High Confidence Groundwater Reserve Determination Study in the Berg Catchment

WP11398
Inception Report

Report Number: RDM/WMA19/02/CON/COMP/0122

April 2022

water & sanitation

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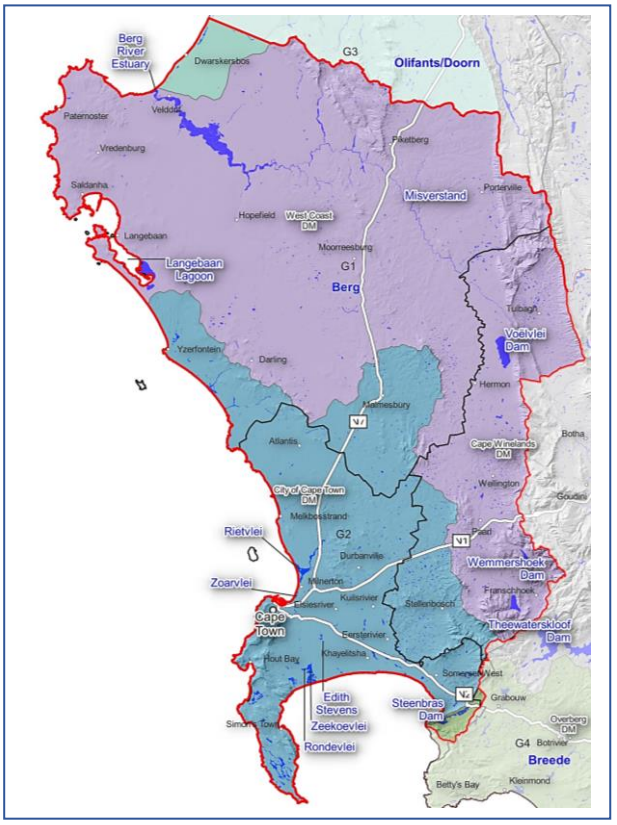

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Version 1 – Final

Prepared for:

Department of Water and Sanitation

Chief Directorate: Water Ecosystems Management

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Executive Summary

Sustainability, efficiency and equity have been identified as the chief guiding principles in the conservation, protection, development, use, and management of South Africa's water resources. In response to the National Water Act (Act No. 36 of 1998) (NWA) the Department of Water and Sanitation (DWS) has established Resource Directed Measures (RDM) to facilitate and assure the protection and sustainable development of the natural water resources. The RDM outlines three interrelated components namely: Classification, The Reserve and Resource Quality Objectives (RQOs). It has been determined that some water resources require a higher level of protection based on their ecological importance, while others may serve the country's economic development goals.

The Reserve is an integral part of the RDM and is the only right to water according to the NWA. It has priority over all other water use allocations and is defined as the water that is 'set aside' to provide for basic human needs (BHN) and to protect aquatic ecosystems.

Due to the increasing number of groundwater water use licence applications (WULAs) in the Berg catchment, the associated impacts that the proposed developments might have on the availability or quality of water resources, the conservation status, and the complexity of geological and hydrogeological characteristics make it increasingly impossible to assess applications using a low confidence desktop groundwater Reserve. In response, the DWS has initiated a high confidence Reserve determination study to support the gazetted Water Resource Classes and RQOs for the Berg catchment. This study will determine the required groundwater contribution in terms of quantity and quality to satisfy the BHN Reserve and ecological water requirements (EWR) for the Berg catchment by completing the eight-step process outlined in the Groundwater Resource Directed Measures (GRDM) process as defined by Regulation 2(4) of the NWA.

The Berg catchment, which falls entirely in the Western Cape Province of South Africa, includes catchments for several rivers such as the Berg, Diep, Kuils, Eerste, Lourens, Sir Lowry's and Steenbras. It is important to note that groundwater resource units do not follow conventional surface water catchment boundaries, thus a broader extent will be considered to ensure that all Groundwater Resource Units (GRUs) are adequately evaluated. The GRDM will consider factors which include, but are not limited to, climate, hydrology, geology, hydrogeology, and water supply infrastructure.

The Inception Phase will include the identification and description of the:

- Aims and objectives of the project;
- Project scope and task outline;
- Stakeholders and their engagement throughout the GRDM process;
- Capacity Building programme;
- Project budget and billing schedule; and
- Interfacing with other DWS initiatives and ongoing studies.

A key component of the Inception Phase is stakeholder engagement. DWS officials and interested or effected parties will be engaged throughout the project, particularly during the evaluation of operational scenarios and its integration based on the physical and chemical aspects of the system. A capacity building and mentorship programme, which will include both DWS and PSP (professional service provider) staff members will offer opportunities to work and collaborate with individual project specialists.

The following phase for the project is to review all collated data and available water resource models and identify any data/information gaps to determine its integrity, reliability and representivity for a high confidence determination. Where shortcomings are identified, recommendations or suggestions will be provided to bolster information gaps based on specific relevance to the study.

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List of Abbreviations

%	-	percentage
~	-	approximately
BHN	-	Basic human needs
CFA	-	Cape Flats Aquifer
CD:WEM	-	Chief Directorate: Water Ecosystems Management
CMB	-	Chloride mass balance
CoCT	-	City of Cape Town
DEM	-	Digital Elevation Model
DWAF	-	Department of Water Affairs and Forestry
DWS	-	Department of Water and Sanitation
D:RD	-	Directorate: Reserve Determination
EI	-	Ecological Importance
e.g.	-	For example
ES	-	Ecological Sensitivity
et al.	-	and others
etc.	-	etcetera
EWR	-	Ecological water requirements
GIS	-	Geographic Information System
GRDM	-	Groundwater Resource Directed Measure
GRU	-	Groundwater Resource Unit
i.e.	-	That is
IUA	-	Integrated unit of analysis
m	-	metre
MAE	-	Mean annual evaporation
MAP	-	Mean annual precipitation
MAT	-	Mean annual temperature
NGA	-	National Groundwater Archive
NWA	-	National Water Act
PCA	-	Potentially contaminating activities
PES	-	Present Ecological State
PMC	-	Project Management Committee
PSC	-	Project Steering Committee
PSP	-	Professional Service Provider
RDM	-	Resource Directed Measure
RU	-	Resource unit
RQO	-	Resource Quality Objective
TMG	-	Table Mountain Group
TMGA	-	Table Mountain Group Aquifer
WARMS	-	Water Use Allocation and Registration Management System
WCWSS	-	Western Cape Water Supply System
WRC	-	Water Research Commission
WULA	-	Water Use License Application

1. INTRODUCTION

1.1. Background to the study and motivation

The Department of Water and Sanitation (DWS), Chief Directorate: Water Ecosystems Management (CD: WEM) initiated a "High Confidence Groundwater Reserve Determination Study for the Berg Catchment" and have appointed Umvoto South Africa (Pty) Ltd (hence forth Umvoto) as Professional Service Provider (PSP) based on the proposal submitted in September 2021 for Project WP11398.

The project will support the gazetted Water Resource Classes and Resource Quality Objectives (RQO) for the Berg catchment (Gazette No.42451:121 of 10 May 2019; hereafter referred to as DWS, 2019: 121). Due to the increasing number of groundwater water use licence applications (WULAs), the associated impacts that the proposed developments might have on the availability or quality of water, the conservation status of various resources within the Berg catchment, and the complexity of geological and hydrogeological characteristics make it increasingly impossible to assess applications using a low confidence desktop groundwater Reserve.

Figure 1-1 outlines the Integrated Unit of Analysis (IUAs) and associated Water Resource Classes that have been delineated for the Berg catchment (DWS, 2019: 121) as outcomes from the *"Determination of Water Resource Classifications and Resource Quality Objectives in the Berg Catchment"* study completed by Aurecon (Pty) Ltd from 15 April 2016 to 15 October 2018. The Gazette (No. 42451 of 10 May 2019) included both recommendations for Water Classes for IUAs (in terms of Section 13(4)(a)(i)(aa) of the NWA, 1998) and RQOs for RUs (in terms of Section 13(4)(a)(i)(bb) of the NWA, 1998) for water resources within the catchment. This study/gazette outlined:

- IUA classified into water resource classes and catchment configurations. Water resource classes are classified into Class I (high environmental protection and minimal utilisation), II (moderate protection and moderate utilisation), or III (sustainable minimal protection and high utilisation).
- RQOs are defined for prioritised surface water RUs for each IUA in terms of water quantity, habitat and biota, and water quality. RQOs were established for (RUs/nodes are observed in **Figure 1-1**):
    - EWR
    - Rivers
    - Estuaries
    - Dams
- In addition to this, the study also delineated priority GRUs (see **Figure 1-1**) and defined RQOs for these.

This study will need to determine the required groundwater contribution in terms of quantity and quality to satisfy the basic human needs (BHN) Reserve and ecological water requirements (EWR) for the Berg catchment.

