

Technical Report GH 3587

A Geohydrological Investigation of the Strydenburg Allotment
Area.

District : Hopetown
Drainage Region : D 60

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ABSTRACT

Strydenburg's municipal water supply is derived from a number of boreholes situated within the townlands. Water supply problems have cropped up repeatedly over the past few years, as evidenced by the numerous water restrictions that have been imposed.

The present municipal water requirements are 35 000 Kl per annum, while the existing groundwater resources are estimated to be in the order of 28 000 Kl. In order to overcome this supply shortfall, it is recommended that the Municipality negotiate obtaining water from existing private boreholes on the property Thornville.

In the long term, additional groundwater resources should be acquired from certain farms in the district, as prescribed in Venables (1985) report.

SAMEVATTING

Strydenburg het oor die afgelope paar jaar etlike probleme met watervoorsiening ondervind.

Die huidige munisipale waterbehoefte is in die orde van 35 000 Kl per jaar, terwyl die bestaande bronne se lewering op 28 000 Kl/jaar beraam word. In die kort termyn word daar aanbeveel dat die Munisipaliteit onderhandel om water vanuit sekere privaat boorgate, op die plaas Thornville aantekoop.

In die langer termyn, moet daar gekyk word na die moontlikhede vir ontwikkeling van addisionele grondwaterbronne op omliggende plase, soos neergelê in Venables verslag van 1985.

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1 INTRODUCTION

Strydenburg's municipal water supply is derived from a number of boreholes situated within the confines of the townlands. Water supply problems have cropped up repeatedly over the past few years, as evidenced by the numerous water restrictions that have been imposed.

The groundwater potential of the Strydenburg and the adjoining farmlands were investigated by Dziembowski (1984) and Venables (1985), respectively.

The Chief Engineer : Water Utilization requested an assessment of Strydenburg's groundwater resources from the Director Geohydrology (reference B13/1/426 dated 09/02/88). This investigation deals with the updating and re-evaluation of the groundwater potential of the townlands.

2 BACKGROUND INFORMATION

2.1 GENERAL

Strydenburg is situated in the Hopetown District of the Northern Cape. The town lies some 53 km southwest of Hopetown.

The average annual rainfall is in the order of 260 mm. The investigation area falls into drainage region D.60.

2.2 PREVIOUS INVESTIGATIONS

2.2.1 GEOHYDROLOGICAL REPORTS

(1) F.W. Schumann (1966) :

Schumann examined the possibilities of acquiring additional groundwater resources to alleviate a supply shortfall. Borehole G 19165 was sited using the resistivity method (Enclosure 1).

(2) J.R. Vegter & S.B. de Villiers (1957) :

A borehole inventory was carried out in Strydenburg. The results of pumping tests performed on municipal boreholes SG 1-3 and SG 5, as well as the geophysical siting of boreholes G 10586 and G 10587 (Figure 1) are discussed. The relevant findings of the investigation are:

- (a) Groundwater in the Strydenburg area is associated with fractured/weathered shales of the Prince Albert formation (Ecca Group). These sediments are underlain by an extensive dolerite sheet. In the town this sheet lies at an average depth of 18m.
- (b) Two groundwater compartments, separated by a north-south striking dolerite structure, were identified. Municipal boreholes SG 1-3 and SG 8 are situated in the so-called "northern compartment", while boreholes SG 5, SG 12-13 are in the "southern compartment" (Enclosure 1). The groundwater level in the southern compartment was some 6-8 m deeper than in the northern compartment.
- (c) It was estimated from the pumping tests that dewatering of the northern compartment by a metre yielded 4 200 Kl of groundwater.
- (d) The "safe yield" of the northern and southern compartments were tentatively estimated at 55 Kl/day and 23 Kl/day, respectively. This represents an annual amount of 30 000Kl.

