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'n Ondersoek van die fokale meganisme ("focal mechanism") van die hoofaardskok het getoon dat die verskuiwing wat daarvoor verantwoordelik was 'n strekking van N 43° W—N 39° het met 'n linkslaterale strekkingsglip langs 'n vertikale vlak.

Aardbewingrisiko

Ten einde 'n skatting te kan maak van die moontlike gevaar van aardbewings in Suid-Afrika, is 'n vergelykende studie deur L. M. Fernandez gemaak van die geskiedenis van aardbewings in hierdie land teenoor ander seismiesaktiewe lande. Deur gebruik te maak van alle beskikbare inligting is 'n redelike skatting dat die seismiese aktiwiteit van Suid-Afrika as 'n geheel geneem ongeveer vier persent van die aktiwiteit van Kalifornië is as laasgenoemde gebied as 'n eenheid geneem word. Deur hierdie waarde in gedagte te hou kan sekere oorwegings en praktiese voorstelle gemaak word ten einde die tarief vir aardskokassuransie vas te stel en te help met die ontwerp van aardskokbestande geboue.

UNDERGROUND WATER

Selection of Borehole Sites and Drilling Results

During the period 1 July 1970 to 30 June 1972 the Geological Survey selected 977 sites for boreholes in the Republic and 508 in South West Africa. During the same period 5 316 water boreholes were drilled in the Republic by and on behalf of the Department of Water Affairs. Of these 281 or 5 per cent were sited by the Geological Survey. The number of successful boreholes, i.e. those yielding 500 l/h or more, was 247 or 72 per cent. Of the 61 boreholes drilled for the South African Railways on sites selected by the Geological Survey, 48 (80 per cent) were successfull. In South West Africa 449 boreholes were drilled on sites selected by the Geological Survey of which 267 (59 per cent) were successful.

Groundwater Investigations and Research in the Republic

A geophysical and geohydrological survey was continued for a distance of 20 km along the bed of the Sand River south-west of Pietersburg by J. de K. Wolfaardt and two Learner Technicians to determine the thickness and extent of alluvium and underlying weathered Archaean granite. It is estimated that at least $2\times10^6 m^3$ of groundwater are extracted annually for irrigation from a 50 km section of the river bed. During the 1970/71 rainy season the river flowed four times, and records showed a rise in water-level from 13 to 10 m from the surface.

In order to determine the thickness and extent of alluvium that overlies Karoo basalt, Cave sandstone, felsite and Waterberg sandstone in the Nyl River valley between Potgietersrus and Nylstroom, where the Department of Water Affairs is conducting an experiment on artificial recharge of groundwater by river water, electrical resistivity surveys were carried out by B. L. Venter and T. M. Burvenich. Interpretation was seriously handicapped by the fact that little or no resistivity contrast exists between the alluvium and the underlying weathered basalt.

S. B. de Villiers and A. C. Mew carried out a hydrological and geophysical survey on farms underlain by Archaean granite east of Alldays in the Soutpansberg District, where borehole yields are generally poor and supplies tend to weaken or dry up after a period of use. It was concluded that conditions are unfavourable for the replenishment of groundwater in this area which has an average annual rainfall of 350 mm. However, where earth dams have been excavated in the immediate vicinity of boreholes, replenishment of underground water from accumulated rain water does take place. Yields of previously dried-up or very weak boreholes have been restored and (or) increased above the original yields when drilled. (See paper in Part 2 of this volume).

S. B. de Villiers also investigated the occurrence of artesian water in eight boreholes near Ellisras in the Waterberg District. It was found that they are situated in a low-lying area near the Mogol River and that the water was struck at a depth of about 40 m in Waterberg sandstone, overlain by impervious Karoo shale which also builds higher ground to the south. In one borehole a flow of 160 m^3/h was measured. Chemical analysis of the artesian water revealed an excessively high fluoride content of 14 p.p.m.

Thermal springs on the farms Buffelskloof 141 JS, De Bad 396 KT and Vraaiuitzicht 343 KT, all in the Lydenburg District, on Perry's Farm 9 JU in the Witrivier District and a thermal artesian borehole on Schoongezicht 225 IR in the Delmas District, were investigated by L. E. Kent. The last has been developed as a health resort by the Provincial Administration, and that on Perry's Farm is being exploited by a private company.

At Bryntirion, Pretoria, W. K. Boehmer and O. Gombar carried out pumping tests on five boreholes drilled in Daspoort shales of the Pretoria Series to supply additional water for the maintenance of gardens on Government properties. The shales are bounded by lava and diabase and the tests showed that in the Pretoria area these sediments are a highly permeable anisotropic aquifer. According to the pumping-test data and the behaviour of water levels over approximately one year, it was concluded that a collective pumping rate from the five boreholes of 200 m^3/h for a 10-hour pumping day would not exceed the average rate of recharge.

Pumping tests were carried out on boreholes in weathered and jointed Archaean granite and Ventersdorp lava on Damascus, Bulpan, Boschkoppie and Boschpan in the Delareyville District after exploratory geophysical fieldwork and drilling of production and observation boreholes had been completed. As a result of this work, including that on Blesbokpan in the same area, an additional groundwater supply of at least 2 000 m^3/day was proved for Delareyville and its border industries.

After exploratory electrical resistivity and magnetometric fieldwork, and the drilling of production and observation boreholes in Ecca shale and dolerite sheets on the townlands of Hertzogville, eight pumping tests were carried out under the control of O. Gombar and J. S. Korb. It was concluded that the town's entire needs of 300 m^3/day can be obtained from two of these boreholes yielding collectively 60 m^3/h.

In order to augment existing municipal water supplies, exploratory geophysical and hydrogeological fieldwork was undertaken at the request of the Department of Water Affairs along the Brak River south-west of De Aar, in the immediate vicinity of Kamieskroon, and on the townlands of Kestell and Lindley. Accordingly, sites for production water boreholes in alluvium at De Aar, in zones of jointing at Kamieskroon, in jointed shales at Noupoort, and in dolerite dykes at Kestell, Lindley, Thaba Nchu and Steynsrus were selected under the supervision of J. R. Vegter and T. S. Kok. Subsequently, borehole yields of up to 100 m^3/h, 8 m^3/h, 50 m^3/h, 50 m^3/h and 60 m^3/h were obtained respectively in the first five years mentioned.

