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THE ALICE SPRINGS TOWN BASIN A CASE HISTORY

by

T. Quinlan

Prepared for the 1967 Groundwater School, Adelaide.

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SUMMARY

The Alice Springs Town Basin is a small basin which has been filled to a maximum depth of 75 feet with alluvial sediment of Quaternary age. Several methods have been tried to construct efficient bores which could be pumped for the town supply. It contains groundwater of four different chemical types; groundwater suitable for domestic use occurs in the vicinity of the Todd River. The volume of water in storage fell from 647 million gallons in 1953 to 357 million gallons in 1964, as a result of an increase in the amount of water pumped from the basin. Average values for the aquifer constants (30,000 gallons per day per foot for the coefficient of transmissibility and 0.07 for the coefficient of storage) were calculated from aquifer performance tests.

Maximum use could be made of the water available as recharge if groundwater was withdrawn at a rate of 20 million gallons per month for a period of 2 months following a river flow, and then reducing the withdrawal rate by 3.5 million gallons per month until the next period of recharge.

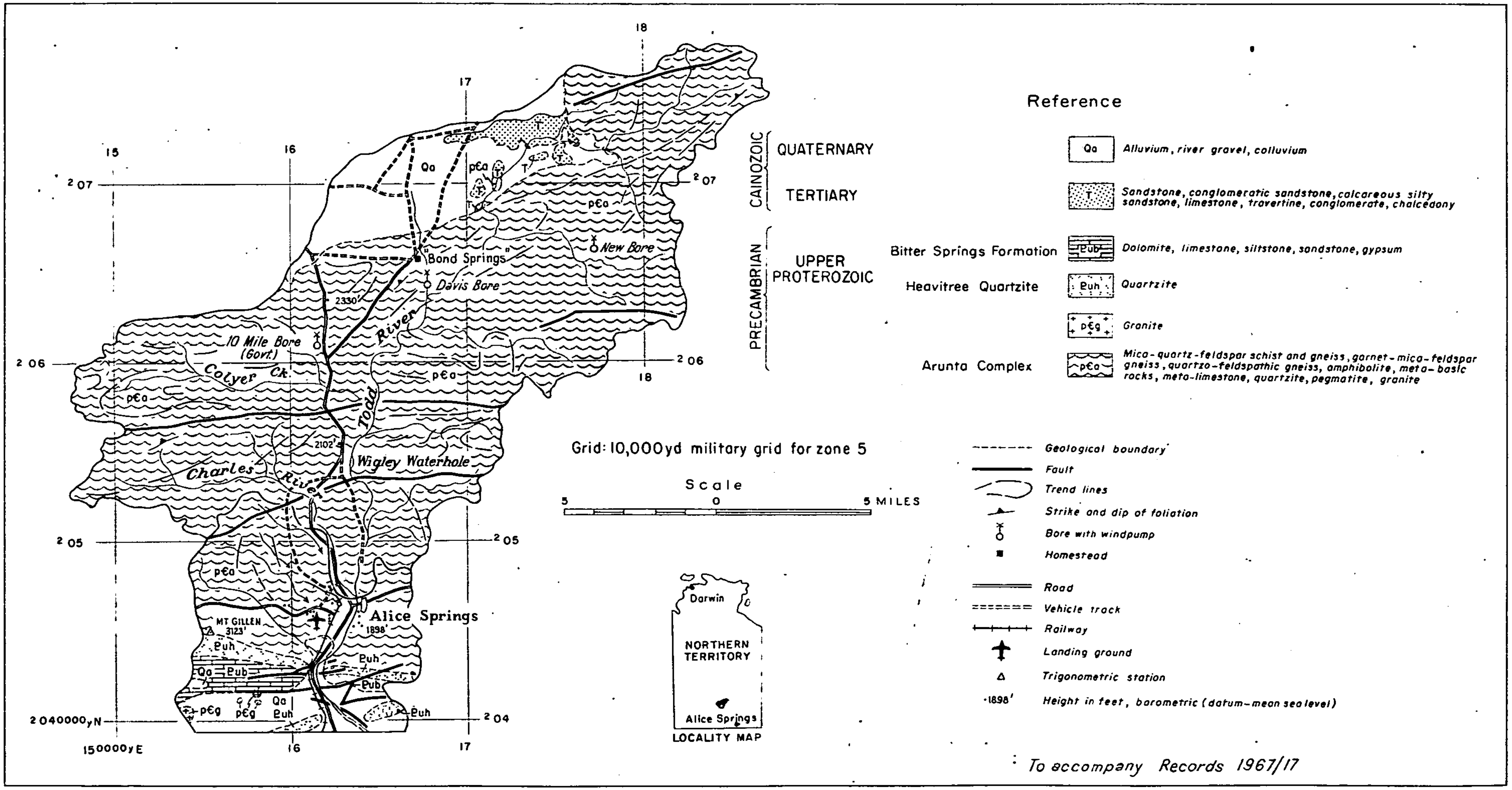

Fig. I Locality map and regional geological map of the catchments of the Todd and Charles Rivers

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INTRODUCTION

The Alice Springs Town Basin is a small alluvial basin with a maximum depth of approximately 75 feet and a surface area of approximately 3 square miles. Groundwater is withdrawn from the basin for the Alice Springs town supply, and until January 1964 this was the only source of supply. Water for the town supply was imported from the Inner Farm Basin in limited quantities from January 1964 to April 1965. In the latter part of 1964, pumping from the Town Basin virtually ceased when production from an alternative source of groundwater in Palaeozoic sandstone was commenced. The annual consumption at that date was about 250 million gallons, of which approximately 200 million gallons was withdrawn by the town supply bores.

Between 1943 and 1964 information on the occurrence of groundwater and the hydrology of the basin was collected by residents of the town, the Australian Army, the Commonwealth Department of Works, the Water Resources and Animal Industry Branches and the Resident Geologists of the Northern Territory Administration.

Some aspects of the methods used to collect this information and the interpretations which were placed on it are discussed in this report.

History of Investigations