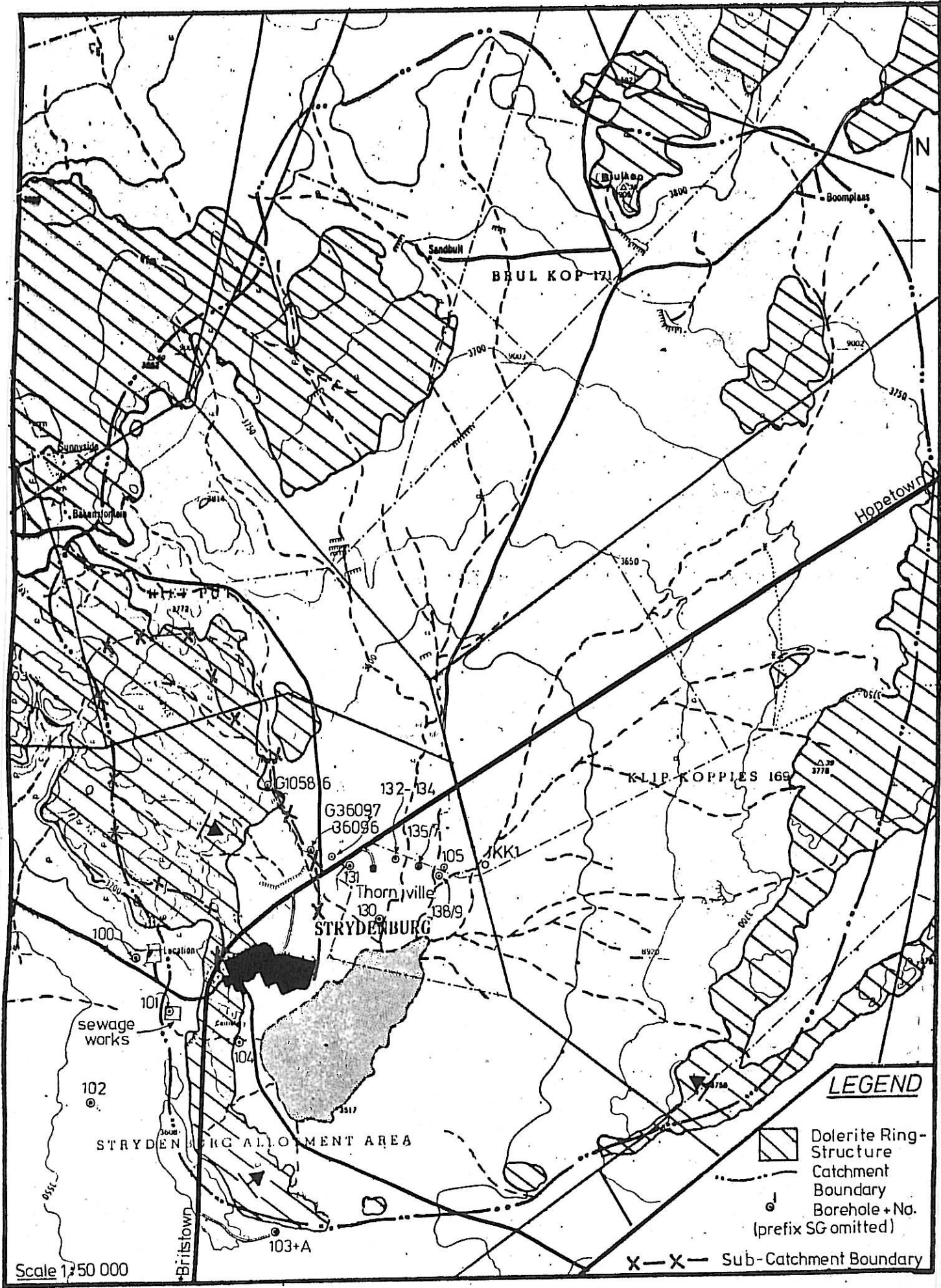


FIGURE 1 - STRYDENBURG ALLOTMENT AREA.

(3) Z.M. Dziembowski (1984) :

The groundwater resources of the townlands were investigated. Dziembowski identified a 5 km² sub-catchment in which the municipal production boreholes are situated (Figure 1). He estimated an average groundwater recharge of 70 000 Kl/year, assuming a rainfall/ recharge factor of 5.5%.

The safe yield of the municipal production boreholes were estimated to be in the order of 30 000 to 40 000 Kl/yr. He concluded that additional supplies could be obtained within the same sub-catchment.

Dziembowski found that groundwater elevations in the southern compartment were lower than those in the pan area, resulting in the intrusion of saltwater from beneath the pan. He recommended that groundwater abstraction be confined to the northern compartment, until waterlevels in the southern compartment had restored to above those in the pan.

(4) C.J.H Erasmus (1984)

The report describes the siting of four boreholes (G 36095-36098) and the drilling of boreholes G 36096 and G 36097 (Figure 1). The results of the drilling were disappointing and it was recommended that further groundwater investigations be conducted beyond the boundaries of the town.

(5) A.J. Venables (1985)

Venables investigated the farmlands within a 10 km radius of Strydenburg, with aim of locating possible additional groundwater resources for the town.

He recommended borehole BR 1 on the farm Britzkraaal as the most favourable possibility, in terms of both the groundwater quantity and quality.

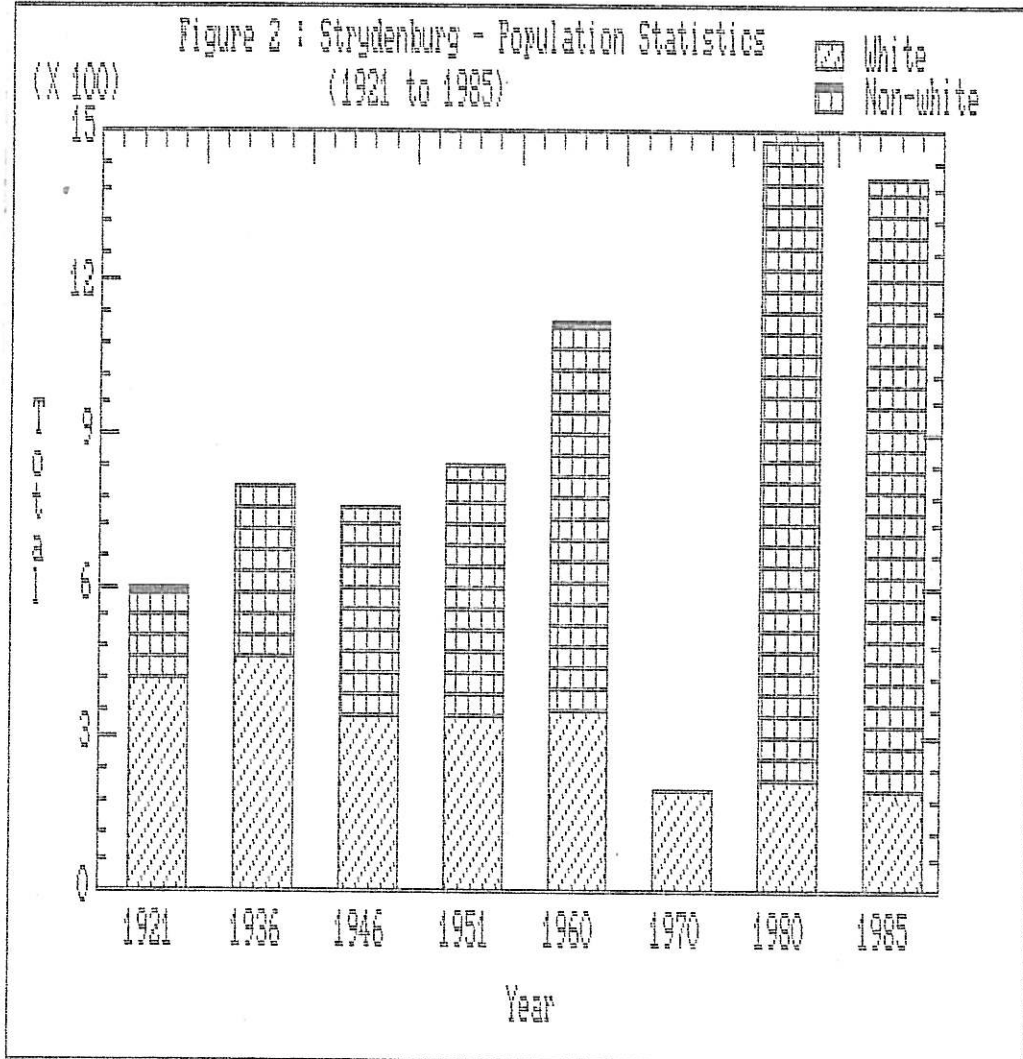
2.2.2 OTHER REPORTS

(a) Ninham Shand Eng. (1987)

