

AN INVESTIGATION OF THE GROUND
WATER RESOURCES OF THE ALLUVIAL
AQUIFER SYSTEM OF THE CROCODILE
RIVER NEAR THABAZIMBI

by

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Abstract:

This report deals with the ground water potential and related aspects of the alluvial basin of the Crocodile River, from which Thabazimbi derives its water. The investigation was undertaken at the request of the South African Iron and Steel Corporation (ISCOR) in order to appraise the ground water resources of the area.

The major aspects of the occurrence of ground water and its interrelation with the geology are discussed. Estimates of the safe yield of the aquifer system were made from pumping tests and a water balance study, and compared with a theoretical estimation based on borehole logs.

The effect which dams being built upstream of the pumping area is likely to induce in the river flow, was also investigated.

1. Introduction:

Abundant ground water resources underlie the Crocodile River basin. These resources have lately been developed extensively at several places along the river, for instance at Brits, Koedoeskop, Thabazimbi and in the Makoppa area.

The ground water is derived from the alluvial deposits, but water is also obtained directly from the river bed by well points. The water is used extensively by riparian farmers, mainly for the irrigation of cash crops. The ISCOR mine on the other hand pumps water for the town and for mining purposes. Unlike the farmers ISCOR is not permitted to extract water directly from the river but only from the alluvial beds.

Initially a number of wells were sunk by ISCOR
and/.....

and abundant supplies were found. For a number of years the wells were adequate to meet requirements. However the water consumption of the mine has increased over the past few years on account of increased mining activities and rapid expansion of the town. The present water abstraction is about .8 million gallons per day compared to 0.55 million gallons per day in 1954. As a result of this increase in water usage the wells have gradually been replaced by boreholes. These have yielded more water, both because they penetrate deeper into the aquifers and because more sophisticated borehole construction techniques and devices, such as screens, have been used. Severe drought conditions which prevailed in the early sixties adversely affected the ground water resources by reducing recharge. Ground water reserves were thereupon gradually depleted by increased pumpage. The situation was aggravated by a certain degree of interference between boreholes.

The water position caused concern amongst local ISCOR officials, and the Department of Water Affairs was requested to investigate the matter and also to consider an allocation of water from the new Vaalkop Dam being constructed in the Elands River.

In view of these considerations the Hydrological Research Division undertook the investigation and this report deals with the hydrogeology and related aspects of the area. The main object of the investigation was to assess the ground water potential of the aquifer system.

2. Locality and Topography:

The area of investigation forms part of the drainage basin of the Crocodile River which traverses a vast alluvial plain. The ISCOR pumping field is located/.....

located on the farms Buffelshoek and Wachteenbietjiedraai, about six miles south of Thabazimbi - see Fig. 1.

The topographical features of the area vary strikingly from the flat alluvial plain sloping gradually to north (about 3 feet per mile) to the mountainous area surrounding the basin in the north and north-east.

The Crocodile drainage system with the Elands and Pienaars River as the main tributaries, traverses the pumping field and also constitutes the main source of recharge of the ground water supplies.

3. Geology:

The geology of the area has been carefully mapped by the Geological Survey and Fig. 2 has been compiled from these geological maps. Irrelevant detail has been omitted, since this report is concerned mainly with the water potential of the alluvial basin.

The base rock, which underlies and surrounds the alluvial basin, forms part of the Transvaal geological system. It consist of a succession of strata with an east to west strike and dipping about 50° south. The geological formations outcrop extensively at various places, especially the quartzite bands, the banded ironstone and dolomite. In valleys between these hills, the formations are concealed by banded ironstone rubble and ore debris.

The parallel ridges, mainly the quartzite ridges, presumably subdivide the alluvial basin into five ground water compartments, also shown in Figure 2. In the north the alluvial fan is bounded by a small quartzite band of the upper/.....