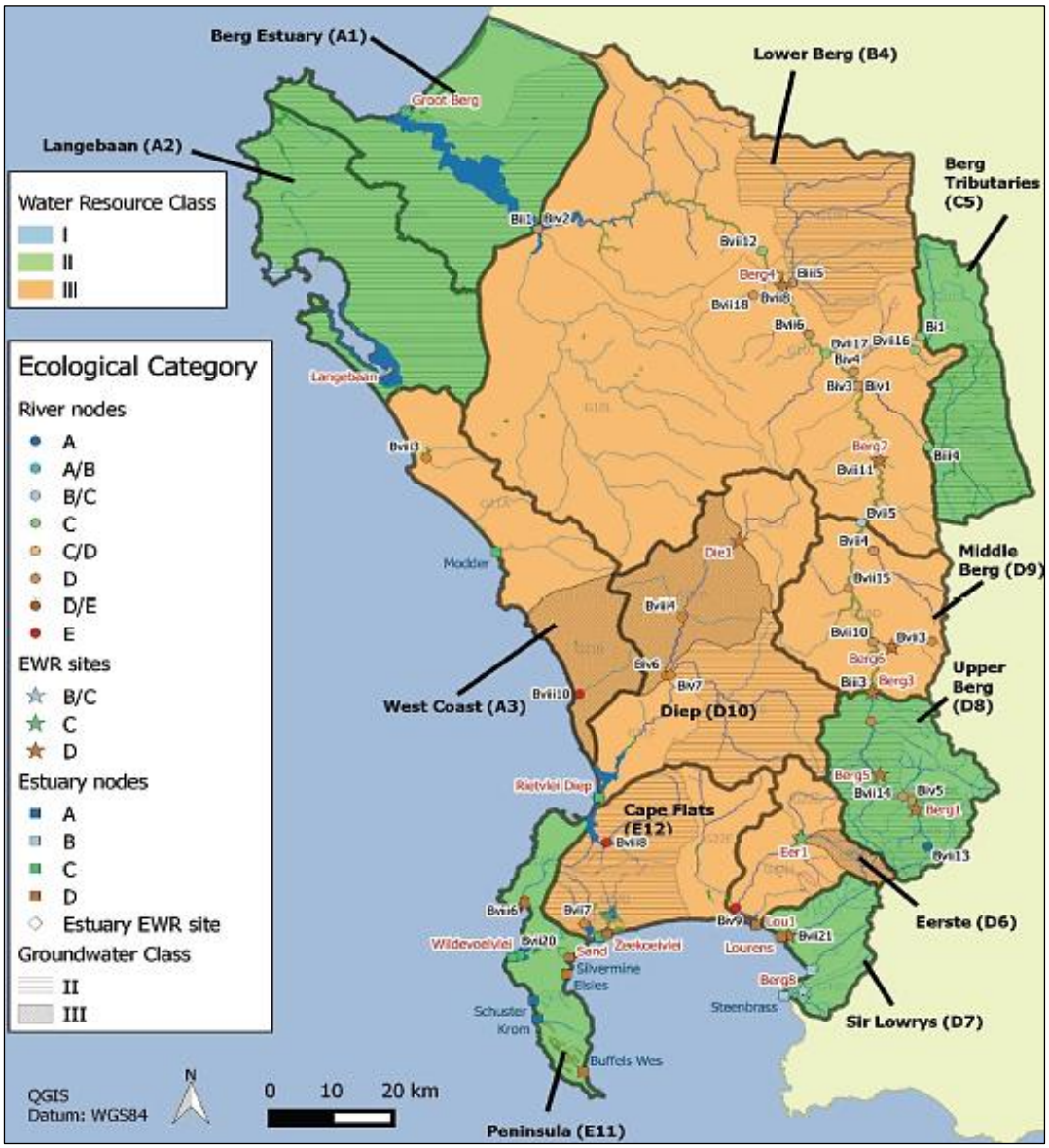

Figure 1-1 Proposed Water Resource Classes, including IUAs (after DWS, 2019: 121).

1.2. Terms of Reference

The Terms of Reference for the study, as provided by the DWS CD:WEM, stipulates the aim and objectives as follows:

"The primary objective of this study is to determine a high confidence groundwater Reserve requirements (quantity and quality) to satisfy the basic human needs and to protect aquatic ecosystems in different priority water resources within the Berg catchment"

"Detailed determinations aim to produce high-confidence results, are based on site-specific data collected by specialists and are used for all compulsory licensing exercises, as well as for the individual licence applications that could have a large impact on any catchment, or a relatively small impact on ecologically important and sensitive catchments"

The groundwater Reserve determination aims to support the gazetted Water Resource Classes and associated RQOs in completing the Groundwater Resource Directed Measures (GRDM) process as defined by Regulation 2(4) of the NWA (No. 36 of 1998; referred to as Regulation 2(4) hereafter). The Reserve will assist the DWS in making sound management decisions regarding stressed or over-utilised catchments, and also ensuring that water resources are afforded a level of protection that will assure a sustainable level of utilisation in the future.

The Terms of Reference indicate that the Reserve Determination process must follow the eight-step process outlined in the RDM manuals, namely the "Groundwater Resource Directed Measures" outlined by the Water Resource Commission (WRC, 2013). Additional GRDM manuals will also be consulted, such as the WRC (2007) "Groundwater Resource Directed Measures Manual" and the preliminary recommendations from an ongoing review of GRDMs by the WRC (if preliminary findings can be provided to the PSP) to ensure that groundwater Resource Units (GRUs) are adequately considered.

1.3. Aims and objectives of this report

The purpose of this report is to identify, assess and understand the nature and scope of the project with respect to:

- Identify the background to and aims and objectives of the project (**Section 1**) and briefly describe the study area (**Section 2**).
- Outline the scope of work or additional tasks and the project approach to the eight step GRDM procedure (**Section 3**) for agreement with DWS.
- Present a provisional list of stakeholders that will be engaged throughout the groundwater Reserve Determination process (**Section 4**).
- Update the work programme (**Section 5**) as per the adjusted project commencement date (see **Section 1.4**).

- Present the Project Team (**Section 6**) and suggest external reviewers for agreement with DWS.
- Detail the components and programme of Capacity Building so that DWS staff can be allocated to the various components of interest (**Section 7**)
- Present the project budget and billing schedule for agreement with DWS (**Section 8**).
- Ensure the various subsequent project phases will meet DWS requirements and are structured in a way to achieve the required deliverables more efficiently.

1.4. Project dates

The length of the study is 24 months, officially commencing on date of signing the contract (19 January 2022). However, due to a delay in issuing and receiving the Purchase Order, the commencement date has been moved to 22 February 2022. Hence, study completion date is 22 February 2024.

Due to this delay it was agreed at the inception meeting, held on the 16 March 2022, that deliverable due dates are each extended by a month (see **Section 5.1**). However, the PSP will aim to expedite progress during Phase 3 and submit draft deliverables to the DWS during the prior month to ensure compliance with the Directorate: Reserve Determination (D:RD)'s Operational Plan for 2022/2023 financial year.

2. GENERAL OVERVIEW OF THE STUDY AREA

The Berg catchment forms the main study area boundary (**Figure 2-1**), however GRUs do not follow surface water catchment boundaries and a broader extent will be considered to ensure that all GRUs are adequately evaluated.

The Berg catchment is located in the southwestern corner of South Africa and falls entirely in the Western Cape Province (**Figure 2-1**). The Berg catchment borders the Olifants/Doring catchment to the north and the Breede-Gouritz WMA to the east (**Figure 2-1**). The Berg catchment consist of secondary drainage regions G1 and G2, as well as the quaternary catchments G30A in the north and G40A in the south, covering a total area of 13 000 km^2 (**Figure 2-1**). It includes catchments for several rivers such as the Berg, Diep, Kuils, Eerste, Lourens, Sir Lowry's and Steenbras rivers (**Figure 2-2**).

2.1. Climate

The Berg catchment experiences a Mediterranean climate with rainfall received in winter (Peel et al., 2007). There is however a large spatial variability in mean annual precipitation (MAP) due to the varying topography (**Figure 2-2**) from low lying coastal plains (blues to greens in **Figure 2-2**;300 mm per annum in the northwestern part of the catchment) to high mountain ranges (pale browns to white in **Figure 2-2**) such as the Cape Peninsula (3 000 mm per annum) and eastern side of the catchment, that have an orographic influence. Mean annual temperature (MAT) is also variable and controlled by a variety of factors such as varying altitude, onshore winds and latitude. Typically, MAT is lower in the mountainous regions (~10 - 14°C) and increases along the coast in the low-lying areas (~16 - 20°C; Schulze, 2009).

Evaporation generally increases with latitude northwards within the catchment. Based on the A-Pan mean annual evaporation (MAE) rates provided by Bailey and Pitman (2016), the southern extent of the catchment (around Cape Town) experiences lower MAE rates (~1800 – 2200 mm), whereas the northern reaches of the catchment experience relatively higher MAE rates (~2200 – 2600 mm). Coastal stretches along the Atlantic seaboard (~1800 – 2000 mm) and the mountainous regions (<1200 – 1600 mm) show lower rates of MAE most likely due to onshore winds and elevation effects (Bailey and Pitman, 2016).

Mean wind speeds are also variable within the catchment, as provided by SANEDI (2014), with wind speeds increasing inland (~5 – 6 m/s in the coastal plains) and the highest wind speeds occurring at altitude (~8 – 10 m/s). Valleys are typically sheltered from higher wind speeds (~7 m/s). Dominant wind directions in the catchment are southerly in summer and northwesterly to south-westerly in winter. These coastal winds correspond to the higher wind speeds experienced along the coast (~7 – 8 m/s; SANEDI, 2014).

2.2. Hydrology

The Berg River catchment is the largest catchment within the study area, along with smaller catchments such as the Diep, Kuils, Eerste, Sir Lowry's Steenbras and numerous small catchments on the Cape Peninsula and West Coast (see **Figure 2-2**). There are 22 estuaries in the Berg catchment including the Berg River and Langebaan Lagoon estuary which receive contributions from groundwater. Several significant wetlands are of importance in the Berg catchment, namely the Edith Stevens Wetland Park, Zeekoevlei, Rondevlaie, Zoarvlei and Rietvlei (see **Figure 2-2**).

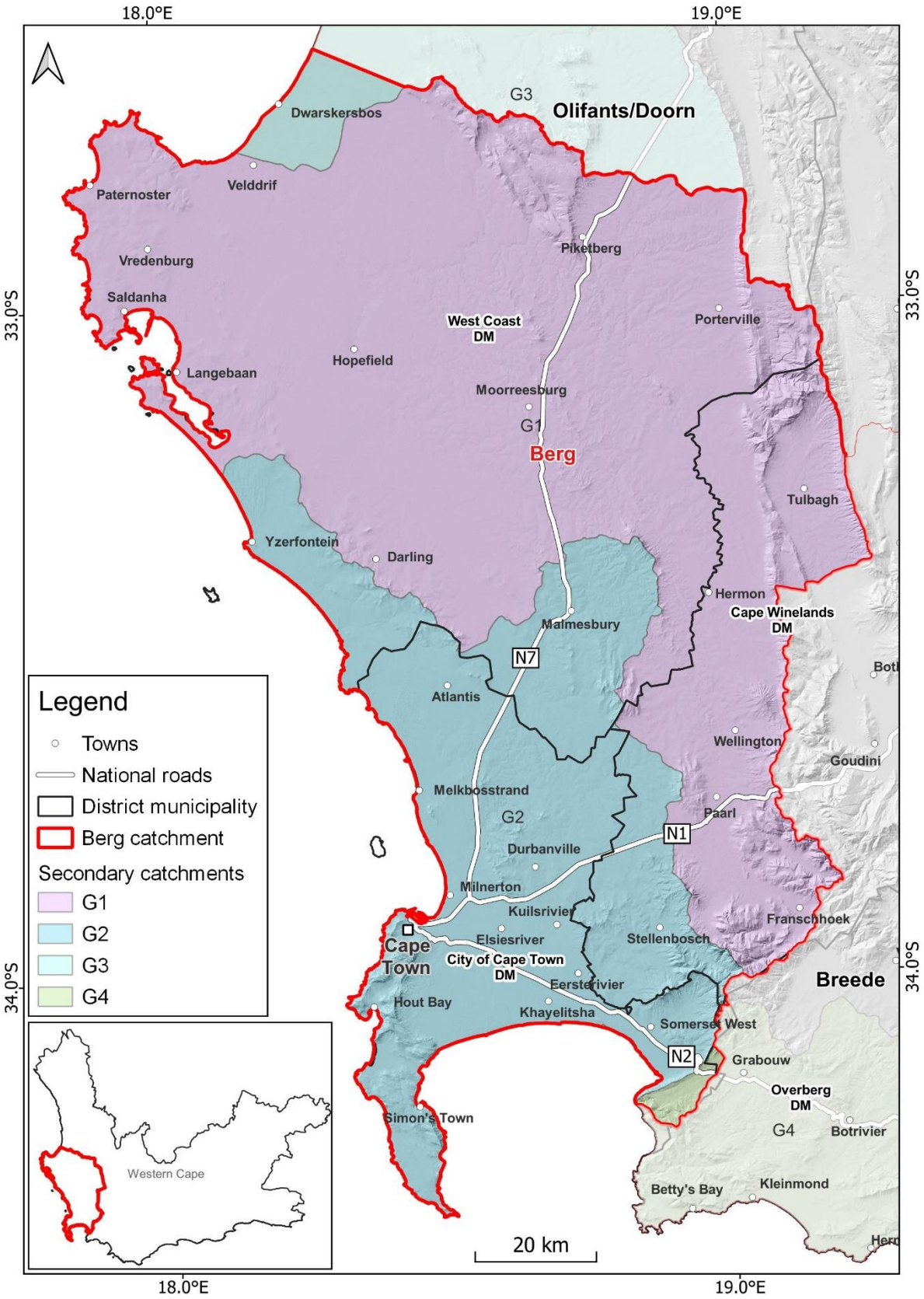

Figure 2-1 **Locality map of the Berg catchment and preliminary extent of the study area. A broader study area extent will be considered to ensure that all GRUs are adequately evaluated (GRUs do not necessarily follow surface water catchment boundaries).**

