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EMERGENCY SUPPLY FROM DOLOMITIC GROUND-WATER SOURCES : RAND WATER BOARD SUPPLY AREA

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I SUMMARY (J.R. Vegter)

At the meeting between the Rand Water Board and the Department on 14 October 1983, it was decided that apart from increased abstraction from the abandoned Cornelia colliery (Maccauvlei), emergency supplies are to be developed in three areas :

1. Zuurbekom and Gemsbokfontein compartments.
2. Dolomite compartments in the Pretoria Area.
3. Steenkoppies compartment.

The Division of Geohydrology has since then devoted its attention to :

A. Compilation of lists of
   (i) Hydrogeological and engineering geological consultants
   (ii) Geophysical (gravity) contractors
   (iii) Surveying contractors
   (iv) Drilling contractors
   (v) Test-pumping contractors

See appendices A, B, C, D and E. Information was also obtained as far as possible on capabilities and competency.

B. Drawing up a master plan for the development of emergency supplies from these areas. Development is to commence in January/February 1984 and to be completed by the beginning of September '84.

The details may be summed up as follows :

1. Zuurbekom/Gemsbokfontein compartment
   The envisaged rates of abstraction are:
   Zuurbekom compartment : RWB pump station 30 Mℓ/d
   New boreholes 52 Mℓ/d
   Gemsbokfontein compartment : Western Areas G.M. 30 Mℓ/d
   New boreholes 20 Mℓ/d
   As these compartments have in the past been adequately surveyed by gravity measurements, the following aspects only, require attention :
   Borehole and ground-water use inventory;
   Siting of boreholes on available data;
   Drilling and test pumping of boreholes;
   Evaluation of results and recommendations re equipping of boreholes;
   Engineering geologic aspects(risk of sinkholes, subsidence).
   It is proposed that all these aspects be dealt with by a firm of consultants competent in both hydro- and engineering geology.
   Drilling and test pumping to be given out on contract.
   The Division of Geohydrology to supervise.

2. Pretoria Area
   The envisaged rates of abstraction are as follows :

(i)	Western Fountains-Erasmia compartment	67 Mℓ/d
(ii)	Eastern Fountains compartment	24 Mℓ/d
(iii)	Rietvlei compartment	17 Mℓ/d
(iv)	Witkoppies compartment	34 Mℓ/d
(v)	Sterkfontein compartment	9 Mℓ/d
		151 Mℓ/d

   In the first three areas boreholes will be drilled on municipal and goverment land (Dept. of Defence). The same may be possible for (iv) and (v) but more information on ownership of land and water rights is required.

The Divisionof Geohydrology will concentrate its available personnel on the Pretoria and the Steenkoppies/Swartkrans areas.
The different aspects will be dealt with as follows :

Inventory of boreholes and ground-water use Gravity survey, Rietvlei compartment only Electromagnetic and magnetic surveys Borehole siting, control and supervision of drilling and test pumping operations including observations Evaluation and recommendations re equipping of boreholes and establishment borehole field(s)	Division of Geohydrology
Gravity surveys all compartments excluding Rietvlei	Geophysical contractor(s)
Drilling	Contractor(s)
Test pumping	Contractor(s)
Engineering geology including examination of all borehole cuttings	Engineering geological consultant

3. Steenkoppies-Swartkrans compartments
The envisaged rate of abstraction : 65 Mℓ/d. Abstraction in this area will have to be from private land and in competition with local users. This may necessitate compensation for temporary diminution or loss of water supply, arranging for an alternative supply or purchase or expropriation of water rights and/or land.

The different aspects of development of the ground-water supply will be dealt with in a similar manner as in the Pretoria Area.(see preceding paragraphs).

For more details consult Appendix I - a table detailing the nature and volume of work to be undertaken, time required and cost-, and Appendix J - a planning schedule. When comparing the demands of the Planning Schedule with the list of consultants and contracters (a) it is evident that there are an adequate number of hydrogeological and engineering geological consultants to choose from and that no problem should be experienced with the gravity surveys.
(b) it appears doubtful whether the number of competent drilling contractors and machines are enough to cope with the expected demand. It must be remembered that drilling in karstified dolomite is very difficult.
(c) it is clear that the sole test pumping contractor can not cope with the volume of work required. The available test pumps have insufficient capacities. Only one competent firm.

The Geological Survey can without detriment to its own program not assist except in an advisory capacity with regard to especially gravity surveys and engineering geologic aspects.

Likewise the Boring Services Subdivision has been excluded for two reasons: a lack of suitable drilling rigs and other heavy commitments. High level decisions will be required in both cases on priorities in order to change the position.

Aspects which have as yet not been looked at in detail are : monitoring of ground water levels during emergency abstraction; drilling of additional observation boreholes; full gravity cover of compartments for determination of storage capacity; monitoring for sinkhole formation and subsidences; ground-water modelling of the different compartments and assessment of eventual potential. These aspects will most probably require further services of consultants and contractors.
Is development of other dolomite compartments for the emergency supply envisaged?

Administrative personnel will have to be assigned to deal expeditiously with compensation for loss of water, purchase or expropriation of water rights or land. The Divisions of Hydrology, Planning, Irrigation and Engineering Services likewise will have to assist in determining the effects of pumping dolomitic ground water on runoff to dams, effects on irrigation water and planning of alternatives.

The possibility of declaring all dolomitic water, at least within the area of jurisdiction of the Rand Water Board but preferably also further afield, public water which can be exploited, integrated into surface water supply and allocated to different uses by the State, through an Act of Parliament, should receive urgent attention.

1(a) GEMSBOKFONTEIN KOMPARTEMENT (F.E. Wiegmans)

Die hoofkompartement beslaan 'n oppervlakte van 84 km² begrens in die noorde, ooste en weste deur ondeurlaatbare gange en in die suide deur die grens van dolomietdagsome. (Sien kaart 1). Suid van die hoofkompartement is daar dolomietdagsome waarvan 'n gedeelte hidrologies verbind is met die hoofkompartement. Die totale oppervlakte van die Gemsbokfontein kompartement word gestel op 100 km². Die gemiddelde jaarlikse aanvulling word beraam op 8 x 10^6 m³. Op grond van gedeeltelike ontwatering in 1971/73 en wat sedertdien weer aangevul is, word geraam dat 20 x 10^6 m³/jaar of 55 x 10^3/dag onttrek sou kon word sonder dat groot risikos met sinkgatvorming en versakking geloop word. Mynwater word vanaf vlakke 33 en 50 gepomp.

Onlangs is die noordstrekkende Magasyn of Phantom gang in die sentrale gedeelte van die kompartement vasgestel. Die gang blyk ondeurlaatbaar te wees vir horisontale grondwatervloei op die hoogte van of net laer as die huidige grondwatervlak.

Die Western Areas goudmyn is ten weste van die Magasyn gang geleë. In 1971 het die invloei van grondwater na die myn toegeneem : 25 x 10^3m³/dag tot 60 x 10^3m³/dag tot 120 x 10^3m³/dag. Aanvanklik is die kompartement ontwater maar weens die ontstaan van krake in die grond en sinkgate in die gevaar zones (ingekleurde gedeelte op kaart) word daar tans 93 x 10^3 m³/dag terug gepomp. Weens die hoë pompkoste hieraan verbonde het die myn besluit om te ontwater en verantwoordelikheid daarvoor te aanvaar. Die gedagte van die myn is om die uitgepompte water met 'n aanvaarbare gehalte aan die Rand waterraad te verkoop. 'n Permit aansoek vir ontwatering aan die Dept. van Omgewingsake word binnekort verwag en daar moet voorsorg getref word dat die myn nie die indruk verkry dat die staat of die Randwaterraad die kompartement wou sou ontwater nie.

Die myn pomp tans 45 x 10^3m³/dag grondwater uit die dolomiet vanaf vlak 33 (1 vlak = 30 meter) waarvan 15 x 10^3 m³ deur die myn gebruik word en 30 x 10^3m³ teruggepomp word. Die watergehalte is soos volg (soos telefonies verstrek deur mnr. Roos) en volgens opgawes ingedien :

	Dolomiet water (vlak 33) mg/ℓ	Mynwater (vlakke 50 en 33) mg/ℓ
Cℓ	6,3	21,1
Mg	62	212
SO_4	566	842,0
CO_3	630	688
NO_3(N)	7,7	5,2
Na	-	-
pH	8,0	7,3
TDS	1088	1366
	(Oktober 1983)	(Oktober 1983)

Volgens mnr. Roos kom daar 'n geringe hoeveelheid mynwater by die dolomiet water op vlak 33 by. Die dolomiet water toon besoedeling a.g.v. die verhoogde sulfaatinhoud.

Daar is dus 30 x $10^3 m^3$/dag beskikbaar vanaf die myn. Ten ooste van die Magasyn gang sal daar dus moontlik 20 x $10^3 m^3$/dag of 230 ℓ/s uit boorgate onttrek kan word. 'n Gravitasie opname van die gebied bestaan reeds en 'n kaart wat diep uitlogings sones van die dolomiet aandui (dieper as die huidige grondwatervlak) is vanaf die gravitasie gegewens geïnterpreteer (Sien kaart 2). Afhangende van grondwaterregte kan daar dus ten ooste van die Magasyn gang produksie gate in die uitlogingsones aangewys geboor word. Geen bykomende geofisiese of geologiese ondersoeke word beoog nie. 'n Opname van boorgate en besproeiing is egter noodsaaklik. Om 230 ℓ/s te onttrek sal ongeveer 10 produksieboorgate geboor moet word.