Upper Timeball Hill series, which deflects the river course and alluvial basin to the west on the farm Donkerpoort. This quartzite ridge forms the northern boundary of compartment No. 1, which in the south is confined by Ongeluk andesitic lava intrusion and a major faulting system.

To the south of the Ongeluk lava, dolomite covered partially by a superficial fan of banded ironstone and soil outcrops extensively.

The dolomite together with the banded ironstone forms a prominent ridge running from east to west. This ridge is traversed by the Crocodile River through a narrow poort. At this point the alluvial basin is greatly contracted and this ridge forms another compartment boundary - i.e. that between No. 2 and 3 compartments.

The delineation of the three other compartments is also shown in Figure 2. The southern boundary of compartment No. 5 extends beyond the ISCOR boundary and is not shown.

The alluvial basin of the area investigated comprises about 160 morgen. The northern portion - compartment No. 1 - is still a virgin pumping area and is a potential area for further expansion. Drilling in this area has not been very encouraging so far and the water potential seems to be inferior compared to the rest of the area.

The thickness of the alluvial fan is fairly uniform (about 60 feet) except for a few deeper trenches e.g. in compartment No. 5. In compartment No. 2 the alluvial deposits also extend to a greater depth than the average. Figure 3 indicates the contours of the alluvial basin, which were constructed from drilling logs. The two anomalous/.....

malous points in the floor of the alluvial basin (Compartment No. 2) may be evidence of sinkholes. Various sections of the basin are shown in Figure 3D.

4. Hydrology:

(a) Rainfall

Being typically semi-arid, the region has a continental climate characterized by large seasonal fluctuations in rainfall and moderate variation in temperature. Precipitation occurs predominantly in summer months ie. October to April, whilst the period May to September is normally virtually dry. The mean annual precipitation of the area is about 24 inches there being little variation over the region - see Table 1. There is however a great variability in the monthly and annual precipitation.

Although drought conditions are regarded as a natural feature of the climate of the area, periods of excessive rainfall recur at irregular intervals. Droughts of varying intensity and duration occur frequently and in some instances persist for several years.

During the period 1962 to 1966 severe drought conditions were experienced and this adversely affected run-off and recharge of ground water.

(b) Surface Water

The Crocodile River with its main tributaries the Elands and Pienaars Rivers, constitutes the surface drainage of the alluvial basin. The Sand Spruit which rises in the Waterberge joins the Crocodile River south of the area of investigation (See Figure 1).

The Crocodile River is not perennial in flow and

the/.....

the run-off consists mainly of sporadic flash floods with a small amount of intermittent base flow. The annual run-off pattern is synchronous with the annual rainfall pattern - the first run-off lags the first rainfall slightly and usually commences in November. The period June to September is normally dry; however, after wet seasons such as 1966/7 a certain amount of base flow occurs emanating as return seepage from the alluvial beds.

The entire drainage basin comprises a large area but several reservoirs have been constructed in the upper reaches of the main tributaries. These dams intercept a large proportion of the run-off and the new Vaalkop and Klipvoor dams will further reduce the mean annual run-off to be expected at the pumping field.

The only gauging station in the Crocodile River is situated about 20 miles upstream of the ISCOR pumping area. The flow records date back to only 1959 and are listed in Table 2 together with corresponding records for the flow in the Pienaars and Elands Rivers. The mean annual run-off for the Crocodile River at this gauging point is calculated to be 34230 morgen feet.

Periodically severe floods are experienced in the Crocodile River; for instance in 1944, (unrecorded) 1955 and in 1966 floods of great magnitude swept down the river. The 1966/7 flood completely inundated the ISCOR pumping field and seriously disrupted pumping for some time.

During the period of investigation (August 1967 to April 1969) the highest river stage recorded was about six feet above the river bed. This represents a flood of more than 16,000 morgen feet in that month.

The river is the main source of recharge of the ground/.....

ground water and a reasonable annual flood is essential to maintain recharge and therefore pumpage from the alluvial beds.