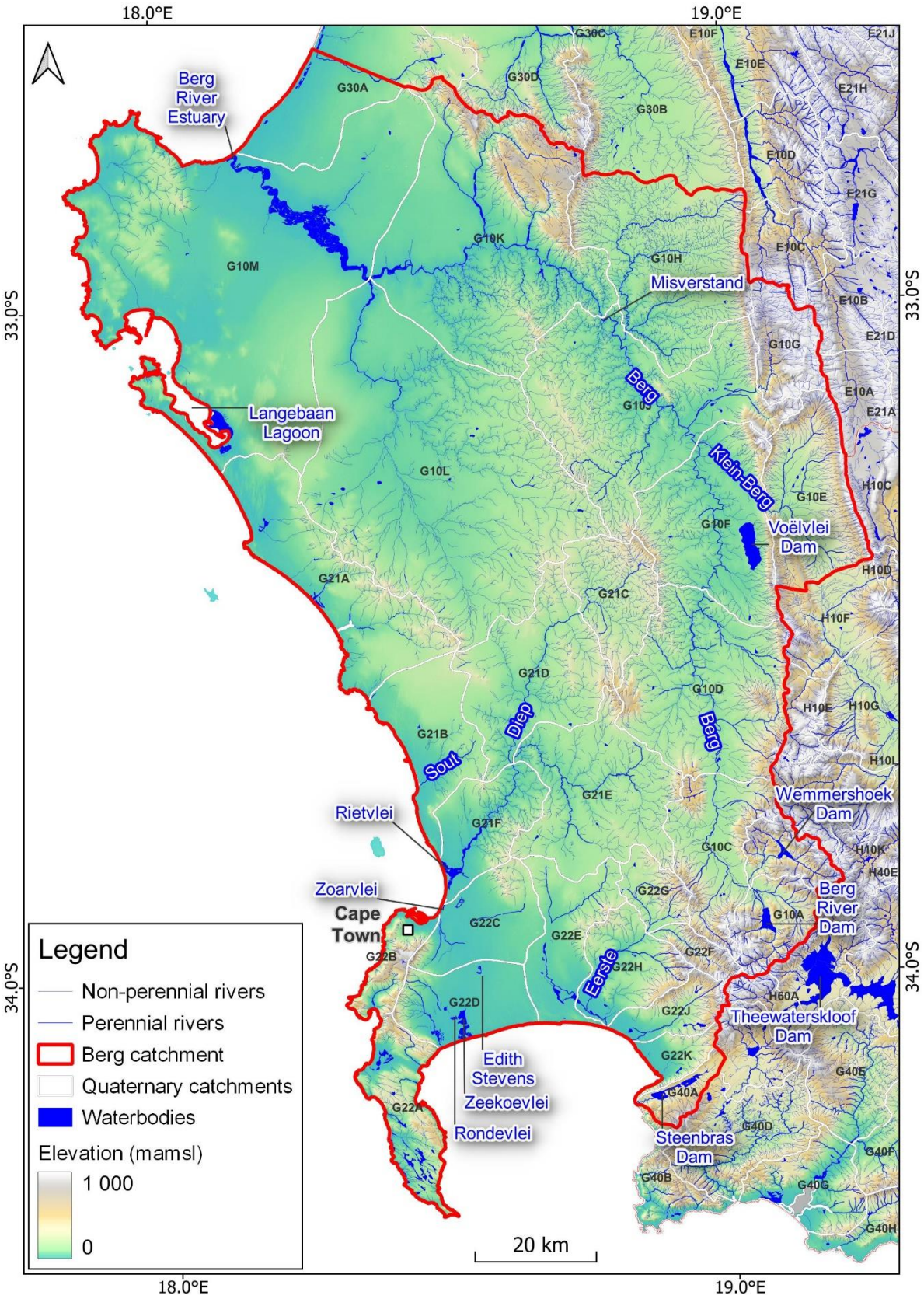

Figure 2-2 Hydrology and topography of the Berg catchment.

2.3. Geology and Hydrogeology

Geologically, the majority of the Berg catchment is underlain by the Klipheuwel and Malmesbury Groups which comprise of argillaceous rock types, typically greywackes and shales (**Figure 2-3**; Theron et al., 1992). These basement rocks have been intruded by the Cape Granite Suite which mainly occur as plutons such as Paarl, Perdeberg and Darling (**Figure 2-3**; Theron et al., 1992). Basement rocks and granites generally form low yielding weathered aquifers with poor water quality unless a particular fault/fracture (see the hydrotects denoted in **Figure 2-3**; DWAF, 2008b) is intersected with higher groundwater potential (DWAF, 2008a,b; City of Cape Town [CoCT], 2012; WRC, 2016).

Following the intrusion of the granites, a long period of uplift and erosion resulted in the deposition of sandstones which form the Table Mountain Group (TMG; **Figure 2-3**; Theron et al., 1992), particularly the Peninsula and Skurweberg formations that form the escarpments (Table Mountain, Hottentot Mountains etc.) of the area due to the erosion resistant quartzites. These form deep fractured rock aquifers (Peninsula and Nardouw [Skurweberg and Rietvlei formations] Aquifers) that are often confined and high yielding with good water quality.

Sediments eroded from these formations, particularly the softer (Malmesbury Group) forming eroded valleys, to deposit in the western and coastal portion of the catchment (**Figure 2-3**; Theron et al., 1992). These sand deposits comprise the Bredasdorp Group, Sandveld Group and Quaternary age deposits that form major primary sedimentary aquifers such as the Cape Flats Aquifer (CFA), Atlantis/Silwerstroom aquifers, and the West Coast aquifers (Yzerfontein, Adamsborskraal, Elandsfontein and Langebaan Road aquifers). These primary aquifers can be extremely high yielding but are vulnerable to contamination due to their unconfined nature and high infiltration rates.

Major groundwater use in the Berg catchment are from the Atlantis/Silwerstroom aquifers that supply the town of Atlantis, CFA for irrigation within the Philippi Horticultural Area (PHA) and from fracture zones within the basement aquifers of the Swartland area. Generally, the high potential TMG aquifers (TMGA) are relatively untouched due to their depth and the associated drilling costs, however Steenbras and Theewaterskloof are currently under exploration and wellfield development.

Based on the TOR, a preliminary review of GRUs in DWS (2019) and a brief literature review (Theron et al., 1992; DWAF, 2008a,b), the following aquifers have been identified:

- Langebaan Aquifer
- Elandsfontyn Aquifer
- Adamsboerskraal Aquifer
- Yzerfontein Aquifer
- Atlantis Aquifer
- Cape Flats Aquifer
- Peninsula TMGA
- Steenbras TMGA
- Wemmershoek TMGA
- Voëlvlei TMGA
- Piketberg TMGA
- Basement hydrotects (specific hydrotects that cross-cut the basement lithologies still to be decided)
- Basement lower Berg

2.4. Water Supply Infrastructure

The Western Cape Water Supply System (WCWSS) covers ~90% of the Berg catchment and comprises of six large dams, namely the Upper and Lower Steenbras, Wemmershoek, Voëlvlei, Theewaterskloof and Berg River (see **Figure 2-4**). Of these, the Berg River Dam is the first bulk water resources development project in South Africa that is directly linked to water demand management and therefore is required to make releases to satisfy all aspects of the Ecological Reserve as prescribed by the NWA. The major water consumers in the Berg catchment include the City of Cape Town, supplied by the WCWSS and agriculture, particularly intensive irrigation in the Upper and Lower Berg River subareas and also the Eerste River and Lourens River catchments.

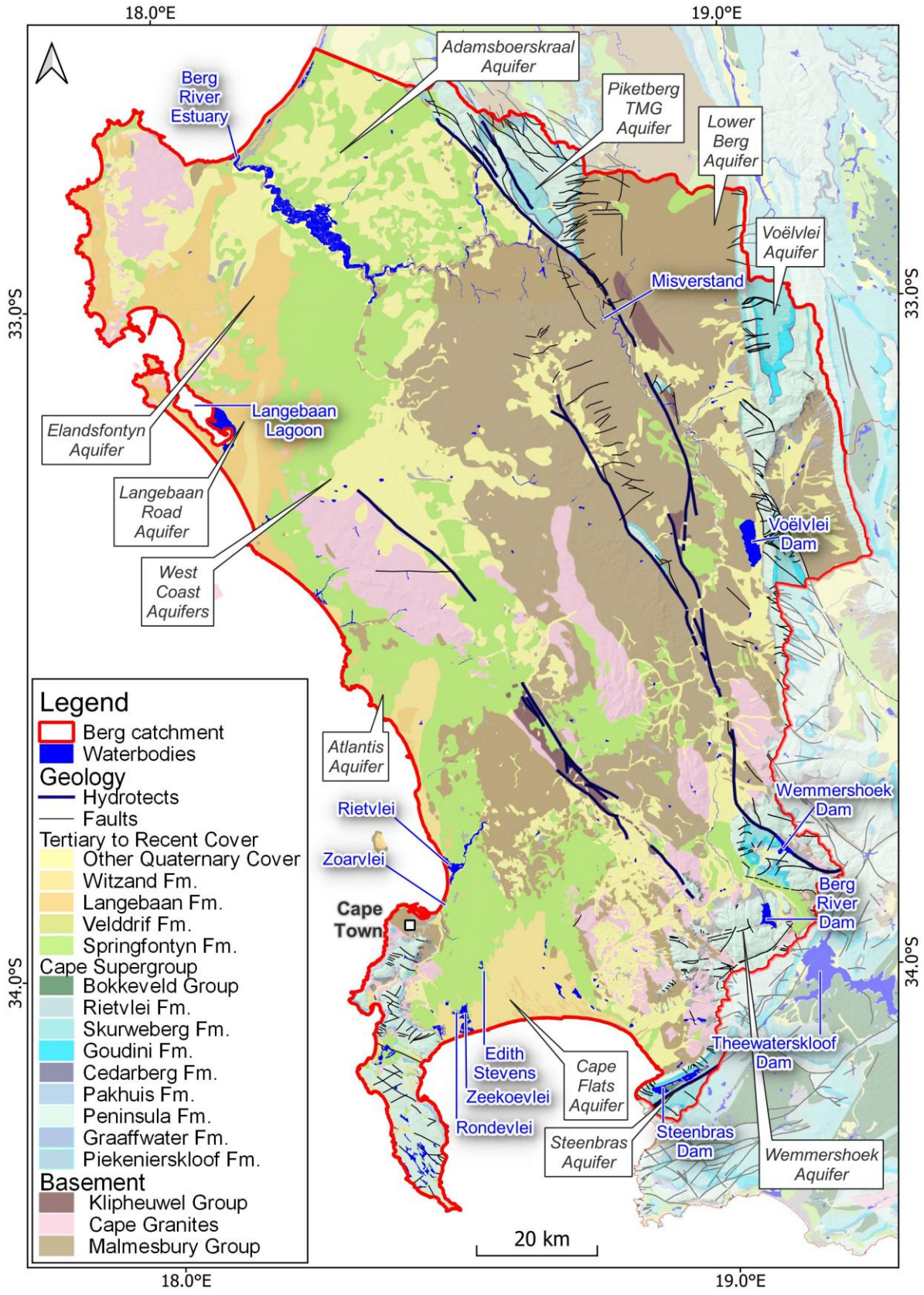

Figure 2-3 **Geological map of the Berg catchment and surrounds (Theron et al., 1992).**