ADDENDUM

AREAS OF POTENTIAL SINKHOLE FORMATION AND GROUND SUBSIDENCES IN THE GEMSBOKFONTEIN COMPARTMENT AS INFERRED FROM AVAILABLE GRAVITY-, BOREHOLE- AND WATER LEVEL INFORMATION - J.H. T. Beukes (Geological Survey)

1. Introduction

A gravity survey of both the Gemsbokfontein and Suurbekom compartments was carried out by the Geological Survey in the early 1970's. Measurements were taken on a 100m grid and a residual gravity contour map was produced.

The hatching on the accompanying map of the Gemsbokfontein compartment reflects areas which are interpreted to be leached to below the ground-water table. These leached zones in the dolomitic bedrock contain lower density residual materials (wad, chert and chert breccia) and Karoo sediments (mainly shale and clay). The unhatched zones reflect areas where solid dolomitic bedrock is interpreted to be relatively shallow and mostly above the present ground-water table.

2. Sinkholes

The northwestern corner of the compartment where the present water level is less than 30m below the surface is the area that will be most susceptable to the formation of sinkholes. The probability of sinkhole formation is highest for the area of shallowest water table. The main developments in this area are a short section of the Randfontein-Vereeniging road and the Donaldson Dam.

It is expected that relatively few sinkholes will occur over the main portion of the compartment, that is where the water table is deeper than 30m. The northern boundary of Karoo sediments, as delineated on the map, defines an area of more stable conditions to the south. There is only a slight possibility of sinkholes forming where thick layers of Karoo sediments are present with little wad below.

Over large gravity-low areas on the higher ground in the southern part of the compartment, a few large sinkholes may occur after the water table has been drawn down by 200m or more.

3. Ground Subsidence

The interpreted zones of deeper leaching shown on the map, are areas which could be weakened during dewatering of the compartment. Ground settlement could occur, the extend depending on the compac-

tibility and thickness of the material being dewatered. In the areas of actual subsidence the greatest differential movement will obviously occur over the edges i.e. greatest damage to structures will occur there.

4. Possible effect of the magazine (Phantom) dyke

If it is found that the Magazine dyke, as recently reported by Spectral Africa Ltd, represents an impervious ground water barrier from the ground water level or slighty below it, there will be no dewatering or only a slight drawdown east of this dyke. The eastern half of the compartment (approximately half of the area) should then not be affected by the dewatering.

1(b) ZUURBEKOM KOMPARTEMENT (F.E. Wiegmans)

Die Zuurbekom kompartement beslaan 'n oppervlakte van 130 km² begrens in die suide, ooste en weste deur kompartementerende gange en in die noorde deur die dolomietgrens (sien kaart 1 en 3). Gangintrusies in die kompartement veroorsaak 'n mate van sub-kompartementering. Noordwaarts styg die grondwatervlakke in ooreenstemming met die topografie of a.g.v. subkompartementering. Die 0-30m grondwatervlak/sones (ingekleur) word benaderd aangedui op die meegaande kaart. Die sones het dan ook die grootste potensiaal vir sinkgatvorming indien grondwatervlakke in die sones met meer as 6 meter sou daal.

Tans onttrek die Randwaterraad d.m.v. bestaande installasies 30 x $10^3 m^3$/dag grondwater vir watervoorsiening aan Soweto uit die Zuurbekom kompartement. Die onttrekking is in dieselfde orde as die gemiddelde jaarlikse aanvulling van 11 x $10^6 m^3$. Indien die oorspronklike grondwatervlak huidig baie min afgetrek is sou sonder oormatige verlaging (minder as 6 meter) 40 x $10^6 m$ of 110 x $10^3 m^3$/dag uit berging oor 'n periode van 1 jaar onttrek kon word, m.a.w. 'n addisionele 80 000 m^3/dag (925 ℓ/s). A.g.v. die droogte is die watervlakke moontlik reeds in 'n mate afgetrek en sal daar moontlik minder onttrek moet word. Die verhoging van die pomptempo uit Zuurbekom kompartement kan plaasvind deur die bestaande installasies van die R.W.R. en die daarstelling van 24 bykomende produksiegate teen 'n gemiddelde lewering van 25 ℓ/s m.a.w. 'n bykomende 600 ℓ/s word beoog.

Daar bestaan 'n gravitasie-en boorgat-opname van die gebied en eksplorasiegate is reeds voorheem geboor. Dié inligting word tans geïnterpreteer deur personeel van die Geologiese Opname en 'n soortgelyke kaart wat die diep uitgeloogde ones van dolomiet aandui (soos vir die Gemsbokfontein kompartement) asook die posisies van beoogde produksieboorgate word voorberei om in die eerste week van Desember 1983 gereed te wees. Geen bykomende geofisiese en geologiese werk word tans beoog nie. 'n Opname van boorgate en besproeiing is nodig om o.a. te bepaal of daar ongebruikte boorgate of eksplorasieboorgate bestaan wat vir produksie aangewend kan word.

Die gravitasie-gegewens dui daarop dat diep uitgeloogde dolomiet sones (dieper as huidige watervlak) deur die kompartement verspreid voorkom en dat beoogde produksie gebiede o.a. afhang van die grondwaterregte waaroor die Randwaterraad beskik (Sien kaart 4).

2. PRETORIA DOLOMITIESE GEBIED (Dr. D.B. Bredenkamp)

1. Inleiding

Die Pretoria dolomiet is om verskeie redes gunstig vir die ontginning van grondwater tydens kritieke droogtetoestande soos wat tans ondervind word.

Die ontginning van ondergrondse water uit die dolomiet by Pretoria is oorweeg aan die hand van

i) Gebiede wat gunstig sou wees vir produksie boorgate met hoë leverings volgens oppervlakaanduidings en in sommige gevalle bestaande gravitasie opnames.

ii) Gebiede wat die minste probleme met sinkgatvorming en versakkings sou gee.

iii) Terreine wat in die eiendom van die stadsraad van Pretoria of die eiendom van die staat is (Verdediging).

iv) Die nabyheid van bestaande pypnetwerke en gebiede waar die water aangewend kan word.

Hiervolgens is die volgende terreine uitgekies waar die ontwikkeling van produksievelde oorweeg kan word - sien Kaart 5.

1. Westelike fonteine/Erasmia kompartement - Gebied A

   1.1 Fonteinedal-Wes - Gebied A1
   1.2 Gebied suid van Eeufeesweg - Gebied A2
   1.3 Snake Valley - area - Gebied A3
   1.4 Gebied suid van Swartkop tot aan die Sesmylspruit - Gebied A4
   1.5 Montaque Kneen Park in Valhalla - Gebied A5
   1.6 Voortrekkerhoogte Wes - Gebied A6
   1.7 Erasmia fontein gebied - Gebied A7
   1.8 Kwaggasrand-Schurweberg - Gebied A8

2. Oostelike fontein kompartement - Gebied B

   2.1 Fonteinedal - Gebied B1
   2.2 Kultuur historiese Museum terrein - Gebied B2

3. Rietvlei kompartement - Gebied C

4. Witkoppies kompartement - Gebied D

   4.1 Grootfontein gebied - Gebied D1
   4.2 Witkoppies Wes - Gebied D2

5. Sterkfontein kompartement - Gebied E

Die oostelike en westelike Doringkloof kompartement is nie ingesluit nie omrede die Munisipaliteit van Verwoerdburg te kenne gegee het dat hulle nie ten gunste van grondwateronttrekking uit die dolomiet is nie en dit op die hoogste vlak sal teenstaan.

2. Bespreking van spesifieke gebiede

2.1 WESTELIKE FONTEINE/ERASMIA KOMPARTEMENT - KOMPARTEMENT A

Die westelike en suidelike kompartementgrense is nie presies bekend nie, maar die noordelike grens word gevorm deur die Pretoria Series en

oostelike grens deur die prominente noord-suid senietgang - die Pretoria gang wat min of meer met die Fonteine - Kloofsig pad saamval.

Die kompartement word dreineer deur die laer fontein by die Fonteinedal (lewering 180 ℓ/s) wat reeds by die watervoorsieningsnetwerk van Pretoria ingeskakel is.

Die kompartement kan egter verder d.m.v. boorgate ontwikkel word in die volgende gebiede :

2.1.1 Fonteinedal-Wes - Gebied A1
5 Produksie boorgate word beoog, met 'n totale lewering van 270 ℓ/s vir die boorgate en die fontein gesamentlik. Die aftrekking sal na verwagting nie meer as 2 meter wees nie sodat versakkings nie 'n probleem behoort te gee nie.

