



HEJA GAME LODGE

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Namibia

REPORT:

HEJA LIFESTYLE AND COUNTRY ESTATE – GROUNDWATER ASSESSMENT

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ABBREVIATIONS

ABBREVIATION	DESCRIPTION
CAN	Central area of Namibia
CC	Close Corporation
DEM	Digital Elevation Model
DWA	Department of Water Affairs
EC	Electrical conductivity
GROWAS	groundwater survey
ha	hectares
h	hour
KFZ	Karibib fault zone
km	kilometre
LTHP	Low temperature high pressure
Ma	Million years
MAP	Mean annual precipitation
m ³	Cubic metre
MAT	Mean annual temperature
mamsl	Metres above mean sea level
mbgl	Metres below ground level
µS/cm	micro siemens per cm
SMZ	Southern Margin Zone
s	second
SZ	Southern Zone
WWTW	Wastewater treatment works

1 INTRODUCTION

1.1 BACKGROUND

Environmental Compliance Consultancy (Pty) Ltd. (ECC) was appointed by Heja Game Lodge (Pty) Ltd to undertake a hydrogeological assessment (comprising a desktop study and hydrocensus) of the remaining portion of Hoofnung Farm, Windhoek Rural Constituency, Khomas Region. Heja Game Lodge (Pty) Ltd propose to establish a housing and lifestyle estate on Hoofnung Rem., with Hoofnung Dam as a central, shared aesthetic feature. It is understood that the development intends to use municipal (NamWater) water for domestic and potable purposes and treated effluent and/or groundwater for commonage and private garden irrigation. Wastewater generated by the development will be treated at a dedicated wastewater treatment works (WWTW). The proposed position for the WWTW is to the west of Village D, outside the western boundary of the Heja Lodge property. The proposed location will allow wastewater from the development to gravitate to the WWTW.

1.2 SCOPE OF WORK

The study aimed to determine the hydrogeological environment of the proposed project and assess risks and impacts related to groundwater and surface water as part of the Environmental and Social Impact Assessment (ESIA), by means of the following:

- A desktop study, based on the analysis of existing available topographical, geological and hydrogeological data e.g. Department of Water Affairs (DWA) databases; 1:50 000 Windhoek 2217C geological and ; 1:1 000 000 Namibia hydrogeological maps; Google Earth/remote sensing satellite imagery and available 30 m x 30 m resolution digital elevation model (DEM) virtual reconnaissance and fracture mapping; and review of geological/hydrogeological information from existing consulting reports.
- A hydrocensus of existing groundwater users in the vicinity of the project location (if data is available), in order to gather any available data about borehole locations, water quality, depths and yields of boreholes.
- Impact assessment of proposed development and associated infrastructure (e.g., wastewater treatment plant) on groundwater and surface water systems.
- Evaluation of applicable water laws, regulations, and by-laws relevant to the proposed development and associated infrastructure.

2 SITE DESCRIPTION

2.1 LOCALITY

The proposed development (Figure 1) occurs in the southern corner of the remaining portion (Rem) of farm Hoofnung No. 66 (total farm portion size ~11283 hectare (ha) and development footprint size 328 ha), situated ~10 kilometres (km) east of Windhoek along the B6 road, within the municipal boundary of City of Windhoek. Central site coordinates are provided in the legend of Figure 1.

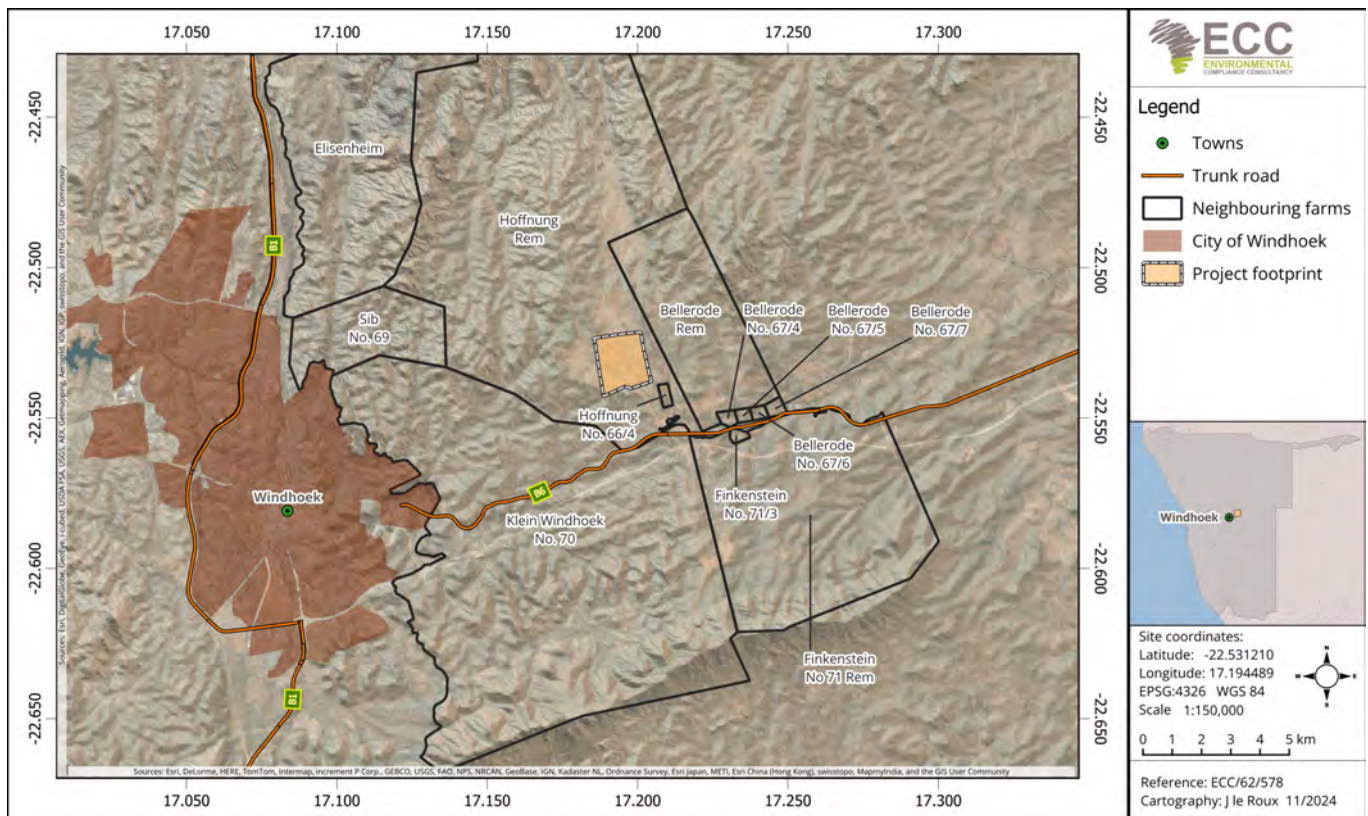


Figure 1 - Locality map of the proposed development area and surrounding farms

2.2 CLIMATE

The climate of the area is expected to be comparable to conditions experienced in Windhoek, although Windhoek occurs at ~200 m lower elevation. The region experiences moderate temperatures and low to average rainfalls. Average annual rainfall ranges between 300-350 mm according to Shikangalah and Mapani (2019), which is supported by long-term rainfall data from the Windhoek weather station (Figure 2). The Windhoek weather station has a 30-year Climate Normal mean annual precipitation (MAP) of 368 mm for the previous Climate Normal cycle from 1961 to 1990. Modelled data for the greater Windhoek area (based on SM2RAIN-ASCAT, IMERG, CHELSA Climate, and WorldClim models; Hengl, 2018a) indicates higher rainfall, with a MAP reaching between 400-420 mm. Differences can exist between

modelled and measured data due to boundary conditions causing imperfections in the modelled output (Kim et al., 2017).

The area receives summer rains between October and April (~55%), while the winter months are relatively dry (May to August; ~1%) – this rainfall seasonality is clearly shown in Figure 3. March to May are the region’s autumn months, receiving the second highest rainfall (~32% of MAP), while spring (September to November) receives the second lowest rainfall (~12% of MAP). Figure 2 shows four drought events (below MAP rainfall for three or more consecutive years) for the period 1950 to 2018 (red bars). Specifically, these drought events were 1958-1962, 1980-1985, 1991-1996 and 2015-2018. The regularity of low rainfall events suggests vulnerability of surface water supply.

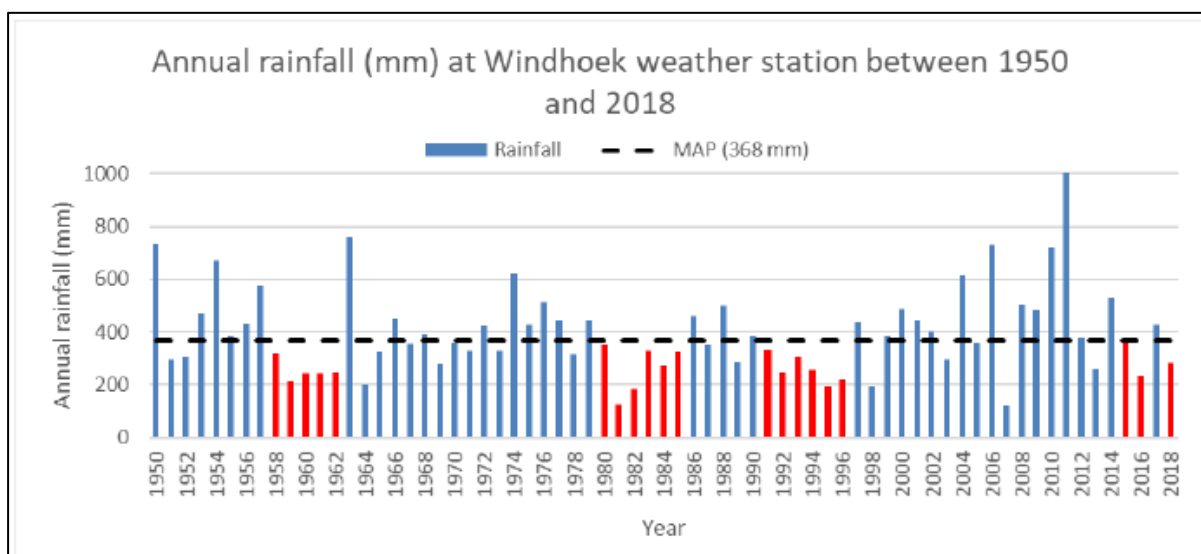


Figure 2 – Annual rainfall (mm, blue bars) at Windhoek weather station between 1950 and 2018 (NMS, 2021).

High evapotranspiration rates occur in summer when temperatures peak above 30°C and rainfall provides adequate water for the evapotranspiration process, while the reverse stands for winter when temperatures fall below 10°C and rainfall is at its annual lowest.

The mean annual temperature (MAT) for the Khomas region (within which the development is situated) is 20°C (as provided by the World Bank Group [2021] for the 30-year Climate Normal period cycle of 1991 to 2020), with average temperatures ranging between 14-25°C. The World Bank Group (2021) records average maximum temperature reaching as high as 33°C in summer (December and January) and average minimum temperatures reaching as low as 6°C in winter (June and July).



Figure 3 - Windhoek region seasonality for 1950-2018 (green line; Namibia Meteorological Service [NMS], 2021) compared to the historical average provided by the Climate System Analysis Group (CSAG, 2021; blue bars) for 1998-2012.

A 15-year (2005 to 2020) long-term observational dataset shows the wind direction and speeds at Windhoek Eros Airport (~15 km southwest of the development site). The data shows a slight bipolar dominance of northerly and southerly winds with the major wind vector being southerly/south-southeasterly (20%), and speeds mostly ranging between 1-4 m/s up to a maximum of 12 m/s (Figure 4).