This report describes an in depth study of Strydenburg's water supply problem. Various water supply schemes are proposed, including water from the Orange River. The following relevant information was obtained from the report:

- (1) The historical population figures and estimated future population levels are presented in Tables 1 and 2, respectively.

The white and non-white population data are graphically presented in Figure 2. It is clear that the non-whites have increased threefold over the past 60 years, while the whites have remained relatively constant since 1970.



- (2) Municipal water consumption for the period 1976 to 1986 (Table 3). Prior to 1984, the non-white consumption is estimated to be 50% of white consumption.
- (3) Present and estimated future per capita water consumption, including and excluding non-white reticulation (Table 4).
- (4) Present consumption and estimated future requirements, including and excluding coloured reticulation (Table 5 and 6, respectively).
- (5) A comparison is drawn between the existing municipal water resources and estimated future requirements (Table 7).

Ninham Shand recommended that the Municipality proceed with the outlined Orange River Scheme.

TABLE 1: Historical Population Figures for Whites, Coloureds and Blacks.

Group	1921	1936	1946	1951	1960	1970	1980	1985
Whites	414	456	345	349	352	200	217	196
Coloureds	181	294	362	435	672	-	1127	1076
Blacks	4	44	52	55	100	-	135	128
Total	599	794	759	839	1124	-	1479	1400

(Source: Central Statistical Services)

TABLE 2: Projected Population Figures.

Group	1990	1995	2000	2005	2010	2012
Whites	208	217	227	237	246	250
Coloureds	1120	1166	1214	1264	1316	1338
Blacks	132	136	141	145	150	152
Total	1460	1519	1582	1646	1712	1740

(Source: Ninham Shand, 1987)

REMARKS - White, coloured and black growth rates of 0.86%, 0.64% and 0.81% /yr, respectively, were used.

TABLE 3: Annual Metered Municipal Water Consumption (Kl).

Year	Whites	Coloureds & Blacks	Average Daily	Total
1976	-	-	36	13269
1977	-	-	47	17030
1978	-	-	49	17744
1979	-	-	58	20998
1980	-	-	61	22087
1981	-	-	65	23712
1982	-	-	77	28116
1983	-	-	80	29260
1984	17276	7766	69	25042
1985	22603	8147	84	30750
1986	20483	9378	82	29861

(Source : Ninham Shand, 1987)

- REMARK : 1- These figures exclude an estimated 12045 Kl/yr unmetered Municipal usage.
 2- Non-whites restricted to usage between 6-10am and 4-8pm.
 3- Prior to 1984, the Non-white consumption is not included in the Total.

TABLE 4: Present and Estimated Future Per Capita Consumption. (including and excluding non-white reticulation).

Year	Whites (l/day)	Non-Whites (l/day)	
		un-reticulated	reticulated
1986	300	21	21
1990	331	25	27
1995	369	30	38
2000	408	37	54
2005	446	45	75
2010	485	55	105
2012	500	60	120

(Source : Ninham Shand, 1987)

- REMARKS * The relatively low white per capita consumption is attributed to the fact that most properties have a private borehole. Ninham Shand expect this to rise to 500 l/day by the year 2012 in the case of water being more freely available.
 * Non-white per capita consumption was assumed to increase by of 4.12% and 6.9% for un-reticulated and reticulated conditions, respectively.

TABLE 5: Present and Estimated Future Water Requirements.
(excluding coloured reticulàtion)

Year	Whites (Kl/yr)	Coloureds (Kl/yr)	Blacks (Kl/yr)	Total (Kl/yr)	Total (Kl/day)
1986	21 900	8 317	989	31 206	85
1990	25 130	10 220	1205	36 555	100
1995	29 227	12 768	1489	43 484	119
2000	33 805	16 395	1904	52 104	143
2005	38 581	20 761	2382	61 724	169
2010	43 548	26 419	3011	72 978	200
2012	45 625	29 302	3329	78 256	214

(Source : Ninham Shand, 1987)

TABLE 6: Present and Estimated Future Water Requirements.
(coloured reticulation included)

Year	Whites (Kl/yr)	Coloureds (Kl/yr)	Blacks (Kl/yr)	Total (Kl/yr)	Total (Kl/day)
1986	21 900	8 317	989	31 206	85
1990	25 130	11 038	1 301	37 469	103
1995	29 227	16 172	1 886	47 285	130
2000	33 805	23 928	2 779	60 512	166
2005	38 581	34 602	3 969	77 152	211
2010	43 548	50 436	5 749	99 733	273
2012	45 625	58 604	6 658	110 887	304

(Source : Ninham Shand, 1987).

TABLE 7: Existing Water Resources Compared to Estimated Future Requirements (Kl/yr).

Year	Maximum Yield Boreholes	Total Requirements		Shortfall	
		1	2	1	2
1986	28 470	43 251	43 251	14 781	14 781
1990	28 470	48 600	49 514	20 130	21 044
1995	28 470	55 529	59 330	27 059	30 860
2000	28 470	64 149	72 557	35 679	44 087
2005	28 470	73 769	89 197	45 299	60 727
2010	28 470	85 023	111 778	56 553	83 308
2012	28 470	90 301	122 932	61 831	94 462

(Source : Ninham Shand, 1987).

