EMERGENCY GROUND WATER SUPPLIES FROM DOLOMITE STRATA IN THE PWV AREA: OVERVIEW AND STATUS OF INVESTIGATIONS NOVEMBER 1983 - DECEMBER 1985

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DIRECTORATE : GEOHYDROLOGY
DEPARTMENT OF WATER AFFAIRS

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1. INTRODUCTION:

1.1 Report Gh3298 "Moontlikhede van Stedelike Watervoorsiening uit dolomietgesteentes in die bedieningsgebied van die Randwaterraad" led in November 1983 to the initiation of extensive investigations of ground water contained in dolomite strata in the PWV area. The following areas were selected for the start: The Van Riebeeck Nature Reserve (Rietvlei Dam area), the Pretoria Fountains - Erasmia, the Tarlton, and Zuurbekom areas. Subsequently attention was also directed to the Bapsfontein - Springs - Delmas area, the Klip River Valley downstream of Zuurbekom to Meyerton and the Natal-Spruit dolomite basin. The investigations were undertaken by the Directorate of Geohydrology and Steffen, Robertson and Kirsten, a firm of consultants. Exploratory drilling was carried out partly with departmental machines; two firms of private drilling contractors Aarwater and Dan Boor en Seuns, however, were responsible for the major part of this exercise. Pumping tests were conducted om contract by the firm Ground Water Practitioners.

1.2 The estimated expenditure since 1983 to January 1986 on dolomite investigations is as follows:

Hydrogeology	R1,4 million	
Geophysical surveys	R0,4 "	
Drilling	R6,6 "	(278 boreholes)
Pumptesting	R0,4 "	
	R8,8 "	

1.3 Data and results to date are summarized as follows:

(i) The dolomite occurrence has been subdivided where justified by data, into compartments which are to a greater or lesser extent, separate hydraulic entities; and elsewhere into geographically conveniently-sized regions.

(ii) The current situation with regard to springs, boreholes and ground water utilisation is sketched.

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(iii) An estimate of the volume of water that may be abstracted without serious risk of sinkhole formation or subsidence is given followed by statements about,

(iv) the status of the investigation and the number of boreholes and the yields which could be used in an emergency;

(v) whether the holes are sufficient in number and adequately distributed to tap the stated volume from storage over a period of 12 months; and

(vi) the chemical quality of the water.

In those instances where additional work and drilling is required, estimates have been made of

(vii) the cost and duration of hydrogeological geophysical surveys;

(viii) the number of holes to be drilled;

(xi) the cost involved in employing consultants (if necessary); and of

(x) drilling and pumping test contractors;

(xi) the effects of abstracting water from storage for emergency supply are briefly outlined.

Not every point is necessarrily reported on in each and every case.

The compartments and areas are shown together with RWB pipelines and reservoirs on the accompanying plan.

The more important figures exploitable storage, available borehole pumping capacity, envisaged capacity and cost estimate of additional work and drilling are also given for each compartment/area.

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1.4 Attention is drawn to the following aspects:

(i) As the (secondary) porosity of the dolomite is extremely variable, both laterally and vertically, the volume of water stored in dolomite compartments can only be determined, through abstraction of known large volumes of water and by observing the effect on ground water levels over the whole of the compartment. All figures of storage given in this report are of necessity very rough estimates based on comparison of conditions in the compartment with some compartments which have been dewatered by mining.

(ii) In determining whether further production boreholes are required to tap the stored water, the following assumptions have been made:

(a) Overall average drawdown is limited to 5m unless stated otherwise;

(b) the pumping capacity of the boreholes should be adequate to allow withdrawal of the stated exploitable volume in one year. Of course if the period for withdrawal of stored water is extended, fewer holes will generally be required and costs could be reduced.

(iii) No estimates have been made of the cost of additional observation boreholes, that may be required; of investigations and monitoring of ground stability; of compensation of private landowners or provision of alternative water supplies to them and follow-up studies to evaluate and model different dolomite compartments/aquifers.

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(iv) This report is based on reports by S.R.K. on the Zuur-- bekom and Pretoria investigations, carried out on contract for the Department, and contributions/reports by the following staff members of the Directorate of Geohydrology: Dr.M.P. Mulder, Dr D.B. Bredenkamp, Dr. T.S. Kok, Messrs W.R.G. Orpen, A.F. Leskiewicz, M.B.J. Foster, C.M. Kuhn, F.E. Wiegmans and C. van der Westhuizen.
Where information or figures in this report are different to or in conflict with those stated in contribution/reports of S.R.K. and others, this is due to the compiler's re-interpretation of the data.

(v) In order to fully understand and describe quantitatively the geohydrology of the dolomite much more work as well as long term observations will be required.

