HIGH-LEVEL BASELINE STUDY

SURFACE AND GROUNDWATER MANAGEMENT AND MONITORING IN THE MINING SECTOR IN NAMIBIA

by

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Abstract

Namibia is the driest country in Sub-Saharan Africa, with the only perennial rivers lying along the country's borders. Given these circumstances, it is not surprising that most of the country depends heavily on groundwater resources. In addition, and due to the pressure on the limited water resources, a desalination plant was built by a mining company at the coast. Large dams provide the third source of water in Namibia.

The uranium mines are located near the central coast, and are supplied by the desalination plant. Copper is mined in the central northern part, in the area of a large karst-aquifer, from where the water is abstracted. Additional copper mines in central Namibia receive their water from a scheme of interconnected dams. Zinc and diamonds are recovered in the far south of the country, where the mines have access to the perennial Orange River. Namibia has two gold mines, one of which is supplied by a dam, while the second one is able to utilise a strong aquifer. Other commodities produced in Namibia are tin, lithium and iron, all operations are supplied by groundwater bore holes. Given the scarcity and high cost of water in Namibia, all mining operations have stringent water management plans in place and achieve high rates of recycling.

1. General overview groundwater and surface water of Namibia

With a total surface area of 824 269 km^2, Namibia is the second largest country in southern Africa. The country borders the Atlantic Ocean to the west between the 17th and 29th latitudes, Angola and Zambia to the north, Botswana to the east, and South Africa to the south and southeast. A narrow strip about 440 km long, the Zambesi Region, extends eastwards up to the Zambesi River, separating Botswana from Zambia, and touching Zimbabwe.

The subdivision of Namibia into geomorphological units is based on its position on the edge of the African continent und under the influence of the cold Benguela Current. In the west, the Namib Desert is a 80 to 120 m wide belt, which extends along the entire coastline. The Great Escarpment separates the Namib Desert from the mountainous Central Plateau which rises up to 2 000 m above sea level and extends over about half of the country. The lower lying northeastern and southeastern areas of Namibia belong to the semi-arid Kalahari Basin, and the northern bush-covered plans are part of the Owambo Basin.

Namibia has an arid climate and is the driest country in Sub-Saharan Africa. The only perennial rivers lie on the country's borders, namely the Orange River in the south, and the Kunene, Kavango, Kwando and Zambesi in the north. All inland rivers are ephemeral rivers which flow sporadically and only after intense rainfall. After such a flood event, a river course is often dry for many years. Rivers such as the Hoarusib, Uniab, Ugab, Omaruru, Swakop, and Kuiseb usually flow in a good rainy season, however, they may not reach the sea for several years.

The Nossob and Fish Rivers also flow with enough rainfall in their catchments, but they dewater inland into the Orange River.