REMARKS : A- Columns 1 = Coloured reticulation excluded.
 2 = Coloured reticulation included.
 B- The unmetered Municipal usage (12045 Kl) is included in columns 1 and 2.
 C- Boreholes max. yield based on Dziembowski's (1984) "safe yield" estimate of 78 Kl/day.

2.3 GEOHYDROLOGY

The townlands are underlain by shales of the Prince Albert Formation (Ecca Group).

Strydenburg is situated on the southwestern edge of a "saucer shaped" dolerite ring-structure (Figure 1). The pan lies in the southern tip of this natural depression. The dolerite sheet is between 60-90 m thick in the vicinity of the town and, although undulating, dips gently beneath the town.

Groundwater is located in the baked/fractured sediments associated with the dolerite intrusive. The groundwater below the pan is highly saline, TDS of 116 000 mg/l, with a typical sodium-chloride character (Dziembowski, 1984). The ring-structure results in a relatively closed groundwater system, where salts are concentrated with time in the groundwater as a result of the low rainfall, high rates of evaporation and shallow waterlevels. The pan filled up following the high rainfall which fell during February/March 1988 (213mm). The average electrical conductivity (EC) of the panwater was 410 mS/m.

3 MUNICIPAL WATER CONSUMPTION AND EXISTING MUNICIPAL WATER RESOURCES

The total metered monthly municipal water consumption data for the period 1984 to May 1988 is contained in Appendix 4. The water consumption record from 1965 onwards is presented in Enclosure 4. The apparent decline in consumption after 1984 is due to an over estimation of the non-white consumption prior to this date. The present annual water requirements is estimated to be in the order of 35 000 Kl or 96 Kl/day.

The present municipal well scheme includes six boreholes (Table 8).

TABLE 8: Immediate Yield of the Existing Production
Boreholes compared to conditions in 1957.

Borehole Number	Immediate Yield (l/s) (waterlevel m)03-1988	Immediate Yield (l/s) (waterlevel m)05-1957
SG 1	0.2 (3.36)	2.4 (6.48)
SG 2	1.0 (3.23)	1.3 (6.30)
SG 5	1.1 (5.32)	+2.3 (13.1)
SG 8	3.9 (5.03)	+3.0 (5.32)
SG 32	3.1 -	-
SG 105	3.5 (2.92)	-
Total	12.8	

REMARKS * Borehole yields were measured using the stopwatch/drum technique and measurements were taken at least 30 min after pumping commenced.

* The yield measured in SG 1 is incorrect, possibly due to pump problems at the time of measurement. According to the Town Clerk the yield should be in the order of 1 l/s.

Boreholes SG 1, 2, 5, 8 and SG 105 are located within the residential area (Enclosure 1), while SG 105 is situated some 2 km northeast of town (Figure 1). Borehole SG 32 was acquired in 1986 and abstraction commenced in October 1986. According to the Town Clerk the borehole yield declined (to <1.9 l/s) during 1987, as did the quality of the water. Borehole SG 105 was drilled by the Municipality during the course of 1987 to help overcome a water supply shortfall. According to the Town Clerk, borehole SG 8 is the most reliable of the production boreholes.

The present yields of boreholes SG 1,2 and SG 5 are somewhat lower than during 1957, although the waterlevel conditions are more favourable (Table 2). This is probably due to borehole failure (e.g. partial collapse of the borehole, salt accumulation in fractures).

The municipal abstraction pattern is complex, as the boreholes are pumped alternatively for different durations. The approximate number of hours operated per month for each of the boreholes was obtained from the pump operator (Table 9).

TABLE 9: Production Boreholes - Average Number of Hours Operated per Month.

Borehole Number	Duration pumped (hour/month)
SG 1	64
SG 2	57
SG 5	57
SG 8	90
SG 32	40
SG 105	80

Under the present conditions (Table 8) an estimated 107 Kl/day could be abstracted from the existing production boreholes, assuming a similar pumping pattern.

SEWAGE EFFLUENT DISPOSAL

The white raw sewage water is pumped into a tanker (6 Kl) truck from various collection points in the town. The effluent is then left to air in earth oxidation dams (Figure 1). The present capacity of the dams is estimated at 3850 Kl, while a further 4500 Kl dam is under construction.

At present the non-whites use the so-called "bucket system". The white effluent production is estimated at 1 440 Kl/month, based on the number of tanker loads pumped per day. Non-white effluent production is estimated at 40 Kl/month, assuming a daily per capita figure of 1 litre. This would represent a total annual volume of 17 760 Kl. The average EC of the effluent was measured at 178 mS/m. The possibility of re-cycling sewage water should also be considered.

The oxidation dams are situated directly upon the dolerite outcrop, which could pose a groundwater contamination hazard. Chemical analysis of groundwater drawn from borehole SG 101, situated alongside the oxidation dams, indicated nitrate pollution (Appendix 2).

4 PREVALENT GROUNDWATER CONDITIONS

4.1 HYDROCENSUS RESULTS

A hydrocensus was conducted to include all boreholes within the townlands (Enclosure 1 and Figure 1). The survey data are contained in Appendix 1. Vegter's (1957) numbering of boreholes SG 1 to SG 67 are used. A large number of these boreholes could not be located or had collapsed. Boreholes SG 100-148 were inventoried during this census.

Some 90 boreholes were visited during the course of the investigation. An estimated 48 private boreholes are in use in the residential area (28 windpumps and 20 engines). Private abstraction is estimated to be in the order of 8 200 Kl/year, mainly for irrigation purposes.

Private borehole yields in the town vary between 0.1 l/s and 1.0 l/s. The majority of the water interceptions appear to be in fractured/ weathered shales directly overlying the dolerite sheet. Many residents indicated that their boreholes had "dried up" during the period 1986/87. A number of boreholes were deepened in an attempt to maintain a usable supply. Furthermore, water quality deteriorated in a number of boreholes, especially in those nearer to the pan.

