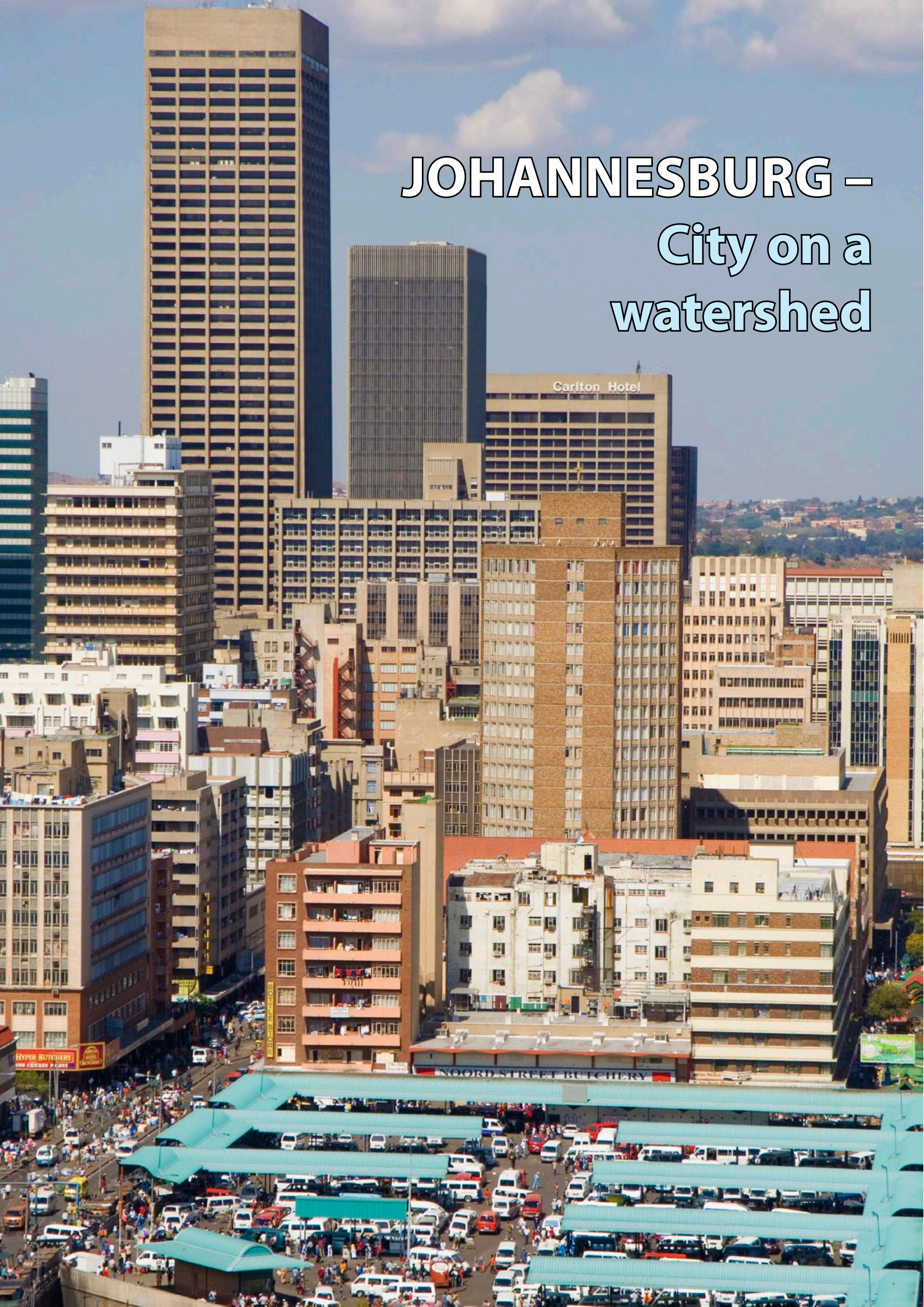

JOHANNESBURG – City on a watershed

Johannesburg's location is both its gift and its curse – close to the gold, but far from water. Article by Petro Kotzé.

Johannesburg's location is both its gift and its curse. On the one hand, the gold-bearing reef that is the reason for its existence has shaped it into the economic heartland of the country. On the other hand, it is one of the few cities in the world not located close to one of the most important resources necessary to sustain its growth: water.

Indeed, where other major cities in the world have developed close to rivers, seas or other water sources, the Witwatersrand metropolitan area has been described as one of the largest concentrations of people so far away from one. The nearest river of any significance, the Vaal, is about 70 km away.

