

DRAFT SITUATION ASSESSMENT ON GONDWANA LIFESTYLE ESTATE BULK WATER SUPPLY

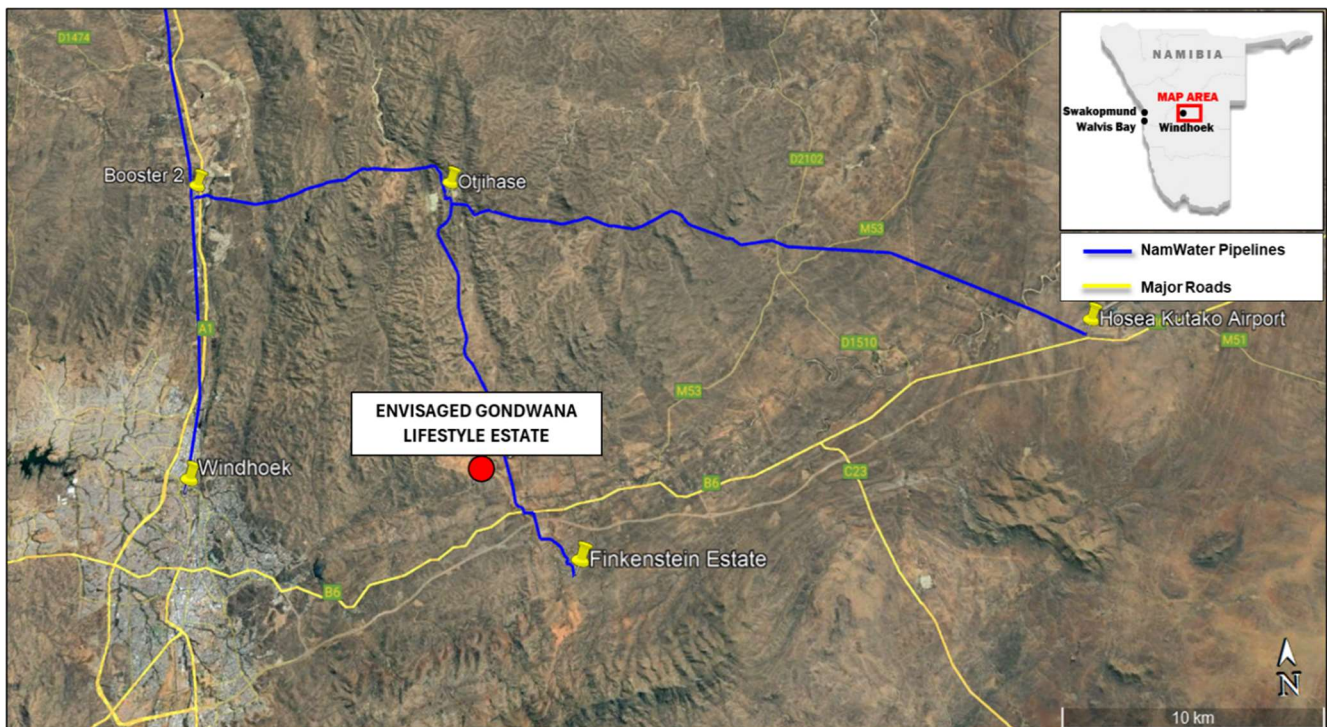


Figure: Location of the planned Gondwana Lifestyle Estate Development at Heja Farm, opposite Finkenstein.

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Executive Summary

Gondwana Collections Namibia, through Windhoek Consulting Engineers (WCE), submitted a bulk water supply application to NamWater for the proposed Gondwana Lifestyle Estate at Heja Farm, Namibia. The development will be located within the City of Windhoek (CoW) municipal boundaries. Ideally, the estate would connect to the city's water distribution network; however, due to the absence of local distribution infrastructure, CoW has directed new industrial and commercial off-takers, including Gondwana, to source water directly from NamWater's bulk water supply infrastructure.

The envisaged development, planned in eight phases, will include residential, commercial, and leisure components, with a Phase 1 water demand of 240,000 m³/a and a full development demand of 940,000 m³/a by 2040. This significantly exceeds the FY2024 demand of the largest customer on the Booster 2 – Otjihase – Airport scheme (Finkenstein Estate, 120,752 m³/a) and roughly doubles the scheme's total demand (456,938 m³/a).

NamWater's Infrastructure Planning Division conducted a Situation Assessment Report to evaluate the impact on the Von Bach – Windhoek and Booster 2 – Otjihase schemes, assess water resource availability, analyse infrastructure sufficiency, and propose development options with cost estimates. The report aims to guide NamWater and Gondwana in ensuring a reliable water supply while addressing regional water security challenges in the Central Area of Namibia (CAN).

The Central Area of Namibia (CAN) Model, indicates that the current run-dry date of Von Bach dam falls slightly short of the required two years assuming no additional inflow, confirming the stress on existing water sources despite a strong rainy season. The projected Von Bach Dam run-dry dates are 20 April 2027 (excluding Gondwana Estate's water demands), 10 April 2027 (including Gondwana Phase 1), and 23 March 2027 (full development). This underscores the urgent need for water source augmentations, such as the Okavango Link (32 Mm³/a, 3–5 years to completion).

Water supply infrastructure sufficiency analyses reveal that the Von Bach – Windhoek infrastructure (Ø1100 mm pipeline, water treatment plant, and pump stations) will reach capacity by FY2033, FY2036, and FY2039/40, respectively, with Gondwana's demand having minimal impact. The Booster 2 – Otjihase scheme is adequate until FY2042 without Gondwana but requires upgrades by FY2030 with Gondwana's phased demands, particularly for the Von Francois Ost (VFO) pump station and Otjihase Reservoirs – Booster pipeline. Emergency groundwater sources, including Hoffnung and Kuruma Fault boreholes, Ondekaremba wellfield, and Otjihase Mine dewatering, offer sufficient potential capacity for an emergency back-up scheme but require further investigation.

The Gondwana Lifestyle Estate's water demands would significantly strain the Booster 2 – Otjihase scheme. Infrastructure upgrades will be required, with the Booster 2 – Otjihase scheme requiring attention by FY2030. Two development options were proposed: Phase 1 (implementation FY2025–2030) includes upgrading the VFO pump station to 220 m³/h and constructing a 12 km Ø315 mm uPVC pipeline, a booster pump station, and a 6,000 m³ onsite reservoir at Gondwana. Phase 2 (FY2030–2035) offers either upgrading the existing pipeline with additional pump stations (Option 1, 360 m³/h) or a new 13.5 km Ø250 mm pipeline (Option 2). Capital costs, to be funded by Gondwana per NamWater's policy, are N\$62.7 million for Phase 1, with Phase 2 costs of N\$57 million (Option 1) or N\$106.6 million

(Option 2), totalling N\$119.7 million or N\$169.3 million when added to Phase 1. Unit incremental running costs are estimated at N\$5.62/m³ (Phase 1), N\$6.05/m³ (Option 1), or N\$6.25/m³ (Option 2), excluding fixed power capacity charges. Emergency groundwater development is essential for Gondwana to mitigate drought risks, given the longer lead-times of major augmentations.

It was recommended that this Situation Assessment Report be submitted to Gondwana Collections and their appointed consultant, Windhoek Consulting Engineers, for their consideration and acceptance, and that it serves as a basis for further water supply dialogue and meeting schedules and commitments with NamWater. Since the proposed estate development falls within the CoW municipal boundaries, an official authorization letter should be obtained from the CoW for NamWater and Gondwana to proceed. The letter should highlight the planned operations and processes regarding the supply of water (i.e. the billing points, entity responsible for billing, storage reservoir locations etc.).

NamWater and Gondwana should prioritize the proposed Phase 1 upgrades by FY2030, including the VFO pump station and dedicated pipeline infrastructure. For Phase 2, Option 2 (new pipeline) is recommended to avoid risks associated with the aging existing pipeline and potential Otjihase Mine demand increases. Gondwana should investigate and develop emergency groundwater sources in collaboration with NamWater (e.g., Hoffnung/Kuruma boreholes, target areas identified by NamWater Geohydrology Division) to ensure their supply reliability during droughts. Finally, NamWater and Gondwana/WCE should further investigate potential power supply upgrades required at Booster 2 to support increased capacities, clarifying cost implications for Gondwana.

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1 Introduction

Gondwana Collections proposes to develop the Gondwana Lifestyle Estate at Heja Farm, encompassing residential, commercial, and leisure facilities within the City of Windhoek (CoW) municipal boundaries. Ideally, the estate would connect to the city's water distribution network; however, due to the absence of local distribution infrastructure, CoW has directed new industrial and commercial off-takers, including Gondwana, to source water directly from NamWater's bulk water supply infrastructure. Consequently, Gondwana has engaged NamWater to explore supply options via the Von Bach Dam – Booster 2 – Otjihase – Airport / Finkenstein scheme, which currently serves the following customers:

- Booster 2 – Otjihase consolidated offtake
- Otjihase Mine and town
- Hosea Kutako International Airport
- Sungate development
- Bergvlug Research Farm
- Neudamm Agricultural College
- Naankuse Guest Farm
- Finkenstein Estate
- Herboth's Blick
- Several smaller customers

On 14 December 2024, Gondwana, through their consultant, Windhoek Consulting Engineers (WCE), submitted a Bulk Water Supply Application to NamWater for the proposed estate. An introductory meeting on 5 February 2025 at NamWater allowed WCE to present the project and its water requirements. In response, NamWater's Infrastructure Planning Division conducted an assessment of existing water resources and infrastructure to meet the estate's projected demands. The objectives of this report are to:

- Summarize the bulk water supply application submitted to NamWater.
- Evaluate current and future water supply and demand dynamics on the Von Bach – Booster 2 – Otjihase – Airport scheme, identifying resources and infrastructure needed to meet Gondwana's requirements.
- Propose a development plan with first-order cost estimates and provide recommendations for implementation.

2 Gondwana Lifestyle Village Project & Bulk Water Application

Gondwana acquired a ±354 ha portion of the Heja Farm property on which the Heja Lodge is situated, which they intend to develop into a lifestyle estate. Development will occur eight (8) phases consisting mostly of single and general residential erven, with some administrative, educational, commercial, leisure and retail land uses. A summary of the phases and corresponding water requirements is shown in **Table 1** and **Figure 1**. The Average Annual Daily Demand (AADD) figures were provided by WCE (including 15% distribution losses), and the Average Day in Peak Month (ADPM) water requirements were estimated assuming a peak factor of 1.4, similar to that of Finkenstein Estate based on historical water sales data.

The development will have a substantial impact on the existing water resources and supply infrastructure. The annual water requirement of Phase 1 (1A, 1B and 1C, **Figure 2**) amounts to **±240 000 m³/a**. In comparison, this figure is roughly double the volume sold by NamWater to the largest offtaker on the Booster 2 – Otjijase – Airport / Finkenstein water supply scheme, namely Finkenstein Estate, i.e. 120 752 m³/a in FY2024. The water requirement of the full development is estimated at **±940 00 m³/a** – roughly double the total volume sold by NamWater to the existing water supply scheme, i.e. 456 938 m³/a in FY2024.

Table 1: Phasing and water requirements of Gondwana Lifestyle Estate.

Project Phase	Estimated Year of Development	Estimated Average Water Demand (AADD)		Estimated Peak Water Demand (ADPM, x1.4)	
		(m³/day)	(m³/a)	(m³/day)	(m³/h)
1A	2026/2027	268	97 784	375	19
1B	2029	157	57 159	219	11
1C	2031	247	90 009	345	17
Sub-Total		671	244 952	940	47
2A	2030	155	56 670	217	11
2B	2030-2037	570	207 915	797	40
3A	2035	422	154 176	591	30
3B	2040	458	167 338	642	32
Commercial	To be Determined	299	109 186	419	21
Total		2576	940 236	3 606	180

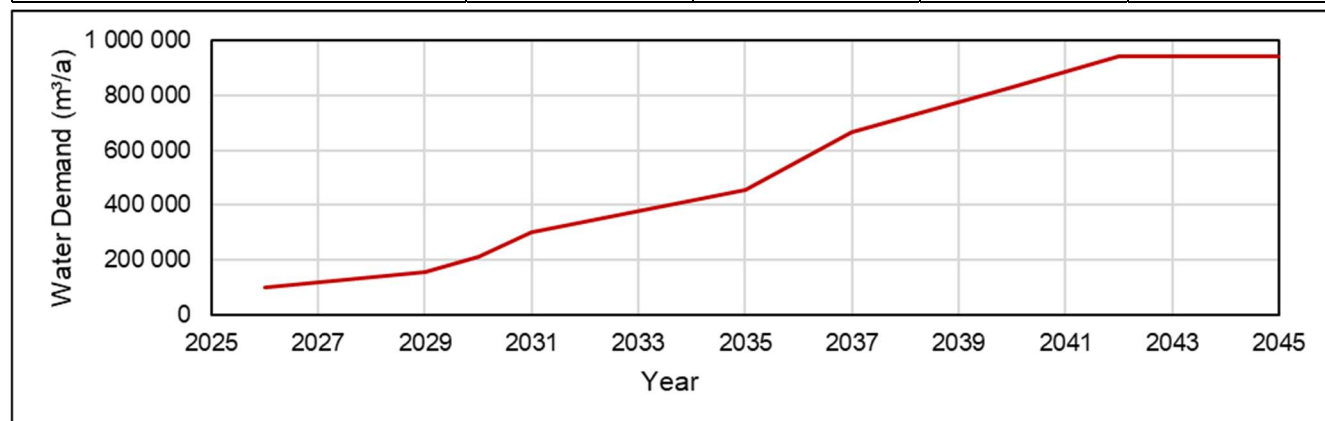


Figure 1: Gondwana Lifestyle Estate annual water demand projection.



Figure 2: Envisaged Gondwana Lifestyle Estate surrounding the Heja Farm dam.

3 Existing NamWater Bulk Water Supply Infrastructure

3.1 Overview & Approach

This section will mainly cover the scheme that is directly relevant to supplying Gondwana's envisaged development, i.e. the Von Bach – Windhoek scheme and the Booster 2 – Otjihase – Airport / Finkenstein scheme.

Although the Otjihase – Airport scheme's infrastructure will not be covered in detail, the impact of its current and future water demands on all upstream water supply infrastructure up to the Von Francois Ost Pump Station at Booster 2 and CAN water sources will be incorporated in the subsequent *Water Demand Assessment* and *Sufficiency Analysis* sections, as shown in **Table 2**.

Table 2: Booster 2 - Otjihase - Finkenstein scheme components and relevant customers.

