

DINOKANA / LEHURUTSHE
WATER SUPPLY

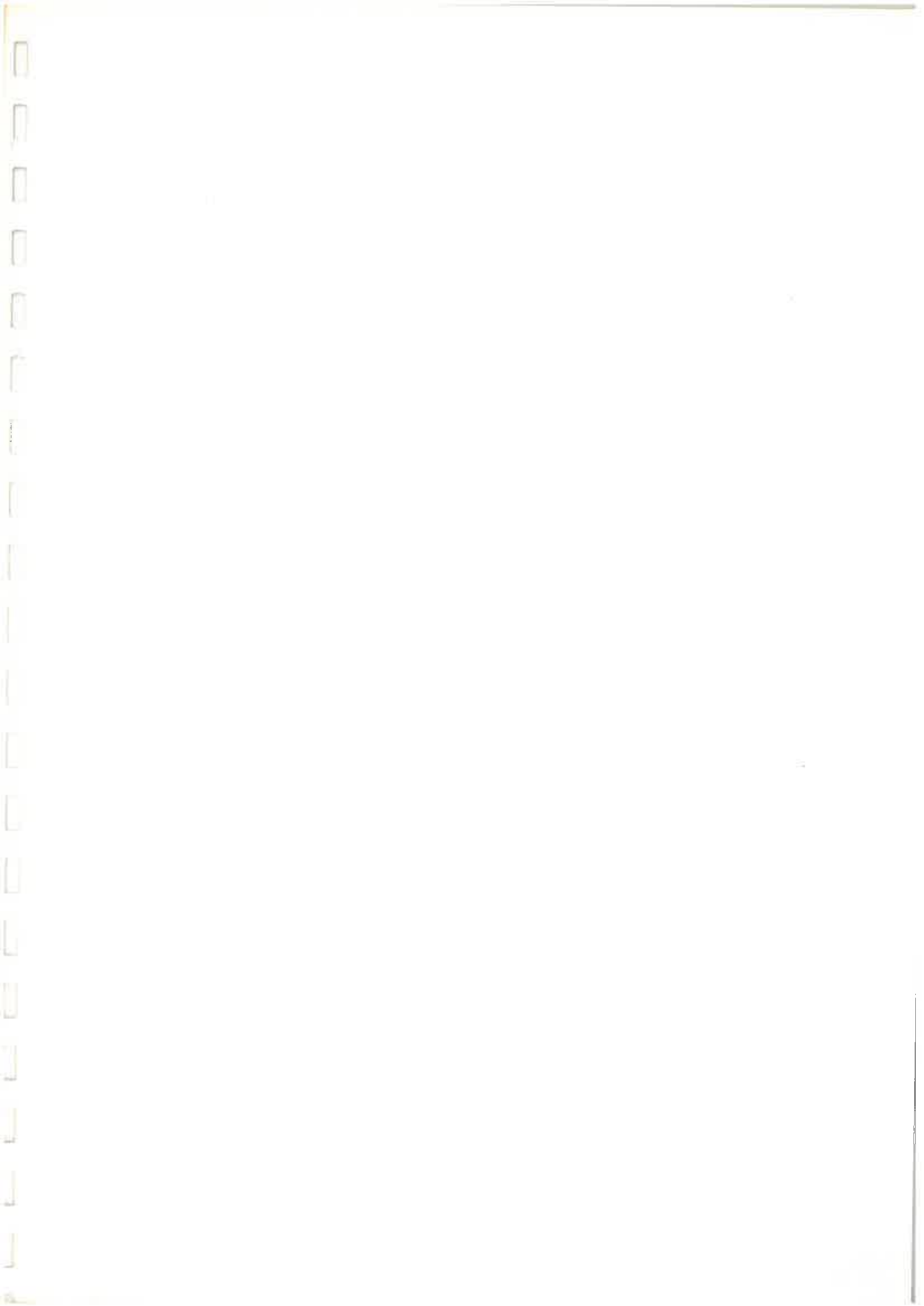
COMPLETION REPORT

DECEMBER 1988

The Secretary
Department of Water Affairs
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EXECUTIVE SUMMARY

This report has been completed as a result of a request by the Bophuthatswana Department of Water Affairs in their letter reference "Water Supply to Lehurutshe : As built drawings and Completion Report : BD 373/87" dated 8 November 1988.

The main aim of this report, therefore, is to examine the past and present situations regarding the water supply and infrastructure, and to make recommendations on:

- apportionment of water
- operation of the scheme
- further infrastructure required.

An attempt was made to keep the report brief and to the point to facilitate a speedy study for reference purposes.

By providing the infrastructure under contract BD 373/87 namely, a dedicated source of water supply together with adequate storage for Lehurutshe, a balancing dam for the Lehurutshe Temisano Irrigation Scheme; storage reservoirs at Dinokana Village as well as a reticulated standpipe system constructed Departmentally with funds from Drought Relief, the discontent amongst the tribal people of Dinokana concerning their water supply should be resolved to a large extent.

Some discontent could, however, still surface between the remaining consumers of water from the Dinokana Upper eye i.e. the Dinokana Village people and the Temisano Irrigation Scheme. Alternatives to solve this problem are discussed in this report and recommendations have been made.

It must be emphasised that the recommendations are based on an average flow from the eyes and that the water available at Dinokana will vary according to rainfall. The apportionment of the referred water will have to be done on a regular basis and good co-operation between the consumers will be required.

This can only be achieved through an Operating Committee which is strongly recommended.

DINOKANA/LEHURUTSHE WATER SUPPLY

COMPLETION REPORT

CONTENTS

<u>SECTION</u>	<u>CONTENTS</u>	<u>PAGE</u>
1.	Objective	1
2.	Historical Background	1
3.	Water Resources	3
4.	Water demand projections	4
5.	Water balance	7
6.	Water apportionment	10
7.	Present water supply infrastructure	12
8.	Future infrastructure requirements	15

APPENDICES

A	-	General layout of scheme	-	White
B	-	Lehurutshe water demand projections	-	Yellow
C	-	Dinokana water demand projections	-	Blue
D	-	Telemetry : Description and operating procedures	-	Green

1. OBJECTIVE

The objective of this report is to examine the past and present situation concerning the water supply to the area and to make recommendations on :

- apportionment of water;
- management and operation of the scheme;
- further infrastructure required and the programming thereof.

2. HISTORICAL BACKGROUND

Dinokana is situated in the Lehurutshe district of Bophuthatswana adjacent to the main road linking Lobatse in Botswana with Zeerust in the Republic of South Africa. The location is shown on the map in Appendix A.