The average borehole depth is 24m. Town boreholes intercept the dolerite sheet (Enclosure 1) at between 5m and 20m, depending on their proximity to the sheet. Boreholes SG 5, 128 and SG 141 are drilled directly into the north-south striking dolerite outcrop. This outcrop is thought to be the surface expression of an undulation within the main body. Borehole SG 141, 64 and SG 127 are drilled through the sheet, indicating vertical thicknesses of 88, 83 and 61 metres, respectively. However, the yields of these boreholes are low (>0.4 l/s). Small amounts of methane gas are emitted from boreholes SG 141 and SG 127.

Boreholes SG 138 and SG 139 on the farm Thornville have yields of 4 and 6 l/s, respectively (Figure 1). The farmer, Mr Bothma, has used these boreholes since 1986 to irrigate 2.5 ha of lucerne. According to the owner the borehole yields remained relatively constant throughout the 1986/87 drought. The Municipality attempted to obtain a similar yield by drilling borehole SG 105 some 50 m away from these boreholes.

4.2 GROUNDWATER LEVEL FLUCTUATIONS

The waterlevel (borehole SG 6) and precipitation data for the period 1965 to 1988 are indicated on Enclosure 4. A comparison between borehole waterlevels measured during the 1957, 1984 and 1988 investigations is presented in Appendix 3.

It is evident that groundwater levels closely mirror the rainfall. During periods of normal rainfall (260 mm) the waterlevels remains above 4 metres. The aquifer was 100% saturated in 1976, following the abnormally high rainfall (> 500 mm). The waterlevel reached an all time low of 13.5 metres during 1986, when only 72 mm of rain fell. During 1968, under similar rainfall conditions (69 mm), the waterlevel in borehole SG 6 only dropped to 7 metres. This is mainly due to the higher groundwater abstraction during 1986, as well as possible inaccuracies in the 1968 rainfall record. The sharp seasonal groundwater level fluctuations of between 2 to 4m are indicative of low aquifer storage conditions.

The groundwater conditions experienced during this investigation are similar to those of 1974, where waterlevels were in the order of 2 to 5m.

A groundwater contour map of the town was compiled from waterlevel data collected in 38 boreholes (Enclosure 2). The borehole, waterlevel and elevation data are contained in Appendix 3. The following observations are made:

- (1) The groundwater gradient slopes towards the pan.
- (2) Waterlevels on the southern side of the town are approximately the same as the waterlevel in the pan (elevation of the pan floor = 1068.67 metres a.m.s.l)
- (3) The impedance of groundwater flow along the north-south striking dolerite outcrop, indicating the its low permeability.

The waterlevels in borehole SG 128 and SG 127 are 2 and 5m, respectively, higher than those measured in nearby boreholes. These represent piezometric levels of water intercepted below the dolerite sheet.

4.3 GROUNDWATER QUALITY

The electrical conductivity (EC) measurements collected during the hydrocensus were used to construct a contour map (Enclosure 3). Nine boreholes were sampled for standard chemical analysis. The results of the analyses are contained in Appendix 3, as well as the analyses collected by Vegter (1957) and Dziembowski (1984).

Boreholes SG 1, 2, 5 and SG 8 were also sampled during 1957 and /or 1984. All three boreholes indicate an improvement in the groundwater quality. This is due to an influx of better quality water following the high rainfalls in February/March.

From Enclosure 3, the following observations are made:

- (a) There is a marked decrease in groundwater quality towards the pan. This is to be expected considering the direction of groundwater movement (Enclosure 2).
- (b) The high EC values on the southern side of town, is due to the inflow of poorer quality water from beneath the pan, following the high rainfalls of February/March.

Anomalously high EC readings were obtained in boreholes SG 59, 64, 127 and SG 128. Boreholes SG 64, 127 and SG 128 are thought to have intercepted poorer quality water below the dolerite sheet. Water from borehole SG 59 was measured in early March and probably reflects the groundwater quality prior to the influence of the rainfall.

All boreholes sampled for chemical analysis show some degree of nitrate pollution. Boreholes SG 101 and SG 110 (51 mg/l) exceed the S.A.B.S limits for domestic use.

Dziembowski (1984) pointed out that if waterlevels in the aquifer were drawn down below 12 metres, it was possible that saltwater intrusion could take place from beneath the pan. Many private borehole owners stated that groundwater quality noticeably deteriorated during 1986. In 1986 the waterlevel in borehole SG 6 declined to 13.5 metres (Section 4.2).

5 EXPLOITATION POTENTIAL OF THE AQUIFER

Dziembowski (1984) defined a 5 km² topographical sub-catchment in which the municipal production boreholes (except SG 105), and private boreholes in town are situated (Figure 1).

It is assumed that direct recharge takes place only over this defined sub-catchment and that no lateral inflow of groundwater takes place. Two groundwater level periods are chosen from Enclosure 4 to calculate aquifer storage, namely:

- (1) Period Jan 1985 - Dec 1985 : waterlevels gradually declined from 5.74 m to 13.5 m (7.75 m).
- (2) Period 01/02 - 30/03/1987 : waterlevels rose rapidly from 13.5 m to 6.0 m (7.5 m).

Potential recharge is calculated for each of the periods:

Period	Rainfall During Period (mm)	Recharge Factor (%)	Potential Recharge (Kl)
1	72	4	14 400
2	102	6	31 000

Recharge factors used are within the range of values commonly used in similar geohydrological investigations. An average factor of 5.5 % of the mean annual precipitation was found to be applicable in the De Aar area, under similar climatological and geological conditions. Different recharge factors were used in the calculations to take into account the rainfall intensity differences between the two periods. It is thought that the effective recharge could be higher due to the large outcrop of dolerite along the north and western catchment boundary.

A simple water balance is used to estimate storativity:

Period	Recharge Kl (+)	Abstraction Kl (-)	Balance (Kl)	Storativity (Kl/m)
		Municipal Private		
1	14 400	34 462 8 200	- 28 262	3 650
2	31 000	4 922 1 366	+ 24 712	3 300

The figure of 3650 Kl/m is chosen for further computations due to length of the period under consideration. This figure is some 550 Kl/m less than Vegter's (1957) estimate for the northern compartment. However, it is considered an average figure for the aquifer (south + north compartments), over the depth for which it was calculated (ie to 13.5 m). Normally the storage characteristics of the aquifer decrease with depth.