2.1.2 Suid van Eeufeesweg en Wes van Ben Schoeman hoofweg - Gebied A2
Hierdie gebied behoort aan Dept. Verdediging en is so pas deur Geologiese Opname ondersoek vir fondasies. Die boorgate wat geboor is, is te vlak gestaak en die lewering van die dolomiet is nie bekend nie, sodat verdere boorwerk nodig is. Verwagte lewering is 100 ℓ/s uit 4 produksieboorgate.

2.1.3 Snake Valley (Dept. Verdediging) - Gebied A3
Hierdie gebied is reeds gravimetries opgemeet en eksplorasieboorwerk kan gou begin word. Die verwagte lewering van die gebied is 60 ℓ/s uit 3 boorgate. As gevolg van die nabyheid van die Ben Schoeman hoofweg en ander geboue sou groter onttrekkings moontlik sinkgat probleme kan oplewer.

2.1.4 Suid van Swartkop tot aan Sesmylspruit - Gebied A4
Die grootste deel van die gebied behoort aan Dept. Verdediging. Skynbaar is daar reeds 'n paar boorgate met goeie lewerings. Gravitasie opnames is nodig.

Verwagte opbrengs van gebied is 100 ℓ/s uit 4 produksieboorgate.

2.1.5 Montaque Kneen Park - Gebied A5
Die Stadsraad van Pretoria het in die verlede water uit boorgate in die park ontgin. Die gate het egter in onbruik geraak en pogings om nuwe gate te boor was nie suksesvol nie. Die Stadsraad is gretig dat boorgate gesink word. Die lewering word op 60 ℓ/s uit 3 produksieboorgate geraam. Geen gravitasie opnames is nodig nie.

2.1.6 Voortrekkerhoogte Wes - Gebied A6
Hierdie gebied is nie op die oog af baie gunstig nie, maar behoort nogtans ondersoek te word omdat dit digby die RWR pyplyn is. Die gronde behoort ook aan Verdediging. Die lewering kan sowat 40 ℓ/s wees uit 2 boorgate.

2.1.7 Erasmia fontein (Grondeienaar Basson) - Gebied A7
Twee boorgate by die Erasmia fontein voorsien tans in al die waterbehoeftes van Erasmia. Die gemiddelde pomptempo is sowat 33 ℓ/s. Die lewering van die boorgate is volgens inligting 90 ℓ/s elk en verdere eksplorasieboorwerk is nodig ten einde sowat 100 ℓ/s te kan onttrek uit 3 boorgate.

2.1.8 Kwaggasrand - Schurweberg - Gebied A8
Op grond van 'n inspeksie ter plaatse is die gebied wes van Kwaggasrand en in die noordwestelike hoek van Schurweberg ook belowend en moet ondersoek word omdat dit water aan Atteridgeville kan voorsien.

Voorlopig word 'n lewering van 50 ℓ/s as mikpunt gestel uit 2 boorgate.

2.2 OOSTELIKE FONTEINE KOMPARTEMENT

2.2.1 Boonste fonteine - Fonteinedal - Gebied B1
Die kompartement lê tussen die noordsuid Pretoria gang en die Daspoort skalies en strek tot suid van die Waterklooflughawe. Die huidige vloei van die fontein is ongeveer 115 ℓ/s en d.m.v. boorgate kan die lewering verhoog word met ongeveer 60 ℓ/s uit 3 boorgate.

2.2.2 Kultuur historiese Museum - Gebied B2
Boorgate al met die oostelike loop van die Apiesrivier en by die museum terrein behoort 'n bykomstige 100 ℓ/s te lewer d.m.v. 4 produksieboorgate. Enkele gravitasielyne is moontlik nodig.

2.3 RIETVLEI KOMPARTEMENT - GEBIED C

Die gebied is by uitstek geskik om addisionele grondwater te ontgin, omdat daar reeds van drie fonteine water verkry word - totale lewering 18 ℓ/s en omdat die grond aan die Stadsraad van Pretoria behoort en die oostelike RWR pyplyn deur die gebied loop.

Hierdie gebied sal deur die Afdeling Geohidrologie geofisies opgemeet word ten einde eksplorasieboorgate te boor en uiteindelik sowat 200 ℓ/s uit 8 boorgate te ontgin. Die fonteine sal na alle waarskynlikheid opdroog maar die bestaande pyplyne kan steeds benut word.

2.4 WITKOPPIES KOMPARTEMENT - GEBIED D

2.4.1 Grootfontein area - Gebied D1
Die Grootfontein lewer tans sowat 60 ℓ/s maar d.m.v. boorgate kan die lewering tot 250 ℓ/s opgestoot word. (10 produksie-boorgate).

2.4.2 Westelike area - Gebied D2
Omdat die Witkoppies kompartement so groot is, word 'n tweede produksieveld in die westelike deel beoog - 6 boorgate met 'n lewering van 150 ℓ/s.

Alhoewel die waterregte van die Grootfontein aan die Stadsraad van Pretoria behoort, is die grond in privaatbesit. 'n Gedeelte behoort egter aan Verdediging (verder suid). Die eiendomsreg sal verder ondersoek moet word.

2.5 STERKFONTEIN KOMPARTEMENT - GEBIED E

Die Sterkfontein voorsien tans sowat 60 ℓ/s aan die Stadsraad. Die lewering behoort na 100 ℓ/s uit 4 boorgate verhoog te kan word. Die gebied wat aan die Stadsraad behoort is nie presies bekend nie.

3. Werksprogram

Die omvang van die opnames en geofisiese werk en boorwerk wat uitgevoer moet word in die gebiede word in Tabel 1 aangetoon.

3 UTILIZATION OF GROUND WATER FROM THE STEENKOPPIES-ZWARTKRANS AREA TO SUPPLEMENT SURFACE WATER RESOURCES IN THE PRETORIA-WITWATERSRAND-VEREENIGING COMPLEX (C. v.d. Westhuizen and P.J. Hobbs)

1. Introduction

Recent developments in regard of the utilization of ground water to supplement the surface water resources of the PWV complex has focussed attention on the dolomitic aquifers of, amongst others, the West Rand in the near vicinity of the Rand Water Board supply pipe-line (see Map 6).

2. Areas of potential high yield

The Steenkoppies-Zwartkrans area can be divided into two sectors for the purpose of this report, namely :

2.1 The sector east of the supply pipe-line :
This sector supports a few high-yielding boreholes centred along the Rietspruit valley with low-yielding boreholes occurring on topographic highs. Owing to the topographical nature of the environment, leaching of the dolomite is probably restricted to the valley's only, with consequently lesser storage than the eastern sector of the Steenkoppies Compartment. The presence of a recently drilled high-yielding borehole in the vicinity of the pipe-line is however significant.

a) Irrigation : (see also Map 6 for localities of fountains and boreholes)

i) Springflow
Usage of flow from fountains for irrigational purposes is restricted to the Kromdraai and Sterkfontein areas, listed below :

Kromdraai - 138 ha : F3 (155 ℓ/s)
Sterkfontein - 40 ha : F1 (15 ℓ/s)

ii) Ground-water
Ground-water is used for the cultivation of mainly vegetables on farm Sterkfontein 173 IQ.

Boreholes with yields in excess of 15 ℓ/s irrigate a total area of approximately 50 ha.

The above does not take into account the small-scale irrigation on the numerous small-holdings. Dependence of such holdings on ground water abstraction for house-hold purposes should also be considered seriously in the event of utilization of this aquifer.

2.2 The sector west of the supply pipe-line :
This sector represents the western portion of the Zwartkrans Compartment, mainly the Beckedan and Marabeth small-holdings, as well as the eastern portion of the Steenkoppies Compartment. Occurences of high-yielding boreholes on the farms Groenplaats 157IQ and Vlakplaats 160IQ, yields in excess of 25 ℓ/s are not uncommon, are probably indicative of the vast storage of ground water in this topographically flat dolomitic aquifer.

a) Irrigation : (see also Map 6 for localities of boreholes)

The use of surface and other sources of water for irrigation within compartment boundaries is limited to insignificant abstraction from the Rietspruit and a network of canals.

i) Ground-water
Ground-water abstraction from several high-yielding boreholes is used solely for the production of vegetables and flowers. The area under irrigation totals some 340 ha.

ii) Springflow
Maloney's Eye, situated approximately 3/4 km north of the northern boundary of the compartment, serves as a natural outlet for the ground-water stored in the Steenkoppies Compartment. Outflow from this spring, varying between 11 x $10^6 m^3$ and 22 x $10^6 m^3$ per year, is directly discharged into the Magalies River, representing approximately 60 percent of the total flow during the critical period (August to October for this area). The area irrigated during the last survey (1971 by the Hydrological Division) was approximately 2500 ha.

Present indications are that ground-water storage may be sufficient to maintain the demand for both irrigation and supply towards the Rand Water Board pipe-line. However, on the long run, as the cone of dewatering increases, borehole yields may diminishes and flow towards the Maloney's Eye decreases, jeopardizing irrigational activities dependent on these sources.

3. Recommendations

From a geohydrological viewpoint, the utilization of ground-water from the Steenkoppies-Zwartkrans area becomes a viable proposition providing that :

i) an intensive geohydrological and geological investigation is carried out, and

ii) a geophysical survey is performed as a help in defining dyke positions as well as favourable borehole sites.