(c) Ground Water

Large supplies of ground water are stored in the alluvial deposits and the excellent hydraulic properties of the aquifer material permit a high rate of abstraction. A large number of boreholes and wells have been sunk in the alluvial basin and forms the water supply of the ISCOR mine and Thabazimbi town.

The yields of the boreholes shown in Figure 2 are listed in Table 3. The maximum tested yield is about 27,000 gallons per hour and 50% of all boreholes have yields between 5,000 and 20,000 gallons per hour. The average depth at which the water is struck varies from 30 to 70 feet - see Table 3. The water is normally struck as soon as the clayey soil overburden is penetrated. The water is contained in sand layers, which range from clayey sand, coarse sand to gravel beds, which have excellent water bearing properties ie a high permeability and high specific yield. The hydraulic properties of the surface layer are poor because of the compaction of the fine material. This renders it rather impermeable so that seepage through this layer is negligible and little if any recharge could take place by vertical infiltration.

The underlying bedrock which ranges from shale, quartzite and banded ironstone to dolomite, is mostly weathered or broken and adds to the water bearing properties of the alluvial deposits. The high yield of boreholes in compartment No. 2 is attributed to good broken dolomite below the alluvial basin.

As/.....

As was discussed in the previous section the alluvial basin is subdivided into five ground water compartments - see Figure 2 which also indicates the ^{density} intensity and distribution of the boreholes and well points that are being pumped as well as those no longer in use.

The numbers of the boreholes agree with those of ISCOR for ease of identification and later reference. The letter R indicates boreholes on which recorders have been installed by the Department of Water Affairs and RI denotes those that have been equipped with ISCOR recorders.

A continuous recording of water table fluctuations was obtained from these gaugings for the period August 1967 to April 1969. These records were compiled into comparative graphs and were used in assessing the recharge and specific yield of the aquifer - see Figure 5, section 5.

Although the number of observation points across the alluvial fan was limited water contours were compiled for the area and are also shown in Figure 3. The water level shows a gradual drop of about 3 feet per mile, which corresponds with the topographical slope. A definitely higher water table reading was found at B47, which indicates that recharge is probably coming from the dolomite. The delineation of the compartments is not regarded as absolutely reliable and they must not be considered water-tight compartments. Moreover considerable leakage occurs through the alluvial strata above these boundaries if the ground water table is sufficiently high. A certain degree of leakage through the outer boundaries is also possible, but since these formations are much more impermeable than the alluvial sediments, this leakage is regarded as negligible.

Most of the recharge is derived from the river during/.....

during floods. The contribution of recharge from the geological strata is probably small except for the dolomite strata. Water samples from the alluvium which have been analysed for natural tritium, indicate that the water is of very recent origin and therefore most probably originates from the river alone.

The response of the ground water is coincident with floods and the recharge is fairly rapid. Quantitative analysis of the water level fluctuations in relation to pumpage and river flow will be discussed in section 5.

(d) Chemistry of Ground Water

The chemical composition of water samples from several boreholes has been determined and is shown in Table 4. The water is of excellent quality and contains about 330 parts per million of dissolved salts. The salt concentration is very consistent except that B23 contains a definitely higher concentration of calcium bicarbonate in solution, indicating that water is recharged from the dolomite also in this compartment. This fact is substantiated by the water table in B47 nearby.

5 Assessment of the Ground Water Potential of the Aquifer System

The main object of the investigation was to evaluate the water resources of the aquifer system. This necessitated the determination of the longterm mean annual recharge and storage of the aquifer.

It/.....

It was anticipated initially that radionuclide tracers could be used to elucidate the ground water movement and would aid in the determination of the aquifer characteristics. Trial experiment however proved that this was not possible due to the stratified nature of the aquifer material and because of complications induced by borehole screens.