The average thickness of the aquifer is estimated to be in the order of 18 m (Vegter, 1957 ; Dziembowski, 1984). However, a cut-off limit of 15 m is assumed, whereafter it would no longer be economically feasible, in terms of quality and quantity, to abstract water.

Under present groundwater conditions (waterlevel 3.5 m), the amount of water available for abstraction is:

$$3650 \text{ Kl/m} * 11.5 \text{ m} = 41\ 972 \text{ Kl}$$

However, abstraction must be coupled with the annual rainfall. The safe yield of the aquifer is estimated at 21 000 (57 Kl/day), assuming a 2 year no recharge condition.

This estimate does not include borehole SG 105. This borehole was never tested, but is not thought to have a safe yield in excess of 7 000 Kl per annum (19 kl/day). The yield of the borehole will be affected by private abstraction in boreholes Sg 138 and SG 139.

The potential of the existing municipal borehole scheme is estimated at 28 000 Kl per annum (77 Kl/day).

6 CONCLUSION AND RECOMMENDATIONS

The present annual water requirements are estimated at 35 000 Kl (96 Kl/day), while the water resources are estimated at 28 000 Kl (77 Kl/day). This represents an annual supply shortfall of 7 000 Kl.

It is therefore recommended that:

- (1) Groundwater supplies in the town are limited and abstraction should not exceed 21 000 Kl.
- (2) The possibility of acquiring groundwater from boreholes SG 138 and SG 139 should be investigated to meet immediate water requirements. A pipeline to borehole SG 105 already exists.
- (3) The acquisition of further groundwater resources beyond the townlands should be investigated, following the guidelines laid down by Venables (1985).
- (4) Waterlevel and abstraction data from borehole SG 105 should be recorded. This will aid in assessing the resources's potential.

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APPENDIX 1 - RESULTS OF HYDROCENSUS

BORE HOLE	DEPTH (m)	YIELD (l/s)	WATERLEVEL (m) & DATE	EQUIPMENT	EC (mS/m)	REMARKS
KK 1	-	-	-	WP	133	irrigation
SG 1	32	0.2	4.03(090388) 3.36(190588)	WH	90	drill 1955
SG 2	30	1.0	3.39(090388) 3.23(190588)	WH(Cyl 75mm)	81	24m pipes. drill 1955
SG 3	5	-	3.35(100388)	O	-	old school WP.Drill 1955
SG 4	20 (drilled 1944)	0.6	4.57(090388)	S	83	irrigate showground.
SG 5	25	1.1	5.32(190588)	WH(Cyl 75mm)	83	24m pipes. drill 1953
SG 6	Waterlevel Recorder (D6N516)					
SG 7	11	-	3.63(090388)	WP	-	out order.
SG 8	25 (water at 16m)	3.9	1.43(100388)	S	73	CPA borehole drilled 1956
SG 9	-	-	-	O	-	
SG 12	collapsed					
SG 12A	-	weak	5.02(180588)	S	-	Hostel 2m from SG 12
SG 13	obstruction at 2m					
SG 14	obstruction at 3m					
SG 18	14	weak	3.82(180588)	WP	113	Irrigation
SG 19	18	0.5	-	S	107	Drill 1986 irrigation
SG 20	15	weak	-	WP(Cyl 50mm)	-	recovers when pan fills up.
SG 21	collapsed					
SG 23	-	-	-	WP	-	
SG 25	17	-	-	WP(Cyl 75mm)	-	Irrigation (0-16m shale, -17 dolerite)
SG 26	collapsed					
SG 27	10	-	3.00(180588)	O	-	
SG 28	3	-	2.595(180588)	O	-	
SG 28A	15	0.8	-	WP	-	Water @ 12m. Black Shale
SG 32	20	3.1	-	S(Cyl 65mm)	129	19.5m pipes.
SG 32A	-	-	-	WP	-	
SG 33	collapsed					
SG 34	-	-	-	S	-	irrigation
SG 36	11	-	2.20(180588)	O	-	Ex submers.bh
SG 37	-	-	-	WP	-	out order
SG 38	6	-	2.41(190588)	O	-	
SG 39	-	-	-	WP	-	out order
SG 44	collapsed					
SG 45	collapsed					
SG 46	collapsed					
SG 48	-	weak	-	WP(50mm)	-	not in use.
SG 49	10	-	5.640(180588)	O	-	
SG 53	-	-	7.39(180588)	WP(Cyl 75mm)	75	Irrigation.
SG 54	collapsed.					
SG 55	-	weak	5.29(180588)	WP(Cyl 50mm)	-	Irrigation
SG 58	22	-	4.60(190588)	WP(Cyl 50mm)	242	Irrigation