Test drilling of the Town Basin (Pl. 1) was begun by the Australian Army in 1943 and was continued by the Department of Works from 1953 to 1961. The earliest reports are those of Owen (1952, 1954), who considered salinity, recharge, and groundwater movement. He used a bedrock contour map to arrive at an estimate of 900 million gallons for the amount of water stored in the basin in 1954.

Jones (1957) was able to refine Owen's ideas and to prepare a more accurate contour map, with the aid of the additional information available. He estimated the amount of water stored in the basin to be 330 million gallons.

The Bureau of Mineral Resources carried out resistivity and seismic surveys in the Town and Inner Farm Basins in 1956 (Dyson & Wiebenga, 1957). The results of these surveys were used in the planning of part of the Department of Works investigatory drilling programme.

Wilson (1958) conducted an investigation for the Department of Works and examined groundwater movement, salinity distribution, and groundwater storage. He estimated that 1110 million gallons of water were stored in the Town Basin. He also carried out pumping tests on some of the production wells and measured some flows of the Todd River.

Forbes (1962) studied groundwater movement and salinity in both Town and Inner Farm Basins and estimated that the annual safe yield from the Town Basin would be 149 million gallons. He also estimated the average annual yield of surface run-off at Heavitree Gap to be 3180 million gallons.

Jephcott (1959) studied the relationship between groundwater salinity and river flow in the Town Basin, and concluded that sodium and bicarbonate are the most sensitive indicators of basin recharge.

Quinlan & Woolley (1962) discussed the occurrence of groundwater in the Town Basin, using the results of the drilling programme to 1960. They drew attention to the decline in the volume of groundwater in storage from 1953 to 1960, and made a preliminary interpretation of the results of some of the pumping tests. Subsequently they (Quinlan & Woolley, 1967) refined their concept of the geology of the basin and presented it in maps of five aquifer systems. These were used as a base to illustrate the variation in the chemical character of the groundwater. Further estimates for hydrological parameters were given and an elementary attempt was made to predict the change in storage which would result from three methods of management.

GEOLOGY

Fluviatile sediment assigned to the Quaternary period is preserved in the Town Basin, and rests unconformably on Precambrian sedimentary, igneous and metamorphic rocks. These facts together with the approximate position of its margins were known to Owen (1952). However little was known of the 'distribution of the different grades of material of which the beds are composed, and it is improbable that the sediments of the basin, having been laid down and reworked by a meandering stream, contain any particular bed that persists for any great distance.'

