

REVIEW  
OF  
STERKSTROOM BULK WATER SUPPLY



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## S Y N O P S I S

Proposed future development for Sterkstroom as well as other related factors has necessitated an appraisal of the towns' water supply situation.

The scope of the report comprises the evaluation of the present infrastructure and bulk water supply.

Estimated future demands have been considered and projected to the year 2015.

In our recommendations, we suggest that the present infrastructure be updated in order to gather more meaningful design data. A strategy for the town's future water supply could then be formulated and implemented thereafter.

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## 1. INTRODUCTION

Future expansion within Sterkstroom is linked to the availability of sufficient water, and this has necessitated the need for an appraisal of the present system. The town has over the years obtained its supply of water from two sources:

- a) Artesian wells situated on a farm at Carnarvon 15 km due east of Sterkstroom, and,
- b) Five boreholes scattered around the northern outskirts of the town.

The South African Transport Services (S A T S) also draw their water from the farm wells, and cognizance of their requirements as well as the farm's needs is necessary.

## 2 SCOPE OF INVESTIGATION

This preliminary report is based upon information received from the Sterkstroom Municipality and Mr R Halse of Carnarvon. The preliminary investigation covers the following aspects:

- a) The Bulk Water Supply Scheme - both present and future,
- b) Existing sources of water supply,
- c) Alternative water sources, and,
- d) The present infrastructure and its capabilities.

## 3 BULK WATER SUPPLY SCHEME

### 3.1 PRESENT BULK WATER DEMAND

#### 3.1.1 Sterkstroom

- a) The bulk of the water consumed by Sterkstroom is obtained via the old S A T S pipeline which is supplied by two artesian wells at Carnarvon. A metered off-take just north of the town supplies the main reservoir.

In times of peak demand, the boreholes supplement the pipeline supply and this is not metered at present.

It is therefore impossible to be sure of the exact water at present being delivered to the town's reservoir.

b) Consumption within the town itself is metered in the following ways:

- i) Each town dwelling is metered in the normal Municipal manner, and,
- ii) Two meters measure the flow of water into the black township.

There is no meterage of municipal consumption.

Metered consumption figures for the last year are shown in Table 3.1 below. The water supplied to Sterkstroom through the S A T S pipeline has also been included.

TABLE 3.1 : METERED FLOW RECORDS OF STERKSTROOM'S CONSUMPTION vs. METERED PIPELINE SUPPLY

YEAR/MONTH	WHITE POP. CONSUMPTION (m <sup>3</sup> )	BLACK POP. CONSUMPTION (m <sup>3</sup> )	MUNICIPAL* CONSUMPTION LOSSES (m <sup>3</sup> )	TOTAL CONSUMPTION (m <sup>3</sup> )	SUPPLY** PIPELINE (m <sup>3</sup> )	
1986 Feb	3 328	2 450	578	6 356	9 078	3,75
Mar	3 795	2 432	623	6 850	10 379	3,87
Apr	4 412	3 110	752	8 274	8 775	3,55
May	3 548	2 664	621	6 833	8 148	5,04
June	1 136	2 547	368	4 051	10 518	4,06
July	4 690	2 998	769	8 457	9 187	3,43
Aug	4 382	2 975	736	8 093	11 001	4,11
Sept	4 814	3 467	828	9 109	9 844	3,80
Oct	4 343	6 377	1 072	11 792	11 238	4,20
Nov	4 605	2 879	748	8 232	9 353	2,61
Dec	3 017	1 148	417	4 582	11 646	4,35
1987 Jan	4 059	5 940	1 000	10 999	9 932	3,71
TOTAL	46 129	38 987	8 512	93 628	119 099	
AVERAGE MONTHLY CONSUMPTION	3 844	3 249	709	7 802	9 925	
CONSUMPTION l/HEAD/DAY	214	18	-	39	50	

\* Assumed 10% of total consumption as recommended by Department of Development Aid - Water Supply Design Parameters

\*\* Note that borehole supply has not been included.

- c) From the table it can be seen that the average metered supply to the town reservoir via the pipeline is 27% more than the metered consumption. If we were to take into account the water supplied by the borehole, this figure would be higher.

Possible explanations for this deficit between supply and demand could be due to:

- i) faulty meters,
- ii) Excessive losses, or,
- iii) Unmetered consumption.

The metered figure of 18 l/head/day attributed to black consumption is low. Present day consumption based on metered flows is thus inconclusive.