BORE HOLE	DEPTH (m)	YIELD (l/s)	WATERLEVEL (m) & DATE	EQUIPMENT	EC (mS/m)	REMARKS
SG 59	15	weak	7.50 (090388)	S	826	Irrigation
SG 60	10	-	5.69 (090388)	O	-	15m from 60A
			4.05 (190588)			
SG 60A	-	-	-	WP	-	out order.
SG 61	-	-	-	S	-	
SG 62	14	-	4.90 (090388)	O	-	
SG 64	98	0.3	-	S	191	methane gas
			(0-12 shale, -95 dolerite, -98 shale)			water @11.5m
SG 66	14	1.0	2.84 (180588)	O	-	saline ex-WP
SG 67	collapsed					
SG 100	100	dry	14.71 (090388)	O	-	Drill Apr1987
			13.75 (190588)		-	Black Shale & dolerite.
SG 101	20	0.9	6.99 (090388)	S (Cyl 50mm)	142	Irrigation in coloured township.
			5.74 (190588)			Stock
SG 102	-	-	12.28 (100388)	WP	-	
SG 103	23	-	9.41 (100388)	O	-	
SG 103A	-	-	25.45 (100388)	WP	223	Pumping.
SG 104	-	-	5.83 (100388)	WP	-	out order.
SG 105	30	3.5	2.92 (100388)	S (Cyl 65mm)	143	Drill 1987
			(0-10m alluvium, -30m shale, water @6m)			casing 18m
SG 110	-	0.5	4.78 (100388)	S (Cyl 50mm)	419	Irrigation
SG 111	18	-	7.55 (180588)	O	-	block 0.4m
SG 111A	collapsed					
SG 112	12	-	3.75 (100388)	WP out order	-	block 0.5m
SG 113	12	-	3.52 (100388)	O	-	
SG 114	9	-	3.15 (100388)	O	-	
SG 115	-	1.2	-	S (Cyl 50mm)	288	NG church
SG 116	53	weak	5.30 (180588)	O (ex S)	-	
SG 117	42	-	6.26 (180588)	O	-	drill 1987
			(intercepted dolerite)			block 0.7m
SG 118	14	-	4.21 (180588)	S	-	irrigation
SG 119	-	weak	-	WP	-	irrigation
SG 120	18	0.7	3.13 (180588)	WH	100	dry in 1987
			(water at 9, 14 & 15m, black shale)			drill 1979
SG 121	15	-	1.39 (180588)	WP (Cyl 50mm)	355	
SG 122	25	0.4	2.74 (180588)	S	-	water @ 14m
			(0-15m shale, -25m dolerite)			
SG 123	14	1.0	-	M (Cyl 63mm)	223	as SG 122
						irrigation
SG 124	-	0.5	-	M	-	irrigation
SG 125	-	weak	3.69 (180588)	WP	-	Irrigation
SG 126	15	weak	-	WP	-	dolerite @13m
SG 127	100	0.6	1.21 (190588)	S	130	drill 1985
			(0-8m shale, -69 dolerite, -100 shale, water @90m)			pipes 100m.
SG 128	110	0.3	1.15 (190588)	S	209	suck air
			(2-90m dolerite?, 1st water @96m)			irrigation
SG 129	13	-	5.42 (190588)	O	-	Mr Botha
SG 130	2m pit		0.5 (190588)	F+WP	135	Irrigate 0.5
			(used to pump centrifical yield 2.0 l/s)			Mg lucerne.
SG 131	16	0.2	5.40 (190588)	WP (Cyl 50mm)	119	domestic

BORE HOLE	DEPTH (m)	YIELD (l/s)	WATERLEVEL (m) & DATE	EQUIPMENT	EC (mS/m)	REMARKS
SG 132	15	-	2.18 (190588)	WP (Cyl 75mm)	197	pipes 6m
SG 133	5	-	2.12 (190588)	O	-	water @ 6m.
SG 134	14	-	2.32 (190588)	WP (Cyl 75mm)	-	water @ 6m.
SG 135	25	-	2.71 (190588)	WP (Cyl 75mm)	-	water @ 6m. drill 1987
SG 136	20	-	-	WP (Cyl 75mm)	156	20m from 135 drill 1987
SG 137	17	-	2.86 (190588)	O	-	10m from 136 drill 1987
SG 138	20	4.0 (owner tested for 30hr)	2.35 (190588)	S	-	drill 1986 50m from 105
SG 139	20	6.0 (owner tested for 12hr)	-	M (Cyl 65mm)	-	20m from 139
(SG 132-139 used to irrigate 2.5 Ha lucerne (boreholes drilled 1986/87 intercepted black shale))						
SG 140	18	weak	-	HP	115	
SG 141	85	weak	-	O	-	sealed.
SG 142	22	0.5	3.35 (190588)	S	-	weak
SG 143	21	0.5	-	S	-	irrigation
SG 144	18	0.3	-	S	129	Mr Van Wyk
SG 145	18	0.2	-	S	-	Mr Wiid.
SG 146	-	weak	-	WP	-	irrigation
SG 147	-	-	-	O	-	
SG 148	-	-	-	WP	-	
G18056	20	-	6.54 (100388)	WP (Cyl 75mm)	65	Stock
G19165	-	weak	3.47 (100388)	S	73	irrigation caravan park.
G36096	-	-	5.17 (100388)	O	-	
G36097	-	-	4.99 (100388)	O	-	

Reference to Equipment column:

- WP - windpump
- O - Open borehole
- HP - Handpump
- M - Mono
- T - Turbine
- WH - Working-Head
- S - Submersible

30/7 DBA

APPENDIX 2 -HYDROCHEMICAL DATA

Borehole Number	Date	pH	EC mS/m	TDS	TAL (mg/l)	NO3	NH4	P
SG 3	----55	7.3	85	560	358	7.0	0.08	-----
SG 68	020284	3.8*	12900	116346*	0	72.30*	0.98	0.046
SG 64	010284	6.2	204.8	952	31	0.60	0.60	0.017
SG 52	020284	7.6	224.0	1425	306	27.99*	0.09	0.011
SG 5	----55	8.0	150	780	370	2.7	>3.9	-----
SG 5	020284	7.9	88.0	703	331	6.01	0.04	0.011
SG 5	090388	7.9	77.2	594	283	3.20	0.02	0.002
SG 37	020284	7.9	224.0	1478	283	7.21	0.03	0.013
SG 8	----57	7.5	110	710	290	7.0	0.04	-----
SG 8	020284	7.8	76.0	629	308	4.19	0.04	0.012
SG 8	090388	8.0	75.5	608	324	4.69	0.00	0.006
SG 1	----57	7.7	159	1026	330	11.3*	0.00	-----
SG 1	090388	8.0	84.1	649	294	3.20	0.00	0.002
SG 2	----57	7.5	109	703	322	11.3*	0.00	-----
SG 2	090388	7.9	74.7	595	310	2.96	0.04	0.014
SG 32	090388	7.9	123.2	871	292	5.69	0.05	0.005
SG 101	090388	7.8	139.1	1036	234	10.17*	0.03	0.005
SG 103A	090388	7.8	220.4	1195	176	0.64	0.30	0.007
SG 105	090388	7.7	122.2	870	264	7.95	0.07	0.012
SG 110	090388	7.7	470.2	2980*	264	50.75*	0.02	0.011