The two Dinokana Springs are located on land falling under the tribal authority of Chief Moiloa. Before the advent of the Rice Scheme, the Lehurutshe Urban Development and the Dinokana Irrigation Scheme, the full yield of the two springs was available for the use of the local tribal population. At this time, a large number of flourishing gardens, orchards and fields existed, fed via an intricate canal system. The implementation of the aforementioned schemes has increased the demand for the available water and some discontent amongst the tribal population surfaced.

Their discontent was compounded by the fact that they were promised a village water reticulation system in compensation for the loss of water from the upper spring to the Dinokana Irrigation Scheme in 1982.

This firm was appointed in 1986 to design a standpipe water reticulation network for the Dinokana rural village area. The appointment was made as a result of the Drought Relief Secretariats decision to supply sufficient funds to purchase and install the piping required for this project.

During the course of the preliminary design investigations it became evident that far more efficient control and management of the water available at Dinokana was required in order to satisfy all consumers. The following actions were recommended:

- (a) The completion of the Dinokana primary water reticulation network;
- (b) The provision of additional storage at Lehurutshe together with the repair of the pipeline supplying Lehurutshe;
- (c) The provision of balancing storage at the Dinokana Upper Eye for the Dinokana Irrigation Scheme;
- (d) The development of an additional dedicated source of water supply for Lehurutshe.
- (e) The formation of an Operating Committee to discuss, determine and enforce water allocations to the various consumers.

The abovementioned recommendations were accepted and this firm was instructed to proceed with the design and implementation thereof. Construction started during 1987 and was substantially completed by the end of 1988.

The Operating Committee referred to in (e) above functioned for a relative short period between October 1986 and June 1987 at which time it was discontinued for reasons unknown.

3. WATER RESOURCES

There are three main sources of water supply to the Lehurutshe - Dinokana area as follows:

3.1 Dinokana Upper Eye

The Dinokana upper eye has been the major source of water for Dinokana for many years. An examination of flow records obtained from the Department of Environment Affairs, RSA for the years 1961 to 1985 reveals fluctuating levels from a minimum of ^{70 c/s} 2,2 Mm³/a in 1966 to a maximum of ^{250 c/s} 7,8 Mm³/a in 1978. For the purposes of this report the average value of 3,0 Mm³/a will be used. (P.C. Partridge, October 1987) This is equal to a flow rate of 95 l/s. Obviously, when good rainy seasons such as those in the seventies are experienced extra water will be available.

3.2 Dinokana Lower Eye

The lower eye has generally had a much smaller flow than the upper eye and has been mainly used for irrigated crop production.

Flow records indicate variations between ^{70 c/s} 2,3 Mm³/a and ^{20 c/s} 0,7 Mm³/a.

For this report a flow of ^{30 c/s} 1,0 Mm³/a (P.C. Partridge, October 1987) will be used. This is equal to 31 l/s.

3.3 Dolomitic Wellfield

The wellfield is situated in the dolomites to the west of Dinokana (See Appendix A). In 1987, after a detailed hydrogeological survey, 7 sites for groundwater extraction were recommended. The available yields from these are listed below.

Borehole No	Borehole Depth (m)	Recommended Pump Installation Depth (m)	Maximum Discharge (l/s)	Pumping Period (hrs)	Maximum Permitted Daily Abstraction (m ³)
DK 1	51	46	15	24	1300
DK 2	32,5	28	15	24	1300
DK 3	65	61	5	24	430
DK 4	56	51	5	24	430
DK 5	42	39	15	24	1290
DK 9	60	58	10	24	865
DK11	46,5	40	15		1290
Totals			80		6905

The total available water from the well field used in this report is 2,5 Mm³/a. This far boreholes DK1, DK2, DK5 and DK9 have been equipped to supply 55 l/s or 4,7 Ml/d.

4. WATER DEMAND PROJECTIONS

4.1 Consumers

The major consumers are the following:

(a) Lehurutshe Town

Lehurutshe is a town which has been growing rapidly in the recent years. There are over 1000 houses, a hospital with 100 beds, a number of schools with over 2000 pupils, a business area and an industrial area in the town. The population in 1985 was 3500. The present consumption is approximately 2 ^{23 l/s} Ml/d. This is well over the adopted standards but it is expected that with the recent introduction of billing, the water consumption will drop to 1,7 Ml/d average.

(b) Dinokana Village

The Dinokana village has a rural setting and is the Tribal Seat. The population of the village in 1985 was 17415. No actual consumption records are available as the water flowing from the eyes has been abstracted from furrows that run through the village.

Besides primary consumption, water has also been used to maintain a number of vegetable gardens in the village.

(c) Dinokana Rice Project

A number of years ago, a rice project was established near the lower eye. Besides rice the project produces a limited quantity of vegetables. No records of consumption are available, but generally speaking most of the water available from the lower eye is used by the project.

(d) Lehurutshe Temisano Irrigation Scheme

This irrigation scheme is situated on the south-east of Dinokana. It comprises 98 ha and produces a variety of vegetables. It is supplied from the upper eye directly through a pipeline. The annual consumption is estimated to be just under 1 Mm³/a while the peak flow demand is 6,4 Ml/day or 74 l/s.

4.2 Water demand projections

In order to determine the limits to the existing supply sources an estimated projection of the demands was carried out. The projections were based on the following parameters:

4.2.1 Lehurutshe

- (a) Population : 3500 persons (1985) @ 150 l/c/d
: growth rate 1985 - 1990 @ 8%/a
1990 - 1995 @ 7%/a
1995 - 2000 @ 6%/a
2000 - 2005 @ 5%/a
2005 - 2010 @ 4%/a
- (b) Schools : 2000 pupils (1985) @ 50 l/c/d
: growth rate - same as in (a)
- (c) Hospital : 100 beds @ 800 l/b/d
: growth rate - Nil
- (d) Industries : 8 ha @ 25 kl/ha/d
: growth rate @ 5%/a
- (e) Business area: Consumption of 250 kl/d
: growth rate @ 5%/a
- (f) Losses : Allowance of 20% from the source
of supply

The water demand projection is graphically shown in Appendix B.

4.2.2 Dinokana

- (a) Population : 17500 persons (1985) @ 50 l/c/d
: growth rate 1985 - 1990 @ 3 %/a
1990 - 1995 @ 2,5%/a
1995 - 2000 @ 2 %/a
2000 - 2005 @ 1,5%/a
2005 - 2010 @ 1 %/a

- (b) Gardening : a maximum allowance of 2 Ml/day from the upper eye under peak demand conditions.

