| Maturation/aerobic ponds | Limited sludge accumulation                                                               | Removal only when operationally required                                             |
| Existing WWTW ponds      | Accumulated sludge to be removed during decommissioning                                   | Classification, possible onsite treatment (and reclassification) and lawful disposal |
| Inlet works              | Screenings and grit                                                                       | Managed separately from sludge and disposed of at an approved facility               |
| Sludge drying beds       | Drying area for sludge removed from ponds                                                 | Controlled drying, filtrate return and removal of dried sludge                       |

## 1.5 Sludge Production and Desludging Criteria

Anaerobic ponds will accumulate sludge over time and will require periodic desludging. The desludging frequency is not fixed and must be determined through routine sludge-depth monitoring as a practical operating criterion.

Desludging should generally be considered when sludge accumulation reaches approximately one-third of the relevant pond volume, or where sludge accumulation affects treatment efficiency, hydraulic retention time, flow movement through the pond, odour conditions or effluent quality.

The final desludging frequency must be confirmed during operation based on:

1. Sludge-depth measurements (typically 30% to 50% of operational pond depth).
2. Pond performance (hydraulic retention time).
3. Available pond capacity.
4. Effluent quality trends.
5. Operational condition of the sludge drying beds.
6. Recommendations of the Process Controller, Engineer or Municipality.

## 1.6 Desludging Method

Desludging must be undertaken in a controlled manner to prevent sludge spills, uncontrolled discharge, odour impacts, runoff pollution and health and safety risks.

The following general approach must be followed:

1. The relevant pond must be isolated where practicable.
2. Flow must be diverted to another pond or treatment unit where operationally possible.
3. The pond must be drawn down, or water must be removed in a controlled manner.
4. Settled sludge must be removed using a suitable method, which may include:
  - Mobile pump mounted on a trailer
  - Flexible pipework to pump sludge to the drying beds
  - Vacuum pumping
  - Mechanical removal; or
  - Manual removal only where safe and appropriate.
5. Where sludge has solidified due to long retention time in the ponds, one anaerobic pond may need to be emptied at a time, and the sludge removed physically.
6. Sludge must be conveyed only to the designated sludge drying beds or other approved contained area.
7. No sludge may be placed on bare ground or outside the approved WWTW footprint.

## 1.7 Sludge Drying Beds

### 1.7.1 Design Basis

The proposed design makes provision for sludge drying beds for the drying of sludge removed from the anaerobic ponds. Sludge drying beds are appropriate for oxidation pond systems because sludge is removed periodically and can be passively dried before final disposal or reuse.

The drying beds will be used to dewater sludge removed from the oxidation ponds during periodic desludging campaigns. Sludge will be placed on the beds and allowed to drain and dry through natural evaporation and percolation through the filter media and underdrain system. The dried sludge cake will then be removed mechanically and transported to an approved disposal or beneficial-use facility.

The sludge drying beds are designed to prevent seepage, contaminated runoff and uncontrolled discharge to the environment.

The sludge drying beds are designed for a population of 31 150 persons on a 20-year design horizon. Sludge accumulates primarily in the anaerobic ponds with a desludging cycle of every 5 to 7 years, which is typical for anaerobic pond systems operating at these retention times. The design parameters are outlined in the table on the next page.

Table 2: Design Parameters

| Parameter                     | Value                                             |
|-------------------------------|---------------------------------------------------|
| Design Population (20-year)   | 31 150 persons                                    |
| Sludge Generation Rate        | 0.04 m <sup>3</sup> /person/year (DWAf guideline) |
| Annual Sludge Volume          | 31 150 × 0.04 = <b>1 246 m<sup>3</sup>/year</b>   |
| Desludging Cycle              | Every 5 – 7 years                                 |
| Sludge Volume at 5-year cycle | 1 246 × 5 = <b>6 230 m<sup>3</sup></b>            |
| Sludge Volume at 7-year cycle | 1 246 × 7 = <b>8 722 m<sup>3</sup></b>            |

### 1.7.2 Sizing and Layout

Table 3: Drying beds sizing parameters

| Parameter                    | Value                                            |
|------------------------------|--------------------------------------------------|
| Application Depth per Batch  | 0.25 m (250 mm)                                  |
| Drying Cycles per Year       | 6 (≈ 20 days per batch, Northern Cape semi-arid) |
| <b>Minimum Area Required</b> | 1 246 / (0.25 × 6) = <b>830.7 m<sup>2</sup></b>  |

The total sludge drying bed area recommended is approximately 1 500 m<sup>2</sup>.

It is proposed that 10 sludge drying beds be provided. The final dimensions, bed layout, pipework arrangement, access route and operating sequence will be confirmed during the detailed design stage.

Therefore, the proposed Layout is 10 Beds × 25 m × 6 m.

Table 4: Dry beds capacity

| Parameter                  | Value                                              |
|----------------------------|----------------------------------------------------|
| Number of Beds             | 10                                                 |
| Bed Dimensions             | 25 m × 6 m                                         |
| Area per Bed               | 150 m <sup>2</sup>                                 |
| <b>Total Area Provided</b> | 10 × 150 = <b>1 500 m<sup>2</sup></b>              |
| Minimum Area Required      | 830.7 m <sup>2</sup>                               |
| Surplus                    | <b>+669.3 m<sup>2</sup></b>                        |
| Annual Handling Capacity   | 1 500 × 0.25 × 6 = <b>2 250 m<sup>3</sup>/year</b> |
| Factor of Safety           | <b>1.81×</b>                                       |

The sludge drying beds will be located within the controlled WWTW footprint and will be accessible for sludge transfer, maintenance, removal of dried sludge, and emergency response. The figure on the next page shows the proposed location of the drying beds.



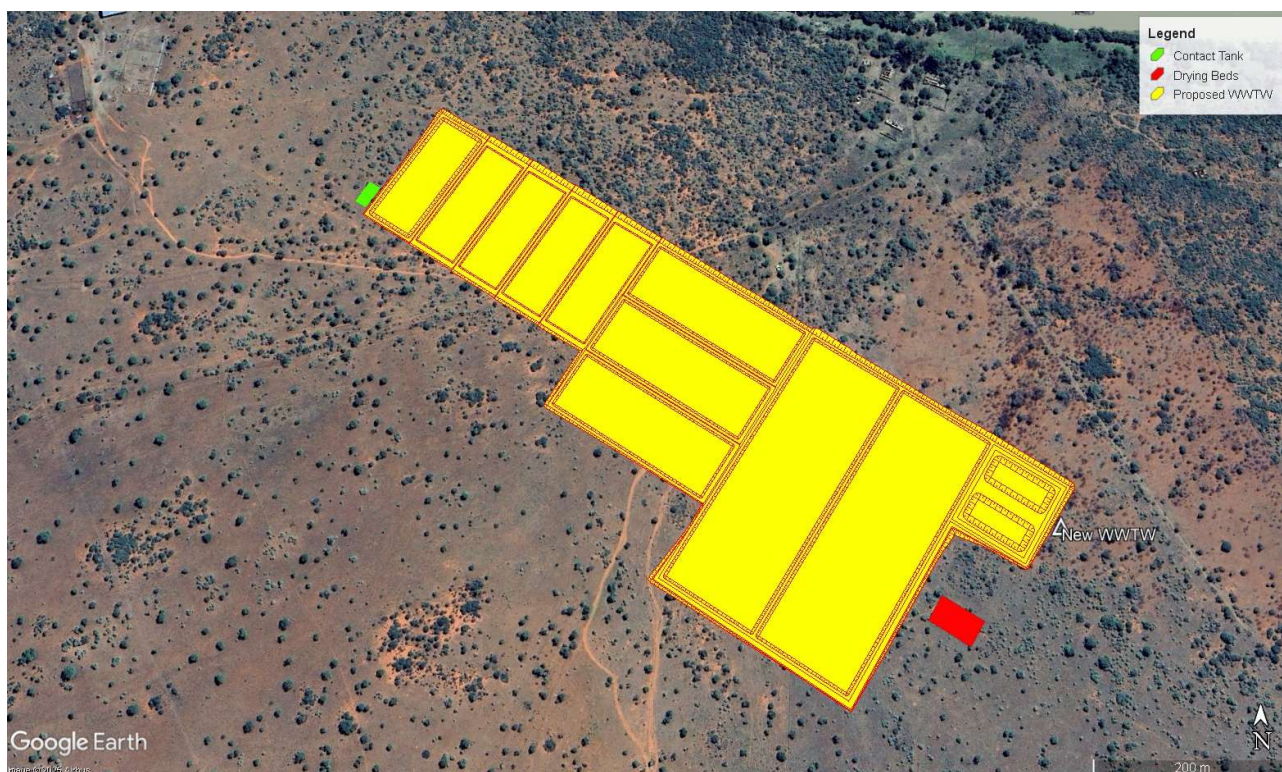


Figure 2: Drying beds location in Red

### 1.7.3 Construction Requirements

Each sludge drying bed should include, where applicable:

- Compacted and prepared subgrade.
- Impermeable base (concrete).
- Gravel drainage layer.
- Perforated underdrain pipes.
- Geotextile separator where required.
- Sand drying layer.
- Perimeter bunding or kerbing.
- Controlled discharge manifold.
- Filtrate collection system.
- Access for removal of dried sludge.



## 1.8 Filtrate and Supernatant Management

The filtrate, drainage liquor and supernatant from sludge drying beds will be collected via a dedicated drainage system and returned to the head of works through gravity pipework for re-treatment.

The sludge drying beds will therefore include an underdrainage system that collects filtrate from the base of the beds and conveys it to a sump or collection point. From there, the filtrate will, by gravity, be conveyed back to the inlet works or head of works.

No filtrate, supernatant, leachate or sludge-contaminated runoff may be discharged to the environment, stormwater system, drainage line or watercourse.

## 1.9 Operation of Sludge Drying Beds

The sludge drying beds must be operated on a rotational basis to allow sufficient time for filling, drainage, drying and removal of dried sludge.

The following operational controls must be applied:

- Only available and prepared beds may receive sludge.
- Isolation valves on the discharge manifold must be used to control which beds receive sludge.
- Beds must not be overloaded beyond their design capacity.
- Sludge distribution must be such as to optimise drying times.
- Sludge must be allowed to drain and dry sufficiently before removal.
- Filtrate must be returned to the head of works.
- Dried sludge must be removed from the surface of the beds once sufficiently dry.
- Beds must be inspected for clogging, erosion, liner damage, standing water and loss of drying capacity.
- Damaged or blocked beds must be repaired before reuse.

## 1.10 Sludge Classification

- A representative sludge sample must be taken and classified before final disposal or reuse.
- The sludge must be classified in accordance with the applicable South African sludge guidelines, waste legislation, receiving facility requirements and any Water Use Licence conditions.
- The classification must determine whether the dried sludge is suitable for controlled beneficial use or whether it must be disposed of at an authorised waste disposal facility.

## 1.11 Final Disposal or Reuse of Dried Sludge

The final management option for dried sludge will depend on the sludge classification results.

Table 5: Sludge Classification and Management

| Classification/condition                                 | Management approach                                                                                                                                                          |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Class A1a or equivalent suitable classification          | Dried sludge may be stockpiled on a dedicated concrete slab within the WWTW site for collection by farmers or approved users, subject to all required controls and approvals |
| Lower classification / unsuitable for agricultural use   | Dried sludge must be placed in dedicated skips or containers and removed to a certified Class B landfill or other authorised waste management facility                       |
| Contaminated sludge or sludge mixed with grit/screenings | Must be managed as contaminated waste and disposed of at an authorised facility                                                                                              |
| Sludge from existing WWTW decommissioning                | Must be sampled, classified, potentially treated on site (and reclassified), removed, and lawfully disposed of before rehabilitation                                         |

A dedicated concrete slab of approximately 6 m may be provided on site for the temporary stockpiling of dried sludge where classification confirms that the sludge is suitable for agricultural application or collection by farmers. The final dimensions and design of this slab will be confirmed in later stages.

Where sludge is not suitable for agricultural application, dedicated skips, such as 2 m<sup>3</sup> to 3 m<sup>3</sup> skips, must be provided for the dried sludge. The skips must be used exclusively for dried sludge and must be removed to an appropriately authorised landfill or waste facility.

No uncontrolled land application, burial, dumping, discharge or informal disposal of sludge may occur.

## 1.12 Sludge from Decommissioning of the Existing WWTW

The existing Warrenton WWTW must only be decommissioned once the new WWTW is fully operational and authorised.

Before decommissioning, the existing ponds and sludge accumulation areas must be inspected to confirm the presence, depth and condition of sludge, screenings, grit and contaminated material.

The following procedure must be followed:

- Isolate the relevant process units under Engineer or operator supervision.
- Remove remaining wastewater in a controlled manner.
- Return contaminated water to treatment or dispose of it as authorised.
- Remove accumulated sludge from existing ponds and sludge areas.
- Place sludge only in approved contained drying, stockpiling or loading areas.
- Classify sludge before final disposal or reuse.
- Dispose of dried sludge at an authorised facility unless approved for controlled reuse.
- Remove screenings, grit and contaminated debris separately.
- Retain disposal slips, waste manifests and photographic records.
- Rehabilitate disturbed or contaminated areas after sludge removal.