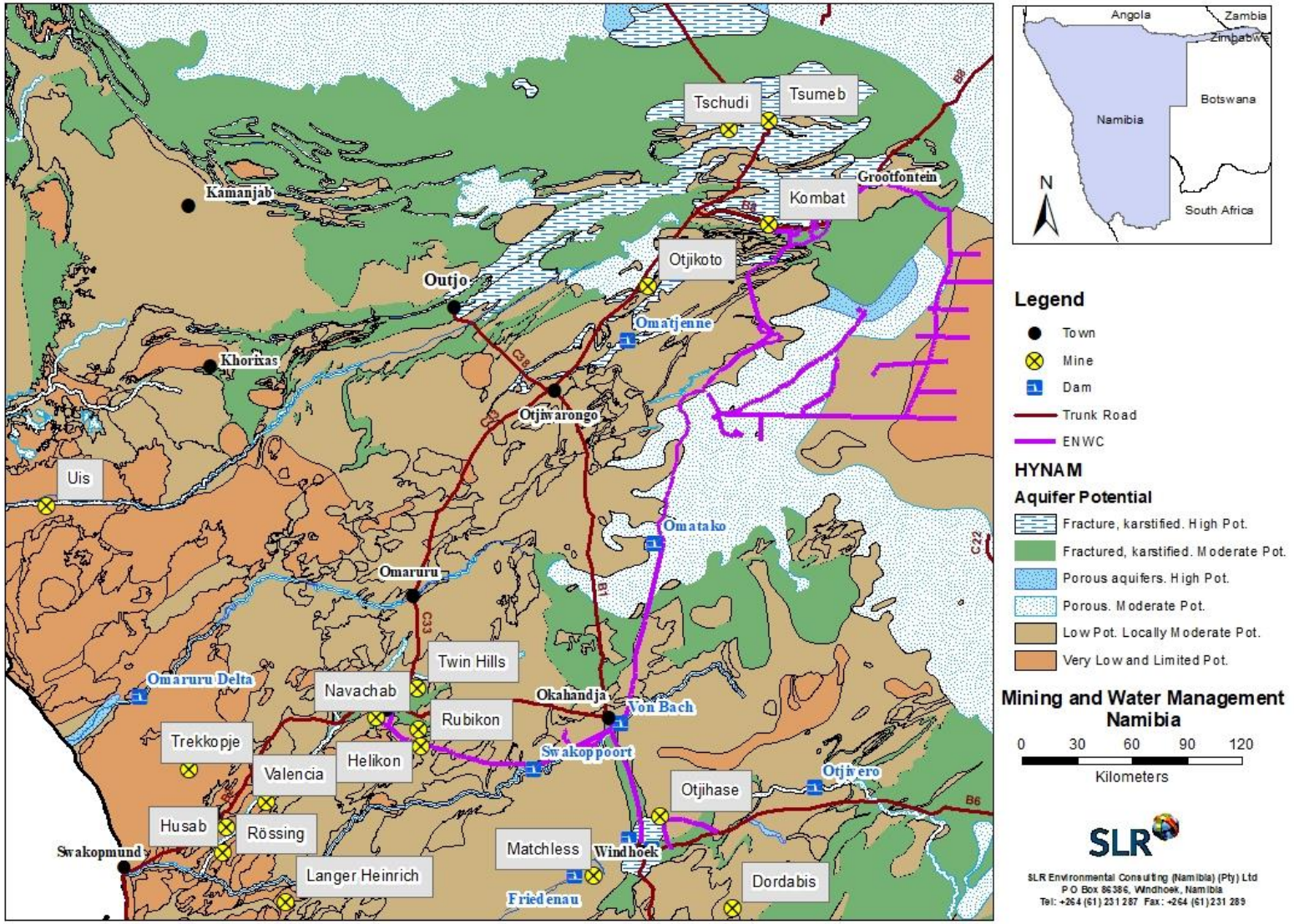
Most of Namibia falls within the summer rainfall region with the main precipitation in the months of January to March. The average precipitation varies between less than 50 mm per year in the southwestern parts and 700 mm in the eastern Zambesi Region, while the mean gross evaporation ranges between 2 500 and 3 800 mm per year.

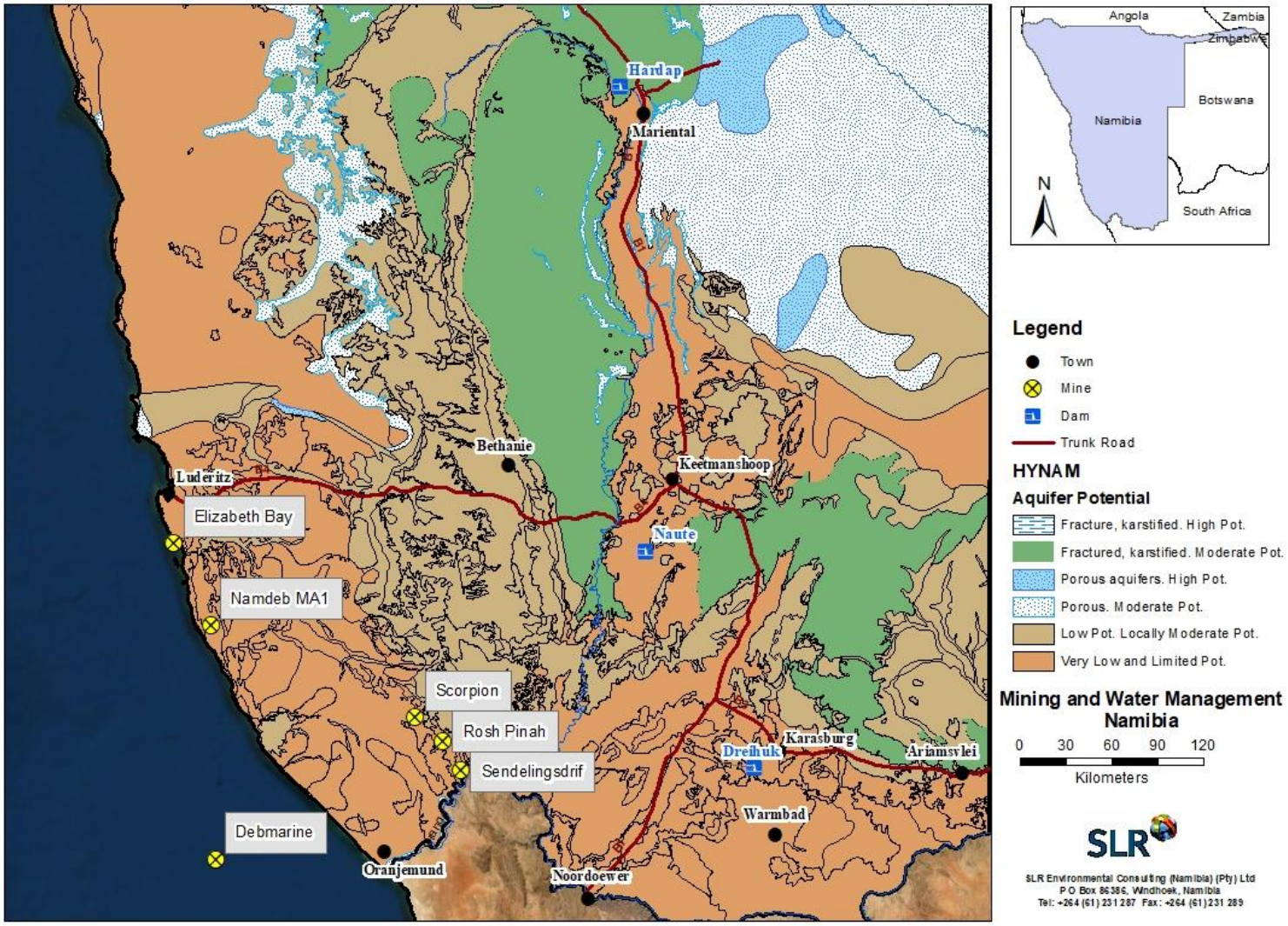
Given these circumstances, it is not surprising that most of the country depends heavily on groundwater resources. There are an estimated 40 000 producing boreholes in Namibia. Numerous small farm dams augment the boreholes, at least for part of the year, and assist in groundwater recharge.