Geohydrological and geological investigations should be aimed towards :

i) surveying the area for high-yielding structures other than leached dolomite,
ii) borehole information, especially boreholes drilled for exploratory purposes by some mining companies,
iii) water consumption and usage by the various bodies and farmers concerned,
iv) determining the possible influence of large-scale, long-term abstraction on the regional ground-water regime as well as the effect it would have on springflow (Maloney's Eye and Zwartkrans)
v) determining the effect of lowering of the water table on borehole yields and thus on owners of small-holdings.

Geophysical surveys, pending initial results, should be restricted to exploratory gravimetric surveys in conjunction with ground magnetic and electro-magnetic procedures in target areas (see Map 6).

The detailed nature and volume of work to be undertaken, including a time and cost analysis appear in Appendix 1, while Appendix J shows the planning schedule.

4. SINKGATVORMING EN GRONDVERSAKKINGS MET VERLAGING VAN DOLOMITIESE GROND-WATERVLAKKE - F.E. WIEGMANS

1. Singate :

Die potensiaal vir sinkgatvorming word verhoog indien :
- die oorspronklike grondwatervlak minder as 30m onder oppervlakte was,
- die dolomiet dieper as die oorspronklike grondwatervlak uitgeloog is en
- die oorspronklike grondwatervlak met meer as 6 meter verlaag word.

2. Grondversakkings :

Grondversakkings kan plaasvind in gebiede waar die oorspronklike grond-watervlak dieper as 30m was, met die omvang 'n funksie van kompakteer-baarheid en dikte van die materiaal wat ontwater word. Die grootste differentiële beweging m.a.w. skade aan strukture sal plaasvind op die rand van uitgeloogde sones.

In gebiede waar die oorspronklike grondwatervlak dieper as 30 meter is, is die meganisme vir sinkgate hoofsaaklik opdamming van oppervlak-water en nie soseer watervlakdaling nie.

APP.A

I GEOHYDROLOGICAL CONSULTANTS (FOR DOLOMITE INVESTIGATIONS) - IN ORDER OF COMPETENCE

1. Steffen, Robertson and Kirsten
   P.O. Box 8856
   Johannesburg
   2000
   TEL. 011 832-6201
   Contact person : D. Connelly
   Remarks : part of large engineering and geotechnical organisation. Have also expertise in Engineering Geology. The firm have already detailed knowledge of the Zuurbekom and part of the Gemsbokfontein area by way of previous investigations for Mining Companies.

2. E. Martinelli & Associates
   P.O. Box 51316
   Randburg, 2125
   TEL 022 782-0041
   Remarks : experienced hydrogeologists. Staff available about six. Extensive experience in dolomitic areas in Zambia and R.S.A.

3. Gombar & Gombar
   42 Henry St
   King Williamstown 5600
   TEL. 0433-22317
   Remarks : Mr. A. Gombar is an experienced hydrogeologist (formerly Chief Hydrologist of Div. of Geohydrology) and an expert on testpumping. Presently the organisation is only two persons plus a boring chargehand.

4. Partridge, de Villiers & Associates
   Pretoria address (D.J. de Villiers) : 6 Newway Centre
   Villiera)186
   TEL 702214
   Johannesburg address (Dr Partridge) : 12 Cluny Rd
   Forest Town 2193
   TEL 011 646-3324
   Remarks : only 2 geologists available, no geophysical expertise. Mainly engineering geological consultants (Mr. D.J. de Villiers)

5. Dames & Moore (Pty) Ltd
   P.O. Box 78200
   Sandton 2146
   TEL 011 783 7120
   Contact person : Mr. Sara
   Remarks : claim to have 4 geologists available. Expertise is somewhat doubtfull.

6. R.F. Loxton, Venn & Ass.
   P.O. Box 39265
   Bramley 2018
   TEL. 011 786-6000
   Contact person : Dr. E.C. Thatcher
   Remarks : presently the whole geological division number only 4 persons. (Dr. Thatcher included),with Mr. v. Straaten doing hydrogeology, part time.

II ENGINEERING GEOLOGICAL CONSULTANTS (who can deal with ground water-related problems in dolomite)

1. Weber, de Beer & Assoc.
   P.O. Box 55291
   Northland 2116
   TEL. 011 788-2617
   Contact person : Mr. J.H. de Beer
   Remarks : recommended by Geological Survey. The firm has extensive experience in dolomitic areas; 2 eng. geologists and 2 geotechn. engineers.

2. P.G. Hartop and Assoc.
   P.O. Box 391152
   Bramley 2018
   Remarks : recommended by Geological Survey. Mr. Hartop back from the field by 24 Nov. '84.

3. Partridge, de Villiers & Associates
   Pretoria address (D.J. de Villiers) : 6 Newway Centre
   Villiera 0186
   TEL : 702214
   Johannesburg address (Dr. Partridge) : 12 Cluny Rd
   Forest Town 2193
   TEL : 011 646 3324
   Remarks : only 2 geologists available, no geophysical expertise. Mainly engineering geological consultants (Mr. D.J. de Villiers) and recommended by Geological Survey.

4. Steffen, Robertson and Kirsten
   P.O. Box 8856
   Johannesburg 2000
   TEL. 011 832-6201
   Contact person : D. Connelly
   Remarks : part of large engineering and geotechnical organisation. Have also expertise in Engineering Geology, but tend to incorporate a lot of irrelevant information. They have carried out an investigation in the Zuurbekom Compartment for a mining company.

5. Webb & Associates
   P.O. Box 511
   Hartebeespoort 0216
   TEL. 01211-20124 and Carltonville 01491-2868
   Contact person : Dr. Wolmarans
   Remarks : claim to have extensive experience in dolomitic areas. A geophisicist is also on their staff, not recommended by Geological Survey.

6. Bruinette, Kruger & Stoffberg (Inc.)
   SAAU Bld., Schoeman St.
   Pretoria 0002
   Remarks : a large firm. They will submit an offer in writing. As far as is known they don't have suitably trained/experienced personnel for the envisaged contracts.

NB : Due to the specialised nature of the investigations, it is recommended that the selection of the consultant(s) should be based on a submission of a quotation, to be judged by Chief, Geohydrology in conjunction with the Geological Survey - and not by tender or the "Terrain Commission".

APP. No. B

GEOFISIESE KONTRAKTEURS VIR GRAVITASIE OPNAMES

'n Lys van geofisiese kontrakteurs wat gravitasie opnames onderneem verskyn in meegaande selfverklarende tabel. Die nommervolgorde in die tabel dui die voorkeurvolgorde in dalende hoedanigheid van die verskeie kontrakteurs.

Die kontrakteurs beskik self oor of kan gravimeters huur wat die totale gesamentlike aantal instrumente op 17 gravimeters stel. Om moontlike oorvleueling tydens huur van instrumente uit te sluit is daar vir beplanningsdoeleindes op 13 beskikbare gravimeters gereken. 'n Gemiddelde aantal van 60 stasie/dag met 'n herhaalbaarheid van 0,03 mgal is as tempo aanvaar vir 'n 50 x 50 rooster tot 'n 100 x 200 rooster.

Die Geologiese Opname beskik oor 4 gravimeters wat aan die Dept. Omgewingsake beskikbaar gestel word. Weens 'n tekort aan personeel kan die Geologiese Opname nie hulp met veldwerk verleen nie. Slegs Bougeuranomaliekaarte word van die kontrakteurs verwag, die moontlike terrein-korreksies, verwerking en interpretasie sal deur die personeel van die Geologiese Opname en Afd. Geohidrologie gehanteer word.

Met die 4 gravimeters van Geologiese Opname sal die Afd. Geohidrologie in staat wees om die beoogde gravitasie opname in die Rietvlei Kompartement af te handel. Alle ander beoogde gravitasie opnames sal op kontrak uitgegee moet word om die afhandeling daarvan te bespoedig.

Alle magnetiese en elektromagnetiese opnames sal deur die Afd. Geohidrologie behartig word, indien nie gespesifiseer word nie.