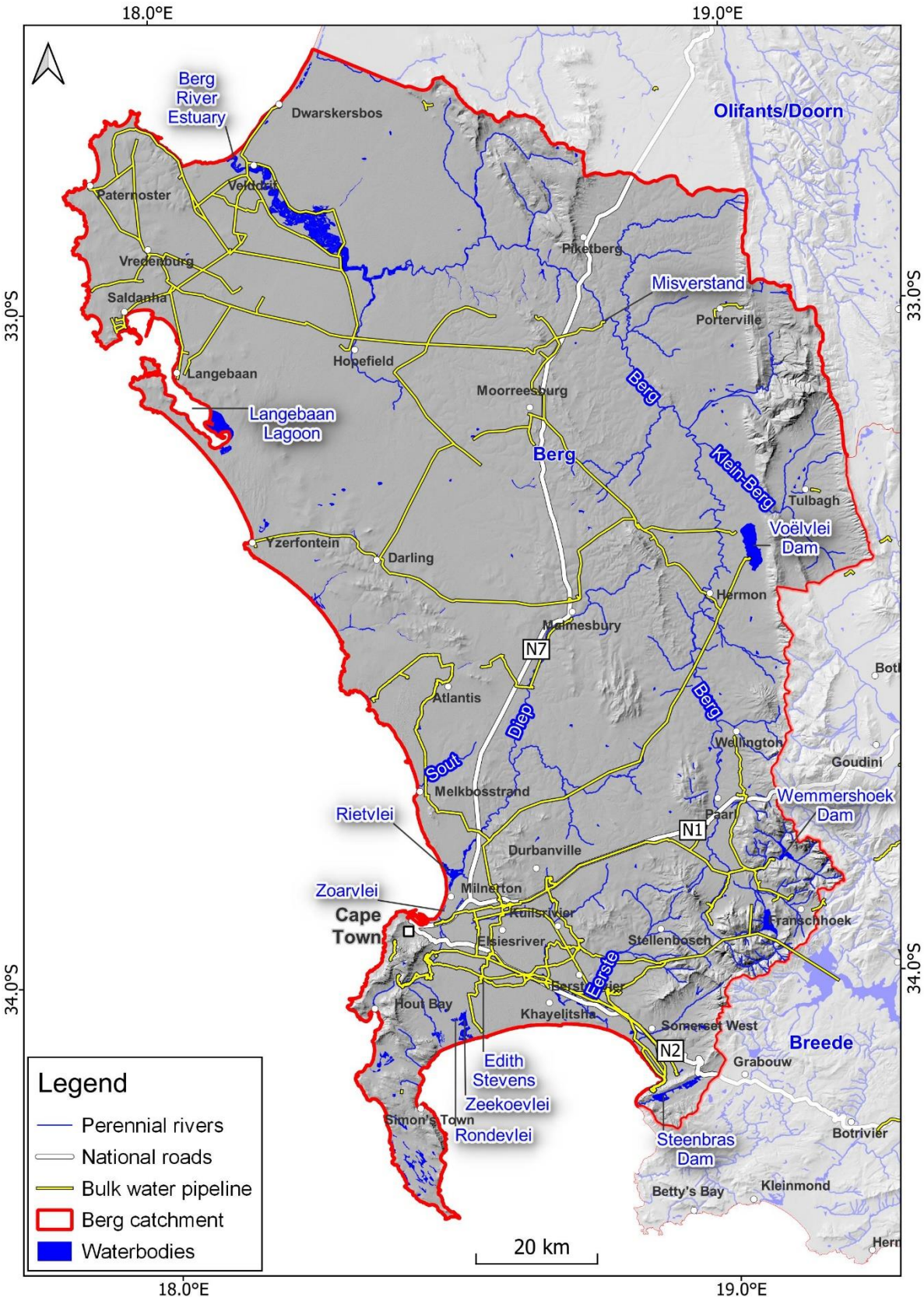

Figure 2-4 **Dams and bulk water supply infrastructure of the WCWSS (Department of Water Affairs [DWAF], 2007).**

3. SCOPE OF WORK

The project has been sub-divided into three phases, (with an additional overarching project management phase), and further sub-divided into tasks with associated key deliverables. These are summarized in **Table 3-1**.

The work schedule of these tasks and deliverables are outlined in **Section 4**.

Table 3-1 Summary of project phases, tasks and associated deliverables. See Table 5-1 for the reporting schedule of outlined deliverables. Reserve determination steps according to WRC (2013).

Phase 0	**Project Management, Administration, Communication and Capacity Building**		
Task P0a	General Project Management		
Task P0b	12 Project Management Committee (PMC) Meetings		
Task P0c	4 Project Steering (PSC) Meetings		
Task P0d	Ad Hoc Meetings		
Task P0e	Capacity Building Programme		
Task P0f	Monthly Progress Reports		
Phase 1	**Project Inception**		
Task P1a	Inception meeting		Deliverable 1: Inception Report
Phase 2	**Review of Water Resource Information and Data**		
Task 2.1	Data collection and collation		Deliverable 2.1: Gap Analysis Report Deliverable 2.2: Inventory of Water Resource Models
Phase 3	**Reserve Determination**		
Task 3.1	Step 1	Initiate Groundwater Reserve Study	Recorded in Deliverable 2.1 and Deliverable 2.2
Task 3.2	Step 2	Water RU Delineation	Deliverable 3.1: Delineation of Water RUs
Task 3.3	Step 3	Ecological Status and Reference Conditions per RU	Deliverable 3.2: Ecological Reference Conditions
Task 3.4	Step 4	Determine BHN and EWR	Deliverable 3.3: BHN and EWR Requirement Report
Task 3.5	Step 5	Operational Scenarios & Socio-economic	Deliverable 3.4: Operational Scenarios & socio-economic and ecological consequences
Task 3.6	Step 6	Evaluate scenarios with Stakeholders	Deliverable 3.5: Stakeholder engagement of operation scenarios
Task 3.7	Step 7	Monitoring Programme	Deliverables 3.6: Monitoring Programme Report
Task 3.8	Step 8	Gazette & implement Reserve	Deliverable 3.7: Groundwater Reserve Determination Report Deliverable 3.8: Database of all information and data (including spatial) Deliverable 3.9: Gazette Template

3.1. Project Tasks and Deliverables

3.1.1. Phase 0 - Project Management, Administration and Communication

Project management and administration will run through the duration of the project and the aim of this task is to:

- ensure that the work is carried out in line with the primary objectives of the project by monitoring progress in the form of progress reports, milestone deliverable reports, and select capacity building training;
- monitor actual expenditure and cash flow estimates on an ongoing basis; and
- ensure clear, accurate and transparent communication throughout the project.

As per the Terms of Reference (Section 4.4, pg. 7.) the following project management tasks will include monthly progress reports and a project file. This includes organising, presenting, and acting as secretariat (i.e. minutes recording etc.) at the various required meetings:

- Project Management Committee (PMC) – PMC (Client, Project Management Team including Chief Directorate: Water Ecosystems, other DWS Directorates and PSP) meeting every 2 months during the duration of the study, therefore **12 PMC meetings** in total over the 24-month study period, held at the Umvoto offices in Cape Town or the DWS offices in Bellville, Cape Town or virtually. Umvoto will submit detailed progress reports, including progress and budget tracking, to the members at least 7 days before the PMC meeting date. The DWS will be responsible for secretarial duties (invitations, agenda, meeting minutes, etc.) for these meetings, as per instructions provided in the inception meeting briefing.
- Project Steering Committee (PSC) – PSC meeting comprising relevant DWS directorates, local specialists and relevant stakeholders at least every 4 months during the duration of the study, therefore **6 PSC meetings** in total, held as hybrid virtual and in person events at the Umvoto offices in Cape Town or the DWS offices in Bellville, Cape Town, depending on COVID protocols. The PSP will be responsible for secretarial duties (invitations, agenda, meeting minutes, etc.) for these meetings, as per instructions provided in the inception meeting briefing.
- Ad-hoc Meetings – an additional **4 ad-hoc online meetings** have been included for Umvoto's technical team where required.

As agreed upon in the Inception meeting, Umvoto will also make themselves available for the Public Participation Comments after the 60 day public comment period has been completed.

3.1.2. Phase 1 - Project Inception

The aims of the inception phase and report has been described in the proposal and in **Section 1.3**.

3.1.3. Phase 2 – Review of Water Resources Information and Data Gathered

The aims of this task are to collect, collate, review and analyse all available, relevant data and literature (including any sensitive information and data) pertaining to the project area in the form of a desktop assessment. This data/literature will include (but not be limited to):

- Available water resource models;
- Water resource planning for the catchment;
- EWR and BHN determinations within the Berg catchment;
- Classification of water resources within the Berg catchment;

- RQO's for the Berg catchment;
- Surface and groundwater quality data;
- Groundwater usage;
- Socio-economic data in addition to that listed in the Resource Classification; and
- Augmentation and reconciliation strategies (such as the Reconciliation Strategies for All Towns, and Water Reconciliation Strategy for the WCWSS, that Umvoto worked on).

The review of the collated data and available water resource models will be used to identify any data/information gaps within the project area to determine its integrity, reliability and representivity for a high confidence determination. This will form part of a Gap Analysis which will include recommendations on how to overcome any data gaps or missing information in Phase 3, such as a hydrocensus in priority areas if required. The gap analysis will form **Deliverable 2.1 - Gap Analysis Report** and **Deliverable 2.2 - Inventory of Water Resource Models** which will also contribute to Step 1 of the GRDM process outlined by WRC (2013).