Component	Description	Relevant Customers / Demand Centres
Water Source	CAN Integrated Sources	<u>Von Bach – Windhoek Customers</u> Windhoek, Osona Military Base, Osona Village, NPI, Brakwater, Elisenheim, Monte Christo, Ongos, other online customers
Treatment Plant	Von Bach WTP	
Pump Stations	Base and Booster 1 & 2 Pump Stations	<u>All Booster 2 – Otjihase – Airport / Finkenstein Customers</u> (See below)
Pipeline	Von Bach - Windhoek	
Booster 2 - Otjihase		
Pump Station	Von Francois Ost	<u>Booster 2 Otjihase Customers</u> Otjihase mine & town Various smaller Customers
Pipeline	Booster 2 - Otjihase	
Reservoirs	Otjihase	<u>Airport Scheme Customers</u> Hosea Kutako Airport, Sungate, Neudamm Agriculture College, Herboth's Blick, Bergvlug Research Farm, Various smaller customers
Pipeline	Otjihase Reservoirs - Pump Stations	
		<u>Towards Finkenstein</u> Finkenstein Estate Gondwana Lifestyle Estate (potential)
Otjihase - Finkenstein		
Pump station	Otjihase - Finkenstein	<u>Finkenstein Pipeline</u> Finkenstein Estate
Pipeline	Otjihase - Finkenstein	
		<u>Proposed New Dedicated Pipeline</u> Gondwana Lifestyle Estate (potential)

Von Bach – Windhoek Scheme Overview

Potable water is conveyed from three clear water wells at the Von Bach Water Treatment Plant (VBWTP) into the 30 000 m³ terminal reservoir in Windhoek via the Von Bach – Windhoek transfer scheme (see **Figure 3**). The scheme consists of the following main components:

1. Von Bach Dam, augmented by the CAN integrated system
2. Von Bach base pump station
3. Two Booster pump stations (Booster 1 and Booster 2)
4. Dual clear water transfer pipelines, laid in parallel, consisting of:
 - i) A Ø600mm nominal diameter spiral welded, bitumen coated and lined steel pipeline. This pipeline was decommissioned due to the bitumen lining coming loose and some of the valves having rusted in position (LCE/PHIM, 2021).
 - ii) A Ø1100mm nominal diameter pre-stressed concrete pipeline.
5. Windhoek Terminal Reservoir.

Booster 2 – Otjihase – Airport / Finkenstein Scheme Overview

NamWater also supplies treated surface water from Von Bach Dam to the Booster 2 – Otjihase – Airport / Finkenstein scheme as follows (see **Figure 4**):

1. At Booster 2, water is pumped from the Von Francois Ost pump station to two reservoirs at Otjihase mine.
2. An above-ground steel pipeline from the Otjihase reservoirs feed two booster pump sets at Otjihase that transfer water through two separate pipelines to Finkenstein and the Hosea Kutako Airport.
3. For the Otjihase – Airport component, a dedicated booster pump station transfers water to a collector reservoir located on top of the eastern water shed, from where it gravitates to Hosea Kutako Airport and en route customers.

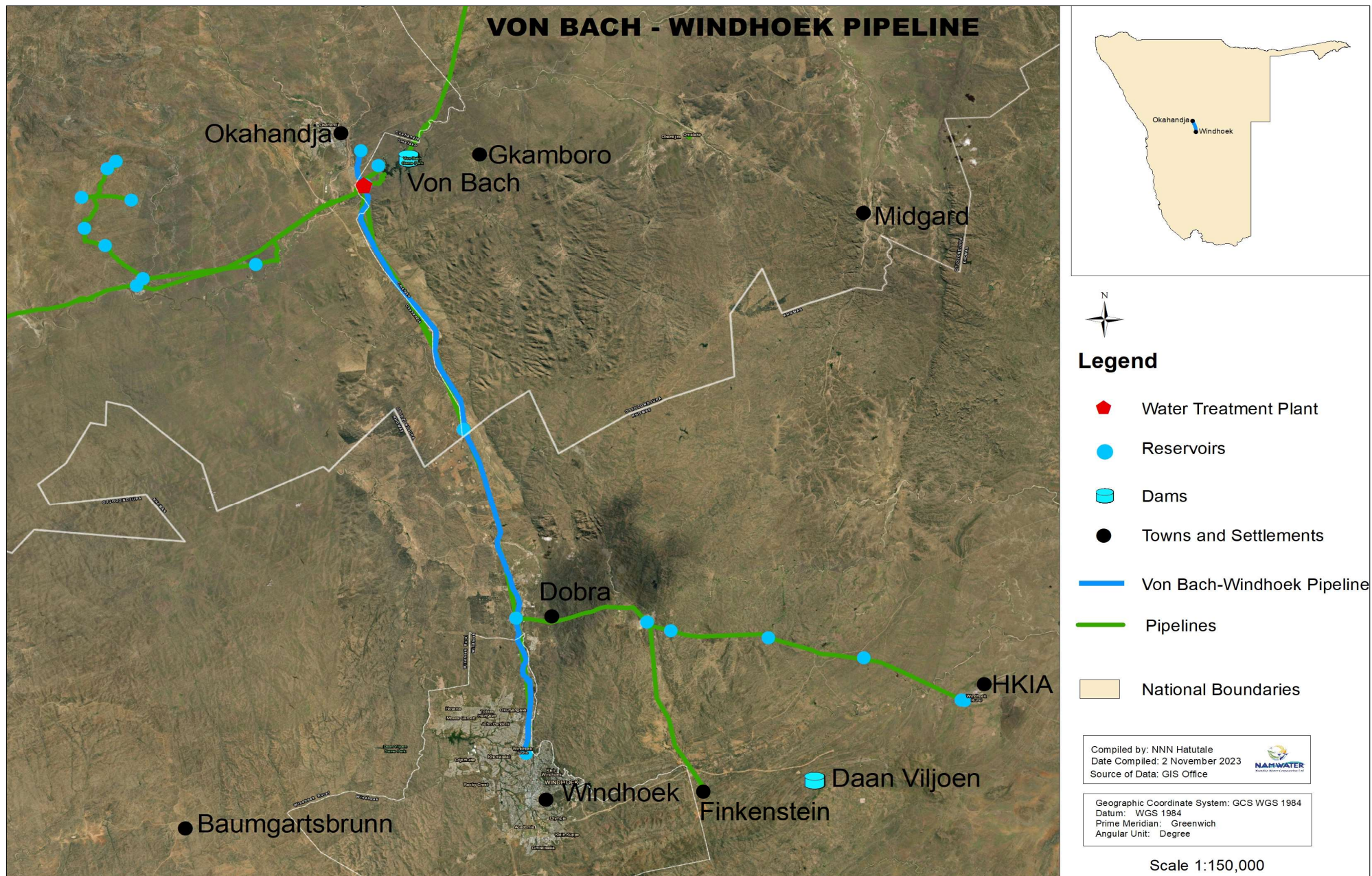


Figure 3: Locality of Von Bach - Windhoek water supply scheme and major components.

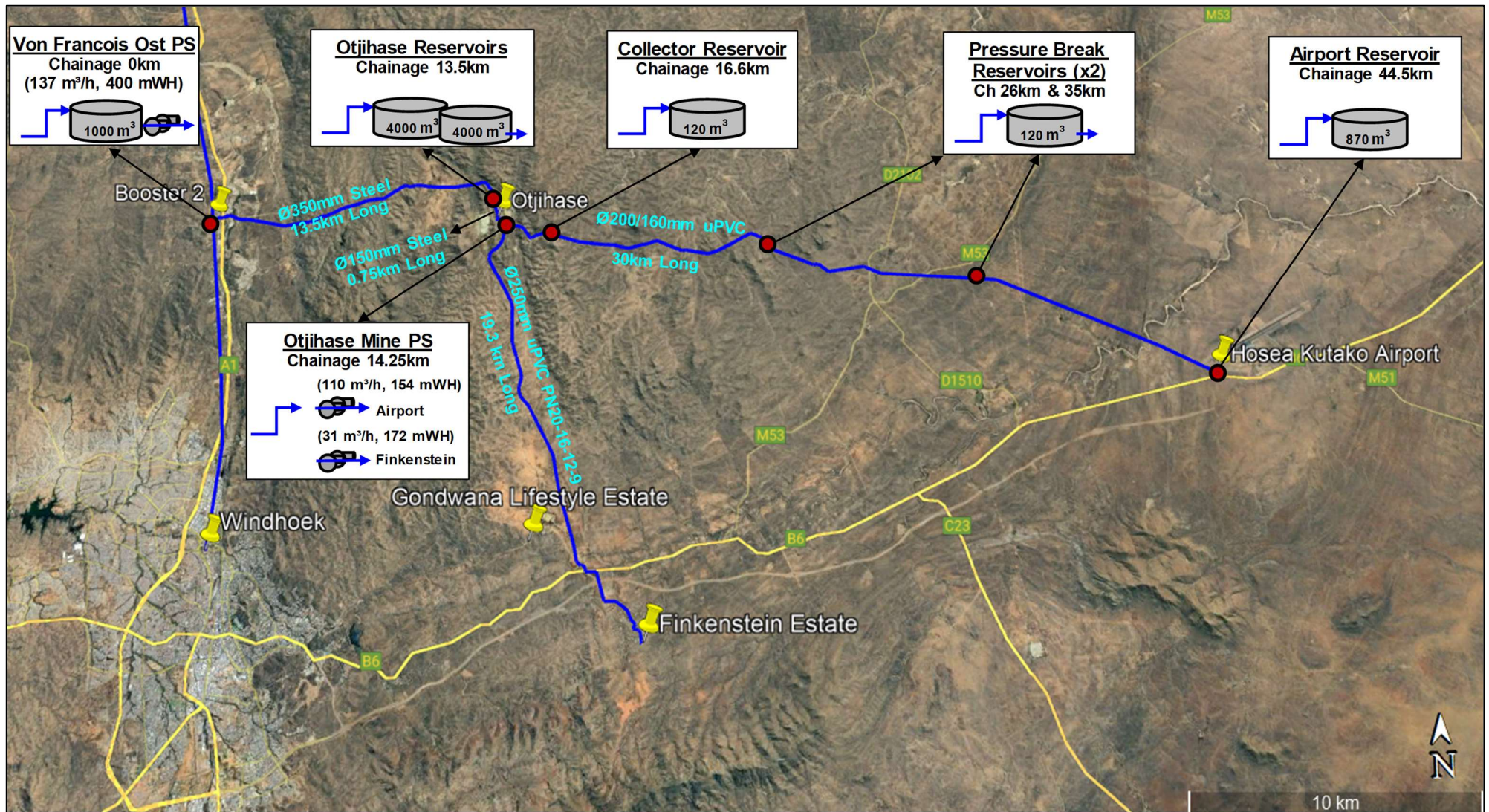


Figure 4: Schematic of Booster 2 - Otjiase - Airport / Finkenstein bulk water supply scheme.

3.2 Water Sources

3.2.1 Von Bach Dam & Central Area of Namib (CAN) Integrated System

Von Bach Dam is augmented by the Integrated Central Area of Namibia (CAN) water supply system, including Swakoppoort Dam, Omatako Dam, and non-surface water sources including several groundwater aquifers and the City of Windhoek's Water Reclamation Plant. A map of the CAN system is provided in **Figure 5**.

Water availability to the customers in Table 2 is impacted by dam inflows and operational conditions at the various supplementary water sources. Hence, water availability and run-dry dates are regularly re-evaluated by NamWater using the **Central Area of Namibia Model (CAN Model)**. The results of this analysis including the Gondwana Lifestyle Estate Development will be covered in the *Sufficiency Analysis* section.

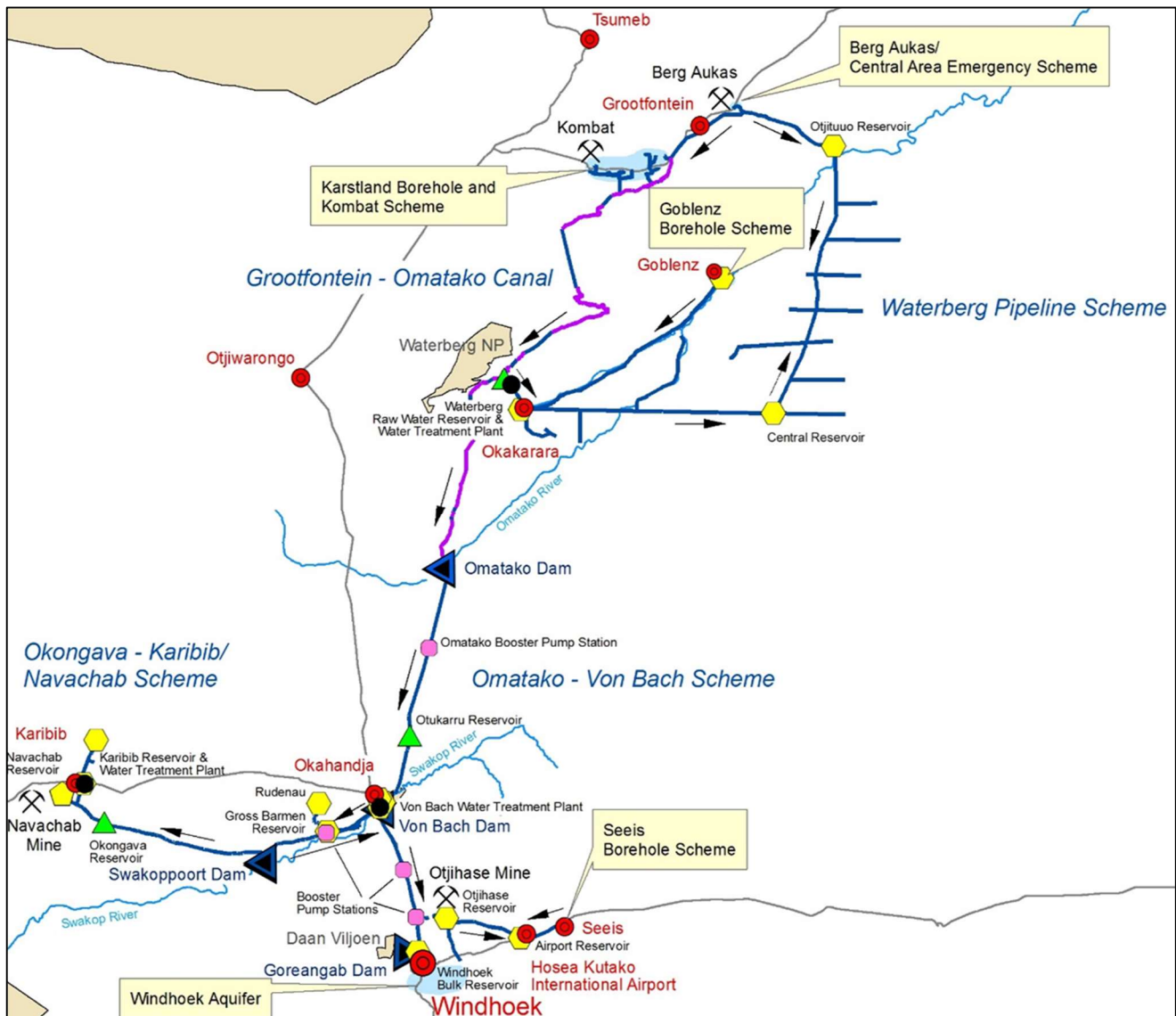


Figure 5: Integrated Central Area of Namibia (CAN) water supply system.

Planned Augmentation of CAN Water Sources

a. Okavango Link

Status: R&D work Ongoing

Most of the water sources within the CAN have already been developed and are nearing the limit of their supply potential. The long-term water security for the CAN has been an issue the Government of Namibia has been trying to address since the 1970s as evidenced by the feasibility studies that identified drawing water from the perennial Okavango River or abstracting desalinated water from the Central Coastal Area. The Eastern National Water Carrier (ENWC) canal that links Grootfontein and the integrated supply system feeding Windhoek was built in 1987 with the provision for water to be abstracted from the Okavango River as a lifeline for Windhoek.

A 280 km long pipeline and pumping scheme is still required to complete the connection to the Okavango River, referred to as the Okavango Link (**Figure 6**). NamWater motivated the implementation of the Okavango Link Project to Government via a 2024 Cabinet submission. Cabinet subsequently approved funding for the implementation of the project to transfer a volume of 32 Mm³/a. NamWater is currently engaged in the procurement of a consultant to conduct the Environmental and Social Impact Assessment (ESIA) study and an engineering consultant was appointed to carry out the Front-End-Engineering-Design (FEED)/Design Development and Report, preliminary design and bid documentations for the effective implementation of the Okavango link project. Being in its early stages, the associated completion timeline is still unclear and currently estimated between 3-5 years.