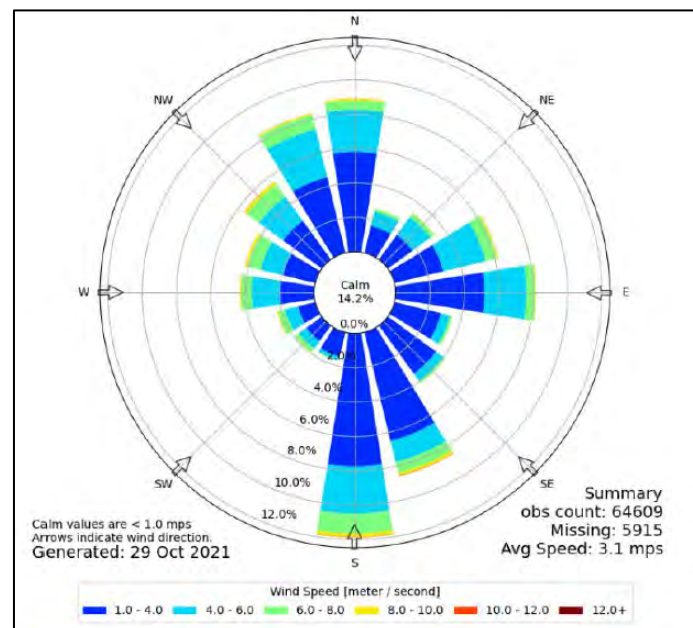


Figure 4 – Wind rose at Windhoek Eros Airport from 2005-2020 showing the distribution of wind direction (arrows) and wind speed (m/s) (Umvoto, 2023)

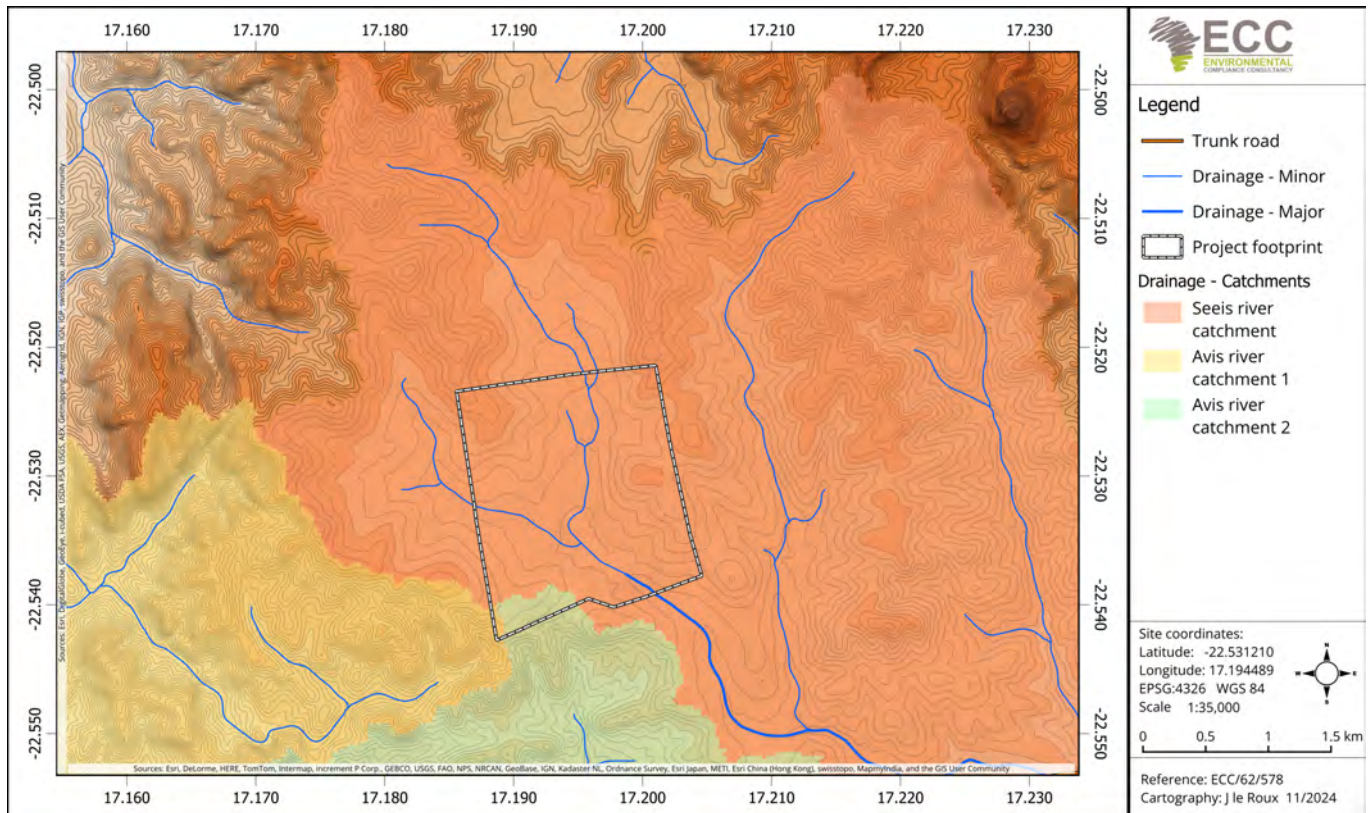
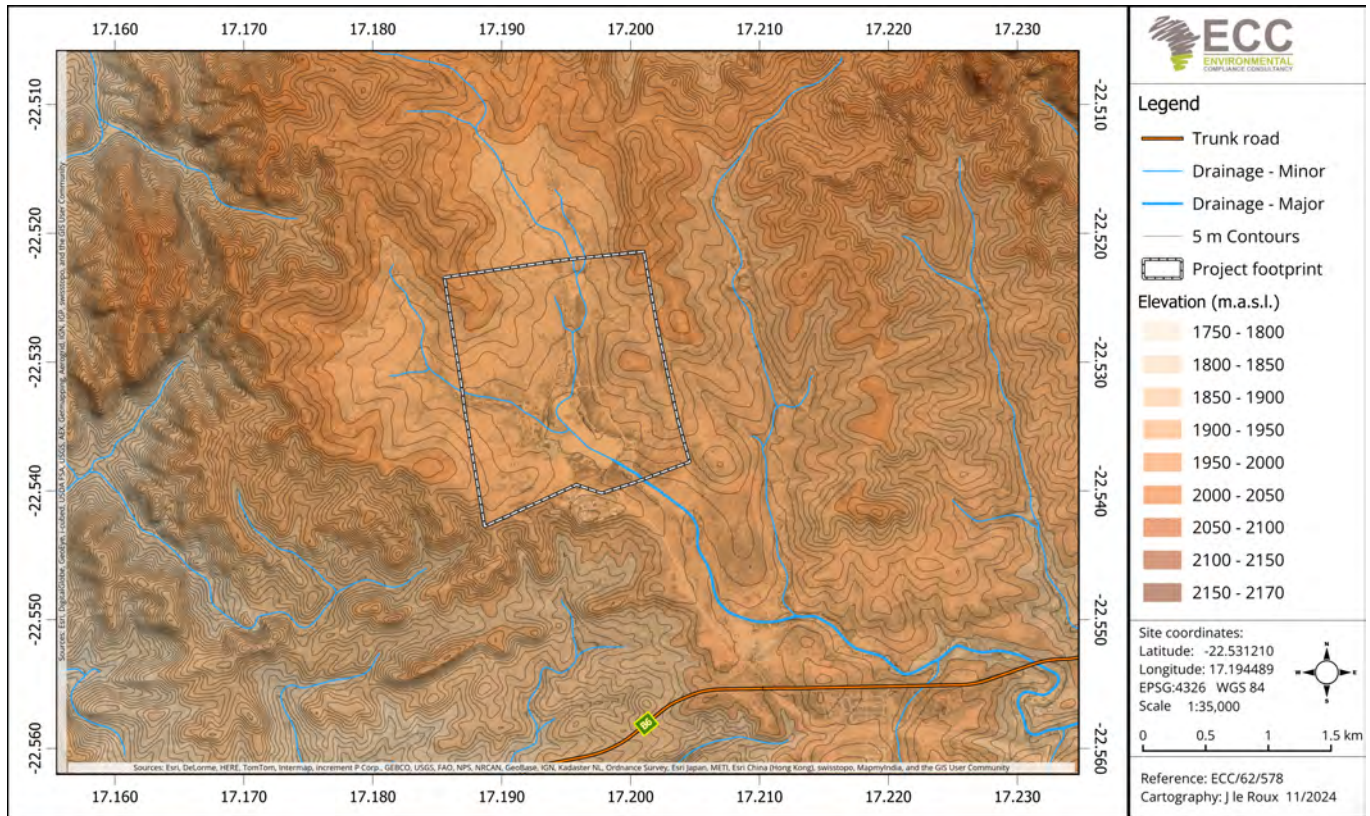
The secondary wind is northerly/north-north-westerly (17%) with lower maximum wind speeds of 10 m/s. Westerly and easterly winds, though to a lesser frequency, do provide balance to the north-south dominance providing a well-balanced four-quarter wind direction which can be expected in locations removed from oceanic influence. The wind direction is also influenced by topography – the Eros airport is located in a generally north-south low-level valley with a NE-SW orographic barrier to the south which may impact wind directions. Average wind speeds for the 15-year time period are 3.1 m/s with calms (winds <1 m/s) at 14%.

2.3 TOPOGRAPHY AND DRAINAGE

The proposed development is at elevation between ~1920 – 1970 metres above mean sea level (mamsl) gently sloping to the south with a relatively flat relief surrounded by undulating hills typical of the Khomas Hochland (Figure 5). Topography is incised in areas where drainage occurs, creating valleys in the terrain with drainage lines showing relatively narrow and straight (non-meandering) courses, indicative of intermittent, moderate to high velocity flow during sufficiently wet periods.

The project site occurs in the western headwaters of the Seeis River catchment (~ 34.8 km² in size), draining via four distinct valleys toward the southeast (Figure 6). Two water courses, contributing to a tributary of the Seeis River, converge at the Hoofnung dam and crosscut the development site area, the catchment size of these two western valleys draining through the development area is ~9.2 km². Hoofnung Dam occurs in an erosional peneplain formed by its contributing water courses within the development's footprint. The existing Heja Lodge is within 100 m of the riparian zone, along the southwestern bank of the dam, while the northeastern bank remains undeveloped except for a gravel road. Upstream of the dam the water courses and riparian zones are crosscut in places by gravel farm roads with concrete drifts, with no other structures within 100 m of the riparian zone. The spillway for the dam occurs in the southeastern corner of the dam

The water course down stream of Hoofnung dam has been extensively disturbed and is unlikely to contribute significant flow to Hoffman Dam, a dam located further downstream near the railway siding. Any potential discharge or overspill from Hoofnung dam is expected to be detained by a secondary embankment and associated borrow pit that has excavated material from the water course ~500 m downstream of the dam wall. Another southward flowing water course ~700 m from the developments eastern most boundary, on Remaining portion of Farm Bellerode, restricts flow from headwaters by two earth dams along the course of the riverbed further reducing contributions from the headwaters of the catchment into the non-perennial tributary of the Seeis River.



2.4 GEOLOGY AND HYDROGEOLOGY

Geologically the greater Windhoek region (including the proposed development site) is dominated by the pre-Damara gneissic basement and Damara Supergroup metasediments (Miller, 2008a and 2008b). Both were subjected to polyphase deformation (i.e. multiple deformation events) and metamorphism during the Pan African Damara Orogen (peak orogenesis at 550 million years [Ma]; Mapani et al., 2014) as a result of the collision between the Congo (to the north) and Kalahari Cratons (to the south). The regional study area straddles the low-temperature-high pressure (LTHP) stratotectonic Southern Zone (SZ) and Southern Margin Zone (SMZ) of the Damara Belt (Miller, 2008a).

The stratigraphy of the greater Windhoek region is summarised in Table 1, as described in Miller and Grote (1988), Miller (2008a, 2008b and 2008c), Umvoto (2023) and the 1:50 000 2217CA geological map of the Windhoek area (see Figure 7; after Hoffmann and Schreiber, 2011). In the development study area a portion of the SZ is observed (red square in Figure 7), which includes the Kuiseb and Kleine Kuppe formations of the Neoproterozoic Khomas Complex (~600-620 Ma; see Table 1 and Figure 8), consisting of both spreading phase sediments and syntectonic sediments associated with the closure of the Khomas Ocean (Miller, 2008a and 2008b).