A. Pumping Tests.

Several pumping tests were carried out in the area, using existing production boreholes and nearby abandoned boreholes for the water drawdown observations. Distance and time drawdown curves were obtained according to the simplified version of the Theis non-equilibrium equation. These drawdown curves are included in the report (Figures 5 to 16) and the results are tabulated in Table 5.

The transmissibility of aquifer No. 3 was determined from pumping test performed on B.7 using P.3 (Well No.3) as observation well. The higher values listed in Table.5 probably reflect the correct transmissibility. The others which are about half this value are 50 per cent too low, because of an increased drawdown rate caused by the limited extent of the aquifer - the so-called boundary effect. The specific yield values are not appreciably affected by this boundary effect since the time t_0 the start of drawdown is dependent of the slope of the curve. The average value of 8.5% for the specific yield is acceptable for the

type/.....

type of aquifer material present.

A pumping test performed on B.31 in August 1968 yielded a transmissibility of about 1.3 million gallons per day per foot and a specific yield of 12.2%. The spacing of boreholes in compartment No.4 was not suitable for reliable pumping tests as the observation boreholes were too far from the pumped boreholes.

Pumping tests were also carried out on B.21, P.14, P.15 and B.27. In the latter instance the drawdown effected by B.27 on P.15 and P.14 was very small so that no drawdown rate could be obtained. The calculated transmissibility values obtained from the water level lowering in P.15 and P.14 themselves when pumped, were used to reconstruct a distance drawdown curve for B.27. This permitted the specific yield of 16.9% to be calculated.

An average value of 12.5% is obtained for the overall specific yield of the aquifer system and 1,191,000 gallons per day per foot for the transmissibility. The lateral flow through the alluvial beds is calculated to be 230,000 gallons per day under a piezometric gradient of 2.5 feet per mile and this could constitute a large proportion of the aquifer recharge. The gravel flow would be substantially increased if a certain degree of drawdown in the aquifer were maintained.

The volume of the water contained in the alluvial reservoir was accordingly estimated from the pumping test results and is listed on the following page.

Calculation/.....

Calculation of water storage of aquifer - pumping test results.

Aquifer No.	Volume of Aquifer (Effective depth of Aquifer 20')	Specific Yield (%)	Water Storage (morgen feet)
2	8.58 x 10 ⁶ cub.ft.	16.9	315.7
3	15.9 x 10 ⁶ " "	8.5	294.6
5	27.7 x 10 ⁶ " "	12.2	737.7
4	27.25 x 10 ⁶ " "	12.5 _#	743.5
	Total water storage		2091.5mg.ft.

Average of 2,3 and 5.

B. WATER BALANCE STUDY

1. Calculation of Specific Yield of Aquifer:

The water balance method is essentially a balance between the total accretions to and total losses from a ground water reservoir. The water balance equation however, involves several parameters such as leakage into the compartment, percolation through the soil, effluent seepage and evapotranspiration losses that are hard to quantify. Under certain hydrogeological conditions several of these terms are zero and the equation is greatly simplified. In the event of recharge also being negligible, the equation reduces to the following:-

$$\text{Pumpage} = \text{Aquifer storage per foot} \times \text{lowering of the water table in feet}$$

This equation could be applied to the period July 1968 to October 1968, when the river flow stopped completely and flood recharge accordingly was negligible. Lateral flow through the alluvial beds could be discarded for the downstream compartments 2,3 and 4, since pumping upstream would effectively cancel such gravel flow.

Comparitive graphes of the water table fluctuations/.....

tions in relation to pumpage and river flow for the period October 1967 to April 1969 are shown in Figure 4. The respective water level drops that occurred in compartments 2 and 3 and the corresponding amounts of water abstracted provided an estimate of the aquifer yield per foot - see Table 6. By incorporating the volume of the aquifer material which had been dewatered, the specific yield could be calculated. The respective values obtained for aquifers 2, 3 and 4 were 14.3, 3.7 and 4.7 percent.

2. Calculation of Recharge

In the event of complete recovery of the water table to the level which prevailed at the beginning of a period of pumping, the total amount of water abstracted must equal the recharge.