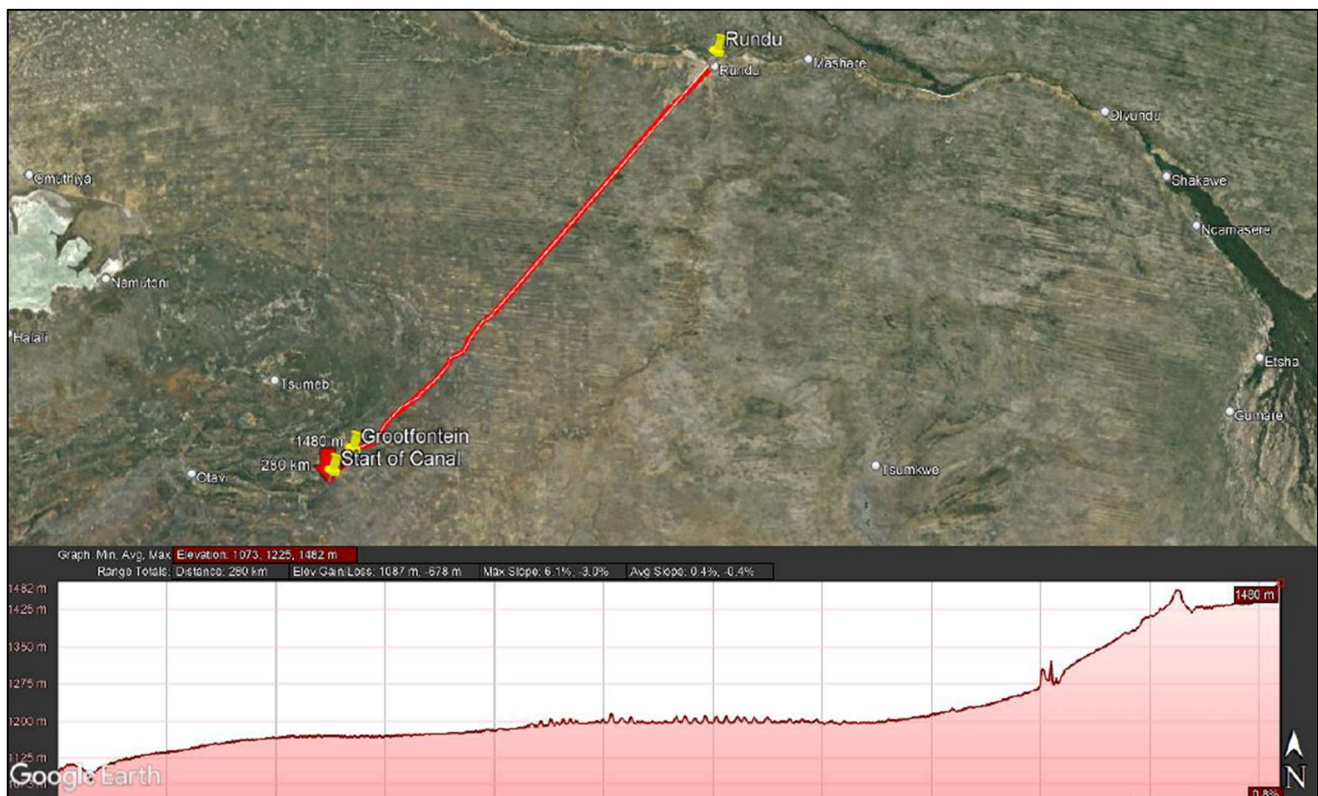


Figure 6: Okavango Link preliminary pipeline route and longitudinal profile (Google Earth).

Additionally, NamWater has initiated several short- to medium-term projects to augment supply to the Central Area of Namibia (CAN):

b. Abenab Emergency Groundwater Scheme

Status: On hold due to environmental concerns and re-allocation of budgets

The Abenab option entails an emergency groundwater scheme north of Grootfontein. The pumping - scheme via a new pipeline of an estimated length of ± 39 km will discharge the water onto the existing ENWC system through which it will be conveyed to the rest of the CAN. The scheme could transfer a maximum of $13.4 \text{ Mm}^3/\text{a}$ in three consecutive years followed by a 12-year recharge period, or $2.4 \text{ Mm}^3/\text{a}$ continually.

c. Gammams Advanced Water Reclamation Plant (GAWRP), known as 'DPR2'

Status: R&D work Ongoing

The City of Windhoek (CoW) is planning a second Direct Potable Reclamation Facility (DPR2) to address water supply shortages and produce an additional $3.6 \text{ Mm}^3/\text{a}$ by 2030. Recent developments confirm that the Government of Namibia will fund upgrades to the GAWRP and the DPR2 facility through a KFW loan, with CoW appointed as the implementing agent. Upon completion, both the DPR2 facility and the upgraded GAWRP will be transferred to NamWater.

d. Other Short-Term Projects

Short-term projects being undertaken by NamWater are listed below:

- Von Bach bypass pipeline, additional volume $1.33 \text{ Mm}^3/\text{a}$, completion by 2026/27.
- Kombat capacity increase, additional volume $2.5 \text{ Mm}^3/\text{a}$, completion by 2026/27.
- Goblenz Waterberg Water Supply, additional volume $2 \text{ Mm}^3/\text{a}$, completion by 2027/28.
- Berg Aukas Additional Boreholes, additional volume $1.5 \text{ Mm}^3/\text{a}$, completion by 2026/27.
- Windhoek Boreholes Exploration – still to be investigated
- Water Demand Management (Reduced Consumption / Water Savings)

Notwithstanding the planned augmentation of CAN water sources, which entail uncertainty and unclear lead-times, it is important to recall that Namibia experienced a very severe drought before the strong 2024/25 rainy season, leading to water savings initiatives and deferred bulk water applications. No additional major water source developments have been completed in the interim to reduce the risk of a repeated drought situation in the CAN, which could disrupt water supply security to Gondwana Estate and the wider CAN system.

Therefore, the development of a dedicated or semi-dedicated groundwater scheme at the Hoffnung boreholes / Otjihase area is deemed crucial to ensure reliability of water supply to Gondwana Estate. These potential groundwater sources are discussed in the following sub-section.

3.2.2 Farm Hoffnung / Otjihase Potential Groundwater

This section covers four potential groundwater sources, namely (i) drilled but uninstalled existing boreholes in the Hoffnung and Kuruma Faults, (ii) decommissioned boreholes of the Ondekaremba wellfield, (iii) Otjihase mine water from the Hoffnung Fault that was intercepted by mining activities, and (iv) potential target areas (see **Figure 7**). While it is envisaged that the Gondwana Estate will be supplied with surface water from the Von Bach dam, these potential groundwater sources should be investigated and developed as emergency sources to ensure supply reliability during drought periods.

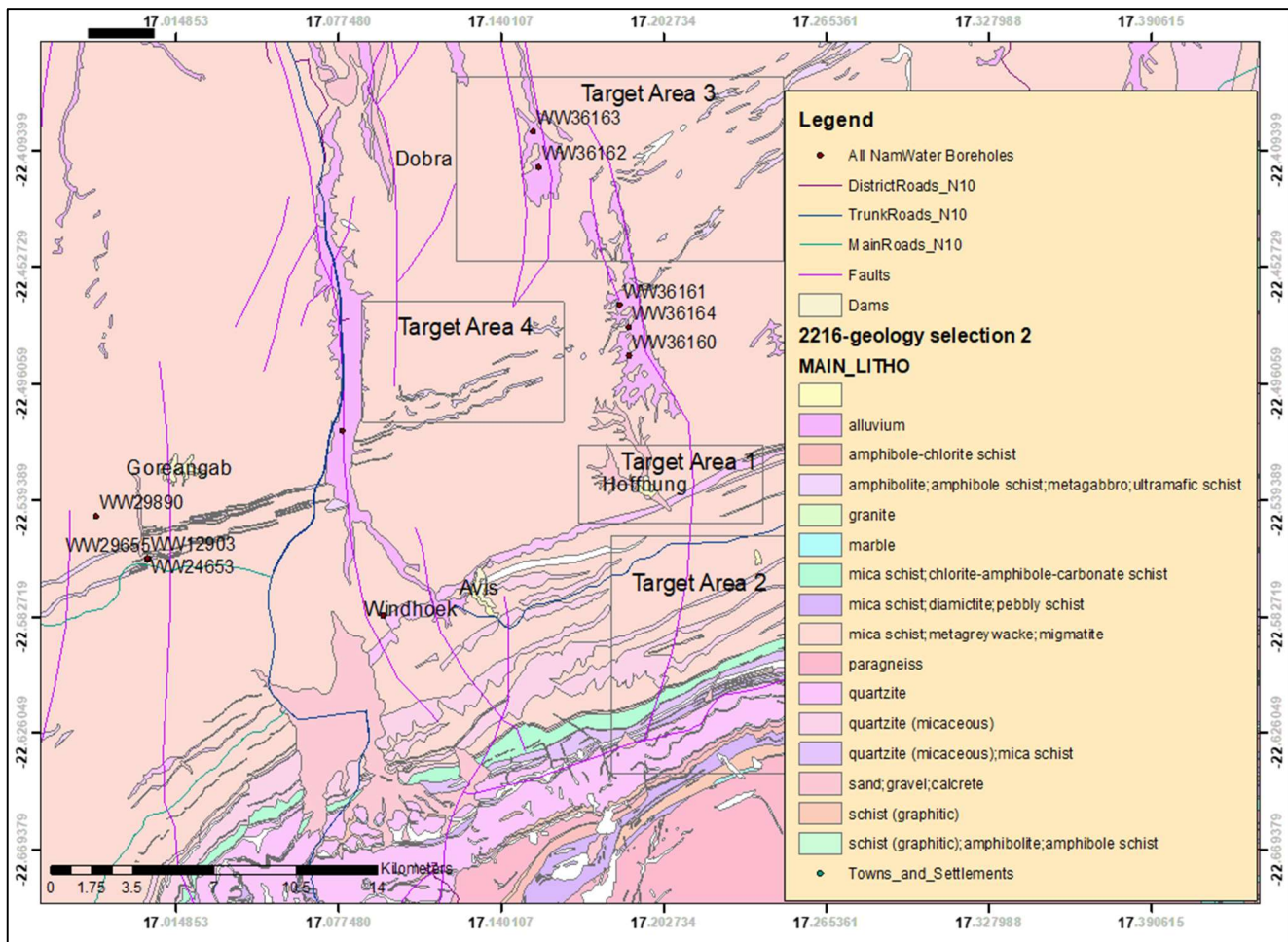


Figure 7: Geological formations, boreholes and target areas (Namwater Geohydrology, 2025).

Existing Hoffnung and Kuruma Fault boreholes

Currently, there are five (5) existing boreholes located within the Otjihase – Heja Farm area that were drilled between 1996 and 1997 by the Department of Water Affairs, namely WW36161, WW36164, WW36160, WW36163 and WW36162. None of the boreholes are currently installed, and a connecting pipeline was constructed for WW36161.

WW36161, WW36164, and WW36160 were drilled into the Hoffnung Fault south of Otjihase Mine, while WW36163 and WW36162 were drilled into the Kuruma Fault west of the mine. The geohydrological environment can be described as a schist matrix with major faulting as main water strike targets. In 2016, SLR Environmental Consulting (Namibia) (Pty) Ltd was appointed by the Portion Three Trust

(PTT) to conduct a geohydrological investigation with the aim of connecting WW36161, WW36164, and WW36160 to supply Finkenstein Estate during emergency drought periods only. The three boreholes were rehabilitated and WW36161 was pump tested. Although a Ø100 mm connecting pipeline was constructed from WW36161 to the Otjihase-Finkenstein pipeline, its power supply and pump installation was not completed. This borehole was previously intended to serve as a back-up source for Finkenstein Estate.

The recommended abstraction strategy is shown in **Table 3**, and indicates a combined sustainable yield of **288 000 m³/a**. The additional two Kuruma Fault boreholes have not been pump tested, however, it is estimated that they could yield **28 800 m³/a** based on blow yield results. This amounts to a total available yield of **316 800 m³/a** from the five existing boreholes between Otjihase and Heja Farm.

Table 3: Recommended abstraction strategies of boreholes WW36161, WW36164 and WW36160.

Borehole Number	Water Quality	PID (m)	Recommended abstraction strategy				
			m ³ /h	h/day	m ³ /day	m ³ /month	m ³ /annum
WW36161	A	102	25	20	500	15 000	180 000
WW36164	A	102	10	20	200	6 000	72 000
WW36160	Not Tested	102	5	20	100	3 000	36 000
Total			40		800	24 000	288 000

Ondekaremba Wellfield

There are four (4) boreholes (WW8982, WW7643, WW7358 and WW21504) at Ondekaremba that were decommissioned around 2001 and can be recommissioned pending borehole camera inspections. The boreholes can deliver approximately 48 000 m³/a.

Otjihase Mine Potential Groundwater (Dewatering) – Hoffnung Fault

In 2003, NamWater Infrastructure Planning conducted a reconnaissance study: utilization possibilities of groundwater at the Otjihase Mine. The study revealed that the Hoffnung Fault was intercepted by mining operations about 500 m below ground surface. The mine management at that time considered taking water from the fault in a controlled way to supply a part of the mine's water requirement with the possibility of surplus water being available for NamWater to supply other customers.

According to the study, a preliminary estimate of **1.4 Mm³/a** sustainable yield can be expected, of which about 0.3 Mm³/a was already used that time, 0,5 Mm³/a was required by the mine for their own potable water demand and **0.6 Mm³/a** was indicated to be available to NamWater.

There are risks and challenges associated with this option. Firstly, it will require negotiations and agreements with the current owners of the Otjihase Mine, Consolidated Copper, to develop water supply infrastructure, which may include the following (NamWater INF Planning, 2003):

- Construction of collector and balancing reservoirs underground and at the mine surface that offer protection to the water against contamination.
- Installation of underground base and booster pump stations, and associated power supplies and control systems.
- Construction of pipelines in the mine.
- Pipework connections at the reservoirs to allow for incoming water from the mine in addition to incoming water from Booster 2.

Secondly, although this Report considers groundwater as an emergency backup source in case of a drought, it should be noted that the groundwater from Otjihase mine may entail water quality challenges. According to samples collected in 2002, the water quality was classified as Group B and considered marginally suitable for human consumption. However, a sulphate concentration of 490 mg/l was reported, which does not conform to the new Acceptable Standard requirement for human consumption of < 300 mg/l stipulated in the Water Resources Management Act 11 of 2013 Regulations. Similarly, total hardness of 580 mg/l was reported, which does not conform to the Acceptable Standard requirement of < 400 mg/l.

An investigation that was carried out by the Geohydrology Division of the Department of Water Affairs (DWA, 1989) also indicated that the possibility of pollution of the Hoffnung fault water by leachates from the Otjihase mine tailings dam should be considered as a potential threat to the utilisation of the water for human consumption.

Potential Target Areas

There is potential for further investigation in the fractured zones, targeting the Hoffnung Fault north and south of the existing three boreholes, the Kuruma Fault and north-south trending faults to the west and east of the mining area (DWA, 1997). The main water strikes are expected at depths between 150m and 250m. Other targets to investigate further are the quartzites of the Auas and Kleine Kuppe Formations trending southwest to northeast.