GEOFISIESE KONTRAKTEURS

	KONTRAKTEUR	AANTAL GRAVIMETERS	BESKIKBAARHEID NADAT TENDER GOEDGEKEUR IS	OPMEET EN UITLê VAN STASIES	NAME VAN PERSONE WAT GRAVITASIE LESINGS SAL WAARNEEM
1.	Relly, Milner and Shaddon P.O. Box 32107 Glenstansia 0010 Tel (012) 43-7303 Brian Milner	2 self	10 dae	Self	Olliver Wright, Peter Dow, Bernard Sekati, Brian Milner
2.	Geodaso S.A. (Pty) Ltd. P.O. Box 61447 Marshalltown 2107 Tel (011) 331-2711 Trevor Grace	4 self Moontlik verdere 2	Onmiddelik 2-3 weke indien nodig	Self	Nevil Brown, Roy Kendall, Mclelland, Ansara, Trevor Grace, Marchesi
3.	Steffen, Robertson and Kirsten P.O. Box 8856 Johannesburg 2000 Tel (011) 832-1201 Johan Faurie	2 self	1 week	Gebruik konsultant. Howard Brown Tel(011) 7067474 Sal self met konsultant kontrak aangaan	Kevin Mitchell, Dirk Stigter
4.	Loxton Venn and Associates P.O. Box 39265 Bramley 2018 Tel (011) 796-6000 N.R. Wainwright	1 self 2 kan gehuur word	1 week	Konstultant Sal self met Konsultant kontrak aangaan	N.R. Wainwright, A. Watson, Oliver Wright (J. van Straten - Geofisikus)

	KONTRAKTEUR	AANTAL GRAVIMETERS	BESKIKBAARHEID NADAT TENDER GOEDGEKEUR IS	OPMEET EN UITLê VAN STASIES	NAME VAN PERSONE WAT GRAVITASIE LESINGS SOU WAARNEEM
5.	Geoterrex P.O. Box 391448 Bramley 2018 Tel (011) 786-2067 Hampson	2 self	2 weke	Self	Hampson Neil - beskikbaar na 23.12.1983
6.	Webb and Associates Posbus 511 Hartbeespoort 0216 Tel (011) 20124 Johan Wentzel	kan 2 huur	Januarie 1984 (moontlik Desember 1983)	Self	Robbie Schoeman, Leon Wentzel

APP. No. C

OPMETINGSKONTRAKTEURS (opgestel deur Opmetingsdienste)

NAAM EN ADRES	TELEFOON
Antelme J.G.M. Posbus 11025 Brooklyn 0011	46-9248/9
Bekker en Whitehorn Lawleystraat 430 Waterkloof 0181	46-3396
Bell en Muller Evalaan 1 Waverley 0186	73-6861
Court G.L. Posbus 1216 Pretoria 0001	28-3046
Greef T.G. en H.J. Trevorstraat 34 Murrayfield 0184	Kantoor : 47-2679 Thomas : 83-1468 Hendrik : 97-1600
Pienaar S.W. Posbus 710 Pretoria 0001	26-2679
Viljoen M. Posbus 20433 Alkantrant 0005	Kantoor : 86-2008 Huis : 57-4295
Opmetingsdienste (Edms) Bpk Posbus 27792 Sunnyside 0132	79-8915
Nick van Dyk	44-8333
Christison H. P.O. Box 7069 Primrose Hill 1416	(011) 825-6676
Coetzee K.A. 261 Brooklyn Road Brooklyn 0181	43-3963

NAAM EN ADRES	TELEFOON
Coetzer P.W.J. Posbus 15366 Lynneast	82-1298
Manthé N. Posbus 681 Silverton 0127	86-8185
Uys C.J. Posbus 68626 Bryanston 2021	(011) 793-5765 (H) (011) 23-6762/3 (W)
Vermeulen P. Posbus 20256 Alkantrant 0005	47-6191/2/3
Viljoen S.P. Posbus 27282 Sunnyside 0132	45-1857
Wiggill E.H. Swemmerstraat 718 Rietfontein 0084	70-5732
Williams J.L. Posbus 28792 Sunnyside 0132	42-6153
Hennie Luus	(011) 763-2234

APP. D.

BORING CONTRACTORS

FOR DRILLING OF EXPLORATION AND PRODUCTION BOREHOLES IN DOLOMITIC AREAS

I. PROBABLY BEST EQUIPPED AND EXPERIENCED

1.1 Aarwater (Pty) Ltd
P.O. Box 6136
Bloemfontein, 9300
Tel. 051-84374
Contact persons : Mnr. Muller, Mr. L.T. Kennedy

Available by January 1984 :
at least four combination rigs (Schram and others) and if necessary two rotary-mud machines.

Experience in dolomitic areas :
quite extensive, including contract with Dir. of W.A. in the Gathlose area, Northern C.P. in early 1983.
Remarks : probably the best contractor.

1.2 F.B. Drilling 'Pty) Ltd
P.O. Box 3914075
Bramley 2018
Tel. 011 786-4442
Contact person : (Manager) Mr. L. van Poppering

Available by January 1984 :
About 7 rigs : 5 combination machines (Dendo?) and two air rigs (Schram)

Experience in dolomitic areas :
quite extensive but mainly for pilot holes to be followed by diamond drills. Randfontein Estates.
Remarks : F.B. Drilling is associated with Frankipile, a large engineering contractor. The firm should have the necessary resources.

II. DOUBTFULL CONTRACTORS

2.1 Booysen & Booysen(Edms) Bpk
Posbus 24
Bon Accord
Tel (012) 554165
Contact person : Mr. Booysen

Available by January 1984 :
5 Air rigs with percussion drill for following work.
Compressors can be rigged in tandem if required.

Experience in dolomitic areas :
claim to be quite extensive, including exploration holes for Geological Survey.

Remarks : Experience of contract work for Boring Subdivision about 3 years ago was poor. SRK (Mr. Connelly) said that their experience with B & B was very poor.

2.2- Universal H.S. Drillers (Pty) Ltd
P.O. Box 1390
Edenvale
Tel. 011- 609-8230
Contact persons : du Preez (rather new with the firm)
Manager : Mr. F. Goddard

Available by January 1984 :
about four air-rigs, including a Schram crawler. A booster compressor is available.

Experience in dolomitic areas :
limited to pilot holes for mining companies, du Preez couldn't tell me which. No experience with boreholes for ground-water exploitation. Their drilling efforts in Valhalla for the Pta - Municipality was not a success. SRK (Mr. Connelly) said that the firm was not very efficient, and their operations require close supervision.

2.3 Cementation (Pty) Ltd. (Part of the Goldfields Group)
Contact person : Mr. Lombard
Tel : company on 833-1430
Mr. Lombard (presently) at Carltonville :
01491-811061

Remarks : Although a very large firm, they are specialised in drilling for grouting purposes with 100mm boreholes. No experience with ground-water drilling in dolomite.

2.4 F. Fairbrother Drilling Co
Estmil Close
Diep River 7800
Tel 021 72-7153

Remarks : An (unsuccessful) tenderer for a drilling job in the Cape Flats. The company has extensive experience in drilling in unconsolidated formations and borehole development, but none in dolomitic areas; they are far away from the job and expensive.

2.5 McLaren & Eger (Pty) Ltd
P.O. Box 31058
Braamfontein 2017
Tel 011 392071

Remarks : A large firm, but specializing in large-diameter exploration holes and foundation drilling. No experience with ground-water exploitation.

2.6 Boring Subdivision of Dir. of W.A.
Presently all the machines are fully committed with drilling in the drought stricken areas with a long list of applications ahead. However, the matter should be taken up at higher level in the near future; circumstances might change. The subdivision could be engaged where the dead line is not so critical.

III. SMALLER CONTRACTORS

3.1 J. de Klerk, Oberholzer, tel 01491-4387
Claims to have extensive experience in dolomitic areas. Has 3 air rigs and 5 jumper rigs available. Should be contacted to submit a tender.

3.2 Presisie Boorwerk, Brandfort, Tel 05222 x 377
Mr.Groenewald has drilled cheaply and quite efficiently in Karoo-formations on contract for the Ground Water Institute of the UOVS (Prof. Hodgson)
No reply to telephone calls.

APP No. E

CONTRACTORS FOR BOREHOLE YIELD TESTS

1. Ground-water Practicioners
   P.O. Box 107
   Sundra 2200
   Tel. 011 732-1010
   Contact person : Mr. Shearer (director)
   Remarks : the only known reliable and competent contractor. Has presently only one set of equipment, capable of delivering 37 ℓ/s for long duration tests, but to 50 ℓ/s for short periods (one hour).

2. Water test (Pty) Ltd
   P.O. Box 796
   Pretoria 0001
   Tel. 63-2422
   Contact person : Mr. Ferreira
   Remarks : max pump capacity 30 ℓ/s (insufficient capacity) but could be considered.

3. Spraymore irrigation Tel 72344
   Pretoria
   Contact person : Mr. Boet Joubert
   Remarks : Recommended by J.B. Stamp and by Dames & Moore. Owner could not be contacted by telephone.

   Also contacted : "Olivier Pompe", Pretoria 73-4037, Very limited pump capacity and therefore can not be considered (7,5 ℓ/s) but Mr. Olivier has extensive experience with hydrological test pumping.
   D.J. Burke (Pty) Ltd. Tel. 011 693-3714
   Box 217
   Randfontein
   Recommended by SRK. Could not be contacted by telephone.

APP. F

DRAFT SPECIFICATION FOR HYDROGEOLOGICAL CONSULTANCY

1. It is deemed necessary that hydrogeological work be conducted in the Zuurbekom/Gemsbokfontein (see attached map) dolomitic area for exploitation of the ground water resources for metropolitan use.

   The work would consist of the following :

   a) Siting of production of boreholes capable of yielding more than 25 ℓ/s on the basis of available geological, geophysical and borehole data supplemented, if necessary, by additional geological/geophysical work.

   b) Assisting if required in arranging contracts for drilling and test pumping of boreholes.

   c) Drawing up of an inventory of all boreholes in existence in the area.

   d) Supervision and control of drilling operations including geological logging and if required geophysical logging of boreholes.

   e) Conducting step-drawdown and constant yield tests as required.

   f) Evaluation of drilling and test pumping results and advising accordingly on the equipping and establishment of borehole field(s).

   g) The final report should inter alia give estimates of the short and long term abstraction rates and volumes per compartment; indicate what the chances are of sinkhole formation and/or subsidence and advise on a ground water, sinkhole and subsidence monitoring system.