2. SUMMARY STATEMENT ON GROUND WATER RESOURCES

2.1 PRETORIA AREA

2.1.1 Aalwynkop Compartment

(i) Area 15 km^2

(ii) Present ground water situation:

(a) Spring in Hennops River bed - flow unknown, not measurable.

(b) Twelve private boreholes on farmland/plots mainly for domestic use. Five of these holes are also used for irrigation. Within the western part of Erasmia township there are 12 private holes on erven. No estimate of present day pumpage has been made.

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(iii) Exploitable storage 4 million m^3.

(iv) Status of investigation: Compartment has received relatively little attention Further hydrogeological and geophysical work is required plus drilling in order to tap storage.

(v) Exploration holes drilled : Four holes have been drilled in the southern part of the compartment. One hole just west of Atteridgeville is judged to have a yield in excess of 20 ℓ/s but has as yet not been tested.

(vi) Additional work required : The goal is to establish several production holes capable of yielding 130 ℓ/s combined.
Hydrogeological/geophysical work including supervision of drilling and pumptesting : 2 months.
Drilling and pumptesting 5 holes, 750 metres : 2 months.
Total : 3 months.

(vii) Estimated costs

Hydrogeological/geophysical work	R50 000
Drilling and pumptesting	R230 000
Total	R280 000

(viii) Abstracting from storage will lead to diminution of ground water increment to Hennops River flow and yields of boreholes on farmland/plots may diminish and fail, particularly the shallow boreholes. Deepening of holes may solve this problem. It is envisaged that abstraction should take place in the north, i.e. west of Atteridgeville and remote from the river and private boreholes.

(xi) The quality of the water should be good - no analysis available.

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(x) Production holes will be situated mostly, if not all, on State land (military)

2.1.2 Laudium Compartment

(i) Area 6 km².

(ii) Present ground water situation:

(a) No springs.

(b) Minor abstraction from a few private boreholes in the northern parts of Erasmia township.

(iii) Exploitable storage 1,6 million m³.

(iv) Status of investigation : Gravity, electromagnetic and magnetic surveys have been undertaken, particularly in the northern part of the compartment.

(v) Four exploration boreholes have been drilled with insignificant yields.

(vi) Additional work required in order to develop a supply of 50 ℓ/s.

Hydrogeological/geophysical work : 2 weeks.

Drilling and pumptesting : 3 holes, 450 metres (1 month)

Total : 1 1/2 months.

(vii) Estimated costs

Hydrogeological/geophysical work	:	R 25 000
Drilling and pumptesting	:	R130 000
Total		R155 000

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(viii) No problems are expected with a limited lowering of ground water level.

(xi) Quality of water expected to be satisfactory.

(x) Production holes will be situated on municipal land.

2.1.3 Erasmia - Fountains West Compartment

(i) Area 92 km²

(ii) Present ground water situation:

(a) This composite compartment is drained by the Erasmia spring alleged to have had a yield of 0,5 million m³/a but now defunct as water is abstracted from a municipal borehole at about 16 ℓ/s. It seems very likely that the Hennops (or Six Mile Spruit)is fed by dispersed discharge of ground water in the stream bed along its course. The rate of drainage is unknown.
In the north ground water is drained from the compartment through the lower or western spring of the Fountains, at a rate of 100 to 190 ℓ/s.

(b) Apart from municipal boreholes at the Erasmia spring and in Montaque Kneen Park and some boreholes on military land, the hydrocensus has indicated the existence of some 60 - 70 private boreholes on farmland/plots and in townships. No estimate has been made of the rate of abstraction. The hydrocensus also does not cover that part of the compartment which lies south of the Hennops River in the Verwoerdburg municipal area.
Abstraction for public urban supply by the municipality of Pretoria is estimated at about 5 million m³/a.

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(iii) Exploitable storage 14 to 23 million m^3.

(iv) Status of investigation: The southern part of the compartment within Verwoerdburg has not been covered. Hydrogeological and geophysical work and drilling in the northern parts of the compartment have been completed.

(v) Twenty three exploration boreholes were drilled. Of these 11 could be utilized for water supply.

The holes are:

		Recommended pumping rate ℓ/s
GF1A	west of Fountains	85
ZP12-A	east and west of Ben Schoeman highway	)0
ZP13		65
ZP16		75
ZP17		45
ZP14-13	Between Valhalla and Erasmia	90
ZP20		30
VA-1	Montaque Kneen Park, Valhalla	90
EA-1	Eastern side of Erasmia township	80
EA-3(G36I66)		100
EA-4(G36067)		35
	Total	785

(vi) Additional work required: None north of the Six Mile Spruit. The aim is to have production boreholes as far south as possible and to step up borehole pumping capacity to 1 000 ℓ/s.
Hydrogeological and geophysical work in the southern (Verwoerdburg) part of the compartment is envisaged as well as some drilling. Development of additional holes will be mainly on municipal land.