There are four (4) potential target areas (Figure 7), Target Area 1 (3 boreholes), Target Area 2 (6 boreholes), Target Area 3 (3 boreholes) and Target Area 4 (2 boreholes), located about 2 km southeast, 10 km south, 12 km north and 11 km northwest of the envisaged Gondwana Estate development respectively. In total, 14 target boreholes were identified, with 370 m expected drilling depth, each borehole expected to yield $\pm 10 \text{ m}^3/\text{h}$ for 20 hours per day, translating to $\pm 1 \text{ Mm}^3/\text{a}$. The total cost for siting, drilling and test pumping of the target boreholes was estimated by the NamWater Geohydrology Division at **N\$ ±40 million** (excl. VAT). The development cost of this groundwater scheme can only be estimated to a reasonable level of accuracy once the available sources have been thoroughly investigated.

3.3 Pipelines

3.3.1 Von Bach – Windhoek Pipeline

The active pipeline between the VBWTP and Windhoek Terminal Reservoir consists of a Ø1 100 mm nominal diameter pre-stressed concrete pipeline, built in 1976, with pressure classes between 60 and

180 mWH, and a length of 62 km. Based on an inspection of the sections of the pipeline removed with the connection to the new KSB pump stations (2012 – 2014), this pipeline was considered to be in a good condition (LCE/PHIM, 2021).

3.3.2 Booster 2 – Otjihase Pipeline

Water is pumped from the Von Francois Ost (VFO) pump station to the Otjihase reservoirs against a static head of ± 420 mWH through a 13.5km long, Ø350mm steel pipeline. The pipeline was constructed in the 1970s with a design capacity **260 m³/h** (NamWater Infrastructure Planning, 2003). Based on the results shown in **Figure 8**, the design flowrate of 260 m³/h corresponds with a head of **460 mWH** at the VFO pump station. NamWater will need to procure a suitable gauge to measure the actual pressure and verify accuracy the modelling assumptions.

Concerns have been raised that operating the old steel pipeline at higher pressures will result in pipe failures or excessive leakages, and this could not be verified through the Situation Assessment. The only relevant information that could be obtained is that the test pressure range of the first 4 km section of the pipeline (pipe wall thickness of 10 mm) was stipulated as 50 – 62.5 bar (DWA Drawing 13371, 1973). The design capacity of 260 m³/h was adopted for the Sufficiency Analysis, governed by the assumed allowable pumping pressure from Booster 2 since the maximum flow velocity is only 0.81 m/s.

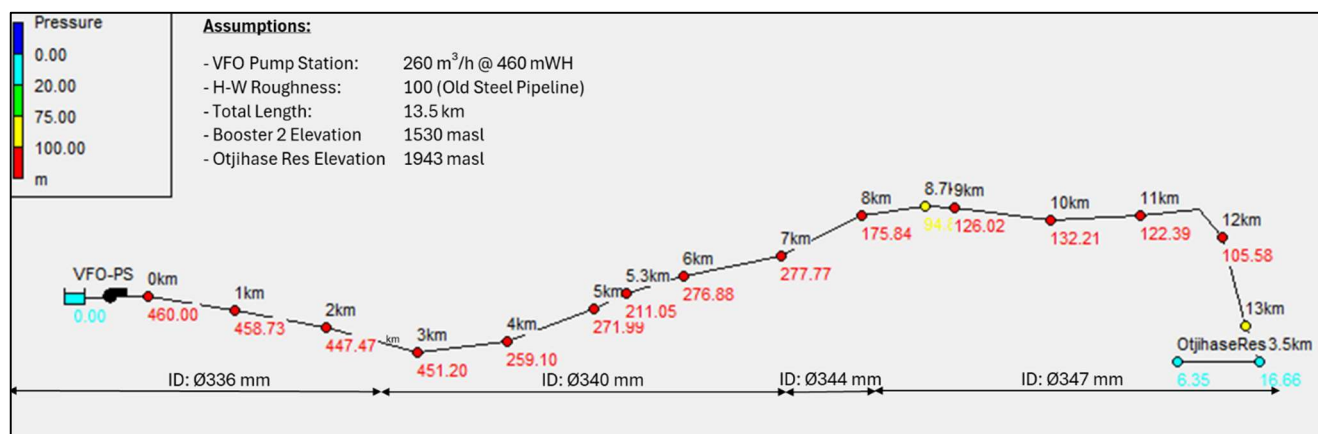


Figure 8: Hydraulic modelling results of the B2 – Otjihase pipeline at 260 m³/h and 460 mWH.

3.3.3 Otjihase Reservoirs – Booster Station Pipeline

Water gravitates from the Otjihase reservoirs to the Airport scheme / Finkenstein booster pump station through a 750m long, Ø150 mm above ground steel pipeline. Hydraulic modelling results suggest that the capacity of this pipeline is **±130 m³/h** (V = 2 m/s, residual head of ± 40 mWH at the booster station).



Figure 9: Otjihase reservoirs to booster station gravity pipeline.

3.4 Pump Stations

3.4.1 Von Bach – Windhoek Pump Stations

The base and booster pump stations that transfer water to Windhoek consist of KSB Omega 300-700 A horizontal split casing pumps in a 3 + 1 duty and standby configuration, with provision for a 4 + 1 configuration in future. Each pump has a flow capacity of 1 800 m³/h and will amount to 7 200 m³/h with four pumps in operation. however, the transfer capacity is for the time being limited to 5 400 m³/h (the current 3+1 configuration), which is the capacity of the Ø1100 mm diameter pre-stressed concrete pipeline to Windhoek.

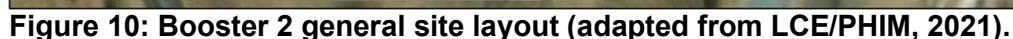
3.4.2 Von Francois Ost Pump Station

The Von Francois Ost (VFO) pump station is located at Booster 2 and transfers water from a 1 000 m³ balancing reservoir to the two 4 000 m³ concrete reservoirs at Otjihase. The pump station contains two Sulzer multistage pumps with space for a third. Only one pump is currently in operation (installed 2014) due to an issue with the base frame of the second pump (installed 2023). The operational pump supplies **137 m³/h**. The operating pressure at 137 m³/h could not be firmly established since the pressure transducer that displayed 400 mWH during the site visit may be inaccurate according to the NamWater M&E Department. A flow rate of 137 m³/h corresponds with a head of 470 mWH according to the pump curve, while hydraulic modelling suggests 430 mWH.

As shown in **Figure 10**, the Booster 2 site contains the new pump station building, the older Sulzer pump station building, the Von Francois Ost pump station, balancing reservoir, pressure / surge tower and the associated manholes and pipework. An electrical sub-station and transformer are located on the southern side of the site.

The total supply capacity is also affected by daily pumping hours, which depend on the operational schedule between Von Bach and Windhoek. Insufficient balancing capacity at Booster 2's reservoir means the Otjihase scheme pumps can only operate when the Von Bach-Windhoek pumps are active. Based on Citect data, the scheme is currently in operation for ±20 hours/day.

There is an ongoing project for the construction of the new 8 000 m³ Brakwater reservoir at Booster 2. The project is currently entering the design stage and construction may be completed by 2027/28 according to NamWater Programme Management. Additionally, NamWater prefers that the Gondwana Lifestyle Estate ensures the standard 48-hours of on-site clear water storage to ensure reliability of supply. Therefore, this report does not consider additional storage at Booster 2.



The Otijhase – Airport pump station consists of two 75 kW WEG 3~phase induction motors and KSB pumps that deliver **110 m³/h @ 154 mWH** in a 1 + 1 duty and standby configuration.



Figure 11: Otjihase - Airport and Finkenstein pumps.

3.5 Reservoirs

At Booster 2, the VFO pump station transfers water to Otjihase from a 1 000 m³ reinforced concrete balancing reservoir. Clear water storage at Otjihase consists of 2 x 4 000 m³ reinforced concrete reservoirs (**Figure 12**). Disinfection at Otjihase is done with an old venturi system. NamWater BU Central is considering relaying power to the reservoirs and installing a proper automatic dosing system.



Figure 12: Otjihase 4 000 m³ reinforced concrete reservoirs.

A summary of the relevant water supply infrastructure and their capacities are provided in **Table 4**.

Table 4: Summary of scheme components and capacities.

Scheme Component	Description / Comments	Capacity
VON BACH - BOOSTER 2		
Von Bach Water Treatment Plant	Design capacity	6500 m ³ /h
Base and Booster Pump Stations	Capacity of current 3 + 1 configuration	5400 m ³ /h
Von Bach – Windhoek Pipeline	Ø1100mm prestressed concrete	5400 m ³ /h
BOOSTER 2 - OTJIHASE RESERVOIR		
VFO Pump Station - Current	1 x Sulzer multi-stage pump Capacity based on current operation	137 m ³ /h @ 430 mWH
VFO Pump Station - Potential	2 x Sulzer multi-stage pumps With two pumps in operation	220 m ³ /h @ 440 mWH

VFO Balancing Reservoir	1 000 m ³ RC Ground Level Reservoir	1 000 m ³
Booster 2- Otjihase Pipeline	13.5 km long, Ø350mm Steel (460mWH)	260 m ³ /h
Otjihase Reservoirs	2 x 4 000m ³ RC Reservoirs	8 000 m ³
Otjihase Reservoirs - Booster Pipeline	0.75 km long, Ø150mm Steel, Above Ground, V = 2 m/s	130 m ³ /h
OTJIHASE BOOSTER - FINKENSTEIN		
Finkenstein Pump Station (observed capacity)	2 x CR32 Grundfos vertical multistage pumps (1 + 1 duty and standby)	31 m ³ /h @ 172 mWH
Finkenstein Pipeline (design capacity)		32 m ³ /h

3.6 Power Supply

3.6.1 Booster 2 Pump Stations

Power is supplied to the Booster 2 pump stations from the substation located immediately to the south of NamWater's premises. The substation consists of two transformers; one is dedicated to the NamWater pump stations, the other for other users in the area.

NamWater's current contractual Notified Maximum Demand (NMD) with NamPower is 1913 kVA, of which NamWater utilized an average of 1558 kVA to supply ±1300 m³/h during December 2024 to February 2025. NamWater intends to increase the contractual NMD to enable larger transfer capacities from Booster 2 to Windhoek, which will entail additional fixed capacity charges and a security deposit to NamPower. Hence, if an intermediate upgrade of the Von Francois Ost pump station to two operational pumps (220 m³/h capacity) is required to supply the Gondwana Lifestyle Estate, similar capacity charges and security deposit will be attributable to Gondwana.

If a third operational pump is to be added to the VFO pump station to supply the full development of the Gondwana Lifestyle Estate, it is foreseen that the 5 MW substation would need to be replaced with a larger substation. While the substation is being replaced, temporary power supply will also need to be established to service the users in the Brakwater area. The cost of such an upgrade could be in the order of N\$ 15-20 million, however requires further investigation.

3.6.2 Otjihase Pump Station

The installed transformer capacity at the Otjihase pump station is 315 kVA (WCE, 2009). The Otjihase – Airport and Otjihase – Finkenstein pump stations require 60 kVA at their maximum pumping capacity, which also leaves substantial surplus capacity from the 315 kVA transformer, which is deemed sufficient to accommodate an additional pump station to supply Gondwana (±100 kVA).

4 Water Demand Assessment

4.1 Von Bach – Windhoek Customers

The water demands of the Von Bach – Windhoek customers supplied from surface water were adopted from the Central Coastal Desalination Feasibility Study (ILF, 2021). The FY2025 annual water demand was estimated at 20.86 Mm³/a, with a peak month factor of 1.27 based on monthly historical volumes. The future demand projection includes further growth of other major envisaged developments such as Ongos, Monte Christo, Elisenheim, and Brakwater.

4.2 Gondwana Lifestyle Estate

As discussed in Section 2, the Gondwana Lifestyle Estate will be phased gradually, starting in 2026/27. The maximum annual water requirement of the full development as stated in the Bulk Water Application will be ±940 000 m³/a. The corresponding peak hourly demand is estimated at **180 m³/h** based on an assumed peak month factor of 1.4, i.e. similar to the observed peak factor of Finkenstein Estate.

4.3 Booster 2 – Otjihase – Airport Customers

The water demands and growth rates of the Booster 2 – Otjihase – Airport customers were estimated based on a combination of historical water sales data and the 2021 Desalination Feasibility Study (ILF, 2021). The total water sales volume in FY2024 was 0.46 Mm³ (**Figure 13**). The projected FY2050 water demand excluding Gondwana Estate is 0.95 Mm³/a. This also includes provisions for potential customers that are currently supplied from private boreholes, such as Sonnleiten Village.

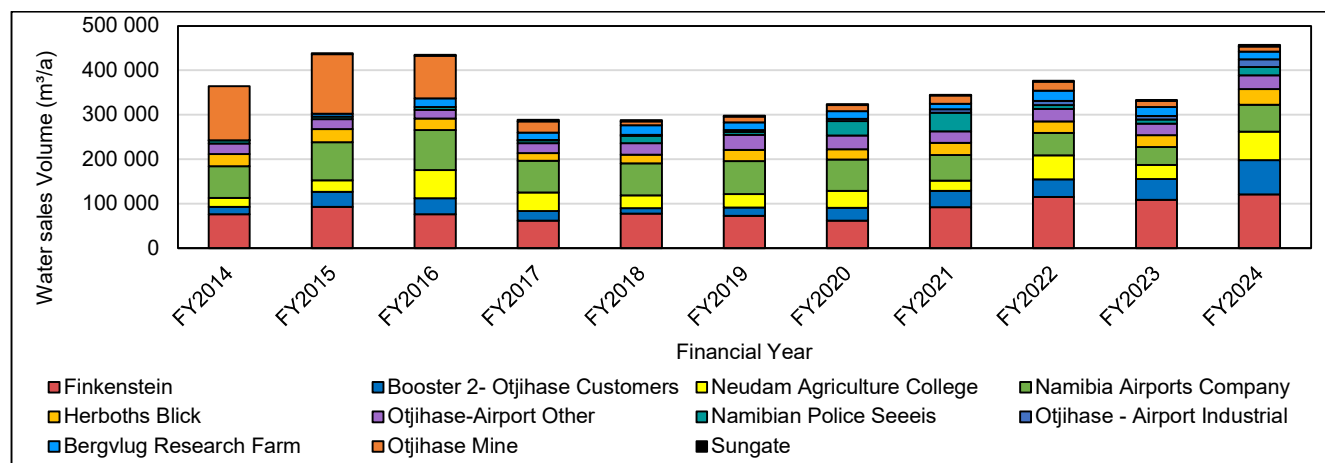


Figure 13: Annual historical water sales volumes of the Booster 2 – Otjihase – Airport scheme.

The Sungate development's water demand was initially projected at 1,373,878 m³/a by 2023 (WCE, 2009), but only 3,459 m³ was recorded in FY2024 due to limited progress. For this assessment, Sungate's demand is assumed not to exceed 20,000 m³/a within the planning horizon.

The Otjihase Mine, owned by Consolidated Copper and currently under care and maintenance, plans to resume operations according to workers at the mine. However, as Consolidated Copper did not respond to NamWater's requests for additional information, a maximum water demand of 300,000 m³/a was adopted based on ILF (2021) projections. A summary of the water demand projections is provided in **Table 5** and illustrated in **Figure 14**.

Table 5: Projected annual water demands of the Von Bach – Windhoek and Booster 2 – Otjihase schemes (Mm³/a).