### 1.13 Stormwater and Runoff Control

Stormwater runoff management around sludge handling areas is addressed separately in the project Stormwater Management Report, which provides the necessary measures to control and safely convey runoff away from the treatment units and associated infrastructure, including drying beds.

Stormwater runoff will be diverted around sludge drying beds, sludge stockpile areas and sludge loading areas. Any water that comes into contact with sludge, including drainage from the sludge drying beds and runoff from active sludge handling areas, will be regarded as contaminated and will be collected and returned to the head of the treatment works.

The following controls must be implemented:

- Perimeter bund wall around sludge drying beds.
- Diversion of surface stormwater away from sludge areas.
- Collection of contaminated runoffs from sludge handling areas.
- Inspection of sludge areas before and after rainfall events.
- Immediate repair of erosion, bund failure or runoff pathways.
- No discharge of sludge-contaminated water to the environment.

These measures will ensure that sludge handling activities do not result in uncontrolled releases to the environment and that the sludge drying bed facility operates in accordance with the broader stormwater management strategy developed.

### 1.14 Groundwater and Surface Water Protection

All sludge handling and drying areas must be designed and operated to prevent contamination of groundwater and nearby surface water resources.

The following measures must be implemented:

- Sludge drying beds must have an impermeable base or approved seepage-control system.
- Sludge must not be placed directly on bare ground.
- Filtrate must be collected and returned to the head of works.
- Sludge stockpile areas must be located on hardstand or concrete surfaces.
- Any seepage, ponding, liner damage or uncontrolled runoff must be reported immediately.
- Repairs must be undertaken before the affected sludge bed, or stockpile area is reused.
- Monitoring boreholes, where required by the WUL or geohydrological recommendations, must remain accessible for monitoring.

## 1.15 Odour, Vector and Public Safety Controls

Sludge management must be undertaken in a manner that prevents nuisance conditions and health risks.

The following controls must be implemented:

- Sludge must not be allowed to remain wet and stagnant for extended periods.
- Drying beds must be operated to avoid excessive ponding.
- Dried sludge must be removed regularly.
- Vegetation around sludge areas must be controlled.
- Access to sludge drying beds and stockpile areas must be restricted.
- The sludge handling area must be fenced or located within the secured WWTW site.
- Workers handling sludge must use suitable PPE.
- Odour complaints must be recorded and investigated.
- Vector breeding must be controlled through good housekeeping and proper drainage.

## 1.16 Emergency and Incident Management

The following events must be treated as sludge-related incidents:

- Sludge spill outside the designated handling area.
- Overflow from sludge drying beds.
- Filtrate or dirty runoff entering stormwater systems or drainage lines.
- Sludge-contaminated water reaching a watercourse.
- Liner failure or visible seepage.
- Unauthorised dumping or removal of sludge.
- Odour or vector nuisance caused by poor sludge management.

Corrective action must include:

- Stop the activity causing the incident, where safe to do so.
- Contain the spill or runoff.
- Recover sludge and contaminated material.
- Clean the affected area.
- Dispose of contaminated material lawfully.
- Repair damaged containment infrastructure.
- Record the incident, cause and corrective action.
- Report to the Engineer, ECO, Municipality and DWS, VOCMA where required by the WUL or EMPr.

## 1.17 Monitoring and Record Keeping

The Municipality or appointed operator must maintain a Sludge Management Register.

The register must include:

Table 6: Typical Sludge Management Requirements

| Record                  | Requirement                                                                            |
|-------------------------|----------------------------------------------------------------------------------------|
| Sludge-depth monitoring | Date, pond number, measured sludge depth and person responsible                        |
| Desludging event        | Date, pond desludged, method used and reason for desludging                            |
| Quantity removed        | Estimated wet sludge volume and dried sludge volume/mass                               |
| Drying bed used         | Bed number, filling date, drying period and removal date                               |
| Filtrate management     | Confirmation that filtrate was returned to the head of works                           |
| Classification results  | Laboratory results and sludge classification                                           |
| Disposal or reuse route | Farmer collection, agricultural use, landfill or other authorised option               |
| Disposal proof          | Waste manifest, weighbridge slip, disposal receipt or collection record                |
| Incidents               | Type of incident (spills, odour complaints, runoff, overflow or non-compliance), cause |
| Corrective actions      | Action taken, responsible person and close-out date                                    |
| Photographic record     | Photos taken before, during and after desludging/removal                               |

## 1.18 Summary

Sludge generated at the Warrenton WWTW will be managed through periodic desludging of the oxidation pond system, with desludging frequency determined by sludge-depth monitoring and operational performance. Sludge will be transferred to dedicated sludge drying beds with an estimated total area of 1 500 m<sup>2</sup>, where it will be passively dried. Filtrate and supernatant from the drying beds will be collected and returned to the head of works for treatment.

Dried sludge will be sampled and classified before final disposal or reuse. Where sludge is classified as suitable for agricultural application, it may be temporarily stockpiled on a dedicated concrete slab for collection by approved users. Where sludge is classified at a lower rating or is unsuitable for reuse, it will be placed in dedicated skips or containers and removed to an appropriately authorised landfill or waste management facility.

All sludge handling, drying, storage, transport and disposal activities will be managed to prevent contamination of soil, groundwater, stormwater systems and nearby water resources. Disposal records, classification results, waste manifests and monitoring records will be retained for compliance and inspection purposes.

Implementation of this plan will maintain the long-term hydraulic and treatment performance of the WWTW while protecting public health and the receiving environment and ensuring compliance with applicable South African legislation and licence conditions.





## **Stormwater Management Plan Report for The Relocation of the Existing Warrenton Wastewater Treatment Works and Related Bulk Infrastructure**

**Prepared for: Magareng Local Municipality**

**12 May 2026**

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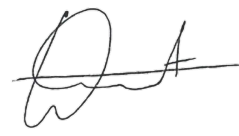
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| Glossary          |                                     |
|-------------------|-------------------------------------|
| m <sup>3</sup> /s | Cubic meters per second             |
| DWS               | Department of Water and Sanitation  |
| FBDM              | Frances Baard District Municipality |
| h                 | Hour                                |
| IRS               | Implementation Readiness Study      |
| km                | Kilometre                           |
| ℓ                 | Litre                               |
| ℓ/s               | Litres per second                   |
| m                 | Metre                               |
| MLM               | Magareng Local Municipality         |
| mamsl             | Meters above sea level              |
| mbgl              | Meters below ground level           |
| m/s               | Metres per second                   |
| mm                | Millimetre                          |
| m <sup>3</sup> /d | Cubic meters per day                |
| NGL               | Natural ground level                |
| O&M               | Operation and Maintenance           |
| p.a               | Per annum                           |
| PFR               | Peak Flow Rate                      |
| s                 | Second                              |
| SABS              | South African Bureau of Standards   |
| uPVC              | Unplasticized polyvinylchloride     |
| v                 | Flow velocity (in m/s)              |
| WSA               | Water Services Authority            |
| WSP               | Water Services Provider             |
| WWTW              | Waste Water Treatment Works         |

# 1 INTRODUCTION

BVi Consulting Engineers (Central) was appointed by Magareng Local Municipality (MLM) to develop an Implementation Readiness Study (IRS) and oversee the implementation of the new Warrenton Wastewater Treatment Works (WWTW) along with the associated bulk infrastructure.

BVi Consulting Engineers Central appointed the Environmental Management Group (EMG) to perform professional environmental services for the project. EMG is overseeing the Water Use Licence Application (WULA) and Environmental Authorisation (EA) processes for the relocation of the Warrenton WWTW. As part of the application, the stormwater management plan at the new WWTW is required per the National Water Act (Act 36 of 1968), Section 21.

The purpose of this report is to define an integrated stormwater management system, including the sizing of the upstream stormwater cut-off channel, that prevents pollution, protects receiving watercourses, and ensures compliance with applicable legislative and regulatory requirements in supporting the Water Use Licence Application (WULA) to the Department of Water and Sanitation (DWS).

This report is limited to stormwater management for the proposed WWTW site and related bulk sewer infrastructure. It addresses clean and dirty stormwater separation, erosion and sediment control, stormwater diversion, the proposed stormwater channel, runoff control around treatment units, construction-phase controls, operational-phase controls, monitoring, incident response and rehabilitation.

## 1.1 Project Overview

The project entails the relocation of the existing Warrenton WWTW and the construction of a new WWTW with associated bulk sewer infrastructure. The existing works is hydraulically and organically overloaded and does not provide sufficient long-term treatment capacity for Warrenton. The new works are intended to provide improved treatment capacity, reduce pollution risks and support future growth.

The preferred treatment technology is a conventional oxidation pond system with horizontal-flow reed beds as a polishing stage and a downstream treated effluent storage pond for the management and reuse of final treated effluent for irrigation purposes. The stormwater management measures in this plan are intended to keep external stormwater separate from wastewater treatment infrastructure and to prevent contaminated runoff from leaving the managed construction and operational areas.

The proposed WWTW will be constructed on a greenfield site currently characterised by natural drainage patterns and undeveloped land.

A pond system WWTW generally requires a large footprint area, and the proposed plant area is 15.1ha.

The surface areas for the wastewater treatment works components are summarised in the table below on the next page.



Table 1: Pond's Surface Area

| Component                 | No | Surface Area<br>(m <sup>2</sup> ) | Total Area<br>(m <sup>2</sup> ) |
|---------------------------|----|-----------------------------------|---------------------------------|
| Anaerobic Ponds           | 2  | 2 304                             | 4 608                           |
| Facultative Ponds         | 2  | 34 438                            | 68 876                          |
| Aerobic Maturation Ponds  | 3  | 13 242                            | 39 725                          |
| Horizontal Flow Reed Beds | 4  | 7 345                             | 29 381                          |
| Storage Pond              | 1  | 8 176                             | 8 176                           |
| <b>Total</b>              |    |                                   | <b>150 765m<sup>2</sup></b>     |

## 1.2 Terms of Reference and Objectives

The introduction of treatment infrastructure, including oxidation ponds, access roads, and ancillary facilities, will alter the natural hydrological response of the site by increasing runoff and introducing potential sources of contamination.

Accordingly, the stormwater management approach prioritises:

- The upstream contributing catchment draining toward the proposed oxidation ponds.
- The upstream cut-off channel and associated erosion protection.
- Stormwater management during operation of the WWTW.

The terms of reference for this report are to provide detailed designs of the stormwater management systems and any other associated infrastructure in accordance with governing statutory regulations and industry best practice guidelines that will:

- Prevent ingress of stormwater into the oxidation pond system and diversion.
- Divert stormwater runoff away from treatment ponds, reed beds, the treated-effluent storage pond, wet wells, trenches, stockpiles, drying beds and potentially contaminated work areas.
- Contain and manage stormwater from disturbed or potentially contaminated areas through appropriate sediment and pollution-prevention controls.
- Ensure that the stormwater channel and associated drainage controls are installed, maintained and inspected as key water-resource protection measures.
- Minimise erosion and structural risks to pond embankments
- Prevent sediment-laden runoff from leaving the managed construction footprint or entering drainage features, watercourses, riparian areas or open veld.
- Prevent contaminated runoff from fuel, oil, chemicals, cement, concrete washout, sewage, sludge, screenings or grit areas; and
- Ensure that disturbed areas are stabilised and rehabilitated to prevent long-term erosion or altered drainage patterns.