Jones (1957) recognized the importance of such knowledge, as the available evidence indicated that 'less than half the alluvium yields water readily'. Sufficient information became available as a result of the programme of test drilling undertaken by the Department of Works in 1956 and 1957 to form an initial hypothesis concerning the distribution of aquifers. This was not done at the time as a geologist was not associated with the project. At that time adequate logs were available for approximately 150 bores.

Quinlan and Woolley (1962), using the results of drilling to 1961 postulated a sequence of events during the deposition of alluvium in the basin. This led to the concept of linear zones of high permeability and the presence of hydraulic boundaries within the alluvium. That this concept was somewhat idealistic is evident from a comparison with later work (Quinlan & Woolley, 1967). The geological maps of the five aquifers (Pl. 2) prepared by them were based on subjective correlations between bore logs. This might not be a satisfactory basis for mapping, but it is justified as some understanding of the geology of the basin, and the distribution of aquifers within it, is a prequisite for the development of hypotheses regarding the hydraulic behaviour of the basin, and the chemical character of groundwater which it contains.

GEOPHYSICAL INVESTIGATIONS

Seismic and resistivity surveys were undertaken by Dyson & Wiebenga (1957).

Two maps of the areal distribution of their apparent resistivity measurements were prepared, one for an electrode spacing of 200 feet and the other for a spacing of 400 feet. The apparent resistance for each is thought to be largely influenced by the resistance of the Precambrian rocks and only prominent geological and hydrological features are represented in the contour maps.

Quinlan and Woolley (1967) attempted to estimate the porosity of the alluvium by using the monogram of Dyson & Wiebenga (1957, fig. A1). Values of the resistance of the saturated alluvium obtained from the depth probes were compared with values of the salinity of the pore fluid, estimated from the analyses of water samples taken from bores in the vicinity. Most of the estimates for the porosity were found to be greater than 30 percent and are not considered to be realistic.

Using the seismic refraction method, Dyson & Wiebenga (1957) distinguished two discontinuities which they considered to be (a) the top of the zone of saturation, and (b) the base of the weathered zone in the Precambrian rocks.

The base of the zone of weathering is irregular and its thickness is influenced by the lithology of the parent rock and its susceptibility to weathering. Assuming that these factors are constant, the base of the weathered zone will be at about the same depth below the surface of the Precambrian. Having made this assumption the contoured map prepared from the results of the seismic refraction survey was valuable for planning drilling programmes. Its usefulness decreased as the number of bores increased and contours could be drawn on the surface of the Precambrian with some confidence.

HYDROLOGY

Availability of Groundwater

Groundwater can be extracted from bores and wells which intersect permeable beds of silty sand below the piezometric surface. The specific capacities of bores within the areas of silty sand which are mapped on Plate 2 may be over 1000 gallons per hour per foot of drawdown. The capacities of bores outside these areas is variable, and will probably be less than 3000 gallons per hour per foot of drawdown.

Until 1956 wells were used to withdraw water for the town supply and for private consumption from shallow aquifers. These proved to be unreliable in the succeeding years because of a general decline in the piezometric surface, and they were replaced by bores which were able to withdraw water from the deeper aquifers. The fall in the piezometric surface was sufficient to cause a significant reduction in the area of the saturated alluvium and volume of groundwater available.

Methods of Construction and Development of Bores

Included within the funds made available in 1956 for the replacement of the town supply wells was a provision for test drilling. The test holes were designed to obtain information on the rapid lateral and vertical changes in lithology, to evaluate the resources of the basin, and to find suitable sites for the construction of production bores.

Wilson (1957) drilled approximately 90 bores, of which one was completed with screens and five with perforated casing as production bores. Three of the latter were unstable and were subsequently abandoned. Quinlan and Woolley were responsible for drilling approximately 100 bores between 1959 and 1962, of which 8 were completed as production bores.

Little is known of the methods used by Wilson, and the following discussion is based on Quinlan & Woolley (1967). Contractors with percussion rigs were engaged to drill under the supervision of a geologist. The holes were drilled with a chisel bit and without casing to the first aquifer. A string of 6-inch blank casing was then run into the hole, and casing measurements were kept to check on the position of the casing shoe in relation to the bottom of the hole. Below the piezometric surface the casing shoe was driven ahead of the hole, except when in thick intervals of clay or silt where an open hole was drilled ahead of the shoe for 2 or 3 feet to free the casing.