Figure 4 indicates that despite recurrent recharge to the same level within the period this condition is satisfied for the period October 1967 to April 1969. The total pumpage during this period amounted to 754 morgen feet (433 million gallons) which then equals the total recharge. This reduces to an abstraction rate of 0.77 million gallons per day for the whole aquifer system. The total river discharge for the equivalent period, according to the gauging at Piet Groblersdrif (Station A2M25) was of the order of 37,600 morgen feet. This indicates that compared to the river gauging at A2M25 the recharge amounts to about 2% of the river flow. The recharge rate is obviously a function of the river stage and storage created in the aquifer. Nevertheless if this ratio is applied to the mean annual run-off of the river i.e. 31,230 morgen feet according to records for A2M25 (using only 10% of the 1966/7 flood in order not to overestimate the run-off), an annual potential recharge of 624 morgen feet (358 million per year) is obtained for the aquifer system. This/.....

This estimated recharge implies that a average daily, abstraction rate of 1 million gallons is permissible. This rate of pumping exceeds the present rate of abstraction by about 20%.

As the recharge is dependent on the hydraulic gradient, the recharge could be substantially greater if a certain degree of drawdown below the normal water table could be maintained.

This is illustrated by Table 7 showing the recharge of Aquifer No. 2 in relation to river flow and drawdown of the water level below the normal water table. These results were obtained from a more detailed scrutiny of the water level fluctuations in relation to pumpage, for instance when the water level remains constant the rate of recharge equals the rate of pumping.

Due to the variability in flood magnitude and occurrence, recharge to the extent of the estimated mean annual amount, is not an annual event. In dry periods the recharge could be negligible and these periods are the critical ones, since pumping is then dependent on ground water in storage.

On the other hand the potential recharge of an extreme flood such as the 1966/7 flood, could exceed the total ground water storage capacity and an almost empty ground reservoir could be replenished by that one flood alone.

C. THEORETICAL STORAGE CAPACITY

In view of the assumptions made in the water balance study and the non-isotropic nature and other limitations of the aquifers, which could have affected the pumping tests, the results obtained from these methods are still subject to a certain degree of uncertainty. These results were therefore supplemented by a theoretical assessment of the aquifer storage capacity. This was done by classification/.....

sifying the alluvial material according to drilling logs and assigning a theoretical specific yield to each.

Isopachous maps of the various materials were produced and the volume of each was determined. The ground water content was subsequently calculated and the sum total of them all provided the overall storage capacity of the aquifer system.

These results are shown in Table 8.

The total water storage of the aquifer appears to be a minimum of 744 morgen feet, since the volume of the alluvial material only pertains to that of the contoured basin, which covers only portion of the basin - see Fig.3

The maximum amount of water contained in the ISCOR basin, excluding No. 1 compartment, is estimated at three times this value namely 2232 morgen feet, on the basis of an estimation of the total volume of aquifer material.

D. Influence of New Reservoirs on the Aquifer Recharge.

Since the recharge of the aquifer system is derived from river flow, it was deemed necessary to investigate the effect that the new dams Vaalkop and Klipvoor are likely to induce on the river flow.

The overflow from these dams which constitutes part of the flow responsible for the recharge, was simulated with the aid of the computer. The inflow, capacity and draught pattern of the water usage from the dam were taken into account in this evaluation.

The resulting annual spill of the dams is listed in Table 9. The annual reduction in run-off caused by the dams is also shown. The maximum annual reduction in the
potential/.....

potential recharge, calculated on the basis of 2% of the flow reduction, was subsequently determined and expressed as a percentage of the total potential recharge.

The results indicate that with respect to the A2M25 flow the average reduction in the potential recharge is about 36%. However the river flow at A2M25 constitutes only 80% of the expected flow at the area of investigation -- on the basis of catchment area ratios. The average reduction in recharge therefore reduces to about 29% reduction in the potential recharge.