At Caroluspoort near De Aar, where the South African Railways has developed wells in water-bearing alluvium with a saturated thickness of approximately

10 m on the advice of the Geological Survey, and has been extracting $40 \times 10^3 m^3$ per month since 1961, Z. M. Dzlembowski re-evaluated the water-level and pumpage data of the aquifer. Consequently the Railways Administration was advised on the possibilities of development of two new wells in a relatively unaffected area, and the maximum safe monthly rate of abstraction from the entire aquifer was determined to be approximately $60 \times 10^3 m^3$.

J. K. Whittingham completed a hydrogeological survey of the Cango fault-zone between Ladismith and Willowmore, Cape Province. Contrary to general expectation, boreholes in the fault-zone with possibly a few exceptions, do not have high yields (20 000 l/h or more). One reason seems to be the presence of impervious shaly material. It would appear that larger yields are best found in fractured and less brecciated Table Mountain sandstone and quartzite away from the fault-zone.

On the recommendation of the Geological Survey, an experimental drilling programme is being undertaken in the vicinity of Oudtshoorn by the Department of Water Affairs to test the possibility of developing high-yield boreholes in Table Mountain sandstone under a cover of Cretaceous and Bokkeveld beds with thicknesses ranging from 200 to 500 m. The first borehole south of the fault at Schoemanshoek will also test the geological-geophysical interpretation of the structure of the Cretaceous basin.

In an area of about 750 km^2 between Grahamstown and Port Alfred, where outcrops of the Witteberg and Bokkeveld Series are mostly obscured by red soil and thick bush, P. S. Meyer measured the dionic conductivity of borehole water samples to delineate areas where water of reasonable quality can be found, either in Witteberg or Bokkeveld sandstone. Groundwater from the Witteberg Series always contains less than 1 000 p.p.m. total dissolved solids, whereas that from the Bokkeveld shales invariably contains more than 3 000 p.p.m.

In the dolomite area east of Rooigrond, Mafeking District, where groundwater development is controlled, aero-magnetic anomalies were followed up by J. Korb and B. L. Venter by means of magnetic and electromagnetic surveys in order to delineate the different compartments formed by the dykes.

To determine whether seepage from a proposed slimes dam at a fluorspar mine situated on rocks of the lower part of the Pretoria Series and near the contact with the Dolomite will pollute groundwater in the dolomite, a detailed geohydrological survey was carried out by T. E. K. Diettrich. Owing to the imperviousness of the unweathered Pretoria Series and underlying chert, pollution presents no serious threat to groundwater supplies.

B. L. Venter conducted electrical resistivity, electromagnetic and magnetic surveys in the vicinity of sucessful and dry boreholes near diabase intrusions in Waterberg sandstone on farms near Vaalwater, Waterberg District, in an attempt to establish a basis for the selection of borehole sites.

A. C. Mew carried out a borehole survey in the Limburg-Gilead area north-west of Potgietersrus, and found that boreholes with yields ranging up to 106 m^3/h are used extensively for irrigation. In an area of 100 km^2, approximately $5 \times 10^6 m^3$ were abstracted during 1971.

Water-levels were measured monthly in 810 boreholes throughout the country. Of these holes, 226 are equipped with automatic recorders.

Groundwater Investigations and Research in South West Africa

Investigations to assess and develop groundwater supplies in Hereroland were continued by F. W. Schumann, K. G. Seeger, S. Z. E. Dippenaar, C. P. Venter and others. Gravity and ground magnetic traverses totalling 3 766 and 6 172 observations respectively, and also electrical resistivity depth probes, were carried out. In the south, electromagnetic surveys were undertaken to trace conductive zones—presumably fractured and water bearing—in Tsumis quartzite under a relatively thin cover of sand. Sites were selected for boreholes which, apart from whether water is struck or not, should yield valuable information for unravelling geological structure and assessing possibilities for groundwater development. During the 1970 drilling programme usable supplies of water were found in a fault-zone cutting Damara rocks, and also in Karoo and younger beds. It would appear that in selected areas groundwater supplies could be developed for domestic use; however, the question of the quantity stored underground and its replenishment still needs to be investigated.

Gravity and magnetic surveys were continued by C. P. Venter, A. P. Alchin, I. Foerster and J. P. Jonker in the dolomite area north-west of Tsumeb with a view to determining its groundwater potential. Five test holes selected on gravity and magnetic anomalies have been drilled by the Department of Water Affairs, of which two have high yields. Five conspicuous gravity and magnetic anomalies in the area covered by Kalahari Beds to the north are also to be investigated by exploratory drilling. Water-levels are being measured regularly in 96 boreholes. After the rainy season there was a rise in the water-table of up to 1 m in the dolomitic areas, followed by a gradual drop during the dry period.

In the vicinity of Grootfontein a groundwater survey was carried out over an area of 12 200 km^2 to locate areas where high-yielding boreholes are concentrated. A plan and list of boreholes were compiled (C. P. Venter).

F. W. Schumann, L. W. R. Blom, A. G. Palfi, A. P. Alchin and others undertook a geohydrological investigation along a 50 km section of the Omaruru River to determine the groundwater potential of the sand in the river-bed. Electrical resistivity surveys were carried out to determine the thickness of the sand, and an auger was used to check the depths to bed-rock as deduced from the resistivity curves. Exploration boreholes were drilled by the Department of Water Affairs and pumping tests were carried out on six boreholes. From the pumping tests, permeability and storage capacity figures were computed and a report submitted to the Department of Water Affairs in which the drilling of production boreholes was recommended; eight have subsequently been drilled. Water-levels in boreholes and wells near the Omaruru River are also being measured at monthly intervals. Nine boreholes at selected points near the river are to be equipped with water-level recorders. This investigation is a long-term project and will be continued with the aim of determining the water balance and safe yield in this section of the river. The results may prove useful in determining safe yields in other sand-filled rivers in areas with comparable climate.