- d) Likely consumption figures can be obtained by utilizing normal design parameter figures. Under the circumstances, this is probably the best solution and these figures are summarized in Table 3.2 below:

TABLE 3.2 : ESTIMATED PRESENT BULK WATER REQUIREMENTS USING NORMAL DESIGN PARAMETERS

USER	POPULATION (1986)	AVERAGE DAILY* CONSUMPTION (l/head/day)	AVERAGE MONTHLY CONSUMPTION (m <sup>3</sup> /month)
Whites & Coloureds	591	240	4 314
Blacks	6 000	50	9 125
Municipal Usage and losses	-	10% of total consumption	1 344
TOTAL			14 783

\* Recommended design parameters as recommended by the Department of Development Aid

- e) By inspection, the anticipated average consumption figure of 14 783 m<sup>3</sup>/month is 4 851 m<sup>3</sup>/month more than the average pipeline supply figure of 9 932 m<sup>3</sup>/month. This present short-fall could be expected to be supplied by the boreholes thus representing an average supply of 6 600 l/hour (158 m<sup>3</sup>/day).
- f) For the purposes of this report, it will be assumed that the design figures used in Table 3.2 above are applicable to the situation in Sterkstroom, and that the average monthly consumption at present is 14 783 m<sup>3</sup>/month (486 m<sup>3</sup>/day).

### 3.1.2 South African Transport Services (S A T S)

In addition to supplying the town's reservoir, the pipeline directly accounts for the requirements of S A T S. They do not make use of the town's storage facilities and are thus an entity on their own.

Their consumption is metered separately and is at present of the order of 1 500 m<sup>3</sup>/month.

### 3.1.3 Carnarvon

- a) The catchment area of Carnarvon is at present responsible for the supply of water to the S A T S pipeline as well as supporting 40 hectares of irrigation.

The crops being cultivated vary from Italian rye grass and lucerne (perennial crops), to seasonal crops like turnips, rape and spring cereals.

It is estimated that the annual demand of these irrigated fields is of the order of 248 000 m<sup>3</sup>/year.

- b) The water requirements for the livestock and staff residing on the farm are minimal in comparison to the irrigation demands and have not been considered.

## 3.2 FUTURE BULK WATER DEMAND

### 3.2.1 Sterkstroom

- a) The Cape Provincial Administration have historical census figures for Sterkstroom which have been tabulated in Table 3.3 below.

TABLE 3.3 HISTORICAL POPULATION FIGURES FOR STERKSTROOM

YEAR	POPULATION FIGURES			
	WHITES	COLOUREDS	BLACKS	TOTAL
1921	971	246	987	2 204
1936	1 060	285	1 670	3 015
1946	1 023	315	2 126	3 464
1951	1 106	219	2 354	3 679
1960	859	205	2 764	3 828
1970	639	155	3 219	4 013
1980	603	167	3 675	4 445

As can be seen, both the white and coloured population groups have shown a negative growth rate over the years. The Administration have utilised these past trends in order to predict future population figures to the year 2015. These figures have been linked to our design parameter figures in order to estimate future bulk water requirements.

A summary of the expected population growth and water requirements are shown in the table below:

TABLE 3.5 : EXPECTED POPULATION GROWTH AND BULK WATER REQUIREMENTS FOR STERKSTROOM

YEAR	POPULATION			WATER REQUIREMENT (m <sup>3</sup> /month)		
	WHITE	COLOURED	BLACK	POPULATION	MUNICIPAL	TOTAL
1990	455	134	6 410	14 050	1 405	15 455
1995	409	124	6 906	14 390	1 439	15 829
2000	368	113	7 440	14 830	1 483	16 313
2005	330	103	8 015	15 350	1 535	16 885
2010	297	93	8 640	15 987	1 599	17 586
2015	267	82	9 300	16 690	1 669	18 359

c) As has already been stated, these figures are based on past growth trends. The development of new coloured and black townships, as is being proposed, would require a revision of these demand figures as well as the supply infrastructure.

### 3.2.2 South African Transport Services (S A T S)

At present the monthly consumption of water by S A T S does not vary much. It has been assumed that the future demand will not differ greatly from the present average consumption of 1 529 m<sup>3</sup>/month.

### 3.2.3 Carnarvon

Plans are afoot to increase the present 40 hectares of irrigated lands to 60 hectares. The water requirement would also increase and it is estimated that future demand should be of the order of 372 000 m<sup>3</sup> annually.