Even this figure is regarded as high since the recharge takes place mainly during years of excessive rainfall when overflow of the dams is likely to take place. In addition to this the lateral recharge through the alluvial material would be fed by the water releases from these dams and an increased assured supply from this source of recharge is likely to result.

The calculated figure could be regarded as the maximum influence the dams could have on the recharge. In effect this means that the estimated 1.0 million gallon per day safe abstraction rate previously calculated is reduced to 0.71 million gallons per day, which is about the present rate of abstraction.

Summary:

The outcome of the investigation could be summarized as follows:

- (1) The recharge of the alluvial basin is derived mainly from the Crocodile river, though some recharge could also come from the dolomite. At the present river flow conditions the mean annual recharge is estimated at 624 morgen feet.

This/.....

This represents about 2% of the river run-off measured at river gauging station# A2M25.

- (2) The aquifer storage capacity was calculated by three independent methods and the results were in reasonable agreement considering the complexity of the aquifer system. The estimated water storage of the aquifer is given below:

Method	Water Storage (morgen feet)	(million gallons)
(a) Theoretical assessment	2232	1281
(b) Water balance	1122	644
(c) Pumping Tests	2091	1200
Average	1815	1042

The lower value obtained from the water balance study could be attributed to an overestimation of the water level drop in the relative aquifers because of non-static water table conditions.

The three methods yield an average value of 1815 morgen feet for the aquifer storage capacity. On the assumption that depleted drawdown of the aquifer will not influence the pumping rates, the aquifer storage is apparently sufficient to sustain pumpage without recharge occurring for a period of about 2.8 years - (at an average pumping rate of 1 million gallons per day).

- (3) The hydraulic properties of the aquifer are excellent and permit a high rate of abstraction. A mean value of 1.19 million gallons per day per foot is obtained for/.....

for the aquifer transmissibility so that the water seepage through the alluvial beds is estimated at 230,000 gallons per day.

(4) The influence that the new dams is likely to have on the recharge of the aquifer system is theoretically estimated to amount to a maximum reduction of 29% in recharge.

(5) The safe yield of the aquifer system is considered to be equal to the mean annual recharge as prolonged periods of below average recharge could prevail. During these periods pumpage is sustained by the water stored in the aquifer. At the present river flow conditions the safe yield is therefore estimated at about 358 million gallons per year (624 morgen feet).

When the estimated reduction in recharge due to the construction of the new dams (Vaalkop and Klipvoor) is taken into account the safe yield reduces to about 255 million gallons per year. This is equivalent to a daily rate of abstraction of ± 0.7 million gallons, which is approximately the present rate of abstraction.

Conclusion:

It appears that the present rate of abstraction could be maintained without exhausting the alluvial ground water supplies. The storage capacity of the aquifer system seems adequate to sustain pumpage for a period of about 2 years in the event of no recharge to the system occurring.

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ACKNOWLEDGEMENTS:

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K.P. Penny

Borehole Number	Thickness of Alluvium (ft)	Depth Water struck(ft)	Borehole Yield (gph)
3	63	60	9000
3A	60	40	5000
4	62	44	9000
7	67	30	27000
11	57	45	7200
12	62	45	6200
18	100	72	11000
21	75	52	11000
23	68	46	17000
24	30	-	Not tested
26	72	56	5000+
27	57	-	5000
29	64	34	2000
31	60	36	7000
32	60	36	4300
35	60	53	8000
36	72	48	10800
42	70	48	20000
47	10	-	15600
49	68	50	-

Average depth of boreholes	-	87 feet	(2)
Average " " alluvial sediment	-	61 feet	(2)
Average " " water level	-	37 feet	(2)

(2) Based on all available data.

TABLE 3. Relevant data of boreholes shown in Fig. 2.