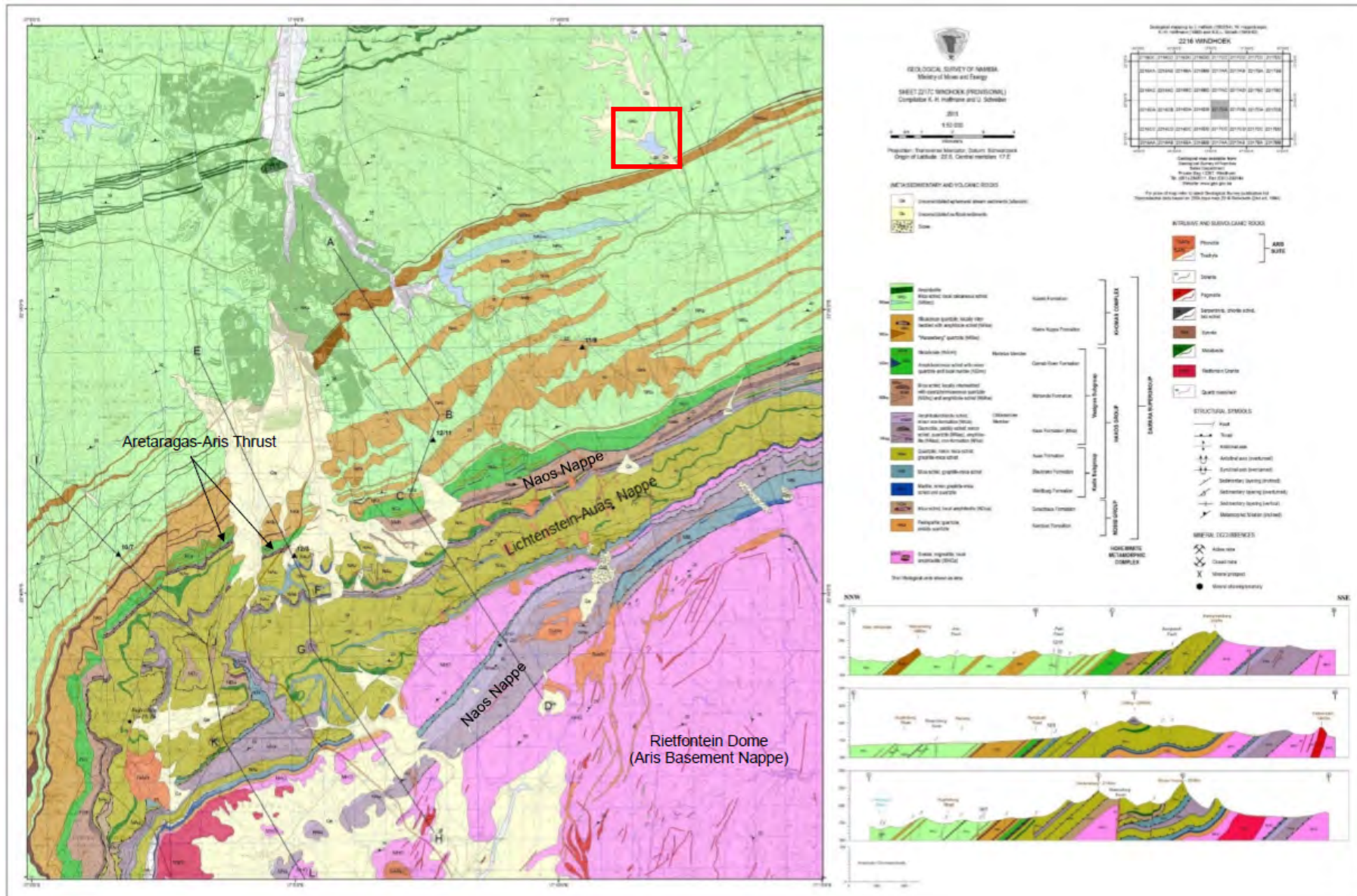


Figure 7 - 1:50 000 2217CA Windhoek geological map and cross sections (after Hoffmann and Schreiber, 2011).

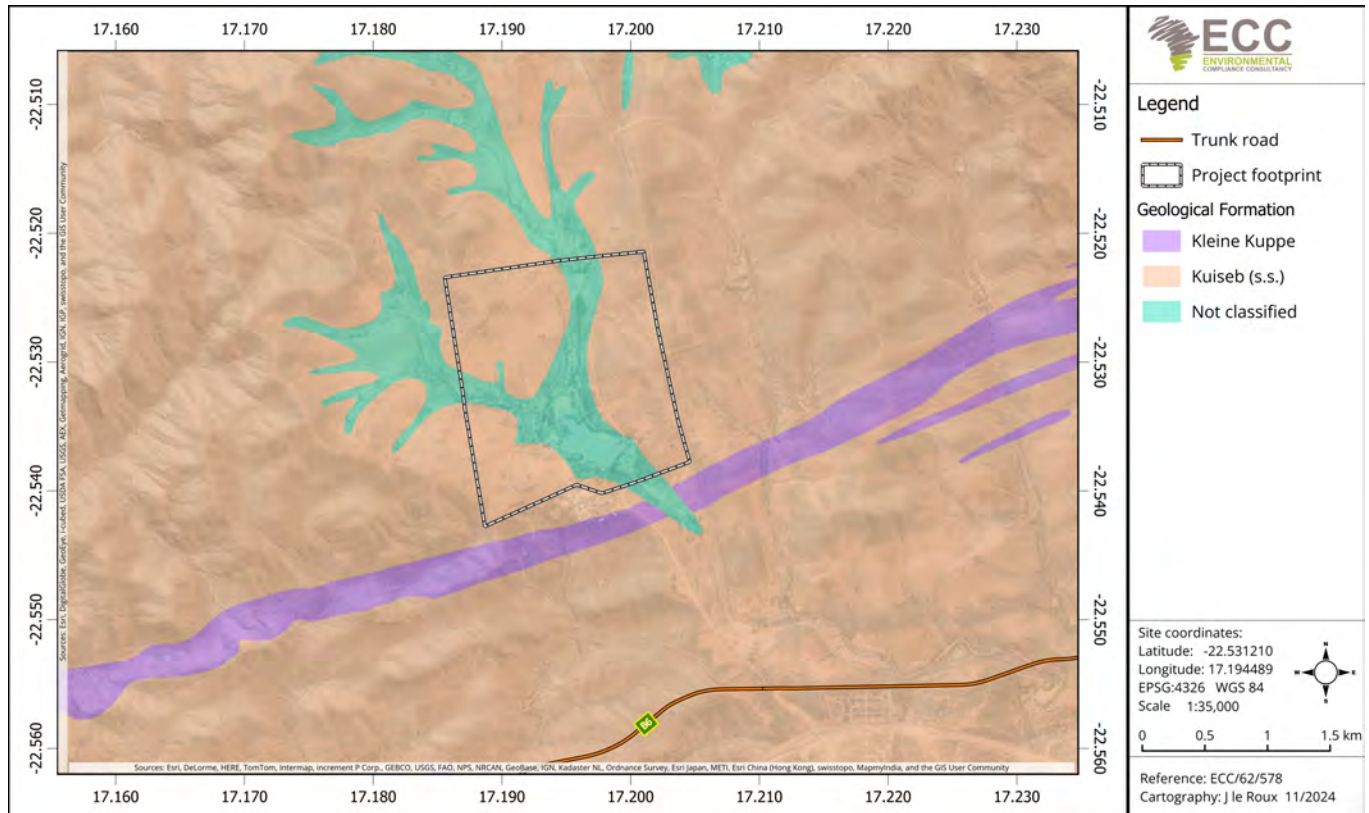


Figure 8 – Lithostratigraphy of the proposed development site

The Kleine Kuppe Formation occurs at the base of the Kuiseb Formation (Hoffmann, 1983). It consists of quartzites (Wasserberg quartzites) that have interbeds of quartz and mica schists, as well as amphibolites, but are also interbedded with the Kuiseb schists (Miller, 2008a). These quartzites pinch out towards the west but have the thickest development in the Windhoek area (~8km) (Miller, 2008b). The quartzites form a major secondary fractured aquifer and groundwater reservoir due to their lateral extent, thickness, and fractured nature (Murray, 2002). Targeting this formation within the southern area of the development's footprint would require drilling depths between 100 - 250 m (this can be better confirmed if groundwater development is required and field mapping / geophysical surveys undertaken).

The overlying and interfingering Kuiseb Formation (surface geology underlying the development site) is distinct from the schists of the Kleine Kuppe Formation as the Kuiseb schists are coarse-grained (Miller, 2008b). The rocks are strongly tectonised and have alternating layers of foliated semi-pelitic to pelitic schists (Miller, 2008b). The Kuiseb Formation has been subject to LTHP metamorphism indicated by the primarily chlorite-muscovite-biotite-plagioclase schists with garnet, staurolite and kyanite (Miller, 2008b). Once graded distal greywackes, the Kuiseb Formation includes the metavolcanic Matchless Amphibolite Member which represents the mid-ocean ridge or ocean floor basalts of the Khomas Sea that lay between the Congo and Kalahari Cratons prior to closure during the Damara Orogen (Finnemore, 1978).

Sediments of the Damara Supergroup have been subject to polyphase deformation and associated metamorphism, largely related to intracontinental rifting and continent-continent collision during the Pan African Damara Orogen (Miller, 2008b). Additionally the area has been subject to brittle faulting by both Damara- and Cretaceous-aged faults (Tankard et al., 1982; Carr Barbour and Associates, 1999). Despite the complex folding and thrusting in the area, the Damara Supergroup succession generally dips gently (20°-35°) to the northwest (Miller et al., 2018). Variations in dip occur due to folding but due to the pervasive nature of the regional structure, it is thought that the faulting extends to depth. A large north-south trending fault is mapped ~1 km from the development's eastern most boundary, and a northwest-southeast trending fault ~3.5 km from the western most boundary. These faults are variably annealed or cemented, affecting the openness of the fractures, with important implications for groundwater flow (Murray, 2002; Miller et al., 2018). Less competent units, such as the schists, are more susceptible to shearing and ductile deformation, resulting in an increase in closed fractures/faults, whereas the quartzites typically have open faults and fracture networks allowing for improved groundwater flow (Murray, 2002). No further structures have been mapped in the immediate vicinity of the development.

The division and sub-division of the litho/tectono-stratigraphy into hydrostratigraphic units is shown in Table 1, and the aquifer type as mapped on the 1: 1000 000 hydrogeological map of Namibia in Figure 9.

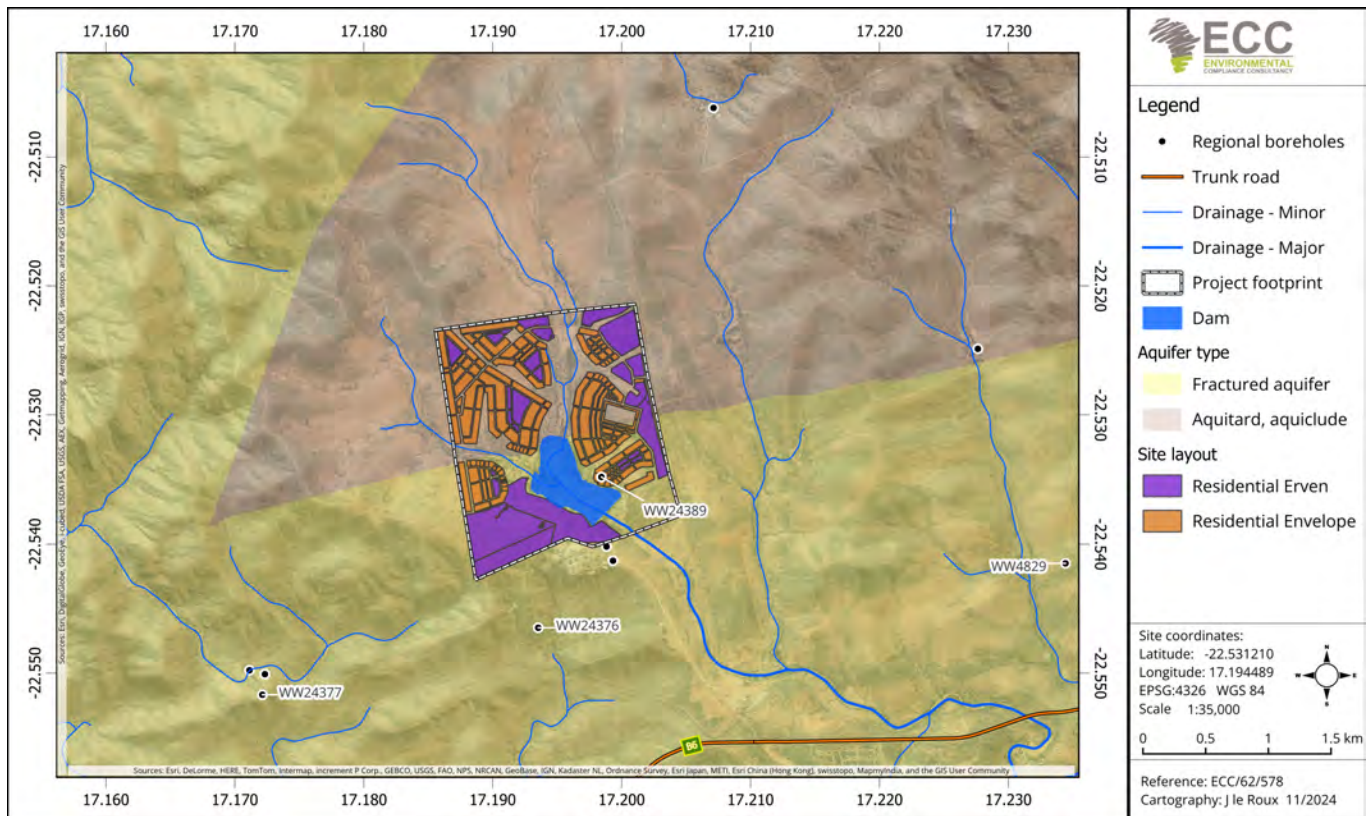


Figure 9 – Aquifer type underlying the development site based on the 1: 1000 000 hydrogeological map of Namibia

The hydrogeological map closely relates to the geology of the area, with the Kuiseb Formation representing an aquitard or aquiclude and the quartzites of the Kleine Kuppe Formation forming a fractured aquifer. Although the schists of this Kuiseb Aquiclude are folded and faulted, they respond in a ductile manner to stress and therefore have poorly developed secondary porosity (Murray et al., 2016) and are hence less transmissive in terms of groundwater flow. The micaceous quartzites of the Kleine Kuppe fractured aquifer are in parts interfingering with the schists of the Kuiseb Aquitard, reducing the permeability of the Kleine Kuppe aquifer in the region.