The following legislation guides this stormwater management plan:

- National Water Act (Act 36 of 1998)
- National Environmental Management Act (Act 107 of 1998)
- DWS Stormwater Management Plan Guidelines (2021)
- Frances Baard District Municipality stormwater policies under the Disaster Management Plan

### 1.3 Applicable Water Uses

Based on the preliminary design information and the WULA context, the following Section 21 water uses are relevant to the construction and operation of the proposed works:

Table 2: Applicable Water Uses

| NWA Section 21 water use        | Project relevance                                                                                                                                                                               | Stormwater management relevance                                                                                                                                                                                                                    |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Section 21(e)                   | Controlled activity associated with irrigation of treated wastewater.                                                                                                                           | Stormwater controls must prevent external stormwater from entering treated-effluent storage and irrigation infrastructure in a manner that could cause ponding, over-irrigation, erosion, runoff outside approved areas or unauthorised discharge. |
| Section 21(g)                   | Disposal of waste in a manner that may detrimentally impact a water resource, including wastewater treatment ponds, sludge handling, screenings, grit and associated wastewater infrastructure. | Stormwater controls must prevent clean stormwater from becoming contaminated. Runoff from wastewater, sludge, screenings, grit, fuel, oil, cement and waste handling areas must be prevented from leaving the managed site.                        |
| Section 21(c) and Section 21(i) | Impeding or diverting flow and/or altering the bed, banks, course or characteristics of a watercourse where approved infrastructure or work areas are located within a regulated area.          | Stormwater controls must maintain approved working limits, prevent erosion and sedimentation, keep runoff control measures within the authorised footprint and rehabilitate disturbed areas after construction.                                    |

## 1.4 Project Stormwater Risks

Table 3: Project Stormwater Risks

| Project activity/area                                 | Stormwater risk                                                                                            | Required management response                                                                                                                  |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Site establishment and laydown areas                  | Runoff may collect sediment, litter, fuel, oil, cement residue or waste.                                   | Locate in approved areas; install temporary channels or drains; provide spill kits, bunding and waste controls.                               |
| Bulk earthworks for ponds and platforms               | Exposed soils and embankments may generate sediment-laden runoff.                                          | Install stormwater channels, cut-off drains, silt fences and sediment traps before major earthworks commence.                                 |
| Pond excavations and pond embankments                 | Stormwater may enter excavations, damage prepared surfaces, erode embankments, or carry sediment off-site. | Divert clean water away; manage accumulated rainwater through sediment controls; stabilise slopes progressively.                              |
| Liner and water-retaining structure construction      | Runoff may damage prepared subgrade, anchor trenches or concrete works.                                    | Protect subgrade; keep clean water away; contain cement and concrete wash water.                                                              |
| Reed beds and treated effluent storage pond           | Sediment can contaminate media, pipework and outlet structures.                                            | Install upstream sediment controls; prevent runoff from entering reed bed media or treated-effluent storage structures during construction.   |
| Pipeline trenches and manholes                        | Open trenches may intercept runoff and convey sediment along the works.                                    | Limit open trench lengths; divert stormwater around trenches; manage accumulated rainwater through sediment controls; and reinstate promptly. |
| Access roads and internal roads                       | Concentrated runoff may cause rutting, erosion and sediment transport.                                     | Provide side drains, mitre drains, stable outlets and erosion protection.                                                                     |
| Stockpiles and spoil areas                            | Sediment may wash into drainage paths or surrounding areas.                                                | Locate outside flow paths; stabilise and protect stockpiles; install toe controls.                                                            |
| Refuelling, hazardous substances and concrete washout | Polluted runoff may contaminate soil and water resources.                                                  | Use bunding, drip trays, lined washout areas and no-discharge controls.                                                                       |
| Approved work in regulated areas                      | Sediment, erosion or poor reinstatement may affect water resources.                                        | Keep within approved working limits; install erosion and sediment controls; reinstate and rehabilitate immediately after works.               |

## 1.5 Site Description

### 1.5.1 Locality

The geographical coordinates of the proposed WWTW are given in Table 1 below.

Table 4: Geographic Coordinates of the site

| Latitude      | Longitude     |
|---------------|---------------|
| 28° 7'23.12"S | 24°49'33.83"E |

The proposed WWTW site is located on Portion 7/12 of Doornfonteyn Farm, approximately 3 km west of the Warrenton town centre, within the jurisdiction of Magareng Local Municipality. The site is situated just outside the urban edge and is currently undeveloped, with surrounding land uses including agriculture and a poultry farm. Access to the site is obtained via Erasmus Street. The Google Earth image below shows the locality of the site.

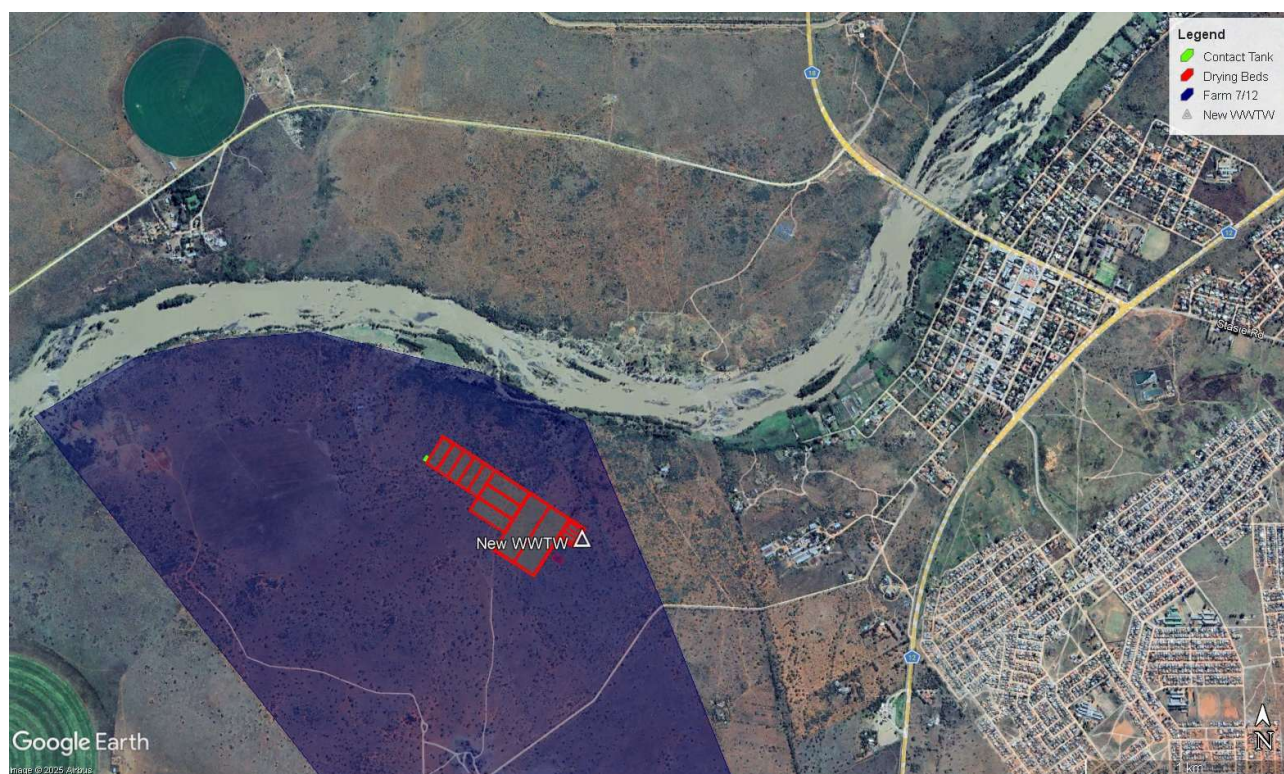


Figure 1: Site Locality Map

The proposed WWTW will be situated further than 300 metres away from the delineated riparian zone of the Vaal River, refer to the figure on the next page.



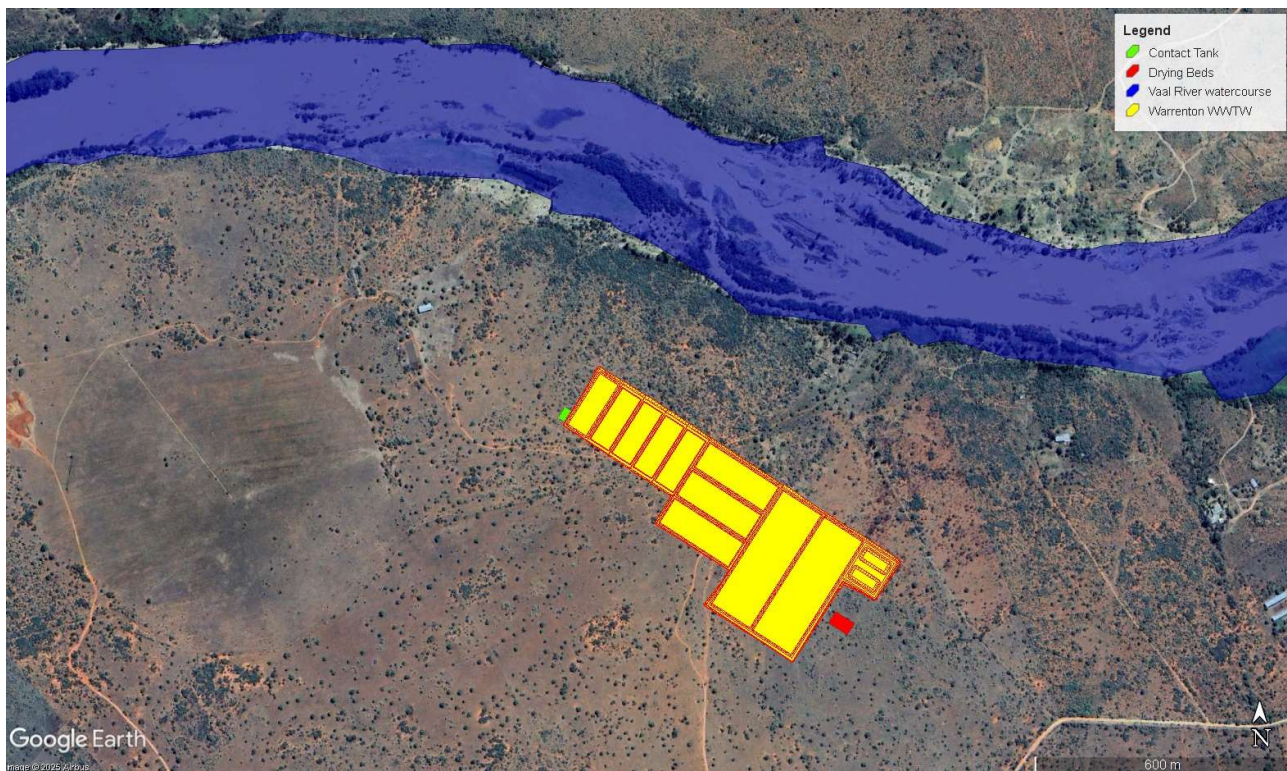


Figure 2: Locality of the WWTW in relation to water bodies

### 1.5.2 Site Information and Land Use

The proposed site is located within the 7/12 Doornfonteyn Farm, previously known as Middelplaats. The farm was acquired during the year 2000 for the Magareng Local Municipality to assist with the extension of the Warrenton Commonage. Based on the Agricultural Potential Report (APR) compiled at the time of acquisition, the farm was used for both irrigation and livestock production. According to the Land Use Management Scheme LUMS from Frances Baard DM, it is zoned Agriculture Zone I (agricultural purposes).

### 1.5.3 Vegetation and Geology

According to Mucina and Rutherford (2006), the area where the proposed WWTW is located comprises Kimberley Thornveld and is in the Eastern Kalahari Bushveld Bioregion. This region is typically characterised by irregular plains, and well-developed tree layers, comprising typically of Camel Thorn/Kameeldoring (*Vachellia erioloba*), Umbrella Thorn trees (*V. tortilis*), Sweet Thorn trees (*V. karroo*) and Shepards Trees (*Boscia albitrunca*) (Mucina & Rutherford, 2006). The existing vegetation across the site comprised of sparse bushes and small trees with a sparse grassy ground cover.

According to the geology map “2824 Kimberley 1:250 000”, the immediate area is comprised of andesite, quartzite and conglomerate lens (Ra), while the surrounding regions are comprised of calcrete, calcified pandune and surface limestone (Gc) and dolerite (Jd).

According to Mucina and Rutherford (2006), Geological formations; the Kimberley Thornveld region comprises two geological formations, namely Andesitic lava of the Allanridge Formation in the north and west and fine-grained sediments of the Karoo Supergroup in the south and east.

#### 1.5.4 Climate

Rainfall occurs during the Summer and Autumn months, while Winters are very dry (Mucina & Rutherford, 2006), with the hottest and wettest month being January and the coldest and driest month being July (Weather and Climate, 2026). The annual average precipitation for the area is 19.06mm. The mean monthly maximum and minimum temperatures for Warrenton are 36.08°C and 9.13°C for January and July, respectively (Weather and Climate, 2026). The figure below shows the mean monthly temperature and precipitation of Warrenton in recent years.

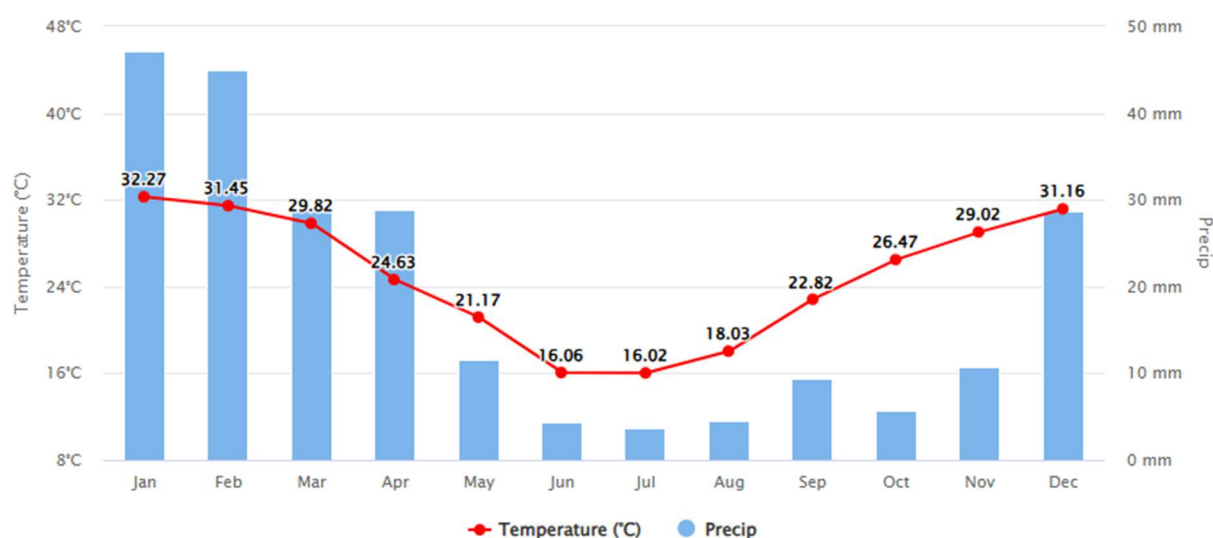


Figure 3: Warrenton mean monthly temperature and precipitation in recent years

#### 1.5.5 Drainage

The area under investigation falls within the C91D Quaternary Catchment Area (Vaal River) of the Vaal Water Management Area.