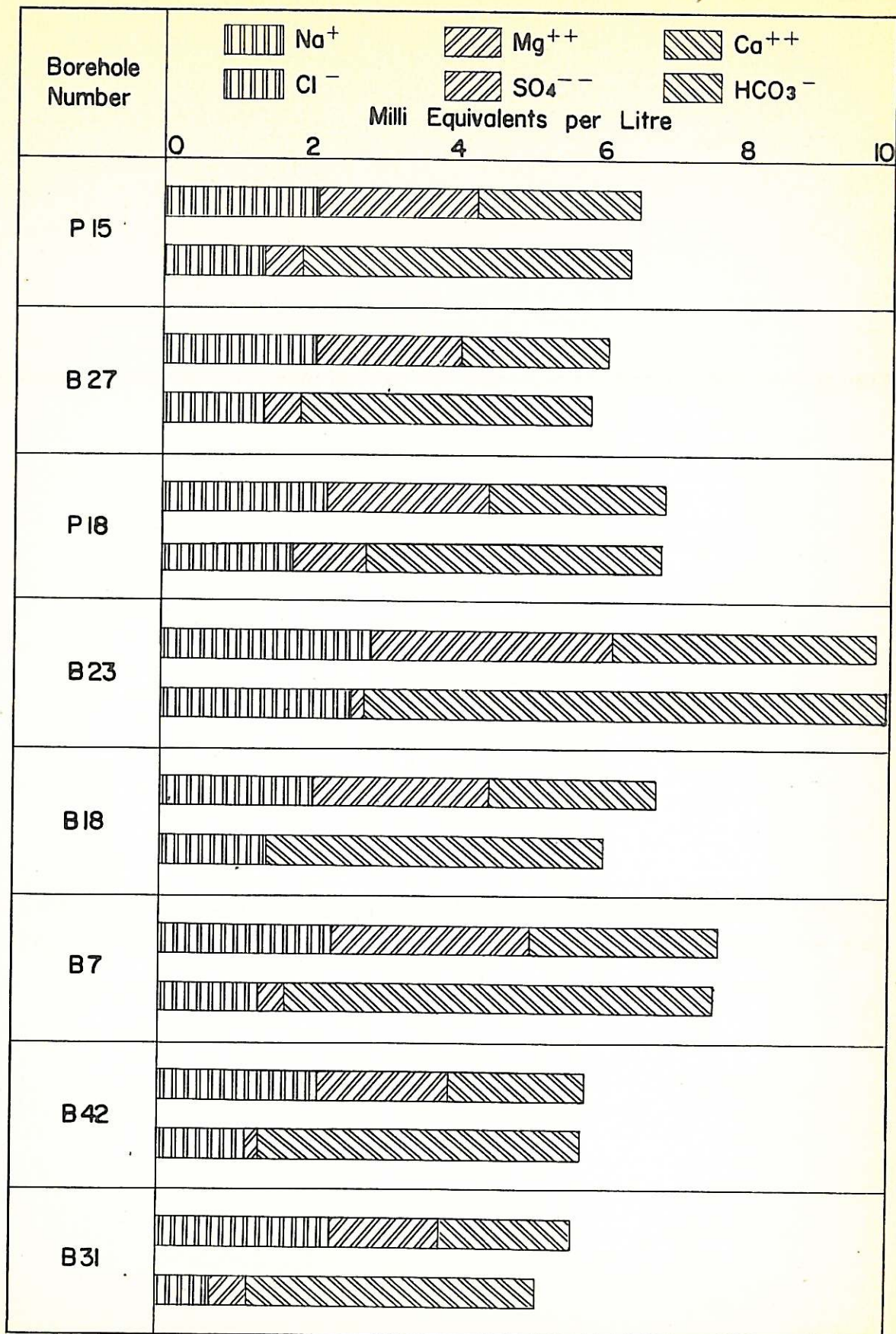


Table 4

Chemical composition of Ground Water Samples

Date	Borehole pumped	Observation Borehole	Transmissibility (gpd per ft)	Specific Yield (%)	Average (%)
14-11-67	B7	B7(a), P1 P3, B11	1,513,600	9.00	
23-11-67	B7	P3	786,630	7.6	
19-3- 68	B7	P3	786,340	5.9	
18-4- 68	B7	P3	733,920	4.9	
6-5- 69	B7	P3	1,173,330		8.5
8-8- 68	B31	B32	2,055,420	18.0	
8-8- 68	B31	B40	1,403,700	5.6	
8-8- 68	B31	B32+B40	504,840	13.1	12.2
28-8- 68	B21	B24	1,967,000	8.8	
6-5- 69	B27	P15	274,000	25.06	
6-5- 69	P14	P14	141,000		16.9

Mean Specific Yield 12.5% Mean Transmissibility 1,191,000 gpd per ft.

TABLE 5. Results of Pumping Tests.

Compartment Number	Pumpage (gallons)	Drawdown (feet)	Aquifer storage per foot (gallons)	Specific Yield (%)
2	65,243,000	8.5	7.68×10^6	14.3
3	19,679,000	5.4	3.644×10^6	3.7
4	23,862,000	3	7.95×10^6	4.7

Water Balance Method - Period July 1968 - October 1968.
 #Average Depth of Aquifers taken to be 20 feet.

TABLE 6. Calculation of aquifer storage per foot and specific yield.

TABLE 7.

THABAZIMBI GROUND WATER INVESTIGATION.

AQUIFER NO. 2

CALCULATION OF DAILY RECHARGE RATE BY INTERPRETATION OF
WATER LEVEL RECORDINGS.

PERIOD BEGIN	PERIOD END	DURATION (DAYS)	WATER LEVEL (FEET)	RECHARGE PER DAY (GALLONS)	WATER LEVEL IN RIVER (FEET)