J. O. G. Kirchner processed borehole data from the Stampriet Artesian Basin and is compiling maps and sections showing the distribution of the Kalahari Beds, the elevation of the base of the Kalahari Beds above sea-level, and other relevant data. He is also endeavouring to determine the relationship between the water quality and the different aquifers encountered in the area.

F. W. Schumann, L. W. R. Blom and others investigated and reported on the possibilities of additional groundwater development in the Damara and Nama homelands and for the Municipalities of Kamanjab, Aus, Bethanie, Gochas, Otjiwarongo and Karasburg, as well as the Oamites mine north of Rehoboth.

The South West Africa Water Board was advised on the drilling of boreholes in the Stampriet Artesian Basin.

One hundred and thirty samples of groundwater from various parts of South West Africa were collected, treated and despatched to the Natural Isotopes Division of the CSIR for age determination (J. O. G. Kirchner).

Groundwater Control

The administration of Section 32 of the Water Act of 1956, for which the Geological Survey is responsible, was continued. It included the acknowledgement of receipt of notices of intent to drill and of completion forms, the despatch of reminders and the filing of borehole records. The card index with particulars of individual boring contractors, which are furnished by the Department of Water Affairs, was kept up to date.

SINKHOLES AND SUBSIDENCES IN DOLOMITIC AREAS

Far West Rand

Geophysical and geological investigations as well as regular water-level measurements in the various dolomitic groundwater compartments were continued on behalf of the State Co-ordinating Technical Committee on Sinkholes and Subsidences in Dolomitic Areas by a field party under G. F. Filmalter, and after he had returned to Pretoria in October 1971, under J. C. Bekker. J. F. Gordon-Welsh controlled the work from Pretoria and compiled the data for presentation to the Committee. After his return to Pretoria G. F. Filmalter was responsible for the reduction and compilation of the gravity data using the IBM 1130 computer of the Department of Water Affairs.

Regular relevelling of points along roads and in the various towns was undertaken by the Department of Water Affairs and the various mines. Timesettlement curves were compiled by the Geological Survey from these measurements. These show a definite slower rate of ground settlement throughout the western half of the Bank Compartment, i.e. that portion which has been intensively dewatered, and most of the movement had taken place by the end of 1972. The only ground movement recorded in other compartments was at a few isolated localities, the magnitude being almost negligible.

The Bank Compartment has been dewatered at a rate which has decreased progressively from slightly more than 300 Ml per day to about 130 Ml per day. The water-table in the western half of the compartment has been drawn down by between 150 m and 400 m below its original level, while that in the eastern half has been lowered by 10 to 30 m. Large portions of the western area were evacuated by the State Technical Committee because of the incipient danger from sinkholes.

The gravity survey of the mining lease area of the Cooke Section of the Randfontein Estates Gold Mining Co. Ltd, was completed. This survey, which consisted of 5 400 stations (3 100 in 1971) on a 100-m grid, was extended by 7 600 stations in 1971.

Some 19 400 gravity stations were laid out and observed in the various compartments in 1972. Owing to the progressive lowering of the water table in the Gemsbokfontein Compartment, most of them were situated in this compartment, which is now nearly completely covered. Gravity surveys in the eastern part of the Gemsbokfontein Compartment at the Lenz Military Area and Lenasia Township were completed and linked to the main survey of the compartment.

A detailed gravity survey of 1 500 stations at intervals of approximately 15 m was completed during 1971 over Oberholzer Extension No. 1 to determine the effect which the rise and fall of the groundwater table in the Boskop-Turffontein Compartment will have. Large quantities of surplus water were discharged on the surface of the Compartment just west of the Oberholzer dyke by the mining companies and this has resulted in a 20 m rise in groundwater table near the area of influx, and about 5 m in the vicinity of Oberholzer. Several boreholes sited on the basis of the gravity survey were drilled, and these have indicated that there should be no adverse effects except in very narrow fissures which, if any exist, cannot be resolved by the data. Final reduction and interpretation of the data are now in progress.

A number of small but detailed gravity surveys were completed in other areas of the Far West Rand to investigate local areas of ground movement, amongst others at the Dagbreek Primary School in Carletonville, and at Blyvooruitzicht.

The detailed gravity survey of the eastern half of Westonaria was completed in the latter half of 1971. This consisted of 1 560 gravity stations at roughly 30 m intervals. These data have been reduced to the residual gravity stage and will be used to guide the search for filled-in Quaternary sinkholes and for expressing an opinion on the safety of stands for building purposes. The detailed gravity survey of Westonaria Extension No. 6, completed during 1970, was extended to cover a larger area, so that more ground could be examined for the proposed Afrikaans Medium High School. Some 50 boreholes were drilled for these projects. Many were relatively shallow, i.e. about 30 m deep, and were drilled in an attempt to locate filled-in Quaternary sinkholes.

A persistent settlement on the rugby field of the Dagbreek Primary School was reported by the Local Committee on Settlement and Sinkholes in Carletonville. This was examined by drilling 16 boreholes around the apparent centre of the depression. An old filled-in sinkhole was delineated and the whole of the school sports fields were declared unfit for use in January, 1972. A large sinkhole fall occurred in the fenced-off area on 16 April 1972, only three months after the action taken by the State Technical Committee.

A detailed gravity survey of the Brickor plant area, which is situated in the Bank Compartment, was completed to the residual gravity stage during January 1971. A portion of this area was not surveyed during the 1968-69 survey of the compartment due to industrial noise. A minor gravity low feature which had been extrapolated into the area was found to be considerably larger and displaced by about 90 m westward.

The area of Bank Township, which was covered with a detailed gravity survey some years ago, was relevelled to obtain a possible correlation between the original gravity contours and the subsequent subsidence after dewatering. A striking correlation between the two plans was obtained, and this relationship is at present being studied.

A number of proposed road deviations in the Bank and Oberholzer Compartments were investigated for the Transvaal Provincial Administration to find a new route to link Randfontein directly with Carletonville again.

A minor surface subsidence north of the uranium store of the NUFCOR plant was investigated in October 1972 with a detailed gravity survey on a 12,5 m grid spacing. High-accuracy readings were taken, and the final accuracy of the survey can be gauged from the fact that topographical effects due to nearby buildings were observed. A small gravity low just north of the store was delineated and subsequent drilling revealed a small pocket of thick Karoo sediments containing an appreciable amount of montmorillonitic clay.