On the basis of geological structure and groundwater flow, Namibia can be subdivided into twelve hydrogeological regions or groundwater basins. These are the Zambesi Basin, the Okavango-Epukiro Basin, the Cuvelai-Etosha Basin, the Otavi Mountainland Karst Aquifer, the northern Namib-Kaokoveld Basin, the Brandberg-Waterberg Area, the Central Namib-Windhoek Area, the Hochfeld-Dordabis-Gobabis Area, the Stampriet Artesian Basin, the Fish River-Aroab Area, the Southern Namib and Naukluft Area, and the Karas Basement.

Grootfontein, Tsumeb, Outjo, Omaruru and Windhoek operate their own water schemes, with Windhoek also being supplied by Namwater from the Von Bach, Swakoppoort and Omatako Dams, as well as via the Eastern National Water Carrier. In addition, Windhoek's water reclamation plant contributes substantial amounts of water to the city's demands. In the other parts of the country, Namwater is responsible for the bulk water supply to schemes such as the Central Namib Water Scheme, which includes a number of large consumers such as the municipalities of Swakopmund, Walvis Bay and Henties Bay, and the mines in the area. This scheme is notably supported by the privately owned Erongo Desalination Plant since 2013.

The maps below show the mine locations in relation to aquifer potential and surface water sources.




Hardap
Mariental
Bethanie
Keetmanshoop
Luderitz
Elizabeth Bay
Naute
Namdeb MA1
Scorpion
Rosh Pinah
Sendelingsdrif
Karasburg
Dreihuk
Ariamsvlei
Warmbad
Debmarine
Oranjemund
Noordoewer
Angola
Zambia
Zimbabwe
Botswana
Namibia
South Africa
N
Legend
Town
Mine
Dam
Trunk Road
HYNAM
Aquifer Potential
Fracture, karstified. High Pot.
Fractured, karstified. Moderate Pot.
Porous aquifers. High Pot.
Porous. Moderate Pot.
Low Pot. Locally Moderate Pot.
Very Low and Limited Pot.
Mining and Water Management
Namibia
0 30 60 90 120
Kilometers
SLR
SLR Environmental Consulting (Namibia) (Pty) Ltd
P O Box 86386, Windhoek, Namibia
Tel: +264 (61) 231 287 Fax: +264 (61) 231 289

2. Water management by commodity

2.1 Uranium

2.1.1 Rössing

- The Rössing Uranium Mine is situated some 60 km northeast of Swakopmund and operated by majority shareholder CNNC.
- Rössing requires 3 million m^3 of fresh water annually. Abstraction permit for Khan, but not fully utilized, only used for dust suppression because of salinity. Recycling 55%.
- The mine samples and monitors more than 20 monitoring boreholes in the mining license area and in the Khan River on a regular basis (inhouse). Results are report to the authorities.
- Groundwater samples are analysed by specialist laboratories in Namibia and South Africa for metals (including uranium), major ions and radionuclides.