*Notes and the conditions of dam are same as dam*

## 4. EXISTING SOURCES OF WATER SUPPLY

### 4.1 GENERAL

At present the demands of Sterkstroom, S A T S and Carnarvon are being met by the catchment area at Carnarvon, together with the boreholes in Sterkstroom.

The catchment area is the source of two artesian wells the locations of which are illustrated in Figure 1. Surface run-off is harnessed by the two dams, Poplar and Colossal.

③ *the ancient dam*  
*gabruk me*

### 4.2 ARTESIAN WELLS

These wells are perennial and have in the past been exclusively used to supply S A T S and Sterkstroom. Mr Halse has advised that the flow rates of the wells are dependant upon the level of water in the dam Colossal, the month of the year and the severity of the climate in terms of rainfall at any particular time.

*not a single dam station*  
*as damme well is, is damme station*  
*1 damme that will be other well*

An on site measurement has revealed that the wells yield approximately 6,1 l/second (527 m<sup>3</sup>/day).

*the well will have a flow*  
*without water meter*

#### 4.3 SURFACE WATER

The upper catchment areas of the farm are shown in Figure 1. There is a natural gorge formed by the Grootvlei river due west of the farm homestead which commands a catchment area of 27,6 km<sup>2</sup>. The dams of Colossal and Poplar have catchment areas of 9,5 km<sup>2</sup> and 19,2 km<sup>2</sup> respectively.

The preliminary hydrological details of these two dams are compared in Table 4.1 below:

TABLE 4.1. HYDROLOGICAL DATA OF THE CARNARVON CATCHMENT AREA

	FULL CATCHMENT	POPLAR DAM	COLOSSAL DAM
Catchment Area (km <sup>2</sup> )	27,6	19,2	9,5
M A P* (mm)	608	608	608
M A R* (m <sup>3</sup> )	1 324 800	919 680	456 000
Volume (m <sup>3</sup> )	-	43 000	160 000
Reserve Volume (m <sup>3</sup> )	-	2 000	67 000
Surface Area (m <sup>2</sup> )	-	121 400	332 600

\* M A P/M A R - Mean Annual Precipitation/Run-off as recommended by the Hydrological Research Unit Report (1981)

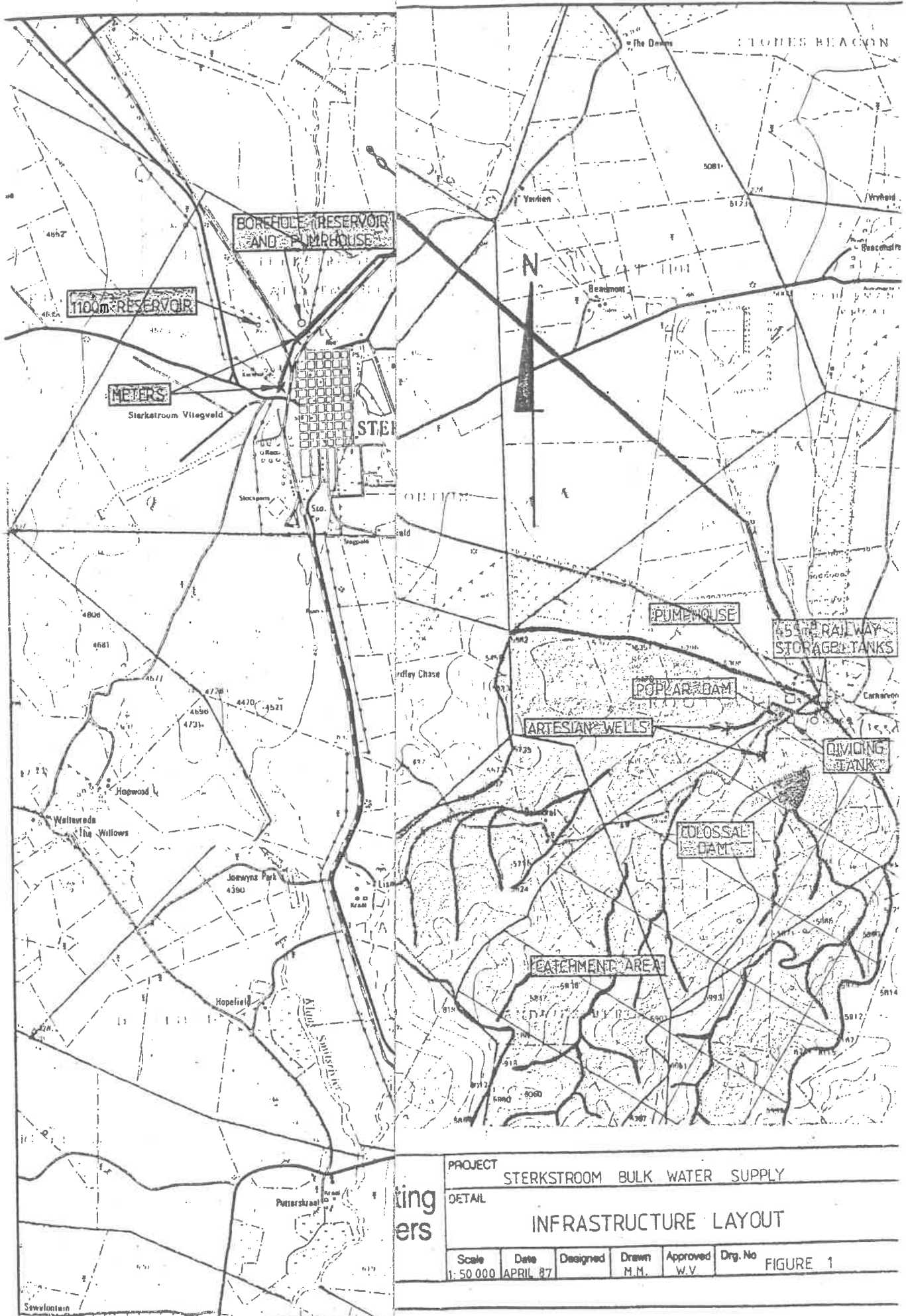
The dams should be able to yield 394 000 m<sup>3</sup> per annum with a 2% risk of failure.