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(vii) Hydrogeological/geophysical surveys (1 month) R 50 000

5 Exploration/production boreholes and tsting (2 months) R230 000

R280 000

(viii) Lowering of ground water level will result in weakening and possible cessation of flow of the western spring at Fountains and of the dispersed flow into the Six Mile spruit. Private boreholes within Valhalla, Erasmia and Verwoerdburg townships would be affected as well as those on farm land/small holdings. Loss of flow to the Apies River in the Fountains area could be compensated for by releasing a portion of that abstracted from boreholes into the stream.

2.1.4 Fountains East Compartment:

(i) Area 31 km^2.

(ii) Present ground water situation:
Although no hydrocensus was carried out of the southern (Verwoerdburg) part of the compartment, it would appear that the only discharge is through the eastern spring at the Fountains. Its flow ranges between 100 - 180 ℓ/s.

(iii) Exploitable storage 4,5 to 7,5 million m^3.

(iv) Status of investigation: Investigation and drilling in the northern part have been completed. Hydrogeological/geophysical surveys should be done in the south followed by exploratory drilling.

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(v) Five exploration holes have been drilled of which three GF-3A (60 ℓ/s), GF-6 (65 ℓ/s) and GF-7A (80 ℓ/s) could be utilized. (Combined pumping rate 215 ℓ/s.) The distribution of these holes is not adequate for effective abstraction from storage.

(iv) Additional work required: Production holes with a total capacity of 400 ℓ/s planned.

Hydrogeological/geophysical surveys southern half of compartment (1 1/2 month) R 70 000

Drilling and testing four exploration production holes (1 month) R180 000

R250 000

(vii) Lowering of ground water level will result in diminution/cessation of spring flows which will have to be made good by abstraction from boreholes. As data are lacking in the south, it is uncertain whether there are private boreholes which may be affected. In order to maintain spring flow as long as possible, abstraction in the south is preferable to utilizing boreholes closer to the spring.

2.1.5 Rietvlei Dam Compartment:

(i) Area 23 km²

(ii) Present ground water situation: Three springs alleged to have a combined flow varying from 15 to 60 ℓ/s. This is collected together with spring flow from an adjacent compartment and piped to the Fountains for urban use.

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No other abstraction of ground water takes place. Surface runoff and sewage effluent in the Six Mile Spruit (or Hennops) is in hydrologic continuity with ground water in the compartment.

(iii) Exploitable storage 8 million m^3

(iv) Status of investigations: Geological mapping, extensive gravity and electromagnetic surveys have been completed. Forty-three exploratory holes have been drilled.

(v) Six boreholes with the following pumping rates have been recommended for use:

G. No.	Recommended rate
36050 ✓ 2528CD29	50 ℓ/s
36052 ✓ 2528CD31	60 ℓ/s
36055 ✓ 2528CD34	80 ℓ/s
35734 ✓ 2528CD7	35 ℓ/s
36060 ✓ 2528CD40	70 ℓ/s
36065 ✓ 2528CD46	70 ℓ/s
Total	365 ℓ/s

To withdraw water from storage (i.e. dewater the upper 5 metres of the dolomite aquifer) the abstraction rate will have to exceed the rate at which water from the stream would infiltrate. If not, there will be no gain on the total quantity of water obtained from Rietvlei Dam and springs. The infiltration rate with lower ground water levels can only be determined experimentally. In May 1985 the surface flow into the Rietvlei Dam Compartment was about 164 ℓ/s.

(vi) No further drilling is envisaged at present. However more holes may be necessary in order to

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obtain water from storage should the surface flow be directed in toto underground by the pumping of boreholes.

(vi) Dissolved solids in Rietvlei ground water range from 150 to 400 mg/ℓ.

2.2 BAPSFONTEIN - SPRINGS - DELMAS AREA

2.2.1 Witkoppies Compartment

(i) Area 45 km².

(ii) Present ground water situation: Grootfontein spring about 80 ℓ/s which is being used by Pretoria Municipality and Erasmus spring 8 ℓ/s for private irrigation. Some of the flow is probably lost to the Six Mile Spruit.
Some irrigation from boreholes takes place in the compartment. Total quantity is small; has not been estimated.

(iii) Exploitable storage is estimated at 22,5 million m³ assuming storage 0,1 and 5m drawdown. The extractable storage may be higher as it may prove safe to effect a greater drawdown.