The water demand projection is graphically shown in Appendix C.

(c) Temisano Irrigation

Area : 98ha
Peak demand supply : 1,0 l/s/ha
Simultaneous demand factor : 75%

The peak demand is graphically shown in Appendix C.

(d) Rice project

This has been ignored as it is assumed that the project will be terminated in favour of other consumers.

It is generally conceded by most concerns that the growing of rice in Bophuthatswana is a luxury and that more water efficient crops should be put under the limited water available.

5. WATER BALANCE

5.1 Lehurutshe

The water supply vs demand is graphically shown in Appendix B. The following can be concluded from the above:

- (a) The three "spare" boreholes i.e. DK3, DK4 and DK11 will have to be brought into the system to augment the supply to Lehurutshe before or by the year 1999 in order to meet the summer peak demand.
- (b) The existing wellfield will have to be extended by the year 2007 in order to meet the summer peak demand.

5.2 Dinokana and Lehurutshe Temisano Irrigation Scheme

The water supply vs demand is graphically shown in Appendix C and C1. The following can be concluded from the above:

- Based on the assumption that the lower eye is excluded from the supply, a shortage of water (based on an allowance of ^{22 cfs} 2 Ml/d from the upper eye for gardening) is already experienced during the months of January (1,2 Ml/d), February (0,3 Ml/d), September (0,5 Ml/d), October (1,2 Ml/d), November (1,2 Ml/d), and December (1,2 Ml/d) (Refer to Appendix G) as a result of the peak flow requirements of the irrigation areas.
- Based on the assumption that the lower eye is included in the supply and that Dinokana gets first preference on water for gardening purposes, then the Temisano Irrigation Scheme will gradually have to be reduced in area as from the year 2000 or alternative cropping patterns will have to be followed to reduce the peak demand flow.

The following alternatives could, however, also be considered:

Alternative 1

The Temisano Irrigation Scheme gets all its water from the upper eye, the rice project is phased out and the flow from the lower eye is allocated for gardening purposes exclusively. Then the water available to the village people for gardening purposes presently is as shown in the table below.

Month	Flow (Ml/day)			Upper eye flow
	Upper eye	Lower eye	Total	(hrs)
Jan	0,7	2,6	3,3	2
Feb	1,7	2,6	4,3	5
March	2,4	2,6	5,0	7
April	3,2	2,6	5,8	9
May	3,9	2,6	6,5	11
June	4,0	2,6	6,6	11
July	3,8	2,6	6,4	11
Aug	2,7	2,6	5,3	8
Sept	1,5	2,6	4,1	4
Oct	0,7	2,6	3,3	2
Nov	0,7	2,6	3,3	2
Dec	0,7	2,6	3,3	2
Total	26,0	31,2	57,2	

The above constitutes a total volume of 1,7 Mm³/a which should presently be available for gardening purposes.

Alternative 2

A maximum of 2 Ml/day (23 l/s) is released from the upper eye to the Dinokana village for gardening purposes during peak demand conditions in January, February, September, October, November and December. This will result in a shortfall for the Temisano Irrigation Scheme of 1,6 Ml/day (19 l/s) during these months which can be augmented by installing a pumpstation at the lower eye to supply water into the gravity line to the Temisano Irrigation scheme.

Alternative 3

A maximum of 2 Ml/day (23 l/s) is released to Dinokana village for gardening purposes during peak demand conditions in the months described in Alternative 2 and the shortfall to the Temisano Irrigation Scheme is made up by releasing water from the wellfield pipeline into the Dinokana system at the upper eye. This is, however, only possible until the year 1993 after which the "spare" boreholes will have to be put in operation which will extend the period until the year 2002.

6. WATER APPORTIONMENT

This subject, has lately been the cause of disagreement and discontent, with the Dinokana population dawning that the Temisano Irrigation Scheme was using more than it's share of the available water and visa versa. The situation can only worsen in future and it is strongly recommended that an Operating Committee, consisting of representations of all the consumers, be reinstated. The primary duty of such a committee would be to apportion available water.

Now that a separate source of supply has been developed for Lehurutshe (only in emergencies will Lehurutshe receive water from Dinokana), the available water at Dinokana has to be apportioned between the Dinokana village and the Lehurutshe Temisano Irrigation Scheme.

The Dinokana domestic reticulation gets first preference which leaves the Dinokana gardening demand and the Temisano Irrigation Scheme.

Although the water utilisation of the Dinokana village for gardening is regarded as rather inefficient, it cannot totally be ignored due to the historical usage of the water.

Alternative 2, as described in paragraph 5, namely that a maximum allocation of 2 Ml/day be made from the upper (6hrs full flow) to Dinokana for gardening purposes during the months of peak demand conditions and that Agricor install a pumpstation at the lower eye to make up the deficit, seems to be the more favourable solution.

The water available from the two eyes to the village for gardening purposes is therefore as follows:

Month	Flow (Ml/day)			Upper eye flow
	Upper eye	Lower eye	Total	(hrs)
Jan	2,0	1,3	3,3	6
Feb	2,0	2,3	4,3	6
March	2,4	2,6	5,0	7
April	3,2	2,6	5,8	9
May	3,9	2,6	6,5	11
June	4,0	2,6	6,6	11
July	3,8	2,6	6,4	11
Aug	2,7	2,6	5,3	8
Sept	2,0	2,1	4,1	6
Oct	2,0	1,3	3,3	6
Nov	2,0	1,3	3,3	6
Dec	2,0	1,3	3,3	6
Total	32,0	25,2	57,2	

7. PRESENT WATER SUPPLY INFRASTRUCTURE

The layout is shown on Appendix A and is described as follows:

7.1 Lehurutshe Supply

(a) Boreholes

Four boreholes namely DK1, DK2, DK5 and DK9 have been equipped with monopumps driven by 37 KW electric motors and are capable of supplying 55l/s for 24hrs/day i.e. 4,7 Ml/day.

These pump installations are covered by steel and corrugated iron structures. The boreholes are automatically controlled from the main control panel at the Dinokana pumpstation through a telemetry system which is explained in more detail in paragraph 7.3.

(b) Supply

Water is pumped from these boreholes to 3 x 600 m³ reservoirs to the south of the Dinokana upper eye from where the water gravitates by means of a 12 532 m long 300 øF.C. pipeline to a 5,7 Ml reservoir at Lehurutshe.