At present, the dams are being used to irrigate 40 hectares of land as described in Section 3.1.3. They have in the past coped with the demand without ever having to rely on water from the artesian wells.

#### 4.4 BOREHOLES

Groundwater is being used in Sterkstroom in order to supplement the water obtained from the Carnarvon wells. Five boreholes are in existence and they are situated to the north of the town.

*Handwritten signature*



PROJECT STERKSTROOM BULK WATER SUPPLY

DETAIL INFRASTRUCTURE LAYOUT

Scale	Date	Designed	Drawn	Approved	Dwg. No
1: 50 000	APRIL 87		M.M.	W.V.	FIGURE 1

ing  
ers

The boreholes are not metered and it is therefore impossible to gauge to what extent they boost supply. They are presently being used to satisfy peak demand periods and represent a reserve supply to be used in times of emergency.

Until water meters are installed at the individual boreholes their exact capabilities in terms of water supply will remain unknown.

#### 4.5 SUMMARY

For simplicity, our projected water demand figures have been graphically illustrated against the potential of the present supply sources. (Figure 2)

4.5.1 The overall position regarding the availability of water for both Sterkstroom's needs as well as Carnarvon's irrigation requirements, does not appear to be good. Calculations based on the S A Hydrological Research Unit Report (1981) indicate that the spring and dam yields would be able to support the present demand with a failure occurring, every 7 - 8 years. Failure constitutes a water shortage which presumably, at present, is being catered for by the town's boreholes.

4.5.2 The position will worsen from year to year as the population increases. Should the irrigated lands be increased to 60 hectares, it appears certain that the dams will not be able to cope with the increased demand.

*would like the increasing demand  
the old die fontaine*

Alternative sources of water supply will require further investigation.