Date	A: Okahandja		Sub-Total A	B: Von Bach - Windhoek					Sub-Total B	C: Booster 2 - Otjihase			D: Otjihase - Airport							E: Otjihase - Finkenstein			Sub-Total C - E	Total VB -Mm Demand
	Okahandja	Resorts		Osona Village	Von Bach - Windhoek (online)	Brakwater and Elisenheim	Ongos and Monte Christo	Windhoek Terminal Res		B2 - Otjihase (online)	Otiase mine & town	Sub-Total C	Hosea Kutako Airport	Sungate	Neudamm Agriculture College	Bergvliet Research Farm	Herbotts Blick	Various Smaller Customers	Sub-Total D	Finkenstein Estate	Gondwana Lifestyle Estate	Sub-Total E		
2025	2.09	0.14	2.23	0.05	0.72	0.71	0.39	18.99	20.86	0.05	0.01	0.07	0.07	0.004	0.05	0.02	0.04	0.08	0.25	0.13	0	0.13	0.45	23.54
2026	2.15	0.14	2.29	0.07	0.75	0.85	0.61	19.25	21.52	0.06	0.01	0.07	0.07	0.004	0.05	0.02	0.04	0.08	0.26	0.13	0.10	0.23	0.55	24.37
2027	2.22	0.14	2.36	0.11	0.78	1.04	0.91	19.51	22.35	0.06	0.02	0.07	0.07	0.004	0.05	0.02	0.04	0.08	0.26	0.13	0.10	0.23	0.56	25.27
2028	2.28	0.14	2.43	0.16	0.81	1.29	1.33	19.78	23.37	0.06	0.02	0.08	0.07	0.005	0.05	0.02	0.04	0.08	0.27	0.13	0.10	0.23	0.57	26.36
2029	2.35	0.14	2.49	0.22	0.84	1.62	1.86	20.05	24.60	0.06	0.02	0.08	0.07	0.005	0.05	0.02	0.04	0.08	0.27	0.13	0.15	0.29	0.64	27.73
2030	2.42	0.14	2.57	0.30	0.88	2.04	2.52	20.32	26.05	0.06	0.02	0.08	0.07	0.005	0.05	0.02	0.04	0.08	0.27	0.14	0.21	0.35	0.71	29.32
2031	2.50	0.14	2.64	0.39	0.91	2.53	3.29	20.51	27.63	0.06	0.03	0.09	0.07	0.006	0.05	0.02	0.04	0.09	0.28	0.14	0.30	0.44	0.81	31.08
2032	2.57	0.14	2.71	0.50	0.95	3.08	4.17	20.70	29.40	0.06	0.03	0.09	0.07	0.006	0.05	0.02	0.04	0.09	0.28	0.14	0.30	0.44	0.82	32.93
2033	2.65	0.15	2.79	0.61	0.98	3.69	5.11	20.89	31.30	0.06	0.04	0.10	0.07	0.006	0.05	0.02	0.04	0.09	0.29	0.14	0.30	0.44	0.83	34.92
2034	2.73	0.15	2.87	0.73	1.02	4.33	6.09	21.09	33.26	0.06	0.04	0.11	0.07	0.007	0.05	0.02	0.04	0.09	0.29	0.15	0.30	0.45	0.84	36.98
2035	2.78	0.15	2.93	0.85	1.03	4.96	7.06	21.28	35.19	0.07	0.05	0.11	0.07	0.007	0.06	0.02	0.04	0.09	0.30	0.15	0.46	0.60	1.01	39.13
2036	2.84	0.15	2.98	0.97	1.04	5.57	7.98	21.28	36.84	0.07	0.05	0.12	0.08	0.008	0.06	0.02	0.04	0.09	0.30	0.15	0.46	0.61	1.03	40.85
2037	2.89	0.15	3.04	1.08	1.05	6.13	8.80	21.28	38.35	0.07	0.06	0.13	0.08	0.008	0.06	0.02	0.05	0.10	0.31	0.15	0.66	0.82	1.25	42.64
2038	2.95	0.15	3.10	1.17	1.07	6.62	9.52	21.28	39.65	0.07	0.07	0.14	0.08	0.009	0.06	0.02	0.05	0.10	0.31	0.15	0.66	0.82	1.26	44.02
2039	3.01	0.15	3.16	1.25	1.08	7.03	10.10	21.28	40.74	0.07	0.07	0.15	0.08	0.010	0.06	0.02	0.05	0.10	0.32	0.16	0.66	0.82	1.28	45.18
2040	3.07	0.15	3.22	1.31	1.09	7.36	10.56	21.28	41.60	0.07	0.08	0.16	0.08	0.010	0.06	0.02	0.05	0.10	0.32	0.16	0.83	0.99	1.47	46.29
2041	3.13	0.15	3.28	1.36	1.10	7.62	10.90	21.28	42.26	0.07	0.10	0.17	0.08	0.011	0.06	0.02	0.05	0.10	0.33	0.16	0.83	0.99	1.49	47.03
2042	3.19	0.15	3.35	1.39	1.11	7.81	11.13	21.28	42.72	0.08	0.11	0.18	0.08	0.012	0.06	0.02	0.05	0.11	0.33	0.16	0.94	1.10	1.62	47.69
2043	3.26	0.15	3.41	1.42	1.12	7.94	11.27	21.28	43.04	0.08	0.12	0.20	0.08	0.013	0.06	0.02	0.05	0.11	0.34	0.17	0.94	1.11	1.64	48.09
2044	3.32	0.15	3.48	1.44	1.13	8.03	11.35	21.28	43.23	0.08	0.14	0.22	0.08	0.013	0.06	0.02	0.05	0.11	0.34	0.17	0.94	1.11	1.67	48.38
2045	3.39	0.15	3.55	1.45	1.14	8.09	11.37	21.28	43.34	0.08	0.16	0.24	0.08	0.014	0.06	0.02	0.05	0.11	0.35	0.17	0.94	1.11	1.70	48.58
2046	3.46	0.16	3.61	1.45	1.15	8.13	11.37	21.28	43.39	0.08	0.18	0.26	0.08	0.015	0.06	0.02	0.05	0.12	0.36	0.17	0.94	1.11	1.73	48.73
2047	3.53	0.16	3.68	1.46	1.17	8.15	11.34	21.28	43.40	0.08	0.20	0.29	0.08	0.016	0.06	0.02	0.06	0.12	0.36	0.18	0.94	1.12	1.76	48.85
2048	3.60	0.16	3.76	1.46	1.18	8.16	11.30	21.28	43.38	0.09	0.23	0.31	0.08	0.018	0.06	0.03	0.06	0.12	0.37	0.18	0.94	1.12	1.80	48.94
2049	3.67	0.16	3.83	1.46	1.19	8.17	11.24	21.28	43.35	0.09	0.26	0.35	0.09	0.019	0.06	0.03	0.06	0.12	0.37	0.18	0.94	1.12	1.84	49.02
2050	3.74	0.16	3.90	1.46	1.20	8.18	11.19	21.28	43.32	0.09	0.30	0.39	0.09	0.020	0.06	0.03	0.06	0.13	0.38	0.18	0.94	1.12	1.89	49.11

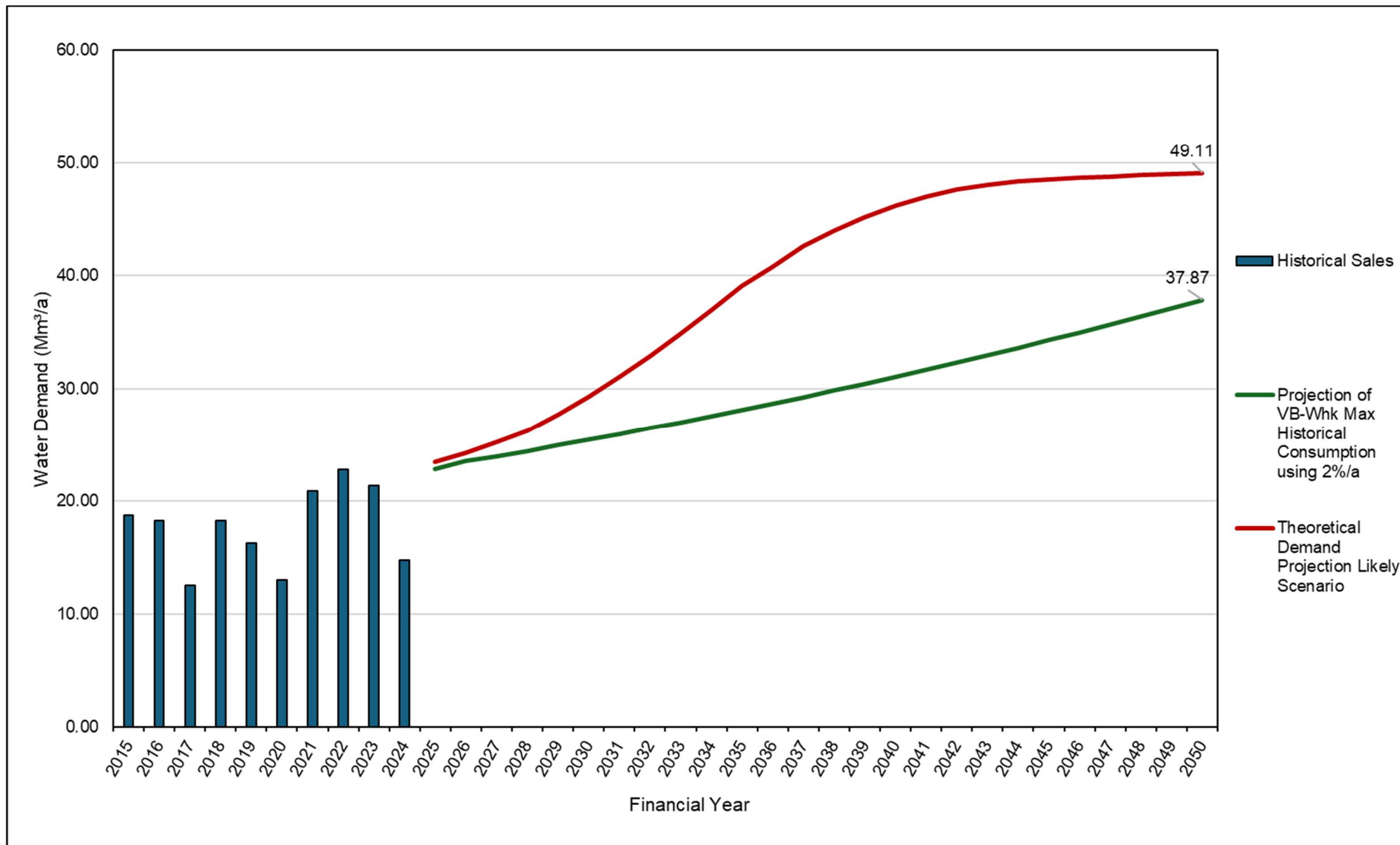


Figure 14: Projected annual water demands of the Von Bach – Windhoek and Booster 2 – Otjijase schemes compared for reference to the maximum historical consumption, excluding water supplied from CoW boreholes and reclamation, projected with 2%/annum (Mm³/a).

5 Sufficiency Analysis

The sufficiency analysis of NamWater's infrastructure to meet the requirements of the Gondwana Lifestyle Estate was divided into two main scheme components, namely the relevant Von Bach - Windhoek scheme infrastructure and the Booster 2 – Otjihase scheme, for the following two water demand projection scenarios:

Scenario 1: Base likely water demand projection, excluding Gondwana Lifestyle Estate.

Scenario 2: Likely water demand projection, including Gondwana Lifestyle Estate.

Estimated surplus or deficit capacities are analysed for short-, medium- and long-term time frames, including FY2025, FY2030, FY2035, FY2042 and FY2050. The sufficiency of the pump stations and pipelines were estimated using peak (ADPM) water demands, while that of the reservoirs was based on the standard 48 hours of Average Annual Daily Demand (AADD) storage requirement of NamWater.

Note on the potential utilization of existing Otjihase – Finkenstein pipeline and pumping scheme:

The design capacity of this scheme is 32 m³/h and is reserved for Finkenstein. Over the past five years, monthly water sales to Finkenstein exceeded 15 000 m³/month on several occasions, which corresponds to ±25-26 m³/h and suggests a surplus of 6 m³/h during these high peak months. However, Finkenstein have plan drawings to develop an additional ±100 erven that may require roughly 6 m³/h if assuming a household demand of 750 litres/house/day, adding 15% distribution losses and applying a peak factor of 1.4. Therefore, this infrastructure does not have sufficient spare capacity to reliably supply both the Gondwana Lifestyle Estate and Finkenstein, except potentially for temporary construction water requirements. Borehole WW36161 with its recommended yield of 25 m³/h could also be installed and to meet construction water requirements.

5.1 Von Bach - Windhoek Component

5.1.1 CAN Water Sources

NamWater utilizes the Central Area of Namibia (CAN) Model, operational for nearly two decades, to evaluate water demand and supply dynamics in the CAN. The model supports short-term forecasting, enabling NamWater to prepare two- to three-year water supply projections. It assesses available water resources, including Omatako, Swakoppoort, and Von Bach dam levels, against demand to calculate run-dry dates, aiming to secure supply across two rainy seasons (two years). As noted in Section 3.2.1, existing water sources are under severe stress, complicating acceptable run-dry dates and necessitating projects like the Okavango Link.

For this Situation Assessment Report, the CAN Model was used to evaluate short-term water availability and the impact of the phased Gondwana Lifestyle Estate development on the current run-dry date. NamWater's Hydrology Division analyzed three scenarios:

- Scenario 1: Base case, excluding Gondwana Lifestyle Estate's water demands.
- Scenario 2: Including Phase 1 water demands of Gondwana Lifestyle Estate.
- Scenario 3: Including full development water demands of Gondwana Lifestyle Estate.

Table 6 shows projected Von Bach dam run-dry dates: 20 April 2027 (Scenario 1), 10 April 2027 (Scenario 2), and 23 March 2027 (Scenario 3). Scenario 1 indicates existing sources fall slightly short of a two-year supply without Gondwana's demands, assuming no further dam inflows. Scenario 2 shows Phase 1 advancing the run-dry date by 10 days, while Scenario 3, reflecting full development, advances it by about one month. Scenario 3 is less realistic, as Gondwana's development is phased and targeted for completion by 2040, but it illustrates the potential impact of full build-out.

These results underscore the urgent need to fast-track additional water sources for the CAN, regardless of Gondwana's development. While sufficient water exists for Gondwana to proceed, they must collaborate with NamWater to develop emergency groundwater sources to ensure supply security during droughts, complementing medium- to long-term projects with longer lead times.

Table 6: CAN Modelling Results (NamWater Hydrology Division).

SCENARIO	DAM WL DATE	SOURCES (Mm ³ /a)					RUN DRY DATES	
		Northern Sources	COW BH	WINGOC	SW to VB	OM to VB	VB DS	SW DS
S1 MAR 2.5 (2Yrs) Nav 3.1	28-Apr-25	BA 2.0, KB 3.81 & Karst 1 BH 0.9	0.5	5.84	10	22.5	20-Apr-27	10-Sep-27
S2 MAR 2.5 (2Yr) Nav 3.1 (2026), Add. Dem 0.252	28-Apr-25	BA 2.0, KB 3.81 & Karst 1 BH 0.9	0.5	5.84	10	22.5	10-Apr-27	10-Sep-27
S3 MAR 2.5 (2Yr) Nav 3.1 (2026), Add. Dem 0.968	28-Apr-25	BA 2.0, KB 3.81 & Karst 1 BH 0.9	0.5	5.84	10	22.5	23-Mar-27	10-Sep-27

5.1.2 Von Bach – Windhoek Water Supply Infrastructure

The sufficiency analysis for the Von Bach – Windhoek water supply infrastructure, presented in **Table 7**, evaluates capacity against projected water demands under two scenarios, with results summarized below.