Lehurutshe is supplied primarily from the wellfield. In emergencies the Dinokana pumpstation, which is equipped with 3 x 60 m³/hr (45 l/s total) electrically driven centrifugal pumps, can supplement the supply to Lehurutshe via the 3 x 600 m³ concrete reservoirs and the gravity pipeline.

7.2 Dinokana Supply

(a) Eyes

The water supply sources are the Dinokana Upper Eye (Gauge Station AIM01) which has a average flow of 95 l/s while the Dinokana lower eye (Gauge station AIM02A) has a average flow of 30 l/s.

(b) Supply

From upper eye

A pick-up weir just downstream of the upper eye facilitates the distribution of water to all consumers save the Rice Scheme.

The raising or lowering of gates fitted to offtakes varies the supply of water available to the pump sump supplying Lehurutshe (now only in emergencies) or the gravity pipeline, the 2 x 600 m³ Dinokana primary reservoirs and the 7 300 m³ (24 hr storage at peak demand) balancing dam from where the 4 750 m gravity pipeline (consisting of 3 650 m x 350 ϕ F.C. and 1 100m x 300 ϕ F.C.) continues to the 100 ha Lehurutshe Temisano Irrigation Scheme.

The Dinokana reticulation network which consists of 5,2 km x 200 ϕ , 1,58 km x 150 ϕ , 2,31 km x 110 ϕ , 7,6 km x 90 ϕ , 27,5 km x 63 ϕ , PVC pipelines with 73 no domestic standpipes, has been designed to satisfy the primary requirements of the population only. The present earth canal system will have to continue to exist, in some form, to enable the rural population to continue with some sort of small scale irrigation.

From the lower eye

The Rice project currently utilises virtually the entire yield of the lower eye.

7.3 Telemetry

The four (4) equipped boreholes in the Dinokana wellfield are controlled by means of a telemetry system operating from a master control panel situated at the Dinokana Eye pumpstation.

With the recently constructed 5,7 Ml reservoir at Lehurutshe filled up, the water level of the 3 x 600 m³ reservoirs at Dinokana will rise. Should the telemetry system be in the automatic mode the borehole pumps will be started and stopped as the level in the 3 x 600 m³ reservoir rises and falls.

In the manual mode the borehole pumps can be started remotely through the telemetry system at the Dinokana Eye pumpstation. In such case the operator will make a decision on how many pumps to start or stop, based on his visual interpretation of the water level indicator of the 3 x 600 m³ reservoirs.

The three existing pumps at Dinokana will be retained as standby units and can only be started manually.

The detailed descriptions and operating instructions are included in Appendix D.

8. FUTURE INFRASTRUCTURE REQUIREMENTS

8.1 Lehurutshe

(a) Wellfield (Refer to Appendix B)

The present wellfield installations will only be able to supply in the summer peak demand until the year 1999 at which time the three "spare" boreholes have to be put in operation. The supply should then be adequate until the year 2007.

(b) Wellfield supply line

The capacity of this pipeline should be adequate until at least the year 2007.

(c) 3 x 600 m³ Reservoirs at Dinokana

There is no need to increase the storage capacity of these.

(d) Gravity pipeline

The capacity of this pipeline is 60 l/s or 5,18 Ml/day. If an allowance for losses of 5% is made, it should be adequate until the year 1998.

(e) 5,7 Ml Storage reservoir at Lehurutshe

To meet the design criteria of 48 hrs storage of the summer peak demand, the storage capacity at Lehurutshe will have to be increased by the year 1991. The estimated present day cost is R850 000-00.

8.2 Dinokana

(a) Storage

The present storage of 1200 m³ is adequate until the year 1990 at which time at least another 1 x 600 m³ reservoir should be constructed. The estimated present day cost is R75 000-00.

(b) Reticulation

This is considered adequate at present but it can be expected that requests for additional branch lines and standpipes will come from the people of Dinokana from time to time.

The reticulation has been designed for standpipes only at 50 l/c/d and the replacement or enlargement of the pipelines will depend on the rate at which house connections take place.

(c) Irrigation

Should the recommendations as set out in Alternative 2 under paragraph 5.2 be accepted, then the construction of a pumpstation and pipeline at the lower eye will be required by August 1989.

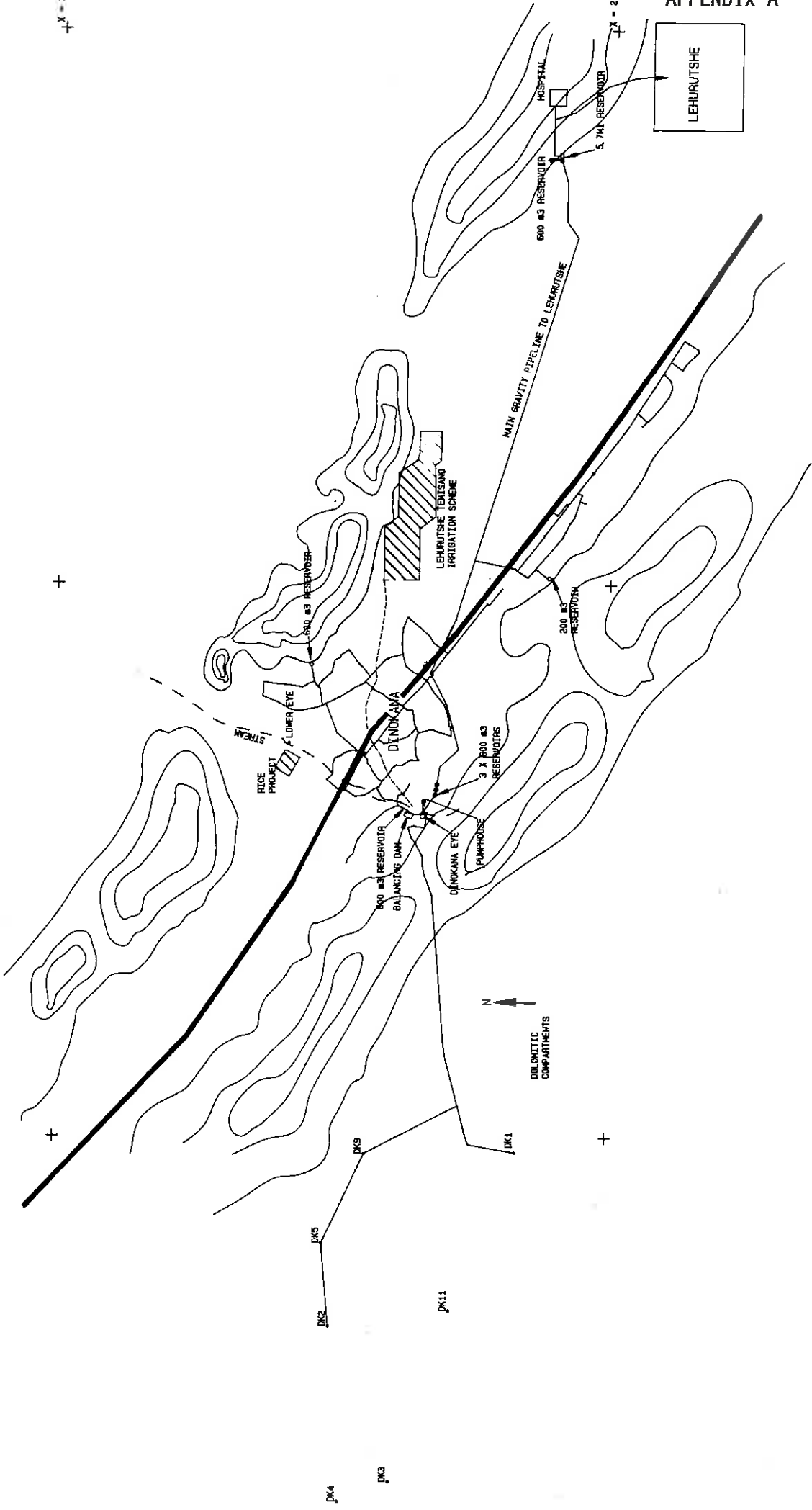
The cost of the above is estimated at R100 000-00.