2.1.2 Swakop Uranium

- Swakop Uranium's Husab Mine is situated in the Namib Naukluft National Park directly southwest of Rössing, and is operated by CGNPC.
- Swakop Uranium's Husab Mine requires 9.6 million m^3 of fresh water annually. Abstraction permit for Swakop River production boreholes, but not utilised because only used during construction phase.
- More than 60 monitoring boreholes within the mining license area and in the Khan and Swakop rivers are regularly monitored, and results reported to the regulators.
- Groundwater samples are analysed by specialist laboratories in Namibia, South Africa, and Germany for metals (including uranium), major ions and radionuclides.

2.1.3 Langer Heinrich

- The Langer Heinrich Mine lies some 80 km east of Walvis Bay in the Namib Naukluft National Park, and is operated by majority shareholder Paladin Resources. It has been under Care and Maintenance since 2018, but a decision to restart the mine has been taken recently.
- Langer Heinrich will require 2.2 million m^3 of fresh water annually, supplied via 80km long pipeline from Swakopmund (desalinated water from ORANO plant), and also from the Swakop River borehole scheme, connected to the mine via a 15 km long HDPE pipeline. The two water sources are blended because of the high salinity of the Swakop River water, and then fed into an on-site desal plant and purified to the processing requirements.
- The abstraction permit for the Swakop River was extended by the DWA in 2020 for the volume of 0.5 Mio m^3/annum. The groundwater is abstracted from two production boreholes tapping the Swakop River alluvium.

- Currently, while under Care and Maintenance, the mine samples 18 monitoring boreholes quarterly and monitors water levels in 33 boreholes monthly on the mine site and in the Swakop River.
- Groundwater samples are analysed by specialist laboratories in Namibia, South Africa, and Germany for metals (including uranium), major ions and radionuclides.

2.1.4 Trekkopje and the Erongo Desalination Plant

- The Trekkopje Mine 70 km northeast of Swakopmund was in operation only from 2012 to 2013, and is currently under care and maintenance.
- During the operational phase water required for the mine was supplied by the purpose built Erongo desalination plant, to which the mine is linked by a dedicated pipeline, and which is an asset belonging to the owner of the mine.
- Should the mine re-open, it will require 8 million m^3 annually, which will once again be supplied by the desalination plant.
- The Erongo Desalination Plant is located 35 km north of Swakopmund, near the settlement of Wlotzkasbaken in the Namib Desert.
- It is the largest reverse osmosis seawater desalination plant in Sothern Africa.
- The desalination plant was originally built to supply water to the Trekkopje Uranium Mine of Orano Mining Namibia, and was inaugurated in 2010. Following the downturn of the uranium market, the mine was placed under care and maintenance, so that the water was no longer required until such time that the mine re-opens.
- An agreement was reached with the Namibian national water utility Namwater to use the potable water produced at the plant to augment the supply to the coastal region.
- Today the desalination plant does not only supply the local municipalities, but also via Namwater other mines, such as Rössing and Husab.
- The seawater desalination process consists of screen filtration, ultrafiltration, reverse osmosis, limestone re-mineralisation, and chloration.
- The first step in the intake of seawater through a pipeline anchored 1 000 m of the coast, at a depth of 10 m. At the intake, a 40 mm diameter screen keeps out aquatic fauna and flora.
- The water is then disinfected and passes through screens that eliminate micro-organisms and particles larger than 60 µm in diameter, followed by ultrafiltration, which removes all remaining particles so that only salt remains in the clear water.
- The next step is reverse osmosis, which separates the water into two streams, namely pure water and a brine stream that is returned to the ocean. The reverse osmosis process forces the water through semi-permeable membranes under high pressure. These membranes allow only water molecules to pass through, thus producing potable fresh water, while the salt remains in the brine.
- After the reverse osmosis step the brine is still at very high pressure. The pressure is exchanged with the fresh incoming seawater, directly recovering 98% of the energy that would otherwise be lost, and reducing the plant's electricity consumption by approximately 40%.
- In 2021, the Erongo Desalination Plant has set a new record by producing 12.7 million m^3 of fresh water.
- Cumulative production since 2013 has now reached more than 75 million m^3.

2.1.5 Zhonghe Resources

- Zhonghe Resources holds a mining license and a number of exploration licenses to the northeast of Rössing.
- Zhonghe Resources is still in the exploration phase and no future water requirements have been calculated.

2.1.6 Valencia

- Valencia holds a mining licence some 80 km northeast of Swakopmund.
- The Valencia deposit has a JORC compliant ore reserve and is construction ready, once the uranium price has reached the required level.
- Once going into production, Valencia will require 3 million m^3 of fresh water annually.