Since dewatering of the Bank Compartment commenced in earnest in June 1969, there have been 114 sinkholes of which 57 occurred in 1970, 41 in 1971 and 15 in 1972.

In all, 194 boreholes with a combined depth of 9 880 m were drilled on the Far West Rand during 1972. The geological work connected with these boreholes was mainly the description of drill cuttings and the compilation of profiles for the purpose of examining danger zones and confirming geophysical indications. This work was done by Dr H. A. Pötter under the supervision of Mr P. Roux.

EARTH SCIENCE RESEARCH IN ANTARCTICA

The Earth Science Research Programme of the South African National Antarctic Expedition is directed by L. E. Kent, Programme Director and the Co-ordinating Geologist, L. G. Wolmarans, both of the Geological Survey. The following projects were completed or partially completed during 1971 and 1972.

12th Expedition

All post-winter fieldwork was done from Grunehogna Base (72° 02.3′ S, 02° 45.5′ W) established in April 1971, where the field party also spent the winter.

Geology.—Geological fieldwork was undertaken between the end of August 1971 and the middle of January 1972. During this period most of the nunataks in the area between Jekselen, Istind, Nashornet, Pasettfjellet and Pyramiden were visited and mapped on a scale of 1:25 000 by J. H. Bredell and A. W. W. Paterson. The area mapped covers approximately 1 400 km².

The main problem investigated was the geology and structure of Jekselen and the area to the east of it, on which the previous expedition had based some controversial theories.

The area between Nashornet and Viddalskollen was investigated for the first time by a South African Expedition and the sediments there were found to be lithologically very similar to those of the Pyramiden Formation. Special attention was also paid to the stratigraphic position of the volcanic rocks.

Geophysics and Glaciology.—A long geophysical/glaciological traverse from SANAE-base on to the Polar Plateau up to the northernmost turning-point of the United States South Pole-Queen Maud Land Traverse and back was planned for the 1971/72 summer. Due to various logistic problems this had, however, to be abandoned and a programme of shorter local traverses in the Ahlmann Ridge was substituted. This programme was successfully completed, a total distance of 1 050 km having been traversed. All the geophysical and glaciological observations except for base observations during the winter months were done along these traverse-lines.

Gravity.—During January 1971 the Worden Master Model Gravity Meter (No. 576) was returned to Antarctica after being repaired and recalibrated by the makers. Shortly after arrival at SANAE three separate sets of drift readings which proved it to be functioning perfectly, were taken.

After leaving SANAE in March, 69 new gravity observations were made along the traverse routes. The most important part of the gravity work was the re-occupation of an absolute gravity station established the previous year by the Norwegian Antarctic Expedition at nunatak 1 320 near Istind. This, which was planned at SCAR XI in Oslo in 1970, now makes possible the long-desired tying-in of the South African gravity traverses to the world-wide network.

Geomagnetic observations.—Following an agreement with the Director of the S.A.N.A.E. Geomagnetic Programme, two instruments for measuring the absolute vertical and horizontal magnetic fields were supplied to the field party.

The following instruments were used on the traverses:

1. Askania GFZ magnetometer for relative measurement of the vertical field.
2. An Elsec Proton Precession Magnetometer for absolute total field.
3. A Q.H.M. for measurement of the absolute horizontal field.
4. A B.M.Z. for measurement of the absolute vertical field.

An attempt was made to re-occupy as many as possible of the magnetic stations established by the SANAE X geomagnetist. With the exception of four, all the stations between SANAE and Dalten were reobserved. Additional major magnetic stations were established at Grunehogna, nunatak 1320, and between Jekselen and Bolten.

All in all 53 P.P.M., 45 G.F.Z., 13 Q.H.M., 13 B.M.Z. and 13 declination observations were made at 16 major stations and 36 minor ones.

At Grunehogna Base the total magnetic field was measured at least once a day from the end of April until the middle of August 1971. During auroral displays readings were made at shorter intervals.

Two short-spacing G.F.Z. traverses were also carried out at Grunehogna and at Dalten. The Dalten traverse was an attempt to determine the origin of the large positive anomaly found there by the SANAE X geomagnetist. This was found to be caused by a dolerite dyke with magnetic ore minerals along its contact with sediments.

Radio-echo sounding.—The S.P.R.I. Mark II radio-echo sounder acquired in 1970 was taken to Antarctica in 1971 and operated in the field by T. G. Schaefer. During the year a continious ice-thickness profile was measured along 630 km of traverse lines. Ice thickness was found to range from 326 m at SANAE on the ice-shelf to more than 1 700 m on the Viddalen glacier.

A part of the seismic ice thickness traverse of G. de Q. Robin in 1951/52 during the Norwegian-British-Swedish Antarctic Expedition was measured by radio-echo sounding and the results of the two measurements were found to agree to within 5 per cent. More than 400 barometric surface altitude determinations were also made along the traverse routes.

Glaciology.—During the pre-winter and post-winter traverses SIPRE-holes were drilled and logged and Rammsonde measurements made at ten localities on the ice-shelf and continent. Snow samples for stable isotope and fall-out determinations were taken from all the holes but these were unfortunately subsequently lost due to melting.

A 10-m SIPRE-hole was drilled and logged during winter at Grunehogna Base. Over a period of a month temparature readings were taken four time daily at

Aanvulling van Grondwater deur Middel van Gronddamme, Oos van Alldays, Distrik Soutpansberg

deur

S. B. de Villiers, B.Sc.

ABSTRACT

Considerable difficulty has been experienced in developing boreholes with adequate and permanent supplies in the Archaean gneiss and associated rocks. Although the water is used mainly for domestic purposes and livestock, which involves relatively low extraction, the supplies decreased considerably and some boreholes dried up completely within a few years or even months after they had been brought into use. The water-levels in many dropped from 2 to 12 m. The natural infiltration of rainwater is inadequate to replenish the underground water supplies.