The overall very gentle-to-near-flat sloping nature of the sites' surface results in low-energy surface runoff (sheet flow), promoting surface water infiltration into the underlying soils rather than rapid surface water flow. This is interpreted to retard runoff, increasing the risk of surface water ponding and fluctuating moisture levels in the subsoils following prolonged precipitation events.

According to the available information, there are no drainage features mapped to traverse the site. The nearest mapped feature is the perennial Vaal River located ~320 m north-east of the WWTW.



### 1.5.6 Topography

The regional setting is seen to be dominated by uniform terrain with the occurrence of broad geomorphological features occasionally broken by the occurrence of large-scale erosional features. The elevation range across the WWTW site is estimated to range between ~1179 mamsl and ~1190 mamsl.

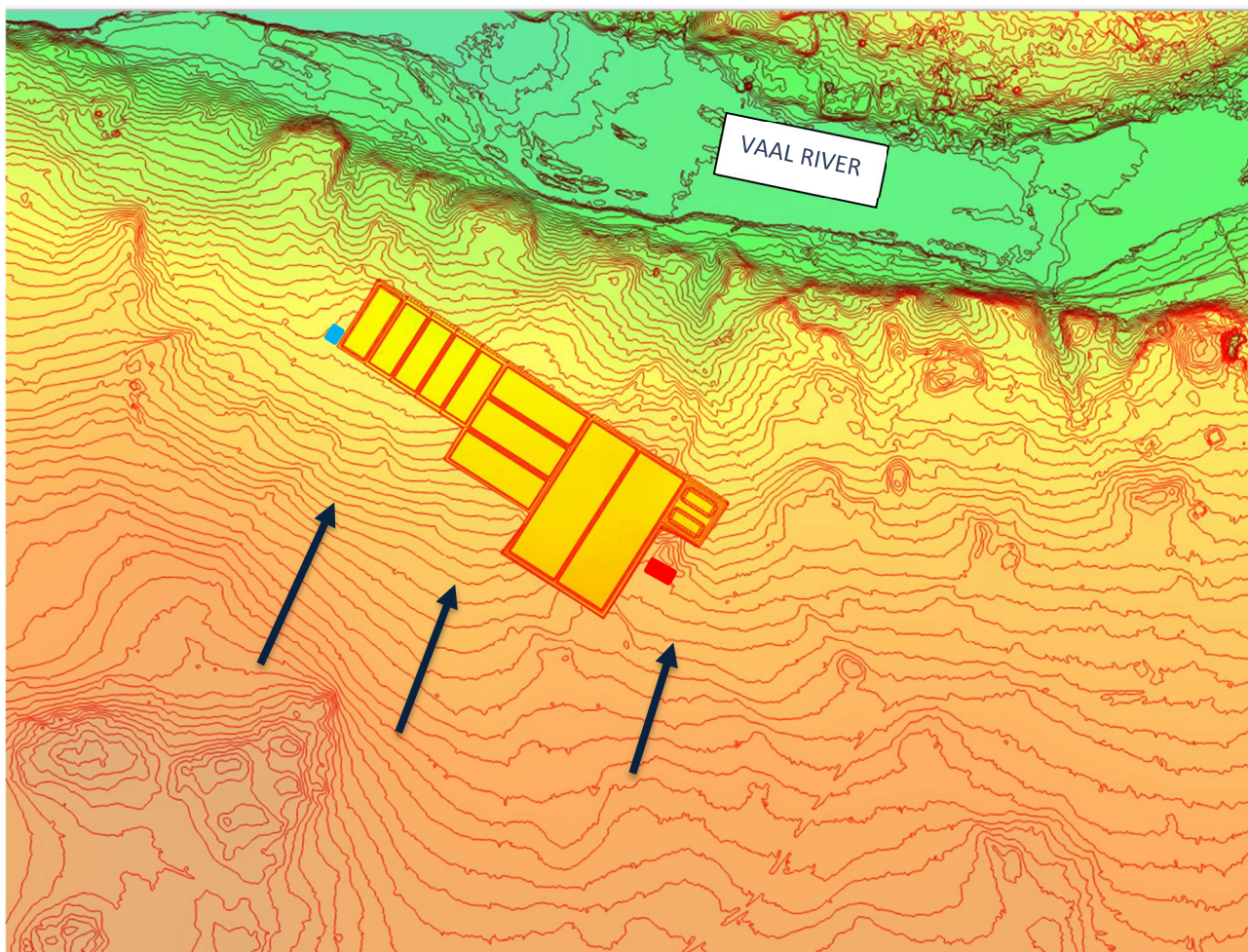


Figure 4: Elevation map of the WWTW site

As depicted in the figure above, a prominent valley (Vaal River) is located to the north of the WWTW area, extending from the north-eastern to south-western portions. The Vaal River meanders north of the WWTW area and is depicted by the blue to green colours in the figure.

The surrounding higher-lying terrain (orange to yellow colours in the figure) is seen to converge on this prominent, with the natural slopes gradually steepening towards the prominent valley (Vaal River) as depicted by the narrowing contour spacing.

As outlined in the figure above, the site is located immediately south of the prominent valley (Vaal River). Consequently, the natural terrain slopes in a general northerly direction as depicted by the arrows in the figure.

According to the available information, the natural terrain displays an overall very gentle to near flat terrain with average measured slopes of less than 1 degree, steepening slightly in a northerly direction.

## 2 STORMWATER MANAGEMENT PHILOSOPHY

The stormwater management strategy for the WWTW is based on a design-led approach, whereby stormwater control measures are integrated into the overall site layout to ensure effective separation, conveyance, and management of runoff in accordance with the requirements of the National Water Act (Act 36 of 1998).

The following key principles apply:

- Diversion of upstream runoff and conveyance:

Runoff originating upstream of the WWTW will be intercepted by means of a cut-off channel and associated berms to prevent ingress into the site.

- Separation of systems:

Stormwater is kept separate from contaminated or potentially contaminated water within the WWTW footprint.

- Containment within the pollution control system:

Stormwater generated within operational areas, oxidation ponds and sludge drying beds is considered potentially contaminated and is contained within the pond system. The oxidation ponds, therefore, function as part of the pollution control system, providing storage, attenuation, and treatment.

- Hydraulic capacity and freeboard provision:

A minimum 500 mm freeboard is provided in all ponds to accommodate stormwater inflows resulting from direct precipitation, thereby preventing overtopping and ensuring continued containment under storm conditions.

- Protection of water resources (Duty of Care):

All reasonable measures are implemented to prevent pollution of surrounding water resources, including nearby drainage lines and the Vaal River, in accordance with Section 19 of the National Water Act.

- Controlled downstream discharge:

Stormwater will be discharged downstream in a controlled and non-erosive manner, with appropriate energy dissipation.

- No uncontrolled discharge:

The system is designed such that contaminated or potentially contaminated water remains contained within the treatment system, with no uncontrolled release to the environment under normal operating conditions.

The filtrate from sludge drying beds is collected via a dedicated drainage system and returned to the head of works through gravity pipework for re-treatment, ensuring full containment within the wastewater process.



## 2.1 Catchment Delineation

The upstream catchment contributing runoff towards the WWTW area has been delineated based on the following:

- Topographic survey and contours
- Observed surface drainage patterns
- Identified natural flow paths

The majority of upstream surface runoff, before the gravel road, drains towards an existing dam (indicated in light blue). The gravel road further intercepts and diverts a portion of the remaining runoff, thereby altering the natural flow regime.

Notwithstanding these existing controls, a residual catchment remains between the gravel road and the WWTW footprint. This area, together with any bypass flow, has been conservatively delineated for design purposes.

The contributing catchment to the proposed cut-off channel (stormwater diversion system) is estimated at approximately 1.0 km<sup>2</sup>, as indicated in Figure 5 below.

The cut-off channel and associated berms are designed to intercept and divert runoff from this catchment around the WWTW. As a result, the WWTW footprint is effectively hydrologically isolated, and no external catchment runoff is permitted to enter the treatment system.

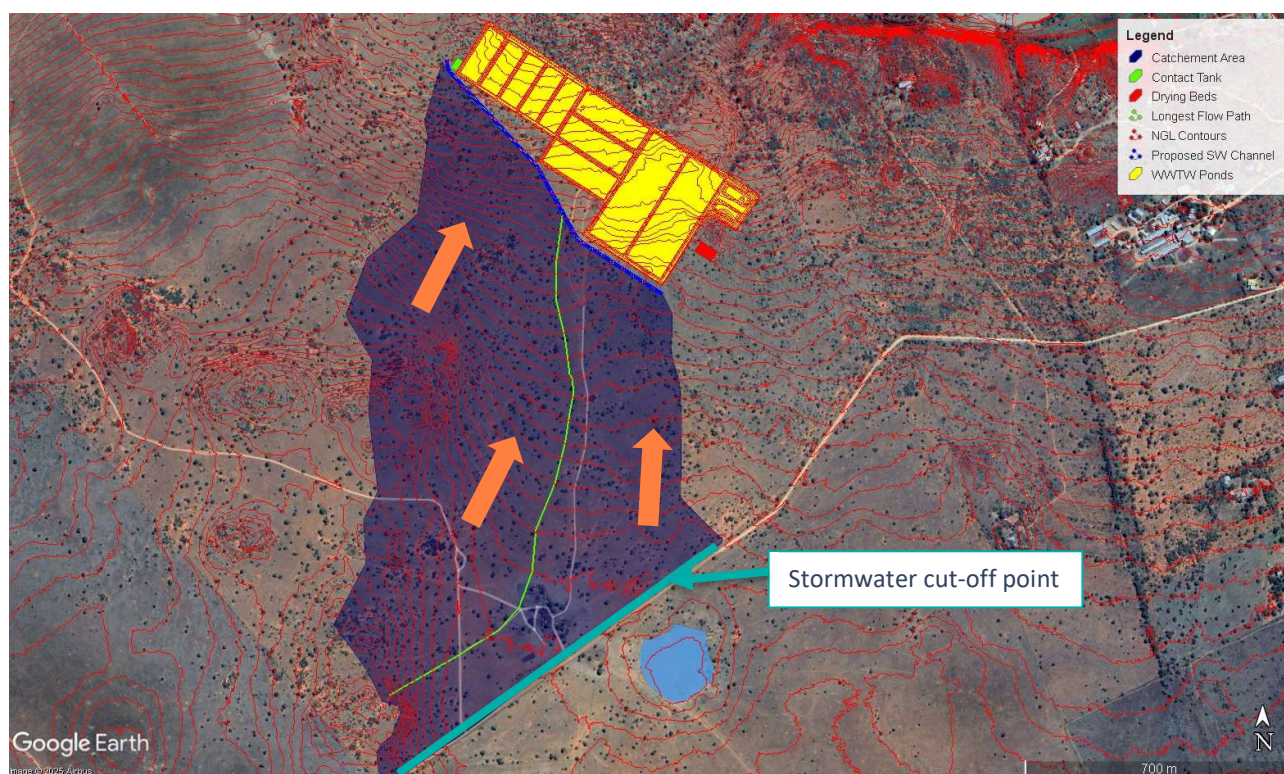


Figure 5: Catchment Area Extents

The derivation of the key hydrological parameters is based on this delineation, as summarised below:

Table 5: Catchment Characteristics

| Item | Catchment Description                                | Value    |
|------|------------------------------------------------------|----------|
| 1    | Catchment Area (km <sup>2</sup> )                    | 1        |
| 2    | Elevation at 0m (mamsl)                              | 1198.360 |
| 3    | Elevation at 1 445m (mamsl)                          | 1184.410 |
| 4    | Elevation at 10% of the longest water course (mamsl) | 1196.268 |
| 5    | Elevation at 85% of the longest water course (mamsl) | 1185.805 |
| 6    | Height difference, H (m)                             | 10.462   |
| 7    | Length of the longest water course, L (km)           | 1.45     |
| 8    | Average Slope, Savg (m/m)                            | 0.00963  |
| 9    | Concentration Time, Tc (hours)                       | 1.7      |

## 2.2 Storm Rainfall Data

The storm data used for this stormwater management plan is derived from the SA Weather Bureau station 0324607W Warrenton.

Station location 28°7' S, 24°51' E

Mean Annual Precipitation (MAP) = 426 mm

The weather station's precipitation summary is provided in the table below.