The proposed development occurs ~5km northeast of the Windhoek Aquifer system boundary and while some hydrogeological features and characteristics are comparable (e.g., Kleine Kuppe aquifer), the project site does not interact with the greater Windhoek Aquifer due to the presence of the Kuiseb Aquiclude that bounds the aquifer (Figure 10). The development is directly underlain by the Kuiseb Aquiclude, which may be deemed advantageous in that groundwater contamination risk is reduced due to the low transmissivity of the schists. Support for this determination stems from the principal that the tightly packed parallel mineral arrangement impedes groundwater flow perpendicular to this, thus reducing permeability. Any faults that extend into the Kuiseb Aquiclude are blocked by the highly altered clays of the Kuiseb schists, resulting in a loss of permeability. This is evident in pumping test curves in Kuiseb Aquiclude boreholes, which indicate that flow is along fractures, but flow boundaries are encountered, therefore the hydraulic link to productive aquifers is poor (Murray, 2002). Another verification of low permeability in the Kuiseb Aquiclude is from historical literature sources describing the presence of springs arising from the fractures in the Kuiseb Aquiclude, indicating that permeability of the fracture zones at depth drop to such an extent that subsurface flow is (was) no longer possible (Gevers, 1932; Murray, 2002).

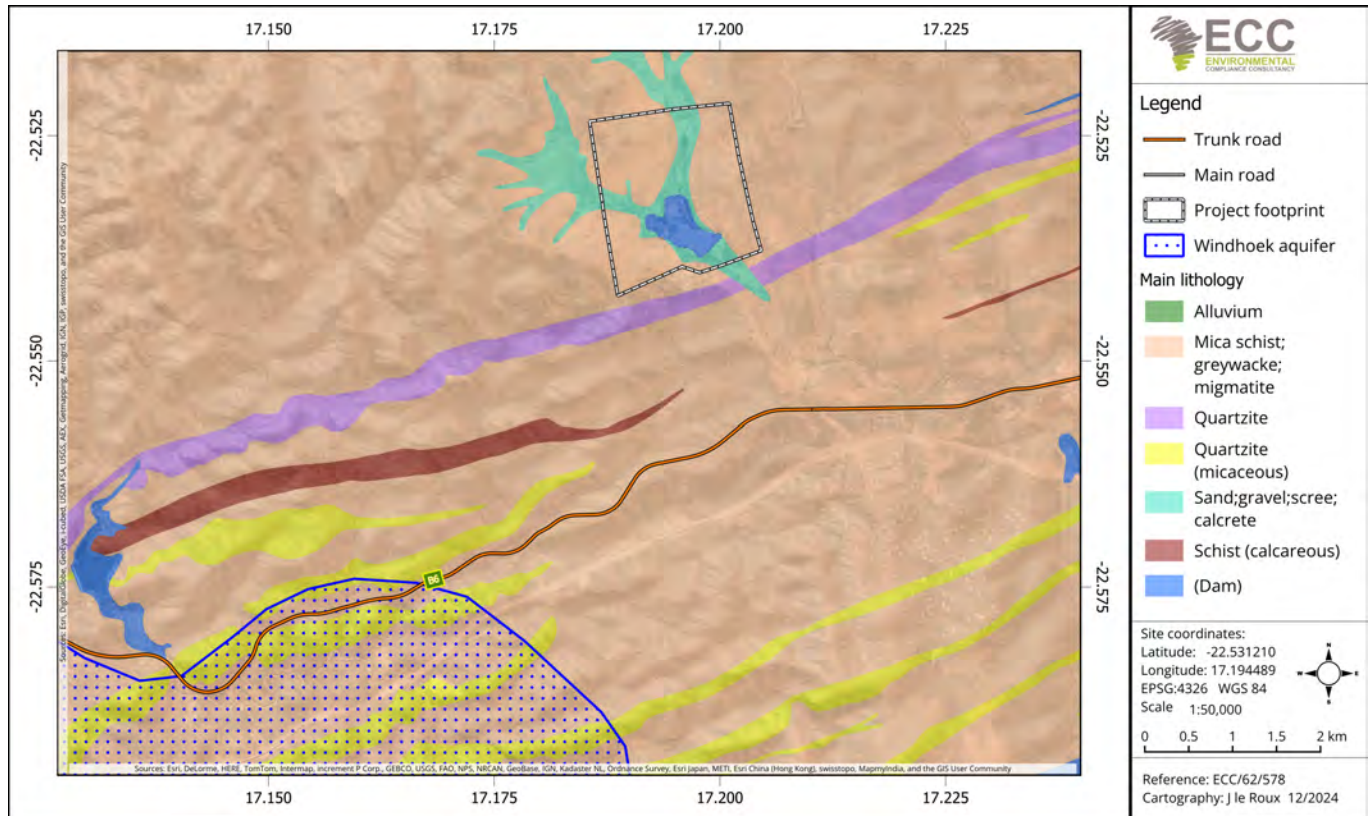


Figure 10 – Proximity of the development to the Windhoek Aquifer north eastern most boundary

Direct recharge of groundwater within the development's footprint is expected to be low, despite the presence of the ephemeral rivers and Dams. The surficial Kuiseb schists weather to clay rich horizons, decreasing infiltration from surface. The alluvial cover is however likely a positive recharge feature, although alluvial thicknesses are expected to be thin (<10 m) in the region, as seen by outcrop in riverbeds. Recharge is expected to be favourable on the quartzitic outcrops south of the site and in areas where local structures intersect surface flow paths. As such the Kleine Kuppe aquifer at depth beneath the development may prove a favourable groundwater target is required. The creation of impermeable surfaces associated with the development is not expected to have an adverse effect on regional groundwater recharge. According to the hydrogeological map of Namibia, the annual groundwater recharge is estimated (on a very regional scale) to be ~3-4 % of the MAP, however Murray (2002) and Zhang et al., (2004) estimate recharge to the Kleine Kupper aquifer to be 0.5% of MAP and near zero in the Kuiseb Schists.

Table 1 - An overview of the stratigraphy and hydrostratigraphy of the Windhoek region (red polygon shows the local site conditions) (modified after Miller et al., 2018, Umvoto, 2023 and the 1:50 000 2217CA Windhoek geological map).

Age	Stratigraphy					Hydrostratigraphy			
	Supergroup	Group	Subgroup	Formation	Description	Super Unit	Unit	Subunit	
52 Ma		Aris Suite (TsARo, TsART)			Trachyte (pipes, sills, dykes, plugs) and phonolites		-	-	-
610 Ma	Southern Zone		Khomas Complex		Kuiseb (NKs)	Amphibolite (NbML); Mica schists, local calcareous schist (NKssc)	-	Kuiseb Aquiclude (Matchless Member)	-
					Kleine Kuppe (NKk)	Micaceous quartzite; locally interbedded with amphibole schist (NKka). Includes Wasserberg quartzite (NKkw)	-	Kleine Kuppe Subaquifer	-
> 635 Ma	Southern Margin Zone	Damara Supergroup	Hakos	Vaalgras	Gomab River (NGr)	Amphibolite/mica schist with minor quartzite and local marble (NGrm). Thin metafelsite (NGrHl)	Windhoek Aquifer	Vaalgras Aquitard/Aquifer	Gomab River aquitard/aquifer
					Mahonda (NMh)	Mica schist; locally interbedded with quartzites/micaceous quartzite (NMhq) and amphibolite schist (NMha). Water strikes encountered in quartzites.			Mahonda aquitard/aquifer
					Naos (NNa)	Amphibolite/chlorite schist, minor iron formation (NNai). Diamictite, pebbly schist, minor schist, quartzite (NNaq); amphibolite (NNaa), iron formation (NNai).			Naos aquitard/aquifer
				Kudis	Auas (NAu)	Turbiditic quartzite fan deposit. Minor mica schist, graphite-mica schist. Thickest in Auas Mountains. Duplicated by thrusting and fractured by Windhoek Graben faulting.			Auas Subaquifer
> 750 Ma			Blaukrans (NBI)		Interbedded with Auas and Waldburg Fms. Mica schist, graphite-mica schist. Variably pyritic.	-	Waldburg Aquitard	Blaukrans Subaquitard	
			Waldburg (NWb)		Marble; minor graphite-mica schist and quartzite. Strongly tectonised dark grey and white dolomitic to calcitic marbles. Water strikes encountered in dolomitic marbles.			Waldburg Subaquitard	
> 780 Ma			Nosib	Duruchaus (NDu)	Mica schist, local amphibolite (NDua)			Duruchaus Subaquitard	
> 1000 Ma				Kamtsas (NKa)	Feldspathic quartzite, pebbly quartzite			Kamtsas Subaquitard	
> 1000 Ma	~~~~ Major unconformity ~~~~					~~~~ Major unconformity ~~~~			
~1750 Ma	Hohewarte Metamorphic Complex (MHO)				Granitic gneisses, migmatites, metasedimentary and basic metavolcanic rocks. Amphibolites (MHOa)		-	Basement Aquiclude	-

Figure 11 – An overview of the stratigraphy and hydrostratigraphy of the Windhoek region (modified after Miller et al., 2018 and the 1:50 000 2217CA Windhoek geological map).

Groundwater levels vary depending on the target aquifer / aquitard and on the interconnectivity of the fault and fracture networks. Regionally, groundwater flow is in a north westerly direction, with the Aus Mountain range in the south being the main recharge zone of the greater Windhoek Aquifer system and associated hydrogeological units (e.g., Kleine Kuppe formation). Locally, quartzitic outcrops and structures cross cutting surface water features are likely to offer recharge to underlying flow paths feeding nearby boreholes.

A summary of the flow characteristics and hydraulic parameter (T= Transmissivity, K= Hydraulic Conductivity, S = Storativity) estimates of the relevant hydrostratigraphic units is provided in Table 2.

Table 2 – Summary of flow characteristics and hydraulic parameter estimates (modified from Murray, 2002)

Hydrostratigraphy	Flow Characteristics	Hydraulic Parameter
Kleine Kuppe	Groundwater flows along permeable quartzites, however, the Kleine Kuppe aquifer does not act as a sizeable groundwater reservoir. The permeable fractures are bounded by less permeable material which restricts flow or acts as complete barriers to flow.	T (formation): 10-550 m ² /day T (fracture): 900-4000 m ² /day K (formation): 0.04-1.35 m/day K (fracture): 5.2-19.61 m/day S (formation): 0.0005 to 0.034
Kuiseb Aquiclude	Kuiseb schists are impermeable, and flow along fractures into the schists shows highly variable permeabilities. The hydraulic link between fracture sets is generally poor.	T (formation): 0.1-40 m ² /d T (fracture): 0.8 to 10 m ² /d S (formation): 0.0001-0.0004

3 HYDROCENSUS

A review of the GROWAS II data from the Department of Water Affairs was not possible due to a delay in the DWA's response to the data request (submitted 22 October 2024, no data received to date). Borehole data from the previous government dataset was evaluated for the region around the proposed development in a 3.5 km radius to assist in the planning of the field hydrocensus and to provide an idea of groundwater use and potential around the proposed development. Ten (10) boreholes were identified from this dataset (Figure 12) dating back to as far as 1940, with the most recent borehole drilling date being 1980. Despite the age of the data, indicative information on borehole depths, yields and water quality could be retrieved. Table 3 shows a summary of borehole details from this dataset.