All relevant geological and hydrogeological information, water resource models will be collected and saved in a GIS dataset, for future client use (input to **Deliverable 3.8 – Database**). The data will be evaluated for correctness, and data from different reporting institutions and companies will be collated for completeness and ease of use.

3.1.4. Phase 3 – Reserve Determination

The 8-step procedure for determining the ecological Reserve, as listed in the ToR, will be followed for determining the groundwater component of the Reserve and will be undertaken as separate tasks as outlined below. The outputs will be integrated with the gazetted Water Resource Classes and RQOs (DWS, 2019: 121).

3.1.4.1. Task 3.1 -Step 1: Initiate the BHN and EWR assessment

The aim of this task is to:

- complete a review of available information and data to determine the process and detail of the assessment and determination;
- as well as identify relevant stakeholders to be included in the project.

Hence, Phase 1 and Phase 2 listed above form Step 1 of the RDM and are recorded in **Deliverable 1**, **Deliverable 2.1.** and **Deliverable 2.2.**

3.1.4.2. Task 3.2 – Step 2: Water Resource Unit Delineation

The aim of this task is to determine eco-regions, delineate groundwater related RUs, select study sites and, where appropriate, align with Step 1 of the RDM (WRC, 2013) procedure set out in Regulation 2(4).

The IUA defined in the Water Resource Classes and RQOs (see 12 IUAs delineated in **Figure 1-1**) and the groundwater related RUs will be reviewed to ensure that groundwater resources are fully encompassed as aquifers cross quaternary catchment boundaries. The final delineation of groundwater resources will be aquifer-specific and prioritised according to ecological sensitivity (ES) of the receiving water resources, high usage and BHN, such as the CFA, Atlantis/Silwerstroom aquifers, Elandsfontein and Langebaan Road aquifers, as well as the various TMG aquifers, e.g. the Steenbras area that is currently being developed by the CoCT.

Study sites in this context usually refer to the surface water EWR sites, where the present ecological status (PES), ecological importance (EI), ES and EWR are determined (see River Nodes, EWR Sites and Estuary Nodes in **Figure 1-1**). These are indications of priority sites from a surface water

perspective. However, from a groundwater perspective, additional surface water sites might be important to consider. Amendments to these surface water sites will need to be discussed with DWS and various stakeholders identified in the **Deliverable 1** as it is understood that no additional surface water study inputs will be provided. It is assumed that the data and findings that informed Water Resource Classes and RQOs for the Berg catchment (DWS, 2019: 121) will be provided by DWS (see **Section 3.3**).

The proposed GRU delineation and additional surface water site selection will form **Deliverable 3.1** (see **Table 3-1** and **Table 5-1** for the reporting schedule).

3.1.4.3. Task 3.3 – Step 3: Ecological Status and Reference Conditions per RU

The aim of this task is to determine the reference conditions, PES, EI and ES of each of the selected study sites.

As above, *'reference conditions, present ecological status and the ecological importance and sensitivity of each of the selected study sites'* refer to surface water EWR sites. It is assumed that the outcomes and associated data that informed the gazetted Water Resource Classes and RQOs will be sufficient to determine surface water reference conditions (see **Section 3.3**).

However, the reference conditions and present status (e.g. aquifer stress, water quality) will be determined for all GRUs delineated in **Task 3.2 – Step 2: Water** Resource Unit Delineation. Depending on available data and the findings of the Gap Analysis (**Deliverable 2.1**), additional data collection may be required to confirm or update the present status. As part of this step, the following data are assessed and determined per GRU:

- **Recharge**: estimated as spatial distribution of % of MAP, total volume per RU at 10, 25, 50, 75 and 90 percentile recurrence, using different methods such as Chloride Mass Balance (CMB), Saturated Volume Fluctuation etc., depending on data availability;
- **Water use**: estimated as spatial distribution and total annual volume per RU, based on recent Water Use Allocation and Registration Management System (WARMS) data, reports and estimates of reasonable water consumption;
- **Discharge**: first order estimate of groundwater contribution to baseflow for each RU, with spatial distribution where sufficient data is available; to be updated as part of Step 4

The reference conditions and present status per RU will be reported on as **Deliverable 3.2**.

3.1.4.4. Task 3.4 – Step 4: Determine BHN and EWR

The aim of this task is to determine the BHN and EWR for each of the selected study sites and, where appropriate, align with Step 4 (WRC, 2013) of the water resource classification procedure set out in Regulation 2(4).

The groundwater component of the BHN and EWR will be determined for all GRUs delineated in Task 3.2 (Step 2), supported by the ecological findings of the gazetted Water Resource Classes and RQOs.

The DWS confirmed during the inception meeting that there is no parallel surface water ecological Reserve study to this high confidence groundwater study and that the surface water Reserve in the gazetted Water Resource Classes and Resource Quality Objectives was sufficient. This forms an amendment to the proposal. The surface water inputs from the surface water Gazette (DWS, 2019: 121) will therefore form the basis for the surface water reference conditions. However, inputs from the water supply project in the Berg catchment, currently being undertaken by the DWS Water Resource Planning Directorate, and the collaborative projects between the DWS and Denmark will also be considered if the data is available to the PSP. The assessment of BHN and EWR per GRU will include:

- **Groundwater dependent population and the associated BHN.**

The BHN will be broken down according to the population that relies on groundwater to meet the high confidence level of the project. Population statistics from Statistics South Africa as well as findings from the Reconciliation Strategies for All Towns will be used as the basis for determining the reliance of towns on groundwater within the Berg catchment.

- **EWR component dependent on groundwater discharge.**

The groundwater component of natural baseflow at selected sites within each GRU will be determined, using baseflow separation methods; depending on the water resource class and determined EWR, the portion of EWR that needs to be provided by groundwater will then be determined. Where sufficient data is available, this determination will be supported by analytical and existing numerical groundwater flow models. It is assumed that groundwater dependent ecosystems will have been identified during the surface water study (findings supporting DWS, 2019: 121).

- **Allocable groundwater volume.**

The theoretical volume of groundwater that can be allocated in each RU will be determined, based on the estimated recharge and the groundwater component of EWR. The allocable volume depends on the current water use in the RU. It is noted that this determination is based on the assumption that any abstraction within a RU will have the same impact on the groundwater discharge, which is not correct. This will be further addressed in Step 5.

- **Groundwater quality component.**

The water quality requirements at the EWR sites will be compared to the groundwater quality within the GRU and impacts related to changes in groundwater quality assessed. The groundwater quality component of the BHN will be based on the water quality within the GRU, using available data sets.

The groundwater component of BHN and EWR per GRU will be reported on as **Deliverable 3.3**.

3.1.4.5. Task 3.5 – Step 5: Operational Scenarios & Socio-economic

The aim of this task is to determine operational scenarios and its socio-economic and ecological consequences.

Future scenarios of water use have been developed and broadly evaluated as part of the water resource classification process. This will be initially used and updated to assess the impact of these operational scenarios on the aquifer, the groundwater component of the BHN/EWR and the water quality. The assessment will include an analysis of groundwater quality impacts from activities such as agricultural return flow and other potentially contaminating activities (PCAs), where these are known.

These scenarios and findings will be integrated with the Water Resource Classification socio-economic and ecological consequences as **Deliverable 3.4**.

3.1.4.6. Task 3.6 – Step 6: Evaluate scenarios with Stakeholders

The aim of this task is to evaluate the scenarios with stakeholders and align with Step 6 of the water resource classification (WRC, 2013) procedure set out in Regulation 2(4).

The outcome of Step 3 (PES), Step 4 (groundwater component of BHN and EWR) and Step 5 (scenarios and consequences) will be presented to stakeholders identified in Phase 1 and evaluated, adjusted and agreed upon. It is assumed that this stakeholder workshop will be one of the six required PSC meetings. Since Step 6 of the Water Resource Classification has been concluded already, the outcome of that process will be used to guide this evaluation. The scenarios and groundwater component of BHN/EWR as reported on in **Deliverable 3.3** and **Deliverable 3.4** will be updated based on the stakeholder input and agreements, and documented as **Deliverable 3.5**.

3.1.4.7. Task 3.7 – Step 7: Monitoring Programme

The aim of this task is to design an appropriate monitoring programme by taking into account the hydraulic characteristics and the status of identified water resources. The PSP will assist in updating existing monitoring programmes, where these exist, and developing a comprehensive monitoring programme for GRUs of the Berg catchment. If the latter is the case, then additional monitoring locations and costs will be discussed in collaboration with and agreed upon by the DWS. The monitoring report should take into account the outcome of the optimisation study, and should clearly outline handover, roles and responsibilities for all elements of the monitoring protocol to ensure it is implemented. The monitoring programme will define the frequency of monitoring and the monitoring parameters at each site, and will include water quality, groundwater level, abstraction volumes and flow rates, *inter alia*. The input provided by the PSP will be summarised in **Deliverable 3.6 – Monitoring Programme Report**.

3.1.4.8. Task 3.8 – Step 8: Gazette and implement the Reserve.

The gazetting template will be drafted, based on the results of the study in terms of PES, REC, agreed groundwater component of BHN and EWR and groundwater quality component per GRU (**Deliverable 3.9**). It is assumed that the DWS and their legal services finalise the gazette for publication.

The outcomes of all the previous tasks will be documented in the Final Groundwater Reserve Determination Report (**Deliverable 3.7**) and all data, including spatial, collated in a database (**Deliverable 3.8**).

3.2. Adjustments to the Proposal

Based on the findings from the Gap Analysis (**Deliverable 2.1**) additional data collection may be required. This will largely be influenced by the availability of raw digital data that informed the Water Resource Classes and RQOs for the Berg catchment (DWS, 2019: 121). Should this data not be available, and the PSP be required to extract the data, then this would have impacts on the budget as this was not catered for in the proposal. This will however be addressed in the recommendations of the Gap Analysis (**Deliverable 2.1**).

The final deliverables order from the proposal have been amended accordingly (see **Table 3-1** and **Section 5** for the list of deliverables and report schedule, respectively):

- **Deliverable 3.7**- adjusted from *"Gazette Template"* to *"Groundwater Reserve Determination Report"*
- **Deliverable 3.8** – adjusted from *"Groundwater Reserve Determination Report"* to *"Database of Information and Data"*
- **Deliverable 3.9** – adjusted from *"Database of Information and Data"* to *"Gazette Template"*

This amendment is to accommodate the integration of feedback from the client and the external reviewer on the final Groundwater Reserve Determination Report which then can subsequently be incorporated into the Gazette Template.

Adjustments to the schedule of PMC and PSC meetings have been made to accommodate most of the PSC meetings in the month prior to a major deliverable, to ensure input from Stakeholders.

Updates to the project team have also been noted in **Section 6.1** due to staff changes at Umvoto.