Table 6: Precipitation associated with various storm durations

| Return Period    |   | 2    | 5     | 10    | 20    | 50    | 100   |
|------------------|---|------|-------|-------|-------|-------|-------|
| Duration in Days | 1 | 45.1 | 62.5  | 74.3  | 85.9  | 101.2 | 112.9 |
|                  | 2 | 56.9 | 79.3  | 94.9  | 110.4 | 131.5 | 147.9 |
|                  | 3 | 62   | 86.2  | 103.2 | 120.3 | 143.4 | 161.6 |
|                  | 7 | 76   | 107.4 | 129.8 | 152.7 | 184.3 | 209.6 |

## 3 HYDROLOGICAL ASSESSMENT

The rate of runoff is controlled, for any topographical slope, by two important mechanisms, the density of vegetation slows the speed at which water can flow over the surface, and the infiltration capacity of the soil, i.e. the rate at which rainwater can be absorbed into the soil, which ranges from near zero to several tens to hundreds of millimetres per hour. The volume of runoff is determined by the capacity of the soil in the top metre or so to hold the water in the root zone of the vegetation from where it is lost by evapotranspiration.

### 3.1 Runoff Estimation Method

Peak runoff from the upstream catchment was estimated using the Rational Method, which is considered appropriate to establish infrastructure feasibility and for sizing of stormwater control measures for small to moderate, predominantly undeveloped catchments.

$$Q = C \cdot I \cdot A$$

Where:

- $Q$  = peak runoff ( $\text{m}^3/\text{s}$ )
- $C$  = runoff coefficient
- $I$  = rainfall intensity ( $\text{m/s}$ )
- $A$  = catchment area ( $\text{m}^2$ )

### 3.2 Parameters

- **Design storm:** 1:20 year recurrence interval
- **Catchment Area (A):**  
 $1.0 \text{ km}^2 = 1,000,000 \text{ m}^2$
- **Runoff Coefficient (C):**  
0.148, corresponding to the 1:20-year design event for a predominantly undeveloped upstream catchment.
- **Rainfall Intensity (I):**  
 $30.85 \text{ mm/hr} = 0.00000857 \text{ m/s}$ , corresponding to the  $T_c$  and 1:20-year design storm as derived from Warrenton weather station rainfall intensity–duration–frequency data.

### 3.3 Peak Runoff Calculation

The summary of the peak runoffs is shown in the table below.

| Return Period | Peak Flows (m <sup>3</sup> /s) |
|---------------|--------------------------------|
| 1:2           | 0.444                          |
| 1:5           | 0.665                          |
| 1:10          | 0.918                          |
| 1:20          | <b>1.266</b>                   |
| 1:50          | 2.039                          |
| 1:100         | 3.023                          |

From the table above, the design peak runoff to be conveyed by the cut-off channel has been determined to be **1.27 m<sup>3</sup>/s**. See Appendix A for the detailed hydrology calculations.

## 4 STORMWATER CONVEYANCE INFRASTRUCTURE

Stormwater conveyance will be achieved through an open channel for surface flow.

Infrastructure will be designed to accommodate peak flows associated with the storm event mentioned above, ensuring safe and controlled conveyance of runoff. The channel alignment considered the site topography, existing drainage lines, pond embankments, access roads, stockpile areas, regulated areas and the final WWTW layout. The channel must not obstruct required operational access or create ponding that may damage infrastructure, cause erosion or redirect flow onto adjacent properties.

A stormwater drainage layout has been developed for the site, illustrating the routing of runoff.

The Figure below shows the proposed stormwater cutoff channel with respect to the WWTW.

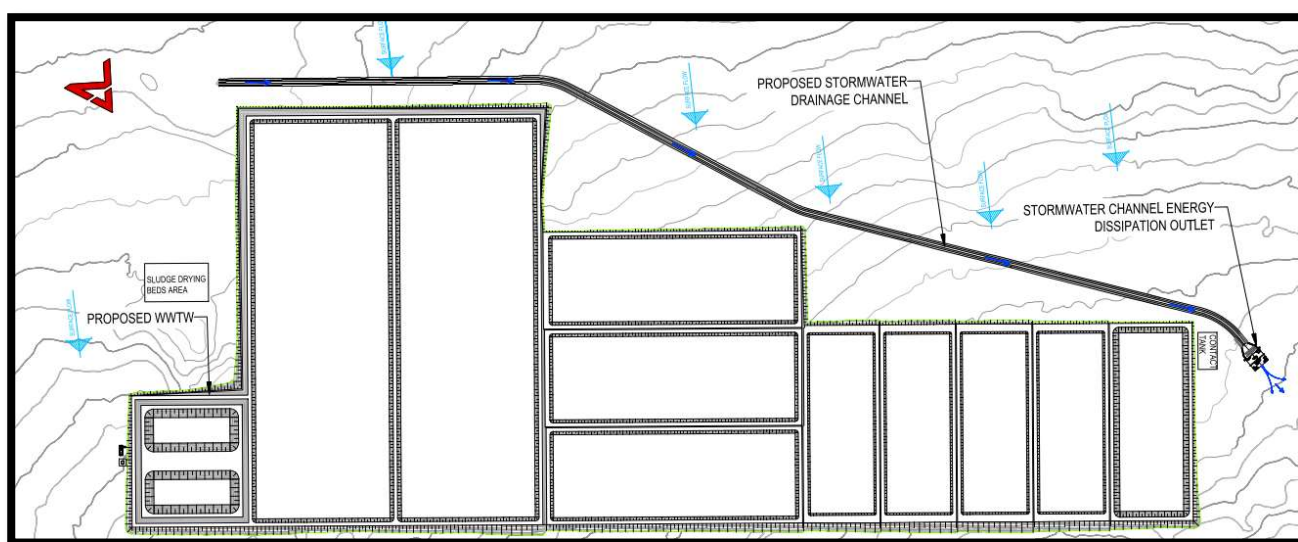


Figure 6: Stormwater Channel in relation to WWTW Layout

### 4.1 Function of the Stormwater Channel

The upstream stormwater channel is an important WULA-relevant control that serves to:

- Intercept sheet flow and concentrated runoff from the upstream catchment
- Prevent clean stormwater from entering oxidation ponds
- Reduce hydraulic loading and overtopping risk
- Limit erosion of pond embankments



## 4.2 Channel Configuration

- Type: Open trapezoidal stormwater channel
- Position: Along the upstream boundary of the oxidation pond footprint
- Alignment: Following natural contours where practicable

## 4.3 Channel Hydraulic Sizing

The stormwater channel has been conservatively sized to accommodate flows in excess of the calculated peak discharge, providing additional freeboard and erosion protection under extreme rainfall conditions.

Table 7: Channel Parameters

| Catchment Description | Value   |
|-----------------------|---------|
| Base width            | 1.500   |
| Side Slope            | 1V : 2H |
| Flow depth            | 0.426   |
| Freeboard             | 0.150   |
| Total Height          | 0.576   |
| Top width             | 3.804   |
| Side length           | 1.288   |

## 4.4 Channel Hydraulics

The stormwater channel has been designed to ensure self-cleansing flow conditions while preventing erosion. Flow velocities are maintained within the range of 0.9 m/s to 1.5 m/s for continuous flow conditions. The lower limit minimises the risk of sediment deposition, while the upper limit prevents scouring of the grass lining.

The longitudinal slope of the drain was taken as the average slope of the natural ground profile along the alignment (approx. 1%). Hydraulic capacity and flow characteristics were assessed using the Manning equation, assuming a roughness coefficient of  $n = 0.035$ , representative of a well-maintained grass-lined channel.

### 4.4.1 Design Flow Condition (Excluding Freeboard)

Cross-sectional properties at design flow depth  $y = 0.426$  m:

- Flow area,  $A = 1.00 \text{ m}^2$
- Wetted perimeter,  $P = 3.41 \text{ m}$
- Hydraulic radius,  $R = 0.293 \text{ m}$

Manning's equation:

$$Q = \frac{1}{n} \cdot AR^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

$$Q = 1.26 \text{ m}^3/\text{s}$$



This confirms that the 1:20-year design discharge is conveyed below the top of bank, without reliance on freeboard. The corresponding mean flow velocity is 1.26 m/s, which is within acceptable limits for a grass-lined trapezoidal channel under maintained grass conditions.

#### 4.4.2 Design Flow Condition (Including Freeboard)

With the freeboard included, the effective depth becomes  $y = 0.576$  m.

Cross-sectional properties at full depth:

- Flow area,  $A = 1.53 \text{ m}^2$
- Wetted perimeter,  $P = 4.08 \text{ m}$
- Hydraulic radius,  $R = 0.375 \text{ m}$

**$Q = 2.27 \text{ m}^3/\text{s}$**

When the freeboard depth is included, the channel provides a reserve hydraulic capacity of approximately  $2.3 \text{ m}^3/\text{s}$ , equivalent to nearly double the design discharge, affording substantial protection against overtopping during extreme rainfall events, sediment accumulation, or partial blockage. The freeboard provision, therefore, ensures a robust and conservative design. The corresponding mean flow velocity is 1.49 m/s, which is also within acceptable limits for a grass-lined trapezoidal channel under maintained grass conditions.

Table 8: Channel Capacity

| Channel Condition | Flow Depth (m) | Discharge ( $\text{m}^3/\text{s}$ ) | Velocity (m/s) |
|-------------------|----------------|-------------------------------------|----------------|
| Design Flow depth | 0.426          | 1.26                                | 1.26           |
| With freeboard    | 0.576          | 2.27                                | 1.49           |

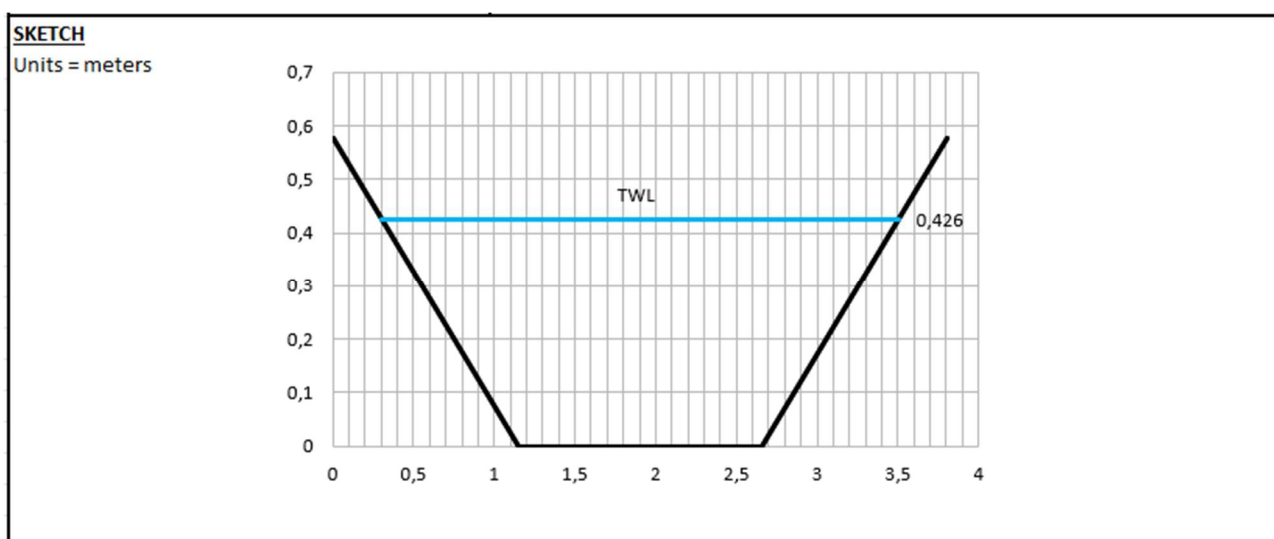


Figure 7: Channel sketch

## 4.5 Channel Lining and Erosion Protection

Based on the hydraulic analysis, the following erosion protection measures are proposed:

### 4.5.1 Channel lining:

Grass lining is considered suitable for the majority of the channel length, with predicted flow velocities of approximately 1.3 m/s under the design event, which is within acceptable limits for well-established vegetation.

### 4.5.2 Localised protection:

Stone pitching, riprap, or equivalent erosion protection will be provided at bends, transitions, and outlet structures where increased velocities and turbulence are expected.

### 4.5.3 Energy dissipation:

Appropriate energy dissipation measures will be implemented at discharge points to reduce flow velocities and prevent erosion or scouring of the receiving environment.

## 4.6 Construction Method for the Channel

- Set out the channel alignment, levels and tie-in points in accordance with the approved stormwater layout.
- Clear only the approved footprint required for the channel and associated drainage works.
- Strip and stockpile usable topsoil separately for reinstatement or rehabilitation.
- Remove unsuitable material from the channel foundation area as instructed by the Engineer.
- Construct the channel using approved material placed in controlled layers and compacted to the Engineer's specification.
- Shape the channel to the approved profile, including crest, side slopes, channel side and discharge points.
- Install erosion protection at bends, outlets, steep sections and areas of concentrated flow.
- Stabilise exposed channel surfaces as soon as practicable using approved vegetation or erosion-control measures.
- Inspect the channel before major earthworks commence and after every significant rainfall event.
- Repair erosion, settlement, cracks, overtopping damage or animal/vehicle damage immediately.