2.1.7 Bannerman

- Bannerman Resources owns an advanced exploration project 30 km southeast of Swakopmund, with a Definitive Feasibility Study expected to be complete by Q3 of 2022.
- Once going into production, Bannerman will require 2 million m^3 of fresh water annually.

2.1.8 Reptile

- Reptile Mineral Resources and Exploration is an advanced stage exploration company and owns the Tumas project for which a Mining Licence has been applied for.
- Once going into production, the Tumas project will require 2 million m^3 of fresh water annually.

2.1.9 Elevate Uranium

- Elevate Uranium owns large tenements in the Namib Naukluft National Park, and holds the Marenica project to the northeast of Trekkopje Mine under a Mineral Deposit Retention License.
- Elevate Uranium is still in the exploration phase for their tenements in the park, and no future water requirements have been calculated for these.
- Once the Marencia project goes into production, it will require 3 million m^3 of fresh water annually.

2.2 Copper

Namibian copper mines are located in the Otavi Mountainland (OML) of north-central Namibia (Tsumeb, Kombat and others) and in the Khomas Hochland along the Matchless

Belt (MB) (Otjihase and Matchless mines). The OML mines source their water from local groundwater, while the MB mines have to import water via pipeline from surface dams.

2.2.1 Tsumeb (Dundee Precious Metals Smelter)

- The Dundee Precious Metals Copper Smelter is located in the town of Tsumeb.
- The smelter has a water demand of approximately 1.3 Mio m^3/annum.
- A small volume of potable water is also required for drinking and lavatory purposes.
- Groundwater is abstracted from the No. 1 Shaft within the DPMT premises.
- Drinking water is supplied to site via Tsumeb Town reticulation. Tsumeb Town has its own production borehole on the western outskirts, intersecting the Tsumeb Subgroup dolomite aquifer.
- In 2020, SLR Environmental Consulting (Namibia) (Pty) Limited (SLR) was appointed by DPMT to firstly update the existing 3D groundwater flow model to simulate sustainable abstraction from Shaft No. 1 to support permitted groundwater abstraction, and secondly to extend the transport model solution to a reactive transport solution to estimate a more realistic plume extension around the DPMT operations.
- In 2020, a groundwater abstraction permit was issued by the DWA based on the results of the above-mentioned groundwater model by SLR.
- A number of monitoring were drilled by DPMT over the years with the main purpose of monitoring groundwater pollution emanating from various sources within the smelter area.

2.2.2 Tschudi

- Tschudi Copper Mine is located west of Tsumeb in the Otavi Mountainland (Oshikoto Region) and is owned by Weatherly International PLC.
- During operation, make up water is required for processing (heap leach process), mining, domestic purposes, and dust suppression. Water demand is approximately 2 710 m^3/day or approximately 1 Mio m^3/annum.
- The water demand was met from local groundwater inflow into the open cast pit. The mine experienced difficulties due to excessive groundwater inflow from the karstified and fractured Hüttenberg Formation and had to interrupt operations for some months to get the groundwater inflow under control.
- The Department of Water Affairs, Ministry of Agriculture, Water and Land Reform (DWA) issued a groundwater abstraction/discharge permit to the mine for the purpose of dealing with excess water from inflow into the pit. The water was pumped via pipeline to a dam downgradient of the mine and then infiltrated into a karst sink hole outside the groundwater catchment of the mine.
- DWA approved the operation after the mine hydrogeologist could show that stakeholders and the environment were not negatively affected by the dewatering.
- The mine is currently under care and maintenance, and the pit it is filled up with groundwater forming a lake.
- During operation groundwater monitoring was carried out quarterly at four on-site monitoring boreholes and four farm boreholes.

- Samples were taken by a consultant with a sampling pump and analysed by specialist laboratories in Namibia and South Africa for metals and major ions.
- Groundwater monitoring is currently on hold.