(iv) Status of investigation: The compartment has been fairly extensively covered by a gravity survey.

(v) Six exploratory boreholes have been drilled. Two of these could probably be used for production. Blow yields during drilling exceed 100 ℓ/s. No pumping tests have been conducted.

(vi) Additional work required : The aim would be to develop a borehole supply of 700 ℓ/s.

Hydrogeology	R 25 000
Gravity and magnetic surveys (1 month)	R150 000
20 holes and pumping tests (2 1/2 drill rig months and 1 1/2 month testing)	R750 000
Total	R925 000

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(vii) At least some of the proposed production holes may be drilled on land belonging to the State. The loss of irrigation water from the spring may be compensated for by supplying the required volume from that pumped out of the holes.

(viii) The ground water is of excellent quality - dissolved solids range from about 80 to 150 mg/ℓ.

2.2.2 Elandsfontein Compartment

(i) Area 60 km^2.

(ii) Present ground water situation:

(a) Elandsfontein spring which flows at about 40 ℓ/s (1984) is used downstream by riparian owners. The spring appears to rise just outside the compartment; the position of the dyke has however not been fixed.

(b) In the south eastern portion of the compartment about 4 million m^3/a are abstracted for irrigation of approximately 500 ha.

(iii) Exploitable storage 15 - 30 million m^3.

(iv) Status of ground water investigations: Compartment fairly well covered by gravity survey.

(v) One exploration hole has been drilled which has not been tested yet. Estimated yield about 35 ℓ/s

(vi) Additional work required: Until more information is available on the delineation of the compartment, the irrigation from boreholes and spring, it is not possible to plan further work.

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2.2.3 Bapsfontein - Delmas strip:

(i) Area including Bronkhorstspruit catchment, comprises 390 km² of which about 200 km² consists of dolomite covered by younger Karoo strata.

(ii) Present ground water situation:

(a) Rietfontein spring is reported as flowing at 40 ℓ/d; at times however, it may be considerably more. Water is used for irriation of land on dolomite.

From measurements during 1983 it was estimated that about 1,6 million m³/a flows out of the area via the Koffiefonteinspruit and tributaries toward Bronkhorstspruit Dam. This volume is thought to be about 50% below average. The ground water component of the flow of the Bronkhorstspruit Dam which rises on the dolomite in the Delmas area has not been determined. Assuming that 50% of the base flow into Bronkhorstspruit Dam (13 million m³/s) is derived from the dolomite part of its catchment, the contribution of dolomitic ground water to flow into the dam amounts to 6,5 million m³/a.

(b) Boreholes:

Abstraction by Delmas for urban use amounts to about 1 million m³/a.
Eloff consumes about 0,25 million m³/a of ground water. About 700 ha in the area are being irrigated at a rate of 5,5 million m³/a.

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Other users are Sentrarand Marshalling yards, small holdings, farms etc with 2 million m^3/a. Total estimated abstraction from boreholes is 8,75 million m^3/a.

(iii) Exploitable storage:

Excluding the Bronkhorstspruit catchment with Delmas, where water is already being abstracted for urban supply, it is thought that a minimum of 55 million m^3 stored water could be abstracted between Leeuwpoort and Katboschfontein.

(iv) Status of investigation:

A considerable amount of hydrogeological and geophysical work has been conducted; of the exploratory boreholes drilled 8 are considered to be capable of yielding over 35 ℓ/s and therefore suitable for production, although no pumptesting has yet been done. A few private boreholes also have yields exceeding 25 ℓ/s.
The drilling and pumptesting will be completed towards end of February 1986.

(v) Additional work required and cost to develop holes capable of yielding 1 750 ℓ/s:

Hydrogeology	R	50 000
Gravity survey (1 month)	R	15 000
40 Exploratory /production boreholes (5 rig months, R1 560 000) and pumping tests (2,5 months), (R60 000)	R1	620 000
	R1	685 000

(vi) With the exception of Sentrarand Marshalling Yards, where possibly some ground water could be developed in addition to what is already being used, all development for an emergency water supply would have to be on private land.

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(vii) The ground water is of good quality ranging from 30 to 350 mg/ℓ of dissolved solids.

2.2.4 East Rand Basin

(i) Area 515 km² of which 350 km² has a cover of younger Karoo strata.

(ii) Present ground water situation:

(a) No definite spring(s) are known although ground water contributes to the flow of Blesbokspsruit.

(b) Abstraction from boreholes for irrigation of about 300 ha, amounts to 2,5 million m^3/a. From boreholes in peri-urban areas an estimated 1,0 million m^3/a is pumped.

Pumpage from mines (Ergo/Grootvlei) amounts to 24,5 million m^3/a. (Has decreased lately to 0,7 million m^3/a).