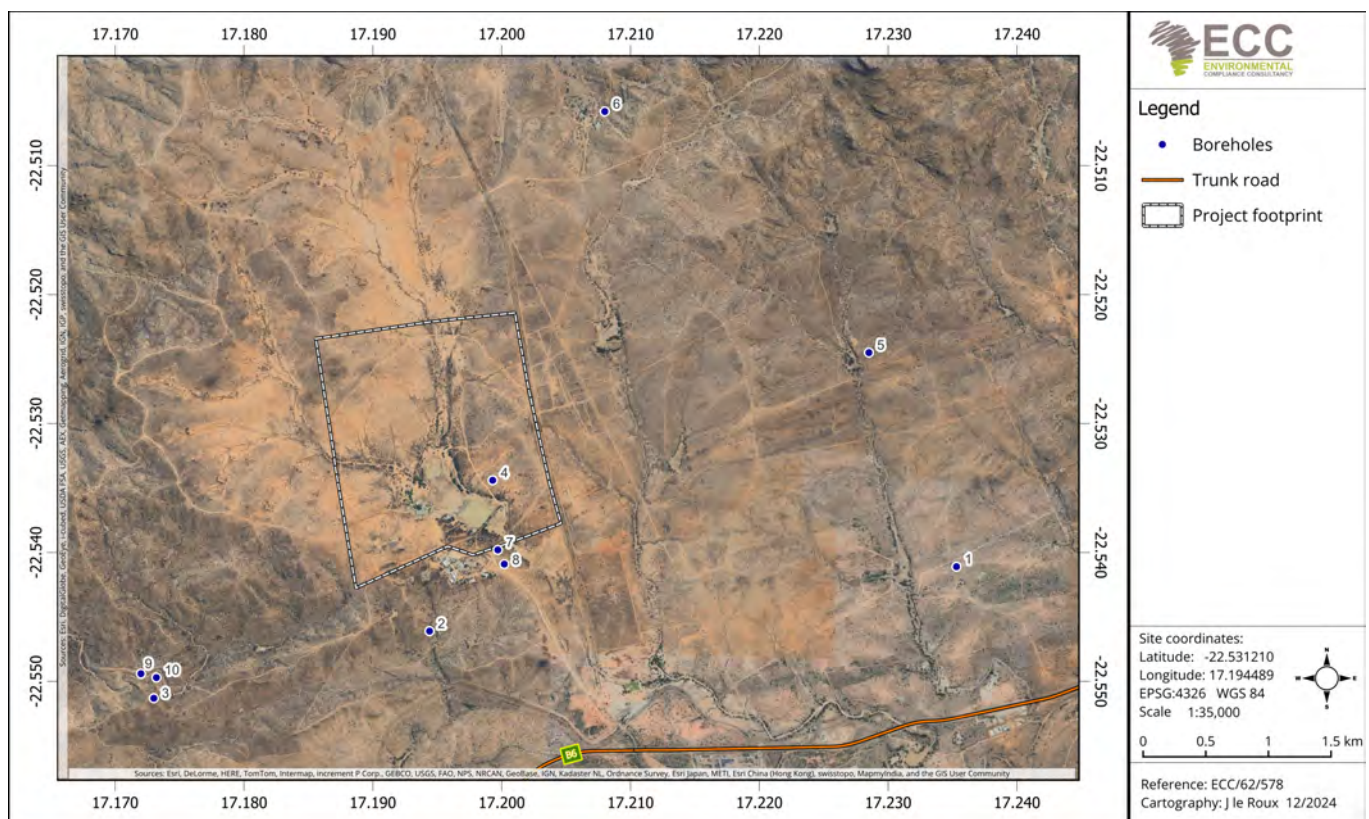


Figure 12 – Locations of boreholes in a 3.5 km radius around the development site identified from the old DWA dataset

Table 3 – Borehole details from the old DWA dataset

Map no.	WW no.	Latitude	Longitude	Elevation (mamsl)	Date drilled	BH depth (m)	Yield (m ³ /h)	Water level (mbgl)
1	4829	-22.5411	17.2353	1901	1955/01/01	70	3	12
2	24376	-22.5461	17.1944	1898	unknown	95	unknown	unknown
3	24377	-22.5513	17.173	1874	1980/01/01	175	unknown	unknown
4	24389	-22.5344	17.1993	1906	1980/01/01	80	5	24

Map no.	WW no.	Latitude	Longitude	Elevation (mamsl)	Date drilled	BH depth (m)	Yield (m³/h)	Water level (mbgl)
5	84899	-22.5245	17.2285	1921	1957/01/01	67	2	61
6	84900	-22.5058	17.208	1945	1940/01/01	91	0.2	61
7	85639	-22.5398	17.1997	1933	1969/01/01	100	3	14
8	85640	-22.5409	17.2002	1933	1952/01/01	103	1	34
9	85641	-22.5494	17.172	1874	1962/01/01	95	1.5	51
10	85642	-22.5497	17.1732	1874	1973/01/01	100	unknown	unknown

A field hydrocensus was undertaken by an ECC staff member on 21 November 2024. Access to neighbouring farms north, south, and west of the development was not possible due to on-going land access challenges, as such access was only possible on Rem Hoofnung and Rem Bellrode to the east. Borehole locations identified in the DWA dataset were visited, however not all boreholes were located, and it is likely, based on the recorded drilling date, that many are no longer in existence (abandoned, overgrown, collapsed). Boreholes and related infrastructure that were identified and visited in the field hydrocensus are depicted in Figure 13 and relevant details summarised in Table 4. Responses received from Finkenstein Manor and Estate indicated only one borehole present >5 km away.

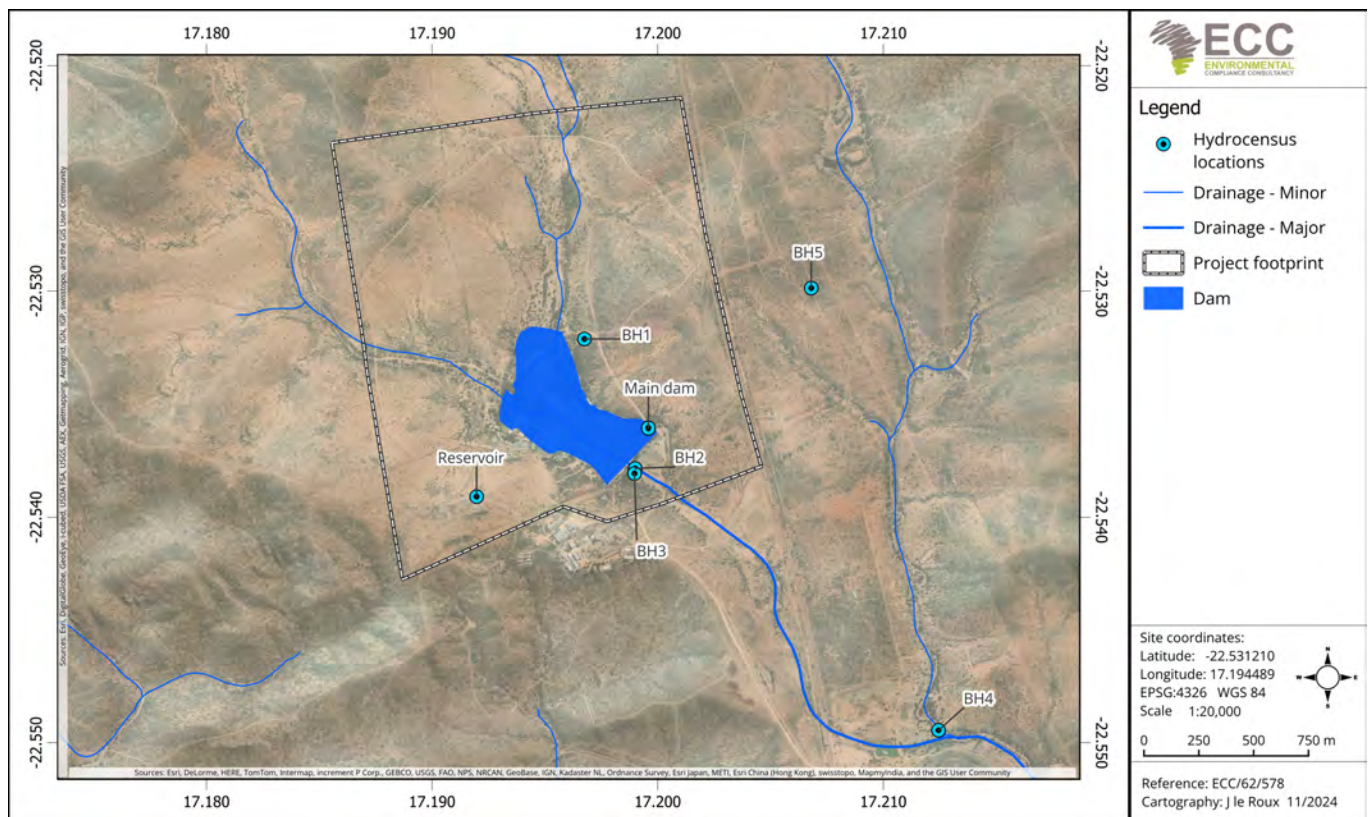


Figure 13 – Map of borehole locations and water infrastructure identified during the field hydrocensus

Table 4 -Hydrocensus data within ~3.5 km radius of the development

ID	Latitude	Longitude	Elevation (mamsl)	Location	Site Type	Depth (mbgl)	Yield (m ³ /hr)	WL (mbgl)	Water Use	Comment
BH1	7506613	725934	1935	Heja Lodge - eastern bank of dam	Borehole	unknown	unknown	unknown	None	Located in the riparian zone. Borehole is caged and has been covered by a stockpile of soil - use has been abandoned.
BH2	7505976	726156	1930	Heja Lodge - beneath Hoofnung Dam wall	Borehole	80	unknown	39.77	domestic	Located in riparian zone at the base of the dam wall. Near to BH3. Flow meter installed. Figure 14
BH3	7505952	726153	1930	Heja Lodge - beneath Hoofnung Dam wall	Borehole	80	0.25	44.24	domestic	Next to BH2. Solar powered. WL measured during active pumping. Flow meter installed. Figure 14
BH4	7504670	727520	1921	Abattoir	Borehole	105	unknown	12	none	Water reportedly contaminated (red) with iron. In riparian zone, near abattoir on large fault.
BH5	7506848	726972	1951	farmland	Borehole	unknown	unknown	unknown	domestic	Borehole caged and locked
Main dam	7506172	726219	1936	Heja Lodge	Dam	n/a	none	n/a	none	Hoofnung Dam, no abstraction, dam embankments <5m.
Reservoir	7505849	725431	1948		Reservoir	n/a	n/a	n/a	domestic	Supplied by BH2 and BH3



Figure 14 – Borehole 2 (left) and BH 3 (right) photographed during the field hydrocensus

Hydrochemical data collected in the field (where possible) and available data from the DWA dataset (and results from Finkenstein's borehole) indicate groundwater in the region to be near neutral (pH 7) with alkalinity, hardness, calcium, and magnesium concentrations indicative of the calc-silicate rocks in the region.

Electrical conductivity (EC) and Total Dissolved Solids (TDS) classify the water as predominantly fresh. Nitrates and fluoride are considered sufficiently low to use water for domestic purposes and all major ion chemistry indicate groundwater can potentially be used for potable supply provided some treatment is applied (disinfection).

Limited insight is available on trace metal concentrations. Two samples were collected from the field for microchemical and trace metal analysis and sent to a lab accredited through the South African National Accreditation System (SANAS). The report will be updated to include the results once received from the lab.

4 LEGISLATIVE CONSIDERATIONS

4.1 WASTEWATER TREATMENT AND DISCHARGE LICENCE

The need for a WWTW triggers the Water Resource Management Act, Act 11 of 2013 (WRMA) and will require an application for a wastewater treatment, effluent discharge, and reuse licence in terms of Part 8, Regulation 66 (1) and Part 13, Section 72 (1) of the WRMA. Additionally, the WWTW requires to be registered with DWA. The following considerations need to be taken into account when evaluating the location of the WWTW:

- Type of WWTW - discharge location, reuse, and quality;
- Proximity to water courses, aquifers, boreholes, and buildings;

The relevant legislation, regulations and guidelines include:

- Water Resource Management Act, Act 11 of 2013 and associated regulations;
- Department of Water Affairs, Code of Practice: Volume 3. Biological Filtration Systems (Trickling Filters) – General Guidelines (2008);
- Department of Water Affairs, Code of Practice: Volume 6, Wastewater Reuse, Grey Water, Reclaimed Domestic and Industrial Effluents (2012);
- Permit Conditions for Wastewater Treatment Systems, Department of Water Affairs and Forestry (2015).

These are discussed in more detail in the following sections:

4.1.1 TYPE OF WWTW

The WWTW will be designed and constructed by Aquarius Consult cc, a reputable water engineering company based in Windhoek. A full technical description of the WWTW proposed for the development is provided as Appendix A.

The WWTW will be an Advanced Biological Filtration System (Trickling Filter System) designed to treat 2130 m³/day of domestic sewage generated by the housing development. The Average Dry Weather hourly flow is 88.75 m³/h with a peak design hydraulic flow of 266.25 m³/h.

The complete sewage treatment process includes screening, anaerobic digestion in a primary clarifier; aerobic treatment in a trickling filter; phosphate removal, biomass removal in a secondary clarifier, disinfection with chlorine gas in a chlorine contact tank, final water polishing using sand and carbon filters, odour control and sludge de-watering.