2.2.3 Kombat

- The Kombat Mine is located in the Otavi Valley some 37 km east of Otavi, and operated by Trigon Mining.
- Kombat Mine is the only mine in Namibia that has been developed in the early 20th century and that is still operating, albeit intermittently.
- Ownership has changed over the years and mining was interrupted for longer periods due to economic reasons and in connection with water management, such as for example a catastrophic groundwater inflow into the mine workings.
- There is currently only a small open cast mine, and operations have once more been suspended as from 01/08/2022 because of the low copper price.
- The current water demand of approximately 0.5 Mio m^3/annum is met by local groundwater resources.
- NamWater has drilled four production boreholes into the mine working near Shaft No. 1 and abstracts up to 4.5 Mio m^3/annum of groundwater to supply water to the central area of Namibia in times of water shortage due to drought conditions.
- Water for the mine and also for the town of Kombat is drawn from the two shafts in the current mining area.
- The high yielding dolomitic aquifer of the Otavi Mountainland is intersected by the underground mine workings and when the mine was in full operation to mining depths of up to 800m, large volumes (up to 3000 m^3/h) had to be abstracted and discharged to surface dams to be able to keep the mine dry.
- In 2018, SLR Environmental Consulting (Namibia) (Pty) Limited (SLR) was appointed by NamWater to develop a 3D groundwater flow model in FEFLOW to simulate sustainable abstraction from the four production boreholes and to supply groundwater to the CAN via north-eastern water carrier.
- Both, Kombat Mine and NamWater, using the same source, have been granted abstraction permits from DWA, which are to be renewed every two years.
- Groundwater levels and abstraction have to be monitored on quarterly and monthly basis, respectively and the data has to be submitted to DWA for review.
- DWA visits a number of monitoring boreholes on a regular basis and measures water levels manually. The DWA monitoring boreholes were installed prior to independence, installed with recorders, but often not properly maintained.
- NamWater records water levels of their production boreholes and takes water samples on a regular basis but does not have own monitoring bores.
- A groundwater monitoring plan was developed for Kombat Mine as part of an EIA carried put in 2016 and approximately 15 monitoring boreholes on site, but also on surrounding farms, were selected and monitored.

2.2.4 Otjihase

- The Otjihase underground mine is located some 40km northeast of Windhoek and has been in operation intermittently since Independence.
- The Otjihase Mine is currently under Care and Maintenance.
- The underlying meta-sediments of the Kuiseb Formation (Damara Supergroup) have a low to medium groundwater potential and borehole yields are not sufficient to meet the water demand of a larger mine.
- Water is supplied by NamWater via pipeline from the von Sartorius von Bach Dam of the Windhoek water scheme.
- The pipeline to Otjihase extends further east to the international airport and supplies agricultural projects en route (e.g. Neudamm college) as well.
- During Care and Maintenance very little water is consumed and no abstraction permit is required.
- As one of the mines developed prior to independence, groundwater monitoring has been limited.
- There are concerns of stakeholders in the catchment area that groundwater and surface water downstream of the mine might be polluted due to seepage from the tailings dam containing high concentrations of sulphates and metals.
- Acid Mine Drainage (AMD) and Acid Rock Drainage (ARD) are a concern due to sulphides mined and reduced acid buffering capacity of the country rock.

2.2.5 Matchless

- The Matchless Mine is situated in the Khomas Hochland to the west of Windhoek.
- Currently, the mine is under Care and Maintenance.
- The Friedenau Dam in the upper catchment of the Kuiseb River was built to supply the mine with water. The scheme, operated by NamWater, is still in operation but currently only small volumes are supplied to the mine.
- Farmers in the surroundings benefit from the dam water.
- The underlying meta-sediments of the Kuiseb Formation (Damara Supergroup) have a low to medium groundwater potential and borehole yields are not sufficient to meet the water demand of a larger mine.
- During Care and Maintenance very little water is consumed and no abstraction permit is required.
- There is no known groundwater monitoring taking place at the mine.
- Acid Mine Drainage is an issue of concern observed at the mine.

2.3 Lead-Zinc

2.3.1 Rosh Pinah

- The Rosh Pinah mine is situated in the Karas Region, 165 km south of Aus, which is 125km east of Lüderitz, approximately 23 km north of the Orange River, and operated by Trevali.
- The mine is situated on state-owned land which borders with privately owned farms.
- The current total water need at Rosh Pinah is 1 653 574 m^3/month. This does not include the demand for the proposed upgrade of the mine.
- The total amount is split between a number of demand units, namely mining (38 979 m^3), plant (39 307 m^3), drinking water (4 410 m^3), and golf course (1 217 m^3).
- The water for dust suppression is abstracted from a dam. On average, the rate for road dust suppression is 1 978 m^3/month, and for tailings dust suppression 1 655 m^3/month.
- Raw water supply for use in the mine, processing plant, and as potable water is from the Namwater Supply Scheme which abstracts water from the Orange River.
- A Water discharge and effluent permit (No. 658) was granted by the Department of Agriculture, Water and Forestry, and is valid until 31 January 2025.
- A 3-dimensional numerical groundwater model was constructed and run for the Rosh Pinah Mine, to simulate
    - Passive groundwater inflows into the underground mine as mining is progressing,
    - Development of a cone of drawdown because of underground mining,
    - Development and migration of a possible contaminant plume from the TSF.
- 15 monitoring water boreholes within and around the mine facilities and the Tailings Storage Facility have been drilled. The monitoring system is in place since 1997, and all monitoring boreholes are sampled quarterly and analysed by NamWater in Windhoek. Samples are analysed for zinc, lead, copper, arsenic, cadmium, and cyanide. The groundwater quality is reported in comparison with the 'Requirements for the purification of wastewater effluent' – General Standards, Water Act of 1956 (Act 54 of 1956).
- Water levels are very constant in the region, staying within 40 to 60m below surface for all measured boreholes. Water depths in the boreholes are taken every 2 weeks.