2. The field investigations, drilling and test pumping as well as advise on equipping and establishment of boreholes field(s) will have to be completed not later than .....

3. The investigation will be conducted by the Consultant on the basis of a modus operandi to be submitted by the consultant and approved by the Chief, Geohydrology prior to the initiation of such investigations.

4. The Consultant shall commence with active field operations not later than 15th January 1984.

5. The consultant shall submit certificates as and when required to the Director-General to the effect that the drilling and test pumping have been executed satisfactorily so that payment can be made.

6.1 The personnel assigned by the consultant to the investigation shall be competent and highly qualified in the field of geohydrological investigations and the persons in charge of various aspects of the field operations shall be professional, academically qualified men.

6.2 The consultant shall at the request of the Chief, Geohydrology and without derogating from the consultants liability in terms of this Agreement, forthwith replace at the consultants expense any officer involved in the investigation who is in the opinion of the Chief, Geohydrology undesirable on account of incompetence, lack of qualification, misconduct or for reasons of security.

7. The consultant as independent operator herewith indemnifies the Minister against any claim for the payment of damages which may arise through injury or damage to the person or property of any person as a result of the consultants activities : Provided that nothing herein contained shall be deemed to render the consultant liable in respect of :

(i) a claim for fees allowing access to any property or fees for permitting the erection of works on any property; and

(ii) a claim arising from any act or omision by officers of the Directorate of Water Affairs.

8. The consultant shall at its own cost supply and transport all equipment and personnel required for the investigation.

9. The consultant shall treat the details of the Agreement, the nature of the investigations and the results thereof as private and confidential. No particulars may be disclosed at any time in any trade or technical paper or elsewhere without the prior consent in writing of the Director-General.

10.1 While operations are in progress detailed fortnightly progress reports shall be submitted to the Chief, Geohydrology.

10.2 A final report shall be submitted to the Chief, Geohydrology within 2 months of completion of field operations.

11.1 A claim for payment in respect of operations carried out during the preceding month, shall be submitted to the Chief, Geohydrology on the 15th day of each calender month, and shall be paid within 30 days of receipt subject to a retention of 10% of the total amount due. In the event of any item included in such claim being in dispute, the undisputed part of such claim shall not be delayed and shall be paid as aforesaid.

11.2 Provided that the Chief, Geohydrology is satisfied that a request for additional time over and above the period stipulated in the modus operandi agreed upon in terms of Clause 1 for field work is reasonable, and not due to default on the part of the consultant, such a request may be acceded to by the Chief, Geohydrology and remuneration in respect of such extension shall be determined according to the attached schedule of tariffs.

11.3 Any amount retained by the Director-General in terms of Clause 10.1 shall be paid to the consultant after receipt and approval of the final report one month of receipt of the final report.

12. The consultant shall not be held responsible for non-completion of the Agreement by reason of strikes, major fires, acts of God and natural disasters, any act of State and any failure of Suppliers and Sub-Contractors.

13. Any dispute between the Minister and the contractor arising out of this Agreement or the aforesaid investigation shall be referred for arbitration in terms of the Arbitration Act, 1956 (Act 42 of 1965).

14. Should any party fail to comply with the provisions of this Agreement, the other party shall without prejudice to any right which may exist, terminate this Agreement after he has given the defaulting party one month within which to remedy such failures or breach.

SCHEDULE OF TARIFFS

ITEM	UNIT	TARIFF
1. Salaries and allowances		
i) Geologist / eophysicist	per month	.....
ii) Geological technician		
2. Final report		
To cover draughting, typing, materials, editing and duplication.		.....
3. Percentage overheads		
if any		
4. Contingencies		
Expenditure subject to approval by the Chief, Geohydrology :		
Consumables as specified	at cost	

APP. G

KONSEP TENDERSPESIFIKASIES VIR DIE UITVOERING VAN DETAIL-GRAVITASIE OPNAMES

Tenders word aangevra vir die uitvoering vir detail-gravitasie opnames wat insluit die plasing van waarnemingspunte, bepaling van hoogtes en koördinate, gravimetriese waarnemings, verwerking van data, die opstel van 'n Bougeur-anomalie kontoerkaart, 'n topografiese kontoerkaart en 'n geologiese kaart volgens onderstaande spesifikasies :

Spesifikasies

A. Gravitasie-Opname

1. Plasing van waarnemingspunte

Die kontrakteur sal verantwoordelik wees vir die uitmeet van waarnemings-punte op 'n rooster wat kan wissel van 50m x 50m tot 100m x 200m soos voorgeskryf deur Direkteur-Generaal. Punte op 'n kilometer rooster moet van sement-bakens voorsien word en die ander tussenin moet duidelik in die veld gemerk word sodat hul maklik weer herwaargeneem kan word deur die kontrakteur of deur 'n waarnemer van die Direkteur-Generaal Omgewingsake. Elke waarnemingspunt moet duidelik genommer word in ooreen-stemming met 'n stelsel soos neergelê deur die Direkteur-Generaal.

Die Lo-koördinate van elke waarnemingspunt moet tot 'n akkuraatheid van $\pm$ 1m moet bepaal word. Indien die terrein dit prakties onmoontlik maak om 'n punt op sy korrekte roosterposisie te plaas kan dit tot 5m in enige rigting verplaas word. Die werklike waarnemingsposisie moet op die finale planne aangedui word.

2. Waarnemingsprosedures

Die kontrakteur se gravimetriese waarnemingsprosedures moet ooreenstem met die prosedures soos verlang deur die Direkteur-Generaal, Omgewingsake. Daar moet gebruik gemaak word van geofisici of tegnici met 'n deeglike ondervinding in hierdie veld. 'n Kort curriculum vitae van alle personeel wat by veldwaarnemings en die verwerking van die data betrokke sal wees, moet vooraf voorsien word.

Veldwaarnemers sal onderhewig wees aan 'n aanvanklike toets om hul bedrewendheid te bepaal. Dit behels die waarneming van 'n aantal reeds waargenome punte op 'n bepaalde terrein. Indien enige nuwe waarnemer tydens die uitvoering van die tender aangestel word, sal hy ook onderhewig wees aan die selfde bepaling van waarnemingsvermoë. Waarnemers moet die toets slaag alvorens hulle vir die Direkteur-Generaal aanvaarbaar sal wees.

Vir elke waarnemingspunt word 'n leesakkuraatheid van 0,01 mgal vereis en nadat vir dryf gekorrigeer is moet 'n akkuraatheid van 0,03 mgal verseker word. Gravitasie-waarnemings moet m.a.w. herhaalbaar wees tot 'n akkuraatheid van 0,03 mgal.

Tydens die uitvoering van die veldwerk behou die Direkteur-Generaal, Omgewingsake hom die reg voor om die gravitasie- en hoogtebepalings van enige aantal waarnemingspunte te kontroleer deur herlees deur die kontrakteur of sy eie toerusting en personeel.

3. Kalibrasie van gravimeters

Alle gravimeters moet vooraf gekalibreer word om te verseker dat die korrekte instrument-konstante gebruik word. Die posisies van die kalibrasiewaarnemingspunte en gravitasiewaardes sal aan die kontrakteur aangedui en gegee word.

4. Dryfkromme

Die kontrakteur sal sy gereduseerde gravitasie-lesings korrigeer vir die effek van aardgety en instrumentdryf. Dit sal gedoen word deur elke uur by 'n basisstasie in te knoop, 'n dryfkromme op te stel en 'n korreksie dienooreenkomstig aan te bring. Die basisstasie(s) moet ingeknoop word by 'n bekende basis in die Pretoria-omgewing waarvan die waarde gegee en die posisie aan die kontrakteur aangedui sal word.

Die kontrakteur sal ook 'n aaneenlopende dryfkromme opstel oor die volle duur van die opname sodat dit gebruik sal kan word om spronge of foutiewe werking van die gravimeter vas te stel.

5. Hoogtebepalings

Hoogtes van gravimeter-waarnemingspunte moet bepaal word in meter bokant seevlak tot 'n akkuraatheid van 0,02m. Dit kan gedoen word deur hoogtes aan te dra vanaf die naaste trigonometriese baken in die omgewing.

Die kontrakteur moet in die tender spesifiseer watter opmetingsinstrumente gebruik gaan word asook watter veldprosedure gevolg gaan word vir die bepaling van hoogtes.

6. Dataverwerking

Data sal verwerk word tot Bouguer-anomaliewaardes en die volgende korreksies moet toegepas word op die waargenome data.

a) Skaallesings moet gereduseer word na gravitasiewaardes en gekorrigeer word vir die effek van aardgety en instrumentdryf.

b) Gravitasiewaardes moet gekorrigeer word vir elevasie deur gebruik te maak van 'n gekombineerde Bouguer/vrylugkorreksie van 0,196854 m/s^2 per meter bokant seevlak.

c) Die normale korreksie vir teoretiese gravitasie vir die breedtegraad van die waarnemingspunt moet aangebring word deur gebruik te maak van die IG8N 71 konstantes in die Internasionale gravitasie-formule.

d) Daar word nie van die kontrakteur verwag om terreinkorreksies te bereken nie.