Final treated effluent will meet the special standards as prescribed in Annexure 11 (Regulation 67) of WRMA. While the licence conditions will inform the monitoring requirements, it is recommended that quarterly sampling of treated effluent be

undertaken and evaluated for the following parameters (Annexure 9, Regulation 37 of WRMA):

Physiochemical Parameters	Microbiological Parameters
pH	Heterotrophic colony count
Electrical conductivity	Total coliforms
Total dissolved solids, determined	Faecal coliforms or E. Coli
Turbidity	
Colour	
Alkalinity/acidity	
Chloride	
Fluoride	
Nitrate	
Nitrite	
Sulphate	
Total hardness, calcium hardness, magnesium hardness	
Sodium	
Potassium	
Calcium	
Magnesium	
Iron	
Manganese	
Silica	
Dissolved oxygen	
Redox potential	
Biological oxygen demand (BOD)	
Chemical oxygen demand (COD)	
Ammonium	
Total nitrogen / Kjeldahl nitrogen	
Ortho-phosphate	
Free and total chlorine	

According to the Inception Report prepared by Windhoek Consulting Engineers (2024), the following benefits are applicable to the proposed treatment solution:

New-Generation Trickling Filters (NGTF) effect advanced biological treatment of an effluent using attached-growth media technology to produce a high-quality final effluent. NGTF employ low-level mechanical technology in the form of submersible pumps, but these require

low levels of service and maintenance. Generally, this technology is gaining increased acceptance for the following reasons:

- It has a small footprint - to treat domestic effluent, NGTF need only approximately 2-5% of the land area typically necessary for other treatment solutions e.g., oxidation ponds (including evaporation).
- High quality final effluent - a final effluent exceeding the Namibian Special Standard is produced. This will be safe for discharge even during periods of severe flooding of the area. Also, the final effluent can be reused for growing selected crops and aquaculture in line with guidelines or for gardening and lawns (e.g. sports fields and public parks) in the development.
- Simple technology - the only advanced mechanical equipment employed are submersible pumps, which can be replaced without specific technical knowledge. Once commissioned, no further process control or adjustment to the process is required.
- Limited mechanical equipment that can break. Only the service/recycle pumps would be of concern, but designers always allow for duty and standby pumps.
- Limited inspection, service and maintenance required. Only submersible pumps, which require periodic inspection and maintenance, are employed. However, the development will also need other pump stations to transfer sewage to the treatment plant and submersible pumps can therefore be regarded as standard mechanical equipment once a full reticulation system has been provided for the development.
- Low power requirements. NGTF use only approximately 40 to 65% of the power required by other advanced treatment processes giving a comparable treated effluent, such as oxidation ditches or activated sludge processes. Not only will the continuous power demand be low, but standby power in the form of a standby generator can be provided at minimal costs.

Based on the detailed design provided in Appendix A, it is evident that there will be no exposure of any hazards related to the WWTW i.e. incorporate a secondary clarifier, phosphate removal, disinfection, polishing, sludge removal and odour control through enclosing all components and incorporating scrubbers.

COP Volume 3 (Section 3.2) states that an advantage of biological treatment systems, such as the one to be employed for the development, is that:

“Can be placed closer to inhabited areas. Whereas pond systems should not be placed closer than 500 m from the closest inhabitants, properly operated and maintained attached-growth systems do not produce undue nuisance constituents and can be placed within 50 m of the closest inhabited area.”

It is noted that should the generic 500 m buffer around WWTWs be unilaterally applied, the development may prove financially unfeasible, resulting in considerable loss of investment,

housing and job creating. COP volume 3 makes lawful provision that this WWTW can be within 50 m of an inhabited area.

The COP Volume 3 goes on to state that (Section 4.1):

“If a septic tank or primary clarifier is employed as primary treatment process this distance may be reduced but is subject to approval by DWAF. ”

As the WWTW for the development will employ a primary clarifier (and all treatment steps following this are enclosed), the DWAF are within lawful rights to reduce the buffer zone of 500 m to 50 m (Figure 15).

4.1.2 PROXIMITY TO WATER COURSES, AQUIFERS, BOREHOLES, AND BUILDINGS

The proposed location of the WWTW is shown in Figure 15 and includes in it the 500 m buffer (as typically applied to licence conditions for WWTWs) in red but it also shows a 250 m (orange) and 50 m buffer (yellow). The COP Volume 3 has confirmed that a 50 m buffer to residential areas is acceptable and can be applied subject to approval by DWA through the licence application process.

Within the 500 m buffer zone, two existing production boreholes currently supplying Heja lodge and the Hoofnung Dam and downstream area thereof are present. Reducing the buffer to 250 m will exclude the Hoofnung Dam, but still include the highly disturbed downstream area of the dam and marginally the existing production boreholes. As groundwater supply will not be required for potable use, it is recommended that either the WWTW be adjusted (current layout remains preliminary) to fall outside the 250 m buffer area or that the boreholes be capped and alternative boreholes be drilled to replace this supply, outside the 250 m buffer area. Alternatively it can be requested to DWA that the buffer area applied be lawfully reduced to 50 m in the licence conditions, in which neither boreholes, water courses nor buildings are affected.

As the downstream alluvium is highly disturbed by other landowners in the region, and all alluvium overlies the Kuiseb Aquitard, the river alluvium is not deemed an aquifer and should not have bearing on the proposed extent of the buffer zones or where effluent re-use is practised.

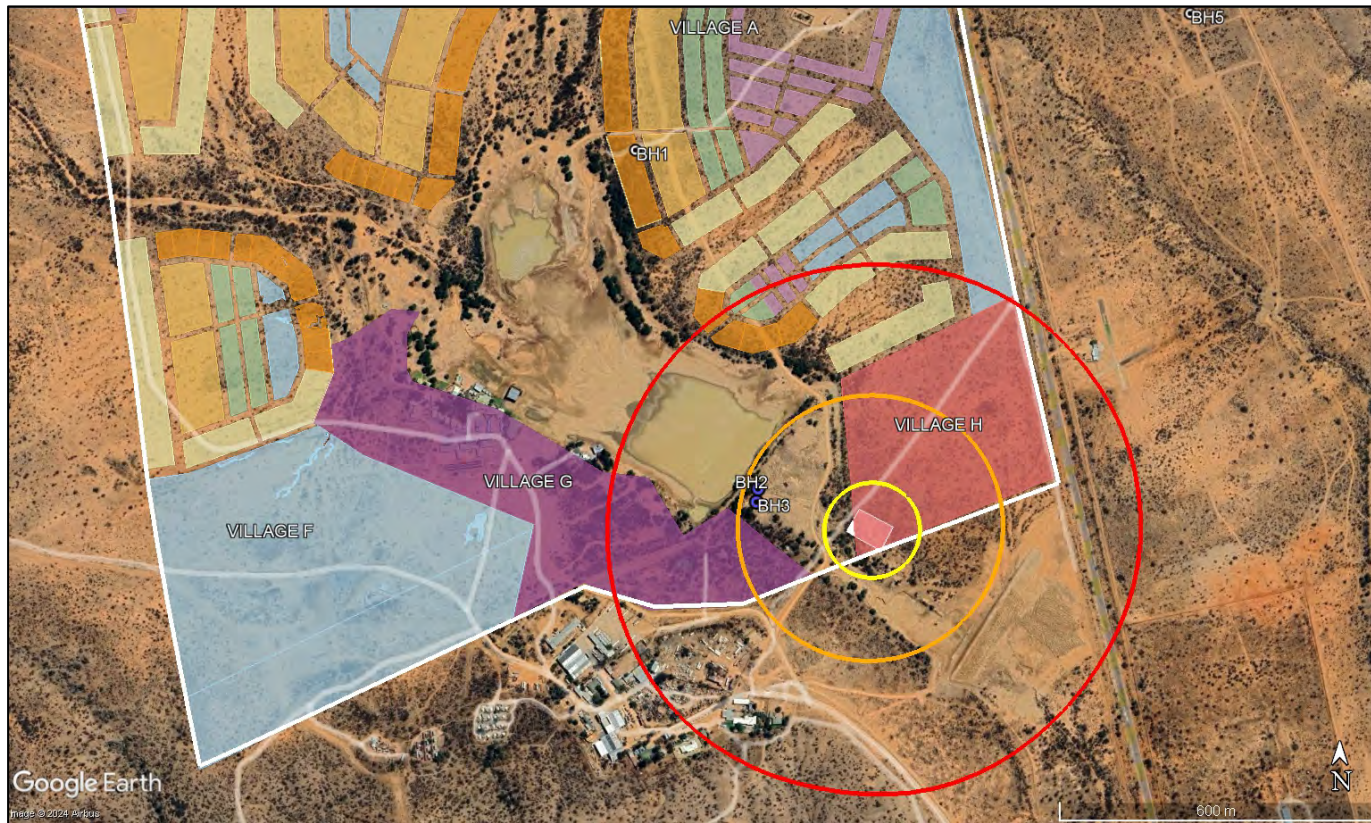


Figure 15 – Proposed location of the WWTW showing the 500 m (red), 250 m (orange) and 50 m (yellow) buffer zones.

Alternative locations

Only one alternative location has been raised for the WWTW (Figure 16). This is due to the reality that the development footprint is in proximity to the two water courses and the respective confluence of these at Hoofnung Dam i.e. no position in the development footprint will meet the 500 m buffer requirement.

The alternative position is situated on southeastern most border with the neighbouring farm (Bellrode Rem). This is the only alternative available in which the development remains financially viable but will still add considerable strain to the design and associated costs. The new location also has a water course fall within 500 m of the proposed location. This water course is deemed to have greater significance within the Seeis catchment than the water course(s) associated with Hoofnung Dam. An abandoned borehole and the abattoir also occur in the 500 m buffer to this alternative location.

A reduction of the buffer to 250 m would effectively exclude any water courses, boreholes, or buildings, however this would require additional investment to purchase the property and extend pipeline routes and security measures. This location also includes additional disturbance of the environment.

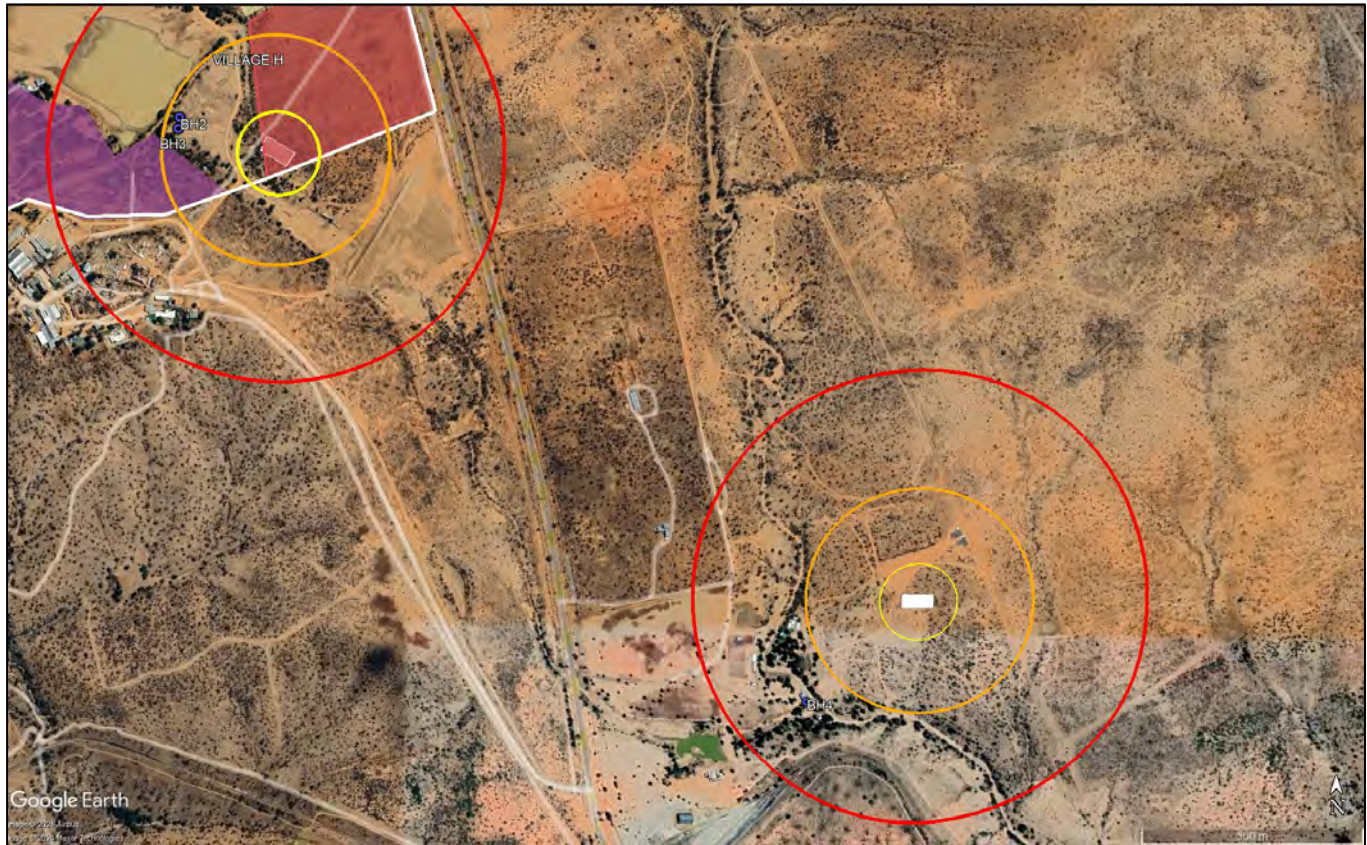


Figure 16 – Alternative position for the WWTW showing the 500 m (red), 250 m (orange) and 50 m (yellow) buffer zones

It is recommended that DWA are consulted on the relaxation of the broadly applied 500 m buffer. As per the COP Vol. 3, and the impact assessment done on the water courses and groundwater system, it is deemed environmentally feasible that the buffer zone can be reduced 50 m. Nearby water courses do not fall within the 50 m buffer, and while the available site layouts indicate small portions of the residential areas to be within the 50m buffer, layout adjustments are anticipated to be able to cater for this and ensure none are within the allotted 50 m zone.