2.3.2 Skorpion

- Skorpion Zinc Mine is located some 20km northwest of Rosh Pinah, and operated by Vedanta.
- The project is currently under Care and Maintenance, but there are plans to re-open the mine soon.
- The water demand is assumed to be similar to Rosh Pinah mine although Skorpion is open cast and not underground like Rosh Pinah.
- Water is supplied via an existing pipeline from the Orange River, operated by NamWater. The water is treated to drinking water standard.

2.4 Gold

Namibia currently has two operating gold mines at Karibib and close to Otjiwarongo. A third one is under construction near Omaruru.

2.4.1 Navachab

- The Navachab Gold mine located approximately 14km south-west from Karibib and has been in operation since 1989. QKR Namibia (Pty) Ltd are the owners after taking over the mine from Anglo Gold Ashanti in 2015.
- Approximately 1 Mio m^3/annum are supplied to the mine via a pipeline from the Swakoppoort Dam.
- The NamWater operated Swakoppoort water scheme is the sole source of water.
- Navachab has a 20 year offtake agreement with NamWater, which was signed in 2018. The relevant DWA permit is in place.
- A dewatering borehole (DW22) on site is used to recycle seepage water from the tailings dam, reducing the inflow of polluted water into the mine pit.
- The mine operates 10 monitoring boreholes in the mining area and downstream. Groundwater samples are taken on a regular basis by mine staff. Analysis parameters include major ions and metals, and a database is maintained by the mine.

2.4.2 Otjikoto

- The Otjikoto Gold Mine, situated approximately half-way between the towns Otavi and Otjiwarongo in the Otjozondjupa Region, is owned and operated by B2Gold Namibia (Pty) Ltd.
- The water demand is approximately 2 Mio m^3/annum for processing, mining and dust suppression purposes.
- The only water source is groundwater from dedicated production boreholes tapping the Karibib Formation marble, and from boreholes dewatering the open cast and mine pits and the underground workings situated in Okonguarri Formation meta-sediments.
- The mine produces surplus water that has to be discharged into the environment. Currently there are investigations planned to artificially recharge the Karibib marble aquifer with the surplus water from the mine dewatering.
- Abstraction permit No. 10971 was initially issued by DWA in 2013, and is renewed every two years.
- A groundwater model was developed to predict the impact of abstraction on other groundwater users and to predict possible pathways of pollution plumes emanating from various sources in the mining area.
- The model supported the abstraction permit application to DWA and the initial Environmental Clearance Certificate and mining licence application with the Ministry of Environment and the Ministry of Mines and Energy, respectively.
- The groundwater model was updated a number of times over the years.
- In 2014 the permitted abstraction volume was increased to 2 Mio m^3/annum.

- Regular groundwater monitoring has been carried out since 2012 after the mine went into operation.
- In 2014, 29 monitoring boreholes located within the mining licence area were sampled and monitored on quarterly basis, using sampling pump.
- The samples were analysed for major ions and metals by specialist laboratories in Namibia and South Africa.
- The number of monitoring borehole has since increased as mining progressed from the Otjikoto pit into the northern Wolfshaag pit and later underground.
- Regional groundwater monitoring on 15 farms surrounding the mine is carried out annually.
- In total 40 boreholes are sampled and or monitored and analysis for metals and major ions is carried out in specialised laboratories in Windhoek and South Africa.
- The number of farms and regional monitoring boreholes has increased since.

2.4.3 Twin Hills

- The Twin Hills project is located about 20km north of the town of Karibib in the Erongo Region and owned by Osino Gold Exploration (Pty) Ltd..
- The project is currently still in the development and exploration phase and the water demand is low. Once in operation the water demand for processing, mining and dust suppression will be approximately 1.8 Mio m^3/annum.
- Water supply studies are still under way and one of the most important local sources is the Karibib marble syncline within which the mine is located.
- A number of potential production boreholes were drilled into fractured marbles, showing partly high yields between 20 and 40 m^3/h.
- Another project currently carried out is the construction of a sand storage – surface water and artificial recharge dam in the nearby Khan River.
- A third option is water supply via pipeline from the Karibib- Swakoppoort pipeline operated by NamWater. Negotiations between the parties are currently conducted.
- Osino Gold has obtained a groundwater abstraction permit no. 11553 from DWA in February 2021. The permit is valid for two years and allows the abstraction of groundwater from one borehole for domestic and exploration purposes. The allowed maximum abstraction is 14 600m^3/annum.
- Groundwater monitoring is carried out only at selected boreholes on neighbouring farms. No monitoring plan has been implemented yet.