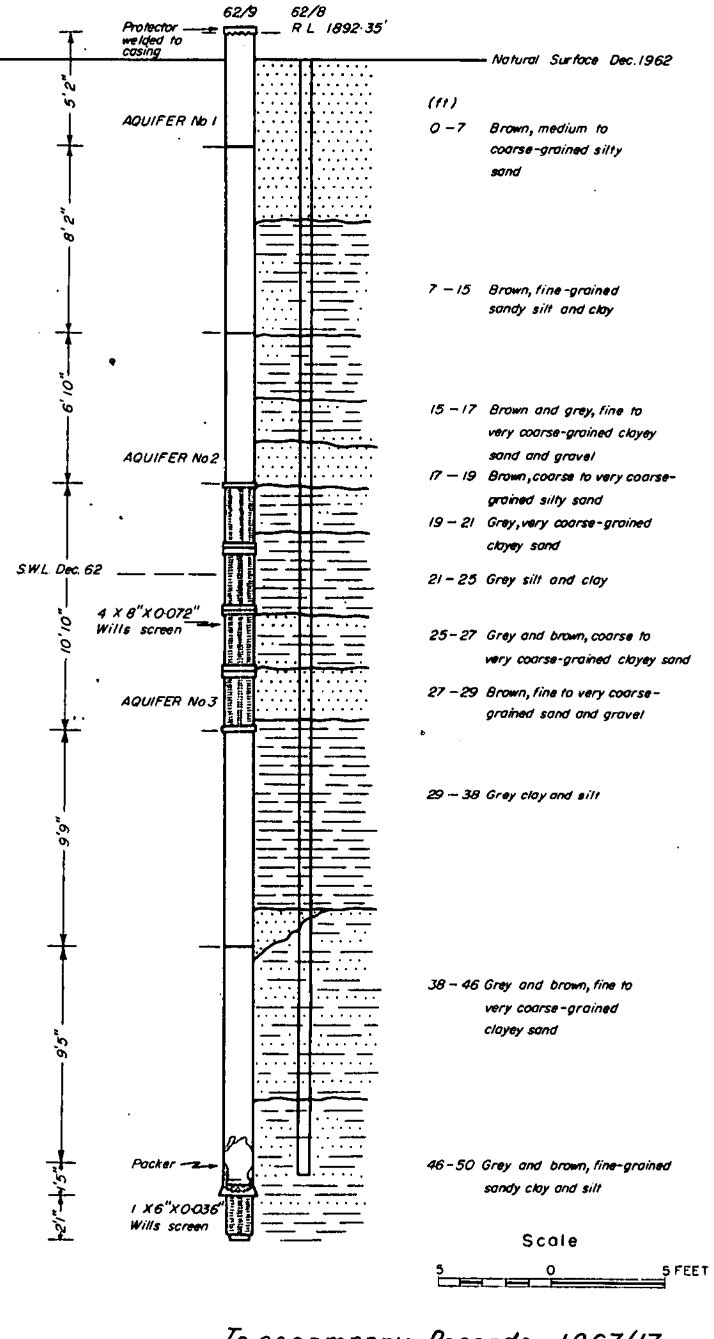
When drilling clays and silts the hole had to be cleaned regularly with the sand pump before an uncontaminated sample could be obtained and water was added to the hole to minimize the risk of sand entering the hole around the casing shoe together with water from aquifers behind the blank casing. This practice made it difficult to obtain a true water sample from an aquifer, and to estimate the yield, but these precautions were necessary to obtain an accurate log of the hole.

Most of the production holes were completed with sandscreens swedged inside 8-inch casing. In the earlier production holes, a screen-slot opening was selected which would allow about 50 percent of the sand near the screen to pass through. Two lengths of screen were generally placed opposite the deepest and thickest aquifer located by test drilling. The holes were developed by means of mechanical surging, using both solid and valve surge tools. Sloughing of silt and clay from the walls was a frequent occurrence, because in most of the holes there are several thin aquifers separated by silt or silty clay, and it was impracticable to place screen opposite each aquifer. Eight inch casing was necessary to accommodate the pumping equipment.