## 4.7 Channel Operation and Maintenance

The stormwater channel shall remain functional throughout construction and, where incorporated into the permanent design, throughout operation of the WWTW. Sediment accumulation, blockages, erosion, vegetation loss, animal burrows, vehicle damage and settlement shall be repaired promptly.

The channel shall not be breached, lowered, driven over, used as a stockpile platform or altered. Where temporary crossings over the channel are unavoidable, they shall be designed and reinstated to maintain the hydraulic function of the channel.

## 4.8 Oxidation Pond Protection Measures

Specific measures are incorporated into the design to protect the oxidation pond system and maintain treatment integrity:

### 4.8.1 Embankment design and freeboard:

The oxidation ponds are constructed above natural ground level and enclosed by engineered embankments, with a minimum 500 mm freeboard provided to accommodate stormwater inflows resulting from direct precipitation.

### 4.8.2 Exclusion of external runoff:

The upstream cut-off channel and berm system ensures that external stormwater runoff is intercepted and diverted around the WWTW, preventing inflow into the pond system.

### 4.8.3 Emergency overland flow routing:

Overland flow paths are defined for storm events exceeding the design capacity, directing runoff away from the WWTW footprint to prevent inundation of critical infrastructure.

### 4.8.4 Supplementary berm protection:

An additional earth berm is provided upstream of the Anaerobic and Facultative ponds as a secondary protection measure against potential overland flow ingress.

### 4.8.5 Operational integrity:

These measures collectively prevent stormwater ingress, minimise hydraulic overloading, and maintain the required freeboard and treatment efficiency.

## 4.9 Prevention of Contaminated Runoff Discharge

Measures to prevent contaminated or potentially contaminated runoff from entering surrounding land and watercourses include:

### 4.9.1 Full containment within the pollution control system:

Runoff generated within the WWTW operational footprint is regarded as potentially contaminated and is contained within the treatment system, including the oxidation ponds.

### 4.9.2 Return to treatment process:

Where feasible, contaminated runoff and filtrate (e.g. from sludge drying beds) are returned to the head of works for re-treatment.

#### 4.9.3 No uncontrolled discharge:

The system is designed to ensure that no contaminated or potentially contaminated water is discharged to the surrounding environment under normal operating conditions.

### 4.10 Downstream Erosion Protection and Flow Attenuation

The discharge of diverted stormwater downstream of the cut-off channel and the WWTW has been assessed to ensure that no adverse erosion or scouring impacts occur within the receiving environment.

The following measures are to be implemented:

#### 4.10.1 Controlled discharge point:

Stormwater from the cut-off channel is discharged at a defined location selected based on existing topography and natural drainage patterns, to avoid concentration of flow in sensitive or unstable areas.

#### 4.10.2 Energy dissipation at outlets:

Energy dissipation structures are provided at the channel outlet to reduce flow velocities to acceptable levels prior to entering the natural environment.

#### 4.10.3 Velocity reduction and spread of flow:

The discharged flows will spread over vegetated areas downstream to promote sheet flow conditions, thereby reducing flow concentration and minimising erosion potential.

#### 4.10.4 Erosion-resistant protection:

Areas immediately downstream of discharge points are protected using reno mattresses at the outlet structure, designed to withstand the anticipated hydraulic conditions.

#### 4.10.5 Stabilisation of downstream flow paths:

Natural drainage lines receiving stormwater will be assessed for stability. Where required, localised stabilisation measures will be implemented to prevent channel incision or bank erosion.

#### 4.10.6 No increase in downstream erosion risk:

The stormwater discharge regime from the proposed channel is such that it does not result in an increase in erosion potential compared to current conditions.

#### 4.10.7 Monitoring and maintenance:

Provision is made for routine inspection of outlet structures and downstream areas, with maintenance undertaken as required to address any signs of erosion or sediment deposition.

## 5 CONSTRUCTION PHASE STORMWATER MANAGEMENT

During the construction phase, appropriate erosion and sediment control measures will be implemented to minimise the transport of sediment, litter, and debris from disturbed areas, in accordance with the duty of care requirements of the National Water Act (Act 36 of 1998).

All control measures will be installed prior to the commencement of earthworks and maintained throughout the construction period.

### 5.1 Site Establishment

The site camp, laydown areas, parking areas, material storage, refuelling areas, waste areas, spoil areas, and concrete washout areas shall be located outside watercourses, drainage lines, flood-prone areas, riparian areas and sensitive stormwater pathways unless specifically approved with suitable protection measures.

- Install temporary stormwater controls before site establishment areas become operational.
- Divert clean runoff around site establishment areas using berms, cut-off drains or diversion channels.
- Contain runoff from refuelling, hazardous substances, concrete washout and waste storage areas.
- Provide spill kits, drip trays and bunded storage where fuels, oils and chemicals are handled.
- Ensure welfare facilities and temporary sanitation do not discharge into stormwater pathways or open ground.

### 5.2 Demarcation and No-Go Areas

Before construction starts, the approved WWTW footprint, stormwater channel alignment, drainage controls, access routes, stockpile areas, spoil areas, pipeline servitudes, watercourse buffers, regulated areas and no-go areas shall be demarcated.

- No construction activity, stockpiling, refuelling, waste disposal, concrete washout, unnecessary vehicle movement or material storage may occur outside the approved demarcated areas.
- Demarcation shall remain in place until the Engineer/ECO confirms that the relevant area may be rehabilitated or opened.

### 5.3 Earthworks and Pond Construction

Bulk earthworks for the ponds, reed beds, treated-effluent storage pond, platforms, access roads and associated infrastructure will expose soils and create a high risk of sediment-laden runoff. Stormwater controls shall therefore be installed before major earthworks commence.

- Construct and maintain the stormwater channel and temporary cut-off drains to keep clean runoff away from earthworks areas.

- Prevent clean stormwater from entering pond excavations, wet wells, pipeline trenches and concrete works.
- Direct sediment-laden runoff from exposed areas to sediment traps, silt fences or settlement areas within the construction footprint.
- Stabilise exposed embankments, slopes and pond edges progressively.
- Protect pond floors, liner subgrades and embankments from erosion before liner installation.
- Avoid placing loose fill or spoil in drainage paths or areas where runoff can mobilise sediment.
- Inspect pond embankments and erosion controls after rainfall and repair damage immediately.

## 5.4 Pond Liners, Reed Beds and Storage Pond

- Prepared liner subgrades shall be protected from stormwater erosion, ponding and contamination.
- Stormwater shall be diverted away from liner works and anchor trenches.
- Sediment shall not be allowed to enter reed bed media, distribution pipework or outlet control structures.
- No wastewater shall be introduced into ponds, reed beds or storage pond until stormwater controls, liners and water-retaining structures have been inspected and approved.

## 5.5 Trenches/Excavations

Trenches shall not be allowed to function as uncontrolled stormwater channels. The Contractor shall limit the length of open trench and shall reinstate and stabilise trenches as soon as practicable.

- Install temporary berms or cut-off drains to prevent stormwater from entering trenches.
- Manage accumulated rainwater in trenches through sediment-control measures within the construction footprint.
- Prevent sediment-laden trench water from being discharged directly to drainage lines, watercourses or stormwater systems.
- Reinstate surface levels and drainage patterns after backfilling.
- Repair settlement, erosion, rutting or ponding along pipeline routes immediately.

## 5.6 Access Roads and Internal Roads

- Use approved access routes only and avoid unnecessary vehicle movement through drainage paths or sensitive areas.
- Provide side drains, cut-off drains, mitre drains or berms where required to prevent road runoff from eroding exposed areas.
- Stabilise road shoulders, culvert outlets, stormwater outlets and steep sections.
- Provide energy dissipation where runoff is concentrated at discharge points.
- Maintain access roads to prevent rutting, sediment transport and erosion after rainfall.



## 5.7 Stockpile, Spoil and Material Management

- Stockpiles and spoil areas shall be located only in approved areas outside drainage lines, watercourses, flood-prone areas, riparian areas and stormwater flow paths.
- Topsoil shall be stockpiled separately from subsoil, spoil, rubble and contaminated material.
- Stockpiles shall be shaped, stabilised and protected with channels, silt fences, covering or vegetation where required.
- Spoil shall not be placed where runoff can carry sediment into drainage features or water resources.
- Excess spoil and unsuitable material shall be removed to approved spoil or disposal areas.

## 5.8 Concrete, Cement and Washout Control

- Concrete washout shall occur only within designated lined washout areas approved by the Engineer/ECO.
- Cement, grout, slurry and wash water shall be contained and shall not enter stormwater drains, watercourses, trenches, pond excavations or open ground.
- Concrete washout areas shall be located away from stormwater pathways and protected from rainfall runoff.
- Cement bags and cementitious material shall be stored under cover and protected from runoff.
- Concrete spills shall be cleaned before hardening and disposed of at an approved facility.

## 5.9 Fuel, Oil and Hazardous Substances

- Fuel, oil, chemicals and hazardous substances shall be stored in bunded areas away from drainage lines and stormwater flow paths.
- Refuelling shall only occur in approved areas using drip trays and spill kits.
- Stationary plant, pumps, generators and compressors shall be placed on drip trays where leakage risk exists.
- Contaminated soil or absorbent material utilised in spill remediation shall be collected and disposed at the appropriately licensed facilities.
- Contaminated runoff shall not be allowed to leave the site or enter stormwater systems or water resources.

## 5.10 Crossings and Regulated Areas

Where pipelines, access roads, road crossings, service crossings, drainage-line crossings or other infrastructure occur within or near watercourses, drainage lines, floodplain areas, stormwater pathways or regulated areas, additional controls shall be implemented.

- Minimise the working footprint and duration of disturbance.
- Install sediment and erosion controls before disturbance begins.
- Keep stockpiles, spoil, waste, fuel, cement and concrete washout outside sensitive areas.
- Maintain natural flow paths as far as practicable.

- Contain drilling fluid, slurry, spoil and sediment-laden water where HDD or open-cut crossings are used.
- Manage accumulated rainwater from open excavations through sediment-control measures within the construction footprint.
- Reinstatement and stabilise disturbed areas immediately after completion of crossing works.

## 5.11 Rainfall Preparedness

The Contractor shall monitor weather forecasts and prepare the site before rainfall events. Before forecast rainfall, the Contractor shall inspect and secure the stormwater channel, cut-off drains, silt fences, sediment traps, stockpiles, concrete washout areas, fuel areas and open excavations.

- Remove loose material from drainage paths.
- Ensure the stormwater channel is continuous and not breached.
- Stabilise or cover erodible stockpiles where required.
- Secure fuel, chemicals, waste and cementitious materials.
- Ensure pumps, spill kits and emergency equipment are available.
- After rainfall, inspect the site, record damage and repair erosion, blockages, sediment build-up or failed controls immediately.

Refer to Appendix D for the checklist.

## 5.12 Management of Accumulated Rainwater in Excavations and Trenches

Accumulated rainwater in pond excavations, trenches, wet wells or foundation excavations shall be managed as a stormwater control issue within the approved construction footprint. If unexpected subsurface water inflow is encountered, the Contractor shall stop the affected activity and obtain instructions from the Engineer, ECO and EAP before any pumping or disposal method is implemented.

Table 9: Rainwater Management Requirements

| Type of water                            | Management requirement                                                                                                                                                                     |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rainwater accumulated in the excavations | Inspect for sediment and contamination. If clean, manage within the construction footprint in a controlled manner that does not cause erosion, runoff to sensitive areas or off-site flow. |
| Sediment-laden rainwater                 | Route through sediment traps, silt bags, stilling basins or settlement areas before any further handling within the construction footprint.                                                |
| Hydrocarbon-contaminated water           | Contain and manage as contaminated water. Do not discharge to soil, stormwater pathways or water resources.                                                                                |
| Cement-contaminated water                | Contain and dispose of lawfully. Do not discharge to soil, drainage lines or stormwater pathways.                                                                                          |

| Type of water                                | Management requirement                                                                                                                                    |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sewage-impacted or sludge-contaminated water | Contain and return to the wastewater treatment process where appropriate and approved or remove for lawful disposal. Do not discharge to the environment. |

### 5.13 Erosion and Sediment Control Measures

The selection and placement of erosion and sediment control measures shall be confirmed by the Engineer according to site levels, soil conditions, drainage patterns, construction sequencing and rainfall risk.