Scenario 1 (Excluding Gondwana Lifestyle Estate):

- The Ø1100 mm pipeline reaches capacity by FY2033.
- Von Bach Water Treatment Plant capacity is exceeded by FY2036.
- Base and booster pump stations become inadequate by FY2040.

Scenario 2 (Including Gondwana Lifestyle Estate):

- The Ø1100 mm pipeline reaches capacity by FY2033.
- Von Bach Water Treatment Plant capacity is exceeded by FY2036.
- Base and booster pump stations become inadequate by FY2039.

The analysis indicates that the pipeline, water treatment plant, and pump stations will exceed maximum capacities by FY2033, FY2036, and FY2039/40, respectively. The Gondwana Lifestyle Estate's water demand has minimal impact on these timelines. In 2016, Lund Consulting Engineers (LCE) recommended replacing the existing pipeline with a Ø1400 mm steel pipeline, but the project was deferred. NamWater should prioritize detailed planning, budgeting, and construction of these upgrades, beyond the scope of this report, to address the projected shortfalls.

5.2 Booster 2 – Otjihase Component

The sufficiency analysis for the Booster 2 – Otjihase water supply infrastructure, presented in **Table 8**, evaluates capacity against projected water demands under two scenarios, with results summarized below.

Scenario 1 (Excluding Gondwana Lifestyle Estate):

- All components remain adequate for existing customer demands until FY2042.
- From FY2042, the VFO pump station requires upgrading from one to two operational pumps to ensure supply security.
- The 750 m above-ground steel Otjihase Reservoirs – Booster pipeline may reach its capacity limit by FY2050, based on an assumed maximum velocity of 2 m/s.

Scenario 2 (Including Gondwana Lifestyle Estate):

- The VFO pump station and Otjihase Reservoirs – Booster pipeline require augmentation by FY2030 due to capacity constraints from phased Gondwana demands.
- By FY2042, all components, including the upgraded VFO pump station, will be inadequate and require further upgrades, augmentation, or replacement.

The analysis highlights that while the infrastructure supports existing demands until FY2042, the inclusion of Gondwana's phased demands accelerates capacity constraints, necessitating upgrades to the VFO pump station and pipeline by FY2030 and comprehensive developments/upgrades by FY2042.

Table 7: Von Bach – Windhoek Water Supply Infrastructure Sufficiency Analysis.

VON BACH - BOOSTER 2 COMPONENT SUFFICIENCY													
Scenario 1 (Base): Excluding Gondwana Lifestyle Estate													
Scheme Component	Type	Unit	Capacity	FY2025		FY2030		FY2035		FY2042		FY2050	
				Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit
Von Bach Water Treatment Plant - Design Capacity	Treatment Plant	m³/h	6 500	3 707	2 793	4 618	1 882	6 219	281	7 551	-1 051	7 702	-1 202
Base and Booster Pump Stations	Pumps	m³/h	7 200	3 707	3 493	4 618	2 582	6 219	981	7 551	-351	7 702	-502
The Von Bach – Windhoek Pipeline	Pipeline	m³/h	5 400	3 707	1 693	4 618	782	6 219	-819	7 551	-2 151	7 702	-2 302
Scenario 2: Including Gondwana Lifestyle Estate													
Von Bach Water Treatment Plant - Design Capacity	Treatment Plant	m³/h	6 500	3 707	2 793	4 655	1 845	6 299	201	7 715	-1 215	7 866	-5 072
Base and Booster Pump Stations	Pumps	m³/h	7 200	3 707	3 493	4 655	2 545	6 299	901	7 715	-515	7 866	-4 372
The Von Bach – Windhoek Pipeline	Pipeline	m³/h	5 400	3 707	1 693	4 655	745	6 299	-899	7 715	-2 315	7 866	-6 172

Table 8: Booster 2 - Otjijase Water Supply Infrastructure Sufficiency Analysis.

BOOSTER 2 - OTJIJASE COMPONENT SUFFICIENCY													
Scenario 1 (Base Scenario): Excluding Gondwana Lifestyle Estate													
Scheme Component	Type	Unit	Capacity	FY2025		FY2030		FY2035		FY2042		FY2050	
				Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit	Required	Surplus/ Deficit
VFO PS: 1 x operational pump	Pumps	m³/h	137	86	51	95	42	106	31	130	7	183	-46
Booster 2- Otjijase Pipeline	Pipeline	m³/h	260	86	174	95	165	106	154	130	130	183	77
Otjijase 2 x 4000 m³ Reservoirs + 1000 m³ @ B2	Reservoirs	m³	9 000	2 945	6 055	3 254	5 746	3 650	5 350	4 472	4 528	6 273	2 727
Otjijase Reservoirs - Booster Pipeline, V = 2 m/s	Pipeline	m³/h	130	83	47	90	40	98	32	110	20	125	5
Scenario 2: Including Gondwana Lifestyle Estate													
VFO PS: 1 x operational pump	Pumps	m³/h	137	86	51	135	2	194	-57	311	-174	363	-312
VFO PS: 2 x operational pumps	Pumps	m³/h	220	86	134	135	85	194	26	311	-91	363	-229
Booster 2- Otjijase Pipeline	Pipeline	m³/h	260	86	174	135	125	194	66	311	-51	363	-189
Otjijase 2 x 4000 m³ Reservoirs + 1000 m³ @ B2	Reservoirs	m³	9 000	2 945	6 055	4 645	4 355	6 647	2 353	10 654	-1 654	12 455	-6 400
Otjijase Reservoirs - Booster Pipeline, V = 2 m/s	Pipeline	m³/h	130	83	47	131	-1	185	-55	290	-160	306	-259

6 Development Proposal

The Development Proposal was carried out based on the sufficiency analysis of water demand Scenario 2, including the Gondwana Lifestyle Estate's phased water requirements. According to the results of the Sufficiency Analysis, the current capacity of the Booster 2 – Otjihase scheme is sufficient to supply all projected water demands up to FY2030, which roughly correlates to Phase 1 of the Gondwana Lifestyle Estate. Thereafter, upgrades and new infrastructure will be required to meet the projected demands. For each development option, the envisaged water supply infrastructure upgrades or developments are subdivided into two phases as follows:

Phase 1: Short-term, to be completed between FY2025 and FY2030 to ensure reliable water supply beyond FY2030.

Phase 2: Medium- to long-term, to be completed between FY2030 and FY2035 to ensure reliable water supply beyond FY2035.

Phase 1 is identical for both options and entails the intermediate upgrade of the VFO pump station to supply 220 m³/h (two pumps in operation) and proposed new dedicated pipelines and a pump station from the Otjihase reservoirs to the Gondwana Lifestyle Estate, where the latter is sized to cater for the full development. For Phase 2, two options are proposed to upgrade or augment the capacity of the Booster 2 – Otjihase component to supply the long-term water demands, where **Option 1** considers upgrading the capacity of the existing pipeline with a booster pump station and **Option 2** considers a separate dedicated pipeline and pump stations for the Gondwana Lifestyle Estate. Kindly note that these high-level options were not optimized with consideration of different materials.

6.1 Phase 1: VFO Pump Station 220 m³/h Upgrade & Otjihase-Gondwana Scheme

The Von Francois Ost pump station contains two Sulzer multistage pumps with space for a third. Only one pump is currently in operation. The intermediate upgrade to two operational pumps will increase the capacity of the Booster 2 – Otjihase scheme to 220 m³/h and will be sufficient until FY2035 based on the projected water demands. Additionally, dedicated water supply infrastructure will need to be developed between the Otjihase reservoirs and Gondwana Lifestyle Estate. In summary, the following concept is proposed for Phase 1:

1. Upgrade VFO pump station to supply 220 m³/h.
2. Construct a 750 m long above ground steel pipeline parallel to the existing feeder pipeline between the Otjihase reservoirs and booster pump station.
3. Construct a new dedicated booster pump station to transfer potable water to Gondwana, 2 + 1 duty and standby configuration with a total capacity of 180 m³/h @ 140 mWH.
4. Construct a new dedicated ±12 km long, Ø315 mm Class 16 (ID 277 mm) uPVC pipeline to the Gondwana Lifestyle Estate, and
5. Construct onsite clear water storage reservoir at Gondwana Lifestyle Estate with a capacity of ±6 000 m³ to provide 48 hours of storage (includes assumed 20% provision for dead storage), including instrumentation, telemetry and controls, meters and chlorination facilities.

The hydraulic modelling results verifying the technical viability of Phase 1 are shown in **Figures 15 and 16** for the Booster 2 – Otjihase component and Otjihase – Gondwana component, respectively.

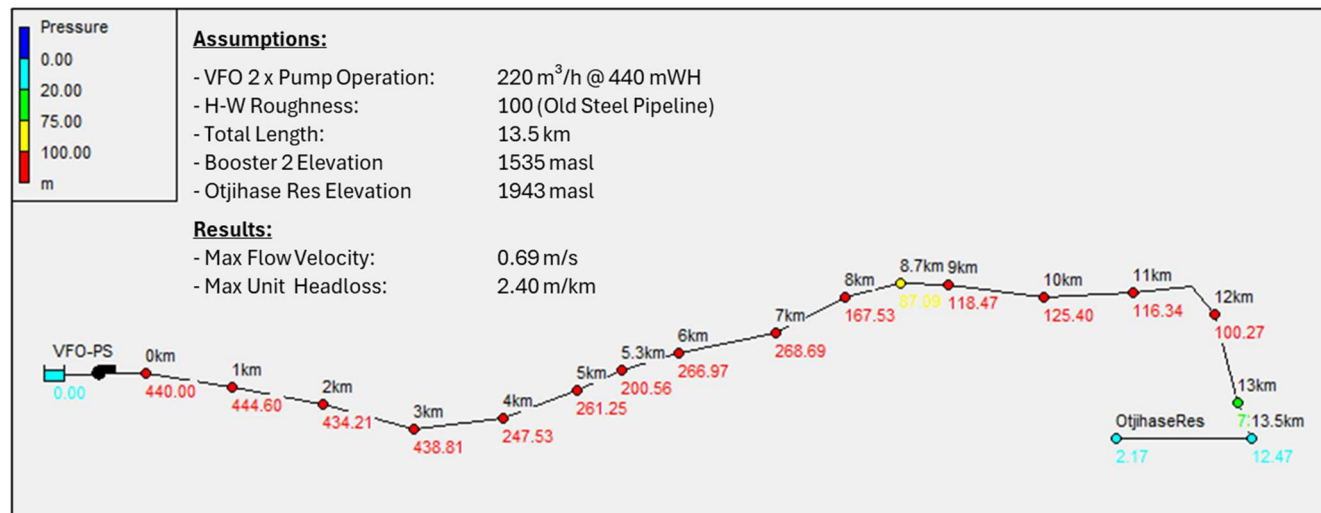


Figure 15: Hydraulic modelling results of Booster 2 - Otjihase 220 m³/h upgrade.

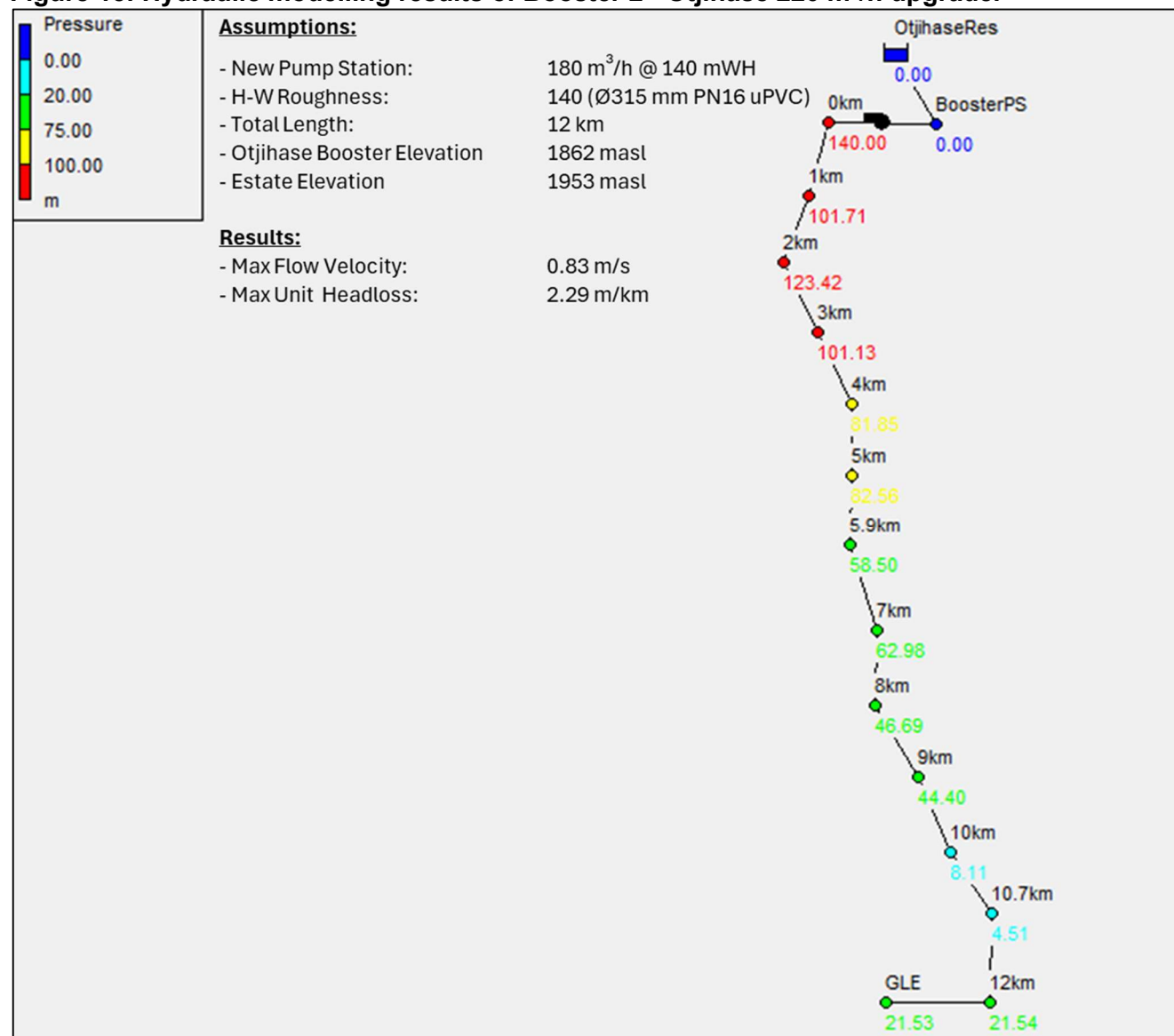


Figure 16: Hydraulic modelling results of proposed Otjihase – Gondwana scheme.

6.2 Phase 2 – Option 1: Increase Capacity of Existing Booster 2 – Otjihase Scheme with New Base and Booster Pump Stations

As mentioned in Section 3.3.2, the design capacity of the Booster 2 – Otjihase component of 260 m³/h was adopted in this report and is governed by the assumed maximum allowable pumping head of 460 mWH through the existing old steel pipeline. However, a higher capacity of 360 m³/h will be achievable if a booster pump station is added along the pipeline. The use of two pump stations will also allow for substantially lower pumping heads, i.e. 270 mWH at each pump station in the proposed option, which may extend the remaining useful life of the pipeline.