Thirteen earth dams with capacities ranging from 1 000 to 25 000 m³ were constructed, most of them during the period 1966 to 1969, in the broad watercourses. It was found that the supplies from boreholes in the immediate vicinity of these dams increased from 450 l/h or less, up to as much as 4 500 l/h. The water-levels in these boreholes are at present (1971) from 7 to more than 20 m higher than the original or previous levels before the dams were constructed. It is concluded that the earth dams are directly responsible for the replenishment of the underground water in their vicinities.

INLEIDING

Op verskeie plase ten ooste van Alldays is aansienlike probleme in die verlede ondervind om voldoende en standhoudende grondwatervoorrade deur middel van boorgate te ontwikkel. Nieteenstaande die feit dat grondwater in die gebied slegs vir huishoudelike doeleindes en as veesuipings gebruik word, het talle boorgate binne enkele jare nadat hulle geboor is aansienlik verswak of selfs opgedroog. Hierdie toestand het veral te voorskyn getree gedurende die tydperk 1963 tot 1966 toe daar 'n paar opeenvolgende jare met abnormale lae reënval was. Gronddamme is veral teen die einde van hierdie tydperk en daarna in die gebied gebou of vergroot om die afloop van reënwater op te vang.

Die jaarlikse reënval soos gemeet by Alldays Polisiestasie, asook die gemiddelde maandelikse reënval oor die afgelope 27 jaar (1945-1971), word in tabel 1 aangegee.

TOPOGRAFIE EN GEOLOGIE

Die blok plase (fig. 1), lê hoofsaaklik op 'n breë, byna reliëflose waterskeiding, met die Brakrivier sowat 10 km suid daarvan en die bolope van die Kolope- en Kwetsanelaagte wat noordwaarts dreineer, aan die noordekant. Die grootste gedeelte van die gebied lê ongeveer tussen 770 en 830 m bo seespieël en sowat 60 tot 90 m hoër as die Brakrivier en bogenoemde twee laagtes. Op die waterskeiding is daar etlike breë plat laagtes wat hoofsaaklik na die noordweste- en suidoostekant dreineer.

Die gebied is redelik bebos maar die plantegroei is nie uitermatig dig nie. Dit bestaan hoofsaaklik uit die soorte wat normaalweg in die Bosvelddele van Noord-Transvaal voorkom.

In die gebied kom Argeïese gneis en verwante basiese en ultrabasiese rotse voor met hier en daar insluitsels van meta- en magnetietkwartsiet. Enkele jonger diabaasplate en dolerietgange is intrusief in die ouer gesteentes. Die rotse dagsoom op plekke op die hoërliggende dele maar groot gedeeltes word egter deur rooi-bruin sanderige leemgrond bedek, terwyl turfagtige grond in sommige breë laagtes voorkom. Van boorstate blyk dit dat die grondbedekking selde dikker as 3 m is. Oppervlakkalksteen word plek-plek saam met basiese gesteentes, veral in laagtes aangetref maar vorm blykbaar nêrens dik afsettings nie.

DIE VOORKOMSWYSE EN VERSWAKKING VAN GRONDWATERVOORRADE

Grondwater in die gebied word, net soos elders in Argeïese gesteentes, aangetref in die boonste verweerde en genate sone waar dit op plekke tot onderkant die watervlak strek. Die enkele verspreide nate wat in die onverweerde rots mag voorkom en water in boorgate kan lewer, word selde of nooit raakgeboor nie. Die feit dat onverweerde rots in die gebied oor die algemeen vlakker as 30 m aangetref word en dat die watervlak hier oor groot gedeeltes dieper as dit is, is die klaarblyklike rede vir die groot aantal mislukte gate wat in die verlede geboor is.

In laagtes waar die verweerde of genate sone op plekke dieper as die watervlak strek, is wel water aangetref. Dit blyk egter dat hierdie gate byna sonder uitsondering na enkele jare of selfs maande aansienlik verswak en dat die watervlak daal.

Gegewens van sowat 16 boorgate in die gebied is beskikbaar (tabelle 2 en 3) wat aantoon dat die watervlak binne kort tydperke, nadat hulle in gebruik geneem is, van sowat 2 tot 12 m gedaal het of dat lewerings van meer as 2 000 l/h afgeneem het tot sowat 900 l/h of minder. Sommige van die gate het selfs opgedroog.

Op Gordon 310 MS het boorgat 9 soveel as 1110 l/h gelewer toe dit in Julie 1970 voltooi is. Die watervlak was destyds 51,8 m vanaf die oppervlak. Binne 'n paar maande nadat die boorgat in gebruik geneem is, het die lewering verswak tot minder as 450 l/h en die watervlak het gedaal tot 58,8 m in Maart 1971 en tot 61,0 m sowat 8 maande later. Op dieselfde plaas het boorgat 8 'n watervlak van 44,2 m gehad en 5860 l/h gelewer toe dit in 1957 geboor is. 'n Jaar later het die lewering verminder tot ongeveer 450 l/h en die watervlak het met 12,5 m gedaal. Ook op Doorenwaard 313 MS het die watervlak in beide boorgate 28 en 26 sowat 6 m binne 'n tydperk van 7 maande gedaal, nadat hulle in 1971 in gebruik geneem is. Die hoeveelheid water wat in dié tydperk uit elk van die twee gate onttrek is, word beraam op minder as 800 kl.

Op Ettenmouth 327 MS, Cottondale 285 MS en Freyburg 283 MS is boorgate wat oorspronklik 3000 l/h en meer gelewer het. Voor of gedurende die droë jare van 1963 tot 1966 het hulle egter verswak tot minder as 450 l/h, alhoewel hulle slegs vir veesuipings aangewend was.

Slegs in enkele gevalle blyk dit dat die watervlak oor 'n aansienlike aantal jare weer tot na-aan die oorspronklike watervlak terugkeer as die gebruik van die boorgat gestaak word. Die watervlak in boorgat 8 op Gordon 310 MS het byvoorbeeld vanaf 1958, oor 'n

tydperk van 13 jaar waartydens die gat baie selde gebruik is, met sowat 10 m gestyg tot omtrent 2,5 m onderkant die oorspronklike (1957) watervlak. In teenstelling hiermee was die watervlak in boorgat 10 op Gordon 310 MS in 1971 meer as 5 m dieper as wat dit in 1958 was, alhoewel hierdie gat en die ander in die onmiddellike omgewing blykbaar nie in gebruik was sedert 1960 nie.