Total : 28 million m^3/a.

(iii) The quality of water abstracted from the mines largely fed from overlying dolomitic strata) is poor.

(iv) Hydrogeological conditions for tapping ground water from storage by means of boreholes are not considered favourable.

2.2.5 Varkfontein - Knoppiesfontein area:

(i) Area about 40 km² forming the upper catchment of the Blesbokspruit

(ii) Present ground water situation: There are no springs in the area. Some minor irrigation is practised with ground water and Sentrarand tap some ground water for household use.

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(iii) Exploitable storage 6 million m^3 (?)

(vi) Status of investigation : A borehole census was carried out. Several gravity lines were run across the southern part of the area. Conditions are not very favourable for high yield boreholes. However, if water could be developed here, Daveyton could be supplied.

(v) Additional work require : Additional work required: Additional gravity lines to be run and 2-3 exploratory boreholes to be drilled.

Cost:

Hydrogeology	R 15 000
Gravity survey (1 month)	R 15 000
Drilling and pumptesing	R100 000
	R130 000

(vi) Quality : Uncertain; lower down the Blesbokspruit quality deteriorates.

2.3 KLIP RIVER VALLEY (downstream from Zuurbekom)

No systematic ground water investigations have been undertaken in the Klip River Valley in the past. The investigaions carried out during 1984 - 85 which are presently being written up, should be seen as the first step in becoming acquainted with the geohydrology of this valley.

The Klip River Valley is dealt within three sections. It should be realised that the river is in hydraulic continuity with the ground water.

2.3.1 Upper or Oliphantsvlei Compartment:

(i) Areal extent 131km^2.

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(ii) Present ground water situation.

(a) No recogniable spring exist. Dispersed or diffuse flow of ground water to the river most probably takes place.

(b) Private boreholes supply in the local rural needs of about 0,1 million m^3/a. No significant irrigation with ground water is practiced. About 16 million m^3/a of river water is used for irrigation.

(c) The sewage outfall works of Johannesburg are situated on the farm Oliphantsvlei.

(iii) Exploitable storage 17 million m^3. Storage in the top 5 metres of the compartment is estimated at 55 million m^3. This volume cannot be abstracted without inducing infiltration from the river which would have to be abstracted as well. (See paragraph (vi) below.

(iv) Status of investigation: Area has been mapped geologically; hydrocensus was made and gravity traverses have been run. Previous gravity surveys for determining ground stability have been undertaken by others in Lenasia.

(v) 13 Exploration boreholes have been drilled of which 7 have yields ranging from 53 to over 100 ℓ/s. Ground water from two boreholes drilled close to the river contains 406 and 630 mg/ℓ of dissolved solids with sulphates 53 and 107 mg/ℓ. Away from the river, the water is of a better quality - TDS ranges between 200 and 300 mg/ℓ. Two other boreholes, (one on municipal property) could possibly also be utilized.

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(vi) It is believed that by pumping from boreholes several kilometres south of the river, close to the overlying strata of the Pretoria Group (some of the exploratory holes have been drilled here), ground water could be withdrawn from storage without inducing infiltration of river water into the aquifer.
Exploratory boreholes G36548,/49,/51,/53,/59 have a combined yield of 385 ℓ/s.

(vii) Work required: The aim is to have production holes with a combined capacity of 500 - 550 ℓ/s. The above-mentioned potential production holes are situated on private land. To reduce the necessity of negiotiation with private landowners, one or two production holes could be drilled on municipal land near the southern boundary of Oliphantsvlei.
Cost:

Three boreholes (one rig month)(one or two on private land)	R120 000
Pumping tests	R 20 000
Hydrogeology and geophysics	R 20 000
	R160 000

(viii) Should abstraction be limited to boreholes on the southern boundary of Oliphantsvlei farm (municipal land) possibly not more than 150 ℓ/s could be withdrawn (or about 4,7 million m^3 over 12 moths).

2.3.2 Middle or Swartkoppies Section,Klip River Valley

(i) Areal extent 105 km^2

(ii) Present ground water situation:

(a) No recognisable springs exist. Diffuse discharge of ground water to the river is probably taking place.

(b) Private boreholes supply in the local rural needs of about 0,1 million m^3/a, Irrigation consumes about 10 million m^3/a of ground water and about 6 million m^3/a is obtained from the river for irrigation.

(iii) Exploitable storage 14 million m^3. Storage in - upper 5 metres 50 million m^3 (see 2.3.1 (iii).

(iv) See 2.3.1 (iv). A gravity survey was conducted on the RWB property Swartkoppies by the Geological Survey more than one decade ago.