7. Voorstelling van data

Die kontrakteur sal 'n meester plan voorsien op 'n skaal van 1:5 000 waarop die waarnemingsposisies en nommers asook die Bouguer-anomaliewaardes aangedui word. 'n Bouguer-anomaliekontoerplan, met 'n kontoerinterval van 0,1 mgal (0,000001 ms^2) op dieselfde skaal moet ook gegee word.

Individuele lyne sal, soos verlang op aanvraag in die vorm van gravitasie profiele verskaf word. Sulke profiele behoort binne 3 dae na afhandeling van veldwaarnemings van die lyn beskikbaar gestel te word.

B. Topografiese Kontoerkaart

Die kontrakteur sal 'n meester plan voorsien op 'n skaal van 1:5 000 waarop die waarnemingsposisies en nommers asook die hoogtewaardes bo seevlak aangedui word. 'n Topografiese kontoerplan, met 'n kontoerinterval van 1 meter op dieselfde skaal moet ook gegee word.

C. Geologiese Kaart

Daar word van die kontrakteur vereis om 'n kaart op 'n skaal van 1:5 000 te voorsien waarop die oppervlakgeologie soos waargeneem tydens en langs gravimetriese waarnemingslyne aangedui word, tesame met gravimetriese waarnemingsposisies en waarnemingsnommers. Verder moet alle boorgate wat in die gebied mag wees ook op die kaart aangedui word.

Die geologiese nomenklatuur en kaartvoorstelling moet in ooreenstemming wees met die wat die Geologiese Opname in dolomitiese omgewings gebruik en sal dus met verteenwoordigers van Geologiese Opname bespreek moet word.

D. Algemene voorwaardes

a) Die kontrakteur sal kwoteer vir elke afsonderlike opname aangesien die aantal waarnemings, die waarnemingsinterval en die lokale toestande van elke gebied mag verskil. Daar word aanbeveel dat die kontrakteur, voordat 'n kwotasie ingedien word, die terrein saam met 'n verteenwoordiger van die departement besoek ten einde vertroud te raak met die plaaslike toestande.

b) Die kontrakteur sal 'n tyd stipuleer vir afhandeling van die kontrak. Hy sal ook meld hoeveel veldpersoneel en instrumente beskikbaar is vir die uitvoering van die kontrak.

c) Alhoewel die Departement Omgewingsake die nodige toestemming sal verkry vir die betreding van private eiendom vir waarnemings sal die kontrakteur verantwoordelik wees vir die uitbetaling van vergoeding aan die Direkteur-Generaal Omgewingsake ten opsigte van enige eise as gevolg van skade aan persone of eiendomme wat mag voortspruit in die uitvoering van die kontrak.

d) Alle veldboeke, datavelle, kaarte of enige ander data wat betrekking het op die kontrak, is die eiendom van die Direkteur-Generaal Omgewingsake en moet as hoogs konfidensieel beskou word. Die kontrakteur mag geen data of afleidings aan 'n derde party voorsien nie.

e) Die kontrakteur moet na voltooiing van die kontrak 'n kort veldverslag opstel wat ook al die betrokke kaarte sal bevat. Daar word nie van die kontrakteur verwag om die resultate te interpreteer of aanbevelings te maak nie.

APP. H

DEPARTMENT OF ENVIRONMENT AFFAIRS AND FISHERIES

TENDER W .....

DUE AT 11h00 ON .....

IN THE TENDER BOX IN THE FOYER

AT LOCARNO HOUSE, 323 SCHOEMANSTREET, PRETORIA

OR

PRIVATE BAG X49, PRETORIA, 0001

ADDRESSED TO THE CHIEF DIRECTOR; STATE PURCHASES

SPECIFICATION FOR THE DRILLING OF

MULTIPLES OF 1000M, TO A TOTAL OF AT LEAST 14000M OF EXPLORATION AND PRODUCTION BORE-HOLES IN DOLOMITIC AREAS NEAR JOHANNESBURG AND PRETORIA

FOR THE

DIRECTORATE OF WATER AFFAIRS
DIVISION OF GEOHYDROLOGY

DEPARTMENT OF ENVIRONMENT AFFAIRS

TENDER W .....

(A) GENERAL CONDITIONS OF TENDER

1. Quotations :

(a) Tenderers are requested to quote for each service A to I on the tender form.

(b) Where no charge is made for any service, it should be clearly stated on the document, "NO CHARGE". Failure to comply with the abovementioned may result in the tender being disqualified.

(c) The tender form, together with Form ST8, both duly signed and completed must accompany every tender. Tenders which are incomplete, may be rejected.

(d) Tender documents are to be returned complete, no portion may be removed.

(e) The tender price quoted for drilling in paragraph C of the tender form must not include the price for permanent casing or well screens and accessories. Tender prices for the latter must be clearly quoted for under paragraph D of the tender form. If temporary casing is going to be required during the drilling process this shall be provided for in the price for drilling in paragraph C.

(f) Quotations qualified by formation types will not be considered.

(g) No tender will be considered where tariffs for drilling, casing and screens, if required, fluctuate according to depth or length respectively. Tenderers are therefore requested to quote only one tariff per meter

2/... ...

(h) All allowances for insertion and extraction of casing and reaming to insert must be included in the price of casing per metre run. Tenders containing unrealistic prices for any material which may indicate that material offered is second hand or of inferior quality, may be disqualified.

(i) Unrealistic quotations against any item A to I may result in the tender not being considered.

(j) Prices quoted must be firm in South African currency.

(k) The Department is not compelled to accept the lowest or any tender.

2. Sub-Contracting

(a) Contractors intending to make use of the services of sub-contractors must submit a separate statement of all the particulars concerning such sub-contractors.

(b) After allotment, no portion of the contract may be sublet without the written authority of the Director-General. Should such authority be granted it will in no way absolve the original contractor from his liability to complete the contract to the satisfaction of the Director-General.

3. Commencement of work

Tenderers should note that it is a condition of this contract that work shall commence within 30 days after the date of the issue of an order but not before 4th January 1984. Late receipt of the order does not constitute an acceptable reason for not starting the work on time. To ensure that the order reaches the successful tenderer in good time, tenderers are advised to leave a forwarding address should the address on the tender document be insufficient for this purpose.

3/... ...

4. Cessation of operations

(a) At the discretion of the Director-General.

(b) After the contractor has commenced drilling operations in accordance with this contract he must, except with written authority of the Director-General, complete the contract within threemonths, ending at the 31st March 1984. See also clause 12.

5. Failure to comply

Should the contractor fail to commence drilling under the contract within 30 days after the date stipulated in paragraph 3 above, or should he, after commencing, cease drilling and/or withdraw his drilling rig from the site, without authority or should he fail to render satisfactory progress, the Director-General may, in addition to any other remedies he may have, agree to the withdrawal of the tender or he may cancel the contract. The Contractor will then pay to the Director-General any additional expense incurred by having either to accept a less favourable tender or, if fresh tenders have to be invited, the additional expenditure incurred by the invitation of fresh tenders and the subsequent acceptance of a less favourable tender.

The Director-General shall also have the right to recover such additional expenditure by set-off against any money which may be due or become due to the contractor under this or any other tender or contract or against any guarantee or deposit that may have been furnished by the contractor or on his behalf for the due fulfilment of this or any other tender or contract and pending the ascertainment of the amount of such additional expenditure, to retain such moneys, guarantee or deposit as security for any loss the Director-General may sustain by reason of default of the contractor.

6. Drilling Machines

Only tenders from contractors who possess suitable drilling rigs

adequately equipped and in good running order which can cope with drilling conditions in mainly cavernous dolomite and unconsolidated formations and complete such boreholes in the allotted time of three months, will be considered. Tenderers are requested to give a list of equipment available for the development of boreholes. At the time of tendering the Director-General should also be advised where the drill(s) is/are situated so that an inspection, if necessary, may be made.

7. Inspection

The Director-General and representatives and authorised contractors/consultants shall at all times have free access to the boring operations and all work shall be subject to his inspection, measurement and approval.

8. Contractors risk and responsibility

All damage caused by the contractor and/or his employees to private or public property at the boring site or en route to or from the site, shall be rectified by the contractor. The contractor is advised to apprise himself of municipal bye laws and regulations, when these are applicable.

9. Technical assistance

Whenever the contractor should experience technical problems and he or his driller should approach the Director-General for advice or assistance and the request be granted, the service will be rendered only on condition that the Director-General will not accept any responsibility in the event of such advise proving to be unsuccessful in solving the problem.

10. Delays through actions of the Director-General and his representative(s)

On completion or partial completion of the work where tests and/or inspections have to be carried out, the contractor shall notify the Director-General.

The contractor will be allowed to claim for delays in excess of 60 minutes per occasion, caused through action of the Director-General. For claims see item J on the tender form.