4.2 GROUNDWATER ABSTRACTION

Part 5, Regulation 44 of the WRMA states that should any groundwater abstraction be planned or undertaken, an abstraction licence application needs to be submitted. It is understood that groundwater use will not be for domestic or potable purposes, however groundwater abstraction for landscape irrigation or ecological flow releases may be required.

4.3 EFFLUENT RE-USE APPLICATION

Part 4 Regulation 5 c) of the WRMA makes reference to Annexure 2 of the Regulations to address the re-use application for the treated effluent. Table 2.3 of Annexure 2 indicates that “Any type of irrigation permissible” for Landscape Irrigation of Primary, Secondary and Tertiary treated effluent meeting the special standards (see also Regulation 69 c). It is further

confirmed that the WWTW will employ sand and granular activated carbon filtration and disinfection as part of the Tertiary Treatment steps.

Part 8, Regulation 66 states an application for a licence to discharge effluent or construct or operate a wastewater treatment facility is required and needs to comply to effluent quality standards provided in Annexure 11 (Regulation 67 and 69).

4.4 DAM, DAM SAFETY AND FLOOD MANAGEMENT

Part 9 Regulation 72 requires that Hoofnung Dam be classified according to Section 129 (1)(i) of the WRMA. Contemplating Annexure 12 of the regulations classifies the Hoofnung Dam as 72a) small dam, being a Category 1 Dam (wall up to 12 m).

As stipulated in Part 9 Regulation 73, person who intends to construct, repair or maintain a dam must ensure that the construction, repairing or maintenance of the dam complies with the requirements set out in regulations 74 to 77, 78 to 82 or 83 to 88 in respect of the category of that dam. As Hoofnung Dam is a Category 1 Dam, only regulations 74-77 apply. As Hoofnung dam is an existing dam, clarity needs to be obtained from DWA in terms of providing a dam design report (Regulation 75 and Annexure 25).

However, the flood hydrology and civil engineering / architectural designs can likely meet most of the requirements for the required dam design report and the dam safety requirements (Regulation 76 and 89), although an assessment and survey of the existing dam wall may be required.

Part 9 Regulation 92 (1) requires a person who owns an existing dam in Namibia to within 180 days

after the commencement of these regulations make an application for the registration of the dam to the Executive Director. This should be actioned by the landowner (dam owner) before 23 February 2025.

4.5 LICENCE FOR USE FOR WETLAND OR DAM

Part 11 Regulation 100(c) states an application for a licence for the use of a wetland or dam is required for a person who intends to construct or erect any developments on the banks or in the riparian zone of any wetland or dam. The required information for the licence application is provided in Annexure 17 of the Regulations. The environmental clearance certificate, the environmental management plan, and the assessment report in respect of the proposed activities upon the environment, existing water resources and resource quality is required to accompany the information listed in Annexure 17. This licence, once issued, is valid for three years.

It is noted that Regulation 110 lists prohibited uses for dams which may impact the proposed development, namely:

- 110 a) any permanent housing development along a riverbank or dam or within a 100 metres distance from the riverbank or dam;
- 110 e) any wastewater storage along a watercourse or within a 100 metres distance from the active stream.

DWA should be consulted regarding the approach to such a licence application and the implementation of the licence conditions. This licence, once issued, is valid for three years.

4.6 LICENCE TO REMOVE RIPARIAN SPECIES, FILL OR EXCAVATE RIPARIAN ZONE OR ERECT STRUCTURAL DEVELOPMENT WITHIN RIPARIAN ZONE

Part 14 Regulation 138 (a-c) states that a person may not a) remove any riparian species, b) fill or excavate a riparian zone or c) erect any structural development within a riparian zone without a licence to do so as issued by the Minister. Annexure 29 of the Regulations provides required details for this application. The environmental clearance certificate, the environmental management plan, and the impact assessment report in respect of the proposed activities upon the riparian species and riparian zone is required to accompany the information listed in Annexure 29.

It is noted that Regulation 141 provides conditions relating to licences issued in this regard that may impact the proposed development, namely:

- a) where there is a reasonable threat to the ecological integrity of any body of water a person may not –
 - o i) remove riparian species from the riparian zone of that body of water;
 - o ii) excavate or fill the riparian zone of the body of water; or
 - o iii) erect any structural development within the riparian zone the body of water;
- b) a person may not remove a protected plant species;
- c) a person may not erect any structural development on the stream or riverbank;
- d) a buffer zone of 100 metres from the stream or riverbank must be maintained to protect streams and riverbanks from soil erosion and reduces flooding;
- e) a person may not remove rocks, sand, or gravel within 100 metres of the riparian zone from the stream or riverbank;
- f) a licence holder who removes rocks, sand or gravel must ensure that such removal does not expose the roots of indigenous trees in any watercourse;
- g) precautionary measures to prevent damage to riverbanks or riparian zones and prevent the pollution or reduction of water resource quality must be implemented by the licensee;

Based on the proximity of the development in and around the riparian edge of the water courses and dam, DWA should be consulted regarding the approach to such a licence application and the implementation of the licence conditions. This licence, once issued, is valid for three years.

Any planting as flora should take into account the species listed in Annexure 13 (Section 102(2) and Regulations 124 and 125) to avoid planting and establishment of aquatic species declared prohibited alien invasive species.

5 IMPACT ASSESSMENT

An impact is essentially any change (positive or negative) to a resource or receptor brought about by the presence of the project component or by the execution of a project-related activity. The potential impacts of the project have been evaluated using ECC's recognised risk assessment methodology. This methodology was developed to enable communication of the potential consequences or impacts of activities on the hydrological (surface water) environment as set out in the Environmental Management Act, No. 7 of 2007.

The impact assessment methodology is outlined in Figure 17 to Figure 20. The assessment of impact concludes with a scoring of the impact with a score from 1 (low) to 12 (major), based upon the intersection of impact sensitivity and impact significance. Sensitivity is a single variable with three options which rank sensitivity from 1 to 3. Significance considers a combination of factors.

The significance of an impact was determined by evaluating the nature (N), frequency (F), duration (D) reversibility (R) and probability (P) which are collectively considered under the heading "Nature and Characteristics -of the Impact." The magnitude of the change (M) is the final factor which influences impact significance. To calculate the rating of significance (from 1 to 4), the following formula was applied:

$$\text{Significance} = \frac{(E + D + R + P) * N * M}{4}$$

All variables in the above except for nature (N) are ranked 1 to 5 in the ECC methodology. Nature (N) is either +1 (beneficial) or -1 (adverse). The resulting significance rating is between -25 and +25. The translation of this scoring to an ECC significance rating of between 1 and 4 requires the division of the rating by 6.25. With significance calculated, it was possible to compare the impact rating to the sensitivity rating to arrive at the final impact scoring (1 to 12; low to major).

ECC IMPACT PREDICATION AND EVALUATION METHODOLOGY

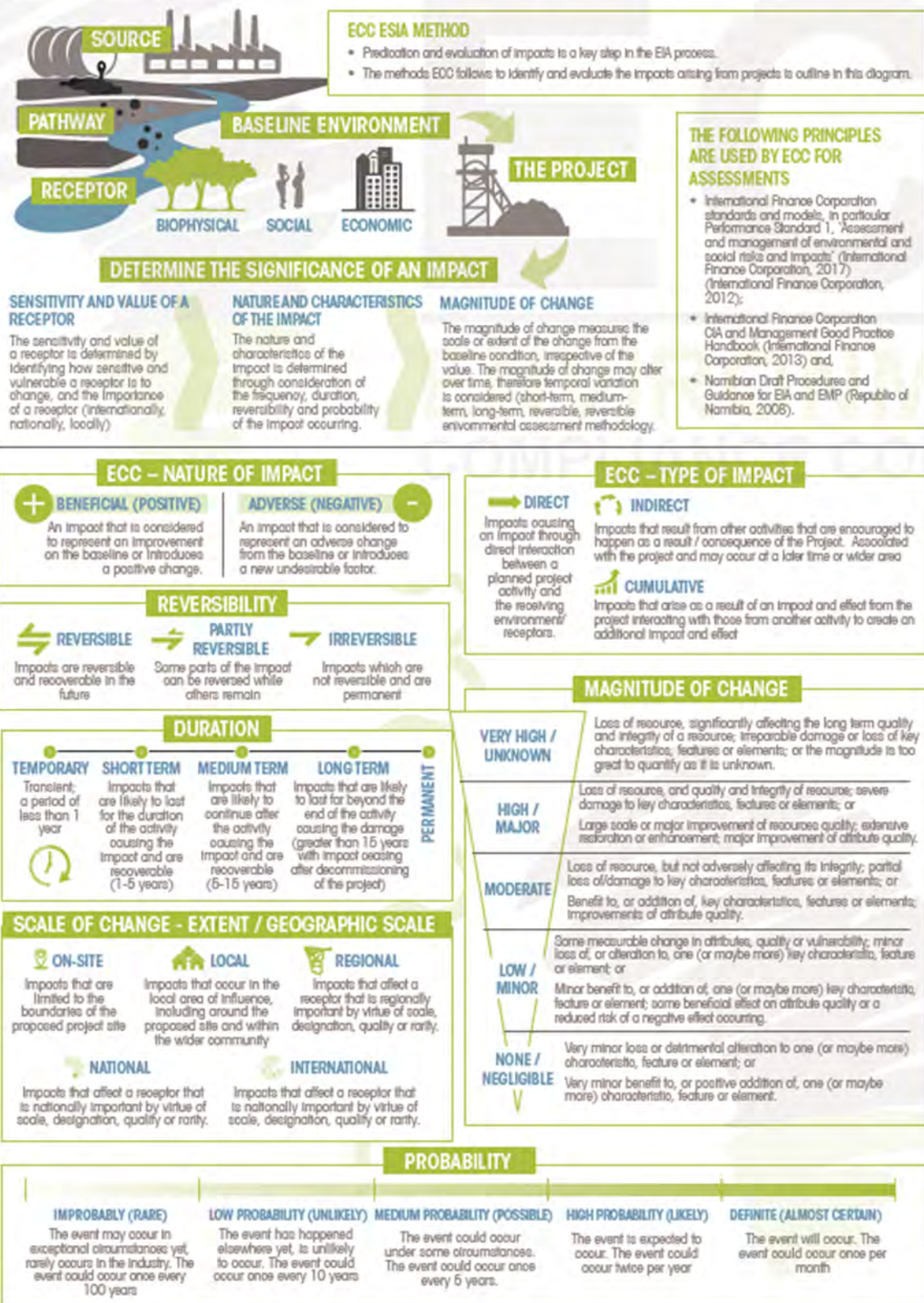


Figure 17 - ECC impact assessment methodology (Part 1)