There are risks associated with utilizing the existing steel pipeline. Firstly, the pipeline was constructed to supply the Otjihase mine. The owners of the mine, Consolidated Copper, have not responded to NamWater's requests for information on their plans to resume mining operations and the associated water requirements. Should the demand of Otjihase mine throughout the planning horizon increase beyond the assumed 300 000 m³/a adopted from the Desalination Feasibility Study (ILF, 2021), this option will not be sufficient. Secondly, it is not clear whether the pipeline (±50 years old) will remain in good working condition throughout the planning horizon.

The following development concept is proposed for Phase 2 – Option 1:

1. 1 x base pump station at Booster 2 and 1 x booster pump station at chainage 6.5 km.
2. Upgrade substation at Booster 2 and relay power to the proposed booster station.
3. Civil modifications to VFO pump station building and a new pump station building at chainage 6.5 km.
4. A 1 000 m³ reinforced concrete pump balancing reservoir at chainage 6.5 km.

The hydraulic modelling results verifying the technical viability of upgrading the existing Booster 2 – Otjihase scheme to deliver 360 m³/h is shown in **Figure 17** and a schematic of Option 1 is shown in **Figure 18**.

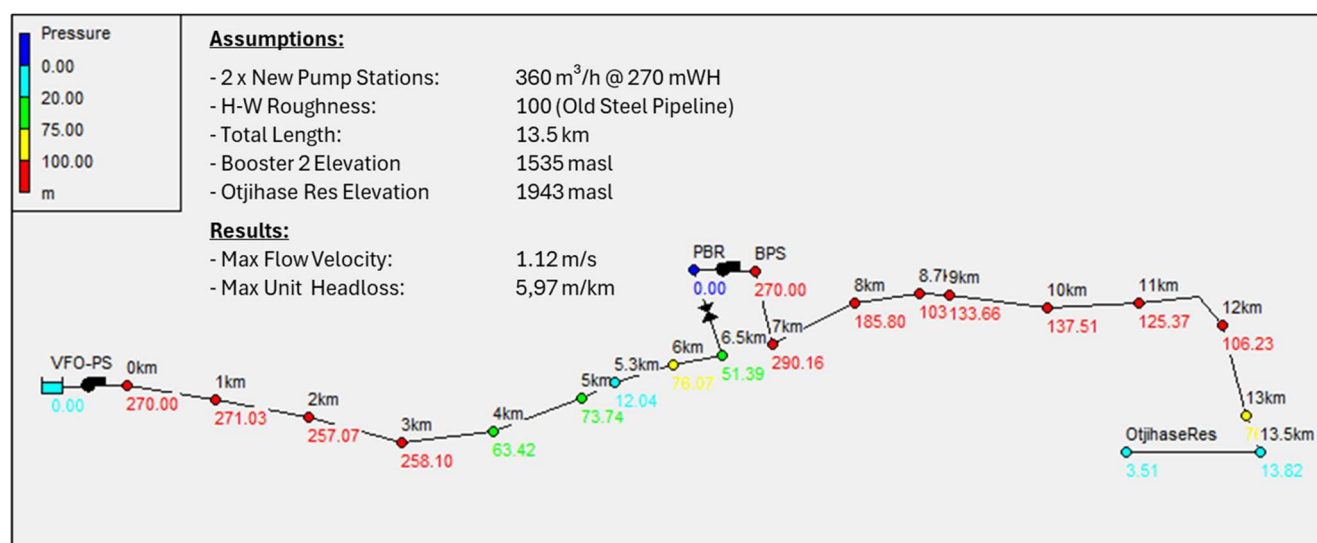


Figure 17: Hydraulic modelling results of Booster 2 - Otjihase 360 m³/h upgrade.

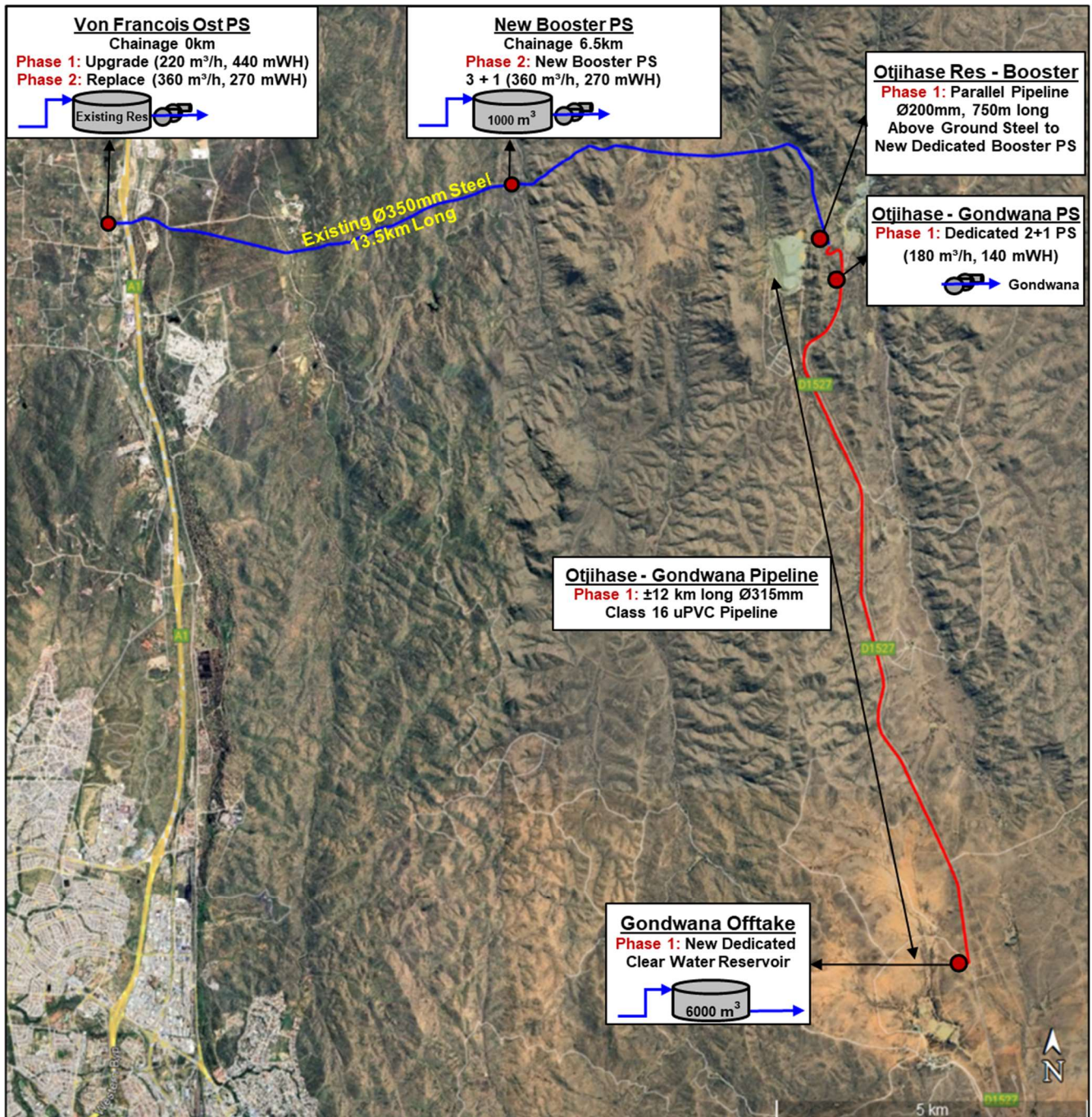


Figure 18: Schematic of proposed Phase 1 and Phase 2 – Option 1.

6.3 Phase 2 – Option 2: New Dedicated Booster 2 – Otjihase Pipeline and Pumping Scheme to Supply Gondwana Lifestyle Estate

To avoid the risks associated with utilizing the existing Booster 2 – Otjihase steel pipeline, it is proposed for Option 2 that a new dedicated pipeline and pumping scheme be developed to supply the Gondwana Lifestyle Estate's estimated peak water demand of 180 m³/h. The following development concept is proposed for Phase 2 – Option 2:

1. 1 x base pump station at Booster 2 and 1 x booster pump station at chainage 6.5 km, each with a 2 + 1 duty and standby configuration with a total capacity of 180 m³/h @ 270 mWH. The base pump station can draw water from either the existing 1 000 m³ reservoir or the new 8 000 m³ Brakwater reservoir that is planned for completion by 2027/28.
2. Upgrade substation at Booster 2 and relay power to the proposed booster station.
3. 2 x pump station buildings.
4. A 1 000 m³ reinforced concrete pump balancing reservoir at chainage 6.5 km.
5. A new dedicated ±13.5 km long, Ø250 mm Class 40 DCI pipeline running parallel to the existing steel pipeline.

The hydraulic modelling results verifying the technical viability of the proposed dedicated Booster 2 – Otjihase scheme to deliver 180 m³/h is shown in **Figure 19** and a schematic of Option 2 is shown in **Figure 20**.

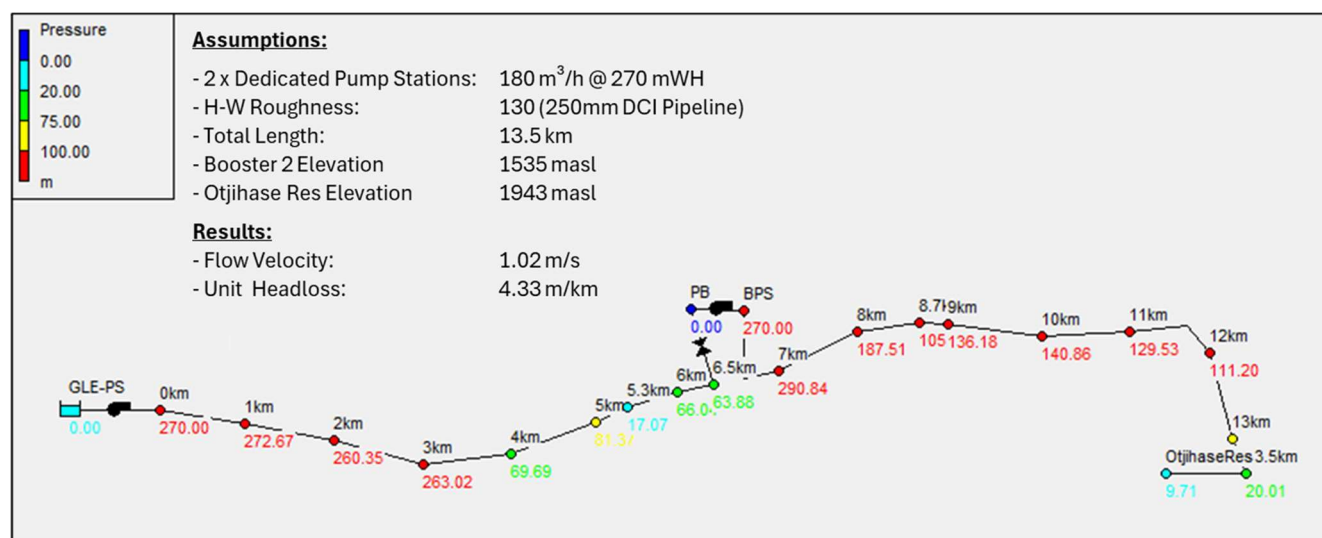


Figure 19: Hydraulic modelling results of proposed dedicated Booster 2 – Otjihase pipeline.

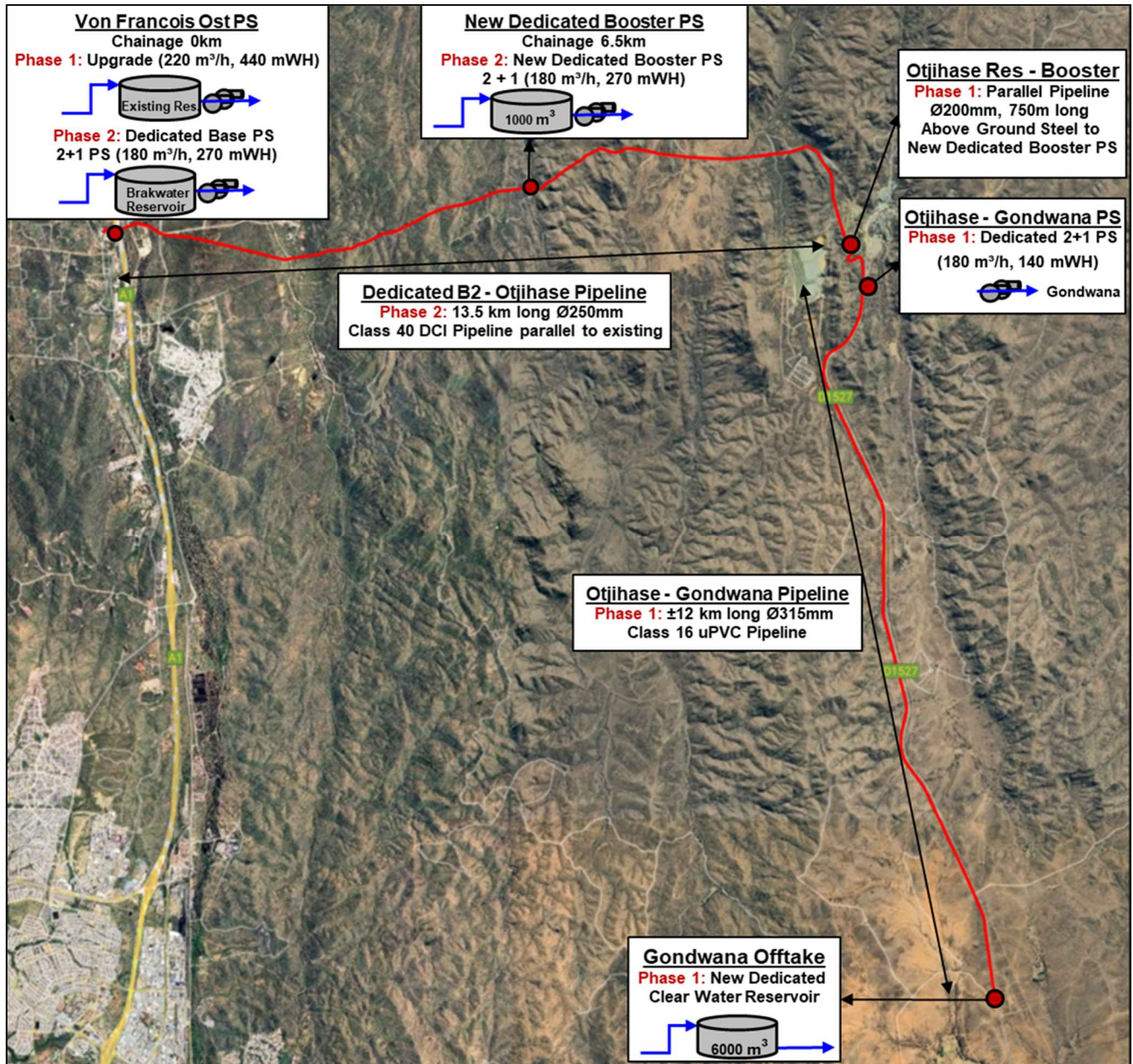


Figure 20: Schematic of proposed Phase 1 and Phase 2 – Option 2.