X = 2 810 000

X = 2 820 000

APPENDIX A

LEHURUTSHE



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DK4

DK9

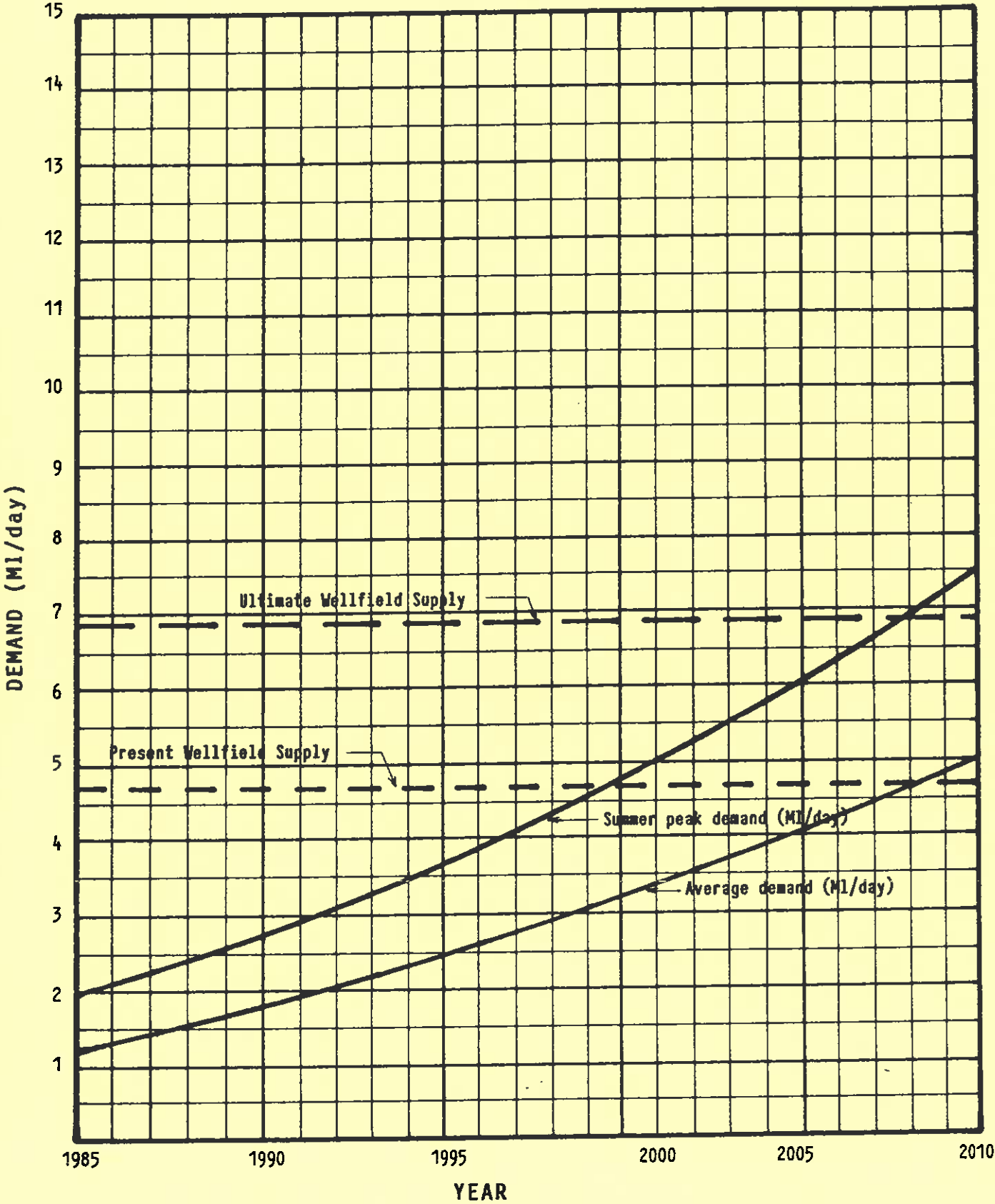