TABEL 1.—Reënval-Alldays Polisiestasie, Distrik Soutpansberg (Weerburo)

Jaarlikse Reenval

Jaar	mm	Jaar	mm
1945	311,8	1959	302,1
1946	601,0	1960	443,6
1947	256,0	1961	300,1
1948	410,4	1962	387,5
1949	433,5	1963	216,4
1950	247,6	1964	245,4
1951	413,4	1965	118,4
1952	269,9	1966	223,4
1953	698,7	1967	554,5
1954	349,4	1968	360,0
1955	590,9	1969	285,3
1956	418,5	1970	266,2
1957	339,5	1971	381,0
1958	428,7	Gemiddeld	365,0

Gemiddelde maandelikse reënval vir tydperk 1945–1971

Maand	mm	Maand	mm
Januarie.....	75,3	Julie.....	0,3
Februarie....	64,2	Augustus....	0,3
Maart.....	36,0	September...	3,8
April.....	27,2	Oktober.....	28,5
Mei.....	5,3	November...	49,7
Junie.....	3,1	Desember....	71,5

Hierdie toedrag van sake dui daarop dat die grondwaterreservoirs in die omgewing van sommige gate betreklik klein is en dat daar min of geen natuurlike aanvulling is nie. Die rede hiervoor is heel waarskynlik lae somerreënval, diep grondbedekking en plantegroei, veral bome wat groot hoeveelhede water transpireer. Heel waarskynlik word die grondbedekking oor groot dele normaalweg byna nooit tot veldkapasiteit versadig nie, met die gevolg dat infiltrasie tot by die watervlak selde en sporadies plaasvind.

INVLOED VAN GRONDDAMME OP GRONDWATER

Op die elf plase in die gebied (fig. 1) is daar die afgelope dekade, maar veral vanaf 1966, 13 gronddamme in die breë laagtes met behulp van stootskrapers gebou of vergroot. Hulle kapasiteite varieer van sowat 1000 tot 25 000 m³. Op sommige plekke het vroeër klein gronddammetjies bestaan, maar hulle is die afgelope aantal jare aansienlik vergroot. Aangesien stortreëns in die somermaande voorkom, versamel hierdie damme heelwat water tydens 'n goeie stortbui. Sommige word byna gevul of loop selfs oor na een of twee stortbuie van sowat 25 tot 50 mm elk in hul opvanggebiede. Die spoed van wegsyfering van die water uit die verskillende damme varieer na gelang van die deurlatendheid van die bodem van die dam, maar oor die algemeen syfer die water binne enkele maande weg. Die dam by die woonhuis op Ettenmouth 327 MS het 'n kapasiteit van ongeveer 6 000 m³. Nadat dit vol was, dreineer al die water, behalwe die wat verlore gaan deur verdamping, in die grond binne sowat 2 maande. Die damme op die noordwestelike grens van Cliffdale 286 MS en dié op Wycombe 312 MS hou water vir ongeveer 6 maande voordat hulle droog is. Hierdie twee damme, wat redelik lank in gebruik is, se bodems is blykbaar minder deurlatend, moontlik as gevolg van slik en grond wat deur die jare in hulle versamel het. Nadat die damme egter heeltemal droog was en modderkrake en openings in hulle bodems ontwikkel het, syfer daar klaarblyklik aansienlike hoeveelhede van die eerste water wat hulle opvang.

Die invloed wat die gronddamme op die ondergrondse watervoorraad het, word weerspieël in die gegewens wat verstrek word in tabel 3. Die toename in die lewerings van boorgate of die styging van die watervlakke nadat gronddamme in hul onmiddellike omgewings voltooi of vergroot is, blyk duidelik uit hierdie tabel. Twaalf van die boorgate wat oorspronklik of op 'n later stadium 450 l/h of minder gelewer het, lewer tans van 900 tot meer as 4500 l/h. Die rushoogte van die watervlak in hierdie gate is op die huidige stadium (1971) oor die algemeen van 7 tot meer as 20 m hoër as wat dit oorspronklik of op 'n vroeëre tydstip was.

Op Ettenmouth 327 MS is drie boorgate by die woonhuis onderkant 'n dam geleë wat in 1966 vergroot is. Alhoewel die boorgate oorspronklik van 1000 tot 3000 l/h gelewer het, het hulle gedurende die jare 1959 tot 1965 in so 'n mate verswak dat twee van hulle slegs sowat 450 l/h of minder gelewer het. Tans lewer twee van die gate meer as 1000 l/h en die derde ongeveer 4100 l/h. Die watervlak in laasgenoemde gat was in 1959 sowat 63,4 m vanaf die oppervlak, terwyl dit in 1971 ongeveer 38 m was.

'n Ander treffende geval is dié van boorgat 16 naby die noordwestelike grens van Cliffdale 286 MS. Hier die boorgat was droog toe dit in 1958 tot 37,8 m geboor is. 'n Gronddam wat na skatting 'n kapasiteit van 25 000 m³ het, is om en by 1960 bokant hierdie gat gebou. In 1971 was die watervlak 6,1 m vanaf die oppervlak en die boorgat het meer as 4500 l/h gelewer. Jaarliks word sowat 6800 kl uit die gat onttrek vir veesuiping. Verder stroomaf onderkant die damwal is boorgat 15 op Viviers 287 MS, wat sedert 1966 meer as 15 000 l/h lewer en waaruit gereeld sowat 1 hektaar besproei word.

Soortgelyke gevalle kom ook op Cliffdale (boorgate 65 en 67) en Cottondale (boorgat 51) voor.

Dat die gronddamme ook die standhoudendheid van die boorgate verseker, blyk uit die feit dat boorgat 30 wat in 1925 op Wycombe 312 MS geboor is en wat destyds 2820 l/h gelewer het, in 1971 nog sowat 2000 l/h gelewer het. In 1925 was die watervlak hier 20,4 m terwyl die huidige (1971) sowat 5 m dieper is. Die dam is hier vermoedelik voor 1958 gebou.