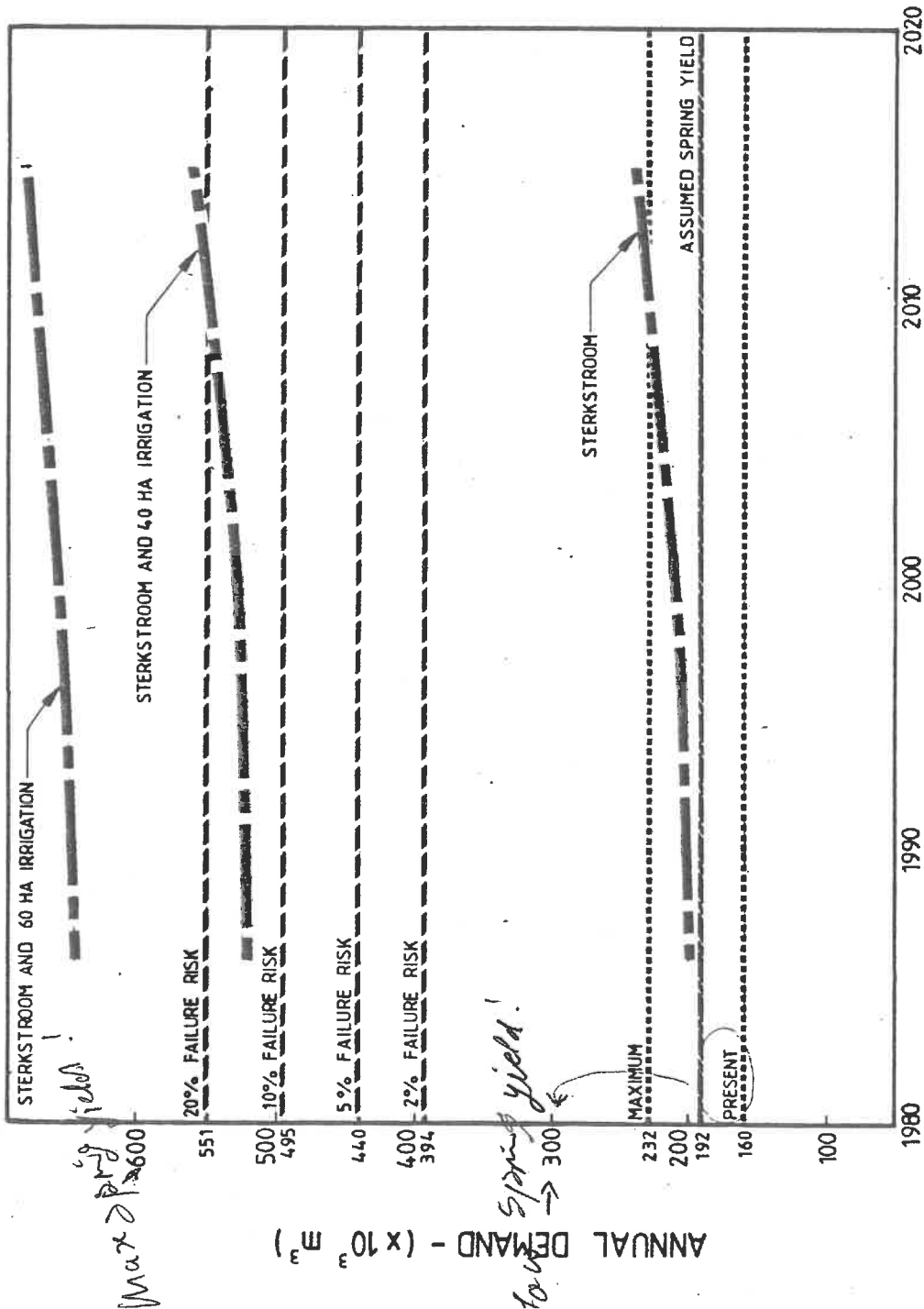
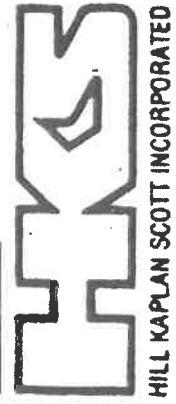


FIGURE 2



PROJECTED WATER REQUIREMENTS  
FOR STERKSTROOM

## 5. ALTERNATIVE SOURCES OF WATER SUPPLY

### 5.1 GENERAL

There are several possibilities available for augmenting the present sources of water supply. All of these would require further investigation in order to ascertain the most feasible and cost effective solution.

### 5.2 CARNARVON

The biggest advantage of developing the catchment area of Carnarvon is that there is already a pipeline available to convey the water directly to Sterkstroom. It is our opinion that the development of the catchment area would be the most likely solution.

At present the <sup>3</sup>(two) dams utilize 70% of the catchment area, and represent a storage of only 15% of its Mean Annual Runoff. This storage capacity could be increased by raising the walls of the dams, but a more likely solution would be to construct a new dam at the Grootvlei neck downstream of Poplar dam. Provided geotechnical conditions are favourable, the gorge is well suited for this, and the new dam would thus benefit from the entire catchment runoff.

### 5.3 ALTERNATIVE DAM SITES

The surrounding area of Sterkstroom does not have much potential in terms of good dam sites. A possible dam site is situated at Buffelskloof, 9 km north/west of Sterkstroom. This would require further investigation.