Since gold was discovered on the Rand in 1886, the once dusty mining town has grown into a metropolis that houses a quarter of South Africa's population and is responsible for about 10% of the continent's economic activity. As the city has grown in size, however, so has its thirst for water, with formidable consequences for its bulk water supplier – Rand Water, established in 1903. Today, the bulk of the water supply is pumped from the Lesotho Highlands, through a system of interconnected water sources, pumps, valves, pump stations, purification plants, pipelines of various diameters and reservoirs.

This growth has put increasing pressure on both the quantity and quality of water available while, according to Rand Water, the increasing volume of people in need of water and sanitation services is a mounting concern. Looming mining applications in the catchment of the Vaal Dam and the possible effects of climate change add further force behind future water supply problems. This puts the City of Gold in a precarious position, not only located on a physical watershed, but according to some, also a metaphorical one – changing from a water-secure to a possibly water insecure city.

SMALL BEGINNINGS

Johannesburg is situated on a divide between the Vaal River catchment (the Vaal itself being a tributary of the Orange River) and the Limpopo River catchment. On one side, water runs down the Vaal and the Orange towards the Atlantic, while on the other side water drains towards the Indian Ocean via the Limpopo River system.

The city straddles this major watershed, known as the Witwatersrand, and the discovery of gold in the conglomerates (sedimentary rock consisting of peddles and sand grains cemented together) underlying the area during the 1880s was the catalyst for its development. The area was named after the pristine springs and small streams that occurred along a ridge some 380 m above the surrounding country, in the southern parts of Gauteng, striking westward in the North West province. It refers to an area stretching between Springs in the east and the Krugersdorp/Randfontein area in the west, a distance of about 90 km. Shortly after gold was discovered, a conglomerate of camps and shanties sprang up to house the thousands of people seeking their fortune.

Originally, water was drawn from the Fordsburgspruit, as well as from a spring at the eastern end of Commissioner Street, near the present day End Street, called Natalspruit. Another water point was a spring at the site of the present Johannesburg general hospital in Parktown. With the expansion of mining activities, industrial development, pollution and population growth, the demand for potable water grew. Soon, the rivulets and boreholes were inadequate sources of supply. Eventually, the need arose to bring water from the Vaal River.

The Vaal River scheme (1914-1924) was to be developed in phases. The first phase would involve the construction of the Vaal Barrage, a purification and pumping works at Vereeniging (1924), a pipeline to Zwartkoppjes Pumping Station, and pipelines to Village Main Reef and elsewhere in the distribution system. The Barrage, deriving water from the Vaal River and the four tributaries, would be capable of yielding 91 Mℓ/day. The Vaal Dam was completed in 1938 (with a yield of 354 Mℓ/day) followed by the Zuikerbosch pump station in 1949.

The first inter-basin transfer from a river basin outside the normal

The Vaal Dam, constructed in the 1930s, remains the centre of Rand Water's supply infrastructure.

Lani van Vuuren

Chris Kirchhoff-mediaclubsouthafrica.com

Courtesy Rand Water

Today Rand Water supplies water through about 3 056 km of pipeline into 58 reservoirs.

catchment of the Vaal system was announced in 1970. The plan was to supplement water using the Thukela River in KwaZulu-Natal by pumping water over the Drakensberg into the Vaal River catchment and other inter-catchment transfers (the Thukela-Vaal Augmentation Scheme).

Currently, the bulk of Rand Water's water supply comes from the Lesotho Highlands. The scheme was designed to deliver some 2,2 x10^9 of water annually to South Africa, and the first water flowed into the Vaal Dam via the Ash River outfall on 8 January 1998.

INTRICATE SYSTEM

From small beginnings in 1905, satisfying an annual daily consumption of water of about 11 Mℓ/day, Rand Water today operates a massive water supply system. Of course, the water utility's operations have expanded way beyond Johannesburg – as far as Rustenburg in the west and Groblersdal in the east.

Water is abstracted from the Vaal Dam and treated at the Vereeniging and Zuikerbosch Purification and Primary pump stations. It is then pumped at a head of about 180 to 360 m to the main booster pump station, Zwartkopjes and its three satellite booster pump stations, Palmiet, Eikenhof and Mapleton.

Each booster pump station then elevates the water a further 180 m to 360 m to reservoirs in and around Johannesburg. From these areas the water flows under gravity and is re-pumped at distribution stations to the extreme boundaries of the supply area.

The water is supplied through about 3 056 km of pipeline into 58 reservoirs (two-thirds of the value of this infrastructure, estimated to be worth R30-billion, lies underground in pipelines). Water is then delivered in bulk from the reservoirs to Rand Water's customers.

In the early days, mining activities gulped up most of the water. This has evolved over the decades, in tune with the changing face of Gauteng, and it is believed that about 70% of the water is now supplied to urban domestic consumers. Thus, demand growth is now closely linked to population growth rates, with economic growth playing a secondary role.