3.3. Initial Data Requirements

In order to initiate the gap analysis phase of this study (see **Section 3.1.3**), the raw input data to the Water Resource Classes and RQOs for the Berg catchment is required. DWS has provided some reports related to this study (available online: https://www.dws.gov.za/RDM/WRCS/default.aspx). Other datasets related to this study; Section 21(a) Surface and groundwater abstraction records off the Water Use Allocation and Registration Management System (WARMS) database, and Groundwater and Groundwater Chemistry related data off the National Ground Water Archive (NGA) have already been requested and received from the relevant DWS programmes (**Table 3-2**).

Data inputs and findings that informed the Water Classes and RQO (DWS, 2019: 121) will form the basis for the surface water reference conditions, as no other parallel surface water ecological reserve studies are being conducted. Should the raw digital data not be available, then the extraction of these data will require amendments to the scope of work and budget.

Table 3-2 Phase 1 data request from Umvoto, indicating the status of the request.

Study	Data Category	Request	Request Status
DWS, South Africa. August 2016. Determination of Water Resource Classifications and RQOs in the Berg Catchment: Project Number WP10987	Reports	Inception Report (RDM/WMA9/00/CON/CLA/0116)	Received
		Stakeholder Identification and Mapping (RDM/WMA9/00/CON/CLA/0216)	Received
		Water Resources Information Gap Analysis and Models (RDM/WMA9/00/CON/CLA/0316)	Received
		Quantification of the EWR and changes in EGSA's (RDM/WMA9/00/CON/CLA/0217)	Received
		Monitoring Programme to Support RQOs Implementation (RDM/WMA9/00/CON/CLA/0318)	**Pending**
		Confidence Assessment for RQOs (RDM/WMA9/00/CON/CLA/0418)	**Pending**
		Water Resources Classes and RQOs Gazette Template (RDM/WMA9/00/CON/CLA/0518)	Received
		Draft Project Close Out Report (RDM/WMA9/00/CON/CLA/0618)	Received
		Support with gazetting process & Final close out Report (RDM/WMA9/00/CON/CLA/0718)	Received
	GIS Datasets and Excel Sheets	Integrated Units of Analysis (IUA) classification polygons & associated attribute tables (Water Resource Classes & Groundwater Classes)	**Pending**
		Resource Units (RUs) classification polygons & associated attribute tables (Estuaries, Dams, Groundwater & Wetlands)	**Pending**
		Priority Resource Units (RUs) classification polygons & associated attribute tables (Estuaries, Dams, Groundwater & Wetlands)	**Pending**
		Polygons & associated attribute tables for areas of specific ecological importance for water resources: Protected Sites, Critical Biodiversity Areas (CBAs), National Freshwater Environmental Protection Areas (NFEPAs), Strategic Water Source Areas (SWSAs)	**Pending**

Study	Data Category	Request	Request Status
DWS, South Africa. 2012. Pre-feasibility and Feasibility Studies for Augmentation of the Western Cape Water Supply System by Means of Further Surface Water Developments, Report No.1: Ecological Water Requirement Assessments, Volume 1 – Riverine Environmental Water Requirements.	Electronic Appendices	Riverine Environmental Water Requirements (PWMA19 G10/00/2413/1): Electronic EWR Data (Appendix 1, 2 and 3)	**Pending**
All Towns Water Reconciliation Strategies in the Western Cape	Data List	Updated Phase 2 allocations/use for current groundwater/conjunctive users (implementations, recommendations, and status)	**Pending**
DWS Monitoring Optimisation Study	Reports and Excel Sheets (where available)	Access to reports and data referred to as the “DWS Monitoring Optimization Study” in the Inception meeting.	**Pending**
National Groundwater Archive (NGA) groundwater and groundwater chemistry related data	Excel Sheets	Information related to boreholes (Berg WMA) including coordinates, drilling data (Casing, Screens, Lithology, etc), water levels, abstraction, field measurements (pH, EC, alkalinity and temperature), groundwater water quality (Major ion and trace element chemistry)	Received
Hydstra	GIS Datasets (where possible) and Excel Sheets	Most up to date surface, groundwater and rainfall data (including data from the Groundwater Level Monitoring Network)	**Pending**
Water Management System (WMS)	GIS Datasets (where possible) and Excel Sheets	Most up to date groundwater quality data (macro element samples), including data from the National Groundwater Quality Monitoring Programme (NGwQMP)	**Pending**
Water use Authorization & Registration Management System (WARMS)	Excel Sheets	Most up to date water use & registration dataset, including all site identifiers.	Received

4. STAKEHOLDER ENGAGEMENT

According to WRC (2013) stakeholders should be included in the assessments to ensure all concerns and issues are addressed, which include socio-economic issues such as land-use, populations statistics and gross geographical product. As such the variety of stakeholders will range in focus. Stakeholder engagement, as described by WRC (2013) GRDM manual, should include:

- Stakeholder inclusion in assessments: this will take the form of DWS and interested and effected parties (see **Appendix A** for the provisional stakeholder list);
- Integration of issues raised by stakeholders on physical and chemical aspects of the system;
- Stakeholder evaluation of operational scenarios. Current reference conditions and implications of operational scenarios to be detailed.

Stakeholder engagement activities will include:

- Stakeholder identification and compilation of a stakeholder database
- Composing the PSC
- Communication and information sharing through reporting, workshops, and progress reports
- External review appointment
- Presentations to PSC
- Meeting minutes

Due to Covid-19 protocols, the stakeholder engagement and PSC meetings will be held as a hybrid virtual and in-person model. This is to not exclude any stakeholder but in-person meetings are encouraged. Due to the spatial extent of the Berg catchment existing stakeholder databases and networks will be utilised to ensure the most relevant stakeholders are engaged throughout the process.

A provisional list of stakeholders is included in **Appendix A**.

5. WORK PROGRAMME

5.1. Rescheduling of the programme

The agreed upon deliverable due dates (as listed in the "Monthly Milestone Update") are each extended by a month to accommodate for the delay in the Inception Meeting and issuing of the Purchase Order. The updated reporting timeline, for final and progress reports, is outlined in **Section 5.2** and summarized in **Table 5-1** and **Table 5-2**.

5.2. Report Preparation

All data and information gathered and analysed during the duration of the project will be reported on based on the requirements of the Terms of Reference (Section 5, pages 8 to 10), and will form the deliverables of this project. These reports will be completed at the end of each phase/task as draft reports, which will then be combined to form the final deliverable of the project, namely the Final Groundwater Reserve Determination Report (**Deliverable 3.7**). The PSP will appoint an independent external reviewer, agreed to by DWS, to review all major project deliverables throughout the study period. The findings of the review will include technical improvements and recommendations in the form of a reviewer report that will be discussed at PSC meetings and included as an Appendix in the final report.

Table 5-1 Project deliverables, related to outlined project tasks, and due dates for final reports.

No.	Deliverable	Due Date
1	Inception Report and Capacity Building Programme	April 2022
2.1	Gap Analysis Report	June 2022
2.2	Water Resource Model Inventory	June 2022
3.1	Delineation of Water Resource Units Report	August 2022
3.2	Ecological Reference Conditions Report	October 2022
3.3	BHN and EWR Requirement Report	February 2023
3.4	Operational Scenarios & socio-economic and ecological consequences Report	May 2023
3.5	Stakeholder engagement of operation scenarios Report	August 2023
3.6	Monitoring Programme Report	November 2023
3.7	Groundwater Reserve Determination Report	February 2024
3.8	Database of all information and data (including spatial)	February 2024
3.9	Gazette Template	February 2024

In addition to the project reporting deliverables, reports will be prepared for the various project management meetings:

- Progress reports every 2 months for PMC (12 in total), based on a template provided by DWS. Progress reports to include task progress and budget tracking.
- Progress reports for the PSC (6 in total). The drafts of all deliverables (see **Table 5-1**) will be submitted during the month prior to the final deliverable date as part of the progress report and for comment. This will also ensure compliance with the Directorate: Reserve Determination (DRD)'s Operational Plan for 2022/2023 financial year

The schedule for these progress reports and meetings are listed in **Table 5-2**. Progress reports will be provided a week prior to PMC or PSC meetings.

Table 5-2 Integrated summary of amended "Monthly Milestone" dates for progress reports, PMC and PSC meetings, tasks and deliverables.

Project Task			2022										2023												2024	
0		**Project Management / Capacity Building**	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	P0a	General Project Management																								
	P0b	PMC Meetings (12)																								
	P0c	PSC Meetings (6)																								
	P0d	Ad Hoc (4)																								
	P0e	Capacity Building Programme																								
	P0f	Monthly Progress Reports																								
1		**Study Inception**																								
	P1a	Kick-off meeting																								
	D1	*Reporting (Deliverable 1)*		X																						
2		**Gap Analysis**																								
	T2.1	Data collection and collation																								
	D2.1	*Reporting (Deliverable 2.1)*				X																				
	D2.2	*Reporting (Deliverable 2.2)*				X																				
3		**Groundwater Reserve Determination**																								
	T3.1	Initiate Groundwater Reserve Study																								
	T3.2	Water Resource Unit Delineation																								
	D3.2	*Reporting (Deliverable 3.1)*						X																		
	T3.3	Ecological Status and Reference Conditions																								
	D3.3	*Reporting (Deliverable 3.2)*								X																
	T3.4	Determine BHN and EWR																								
	D3.4	*Reporting (Deliverable 3.3)*												X												
	T3.5	*Operational Scenarios & Socio-economic*																								
	D3.5	*Reporting (Deliverable 3.4)*															X									
	T3.6	*Evaluate scenarios with Stakeholders*																								
	D3.6	*Reporting (Deliverable 3.5)*																		X						
	T3.7	*Monitoring programme*																								
	D3.7	*Reporting (Deliverable 3.6)*																					X			
	T3.8	*Gazette & implement Reserve*																								
	D3.8	*Reporting (Deliverable 3.7)*																								X
	D3.8	*Reporting (Deliverable 3.8)*																								X
	D3.8	*Databse (Deliverable 3.9)*																								X
		External Review																								

6. PROJECT TEAM

6.1. Organisation

Umvoto will be the PSP and will be responsible for the execution of the study under the auspices of the client, DWS CD:WEM, under the project manager Philani Khoza.

The project organisation is shown in **Figure 6-1** and further details (qualifications, HDI, experience, etc.) of the project team listed in **Table 6-1**. The project team has been updated as a result of staffing adjustments at Umvoto.