### 5.4 MOLTENO PIPELINE

It would be possible to construct a pipeline from Molteno to Sterkstroom and this would entail 24 km of pipeline together with a pumpstation.

### 5.5 GROUNDWATER

It is a necessary requirement of the Department of Water Affairs (D W A) that groundwater potential be investigated before permission is given to construct a new dam. It would therefore be essential to contact the D W A to assess the feasibility of a groundwater augmented supply.

## 6. EXISTING WATER SUPPLY INFRASTRUCTURE AND CAPABILITIES

### 6.1 GENERAL

Under normal circumstances, once a suitable source of water is found, it is necessary to design an infrastructure capable of storing and conveying the water to the user. An appraisal such as this one requires that the present infrastructure be assessed, and its capabilities compared to estimated future demand in order to ascertain its usefulness.

### 6.2 PRESENT INFRASTRUCTURE AND CAPABILITIES

#### 6.2.1 General

- a) At present Sterkstroom has a main water supply reservoir of capacity 1 100 m<sup>3</sup> situated 2,5 km north/west of the town.

The reservoir has a storage capacity of over two times the average daily demand.

The available head for water distribution is approximately 24 m.

- b) Water is piped into the reservoir from:

- i) The S A T S pipeline offtake, and,
- ii) The 60 m<sup>3</sup> capacity borehole collector reservoir.

The S A T S pipeline is able to gravity feed the main reservoir directly, whereas the borehole water is pumped from the collector reservoir into the main reservoir.

#### 6.2.2 S A T S Pipeline

- a) This pipeline was constructed by S A T S for their own use in the early 1900's. It conveys water from Carnarvon to Sterkstroom along a route of approximately 24 km (Figure 1).

At present the pipeline is supplied with water which is piped from the two artesian wells to a dividing tank at Poplar dam. The dividing tank has the facility to direct any overflow back into Poplar dam.

- b) The difference in head between Carnarvon and Sterkstroom is approximately 200 m and the falls are sufficient for the line to gravitate the entire route.

Local elevation differences necessitated the construction of two break pressure tanks on the route. They are situated at Kleinskuur siding and a point 4,5 km west of Penhoek siding known as the 'Penhoek' break pressure tank. The capacities of the tanks are estimated to be 680 m<sup>3</sup> and 455 m<sup>3</sup> respectively.

The pipeline is of cast iron construction and is 125 mm in diameter from Carnarvon to the Penhoek break pressure tank, thereafter becoming a 100 mm diameter pipe.

- c) In the case where the two break pressure tanks are in use, it is estimated that the line should be able to convey 7,4 l/sec (640 m<sup>3</sup>/day).

The line is at present being operated without the benefit of the Penhoek break pressure tank, which has the effect of introducing negative heads within the hydraulic profile leading to possible water column separation. This is illustrated in Figure 3.

Present operating difficulties, which are apparently due to air entrapment, support the theory that air is being sucked into the pipeline at these points. This would have a serious effect on the hydraulic efficiency of the pipeline. Visual evidence suggests that under these circumstances the flow rate is of the order of 5 l/sec (432 m<sup>3</sup>/day), which represents an efficiency rate of 67%.

- d) At some stage in the pipeline's history, S A T S found it necessary to boost the potential of the line. This they did by making provision for increasing the delivery head in the following manner:

- i) Two reservoirs of capacity  $455 \text{ m}^3$  each were constructed 6 m above the dividing tank.
- ii) A pumphouse was constructed downstream of Poplar dam and a diesel pump was installed in order to fill the reservoirs.
- iii) A 200 mm diameter feed pipe was taken from the dam to the pump, which then pumped the water to the reservoirs via a 125 mm diameter galvanised delivery main.

The delivery main was connected in tandem to the main S A T S pipeline so as not to disrupt water supply to the pipeline during the filling operation.

It is estimated that flow rate utilizing the booster reservoirs only would be of the order of 7,7  $\ell/\text{sec}$  ( $665 \text{ m}^3/\text{day}$ ). If the pump were used in tandem to force the water down the pipeline, it is likely that the flow rate could be increased to 8,6  $\ell/\text{sec}$  ( $743 \text{ m}^3/\text{day}$ ).

It should be noted that the advantage to be gained by raising the delivery head in this manner would be offset by running costs.