DK11

DK1

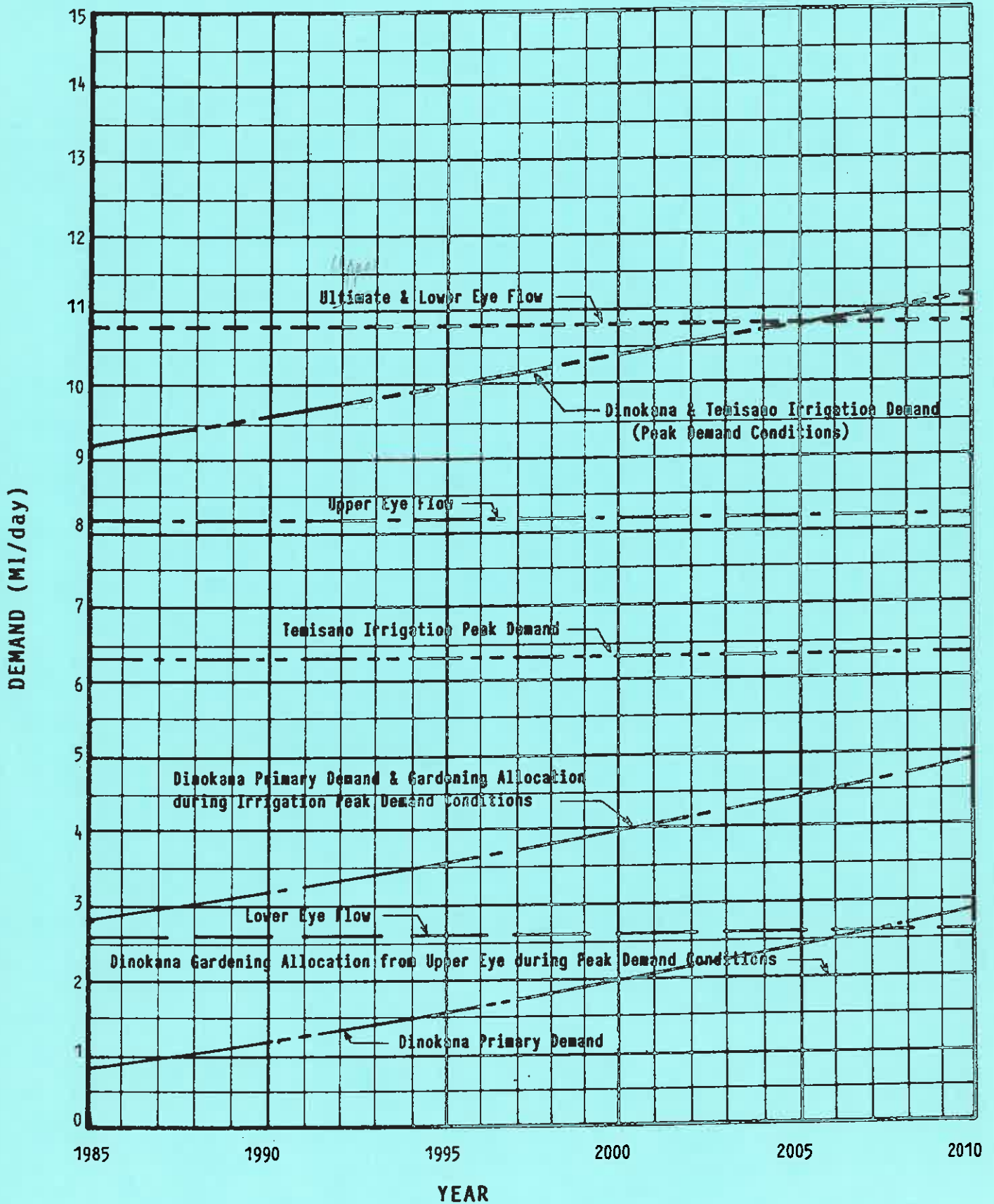
DK2

DK9

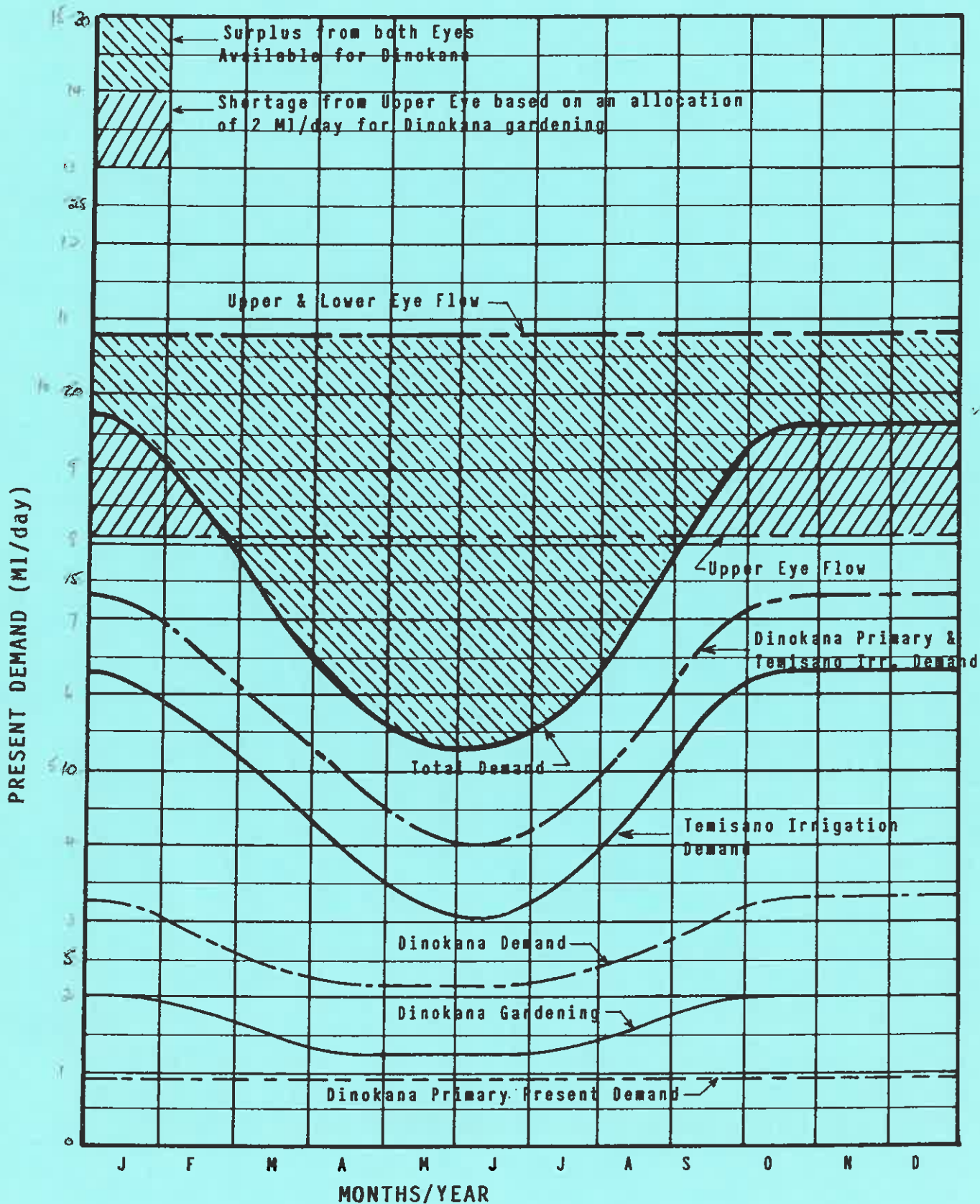
LEHURUTSHE WATER SUPPLY
DEMAND PROJECTIONS