GEVOLGTREKKINGS

Uit die beskikbare gegewens blyk dit dat die natuurlike aanvulling in die gebied nie voldoende is om weer die water wat onttrek word te vervang nie.

Dat aanvulling van grondwater plaasvind as 'n direkte gevolg van die aanwesigheid van die gronddamme en nie as gevolg van abnormale hoë jaarlikse reënval nie, blyk uit die volgende: waar geen gronddamme bestaan nie, verswak boorgate binne kort tydperke nadat hulle in gebruik geneem is en die watervlakke daal aansienlik, afgesien van reënval. Boorgate het nie alleen gedurende die droër jare verswak nie, maar ook gedurende die tydperk 1958 tot 1960 toe die reënval normaal was en in sommige voorafgaande jare heelwat bo die gemiddeld was. Verder het aanvulling plaasgevind in die omgewing van gronddamme wat sedert 1966 gebou is, alhoewel die reënval vanaf 1966 tot 1971, behalwe vir 1967, nie bo gemiddeld was

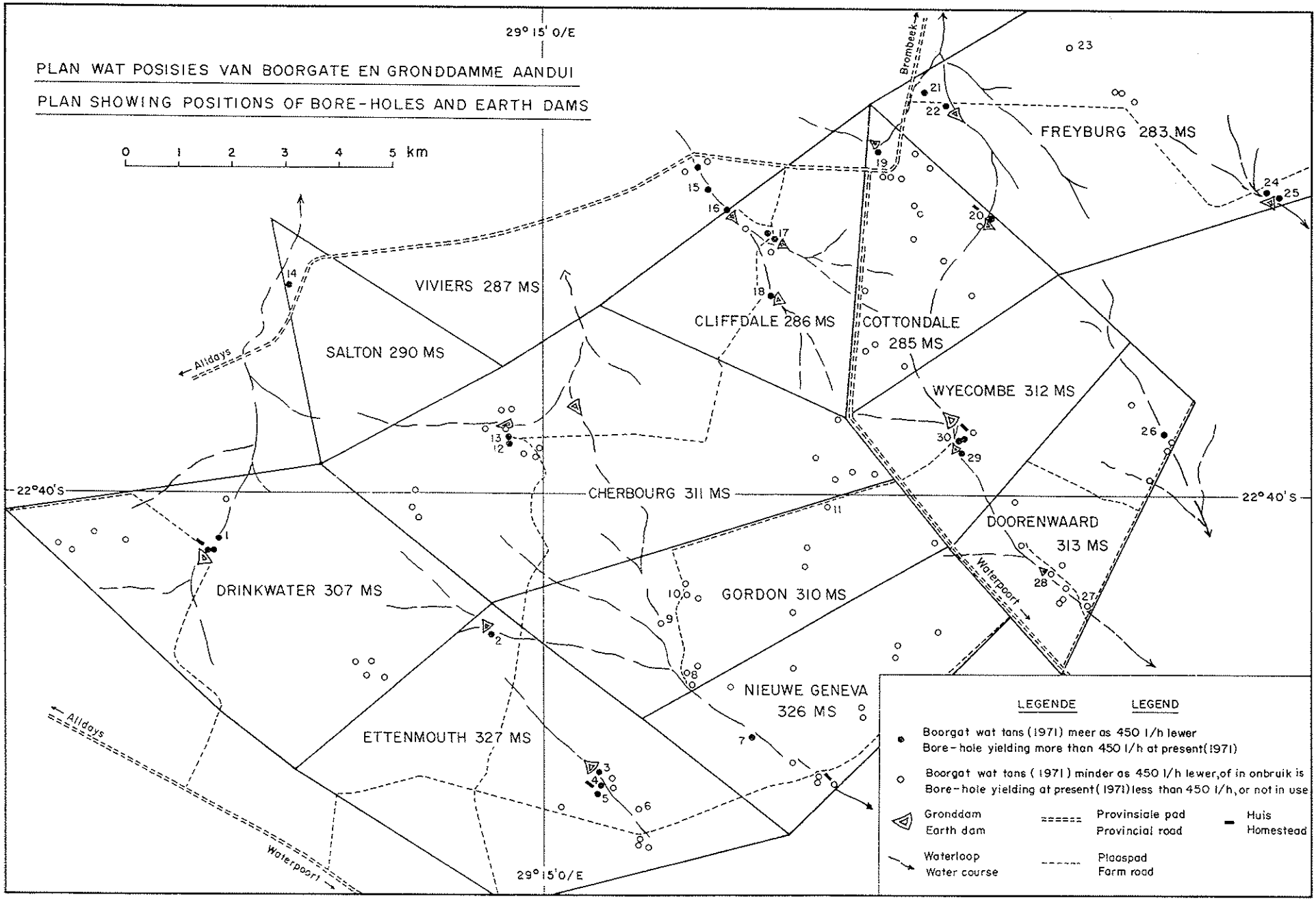
PLAN WAT POSISIES VAN BOORGATE EN GRONDDAMME AANDUI
PLAN SHOWING POSITIONS OF BORE-HOLES AND EARTH DAMS
29° 15' O/E
0 1 2 3 4 5 km
Brombeek
FREYBURG 283 MS
VIVIERS 287 MS
CLIFFDALE 286 MS
COTTONDALE 285 MS
SALTON 290 MS
WYECOMBE 312 MS
Alldays
CHERBOURG 311 MS
22°40'S
DOORENWAARD 313 MS
Waterpoort
DRINKWATER 307 MS
GORDON 310 MS
NIEUWE GENEVA 326 MS
ETTENMOUTH 327 MS
LEGENDE LEGEND
Boorgat wat tans (1971) meer as 450 l/h lewer
Bore-hole yielding more than 450 l/h at present(1971)
Boorgat wat tans (1971) minder as 450 l/h lewer,of in onbruik is
Bore-hole yielding at present(1971)less than 450 l/h,or not in use
Gronddam Earth dam
Provinsiale pad Provincial road
Huis Homestead
Waterloop Water course
Plaaspad Farm road

Fig 1

nie. In dieselfde tydperk het boorgate 9, 11, 23 en 28 verswak of die watervlakke het gedaal, waar geen gronddamme aanwesig is nie.