- e) Any further attempt to increase the pipeline carrying capacity would be limited by the grade between Kleinskuur and Sterkstroom. It would then be necessary to either duplicate certain sections of the line, or to construct a new pipeline altogether.

### 6.2.3 Carnarvon

- a) The sprinkler irrigation system at Carnarvon has been designed to operate under a head of 20 m. The rated capacity of the system is  $104 \text{ m}^3/\text{hr}$  which is designed to yield an application rate of between 4 - 6 mm/hr.

b) At present the head of Poplar dam is sufficient to operate the sprinkler system. The top water level of the dam is maintained using the resources of Colossal dam.

### 6.3 SUMMARY

The estimated present and maximum pipeline carrying capacities have been superimposed on the project water demand graph (Figure 2) for ease of reference.

6.3.1 It would appear that the present S A T S pipeline is capable of catering for the "average" needs of Sterkstroom until the year 2010. The line requires to be serviced and its efficiency improved however, in order to ensure that this target is possible.

6.3.2 According to recognised design procedures, supply pipelines should be capable of conveying up to 1,5 times the average daily demand. The S A T S pipeline is unable to cope with this requirement and would require supplementation from another source in times of peak demand.

At present, peak demand is apparently being satisfied by the Sterkstroom boreholes, but their capability to be able to cope in the future requires further investigation.

## 7. RECOMMENDATION

Our preliminary investigations have shown that the present sources of water supply appear to be insufficient for future development and will require to be augmented in the years ahead. This will especially be the case should the irrigated lands at Carnarvon be increased to 60 hectares.

Information presently available is not sufficient in nature for the planning of future supply schemes. It is accordingly recommended that the following steps be taken to gather the required information necessary for a more detailed investigation:

- 7.1 The Department of Water Affairs should be requested to do an underground water survey for Sterkstroom.
- 7.2 The S A T S pipeline should be upgraded and its carrying capacity monitored. We suggest:
  - 7.2.1 The Penhoek break pressure tank be re-commissioned,
  - 7.2.2 A flow control valve be installed just prior to entry into the main Sterkstroom reservoir,
  - 7.2.3 The air valves at present in the line be serviced and/or replaced, and,
  - 7.2.4 A meter be installed at Carnarvon to measure water supplied to the line.
- 7.3 Meters should be installed on all the town borehole lines and their yields recorded.
- 7.4 Meterage within the town itself should be checked to ensure that all consumption is recorded.
- 7.5 A meter is required at the outlet of the main reservoir to measure total consumption.
- 7.6 The consumption of the irrigated lands at Carnarvon should be metered.
- 7.7 A gathering of information regarding the future development of the black and coloured townships is required in order to prepare a master plan for the town's reticulation system.

The information received, having implemented these steps, would enable presentation of a Preliminary Design Report. Such a report would provide recommendations regarding:

- a) The harnessing of further water resources,
- b) The development of an infrastructure system, and,
- c) Recommendations on how to proceed with the detailed design stage.

7.8 The Cape Provincial Administration and House of Representatives (Coloured Affairs) should be approached to contribute to the cost of the water augmentation scheme as they are responsible for the development of the black and coloured townships.

In addition, the Department of Water Affairs should be approached for a subsidy which could be granted in terms of the Water Act. This initial approach could be made during the preparation of the Preliminary Design Report.

## 8 CONCLUSION

Proposed future development for Sterkstroom as well as Carnarvon farm have underlined the need for detailed forward planning to ensure that the town's future water demands are met.

It appears as though the S A T S pipeline, once upgraded, should be able to cope with the town's average water demand until the year 2010. Peak demand would require borehole supplementation and this could be an unreliable and insufficient source.

Overall water supply sources require further investigation as it is more than likely that the present sources will require augmentation for future demand.

A review of the town's reticulation infrastructure is required should there be any progress in the establishing of a new coloured township. The siting of the township together with the water supply reservoirs and possible purification works would require investigation.

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MPHW/yg/12035

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9 APRIL 1987

9 REFERENCES

1. Mev A M Hechter - Sterkstroom Municipality - Verbal Communication
2. Mr R Halse - Carnarvon - Verbal Communication
3. Sterkstroom - Ondersoek na die voorsiening van water - Januarie 1987 - Cape Provincial Administration
4. Surface Water Resources of South Africa, Volume 5, Pitman W.V, Middleton B J, Midgley D C, H R V Report No 12/81 Water Research Commission 1981.