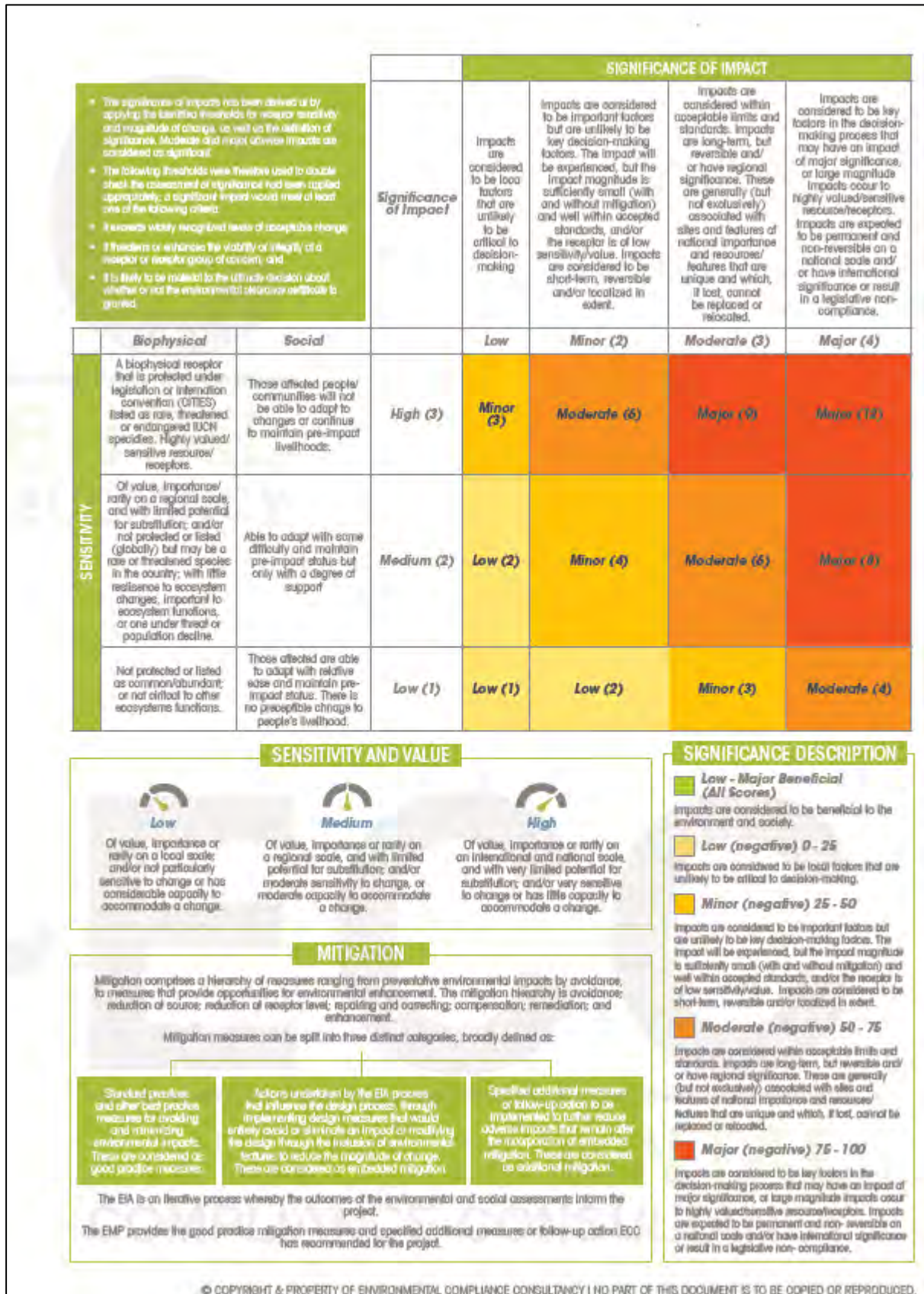


Figure 18 - ECC impact assessment methodology (Part 2)

			Significance of Impact				
			Significance of Impact	Impacts are considered to be local factors that are unlikely to be critical to decision-making.	Impacts are considered to be important factors but are unlikely to be key decision-making factors. The impact will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. Impacts are considered to be short-term, reversible and/or localized in extent.	Impacts are considered within acceptable limits and standards. Impacts are long-term, but reversible and/or have regional significance. These are generally (but not exclusively) associated with sites and features of national importance and resources/features that are unique and which, if lost, cannot be replaced or relocated.	Impacts are considered to be key factors in the decision-making process that may have an impact of major significance, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts are expected to be permanent and non-reversible on a national scale and/or have international significance or result in a legislative non-compliance.
Sensitivity	Biophysical	Social		Low	Minor (2)	Moderate (3)	Major (4)
	A biophysical receptor that is protected under legislation or international conventions (CITES) listed as rare, threatened or endangered IUCN species. Highly valued/sensitive resource/receptors	Those affected people/communities will not be able to adapt to changes or continue to maintain pre-impact livelihoods.	High (3)	Minor (3)	Moderate (6)	Major (9)	Major (12)
	Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or Not protected or listed (globally) but may be a rare or threatened species in country; with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population declining.	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support	Medium (2)	Low (2)	Minor (4)	Moderate (6)	Major (8)
	Not protected or listed as common / abundant; or not critical to other ecosystem functions	Those affected are able to adapt with relative ease and maintain pre-impact status. There is no perceptible change to people's livelihood.	Low (1)	Low (1)	Low (2)	Minor (3)	Moderate (4)

Figure 19 – ECC impact assessment scoring (Part 1)

	Significance Definitions
Low (1-2)	An impact of low significance (or an insignificant impact) is where a resource or receptor (including people) will not be affected in any way by a particular activity, or the predicted effect is deemed to be ‘negligible’ or ‘imperceptible’ or is indistinguishable from natural background variations.
Minor (3-4)	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. Impacts are considered to be short term, reversible and/or localized in extent.
Moderate (4-6)	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that ‘moderate’ impacts have to be reduced to ‘minor’ impacts, but that moderate impacts are being managed effectively and efficiently. Impacts are long term, but reversible and/or have regional significance.
Major (7-12)	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual. Impacts are expected to be permanent and non- reversible on a national scale and/or have international significance or result in a legislative non- compliance.

Figure 20 – ECC impact assessment scoring (Part 2)

Impact	Pathway/ Receptor/Result	Nature of Impact	Type of Impact	Duration	Extent	Probability	Magnitude of Change	Reversibility	Sensitivity	Significance	Scoring	Mitigation
Surface Water												
Erosion of Soils	Eroded soils have the potential to cause sedimentation of downstream watercourses.	Adverse	Direct	Short term	Local	Likely	Moderate	Partly Reversible	Low	Minor	Low	– Implement stormwater management plan. – Suitable erosion control should be utilised. – Construction should, where possible, be scheduled to take place during the dry season when rainfall and associated erosion potential are at their lowest. – Disturbed areas or areas rehabilitated with soils should be stabilised as soon as possible using plants. – Where erosion is nevertheless likely to occur, it is recommended to use settling facilities or silt fences. – Rehabilitation should include topsoil replacement, re-vegetation, and maintenance/aftercare for disturbed areas.
Altered drainage regime / Changes in run off	An increase in runoff could be expected due to the proposed construction of infrastructure which will increase impermeable surfaces.	Adverse	Direct	Short term	Local	Almost certain	Low	Irreversible	Low	Minor	Low	– Implement a stormwater management plan. – Establish 1:5, 1:10, 1:50 and 1:100 return interval flood lines and potential volumes. – Ensure suitable and safe dam wall and embankments along with keeping spillways and flow paths unobstructed and maintained. – Assess downstream ecological water requirements and need for intervention / periodic releases (dam or groundwater). – The minimal extent of watercourses/flow paths reasonably possible should be disturbed. – Altered watercourses should be modified in such a way that allows upstream areas to route back into the natural watercourse downstream of such or facilitate flow (e.g., culverts).

Impact	Pathway/ Receptor/Result	Nature of Impact	Type of Impact	Duration	Extent	Probability	Magnitude of Change	Reversibility	Sensitivity	Significance	Scoring	Mitigation
Pollutants entering the surface water environment	Operation of earthmoving machinery or maintenance of vehicles, discharge of insufficiently treated or raw wastewater, run off of fertilizers from revegetated areas, litter and household chemicals	Adverse	Direct	Short term	Local	Likely	Moderate	Partly Reversible	Low	Minor	Low	– Implement a stormwater management plan. – Provide sufficient waste disposal options/facilities. – Store any chemicals and hydrocarbons on impermeable, bunded areas. – Ensure sufficient capacity for wastewater overflows and emergency discharges. – Develop and implement standard operating and maintenance procedures for WWTWs. – Conduct period checks of all reticulation systems. – Quarterly water quality sampling of dams, standing water and effluents. – Effluent discharge licence from DWA.
Flooding	Flood risk is largely an impact on the proposed development and not the environment as with the other impacts identified.	Adverse	Cumulative	Short term	Local	Rare	High	Partly Reversible	Medium	Medium	Low	– Implement and maintain a stormwater management plan. – Undertake a detailed flood assessment. – Implement surface water capacity and rainfall monitoring (Hoofnung Dam stage monitoring and on-site rain gauge). – Ensure flow paths (spillways, culverts, pipelines, canals, natural drainage lines) remain unobstructed and have sufficient capacity. – Adhere to City of Windhoek flood elevation requirements for development.
Groundwater												
Groundwater contamination	Domestic waste, raw wastewater, fertilisers, pesticides, and household chemicals infiltrating the subsurface	Adverse	Direct	Long Term	Local	Rare	Moderate	Partly Reversible	Low	Minor	Low	– Underlain by an aquitard – limited groundwater recharge. – Deep groundwater levels offering natural attenuation in the vadose zone. – Impermeable and bunded areas as per stormwater management plan. – Implement a groundwater monitoring network near production boreholes and contamination sources (WWTW).

Impact	Pathway/ Receptor/Result	Nature of Impact	Type of Impact	Duration	Extent	Probability	Magnitude of Change	Reversibility	Sensitivity	Significance	Scoring	Mitigation
												- Compliant effluent discharge (quarterly monitoring) and WWTW maintenance and operation. - Sufficient WWTW design capacity.
Reduction in recharge	Impermeable surfaces may decrease recharge of groundwater	Adverse	Direct	Long term	Local	Likely	Minor	Partly Reversible	Low	Minor	Low	- Underlain by an aquitard – limited groundwater recharge. - Limited groundwater users down gradient or in the region. - Distal recharge zones for deep aquifer systems (Kleine Kuppe).
Lowering of groundwater table and available resource	Groundwater abstraction (if undertaken) will be in small quantities, likely for watering of commonage areas.	Adverse	Direct	Short Term	Local	Rare	Minor	Reversible	Low	Low	Low	- Limited groundwater use. - Groundwater abstraction licence from DWA if abstraction is practiced. - Routine monitoring of groundwater levels and abstraction monitoring. - Alternative water supply options and water resilience strategies.

6 CONCLUSION

A desktop assessment and hydrocensus was undertaken for the proposed development of a lifestyle and housing development by Heja Game Lodge (Pty) Ltd around the Hoofnung Dam ~10 km east of Windhoek. The assessment was done to inform impacts to groundwater and surface water due to the construction and establishment of the development as well as its supporting infrastructure – particularly the WWTW. The development is crosscut by two ephemeral water courses and is designed around Hoofnung Dam as a main aesthetic feature.

Based on the understanding gained from the desktop assessment and boreholes identified in the field hydrocensus, an impact assessment was completed and determined all risks to surface water and groundwater systems to be low, provided appropriate and recommended mitigation measures are implemented. This impact assessment will support the Environmental Impact Assessment being developed for issuance of an environmental clearance certificate and also any water related licence applications that may be required. The site is underlain by an aquitard, and thus has limited to no adverse impacts on groundwater, while surface water regimes have been highly disturbed and altered already, and the development will thus pose limited impact and risk to the surface water hydrology of the catchment.

Based on the Water Resources Management Act, Act 11 of 2013, the following licence applications were identified as being required for the development:

- Effluent discharge and wastewater treatment facility licence;
- Effluent re-use licence;
- Licence to use a dam or wetland;
- Licence to remove riparian species, fill or excavate a riparian zone or erect structural development within riparian zones.

Various legislative considerations were explored, particularly with reference to the positioning of the WWTW and proximity of the development to the riparian zone of the water courses and Hoofnung Dam. It was determined that, based on the technology proposed to be employed by the WWTW, the low risk of impact to the water courses, the pre-existing extent of disturbance to the water courses and the lack of an alluvial aquifer, a buffer area of 50 - 100 metres around the WWTW is ecologically and anthropogenically (human health) sufficient and considered lawful if approved by DWA. Evaluation of legislation confirmed that DWA may lawfully make such a determination and that the typically applied licence condition buffer of 500 m is not a requirement for the development's WWTW. An alternative location has also been proposed for the WWTW; however the environmental impact may be comparable to the priority location, and application of the 500 m buffer remains unfeasible and ecologically unnecessary.

The proponent, with support from ECC, are engaged with the DWA to support a favourable and fair outcome with regard to the various licence applications and associated conditions, in line with Namibia's Water Resource Management Act that may benefit the citizens of Namibia without adversely affecting the water resources of the region.

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APPENDIX A – WWTW DESIGN REPORT