Borehole Number	Date	Ca	Mg	Na	Si (mg/l)	K	Cl	SO4	F
SG 3	----55	88	52	25	---	---	71	5	0.5
SG 68	020284	1478	813*	41216*	2.2	151.4	65067*	7297*	0.0
SG 64	010284	11	1	352	6.8	0.7	522	8	9.7
SG 52	020284	183	134	39	24.4	0.6	347	199	0.6
SG 5	----55	132	100	60	---	---	277	96	0.5
SG 5	020284	70	44	55	19.9	0.6	39	45	0.6
SG 5	090388	62	35	48	20.1	0.9	28	40	0.7
SG 37	020284	184	107	130	18.8	1.1	411	250	1.1
SG 8	----57	48	105	53	---	---	149	133	0.5
SG 8	020284	61	39	50	19.3	0.6	27	38	0.6
SG 8	090388	59	37	50	19.2	0.4	8	18	0.6
SG 1	----57	68	158*	55	---	---	284	163	0.5
SG 1	090388	59	38	64	19.6	1.1	35	59	0.7
SG 2	----57	66	89	40	---	---	128	72	0.5
SG 2	090388	58	34	51	19.5	0.9	14	26	0.7
SG 32	090388	86	53	94	20.5	1.3	129	106	0.7
SG 101	090388	139	67	59	21.5	1.7	89	327	0.7
SG 103A	090388	20	22	360	18.6	3.9	497	54	*2.4
SG 105	090388	56	54	114	32.8	2.7	115	138	0.4
SG 110	090388	469	239*	132	18.0	3.4	1067*	505*	0.5

REMARKS : *- Concentration exceeds the max. allowable limits for domestic consumption (SABS 241, 1971).

APPENDIX 3 - COMPARISON OF BOREHOLE WATERLEVELS (ELEVATION).

Borehole Number	Elevation (m) a.m.s.l	Waterlevel (m)		
		Apr/May 1957	Feb 1984	Mar&May 1988
SG 1	1079.37	6.48	7.54	3.36
SG 2	1079.42	6.30	7.48	3.23
SG 3	1076.10	4.36	-	3.35
SG 4	1077.67	7.20	-	4.57
SG 5	1077.92	13.10	16.44	5.32
SG 6	1080.07	5.91	7.3	3.4
SG 7	1078.47	5.88	7.70	3.63
SG 8	1080.93	5.03	-	1.43
SG 12A	1080.1*	-	-	5.02
SG 18	1076.28	11.51	14.68	3.82
SG 27	1074.73	-	8.56	3.00
SG 28	1075.15	7.86	-	2.60
SG 36	1073.58	9.19	7.84	2.20
SG 38	1074.49	10.27	>6.20	2.41
SG 49	1079.0*	-	-	5.64
SG 53	1084.0*	-	-	7.39
SG 55	1077.8*	-	-	5.29
SG 58	1074.7*	-	-	4.60
SG 59	1078.14	10.75	10.37	7.50
SG 60	1076.21	-	-	4.05
SG 62	1073.82	6.65	-	4.90
SG 66	1072.7*	-	9.00	2.84
SG 110	1073.5	-	-	4.78
SG 111	1080.8*	-	-	7.55
SG 112	1074.8*	-	-	3.75
SG 114	1074.2*	-	-	3.15
SG 116	1078.2*	-	-	5.30
SG 117	1081.0*	-	-	6.26
SG 118	1077.2*	-	-	4.21
SG 120	1076.1*	-	-	3.13
SG 121	1073.0*	-	-	1.39
SG 122	1075.1*	-	-	2.74
SG 125	1079.4*	-	-	3.69
SG 127	1082.5*	-	-	1.21
SG 128	1077.7	-	-	1.15
SG 129	1079.7*	-	-	5.42
SG 142	1079.4*	-	-	3.35
G19165	1079.30	-	7.11	3.47

REMARK - * elevation estimated from GHP 1543 (Vegter, 1957)
 - during May 1988 waterlevels were 1.5-3m higher than March 1988.

APPENDIX 4 - MONTHLY MUNICIPAL WATER CONSUMPTION
(1984 - 1986)

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STRYDENBURG - MUNICIPAL WATER CONSUMPTION (K1)

	1984	1985	1986	1987	1988
Jan	2740	3648	4001	3304	3701
Feb	2195	2256	3275	2487	4042
Mar	1705	2941	2717	2435	1793
Apr	1594	3090	2839	1789	2825
May	1369	2330	2338	1900	2277
Jun	976	2125	2290	1987	
Jul	1761	2691	1993	1671	
Aug	1876	1943	2177	1844	
Sept	2124	2002	2307	2178	
Oct	2042	2531	2443	2517	
Nov	3037	2689	3313	3562	
Dec	3625	2396	4769	3431	

Total 22008 30641 34462 29104

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REMARK : * Excludes unmetered usage such as caravan park,
 swimming pool, irrigation of recreation fields.
 * Month ends 15th of each month.
 * 1984 figures exclude non-white consumption.

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STRYDENBURG - NON-WHITE CONSUMPTION (K1)

	1984	1985	1986	1987	1988
Jan	-	1046	1447	971	746
Feb	-	678	991	838	1276
Mar	-	749	782	772	542
Apr	-	720	555	562	913
May	-	688	762	620	591
Jun	341	255	-	645	
Jul	451	388	-	499	
Aug	598	650	686	585	
Sept	513	528	675	654	
Oct	622	880	-	736	
Nov	936	699	1892	1219	
Dec	1078	866	1588	1305	

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REMARK : * Prior to June 1984, non-white consumption was not
 metered. Was assumed by Municipality to be 10%
 of the whites consumption.
 * Month ends 15th of each month.