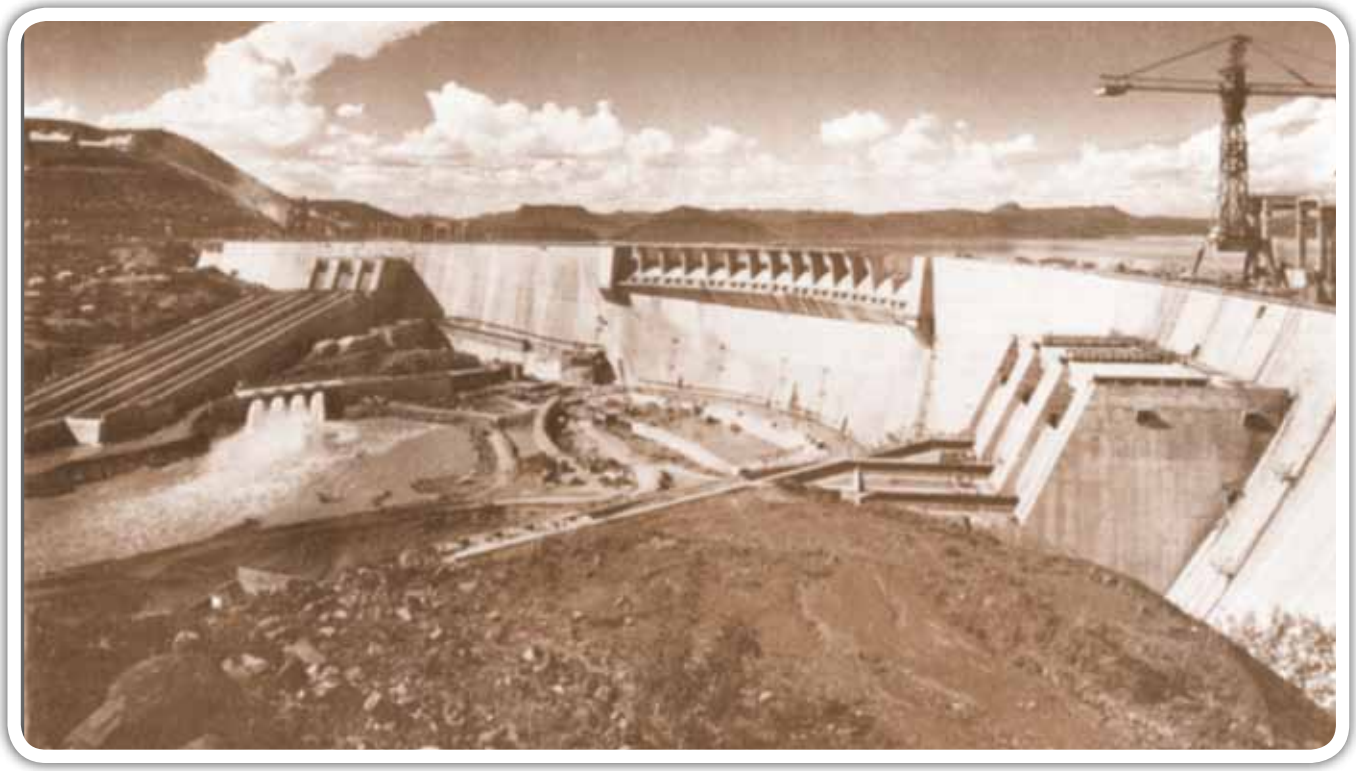
GARIEP

– The dam that tamed the Great River

On 18 November 1966, then South African Prime Minister BJ Vorster pressed a button and blasted a ton of rock into the air to signal the start of construction of the Gariep Dam on the Orange River. Lani van Vuuren looks at the history of the country's largest dam.

Engineers had studied the Orange River for potential water storage sites since the 1870s, however, until the construction of Gariep Dam (or Hendrik Verwoerd Dam as it was known before 1996) the only dam to have been constructed was Buchuberg, in the Northern Cape. At only 10,7 m high, this dam, constructed as a white poverty relief project in the 1930s, would be dwarfed by what was to become the country's largest dam.

Dr Alfred Lewis, who later became Director of the Department of Irrigation (DoI), had a personal fascination with the Orange River or



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The Gariep Dam as it looked close to completion. The dam was eventually completed in 1971.

Gariep (meaning 'Great River') as it was known to the Khoi people. In 1912, when he was a Circle Engineer with the DoI's Northern Circle (headquartered in Kimberley) he undertook a journey down to the banks of the river from Kenhardt to sea.

This journey of around 400 km took 16 days to complete. He started travelling by horse and cart, however, the extremely tough terrain took its toll on his animals, forcing him to complete much of this arduous journey by foot in temperatures of over 41°C.

Written following his ordeal, his detailed report printed in December 1912 was of such value that it served as an information source for planning for many years. In this report Dr Lewis put forward many of the thoughts behind what was to become the Orange River Project, including the whole idea of diverting part of the river's water through a long tunnel to the valleys of the Great Fish and Sundays Rivers.

Lewis' idea germinated until 1944 when field surveys and drillings were initiated, culminating in a technical report. This report was presented to Government in 1948 and proposed a project consisting of a diversion dam on the Orange River, and a diversion canal and tunnel to lead the water under the divide into the Great Fish River Valley, with a diversion into the Sundays River Valley. At that time the scheme was deemed too expensive and it was shelved only to be resurrected in the 1960s.

POLITICAL DECISION

The 1960s were a tumultuous time in the political history of South Africa. In 1960, the Pan African Congress announced a campaign to defy the National Party government's pass laws, which severely restricted the movement of black South Africans. On 21 March, a crowd turned up at the police station in Sharpeville on the eastern Witwatersrand to demonstrate. The police, jumpy after an event in Durban where nine policemen were killed, fired upon the hapless crowd and 69 people died.

The event sent shockwaves through the nation. The political turbulence that followed caused a major outflow of capital. The government countered that by imposing strict controls on the repatriation of profits. But it needed to restore

DAM STATISTICS

- **Type**: Concrete double curvature arch dam
- **Lowest foundation level**: 1 177,4 m above sea level
- **River bed level**: 1 191,7 m above sea level
- **Full water supply level**: 1 258,8 m
- **High flood level**: 1 264,9 m
- **Crest level**: 1 267,9 m
- **Maximum height above foundation level**: 90,5 m
- **Crest length of dam**: 947,9 m
- **Gross storage capacity**: 5 500-million m^3
- **Excavation**: 1,91-mllion m^3
- **Concrete poured**: 1,92-million m^3
- **Final area of lake formed by dam**: 374 km^2 (it inudates about 40 000 ha)

confidence in the country's economy. Shortly after that the announcement came that South Africa would see the construction of its biggest engineering feat yet: the Orange River Project (ORP), of which the Gariep Dam formed the main storage dam.

On 23 March 1962, Minister of Water Affairs, PMK le Roux, announced in Parliament the commencement of the construction of the ORP. During his announcement, Le Roux said that "the government has therefore decided to undertake the biggest, most important and most spectacular water supply project ever initiated in the history of our country's water affairs. Not only is it the biggest in Africa, when seen as a whole, but it will be one of the biggest projects of its kind in the world."

"In the history of all young civilised countries the time arrives when big and imaginative water development projects must be launched to promote the growth of areas of development, the formation of industries and the generation of electric power, and to create a means of coping with the future population increase, so as to maintain the rate of progress for the country as a whole. That is the principal aim of the Orange River Project," said Le Roux.

Top right: *An upstream view of the giant intake openings.*

Bottom right: *The main wall of the dam is of the double curvature concrete type, based on solid dolerite foundations. The two intake sections on either side of the river serve as abutments for the higher portions of the main arch.*

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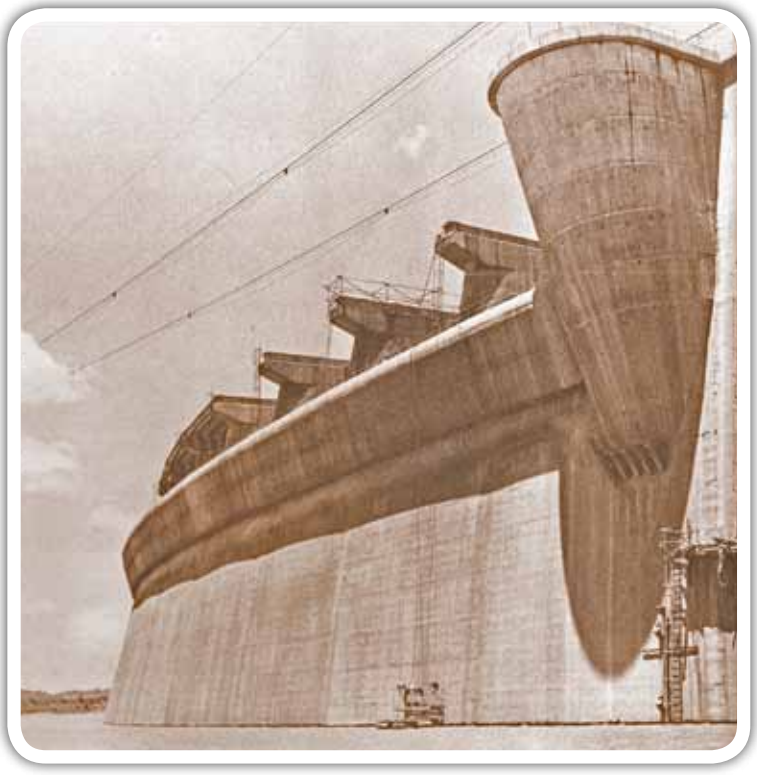

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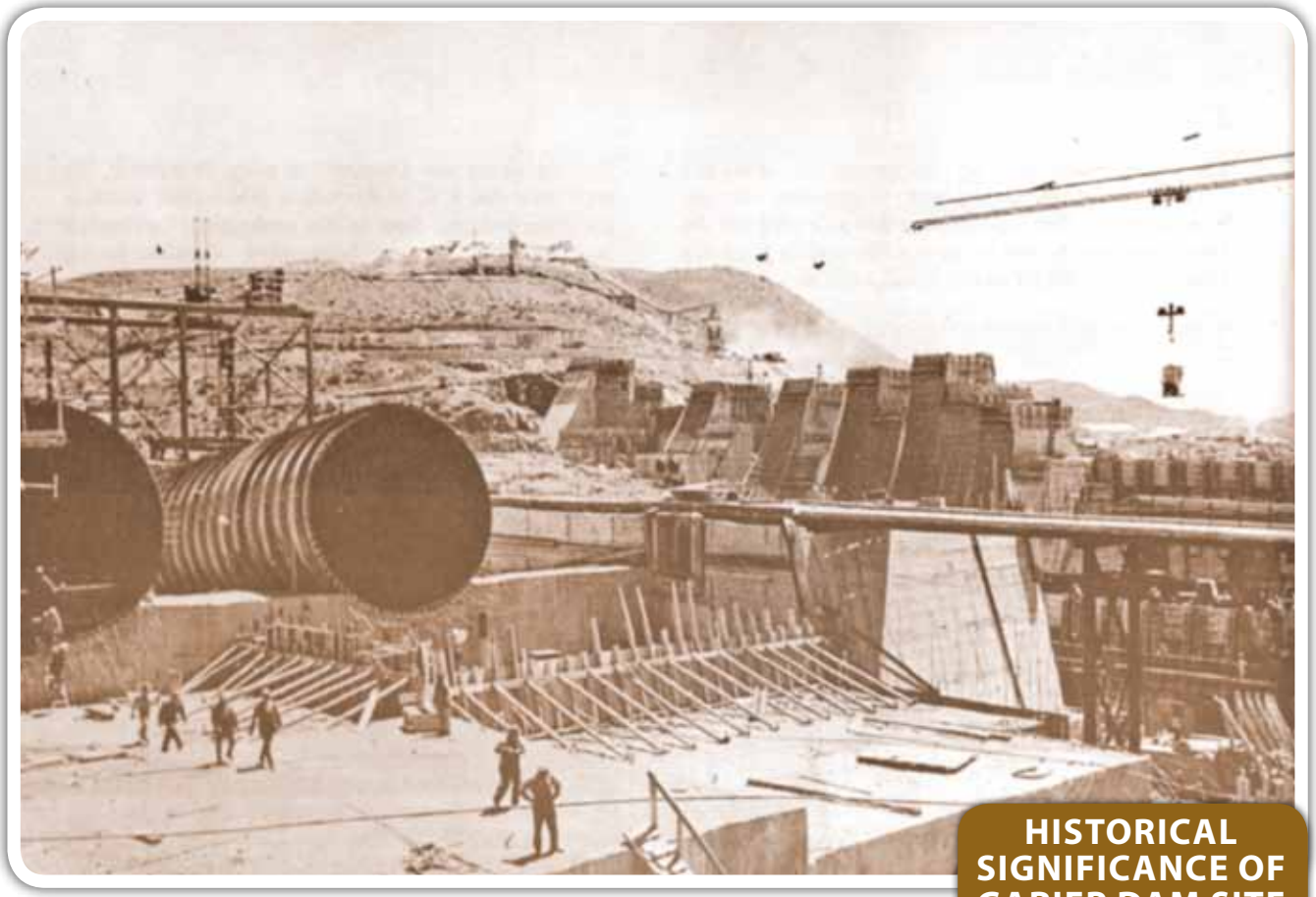
PMK le Roux

According to the government, the ORP would 'transform the desert into a paradise' by increasing land under irrigation in the country by 40%. It would also provide much-needed water for domestic and industrial purposes, while supplying additional hydropower to Eskom.

The entire project was divided into six phases to be implemented over a period of 30 years. In June 1962, Parliament authorised the expenditure of R85-million for the first phase of the project. While it included several



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The double curvature wall is effective in holding back the millions of tons of water pressing against the dam as it deflects the force of the water towards the solid rock hillside into which the gravity sections of the wall abut. The thrust of the water is so tremendous against the convex side of the wall which faces upstream, pushing against the directional flow of the river, that the wall actually gives or bends under it.

elements, in this article the focus falls only on the Gariep Dam.

PLANNING AND DESIGN

The decision as to where to site the Gariep Dam was a complex one. West of the Vaal-Orange confluence the rainfall was too low and undependable to be worth collecting, but above that point the further east the dam was placed the less water it would receive. On the other hand, the furthest east and higher it was the more irrigable land would lie below it and the greater would be its potential for generating electricity.

To serve one of its main purposes it had to be placed high enough above sea level for water to gravitate to the Great Fish River valley. Another consideration was to place the dam wall where it could impound the maximum quantity of water for the smallest cost in construction: that is making it as short and low as possible. With all of these factors in mind, the present site was selected in a gorge at the entrance to Ruigte Valley, five kilometres east of the Norvalspont. Consulting engineers on the project were International Orange River Consultants Company, a consortium of South African and French firms.

Competitive tenders were called from contractors all over the world. Meanwhile, during 1965 to 1967 several self-contained towns were built to accommodate the families of the men who would be engaged on the project. In April 1966, the main contract for the civil engineering works of the Gariep Dam was awarded to the French-South African consortium of Union

HISTORICAL SIGNIFICANCE OF GARIEP DAM SITE

It was only a few kilometres east of the Gariep Dam site that Colonel Robert J Gordon, who gave the Orange River its name first saw the river, and with his draftsman made a panoramic picture of a ravine he called Orange Poort (Orange Gorge). This site was submerged by the dam.

It was at the dam site that John Norval established his pont in 1841.

Near the same spot Voortrekker pioneers of the Great Trek floated their tented wagons and swam their cattle across the muddy flood water on their way to the interior.

Along the south bank the British forces in the South African War of 1899-1902 built block houses connected by fences to control the crossings; and at Norval's Point established a large concentration camp in which hundreds of Boer internees died.

Corporation-Dumez-Borie Dams. Veteran European dam builder André Borie himself paid a special visit to the dam site. Construction started soon after.

While the South African side of the consortium was responsible for the labour and management, general engineering services, drawing office facilities, purchasing, secretarial and medical-related activities, specialist engineers were drawn from France. As such the construction township of Oranjekrag, near Norvalspont, developed a distinctly cosmopolitan atmosphere where French was spoken as often as Afrikaans and English. In turn, it is said that Italian virtually became an official language in the towns of Venterstad and Steynsburg.

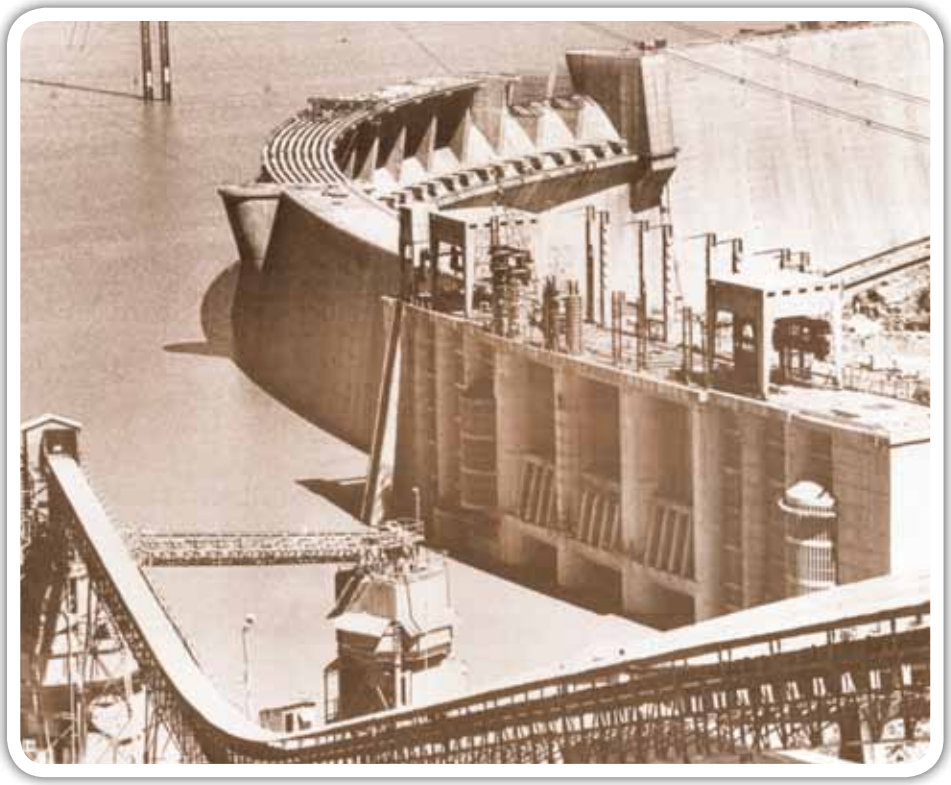
ENGINEERING ASPECTS

A combined gravity-and-arch dam, the Gariep wall was constructed entirely of concrete. Since the gorge at the site where the dam was built was too wide to allow for a complete arch shape, only the central section of the dam is arched. Two concrete gravity section flank walls form artificial gravity abutments for this arch.

The Gariep Dam is a double curvature structure, i.e. shaped like an egg shell (Apparently a cheaper design was initially drawn up, however it was rejected by politicians in exchange for this more impressive and aesthetically pleasing option). The thrust of the water is so tremendous against the directional flow of the river that the wall actually gives or bends under this. This factor had to be taken into account in the design of the dam.

Two huge water sections – one of each flank of the main arch – control the release of water. In the wall on the right (Free State) bank of the river there are river outlet pipes; while in the wall on the left (Northern Cape) bank of the river there are four electric power penstocks.

Six flood spillway openings are situated in the water intake sections, three on each bank, symmetrically positioned, and there are six large



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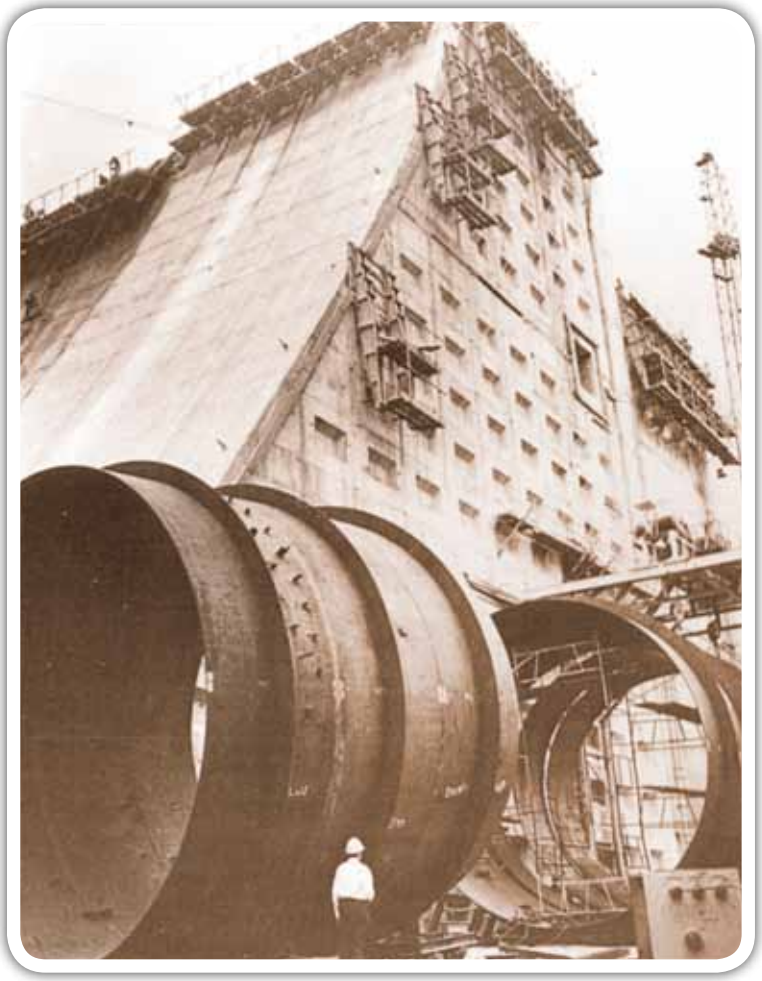

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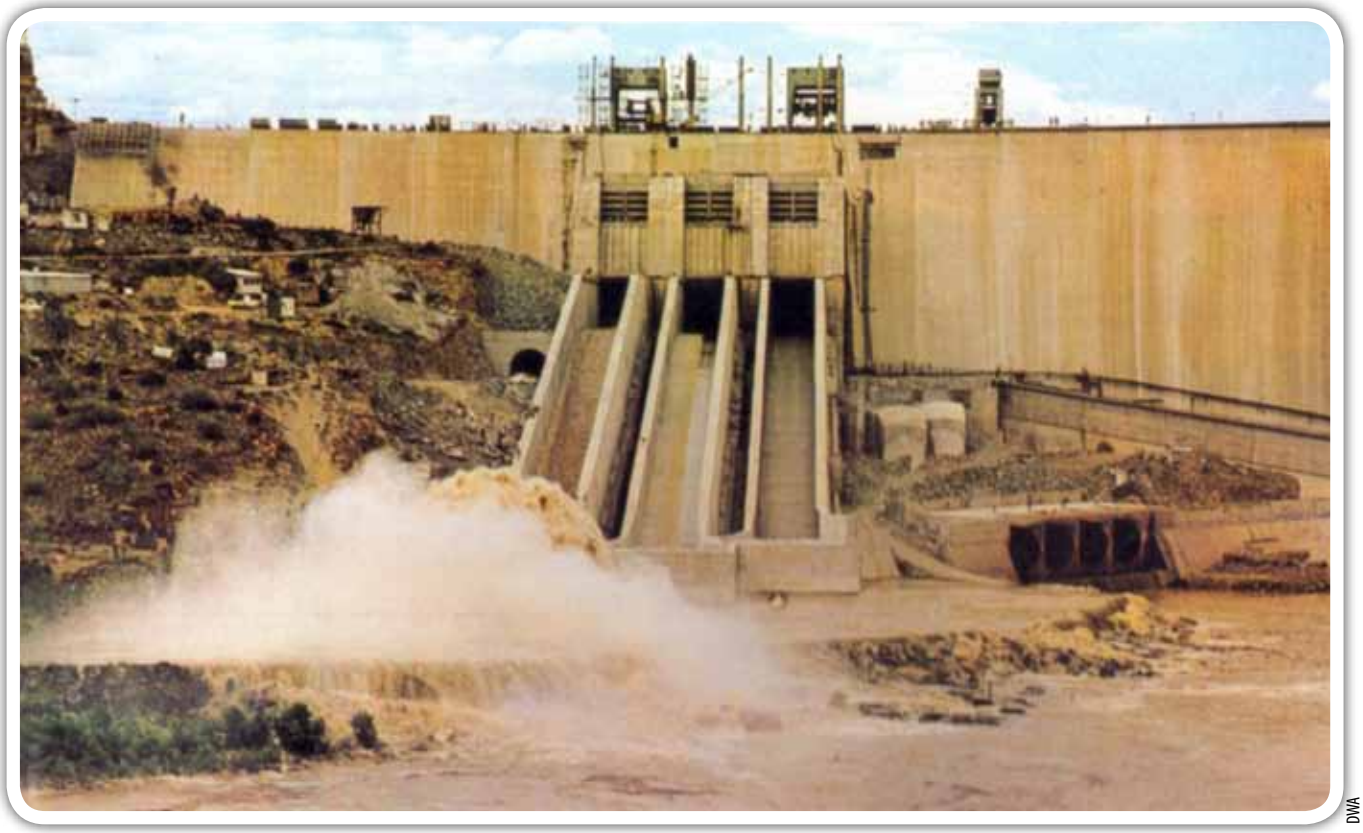
Above: *The Gariep Dam (formerly known as the Hendrik Verwoerd Dam) was the first internationally designed and constructed dam in South Africa.*

Left: *Sections of steel liners of water penstocks. Water is released downstream into the Vanderkloof Dam through four generators for the generation of hydro-electric power.*



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Sluice tests taking place at the dam. Gariep features six flood spillway openings situated in the water intake sections, three on each bank, symmetrically positioned. There are six large concrete channels or chutes – three on each side – and a concrete apron beneath the overspill to prevent the falling water from eroding the rock at the base of the dam.

concrete channels or chutes – three on each side and a concrete apron beneath the overspill to prevent the falling water from eroding the rock at the base of the dam. Under normal maximum flood conditions 8 000 m^3/s of water can be discharged. This is in addition to the 8 100 m^3/s of water which can be discharged through the chute spillways.

Enormous radial gates, three on each side, are situated in the gravity sections of the wall on either side of the main arch. These discharge floodwaters into the six chutes. The radial gates are 8 m high, and the moving parts along in each gate weigh 95 t. The gates were rubber-sealed and faced with stainless steel. These gates are said to have a life expectancy of three centuries – way beyond the life of the dam itself.

Gariep Dam's design also features Roberts splitters or energy dissipaters to break up the sheet of water discharging over the spillway. This design, developed by Lt-Col DF Roberts, was first used on the Loskop Dam in the 1930s. While provision has been made to increase the height of the dam to recover storage capacity lost to siltation this has never been necessary.

In February 1967 the Orange River in one last act of defiance sent down a flood of 8 500 m^3/s through the works. The river catchment received 150 mm of rain in 12 hours, resulting in a peak river flow of 31 350 m^3/s. Luckily no significant damage was done to the dam structure.

Gariep Dap started storing water in September 1971. It was finally commissioned in 1971 and overflowed for the first time in 1972. At its official opening in March 1972, Prime Minister BJ Vorster emphasised the importance of water to South Africa: "Water is too scarce in our country ever to be cheap and water tariffs must be high enough to make everybody realise this and to encourage users of water to do so sparingly... in this way the scarcity value of water in our country will be brought home to all consumers." ❑

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