(v) Seven exploration boreholes have been drilled of which only two holes have yields of 15 ℓ/s. One hole is close to the river and therefore not suitable for use.

(vi) As in the case of the upper compartment (see 2.3.1 (vi)) it is believed that by pumping from boreholes several kilometres south west of the river ground water of a suitable quality could be withdrawn from storage without inducing infiltration of river water into the aquifer.

(viii) Work required:

Hydrogeology	R 40 000
Selection of sites for high yielding boreholes (additional gravity ?)	R 10 000
Drilling of a maximum of 15 boreholes concentrating as far as possible on Swartkoppies (2 rig months)	R600 000
Pumptesting of 8 holes (1 month)	R 50 000
	R700 000

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The goal is to have a combined yield about 450 ℓ/s. One private hole could perhaps be commisioned.

2.3.3 Lower section, Klip River Valley:

(i) Area 213 km².

(ii) In this area, the dolomite is largely covered by by Karoo strata. Little work has been done and only one exploration borehole was drilled.
To assess the possibility of abstracting ground water for emergency supply, geophysical surveys and exploratory drilling will be required. Depending on the results, further work and drilling will be necessary for establishing a sufficient number of production holes.

(iii)	Gravity survey (guestimate)	R 25 000
	5 Exploration boreholes	R200 000
	Pumping tests	R 10 000
		R235 000

2.4 NATAL SPRUIT BASIN:

(i) Area 274 km²

This isolated basin of dolomitic strata is drained by the Natal, Elsburg and Riet Spruits, which have a combined runoff of the order of 70 million m³/a.
The streams are mineralised - TDS ranges from 500 to over 2 000 mg/ℓ at different sampling points.
Streambeds are wide and marshy, much water is lost through evapotranspiration.

(ii) Hydrogeological conditions are unfavourable for high-yielding boreholes over the greater part of the basin, except for a zone along the Natal Spruit.

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(iii) As the Natal Spruit is hydraulically connected to the ground water, there seems to be little reason for abstraction boreholes along its course as these will not be tapping ground water from storage, but will be diminishing surface runoff.

2.5 ZUURBEKOM - GEMSBOKFONTEIN AREA:

2.5.1 Zuurbekom Subcompartment:

(i) The so-called Zuurbekom compartment covers an area of about 130 km^2. However, as far as development of an emergency supply is concerned, only the eastern portion known as the Zuurbekom subcompartment has to be considered. The subcompartment has an area of 70 km^2.

(ii) Present ground water situation:

Ground water is abstracted by the Rand Water Board at an average rate of 25 500 m^3/d or nearly 300 ℓ/s. In addition Randfontein Estates Gold Mine abstracts from boreholes in the western part of the subcompartment about 7 ℓ/s.

(iii) Exploitable storage has been estimated by SRK at at a minimum of 5 and a maximum of 35 million m^3. On the basis of storage figures for the Venterspost Compartment exploitable storage is put at 24 million m^3.

(iv) Status of investigation: Investigation and drilling completed as well as report. Nineteen exploration holes were drilled. Seven of these ZM5, ZM6, ZM11A,ZM21A,ZM36,ZM42, ZM43, are high--yielding with combined capacity of about 600 ℓ/s (over 58 $M\ell/d$).

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(v) The dissolved solids in Zuurbekom ground water range from 120 to about 320 mg/ℓ except near the western boundary of the sub-compartment where there is evidence of pollution (high sulphate and nitrate content) and TDS values of up to 676 mg/ℓ have been recorded.

(vi) No further investigations are presently envisaged. Borehole ZM6 only will be brought into production in the near future yielding possibly over 116 ℓ/s (more than 10 mℓ/d). Details of pumping equipment being installed by Rand Water Board are not available.

2.5.2 Eastern Gemsbokfontein Sub-compartment

(i) The eastern half of the Gemsbokfontein Compartment only, has received attention as a source of supply. The sub-compartment covers an area of 28 km^2.

(ii) Present ground water situation: No significant ground water abstraction and no spring flow. Ground water is discharged from the sub-compartment by leakage through the Panvlakte and Klip River dykes.

(iii) Exploitable storage has been estimated by SRK at a minimum of 2 and a maximum of 14 million m^3. On the basis of storage figures for Venterspost compartment exploitable storage is put at 10 million m^3.

(iv) Status of investigation: Investigation and drilling are completed as well as the report. Ten exploration boreholes were drilled. Five of these ZM29, AM30, ZM44, SY2 and SY14 are high-yielding with a combined capacity of at least 350 ℓ/s (pumping rate could possibly be as high as 520 ℓ/s or 45 Mℓ/d).

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(v) Water quality is good ranging from 130 to 230 mg/ℓ total dissolved solids.