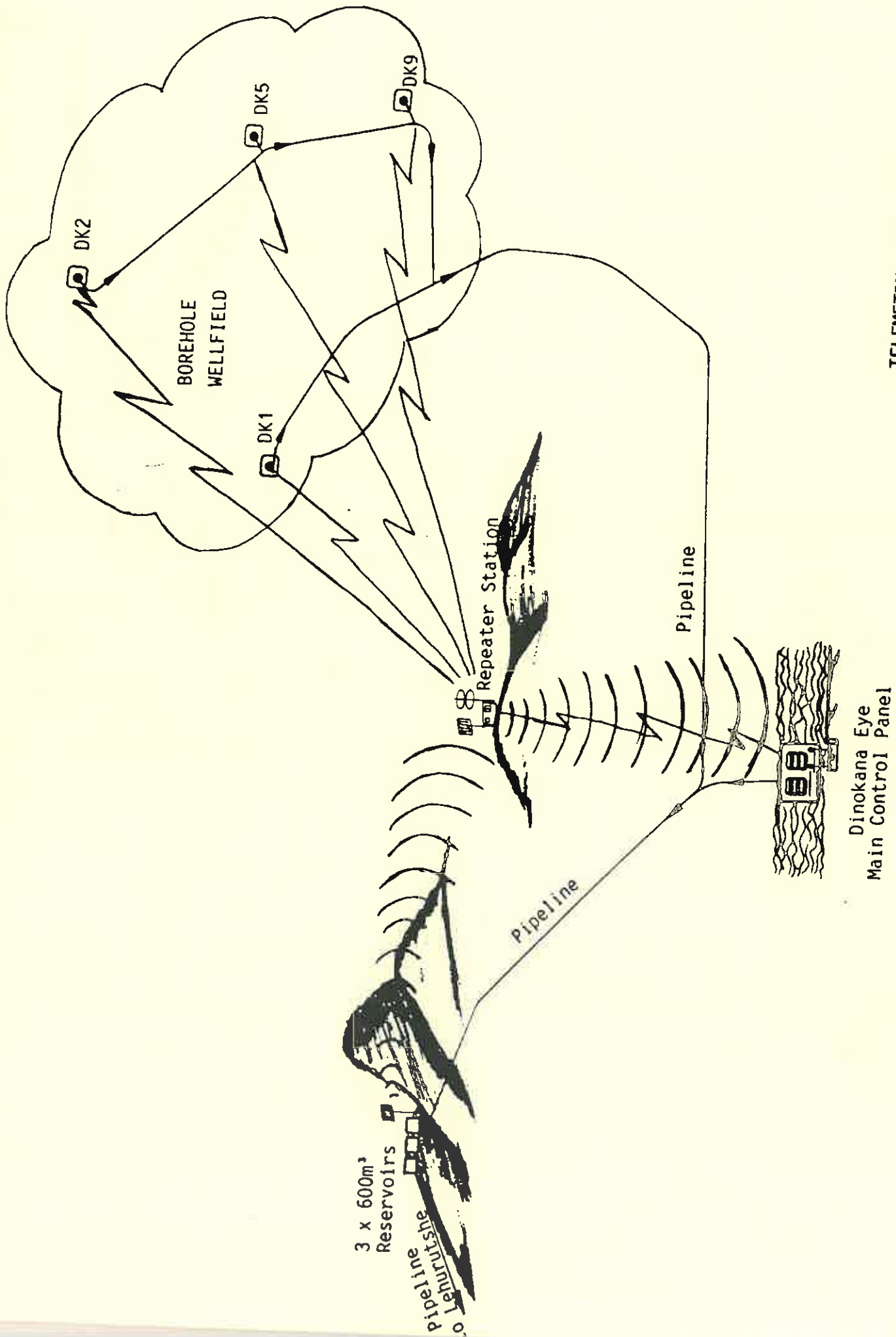
DINOKANA
DEMAND PROJECTIONS



DINOKANA AND LEHURUTSHE IRRIGATION SCHEME
PRESENT DEMAND PATTERN



TELEMETRY



TELEMETRY CONTROL LAYOUT

TELEMETRY

1. GENERAL LAYOUT

The four (4) equipped boreholes in the Dinokana wellfield are controlled by means of a telemetry system operating from a master control panel situated at the Dinokana Eye pumpstation.

With the recently constructed 5,7Ml reservoir at Lehurutshe filled up, the water level of the 3 x 600 m³ reservoirs at Dinokana will rise. Should the telemetry system be in the automatic mode the borehole pumps will be started and stopped as the level in the 3 x 600 m³ rises and falls.

In the manual mode the borehole pumps can be started remotely through the telemetry system at the Dinokana Eye pumpstation. In such a case the operator will make a decision on how many pumps to start or stop, based on his visual interpretation of the water level indicator of the 3 x 600 m³ reservoirs.

The three existing pumps at Dinokana will be retained as standby units and can only be started manually.

2. TYPICAL BOREHOLE CONTROL PANEL

2.1 General

The four equipped boreholes each has similar control panels comprising:-

1. A 0 - 100 Amp-meter.
2. Star-Delta starting switchgear for the installed 37kW electrical motors.

3. Circuit breakers etc to supply power to the electrical motor, the single tube fluorescent light and the telemetry control gear.
4. A FM40 pulse converter, converting the pulses from the pulsator attached to the water-meter to a litre per second valve.
5. A short wave radio and telemetry control board and relays with a small standby battery.
6. Main isolating switch and selector switches.

2.2 Safety Precautions

Strict safety precautions should be followed at all times as the borehole pumps may be started remotely.

Before any work is attempted to either the electrical motor or any part of the pump unit the power to the electrical motor should be switched off by turning the main isolating switch to the "OFF" position. The main isolating switch is situated on the left side of the panel and is clearly marked as such. Alternatively the selector switch may be turned to the "OFF" position or the "MANUAL" position. With the selector switch in the "REMOTE" position and the isolating switch in the "ON" position the pump may be started remotely without warning.

2.3 Panel Selector Switch

The telemetry selector switch has three possible setting positions, namely "OFF", "MANUAL" and "REMOTE".