31/10/67-	5/11/67	5	36.6	398,000	1 - 0.2
5/11/67-	25/11/67	20	35.6	281,000	0.2 - 0
2/12/67-	11/12/67	9	35.25	140,000	0
9/3/67-	12/ 3/68	3	39.0	660,000	0
13/ 3/68-		1	38.9	425,000	0
14/3/68		1	38.9	394,000	0
20/3/68		1	37.3	399,000	0
21/3/68		1	37.3	388,000	0
22/3/68		1	37.3	405,000	0
23/3/68		1	37.3	310,000	0
28/3/68		1	36.6	292,000	0
29/3/68		1	36.7	239,000	0
2/4/68		1	35.25	240,000	0
11/12/67-	9/4/68	119	35.36	275,000	0
24/4/68		1		296,000	0.55
25/4/68		1	35.61	284,000	0.55
26/4/68		1	35.7	281,000	0.55
29/4/68		1	35.5	285,000	0.20
30/4/68		1	35.2	291,000	0.1
1/5/68		1	35.25	291,000	0.05
13/5/68		1	34.90	267,000	0
27/4/68-	1/5/68	4	35.2	250,000	0.4 - 0
16/4/68-	28/4/68	12	35.1	306,000	0-0.55-0.3
22/5/68-	25/5/68	3	35.6	294,000	0
28/10/68-		1	48.0	370,000	0
29/10/68		1	48.0	390,000	0
30/10/68		1	48.0	400,000	0
4/11/68-	9/11/68	1	48.0	386,000	0

Actual Water table = 35 feet below surface.

Average recharge per day = 286,711 gallons.

Alluvial Type	Theoretical assigned Specific Yield (%)	Volume Water (morgen feet)
Clay	1	75.16
Clayey Sand	4	28.55
Sand	20	514.27
Tight Sand	14	71.69
Gravel	18	54.66
Tight Gravel	10	0.365

Minimum Storage Capacity of Aquifer = 744.7 morgen feet.

Maximum Storage Capacity of Aquifer = 2232 mg. ft.

TABLE 8. Theoretical Calculation of Aquifer Storage Capacity.