2.5 Diamonds

2.5.1 Namdeb MA1

- Potable water is supplied to MA1 from Oranjemund Town, which in turn extracts the water from the Orange River aquifer by means of a series of boreholes.
- All MA1 operations, including mining and metallurgical processing, utilise sea water during their activities, for which an abstraction permit is in place.

2.5.2 Sendelingsdrif

- The Sendelingsdrif Mine is located along the Orange River approximately 80 km inland from Oranjemund and 20 km south of Rosh Pinah.
- Process water is abstracted from the Orange River and pumped to a reservoir near the treatment plant.
- An abstraction permit for up to 104 000 m^3 per month is in place.
- Since 2017, the plant has managed to recycle on average 90% of its water.
- Through this recycling effort, the actual abstraction is only approximately 8% of the permitted volume.

2.5.3 Elizabeth Bay

- The Elizabeth Bay mine is located some 25 km south of Lüderitzbucht.
- Plant utilises sea water for process water, and an abstraction permit is in place.
- However, there is currently limited abstraction since the plant is on care and maintenance for upgrading before full production will be resumed by September 2022.
- The mine currently repositioned its seawater intake to dewater a flooded mining area, and will thereqafter commission a planned new intake on the peninsula north of the mine. This intake has been designed and will be constructed towards the end of the year.
- For drinking water the mine is linked to the Koichab Pan water line which also supplies Lüderitzbuch, and the water of which gravitates down to Elizabeth Bay. Water tests are done on a periodic basis.

2.5.4 Debmarine Namibia

- Debmarine Namibia operates the large offshore license area Atlantic 1 to the west of Namdeb's Minig Area 1. A fleet of six production vessels and a dedicated exploration vessel as well as a sampling vessel mine and explore the sea floor at water depths of up to 140 m.
- All vessels are equipped with desalination plants to produce drinking water from sea water for human consumption.
- The processing plants on board the ship all work with sea water.

2.6 Tin

2.6.1 Uis

- The Uis Tin Mine is located some 28 km east of the Brandberg.
- Fresh water is supplied to the mine from a number of boreholes, which belong to the mine.
- The mine has abstraction permits in place for 78 000 m^3 annually.
- 95% of the fresh water used is recycled.

2.7 Lithium

2.7.1 Rubikon + Helikon

- The Rubikon and Helikon open cast Mines are located to the south of Karibib, and operated by Lepidico.
- A permit for the annual abstraction of up to approximately 210,000m^3 of groundwater from four boreholes within the Company's licence area was granted in 2017.
- Water intensity for the operation during the first five years of production is estimated to be 15l/kg of lithium hydroxide, rising to 25l/kg following the planned concentrator expansion.

2.8 Iron

2.8.1 Dordabis

- The Lodestone Iron Mine is located near Dordabis, some 60 km southeast of Windhoek, and operated by Lodestone Namibia.
- Potable water for personnel and minor site use is sourced from three registered boreholes on Farm Tsatsachas within the mining license area.
- The boreholes tap the underlying fractured hard rock aquifer adjacent to the Skaap River.
- There are several hydrological studies from SLR on this subject.
- The water demand of the current operation, which is surface mining, is approximately 40,000 m^3/annum.
- The DWA issued abstraction permit no. 11264 in April 2021 for 43 800 m^3 per annum.
- Phase A (2 million t per year mill feed) requires approximately 0.75 million m^3 of raw input water per year. This will be sourced from grey/semi purified water from the City of Windhoek Waste Water Treatment Plant, which can supply a maximum of 1.5 million m^3 of semi purified water to Lodestone.
- Phase B (6.25 million t per year Mill Feed) requires approximately 2.2 million m^3 of water per year. This will be sourced from Oanob Dam via a 110 km long pipeline.
- The Oanab Dam has an independent assured yield report which ensures that there are at least 5 million m^3 of assured yield over 20 years.
- Phase C (25 million t per year Mill Feed) requires approximately 14 million m^3 of water per year. This will be sourced from desalination from the coast. The 10 million t of product will also be piped down to Walvis Bay, so the backleg pipe will carry desalinated water.
- The Lodestone Iron Mine samples and monitors eight boreholes within the mining licence area on a quarterly basis. Samples are analysed for major ions and metals.
- Seven regional boreholes are sampled/monitored bi-annual on five neighbouring farms. The samples form these monitoring boreholes are also analysed for metals and major ions.