Table 10: Erosion and Sediment Control Measures

| Control measure                      | Application                                                                                                           |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Stormwater channel                   | Primary clean-water diversion around the WWTW footprint and sensitive construction areas.                             |
| Cut-off drains/diversion channels    | Intercept and route clean runoff away from disturbed or potentially contaminated areas.                               |
| Silt fences                          | Control sediment at the toe of exposed slopes, stockpiles and small disturbed areas.                                  |
| Sediment traps/settlement areas      | Settle sediment from dirty runoff or accumulated rainwater before further handling within the construction footprint. |
| Check dams                           | Slow flow velocity in temporary drains and reduce erosion.                                                            |
| Stone pitching/riprap                | Protect outlets, channels, embankments and concentrated flow areas.                                                   |
| Gabions/reno mattresses              | Stabilise high-risk erosion areas and energy dissipation points where required by the approved design.                |
| Geotextiles/erosion blankets         | Stabilise exposed slopes and rehabilitated areas.                                                                     |
| Topsoil replacement and revegetation | Provide long-term stabilisation of disturbed areas after construction.                                                |
| Progressive rehabilitation           | Reduce exposed soil area and long-term sediment generation.                                                           |

## 6 OPERATIONAL PHASE STORMWATER MANAGEMENT

The permanent stormwater management system shall be completed and functional before the WWTW is commissioned. During the operational phase of the WWTW, routine inspection and maintenance of the stormwater management system will be undertaken to ensure continued functionality, hydraulic performance, and protection of surrounding water resources.

Maintenance activities will focus on the cut-off channel, diversion structures, oxidation ponds, irrigation infrastructure, outlet structures, and downstream discharge areas.

### 6.1 Cut-off Channel and Diversion System

The cut-off channel and associated berms are critical in maintaining the separation of clean and contaminated water systems.

- Routine inspections:

The channel will be inspected regularly and after significant rainfall events to identify erosion, sediment build-up, vegetation overgrowth, or structural damage.

- Sediment removal:

Accumulated sediment within the channel will be removed periodically to maintain hydraulic capacity and prevent flow obstruction.

- Vegetation management:

Grass lining will be maintained to ensure adequate cover and erosion resistance. Excessive vegetation that may impede flow will be controlled.

- Erosion repairs:

Any signs of channel bed or side slope erosion will be repaired promptly using appropriate stabilisation measures (e.g. regrading, re-vegetation, or stone protection).

- Berm integrity:

Berms will be inspected to ensure structural stability and adequate crest levels are maintained to prevent overtopping or breaching.

## 6.2 Oxidation Ponds and Embankments

The oxidation ponds form part of the pollution control system and require ongoing maintenance to ensure containment and treatment efficiency.

- Freeboard monitoring:

Pond water levels will be regularly monitored to ensure that the minimum 500 mm freeboard is always maintained.

- Embankment inspection:

Pond embankments will be inspected for signs of erosion, settlement, cracking, animal burrowing, or vegetation that may compromise structural integrity.

- Seepage control:

Any evidence of seepage or leakage will be investigated and addressed promptly.

- Vegetation control:

Vegetation on embankments will be maintained to prevent erosion while avoiding deep-rooted plants that could damage liners or embankment stability.

- Hydraulic performance:

Inflows to the ponds will be monitored to ensure that no external stormwater ingress occurs.

### 6.2.1 Treated Effluent Storage and Irrigation Areas

The downstream storage pond is intended for the storage of treated final effluent and the management of the reuse of final treated effluent for irrigation purposes. Stormwater from external clean areas shall not be intentionally routed into treated effluent storage or process units.

Irrigation infrastructure, pumping infrastructure, and treated effluent storage areas shall be operated to prevent runoff, ponding, over-irrigation, erosion, unauthorised discharge or irrigation outside approved areas.

### 6.2.2 Outlet Structure and Energy Dissipation Measures

Outlet structures and associated energy dissipation systems must function effectively to prevent downstream erosion.

- Structural inspection:

Outlet structures, including aprons and stilling basins, will be inspected for damage, displacement, or blockage.

- Scour monitoring:

Areas downstream of outlets will be monitored for signs of scour or erosion.

- Maintenance and repair:

Any damaged or displaced erosion protection (e.g. riprap or pitching) will be reinstated to maintain design performance.

### 6.2.3 Downstream Discharge Areas

The receiving environment downstream of the WWTW will be monitored to ensure that stormwater discharge remains non-erosive.

- Erosion monitoring:

Downstream channels and flow paths will be inspected for bank instability, channel incision, or sediment deposition.

- Stabilisation measures:

Where erosion is identified, appropriate remedial measures will be implemented, such as additional armouring, regrading, or revegetation.

- Environmental protection:

Measures will be taken to ensure that no polluted or contaminated water is discharged to the surrounding land or watercourses.

### 6.2.4 General Maintenance and Compliance

- Inspection frequency:

Inspections will be undertaken at regular intervals and following significant rainfall events. Appendix E.

- Record keeping:

Maintenance activities and inspections will be documented for compliance and auditing purposes. Appendix E.

- Corrective actions:

Any deficiencies identified during inspections will be addressed promptly to ensure continued system performance. Appendix F.

- Compliance:

All maintenance activities will be undertaken in accordance with the duty of care requirements of the National Water Act (Act 36 of 1998) and applicable licence conditions.



## 7 INSPECTION, MONITORING AND MAINTENANCE

Stormwater controls shall be inspected and maintained throughout construction and operation. Inspection records shall be retained for close-out and for DWS/VOCMA WULA compliance purposes.

Table 11: Inspection, Monitoring and Maintenance Control

| Item                                  | Minimum inspection frequency during construction    | Inspection focus                                                                                |
|---------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Stormwater channel                    | Weekly, before forecast rainfall and after rainfall | Continuity, overtopping, breaches, settlement, erosion, sediment build-up, outlets and tie-ins. |
| Cut-off drains and diversion channels | Weekly and after rainfall                           | Blockages, erosion, sediment accumulation, bypass flow and outlet stability.                    |
| Silt fences and sediment traps        | Weekly and after rainfall                           | Sediment accumulation, undermining, tears, overtopping and effectiveness.                       |
| Pond excavations and embankments      | Daily during active earthworks and after rainfall   | Erosion, ponding, slope failure, liner/subgrade protection and sediment movement.               |
| Pipeline trenches                     | Daily, while open and after rainfall                | Runoff entry, collapse, sediment-laden water, accumulated rainwater and reinstatement.          |
| Stockpiles and spoil areas            | Weekly and after strong wind or rainfall            | Erosion, runoff paths, sediment loss and stability.                                             |
| Concrete washout areas                | Weekly and after concrete works                     | Capacity, containment, leaks and improper disposal.                                             |
| Fuel and chemical storage areas       | Weekly and after rainfall                           | Leaks, bund capacity, spill kits and contaminated runoff risk.                                  |
| Access roads                          | Weekly and after rainfall                           | Rutting, erosion, drainage function and sediment transport.                                     |
| Rehabilitation areas                  | Monthly and after rainfall                          | Vegetation establishment, erosion, settlement and repairs required.                             |

## 8 INCIDENT AND EMERGENCY RESPONSE

Stormwater-related incidents shall be addressed immediately to prevent pollution, erosion, sedimentation or damage to water resources. Incidents shall be recorded and reported in accordance with the WUL, EMPr and applicable project procedures.

### 8.1.1 Stormwater-Related Incidents

- Release of sediment-laden water from the managed construction area.
- Breach, overtopping or failure of the stormwater channel.
- Contaminated runoff entering soil, stormwater systems, drainage lines, watercourses or open ground.
- Fuel, oil, chemical, sewage, sludge, screenings, grit or cement spill.
- Uncontrolled management of accumulated rainwater from excavations or trenches.
- Erosion entering a drainage line or watercourse.
- Stormwater entering wastewater infrastructure and causing overflow or bypass risk.
- Ponding or diversion of runoff causing damage to neighbouring land or infrastructure; and
- Failure of rehabilitation resulting in erosion or sedimentation.

### 8.1.2 Immediate Response Procedure

- Stop the activity causing the incident, where safe to do so.
- Contain the release using berms, sandbags, absorbents, silt fences or temporary bunding.
- Notify the Site Agent, Engineer, ECO and Client representative immediately.
- Prevent further runoff from entering or leaving the affected area.
- Recover contaminated water, soil, sediment or waste where practicable.
- Dispose of contaminated material lawfully.
- Repair failed stormwater controls, berms, drains or erosion protection.
- Photograph and record the incident, cause, corrective action and prevention measures.
- Report to DWS, VOCMA or other authorities where required by the WUL, EMPr or legislation.

## 9 REHABILITATION

Temporary stormwater controls shall remain in place until disturbed areas are stabilised, and permanent stormwater controls are functional. The stormwater channel, diversion drains, channels and outlets shall be reinstated or retained according to the final design.

- Remove temporary infrastructure, rubble, waste, excess spoil and redundant controls where no longer required.
- Reshape disturbed areas to stable, free-draining profiles that do not cause erosion or ponding.
- Replace stockpiled topsoil on disturbed areas where appropriate.
- Stabilise slopes, berms, drainage lines, pond embankments and exposed soils.
- Install erosion protection at outlets, concentrated flow paths and high-risk areas.
- Revegetate disturbed areas using approved species in accordance with the EMPr and specialist recommendations.
- Inspect rehabilitated areas after rainfall and repair erosion, settlement or failed vegetation establishment.

## 10 CONCLUSION

This Stormwater Management Plan demonstrates that stormwater associated with the delineated 1.0 km<sup>2</sup> upstream catchment can be effectively managed through the implementation of an upstream cut-off channel and diversion system, thereby preventing ingress into the WWTW.

The proposed stormwater management system:

- Safely conveys the 1:20-year design discharge within the diversion channel
- Provides adequate freeboard and reserve capacity within the channel system
- Incorporates appropriate erosion protection measures to ensure non-erosive flow conditions
- Ensures complete diversion of external runoff, thereby maintaining hydrological isolation of the WWTW
- Prevents stormwater ingress into the oxidation pond system, protecting treatment processes and maintaining required freeboard
- Facilitates controlled and non-erosive downstream discharge, with energy dissipation measures provided
- Ensures that no contaminated or potentially contaminated runoff is discharged to the surrounding environment under normal operating conditions
- Complies with the requirements of the National Water Act (Act 36 of 1998) and applicable General Authorisations and/or Water Use Licence conditions

The oxidation pond system, constructed above natural ground level and operated with a minimum 500 mm freeboard, provides a robust containment mechanism for wastewater and unavoidable direct precipitation within the facility footprint.

The greenfield nature of the site has enabled stormwater management to be fully integrated into the design from the outset, ensuring a proactive, compliant, and sustainable approach aligned with current best practice.