Aanvulling in die omgewing van gronddamme moet nie alleen toegeskryf word aan die feit dat oppervlakwater op bepaalde plekke gekonsentreer word nie, maar ook veral omdat die bodem van die dam gestroop is van 'n grondbedekking. Moontlik speel die mate van ontbossing, wat in die damgebied plaasvind tydens die konstruksie van die dam, ook 'n rol wat bydra tot aanvulling.

Die klaarblyklike oplossing van die probleem wat in die gebied ondervind word om voldoende en standhoudende grondwater te ontwikkel is dus om groot gronddamme in laagtes te bou waar toestande gunstig is vir insyfering. Geskikte gebiede waar die onderliggende rotse verkieslik tot 'n diepte van 30 m of meer verweer en genaat is, kan met behulp van geofisiese metodes bepaal word.

Wat verder veral van belang is tydens die bou van sulke gronddamme is dat die grondlaag in die bodem van die dam verwyder word tot op die onderliggende verbrokkelde en halfverweerde rots of gruis. Nadat 'n dam 'n aantal jare in gebruik is, sal dit noodsaaklik wees om weer die slik en grond wat in die sentrale gedeelte van die dam versamel het, te verwyder.

TABEL 2.—Lewerings en watervlakke van boorgate waar geen gronddamme bestaan nie

Boorgat Nr.	Plaas	Lewerings (l/h)		Watervlakke (m)		Huidige (1971)	Opmerkings
		Oorspronklike	Op latere datum	Oorspronklike	Op latere datum		
6	Ettenmouth 327 MS	4 091 (1957)	909 (1959) minder as 450 (1965)	—	37,8 (1959)	—	Nie gebruik sedert 1966 nie.
7	Nieuwe Geneva 326 MS	1 850 (1965)	±1 000 (1971)	27,4 (1965)	—	—	In gebruik.
8	Gordon 310 MS.....	5 864 (1957)	±450 (1958)	44,2 (1957)	56,7 (1958)	46,7	Selde gebruik vanaf 1958.
9	Gordon 310 MS.....	1 114 (1970)	Minder as 450 (1971)	51,8 (1970)	—	58,8 (Mrt.) 61,0 (Nov.)	Gebruik 1970.
10	Gordon 310 MS.....	—	Minder as 450 (1958)	—	56,7 (1958)	Dieper as 61,0	Nie gebruik sedert 1960 nie.
11	Gordon 310 MS.....	±450 (1966)	Droog (1971)	—	31,4 (1966)	Dieper as 33,0	Nie gebruik nie.
14	Salton 290 MS.....	13 450 (1966)	—	19,8 (1966)	—	24,2	In gebruik.
23	Freyburg 283 MS...	1 800 (±1968)	Minder as 450 (1970)	—	—	—	—
26	Doorenwaard 313 MS	1 637 (1935)	±900 (1971)	36,6 (1935)	33,8 (1959)	37,5 (Mrt.) 44,0 (Nov.)	Weer in gebruik sedert Mei 1971.
27	Doorenwaard 313 MS	900 (1959)	—	34,1 (1959)	—	35,5	Nie gebruik van 1966–1971 nie.
28	Doorenwaard 313 MS	382 (1971)	—	31,4 (Mrt. 1971)	—	37,5 (Nov.)	Gebruik sedert Mei 1971.
					—	—	

TABEL 3.—Lewerings en watervlakke van boorgate naby gronddamme.

Boorgat No.	Plaas	Lewerings (l/h)			Watervlakke (m)			Dam gebou of vergroot (Datum)
		Oorspronklike	Op latere datum voor gronddam gebou is	Huidige (1971)	Oorspronklike	Op latere datum voor gronddam gebou is	Huidige (1971)	
1	Drinkwater 307 MS.....	2 305 (1966)	—	—	42,7 (1966)	—	33,1	—
2	Ettenmouth 327 MS.....	900 (1959)	—	900	32,0 (1959)	—	33,5	—
3	Ettenmouth 327 MS.....	3 000 (±1957))	450 (1959–1965)	2 300	—	57,0 (1959–1965)	37,5	1966
4	Ettenmouth 327 MS.....	1 140 (±1950)	450 (1959–1965)	±1 370	—	57,0 (1959–1956)	38,4	1966
5	Ettenmouth 327 MS.....	2 730 (±1958)	909 (1959)	4 100	—	63,4 (1959)	±38	1966
12	Cherbourg 311 MS.....	4 546 (±1955)	450 (1959)	2 000	—	37,8 (1959)	19,2	1966–1969
13	Cherbourg 311 MS.....	2 728 (±1955)	450 (1965)	±1 370	—	25,6 (1965)	18,3	1966–1969
15	Viviers 287 MS.....	15 000 (1966)	—	15 000	—	—	—	±1960
16	Cliffdale 286 MS.....	Droog (1958)	—	4 546	37,8 (1958)	—	6,1	±1960
17	Cliffdale 286 MS.....	±450 (Voor 1950)	±450 (1959)	± 909	—	30,2 (1959)	19,7	1966–1969
18	Cliffdale 286 MS.....	Droog (1958)	—	±909	—	—	±15,5	1970
19	Cottondale 285 MS.....	450 (1960–1966)	—	1 820	—	—	30,5	1969
20	Cottondale 285 MS.....	3 180 (1959)	±300 (1965–1966	1 600	—	—	33,0	1966–169
21	Freyburg 283 MS.....	±450	—	1 800	—	—	23,7	±1960
22	Freyburg 283 MS.....	3 180	Droog (±1959)	4 500	—	44,0	16,8	±1960
24	Freyburg 283 MS.....	±450	—	±1 370	—	—	23,1	1966–1969
25	Freyburg 283 MS.....	±22 500	8 100 (1965–1969)	±13 500	—	—	21,3	1966–1969
29	Wycombe 312 MS.....	3 600 (Voor 1970)	—	±3 600	—	—	32,3	Voor 1958
30	Wycombe 312 MS.....	2 820 (1925)	—	±2 000	20,4 (1925)	—	25,7	Voor 1958