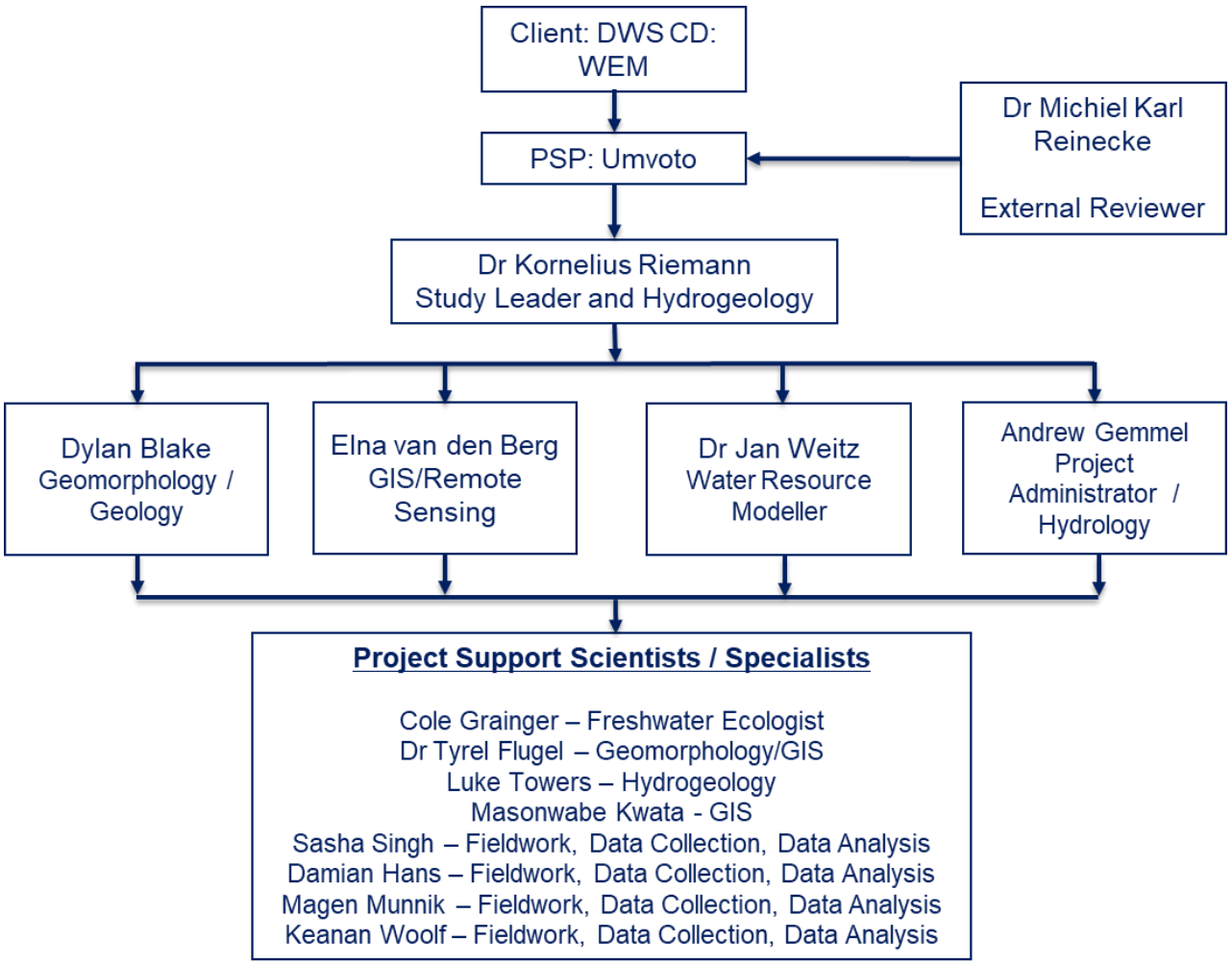

Figure 6-1 Project team organisation.

Dr. Kornelius Riemann (Umvoto) is a Water Resource specialist and will form the Study Lead who is responsible for decisions related to the technical aspects of the project. Decisions will be made in consultation with the relevant specialists and support staff.

Dylan Blake, Dr. Jan Weitz, Elna van den Berg and Andrew Gemmel are Specialist Leads and responsible for the vision and direction of the project with respect to their various specialist fields.

Other support staff, namely Cole Grainger, Dr Tyrel Flugel, Luke Towers, Masonwabe Kwata, Sasha Singh, Damian Hans, Magen Munnik and Keanan Woolf, will add valuable inputs from their various skillsets under the direction of the Specialist Leads (see **Figure 6-1** and **Table 6-1**).

Table 6-1 List of project team with HDI, qualification, professional registration, and experience.

Team Member	HDI	Qualification	Professional Registration	Experience (Years)	Project Role
Dr Kornelius Riemann	WM	PhD Geohydrology	SACNASP Pr.Sci.Nat 400249/04	> 30	Study Lead - Hydrogeologist
Elna van den Berg	WF	MSc Environmental Science	-	23	GIS/Remote Sensing
Dylan Blake	WM	BSc Hons Geology	SACNASP Pr.Sci.Nat 400048/13	14	Geomorphology/ Geology
Andrew Gemmel	WM	MSc Hydrology	SACNASP Ps.Sci.Nat 400426/14	11	Project Administrator/ Hydrology
Dr Jan Weitz	WM	PhD Hydrogeology	SACNASP Pr.Sci.Nat 119623	8	Water Resource Modeller
Dr Tyrel Flugel	WM	PhD Environment & Geographical Sciences	SACNASP Pr.Sci.Nat 119624	9	Geomorphology / GIS
Luke Towers	WM	MSc Hydrogeology	SACNASP Pr.Sci.Nat 114418	9	Hydrogeology
Cole Granger	WM	MSc Conservation Ecology & Entomology	SACNASP Cand.Sci.Nat. 119870	5	Freshwater Ecology
Sasha Singh	BM	BSc Hons Geology	SACNASP Pr.Sci.Nat 119618	5	Hydrogeology Support
Masonwabe Kwata	BM	BSc Hons GIS & Remote Sensing	-	2	GIS support
Damian Hans	BM	MSc Environmental & Water Science	-	3	Hydrological Support
Magen Munnik	BF	MPhil	SACNASP Cand.Sci.Nat 119616	5	Hydrogeology Support
Keanan Woolf	BM	BSc Hons Geology	SACNASP Cand.Sci.Nat 136701	2	Hydrogeology Support
Dr Michiel Karl Reinecke	WM	PhD Ecology	SACNASP Pr.Sci.Nat	20	External Reviewer

Since the submission of the project proposal several staff members have left Umvoto. A separate motivation for the project team update will be put forward for approval by DWS CD: WEM.

6.2. External Review

During the inception meeting discussions (held on 16 March 2022), it was agreed that the PSP will identify appropriate external reviewers who will be consulted throughout the duration of the project. Umvoto identified Dr Michiel Karl Reinecke of Southern Waters Ecological Research and Consulting as the external reviewer, which was approved by DWS CD: WEM.

7. CAPACITY BUILDING PROGRAMME

Capacity building will take place within Umvoto and through interfacing with select DWS staff.

7.1. Internal Capacity Building

Umvoto has a formal intern programme that has assisted more than 52 persons to realize post graduate opportunities in the past 16 years. This project team (see **Section 6**) places special emphasis on addressing the backlog of HDI in the science and engineering industry, and facilitating enhanced career development of these individuals, as exhibited by Umvoto winning the Southern African Young Water Professionals Professional Development Award in 2012. To this extent Umvoto will train its own HDI black, Indian and coloured staff during the project in the following aspects:

- Sasha Singh in desktop hydrogeological data collection and analysis and hydrocensus;
- Masonwabe Kwata in geographic information system (GIS) and remote sensing;
- Damian Hans in hydrological data collection and analysis;
- Keanan Woolf in desktop hydrogeological data collection and analysis;
- Magen Munnik in desktop hydrogeological data collection and analysis;

38% of the team members are black (African, coloured or Indian), and are considered HDI, while 15% of the team members are women. 31% of project fees and 53% of the project time is to be from black, team members, while 7% of project fees and 5.7% of project time are projected to be from women team members. The Umvoto team comprise five HDI, including four black males and one female.

7.2. Interface with DWS

For capacity building in DWS, relevant DWS officials responsible for water resource management will participate to ensure active sharing of ideas and broadening of the RDM skills base to enable officials to conduct Reserve determination studies in the future. Additionally, DWS staff will be seconded to various phases of the project such as data collection, modelling and analysis of the Reserve determination. The capacity building programme will include a training manual and data analysis and interpretation, GRU delineation, groundwater modelling (conceptual, numerical etc.), recharge estimation per delineation (GRU), baseflow estimation per delineation (GRU), groundwater component/contribution to baseflow and groundwater quality.

A provisional timeline for key tasks associated with the capacity building are summarized in **Table 7-1** for guidance to the interested DWS staff. It is envisioned that DWS staff would be seconded for a week at a time during each of the tasks identified for capacity building. The DWS has provided a list of staff (**Table 2-2**), their availability and which tasks they are interested in (based on the training tasks outlined by the PSP) as agreed upon in the inception meeting.

Discussions, training workshops and data analysis will be done at the Umvoto offices, where DWS staff will be mentored.

Table 7-1 Provisional Capacity Building timeline.

Task	Description	Period
2.1	Gap Analysis and Water Resource Model Inventory: data collection, review, and analysis	May 2022
3.1	GRU delineation	July 2022
3.4	Water Resource Modelling: 1 week groundwater modelling training led by Dr. Jannie Weitz and Ms. Annalisa Vicente. Aspects will include: • groundwater modelling (conceptual, numerical etc.), • recharge estimation per delineation (GRU), • baseflow estimation per delineation (GRU), • groundwater component/contribution to baseflow and groundwater quality	January 2023
3.8	Reserve Determination: Attend Final Reserve Determination stakeholder engagement workshop to observe how it is determined and update the reserve reporting based on stakeholder input.	January 2024

Table 2-2 List of DWS officials attending the Capacity Building Programme

Official	Directorate / Region	Tasks
Lakhe Komani	Western Cape Regional Official - Geohydrology	All tasks
Azwidohwi Lambani	Western Cape Regional Official - Geohydrology	All tasks
Tichatonga Gonah	Reserve Determination - Groundwater	All tasks
Kwazikwakhe Majola	Reserve Determination - Groundwater	3.1, 3.4, and 3.8
Adaora Okonkwo	Water Resource Classification	3.1, 3.4, and 3.8
Philani Khoza	Reserve Determination - Groundwater	2.1, 3.1, 3.4, and 3.8
Koleka Makanda	Water Resource Classification	3.1, 3.4, and 3.8
Henry Maluleke	Reserve Determination - Groundwater	2.1, 3.4, and 3.8
Sivashni Naicker	Groundwater Planning	All tasks
Ndivhuwo Netshiendeulu	Reserve Determination - Groundwater	All tasks

8. FINANCIAL

8.1. Project Costs

We propose to undertake the tasks required for a price of **R 3 244 909.00** including disbursements, allowance for escalation and 15% VAT. A summary of the costs for:

- The total hours, rates and costs for each team member are included in **Table 8-1**
- Project disbursements are included in **Table 8-2**
- Each phase of work and a project budget summary are included in **Table 8-3**

Table 8-1 Summary project team rates and hours.