According to information supplied by Karl Lubout, water quality specialist at Rand Water, even though Rand Water's current catchment area largely comprises rural agricultural area the towns in the catchment are growing rapidly. However, proper infrastructure is lagging behind and the volume of people in need of proper water and sanitation services exceeds the service delivery capacity. "The lack of proper sanitation services in our catchment area, especially, is of great concern to us," says Lubout.

With regards to the impact of acid mine drainage, Lubout indicates that it does not currently have an influence of Rand Water's service delivery. Of more concern is the current number of mining applications around the Vaal Dam area. "If these applications are approved it will certainly have a negative impact on the quality of our raw water."

Population and economic growth rates are not the only factors influencing the future of Rand Water's

water supply, broader scale global influences, such as global warming, are also at play.

CLIMATE CHANGE

With regards to the effects of climate change, in general, the overall burden on the country will be disaster management costs, says Francois van Wyk, water quality expert at Rand Water. As an example, he cites the floods in Mozambique in 2000 which reduced that country's annual growth rate from 8% to only 2%. "Should such incidents occur more frequently, poorer countries will suffer massive social problems. The ultimate consequence of climate change is a substantial additional burden to the country's economy, with obvious restraints on Rand Water's financial position."

The predicted increase in extreme weather events, as well as possible prolonged periods of high (maximum) demand as a result of higher temperatures, are some of the pertinent issues with regards to climate change which Rand Water will have to pay attention to. Current inter-basin transfers may become areas of political conflict, elaborates Van Wyk. "If a severe water shortage occurs in the area, Lesotho may not want to release water to South Africa, or they may want to enforce substantially increased tariffs."

Furthermore, Rand Water will have to address and optimise overall energy efficiency. Due to erratic rainfall patterns, security of supply will also be at risk. "This may imply that storage capacity needs to be increased to store more water if and when it rains, while dams and reservoirs may be empty for prolonged periods of time," causing inefficient use at high cost.

Higher temperatures will not only increase evaporation from dams (and so increase water loss), it may also lead to the occurrence of algae during periods of the year not previously experienced, resulting in increased water purification cost.

An added burden as a result of climate change could be that the Rand Water supply area can become more conducive to the transmission of waterborne diseases. "Combined with the free migration of people from northern countries, this could become a major problem," says Van Wyk. In addition to additional storage, flood attenuation measures will need to be implemented, which will also be unused during dry periods, while the possibility of severe floods could cause major damage to infrastructure.

According to Van Wyk, pressures on supply from Vaal Dam could lead to the Department of Water Affairs insisting that Rand Water use a higher proportion of water from the Vaal Barrage, where water is of an inferior quality. This will mean that water treatment plants will have to be adapted to be able to treat this water adequately.

This situation could eventually result in the Clarens pipeline becoming a reality, as no losses of water due to unlawful use (as is currently occurring) or evaporation can be afforded. The Clarens to Johannesburg pipeline would involve constructing a pipeline to gravity feed the water from the transfer tunnel outlet near Clarens northwards to Gauteng. It would include the construction of a storage dam and a new water treatment works located on relatively high ground in Gauteng.

Prof Anthony Turton, water resource management scientist, believes that Johannesburg has reached a watershed moment, and that a limited water supply would, in turn, also limit economic development. "We have reached the end of our available water supply and have arrived at a new future: that of water recycling." Prof Turton believes that the answer lies in giving scientists and researchers the freedom to explore possible solutions. ❑

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Since gold was discovered in 1886, the once dusty mining town of Johannesburg has grown into an African powerhouse.

THE UNWANTED CITY

The first piece of Johannesburg was a triangular piece of *uitvalgrond* called Randjeslaagte between the farms of Braamfontein, Doornfontein and Turffontein. *Uitvalgrond* refers to 'left-over' property between the borders of claimed farms. These automatically belonged to the state as none of the farmers laid claim to it (often because it was unsuitable for agriculture due to a lack of water). That tiny area, just big enough for a village, was to become the biggest city in South Africa within three decades.

Traces of Randjeslaagte can still be found around Johannesburg. The northern point is just off the corner of Boundary Road, Parktown, and Louis Botha Avenue, close to Clarendon Circle. A triangular monument marks the spot.

The south-eastern corner is at the intersection of Market and End Streets. The latter is so named because it marks the eastern boundary of Randjeslaagte. The eastern side of the triangle runs up the hill along Catherine Avenue (adjacent to Nugget Street) and through Hillbrow, meeting the top at the corner of Banket Street.

The south-western corner is at the intersection of Commissioner and Diagonal Streets. Just off that corner is the start of West Street (so named because it marks the west side of the triangle). West Street curves inwards and aims straight at Hillbrow's Clarendon Place, which marks the apex of the pyramid.