7 Cost Estimates

This section outlines the first-order capital development costs and indicative incremental running costs for supplying water to the Gondwana Lifestyle Estate. Per NamWater's standard policy for commercial customers, capital costs for water supply infrastructure will not be embedded in the final water tariff due to the financial risks associated with commercial entities / large development projects. The customer is responsible for funding all capital costs, developing the required infrastructure in collaboration with NamWater, and adhering to NamWater's standards. Upon completion, the infrastructure (excluding onsite facilities at the development) will be transferred to NamWater for operation and maintenance, with the customer being charged a lower tariff that excludes capital redemption costs.

As presented in **Tables 9 to 11**, the total capital development cost of Phase 1 was estimated at **N\$ ±62.7 million**. Depending on whether the existing Booster 2 – Otjihase steel pipeline is upgraded (Option 1) or a new dedicated Booster 2 – Otjihase pipeline is constructed to supply Gondwana, the total capital development costs of Phase 2 – Option 1 and 2 were estimated at **N\$ ±57 million** and **N\$ ±106.6 million**, respectively, amounting to **N\$ ±119.7 million** and **N\$ ±169.3 million**, respectively when added to the cost of Phase 1.

Table 9: Capital development cost estimates for Phase 1.

Description	Unit	Quantity	Rate N\$	2025 Amount N\$
Phase 1: Implementation FY2025 - FY2030				
A: Booster 2 - Otjihase, Upgrade to 220 m³/h Pumping Capacity				
M&E Works				8 870 900
@ Von Francois Ost Pump Station:				
Upgrade pump station to deliver 220 m³/h (2 + 1 duty and standby) - see Annexure 1				
Mechanical: Pump, motor, valves & pipework	Sum	1	4 601 400	4 601 400
Electrical & Instrumentation	Sum	1	4 269 500	4 269 500
Preliminary & General, 15%, Contingencies, 10%, Professional fees, 5%				2 661 270
Sub-Total A				11 532 170
B: Otjihase - Gondwana New Dedicated Scheme				
Pipeline				21 645 000
Otjihase reservoirs - booster parallel pipeline, Ø200mm Above Ground GMS - Supply, lay, joint and strap on pedestals	km	0.75	2 460 000	1 845 000
Otjihase Gondwana pipeline, Ø315mm Class 16 uPVC pipeline - Supply, joint, lay, bed	km	12	1 650 000	19 800 000
Civil Works				12 950 000
6,000 m³ RC Concrete Ground Level Reservoir at Gondwana Estate	no.	1	12 500 000	12 500 000
Pump station civil and structural modifications (2+1 pump station)	no.	1	450 000	450 000
M&E Works				4 780 000
@ Gondwana Reservoir:				
Instrumentation, controls, meters, telemetry, chlorination facilities	no.	1	1 750 000	1 750 000
@ Gondwana Pump Station:				
Pump & motor set (2+1, capacity 2 x 90 = 180 m³/h @ 130 mWH)	no.	3	140 000	420 000
MCC & Electrical	no.	1	750 000	750 000
Flow meters, control panel & other mechanical	no.	1	860 000	860 000
PLC, SCADA and telemetry & control instrumentation	no.	1	1 000 000	1 000 000
Preliminary & General, 15%, Contingencies, 10%, Professional fees, 5%				11 812 500
Sub-Total B				51 187 500
Total Phase 1 (FY2025-2030): A + B				62 719 670

Table 10: Capital development cost estimates for Phase 2 - Option 1.

Phase 2: Implementation FY2030 - FY2035				
C: Booster 2 - Otjihase Scheme: New Base Pump Station & 1 x Booster Station (each 360 m³/h, 250 mWH)				
Civil Works				7 700 000
1,000 m³ RC Ground Level Reservoir at Ch ±6.5km	no.	1	5 200 000	5 200 000
Existing pump station building civil modifications and and new building for booster PS	no.	1	2 500 000	2 500 000
M&E Works				36 125 000
New shared base and booster pump stations:				
Pump & motor sets (3+1, capacity 3 x 120 = 360 m³/h @ 270 mWH)	no.	2	3 000 000	6 000 000
MCC & Electrical	no.	2	1 875 000	3 750 000
Flow meters, control panel & other mechanical	no.	2	2 250 000	4 500 000
PLC, SCADA and telemetry & control instrumentation	no.	2	2 625 000	5 250 000
Bulk power line	km	6.5	250 000	1 625 000
Replace sub-station at Booster 2	no.	1	15 000 000	15 000 000
Preliminary & General, 15%, Contingencies, 10%, Professional fees, 5%				13 147 500
Sub-Total C				56 972 500
Total Phase 2 (Gondwana Cost based on Demand Allocation, 100%)				56 972 500

Table 11: Capital development cost estimates for Phase 2 - Option 2.

Phase 2: Implementation FY2030 - FY2035				
C: Booster 2 - Otjihase Pipeline: New Dedicated Ø300mm Gondwana Pipeline				
Pipeline				46 170 000
New VFO-Otjihase pipeline, Ø250mm DCI Class 40 - Supply, lay, joint and bed	km	13.5	3 420 000	46 170 000
Civil Works				7 200 000
1,000 m³ RC Ground Level Reservoir at Ch ±6.5km	no.	1	5 200 000	5 200 000
Pump station buildings	no.	2	1 000 000	2 000 000
M&E Works				28 625 000
New dedicated base and booster pump stations:				
Pump & motor sets (2+1, capacity 2 x 90 = 180 m³/h @ 270 mWH)	no.	2	1 500 000	3 000 000
MCC & Electrical	no.	2	1 250 000	2 500 000
Flow meters, control panel & other mechanical	no.	2	1 500 000	3 000 000
PLC, SCADA and telemetry & control instrumentation	no.	2	1 750 000	3 500 000
Bulk power line	km	6.5	250 000	1 625 000
Replace sub-station at Booster 2	no.	1	15 000 000	15 000 000
Preliminary & General, 15%, Contingencies, 10%, Professional fees, 5%				24 598 500
Sub-Total C				106 593 500
Total Phase 2 (Gondwana Cost based on Demand Allocation, 100%)				106 593 500

The Indicative incremental unit costs associated with Phase 1, Phase 2 – Option 1 and Phase 2 – Option 2 were estimated at **N\$ 5.62/m³**, **N\$ 6.05/m³** and **N\$ 6.25/m³**. These estimates represent the O&M costs of the proposed water transfer schemes, variable energy costs, maintenance, water quality (chlorination and monitoring), and the standard 15% O&M surcharge by NamWater. Note that the fixed power capacity charges and security deposit associated with power upgrades at Booster 2 require further investigation and were not included.

8 Conclusions

1. **Water Demand Impact of Gondwana Lifestyle Estate:** The Gondwana Lifestyle Estate's phased development will significantly increase water demand on the Von Bach – Windhoek and Booster 2 – Otjihase schemes. Phase 1 (240,000 m³/a) doubles the water demand of the largest existing customer, Finkenstein Estate (120,752 m³/a in FY2024), while the full development (940,000 m³/a) nearly doubles the total FY2024 demand of the Booster 2 – Otjihase scheme (456,938 m³/a).
2. **Water Source Constraints:** The Central Area of Namibia (CAN) Model indicates that existing water sources, including Von Bach, Swakoppoort, and Omatako dams, are under severe stress, with projected Von Bach Dam run-dry dates of 20 April 2027 (base case), 10 April 2027 (including Gondwana Phase 1), and 23 March 2027 (full Gondwana development). These dates fall short of NamWater's two-year supply security target, highlighting the urgent need to fast-track augmentation projects like the Okavango Link.
3. **Infrastructure Capacity Limitations:** The sufficiency analysis reveals that the Von Bach – Windhoek infrastructure (Ø1100 mm pipeline, water treatment plant, and pump stations) will reach capacity by FY2033, FY2036, and FY2039/40, respectively, with Gondwana's demand having minimal impact on these timelines. The Booster 2 – Otjihase scheme is adequate until FY2042 without Gondwana but requires upgrades by FY2030 with Gondwana's phased demands, particularly for the Von Francois Ost (VFO) pump station and Otjihase Reservoirs – Booster pipeline.

For the proposed intermediate upgrading of the VFO pump station to two operational pumps (220 m³/h), NamWater may need to increase its contractual Notified Maximum Demand (NMD) with NamPower, which will entail additional fixed capacity charges and a security deposit to NamPower that will be attributable to Gondwana. For the proposed long-term upgrade to 360 m³/h, it is foreseen that the 5 MW substation would need to be replaced with a larger substation. While the substation is being replaced, temporary power supply will also need to be established to service the users in the Brakwater area. The cost of such an upgrade could be in the order of N\$ 15-20 million, however requires further investigation.
4. **Proposed Development Options:** To meet Gondwana's water requirements, Phase 1 (FY2025–2030) involves upgrading the VFO pump station to 220 m³/h and constructing a dedicated 12 km Ø315 mm uPVC pipeline, a booster pump station, and a 6,000 m³ onsite reservoir at Gondwana. For Phase 2 (FY2030–2035), two options are proposed: Option 1 upgrades the existing Booster 2 – Otjihase pipeline with additional pump stations (360 m³/h capacity), while Option 2 constructs a new dedicated 13.5 km Ø250 mm DCI pipeline and pump stations. Option 2 mitigates risks associated with the ageing existing pipeline and potential Otjihase Mine demand increases.
5. **Cost Implications:** The estimated capital costs are N\$62.7 million for Phase 1, with Phase 2 costs of N\$57 million (Option 1) or N\$106.6 million (Option 2), totaling N\$119.7 million or N\$169.3 million, respectively. Per NamWater's policy, Gondwana must fund these costs, with infrastructure (excluding onsite facilities) transferred to NamWater for operation and maintenance at unit incremental running costs of N\$5.62/m³ (Phase 1), N\$6.05/m³ (Phase 2 – Option 1), or N\$6.25/m³ (Phase 2 – Option 2), excluding additional power-related charges that require further investigation.

6. **Emergency Groundwater Needs:** Given the risk of drought and limited progress on major water source augmentations, developing emergency groundwater sources (e.g., Hoffnung and Kuruma Fault boreholes, Ondekaremba wellfield, Otjihase Mine dewatering) is critical for Gondwana's supply security. These sources, with a combined potential yield of approximately 1.76 Mm³/a, require further investigation and investment to ensure compliance with water quality standards and sustainable abstraction.

9 Recommendations

It is recommended that:

1. This Situation Assessment Report be submitted to Gondwana Collections and their appointed Engineering Consultant, Windhoek Consulting Engineers, for their consideration and acceptance.

[Gondwana / WCE]

2. This Situation Assessment Report provide a basis for further water supply dialogue and meeting schedules and commitments between NamWater and Gondwana. NamWater should appoint a Project Manager to facilitate further meetings and communications on this Project.

[NW Programme Management / Gondwana/WCE]

3. Since the proposed estate development falls within the CoW municipal boundaries, an official authorization letter should be obtained from the CoW for NamWater to proceed. The letter should highlight the planned operations and processes regarding the supply of water (i.e. the billing points, entity responsible for billing, storage reservoir locations etc.).

[CoW / NamWater]

4. NamWater and Gondwana should collaborate to implement Phase 1 upgrades by FY2030 to support initial development phases, prioritizing the VFO pump station upgrade and dedicated pipeline infrastructure from Otjihase. For Phase 2, Option 2 (new pipeline) is recommended despite a higher estimated capital development cost to avoid reliance on the ageing Booster 2 – Otjihase pipeline that may be required to supply Otjihase Mine when they ramp up operations.

[Gondwana / NamWater]

5. Gondwana should invest in emergency groundwater development based on potential sources identified by NamWater in this Report to mitigate drought risks.

[Gondwana / NW Geohydrology]

6. NamWater should expedite CAN water source augmentations such as the Okavango Link Project and consider detailed planning, budgeting, and construction of Von Bach – Windhoek scheme upgrades to address projected shortfalls with adequate lead-times.

[NamWater]

7. The details and cost implications of power supply upgrades at Booster 2 to support increased capacities must be investigated further.

[Gondwana / NW M&E]

10 References

1. ILF Consulting Engineers. (2021). Feasibility Study for Desalination Plant and Water Carriage System to secure Water Supply to Central Coast, Windhoek and en-route Users, Chapter: Water Resources and Water Demand Projections (O992-ILF-OD-0012/REV. 4).
2. LCE-PHIM JV. (2021). Development Proposal for the Von Bach – Windhoek Brakwater Reservoir.
3. LCE-SCE JV (2021). Medium-term Water Supply Alternatives for the CAN.
4. NamWater Geohydrology Division. (2022). Desk Study Report on Investigation of Potential Targets for Groundwater Supply to the Gondwana Lifestyle Estate.
5. NamWater Infrastructure Planning Division. (2003). Reconnaissance Study: Utilisation Possibilities of Groundwater at the Otjihase Mine.
6. Windhoek Consulting Engineers. (2009). Feasibility Study for a Bulk Water Supply Scheme to Sungate.

Compiled by NamWater Infrastructure Planning, May 2025

11 Annexures

Annexure 1: Cost Estimate of Von Francois Ost Pump Station Intermediate Upgrade (NamWater M&E Department, 2025)

OTJIHASE BOOSTER PUMP STATION 220 m³/h Intermediate Upgrade

MECHANICAL			
Item	Unit Costs	QTY	Total Costs
Motor (315 kW)	765 000	1	765 000
Pump (130m ³ /h @ 490mWH)	2 470 000	1	2 470 000
300NB PN10 Wafer Butterfly Valves	30 000	1	30 000
150NB PN64 N0n-Retun Vaklve	180 000	1	180 000
200NB PN64 Wedge Gate Valve	220 000	1	220 000
250NB PN64 Wedge Gate Valve	410 000	1	410 000
50NB PN64 Ball Valve	15 400	1	15 400
50NB PN64 Air Valve	11 000	1	11 000
Pipework PN64	500 000	1	500 000
Sub-Total			4 601 400
ELECTRICAL & INSTRUMENTATION			
Switchboard (Total MCC to be replaced)	1 000 000	1	1 000 000
315 kW Softstarters	375 000	3	1 125 000
By-pass Contactors	75 000	3	225 000
MPU's	250 000	3	750 000
Battery Protection	6 500	1	6 500
Converter	9 000	1	9 000
Battery Charger	6 500	1	6 500
Earthing	60 000	1	60 000
PLC Components	150 000	1	150 000
MB Gateway	9 000	2	18 000
HDMI Touch Screen	20 000	1	20 000
No-Flow Senso	8 000	1	8 000
Serial Protection	1 000	2	2 000
Electrical Cablling	350 000	1	350 000
Assesories	75 000	1	75 000
Casual Labour (Digging of Trenches)	2 000	10	20 000
Air-Conditioning	85 000	2	170 000
Energy Meter	16 000	1	16 000
TMT's	4 500	23	103 500
Cool Room In Building	120 000	1	120 000
Reservoir Level Sensor	20 000	1	20 000
Pressure Transducer (0-600mWh)	15 000	1	15 000
Sub-Total			4 269 500
10% Contingencies			887 090
TOTAL AMOUNT (M&E)			9 757 990

12 Approval

This Situation Assessment Report is submitted to the Head: Business Unit Water Supply Central as a deliverable under this Bulk Water Application.

.....

Head: Planning & Water Resources Management

Date:

.....

Chief: Scientific Services

Date:

.....

Chief: Engineering Services

Date:

This deliverable has been completed to the satisfaction of BU Water Supply Central in accordance with the requirements of the project and I support the recommendations contained in this report.

.....

Chief: Business Unit Water Supply Coastal

Date:

.....

COO: NamWater

Date: