

Knellpoort Dam
Caledon-Modder River
Government Water Scheme

Knellpoortdam
Caledon-Modderrivier-
staatswaterskema



**DEPARTMENT OF WATER AFFAIRS
DEPARTEMENT VAN WATERWESE**



The Knellpoort Dam, which was completed in 1988, is the first arch gravity dam in the world to be built using the rollcrete construction method.

Rollcrete is an abbreviation for roller compacted concrete, which is basically a stiff concrete mix, mixed on site and designed to be transported by high capacity equipment such as dump trucks and conveyor belt systems. The concrete is spread and worked by a bulldozer and the final compaction is done with a vibratory roller. Ideally rollcrete is placed in layers of approximately 300 mm. It is a method of construction that makes rapid and more economical placement of concrete possible.

Rollcrete has been selectively used in the building of dams since the early eighties but until the Knellpoort Dam was built it had only been used in the case of gravity dams.

The Knellpoort Dam is situated on the Rietspruit approximately 4 km upstream of its confluence with the Caledon River and forms part of the Caledon-Modder River Government Water Scheme. The dam is constructed in a narrow gorge eroded through sedimentary rocks of the Karoo Sequence with vertical sandstone cliffs on both banks. It has a catchment area of 757 km² with a mean annual precipitation of 590 mm and a mean annual runoff of 15,5 million m³.

The gross storage capacity of the Knellpoort Dam is 137 million m³. The average contribution from the Rietspruit catchment to the dam is 10,7 million m³ per annum. To reach full supply capacity level the dam will be supplemented by water transferred from the Caledon River.

Description

The Knellpoort Dam is an arch gravity rollcrete structure. The dam wall has a maximum height of 50 m and the radius of the curve of the upstream face is 90 m. The crest length is 180 m. The downstream face and spillway are stepped to facilitate rollcrete placing. This stepped face effectively dissipates some 70% of the energy of water spilling over the dam, thus safeguarding the downstream river bed from erosion.

An innovative crack-inducing system was devised to ensure the eventual structural continuity in the rollcrete arch. Conventional concrete arch dams are built in monoliths which are dimensioned to allow for the contraction of the concrete, and thus cracking which is associated with this contraction is essentially eliminated. Finally the contraction joints between the monoliths are grouted to achieve a monolithic structure.

When using the rollcrete method the dam is built continuously across the river valley, and joint shuttering with a view to forming separate blocks is not used. But a means had to be found to predetermine the cracking which could accompany the contraction of the rollcrete. This was done by means of crack inducers and crack directors: the inducers are situated inside the dam wall close to the upstream and downstream faces and are placed radially opposite each other; the directors are placed at one metre height intervals and are designed to

Die Knellpoortdam wat in 1988 voltooi is, is die eerste swaartekragboogdam in die wêreld waar die rolbetonkonstruksiemetode gebruik is.

Rolbeton is die afkorting vir rollergekompakteerde beton. Dit is basies 'n stywe betonaanmaaksel wat op die konstruksierrein gemeng word en ontwerp is om deur toerusting met 'n hoë dravermoë, soos storttrokke en vervoerbandstelsels, op die damwal gestort te word. Die rolbeton word dan deur 'n stootskrapeer uitgesprei en met 'n vibrerende dromroller verdig. Die ideale plasing van rolbeton is in lae van ongeveer 300 mm. Hierdie konstruksiemetode het tot gevolg dat beton vinniger en meer ekonomies geplaas word. Hoewel rolbeton reeds sedert die vroeë tagtigerjare selektief by die bou van damme gebruik word, was dit tot met die konstruksie van die Knellpoortdam beperk tot massabetondamme.

Die Knellpoortdam lê in die Rietspruit ongeveer 4 km stroom op van sy samevloeiing met die Caledonrivier en maak deel uit van die Caledon-Modderrivier-staatswaterskema. Die dam is gebou in 'n nou kloof met vertikale sandsteenkranses aan beide kante, waar erosie deur sedimentgesteentes van die Karoo Opeenvolging plaasgevind het. Die dam het 'n opvanggebied van 757 km² met 'n gemiddelde jaarlikse reënval van 590 mm en 'n gemiddelde afloop van 15,5 miljoen m³ per jaar. Die bruto opgaarvermoë van die Knellpoortdam is 137 miljoen m³. Die gemiddelde bydrae van die Rietspruit-opvanggebied tot die inhoud van die dam is 10,7 miljoen m³ per jaar. Die oorblywende inhoudsvermoë sal gevul word met water wat vanaf die Caledonrivier na die Knellpoortdam oorgedra word.

Beskrywing

Die Knellpoortdam is 'n swaartekragboogstruktuur. Die damwal het 'n maksimum hoogte van 50 m en die straal van die kurwe van die stroomopvlak is 90 m. Die kruinlengte is 180 m. Die stroomafvlak en oorloop is trapvormig om die plasing van rolbeton te vergemaklik. Hierdie trapvormige vlak versprei ongeveer 70% van die krag van die water wat oorloop om sodoende die stroomafrivierbedding teen uitkalwing te beskerm.

'n Deurbraak is ook gemaak met die ontwerp van kraakvormers om die uiteindelijke strukturele kontinuïteit in die rolbetonboog te verseker.

Konvensionele boogdamme word in blokke van spesifieke afmetings gebou om voorsiening te maak vir die krimpings van die beton. Die krimpingslasse tussen die blokke word daarna gebruyvol sodat die hele struktuur as 'n eenheid reageer onder belasting.

Volgens die rolbetonmetode word die damwal in een stuk oor die breedte van die riviervallei gebou, en word daar nie van dwarsbekisting gebruik gemaak om aparte betonblokke te vorm nie. Dog 'n manier moes gevind word om die posisie van die kroke wat sou kon ontstaan as gevolg van hierdie aaneenlopende konstruksiemetode, vooraf te bepaal. Dit is gedoen met behulp van kraakvormers

encourage the cracking, should it occur, to follow the radial path between the inducers.

The system incorporates instruments to monitor conditions within the dam wall structure and to monitor possible cracking. It also provides for a means of grouting the cracks if they are significant, thus ensuring the monolithic character of the structure.



Purpose

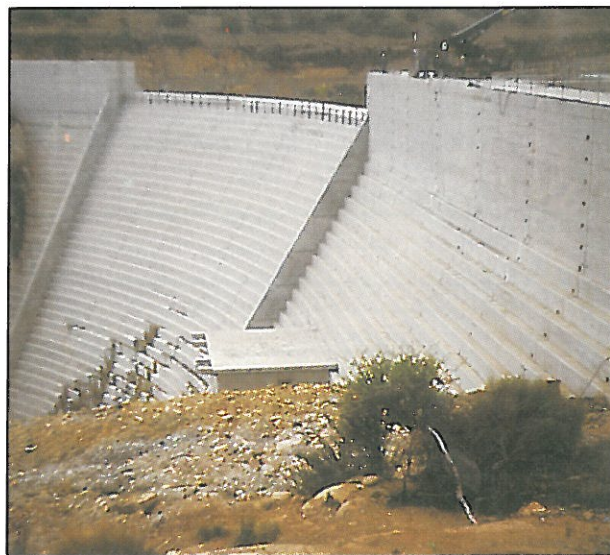
The Knellpoort Dam was built to augment the supply of water from the Rustfontein Dam on the Modder River to the Bloemfontein area, by means of the inter-basin transfer of water. This transfer of water takes place from the nearby Welbedacht Dam on the Caledon River via the Knellpoort Dam to the headwaters of the Modder River in the vicinity of Dewetsdorp.

The Knellpoort Dam also is intended to counteract the problem caused by the silting up of the Welbedacht Dam on the Caledon River where the high rate of sedimentation has reduced its gross capacity, within 16 years, from the original 115 million m³ to about 30 million m³ at present. Water from the Caledon River catchment carries the highest sediment load of all the large catchments in South Africa.

In order to avoid similar sedimentation problems, the Knellpoort Dam functions as an off-channel storage dam. Water is transferred from the Caledon River to the dam via a temporary pumping station and along a canal with a silt trap, over a distance of about 2 km. The temporary pumping station will be replaced by a permanent pumping station to be constructed on the farm Tienfontein on the right bank of the Welbedacht Dam. The Novo inter-basin pumping station, which is to abstract water from the Knellpoort Dam and pump it into the Modder River against a maximum static head of approximately 109 m, is to be located on the left bank of the Knellpoort Dam on the farm Novo.

en kraakgeleiers: die kraakvormers is binne-in die wal naby die stroomop- en stroomafvlakke en op dieselfde radiale straal geplaas; die kraak-geleiers is op hoogte-intervalle van een meter geplaas en is ontwerp om kraakvorming, indien dit sou voorkom, aan te moedig om die radiale baan tussen die kraakvormers te volg. Dié metode maak daarvoor voorsiening dat enige krake wat mag ontstaan, gebryvul kan word.

Die stelsel inkorporeer instrumente wat toestande binne-in die damwal self, asook kraakvorming wanneer dit mag voorkom, monitor.

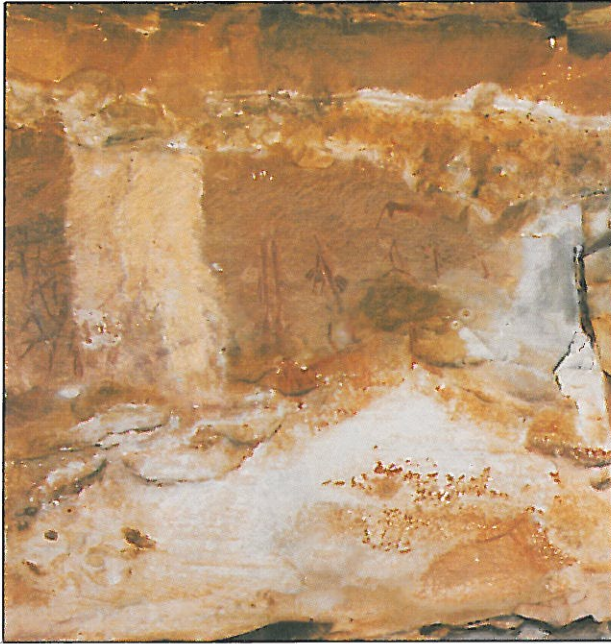


Doel

Die Knellpoortdam is gebou om die watervoorsiening uit die Rustfontein dam in die Modderrivier aan die Bloemfonteingebed aan te vul deur middel van die interbekkenoordrag van water. Dié oordrag van water vind plaas vanuit die nabygeleë Welbedachtdam in die Caledonrivier via die Knellpoortdam na die bloop van die Modderrivier in die omgewing van Dewetsdorp.

Die Knellpoortdam is ook bedoel om as teenvoeter te dien vir die toeslikingsprobleem van die Welbedachtdam in die Caledonrivier waar die hoë toeslikingstempo die dam se bruto opgaarvermoë binne 16 jaar van die oorspronklike 115 miljoen m³ na die huidige sowat ± 30 miljoen m³ verminder het. Die Caledonrivier-opvanggebied is verantwoordelik vir die hoogste slikgvrag van al die groot opvanggebiede in Suid-Afrika.

Ten einde soortgelyke toeslikingsprobleme te voorkom, funksioneer die Knellpoortdam as 'n buiterivieropgaardam. Water word uit die Caledonrivier deur middel van 'n tydelike pompstasie en 'n kanaal met 'n slikgvanger oor 'n afstand van ongeveer 2 km aan die dam voorsien. Die tydelike pompstasie sal vervang word met 'n permanente pompstasie wat op die regteroewer van die Welbedachtdam op die plaas Tienfontein opgerig staan te word. Die Novo-interbekkenpompstasie wat water uit die Knellpoortdam sal onttrek en dit teen 'n maksimum statiese drukhoogte van ongeveer 109 m in die Modderrivier sal pomp, sal op die linkeroewer van die dam op die plaas Novo geleë wees.



Environment

As part of the environmental impact study which followed the decision to build the Knellpoort Dam, a survey was done to identify the areas of socio-historical importance. Bushman paintings of the San era were found in several places below the full supply level of the dam. After copies of these paintings had been made by students of the University of the Witwatersrand, a project was initiated to preserve the paintings. A large rock with an approximate mass of 25 tonnes, containing some of the most unique paintings, was removed and transported to Bloemfontein where it is now housed in a hall in the Bloemfontein Museum.

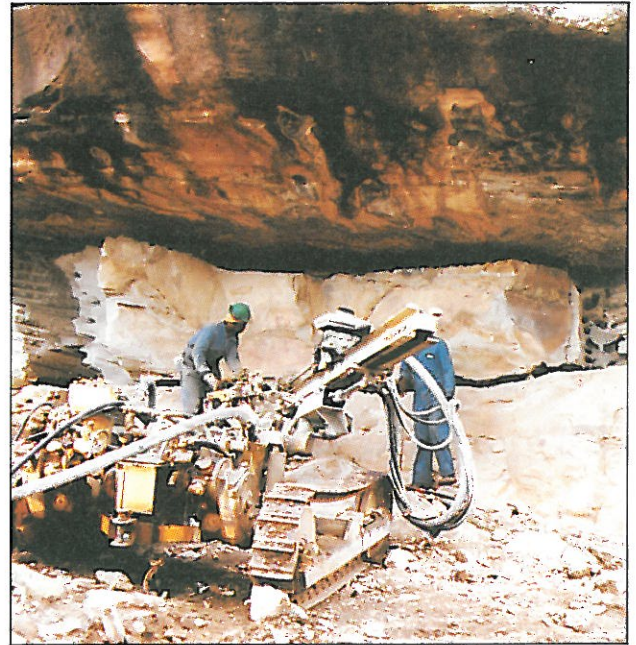
Disturbance of the environment due to construction activities was limited to predetermined areas. These areas were later restored in compliance with the landscape rehabilitation specifications.

General

The Caledon-Modder River Government Water Scheme consists of

- the Knellpoort Dam with a capacity of 137 million m³;
- the Tienfontein temporary pumping station with a 1 m³/s capacity, which started pumping in November 1988;
- The Tienfontein Pumping Station with a 3 m³/s capacity, which is to be completed in 1991 and which will later be expanded in phases as the demand may require; and
- the Novo Pumping Station and rising main with a capacity of 2 m³/s, which is to be completed in 1993 and is also to be expanded in phases as required.

It is estimated that this scheme will meet the demand for water in the Bloemfontein area until the year 2025.



Omgewing

Tydens die omgewingsinvloedstudies wat uitgevoer is nadat daar besluit is om die Knellpoortdam te bou, is opnames gemaak om die gebiede van kultuurhistoriese belang te identifiseer. Boesmantekeninge uit die San-era is op verskeie plekke onder die volvoorraadhoogte van die dam aangetref. Nadat studente van die Universiteit van die Witwatersrand hierdie tekeninge nagetrek het, is 'n bewaringsprojek onderneem. 'n Groot rots met van die mees unieke tekeninge en met 'n massa van ongeveer 25 ton is verwyder en na Bloemfontein vervoer waar dit tans in sy eie lokaal in die Bloemfonteinse Museum besigtig kan word.

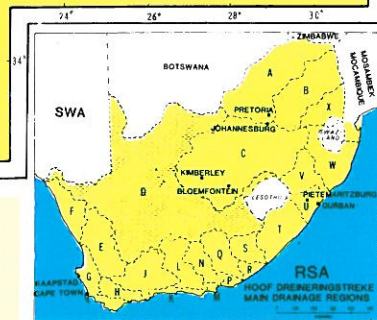
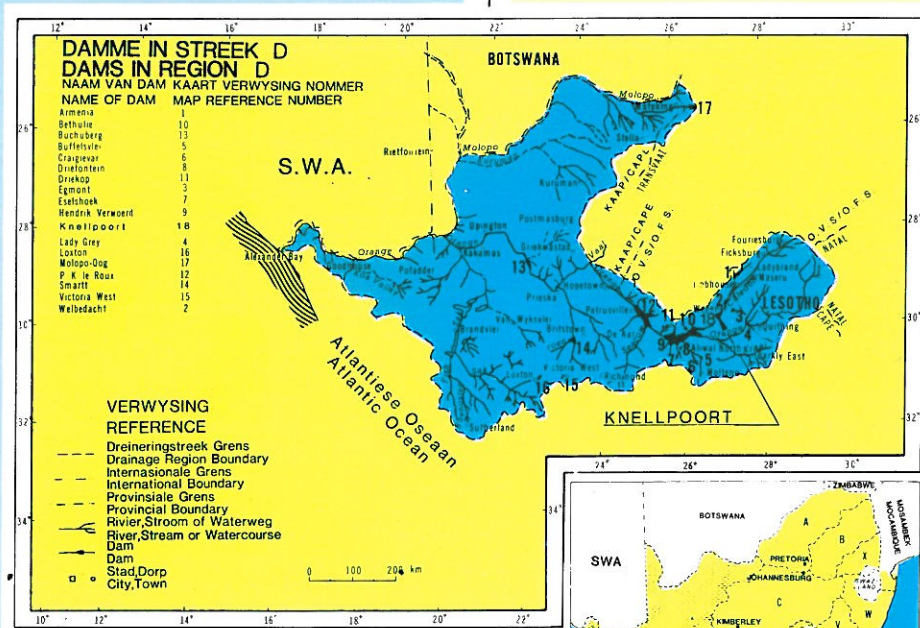
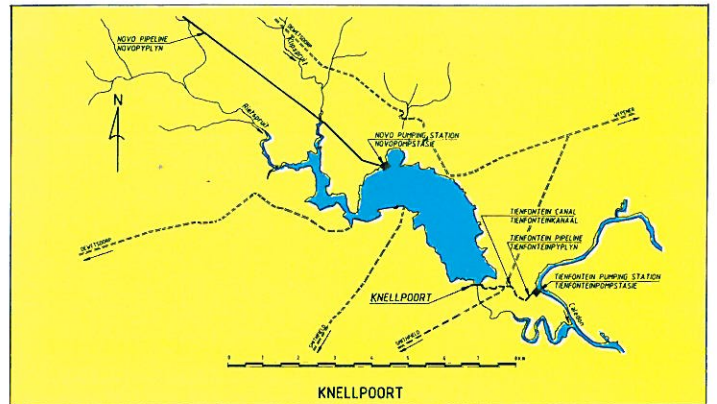
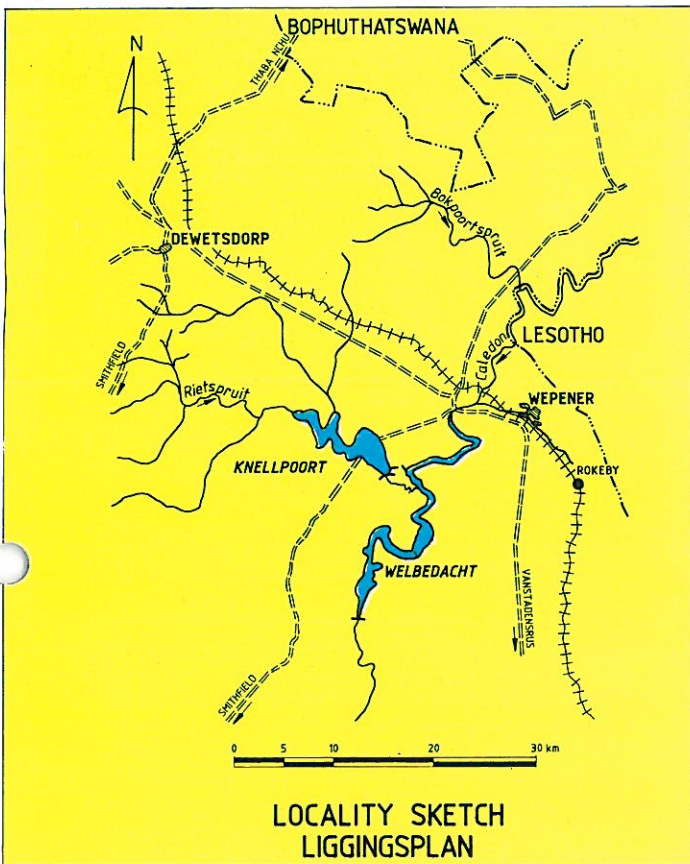
Die versteuring van die omgewing wat deur konstruksie-aktiwiteite veroorsaak is, is tot voorafbepaalde gebiede beperk. Hierdie gebiede is later herstel om aan die voorskrifte vir landskaprehabilitasie te voldoen.

Algemeen

Die Caledon-Modderrivier-staatswaterskema bestaan uit

- die Knellpoortdam met 'n opgaarvermoë van 137 miljoen m³;
- die Tienfontein tydelike pompstasie met 'n pompvermoë van 1 m³/s wat in November 1988 begin pomp het;
- die Tienfontein-pompstasie wat in 1991 voltooi sal word, met 'n pompvermoë van 3 m³/s en wat later na gelang van aanvraag fasegewys vergroot sal word;
- die Novo-pompstasie en -styleiding wat in 1993 voltooi sal word met 'n pompvermoë van 2 m³/s en wat, soos nodig, in fases vergroot sal word.

Na raming sal hierdie skema tot die jaar 2025 aan die waterbehoefte in die Bloemfontein gebied voldoen.



DATA

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| Year of completion Jaar van voltooiing | 1988 |
| Purpose Doel | Domestic and industrial Huishoudelik en nywerheid |
| River Rivier | Rietspruit |
| Nearest town and province Náaste dorp en provinsie | Wepener, OFS Wepener, OVS |
| Type Tipe | Arch gravity, rollcrete Boogswaartekrag, rolbeton |
| Gross storage capacity Bruto opgaarvermoë | 137 million/miljoen m ³ |
| Wall height above lowest foundation Walhoogte bokant laagste fondament | 50 m |
| Crest length Kruinlengte | 180 m |
| Material content of dam wall Volume materiaal in damwal | Concrete/Beton: 14 200 m ³ Rollcrete/Rolbeton: 44 550 m ³ |
| Type of spillway Tipe oorloop | Uncontrolled Onbeheerd |
| Spillway capacity/Oorloopvermoë | 1 050 m ³ /s |
| Surface area of dam at full supply level Oppervlakte van dam by volvoorraadhoogte | 875 ha |
| Owner, design and construction Eienaar, ontwerp en konstruksie | Department of Water Affairs Departement van Waterwese |

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