11. Postal address and instructions

(a) Any mail addressed to the contractor to the address stated on the tender form, or any other address as furnished in writing, will be considered as delivered to the contractor.

(b) Written instructions to the driller in the absence of the contractor will be considered as handed to the contractor.

12. Subdivision of tender into units of 1000 metres each

The Tenderer has an option to quote for one or more units of drilling operations, each of 1000 m total drilling depth (approximately 10 boreholes) with due regard to his available equipment, personnel and especially the dead line of 31st March 1984.

13. Payment

(a) Payments will be made after the Director-General or his accredited representative has satisfied himself that the work has been completed on each borehole, in terms of this specification. Payment will only be made after completion of drilling operations on a monthly basis, if so required.

(b) Payment for transport to the area will only be made on completion of the contract, and on receipt of the "Completion Certificate of Contract". Transport charges at a "per kilometre" rate are not acceptable. Charges for transport from site to site will be entertained in excess of 1 km. Transport will include, erection and dismantling of drilling plant.

(c) No payment will be made for any boreholes which the contractor, for any reason whatsoever, is unable to complete to specification to the required depth.

(d) No payment will be made for any casing or well screens left in boreholes not completed to specification, unless authorised by the Director-General, when such casing or well screes will be paid for at contract rates.

B. SERVICES TO BE RENDERED BY THE CONTRACTOR

1. Services

The services to be rendered are the drilling, insertion of casing and well screens, where required, and the developing and pump testing of production boreholes in the following areas as indicated on the attached plan (see also clause A12) :

i) Zuurbekom/Gemsbokfontein Area (30 km SW of Johannesburg : from a minimum of 34 to 170 boreholes and between a minimum of 4100m to 20 000m of drilling.

ii) Pretoria Area (10-30 km South of Pretoria) : from a minimum of 61 to 270 boreholes and from at least 6200 m up to 27000m of drilling.

iii) Steenkoppies-Swartkrans Area (35 km west of Johannesburg) : from a minimum of 30 up to 150 boreholes and from at least 3400m up to 16 500 m of drilling.

2. Equipment

To supply all machinery, materials, transport, labour, fuel, water and all services required to carry out the work above expeditiously and efficiently.

3. Foreman

To employ an efficient and experienced supervisor(s) stationed at the drill(s) and in personal charge of the drilling contract. Failure to comply with this condition may cause the cancellation of this contract at any stage without compensation.

4. Workmanship

The contractor shall perform all work entrusted to him in an efficient, thorough and workmanlike manner in accordance with this contract and to the satisfaction of the Director-General.

Tenderers are requested to state previous experience in drilling and development of high yield boreholes in dolomitic areas.

5. Drilling and development of boreholes

(i) Drilling of exploration and production boreholes to a maximum depth of 150 metres and with a minimum uncased diameter of 215mm. Yields of more than 25 ℓ/s could be expected. All efforts should be made to achieve maximum yield, including development techniques.

(ii) The supply, delivery and on instruction the installation and centralization of casing of the following specification :

a) 200mm ID, minimum weight 25 kg/m and wall thickness of at least 4,5 mm.

b) 250mm ID, minimum weight 28 kg/m and wall thickness of at least 6mm

Perforated casing has to be made up according to a sample provided by the Director-General.
Arrangements should be made for delivery and installation of Johnson SS Screens where required.All casing material, dimensions and fabrication in accordance to SABS 62 or 719 specifications, with ends prepared for fieldwelding. Pipes fabricated by helical welding seams are not acceptable.

6. General

(i) Formation

The expected formations will probably be as follows :
Overburden of greatly varying depth, consisting of chertfragments in a matrix of sandy clay, partially consolidated calcareous sand and clay pockets. The solid rock is dolomite with chert inclusions, in places cavernous with fillings of wad, gravel, air or water. The Director-General accepts no responsibility as to accuracy of this information.

(ii) Straightness and verticality

All boreholes must be straight and the maximum deviation from vertical shall not exceed 75mm for each 30 metres of depth and must comply with the Bureau of Standards code of practice for testing water boreholes (SABS 045-1974).

(iii) Samples

Samples of the formation, shall be taken at one metre intervals or at smaller intervals if changes in the formation occur, or as directed and shall be kept at the boring site while drilling is in progress. The depths at which the samples are obtained as well as other relevant drilling data shall be furnished by the contractor or his driller.

(iv) Borehole Cover

Each completed production borehole shall be equipped with a 2 metre x 250mm steel casing. The steel casing shall be fitted over the existing casing, and shall extend approximately 300mm above ground level. The protruding portion of steel casing shall be fitted with a lockable heavy hinged or removeable cover.

Borehole numbers (supplied by the Director-General) are to be welded on casing and borehole covers of production and observation holes.

Every abandoned borehole shall be earth filled to surface to render it safe for human beings or animals.

(v) Insertion of casing and screens - according to specifications (B 5(ii))

The contractor shall notify the Director-General or his local representative(s) at least one hour before he will insert casing and/or screens.

(vi) Reports

Copies of borehole logs and completion forms as supplied by the Department shall be submitted to the Director-General immediately upon completion of each borehole.

(vii) Cleaning-up of drilling sites

All waste, empty oil drums and other items no more required, must be removed from the site at the cost of the contractor, to the satisfaction of the Director-General, before the borehole will be certified as being completed.

7. Pumping tests

(a) In the course of this contract, step drawdown and possibly constant rate tests are to be performed on production boreholes.

(b) Step drawdown pumping tests at rates of between 15 ℓ/s and 50 ℓ/s with a minimum of 5 steps will be required. It is expected that a single step would last from half-an-hour to two hours.

(c) Constant rate pumping tests of not more than 72 hours duration may be required.

(d) Suitable pumping equipment, capable of variable capacities ranging from 20 ℓ/s to 50 ℓ/s are required.

(e) Water pumped during pump tests shall be discharged at least 300 metres away from the borehole, or into the nearest storm water drain.

(f) Water level measurements are required to be taken during testing operations. For this reason the pumping equipment used for testing shall allow enough space in the borehole for this purpose.

(g) A straight rigid plastic pipe (internal diameter not less than 25mm) has to be clamped to pumping main from the surface down to pump-intake to allow for water-level measurements prior, during and immediately after pump testing.

(h) A flow meter(s) is/are to be provided in order to measure yield rates from 15 to 50 ℓ/s and provision should be made for a flow meter with rates in excess of 50 ℓ/s.

C. SERVICES TO BE RENDERED BY THE DIRECTOR-GENERAL

1. To select all drilling sites.
2. To stop drilling operations and attend insertion of casing and screens and ensure that they are set to specification.
3. To log boreholes geophysically if required.
4. To prescribe depths at which screens and/or perforated casing are to be set.
5. To state the depths at which plunging and jetting is to be done.
6. To attend the pumping tests, carry out observations of waterlevels and yields.
7. To inspect and take all measurements and approve all work done before payment.
8. To authorize any deviation from the diametres specified.
9. To ensure that all boreholes have been properly capped and sites cleaned-up by the contractor after cessation of drilling, developing and test pumping operations.

TENDER FORM :

A.	Establishment cost, including transport of all plant and accessories to first site	R ..... per plant
B.	Transport for plant thereafter	R ..... per site
C.	Drilling from 0 to maximum 150 metres :	
	(i) 215mm diameter	R ..... per metre
	(ii) 265mm diameter	R ..... per metre
D.	Supply, delivery and insertion of 200mm, stainless steel, Johnson well screens:	
	(i) No. 20 slot	R ..... per 3 m length
	(ii) No. 30 slot	R ..... per 3 m length
	(iii) No. 40 slot	R ..... per 3 m length
E.	Supply, delivery and insertion of casing and/or perforated casing according to specification (B4.ii)	
	(i) 200mm I.D. casing	R ..... per metre
	(ii) 250mm Casing	R ..... per metre
F.	Developing of borehole	R ..... per hour
G.	Erection and dismantling of test pump	R ..... per occasion
H.	Test pumping	R ..... per hour
I.	Supply, delivery and installation of steel borehole cover	R ..... per each
J.	Delays	R ..... per hour

IS OFFER TO SPECIFICATION? YES/NO

ARE PRICES FIRM? YES/NO

WORK WILL COMMENCE ON OR BEFORE ..... 19 .....

Contractor to state if commencing date given is a definite date or a provisional one. If provisional please state proviso .....

.....

.....

Type of machines available for this contract .....

.....

Number of machines to be used .....

Capacity of pumping equipment .....ℓ/s

Method of developing boreholes .....

Contractor to state how many multiples of 1000m each he is capable of drilling and developing within three months (clause A12) .....

Has the contractor any preference to operate in any of the areas indicated on the attached plan (B1) .....

The contractor has to give a written exposition of the equipment with which and the manner in which he proposes to execute the assignment. He should state what experience he has of drilling and developing boreholes in dolomitic areas.

I/We hereby tender for the above services and acknowledge and accept the conditions contained in the covering ST8 form.

Signed this ..... day of ..... 19.....

Address .....

.....

.....

.....

.....

SIGNATURE OF TENDERER

Name of firm to be inserted here.

NB Tenderers to quote for each service, A to J. Where no charge is made for service, it should clearly state "No charge".