## Appendix A – CATCHMENT RUNOFF CALCULATIONS

| RATIONAL METHOD                                                          |                                       |                 |                              |                                     |                |                       |         |
|--------------------------------------------------------------------------|---------------------------------------|-----------------|------------------------------|-------------------------------------|----------------|-----------------------|---------|
| Secondary drainage region number                                         | C9                                    |                 |                              | Main watercourse/river              | Vaal River     |                       |         |
| Tertiary drainage region number                                          | C91                                   |                 |                              | Designed                            | Sesethu Zibaya |                       |         |
| Quaternary drainage region number                                        | C91D                                  |                 |                              | Checked                             | Wynand Smit    |                       |         |
| Catchment description                                                    | Vaal River                            |                 |                              | Date                                | April 24, 2026 |                       |         |
| PHYSICAL CATCHMENT CHARACTERISTICS                                       |                                       |                 |                              |                                     |                |                       |         |
| Rainfall region                                                          | Inland/summer                         |                 |                              | AREA DISTRIBUTION FACTORS           |                |                       |         |
| MAP (mm)                                                                 | 426                                   | mm              |                              | Rural areas ( $\alpha$ )            | 100            | %                     |         |
| Size of catchment (A)                                                    | 1,000                                 | km <sup>2</sup> |                              | Urban areas ( $\beta$ )             | 0              | %                     |         |
| Overland flow distance ( $L_O$ )                                         | 1,450                                 | km              |                              | Lakes ( $\gamma$ )                  | 0              | %                     |         |
| Overland flow height difference (H)                                      | 13,950                                | m               |                              | Dolomite area (D)                   | 0              | %                     |         |
| Average overland slope ( $S_O$ )                                         | 0,010                                 | m/m             |                              | ARTIFICIAL FLOW                     |                |                       |         |
| Overland flow surface (r value)                                          | 0,300                                 |                 |                              | Street flow                         |                | Canal flow            |         |
| Longest main watercourse ( $L_{CH}$ )                                    | 1,449                                 | km              |                              | Flow path length (km)               |                | Canal length (km)     |         |
| Average channel slope ( $S_{CH}$ )                                       | 0,00963                               | m/m             |                              | Slope (m/m)                         |                | Actual velocity (m/s) |         |
|                                                                          |                                       |                 |                              | Actual velocity (m/s)               |                | Max velocity (m/s)    |         |
| RURAL RUNOFF COEFFICIENTS ( $C_1$ )                                      |                                       |                 |                              | URBAN RUNOFF COEFFICIENTS ( $C_2$ ) |                |                       |         |
| Average catchment slope                                                  | %                                     | Factor          | $C_s$                        | Lawns                               | %              | Factor                | $C_2$   |
| Vleis and pans (0-3%)                                                    | 90                                    | 0,010           | 0,009                        | Sandy, flat (<2%)                   |                | 0,100                 |         |
| Flat areas (3-10%)                                                       | 5                                     | 0,060           | 0,003                        | Sandy, steep (>7%)                  |                | 0,200                 |         |
| Hilly (10-30%)                                                           | 5                                     | 0,120           | 0,006                        | Heavy soil, flat (<2%)              |                | 0,170                 |         |
| Steep areas (>30%)                                                       | 0                                     | 0,220           | 0,000                        | Heavy soil, steep (>7%)             |                | 0,350                 |         |
| Total                                                                    | 100                                   | Total           | 0,018                        | Total                               | 0              | Total                 | 0,000   |
| Hydrological soil group/permeability                                     | %                                     | Factor          | $C_p$                        | Residential areas                   | %              | Factor                | $C_2$   |
| Very permeable (A)                                                       |                                       | 0,030           |                              | Houses                              |                | 0,500                 |         |
| Very permeable (A/B)                                                     |                                       | 0,040           |                              | Flats                               |                | 0,700                 |         |
| Permeable (B)                                                            | 70                                    | 0,060           | 0,042                        | Total                               | 0              | Total                 | 0,000   |
| Permeable (B/C)                                                          |                                       | 0,080           |                              | Industry                            | %              | Factor                | $C_2$   |
| Semi-permeable (C)                                                       | 30                                    | 0,120           | 0,036                        | Light industry                      | 0              | 0,800                 | 0,000   |
| Semi-permeable (C/D)                                                     | 0                                     | 0,160           | 0,000                        | Average industry                    | 0              | 0,850                 | 0,000   |
| Impermeable (D)                                                          | 0                                     | 0,210           | 0,000                        | Heavy industry                      | 0              | 0,900                 | 0,000   |
| Total                                                                    | 100                                   | Total           | 0,078                        | Total                               | 0              | Total                 | 0,000   |
| Land use/vegetation                                                      | %                                     | Factor          | $C_v$                        | Business                            | %              | Factor                | $C_2$   |
| Thick bush and plantations                                               | 0                                     | 0,030           | 0,000                        | City centre                         | 0              | 0,950                 | 0,000   |
| Light bush and farm lands                                                | 50                                    | 0,070           | 0,035                        | Suburban                            | 0              | 0,700                 | 0,000   |
| Grasslands                                                               | 45                                    | 0,170           | 0,077                        | Streets                             | 0              | 0,950                 | 0,000   |
| Cultivated land, contoured                                               | 0                                     | 0,070           | 0,000                        | Maximum flood                       | 0              | 1,000                 | 0,000   |
| Cultivated land                                                          | 0                                     | 0,170           | 0,000                        |                                     | 0              |                       | 0,000   |
| No vegetation                                                            | 5                                     | 0,260           | 0,013                        |                                     |                |                       |         |
| Total                                                                    | 100                                   | Total           | 0,125                        | Total                               | 0              | Total                 | 0,000   |
| Total                                                                    | 100                                   | Total $C_1$     | 0,221                        | Total                               | 0              | Total $C_2$           | 0,000   |
| TIME OF CONCENTRATION ( $T_C$ )                                          |                                       |                 |                              | TIME OF CONCENTRATION ( $T_C$ )     |                |                       |         |
| Correction factor ( $\tau$ ) for defined main watercourse                | 2,000                                 |                 |                              |                                     |                |                       |         |
| Overland flow ( $T_{C1}$ )                                               | Defined main watercourse ( $T_{C2}$ ) |                 | Artificial flow ( $T_{C3}$ ) | Total $T_C$                         |                |                       |         |
| 1,211                                                                    | hours                                 | 0,527           | hours                        | 0,000                               | hours          | 1,7                   | hours   |
| DESIGN NOTES                                                             |                                       |                 |                              |                                     |                |                       |         |
| No correction factor to $T_C$                                            |                                       |                 |                              |                                     |                |                       |         |
| Slope calculation method used is 10/85                                   |                                       |                 |                              |                                     |                |                       |         |
| Drainage region numbers are all based on DWS info (KML files downloaded) |                                       |                 |                              |                                     |                |                       |         |
| WEIGHTED RUNOFF COEFFICIENTS                                             |                                       |                 |                              |                                     |                |                       |         |
| Return period (T, years)                                                 | 2                                     | 5               | 10                           | 20                                  | 50             | 100                   | 200     |
| Rural runoff coefficient ( $C_1$ )                                       | 0,221                                 | 0,221           | 0,221                        | 0,221                               | 0,221          | 0,221                 | 0,221   |
| Dolomitic rural runoff coefficient ( $C_{1D}$ )                          | 0,221                                 | 0,221           | 0,221                        | 0,221                               | 0,221          | 0,221                 | 0,221   |
| Adjustment factor ( $F_T$ )                                              | 0,500                                 | 0,550           | 0,600                        | 0,670                               | 0,830          | 1,000                 | 1,200   |
| Adjusted rural runoff coefficient ( $C_{1T}$ )                           | 0,110                                 | 0,121           | 0,132                        | 0,148                               | 0,183          | 0,221                 | 0,265   |
| Weighted runoff coefficient ( $C_T$ )                                    | 0,110                                 | 0,121           | 0,132                        | 0,148                               | 0,183          | 0,221                 | 0,265   |
| DESIGN RAINFALL INFORMATION                                              |                                       |                 |                              |                                     |                |                       |         |
| Return period (T, years)                                                 | 2                                     | 5               | 10                           | 20                                  | 50             | 100                   | 200     |
| Design point rainfall ( $P_{T\&P}$ , mm)                                 | 25,203                                | 34,319          | 43,435                       | 53,624                              | 69,711         | 85,798                | 96,523  |
| Design point rainfall ( $P_{T\&SI}$ , mm)                                |                                       |                 |                              |                                     |                |                       |         |
| Design point rainfall intensity ( $I_T$ , mm/h)                          | 14,499                                | 19,743          | 24,987                       | 30,848                              | 40,103         | 49,357                | 55,527  |
| Areal reduction factor (ARF, %)                                          | 100,000                               | 100,000         | 100,000                      | 100,000                             | 100,000        | 100,000               | 100,000 |
| Areal reduction factor (ARF <sub>RLMA&amp;SI</sub> )                     | 100,000                               | 100,000         | 100,000                      | 100,000                             | 100,000        | 100,000               | 100,000 |
| Average design rainfall intensity ( $I_{T\&V}$ , mm/h)                   | 14,499                                | 19,743          | 24,987                       | 30,848                              | 40,103         | 49,357                | 55,527  |
| Peak flow ( $Q_T$ , m <sup>3</sup> /s)                                   | 0,444                                 | 0,665           | 0,918                        | 1,266                               | 2,039          | 3,023                 | 4,081   |

Appendix B – WWTW STORMWATER CHANNEL LAYOUT

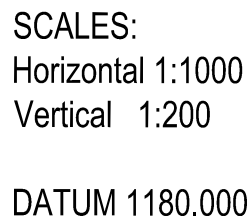
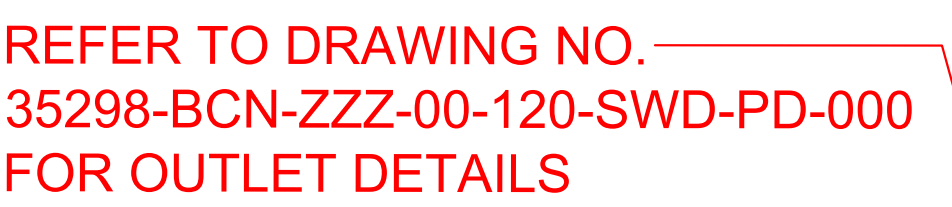






Appendix C – STORMWATER CHANNEL LONGSECTION





| $\alpha$ | $\alpha_{\text{max}}$ | $\alpha_{\text{min}}$ | $\alpha_{\text{max}}$ | $\alpha_{\text{min}}$ |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|
| 20       | 1987140               |                       |                       |                       |
| 40       | 1987224               |                       |                       |                       |
| 60       | 1988319               | 1982210               | 4.059                 |                       |
| 80       | 1988170               | 1982210               | 3.980                 |                       |
| 100      | 1988102               | 1982210               | 3.892                 |                       |
| 120      | 1988704               | 1982210               | 2.884                 |                       |
| 140      | 1988141               | 1982210               | 2.231                 |                       |
| 160      | 1984413               | 1982210               | 1.800                 |                       |
| 180      | 1984466               | 1982210               | 1.586                 |                       |
| 200      | 1984184               | 1982210               | 1.274                 |                       |
| 220      | 1983885               | 1982210               | 1.095                 |                       |
| 240      | 1983872               | 1982210               | 0.762                 |                       |
| 260      | 1983395               | 1982210               | 0.685                 |                       |
| 280      | 1983313               | 1982210               | 0.400                 |                       |
| 300      | 1983224               | 1982210               | 0.314                 |                       |
| 320      | 1983300               | 1982210               | 0.300                 |                       |
| 340      | 1983500               | 1982210               | 0.390                 |                       |
| 360      | 1983077               | 1982210               | 0.187                 |                       |
| 380      | 1982822               | 1982210               | 0.000                 |                       |
| 400      | 1981906               |                       |                       |                       |
| 420      | 1981728               |                       |                       |                       |

|                                                                                                                                                                                                                                                      |               |                         |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------|----------------------|
| NOTES / LEGEND                                                                                                                                                                                                                                       |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
| APPROVED BY COUNCIL / CLIENT                                                                                                                                                                                                                         |               |                         |                      |
| CITY ENGINEER / CLIENT                                                                                                                                                                                                                               | REG. NO.      | DATE                    |                      |
| REVISION CODES                                                                                                                                                                                                                                       |               | SUITABILITY CODES       |                      |
| A,B,C..... : BEFORE TENDER                                                                                                                                                                                                                           | PI :          | ISSUED FOR INFORMATION  |                      |
| T,S,T1,T2... : FOR TENDER                                                                                                                                                                                                                            | FAC :         | FOR ACCEPTANCE CONTROL  |                      |
| 0,1,2,... : CONSTRUCTION                                                                                                                                                                                                                             | JPR :         | ISSUED FOR REVIEW       |                      |
| Z : AS-BUILT                                                                                                                                                                                                                                         | PFC :         | ISSUED FOR CONSTRUCTION |                      |
|                                                                                                                                                                                                                                                      | ASB :         | AS-BUILT                |                      |
| DRAWING REVISION                                                                                                                                                                                                                                     |               |                         |                      |
| DATE                                                                                                                                                                                                                                                 | INITIAL       | NO./CODE                | REVISION DESCRIPTION |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
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| CLIENT                                                                                                                                                                                                                                               |               |                         |                      |
|                                                                                                                                                                                                                                                      |               |                         |                      |
| PROJECT NAME                                                                                                                                                                                                                                         |               |                         |                      |
| RELOCATION OF THE EXISTING WARRENTON VFWTW AND RELATED BULK INFRASTRUCTURE                                                                                                                                                                           |               |                         |                      |
| DRAWING TITLE                                                                                                                                                                                                                                        |               |                         |                      |
| STORMWATER CHANNEL LONG AND CROSS SECTIONS                                                                                                                                                                                                           |               |                         |                      |
| APPROVED BY BVI                                                                                                                                                                                                                                      |               |                         |                      |
| W SMT                                                                                                                                                                                                                                                | REG. NO.      |                         | 12/05/2028           |
| ENGINEER/TECHNOLOGIST                                                                                                                                                                                                                                | DATE          |                         |                      |
| SCALE                                                                                                                                                                                                                                                | AS SHOWN @ A0 | DRAWN                   | S ZIBAYA             |
| DESIGNED                                                                                                                                                                                                                                             | S ZIBAYA      | CHECKED                 | W SMT                |
| SUITABILITY STATUS                                                                                                                                                                                                                                   |               |                         | REV. NO.             |
| ISSUED FOR INFORMATION                                                                                                                                                                                                                               |               |                         | A                    |
| PLAN NUMBER                                                                                                                                                                                                                                          |               |                         |                      |
| 35298-BCN-ZZZ-00-121-SWD-PDR-000                                                                                                                                                                                                                     |               |                         |                      |



Appendix D – RAINFALL PREPAREDNESS CHECKLIST

| Item                                                      | Yes / No / N/A | Comments/action required |
|-----------------------------------------------------------|----------------|--------------------------|
| Weather forecast checked before rainfall event            |                |                          |
| Stormwater channel inspected and no breaches identified   |                |                          |
| Channel outlets clear and erosion protection functional   |                |                          |
| Cut-off drains and diversion channels clear               |                |                          |
| Silt fences and sediment traps functional                 |                |                          |
| Stockpiles stabilised or protected                        |                |                          |
| Loose soil removed from drainage paths                    |                |                          |
| Fuel, oil, chemicals and waste secured                    |                |                          |
| Concrete washout area contained and protected             |                |                          |
| Open excavations and trenches protected where practicable |                |                          |
| Pumps, spill kits and emergency equipment available       |                |                          |
| Post-rainfall inspection completed and repairs recorded   |                |                          |

Appendix E – STORMWATER INSPECTION CHECKLIST

[illegible]



Appendix F – STORMWATER INCIDENT REGISTER TEMPLATE

[illegible]