Team Member	HDI	Hourly Rate	Daily Rate	Hours	Days	Total
Kornelius Riemann	WM	R 2,300	R 18,400	414	51.75	R 952,200
Dylan Blake	WM	R 1,385	R 11,080	132	16.5	R 182,820
Andrew Gemmel	WM	R 1,150	R 9,200	104	13	R 119,600
Elna van der Berg	WF	R 1,000	R 8,000	128	16	R 128,000
Tyrel Flugel	WM	R 940	R 7,520	68	8.5	R 63,920
Luke Towers	WM	R 1,150	R 9,200	92	11.5	R 105,800
Jan Weitz	WM	R 730	R 5,840	252	31.5	R 183,960
Cole Granger	WM	R 600	R 4,800	88	11	R 52,800
Sasha Singh	BM	R 615	R 4,920	872	109	R 536,280
Masonwebe Kwata	BM	R 540	R 4,320	352	44	R 190,080
Damian Hans	BM	R 550	R 4,400	24	3	R 13,200
Magen Munnik	BF	R 550	R 4,400	120	15	R 66,000
Keanan Woolf	BM	R 500	R 4,000	120	15	R 60,000
Dr Michiel Karl Reinecke	WM	R 1,500	R 12,000	66	8.25	R 99,000
					Total	**R 2,753,660**

Table 8-2 Summary of Disbursement rates and costs.

Item	Rate	Quantity	Amount
Meetings (catering)	R 1,000	18	R 18,000
Admin (printing, telephone calls etc.)	R 250	47	R 11,750
Days Subsistence	R 120	25	R 3,000
Kilometres Travel	R 7	5000	R 35,000
Total (excl. VAT)	-	-	**R 67,750**

Table 8-3 Budget summary for each Phase of work outlined in Section 3.

Tasks	Professional Fees	Disbursements	Total	Days
Phase 0 - Project Management / Capacity Building				
P0a - General Project Management	R 138,000	R 6,000	R 144,000	9
P0b - PMC Meetings	R 169,440	R 12,000	R 181,440	18
P0c - PSC Meetings	R 120,720	R 6,000	R 126,720	12
P0d - Ad Hoc Meetings	R 76,120	R 0	R 76,120	7
P0e - Capacity Building Programme	R 46,640	R 0	R 46,640	4
P0f - Monthly Progress Reports	R 169,440	R 0	R 169,440	18
Sub-Total	**R 720,360**	**R 24,000**	**R 744,360**	**68**
Phase 1 - Project Inception				
P1a - Kick-off Meeting	R 32,520	R 1,000	R 33,520	3
D1 - Reporting (Deliverable 1)	R 42,360	R 250	R 42,610	5
Sub-Total	**R 74,880**	**R 1,250**	**R 76,130**	**8**
Phase 2 - Review of Water Resource Information & Data				
T2.1 - Data collection & collation	R 137,520	R 500	R 138,020	23
D2.1 - Reporting (Deliverable 2.1)	R 92,660	R 250	R 92,910	15
D2.2 - Reporting (Deliverable 2.2)	R 19,280	R 250	R 19,530	2.5
Sub-Total	**R 249,460**	**R 1,000**	**R 250,460**	**40.5**
Phase 3 - Groundwater Reserve				
T3.1 - Initiate Groundwater Reserve Study	R 0	R 0	R 0	0
T3.2 - Water Resource Unit Delineation	R 151,480	R 250	R 151,730	24.5
D3.2 - Reporting (Deliverable 3.1)	R 66,340	R 250	R 66,590	9
T3.3 - Ecological Status and Reference Conditions	R 125,800	R 14,850	R 140,650	22.5
D3.3 - Reporting (Deliverable 3.2)	R 92,720	R 250	R 92,970	14.5
T3.4 - Determine BHN and EWR	R 482,600	R 23,650	R 506,250	65
D3.4 - Reporting (Deliverable 3.3)	R 147,120	R 250	R 147,370	18.5
T3.5 - Operational Scenarios & Socio-economic	R 81,720	R 250	R 81,970	12
D3.5 - Reporting (Deliverable 3.4)	R 58,520	R 250	R 58,770	7.5
T3.6 - Evaluate scenarios with Stakeholders	R 58,780	R 250	R 59,030	5
D3.6 - Reporting (Deliverable 3.5)	R 20,120	R 250	R 20,370	2
T3.7 - Monitoring programme	R 99,120	R 250	R 99,370	13
D3.7 - Reporting (Deliverable 3.6)	R 34,240	R 250	R 34,490	3.5
T3.8 - Gazette & implement Reserve	R 67,000	R 250	R 67,250	9
D3.8 - Reporting (Deliverable 3.7)	R 61,960	R 250	R 62,210	9.5
D3.8 - Reporting (Deliverable 3.8)	R 115,840	R 250	R 116,090	14
D3.8 -Database (Deliverable 3.9)	R 45,600	R 0	R 45,600	8
Sub-Total	**R 1,708,960**	**R 41,750**	**R 1,750,710**	**237.5**
Total (excl. VAT)	***R 2,753,660***	***R 68,000***	***R 2,821,660***	-
15% VAT	R 413,049	R 10,200	R 423,249	-
Total (incl. VAT)	**R 3,166,709**	**R 78,200**	**R 3,244,909**	**354**

8.2. Billing Schedule

As stipulated by the DWS, payment will be processed after each deliverable is signed-off and delivered to the DWS in hard copy. Based on this agreement, the estimated billing schedule is outlined in **Table 8-4**. Project management tasks, PMC and PSC meetings, and monthly progress reports will be billed in association with Deliverables.

Table 8-4 Estimated Billing Schedule per deliverable.

Deliverable		Billing Schedule									Total
		Apr-22	Jun-22	Aug-22	Oct-22	Feb-23	May-23	Aug-23	Nov-23	Feb-24	
D1	Inception Report and Capacity Building Programme	R49,001.50									R49,001.50
D2.1	Gap Analysis Report		R288,029.00								R288,029.00
D2.2	Water Resource Model Inventory										R0.00
D3.1	Delineation of Water Resource Units Report			R251,068.00							R251,068.00
D3.2	Ecological Reference Conditions Report				R268,663.00						R268,663.00
D3.3	BHN and EWR Requirement Report					R751,663.00					R751,663.00
D3.4	Operational Scenarios & socio-economic and ecological consequences Report						R161,851.00				R161,851.00
D3.5	Stakeholder engagement of operation scenarios Report							R91,310.00			R91,310.00
D3.6	Monitoring Programme Report								R153,939.00		R153,939.00
D3.7	Groundwater Reserve Determination Report									R133,503.50	R133,503.50
D3.8	Database of all information and data (including spatial)									R52,440.00	R52,440.00
D3.9	Gazette Template									R148,879.00	R148,879.00
T0.1	Management, coordination and liaison	R68,586.00	R30,038.00	R30,038.00	R30,038.00	R60,076.00	R45,057.00	R45,057.00	R45,057.00	R45,057.00	R399,004.00
T0.2	PSC Meetings and stakeholder responses		R24,288.00		R24,288.00	R24,288.00		R24,288.00	R24,288.00	R24,288.00	R145,728.00
T0.3	PMC and Ad-hoc meetings	R17,388.00	R17,388.00	R39,272.50	R17,388.00	R56,660.50	R17,388.00	R56,660.50	R39,272.50	R34,776.00	R296,194.00
T0.4	Capacity building		R13,409.00	R13,409.00		R13,409.00			R13,409.00		R53,636.00
Monthly		**R134,975.50**	**R373,152.00**	**R333,787.50**	**R340,377.00**	**R906,096.50**	**R224,296.00**	**R217,315.50**	**R275,965.50**	**R438,943.50**	**R3,244,909.00**

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APPENDIX A

Provisional List of Stakeholders

National Government Department Stakeholders

National Government Departments	Section/Group
Department of Water and Sanitation	• Directorate: Water Resource Classification (WRC) • Directorate: Reserve Requirements (RR) • Directorate: Sources Directed Studies (SDS) • Provincial Office Western Cape
Department of Agriculture, Land Reform and Rural Development	
Department of Health	
Department of Science and Innovation	• Council for Scientific and Industrial Research (CSIR)
Department of Mineral Resources and Energy	
Department of Forestry, Fisheries, and the Environment	• South African National Parks (SANParks) • Natural Resource Management (NRM) Programme • Working for Water/ Working for Wetlands/Working on Fire/Land • South African National Biodiversity Institute (SANBI) • CAPE Programme • Freshwater Programme

Provincial Government Stakeholders

Provincial Government Departments (Western Cape Government)	Section/Group
Department of Agriculture	
Department of Environmental Affairs and Development Planning	
Department of Health	
Department of Human Settlements	
Department of Transport and Public Works	

Local Government Stakeholders

Local Government	Local Municipality/Department
West Coast District Municipality (DC1)	• Saldanha Bay Local Municipality (WC014) • Swartland Local Municipality (WC015) • Bergrivier Local Municipality (WC013)
Cape Winelands District Municipality (DC2)	• Drakenstein Local Municipality (WC023) • Stellenbosch Local Municipality (WC024) • Witzenberg Local Municipality (WC022)
City of Cape Town Metropolitan Municipality (CPT)	• Disaster Risk Management Centre • Department of Environmental Management • Department of Property Management • Department of Public Housing • Department of Recreation and Parks • Department of Solid Waste Management • Department of Transport • Department of Urban Planning • Department of Water & Sanitation

Water Use Associations & Irrigation Board Stakeholders

Water Use Associations & Irrigation Boards	Contact
Berg River Irrigation Board	
Doornriver Irrigation Board	
Vier en Twintigriviere	
Tulbagh WUA	
Wynland WUA	
Spruit River WUA	

Non-Governmental Organisation Stakeholders

Non-Governmental Organisations	Contact
World Wildlife Fund (WWF)	
Cape Winelands Biosphere Reserve	
Cape West Coast Biosphere Reserve	
Goedgedacht Trust	
Wildlife and Environment Society of South Africa (WESSA)	
Environmental Monitoring Group (EMG)	

Community Based Organization Stakeholders

Community Based Organizations	Contact
Woman of Farms	
Community radio stations	
Goedverwacht community	
For Love of Water (FLOW)	
Black Sash / Black Sash Advocacy Programme	

Academic Institution Stakeholders

Academic Institutions	Contact
Stellenbosch University	
University of the Western Cape	
University of Cape Town	
Cape Peninsula of Technology	

Industrial Organisation Stakeholders

Industry Organisations	Contact
Hortgro	
SATI	
VinPro	
Agri Wes-Cape	
Fresh Produce Exporters' Forum	
GrainSA	
CRI	
Dairy (FairCape)	
MPO	
Green Cape	
Saldanha's Captains of Industry Forum	

Existing Forums Stakeholders

Existing Forums	Contact
Table Bay Nature Reserve Protected Area Advisory Committees	
Zandvlei Protected Area Advisory Committees	
False Bay Ecology Park Steering Committee	
Zandvlei Catchment Forum	
Western Cape Wetlands Forum	
Provincial Inland and Coastal meeting	
Berg River Estuary Management Forum	
Western Cape Estuary Task Team meeting	
Stellenbosch River Collaborative	
WC Sustainable Water Management Plan Steering Committee	
Fresh water forum	
BRIP	
St Helena WQ Trust	
Berg River Partnership	
WCWSS Reconciliation	

Additional Individual Stakeholders

Additional Individual Stakeholders	Contact