(vi) No further investigations for developing an additional supply are presently envisaged. Boreholes ZM30 and ZM44 are being brought into production by the Rand Water Board with a possible output of about 290 ℓ/s or over 25 Mℓ/day. Data on pumps being installed by Rand Water Board are not available.

2.5.3 Western Gemsbokfontein Sub-compartment:

Dewatering of the western Gemsbokfontein Sub-compartment by Western Areas Gold Mining Co. is presently under consideration. It is planned that dewatering is to commence about April 1986.

The sub-compartment covers an area of about 70 km². Various estimates have been made of the volume of water contained in the compartment. In its request for a permit to dewater, the mine puts the total storage of the eastern and western sub-compartments at 171 million m³.

This value appears rather low when compared with the storage of Venterspost compartment (54 km², 460 million m³) and Oberholzer compartment (156 km², 1050 million m³). It seems more likely that the volume stored in the western sub-compartment is of the order of 500 - 600 million m³. The contents of the whole compartment (east and west) would be between 670 and 850 million m³.

The electrical conductivity of dolomitic ground water which is being pumped from the mine and recharged into the compartment at present averages around 130 mS/m which means about roughly 800 mg/ℓ of dissolved solids. It is believed that the quality will improve as the sub-compartment is being dewatered. The present rate of pumping

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from the mine (140 000 m^3/d) is not expected to rise significantly after dewatering starts. Eventually it should recede to about 15 000 - 25 000 m^3/d.

2.6 FAR WEST RAND COMPARTMENTS

(i) As is well-known the Venterspost, Bank and Oberholzer compartments have been largely dewatered. Details about quantities presently pumped by the mines from these compartments and discharged over the Oberholzer dyke need updating and processing. In October 1983 an average or 145 000 m^3/d was being discharged. Of this volume about 85 000 m^3/d can be ascribed to natural ground water recharge. The balance consists probably of ground water withdrawn from storage as well as imported Rand Water Board supply (which is of the order of 160 000 m^3/d). In October 1983 the TDS of the discharged waters (3 streams) ranged between 152 and 589 mg/ℓ.

(ii) Owing to the fact that the ground water levels have receded to below the bottom of many of the monitoring boreholes, very little is known about the present water level in these compartments.

In spite of the low levels, it is still possible that appreciable volumes of water, up to 100 million m^3 and perhaps more, are still held in storage. These could be abstracted by means of boreholes, apparently without risk of further subsidence or sinkhole formation. (State Technical Co-ordinating Committee on Sinkholes and subsidences to be consulted).

It is recommended that available data on water levels be obtained and processed, that consideration be given to the opening up and the deepening of old monitoring boreholes and that if necessary new observation holes be sunk to depths of 300 to 400m.

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Assuming 3 new holes per compartment at R50 000 per hole and allowing R150 000 for cleaning, deepening of old holes a maximum of R600 000 would be required to assess the possibilities of tapping the remaining water in these compartments. The feasibility and economics of pumping from boreholes at depths of 400m below the surface of course also needs analysis.

(iii) The Turffontein compartment is largely untouched by mining and if need be, consideration could be given to using water from the Gerhardminebron and Turffontein eyes which have flows ranging from 650 - 985 ℓ/s and 190 to 540 ℓ/s respectively.

2.7 TARLTON AREA

Field investigations, drilling and pumping tests in this area have been completed in 1985. Data are being processed and a report compiled. Most of the work and drilling has been concentrated in the eastern part of Steenkoppies and the south western part of the Zwartkrans compartment near to the RWB pipeline.

2.7.1 Steenkoppies Compartment

(i) Area 168 km².

(ii) Present ground water situation:

(a) Maloney's Eye rises from this compartment. Its flow varies between 8 and 32 million m³/a averaging 15,5 million m³/a. The flow of the eye comprises about 40% of the supply available to irrigators in the Magalies River Valley.

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(b) Data on the number of boreholes in the compartment are incomplete. For household and stock an estimated 3,2 million m^3/a are used; irrigation requires 10,3 million m^3/a. This figure is due to rise in the near future to about 13 million m^3/a, as a result of further development on Maloney's Eye, Delarey and Wolwekrans.

(iii) Exploitable storage : As the ground water level lies rather deep,a lowering of more than 5 metres may be possible without any undue risks of suitable formation and subsidence.

The minimum exploitable storage is estimated at 80 million m^3, with a possibility that as much as 140 million m^3 could be abstracted safely over the compartment as a whole.

(iv) Status of investigation : Hydrogeological and geophysical field work, exploratory drilling and pumptesting have been carried out.