2.3.1 Selector Switch in the "OFF" Position

The same result is achieved as by physically isolating the system by turning the isolating switch. The pump can neither be started by the telemetry nor by the manual push buttons.

The green "REMOTE" indicating light will go out on the main control panel.

2.3.2 Selector Switch in the "MANUAL" Position

The pump can now be started manually from within the pump cubicle by pressing the "START" push button. The pump is then also stopped by pressing the "STOP" push button.

All information should still be relayed to the main control panel with a green indication light shining when the pump is running and a red light shining when the pump has been stopped. Flow indication will also be relayed to the main control panel. The green "REMOTE" indicating light will also go out on the main control panel (as for the selector switch in the "OFF" position).

2.3.3 Selector Switch in the "REMOTE" Position

This is the only position from which the borehole pumps can be started from the main control panel.

With the selector switch at the borehole in the "REMOTE" position the green "REMOTE" indicating light will burn on the main control panel.

3. TELEMETRY EQUIPMENT AT THE 3 X 600 m³ RESERVOIRS AT DINOKANA

3.1 Measuring of the Water Level

The water level is measured in only the centre reservoir as all the reservoirs are interlinked and the water level thus common to all the reservoirs. The water level is measured through two independent systems. A high and low water level is detected through tear-shaped bulbs while a pressure cell measures the water level continuously.

3.2 Watermeters

Two Meinecke-Cosmos watermeters, complete with KOG-pulsators, will be installed shortly in close proximity to the reservoirs. The one being installed on the inlet side to the reservoirs (measuring the combined flow from all pumps) and the other being installed on the outlet side to Lehurutshe (measuring the flow from the reservoirs).

Pulses from the pulsators will be transmitted to the main control panel where pulses are to be converted to equivalent litre per second units.

3.3 Solar Panel

As now electricity was not available at the reservoirs, a solar panel with battery was provided.

4. REPEATER STATION

The position of the main control panel relative to the boreholes necessitated the installation of a repeater station to ensure proper communication.

The repeater station is equipped with a double solar panel and a battery capacity to cover a period of four days of complete overcast weather.

It is important to emphasise that although the main control panel can be regarded as the brain of the system, the repeater station acts as the heart of the system. All information and commands are relayed by the repeater station.

5. MAIN CONTROL PANEL

5.1 Borehole Displays

Information from the four boreholes are displayed on identical presentations and provision was made to add displays for two more boreholes.

The information displayed are discussed below:-

5.1.1 Warning/Alarm Signals

One yellow and three orange indicating lights are placed at top left corner of each borehole display block. These lights will start flickering as soon as an alarm warning situation arises. These lights should be interpreted as follows:-

ORANGE "AC-FAIL" indicating light. A failure of power at the borehole.

ORANGE "TRIP" indicating light. Borehole stopped due to a tripped condition which could be a borehole low level or protective measure on the electrical motor.

ORANGE "TRESPASSER" indicating light. Trespasser detected at borehole.

YELLOW "TX-FAIL" indicating light. Telemetry radio fail.

An alarm/warning is reset by pressing the "ALARM ACCEPT" push button. Should the alarm condition remain, a fixed light will remain on until the situation has been resolved at which stage the light will go out.

5.1.2 Immediate Flow Meter & Cumulative Flow Indicator
The immediate flow is indicated in litres/second and the accumulated flow in cubic metres.

5.1.3 Stop/Start Push Button
The push buttons act as both acting push buttons and indicating lights. The red light shining when the pumps are not running and the green light when the pumps are running.

A pump is started manually by pressing the green "START" push button and holding it for four seconds. A time lapse of four seconds is required to ensure that the signal is transmitted to a station within a receive/transmit cycle of all the stations. The pumps are stopped in a similar way.

An hour meter will record the accumulated period for which a pump has been running.

The green "REMOTE" indicating light shows whether the selector switch at the remote borehole is on the remote position (refer paragraph 2.3.3).

5.1.4 Individual Selector Switch

Each borehole has a selector switch with the following settings:-

- (i) "OFF" position : Borehole is out of commission and cannot be started.
- (ii) "MANUAL" position : Providing the "REMOTE" indicating light is burning (refer par. 2.3.3) the pump can be started/stopped with the start/stop push buttons discussed under 5.1.3.
- (iii) "AUTO" position : Providing the "REMOTE" indicating light is burning the pump will be started/stopped by the telemetry programme.

5.2 Dinokana Reservoirs Display

The 3 x 600 m³ reservoirs at Dinokana are referred to as the Dinokana reservoirs on the main display panel.

The warning/alarm indicating lights are similar to those discussed at the boreholes under paragraph 5.1.1.

A water level indicator with "high" and "low" level indicating lights with two flow meters complete the Dinokana reservoirs display.

5.3 Dinokana Pumpstation Display

The three existing pumps at Dinokana are also displayed in a similar way as the borehole pumps.

The display comprises:-

- (i) Warning/alarm signals (refer 5.1.1).
- (ii) Stop/Start push buttons (refer 5.1.3).
- (iii) A flow meter showing the total flow.

5.4 Selector Switch on Main Control Panel

The selector switch, placed to the top right of the panel, primarily executes only two functions, namely manual control of the system or automatic control of the system in accordance with predetermined and present criteria.

5.4.1 "MANUAL" Position on Main Selector Switch

Pumps will not be started by the system. Pumps will only be started if the actual pump selector switch is also on the "MANUAL" position (refer 5.1.4) and the green "REMOTE" light is burning (refer 2.3.3). Pumps are started through the stop/start buttons (refer 5.1).

5.4.2 "AUTO" Position on Main Selector Switch

Under the "AUTO" mode the pumps will be started in accordance with the demand for water that do exist at any given time. The demand of water at Lehurutshe will have a direct bearing on the rate at which the water level at the Dinokana reservoirs might fall.

Should the level fall below a certain level, the first pump will be started. In the event of the level dropping even further another pump will start and so on until all the pumps are running in an effort to restore the reservoir water level:

With the supply of water higher than the demand (which is expected with all the pumps running) the water level of the reservoirs will rise again. The pumps will then be switched off again in a reverse order as the water level rises until the reservoirs are completely full and all the pumps have been switched off.

The pump to start first is determined by the actual "AUTO" position selected. With the setting on "AUTO", the borehole pump at DK1 will start first, followed by DK 2 and then DK 5 and lastly DK 9. With the setting on "AUTO 2" the cycle will start at DK 2 going to DK 5, DK 9 and then DK 1. In a similar way selections of "AUTO 5" and "AUTO 9" will start the cycles at DK 5 and DK 9 alternatively.