Eleven boreholes have been drilled of which 7 are considered suitable for production with a combined pumping rate of 295 ℓ/s (12,4 million m^3/a). These holes are located in a small portion of the compartment near its eastern boundary. Another 12 holes were drilled for observation purposes. Two private boreholes on Wolwekrans and 4 on Maloney's Eye yield over 25 ℓ/s.

(v) Additional work: In order to abstract 80 million m^3 from storage in one year will require a spread of holes over the whole of the compartment. This would require:

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Hydrogeology	R 50 000
Additional gravity survey	R 40 000
Drilling of 80 holes; 50% successful averaging 50 ℓ/s	R1 600 000
Pumping test 40 holes	R 240 000
	R1 930 000

(vi) Lowering of the ground water level over the whole of the compartment or immediately above the springs, would lead to cessation of flow of Maloney's Eye. Lowering will also effect yield of private holes and some may fail. Deepening of holes may resolve the problem in a number of cases; otherwise, either replacement holes would have to be drilled or water supplied from the emergency production holes. By abstracting water in areas remote from the eye, particularly to the south of the east-west trending so-called Wolwekrans dyke, the effect would be damped and delayed and might be difficult to distinguish from effects of current pumpage in the compartment and from fluctuations of rainfall and natural recharge.

2.7.2 Zwartkrans Compartment

Investigations and drilling in this compartment which adjoins Steenkoppies on the east were largely confined to its south eastern half.

(i) Area 210 km^2. The compartment is subdivided by 3 north trending dykes as well as one or more dykes running east-west.

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(ii) Present ground water situation: Springs in the compartment are the Danielsrust (alleged to yield 0,6 million m^3/a) and the Kromdraai downstream (alleged to yield 2,8 million m^3/a). The flow of the latter has also previously been reported to be 25 000 m^3/d (i.e. 9,1 million m^3/a). An area of 138 ha is irrigated with spring flow. Boreholes provide an estimated 0,8 million m^3/a for household use and stock-watering and about 15 million m^3/a is abstracted for irrigation. The total consumption of ground water amounts to about 16 million m^3/a. No private holes yielding over 25 ℓ/s exist.

(iii) Exploitable storage: The compartment has been subdivided into 5 sub-compartments. The position in each as follows:

Sub-compartment	Area km^2	Exploitable storage (milliom m^3)
A	9	3 - 8
B	14	5 - 12
C	21	7 - 18
D	40	10
E	126	32(?)
Total	210	57 - 80

(iv) Status of ground water investigation : Hydrogeo-geological and geophysical surveys were conducted and 27 exploration holes were drilled. Of these 18 could be utilised as production holes. The boreholes are situated as follows:

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Sub-compartment	No of potential production holes	Combined Yield (ℓ/s)
A	2	200
B	4	310
C	3	260
D	2	50
E	7	600
Total	18	1 420

(v) The water quality in all these sub-compartments is good. That of E has higher sulphate values.

(vi) Addiitonal work required: Sub-compartment E requires additional hydrogeological and geophysical work.

Hydrogeology (2 months)	R 30 000
Gravity survey (3 months)	R100 000
	R130 000

Drilling for additional production hole is required as follows:

Sub-compartment	Additional No. of holes	Cost including testing	Time required for completion including preceeding surveys and pump-testing (months)
A	-	-	-
B	-	-	-
C	1	R 45 000	0,5
D	5	R225 000	3,0
E	15	R720 000	5,0
	22	R990 000	8,5

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2.7.3 Holfontein Compartment

As it lies west of Steenkoppies compartment and is more distant from pipelines no serious consideration has been given to it. Preliminary indications are that about 38 million m^3 could be taken out of storage. No drilling has been undertaken here and no suitable private holes are available for abstraction.

2.8 VERWOERDBURG - KEMPTON PARK AREA

This area is roughly 400 km^2 in extent and has as yet not received attention as a posisble source for emergency supply.
It is estimated that an investigation to determine its potential consisting of hydrocensus, hydrogeological mapping, geophysical surveys, exploratory drilling and pumptesting would take 12 months to complete. At that time some exploratory boreholes would be available for production, but follow-up drilling will probably be required in order to develop the full potential (i.e. to be able to tap the exploitable storage in 12 months).
Cost Estimate:

Hydrocensus and hydrogeology	R 100 000
Geophysics 5 000 gravity stations	R 75 000
Drilling of 50 holes and pumptesting of 25	R2 125 000
	R2 400 000

2,9 LOWER HENNOPS RIVER VALLEY (west of Aalwynskop Spring)

This area is probably too far west to be considered for investigation and drilling for an emergency supply.

2.10. SUMMARY TABLE

The preceding brief description are summarised in Table I.