Attempts were made to prevent collapse by using gravel packing techniques, but these were not successful in stabilizing all the aquifers in a particular hole. Where separate gravel feed holes were used it was not possible to control the emplacement of the gravel with sufficient accuracy. An attempt to provide a gravel envelope in the annulus between the production casing and the drill casing failed, probably because it was impracticable to use casing large enough to provide a sufficiently wide annulus.

TABLE 1. SPECIFIC CAPACITIES OF BORES

Bore	Method of Construction	Amount of Sand Passing through Screen (%)	Specific Capacity (gph/ft drawdown)	Well Loss (% of drawdown at 3,000 gph)
1.	Perforated casing	80-90	430	29
2.	Casing withdrawn to expose screen	50	120	20
3.	"	80	270	10
4.	"	-	300	5
5.	"	85	450	14
6.	Screen undercut into place	80	1000	14



To accompany Records 1967/17

Fig. 2. Lithological log and completion details of bores 62/8 and 62/9

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In some of the later bores, screens with larger slot openings were used and development was restricted to pumping only, to avoid collapse of aquifers. This was only partly successful, although it was quite successful in developing the screened aquifer.

As the annular space between the wall of the hole and the screen may be sufficient to start collapse, two methods were tried in which the openings in the production string were set opposite the aquifer without withdrawing the casing. In the first method 8-inch casing with $\frac{1}{8}$-inch holes drilled on a $1\frac{1}{2}$ inch square grid was used. The success of this method is probably due to production from two or more aquifers. However the well loss in such a bore is considerably higher than in bores completed with sand screens (see Table 1).

The second method was to undercut into place a production string of screens screwed to 8- inch casing (Fig. 2). A 20 foot length of blank casing was necessary at the bottom of the string to allow the undercut bit to work properly. Development was by pumping with an axial flow turbine pump, with backwashing by stopping the pump. With this method it was possible to construct a bore with a specific capacity of approximately 1,000 gallons per hour and a low well loss.

The specific capacity and well loss as a percentage of total drawdown at a pumping rate of 3,000 gallons per hour, of the different types of bores are listed in Table 1.

Run-off and River Flow

The amount of rainfall required on catchment before run-off will begin is variable and depends on the intensity of the rain and the previous history of rainfall. Two qualitative estimates of this amount have been made: Wilson (1958) considers that 'the Todd River appears to flow only after about $1\frac{1}{2}$" of rain of an intensity approximating to 2" per hour', and Forbes (1962) concluded that an average rain of 40-50 points of sufficient intensity in one day will bring the river down.

These figures, and the daily rainfall totals and recorded volumes of river flows, have been manipulated to estimate the yield of surface run-off from the catchments of the Todd and Charles Rivers. Wilson (1958) considered that an average of three medium flows crossed the East Side Causeway, during the period 1937-57, with total average yield of 600 million gallons per year. Forbes (1962) extrapolated a relation between average annual rainfall and surface flow through Heavitree Gap to derive an average annual yield of 507 million gallons.

A more satisfactory method for estimating the annual yield would be to use the frequency distribution of discharge, estimated from stream gauging measurements, when these become available.

Chemical Character of the Groundwater

The results of water analyses performed in the chemical laboratory of the Animal Industry Branch, Northern Territory Administration, Alice Springs, have been the basis for all interpretations of the chemical character of groundwater.

Jones (1957) constructed a contoured map of the content of total dissolved solids (TDS) of the water in the basin, and demonstrated that the better quality water occurred in the vicinity of the Todd River.

Quinlan & Woolley (1967), using additional information, constructed TDS contours for each of their five aquifer systems (Plate 2). These maps show that there is a relation between the salinity of the water, the variation in permeability of the aquifer, and the distance to a source of recharge water.

Forbes (1962) used the graphical method of Schoeller (1959) to distinguish 8 chemical types of groundwater. He concluded that this method was of little value for this basin.

Quinlan & Woolley (1967) used a method based on the traditional triangular plots of a three component end member system. The cation and anion content were considered separately, and the position of the point plotted for a water analysis was described by the classifying function 'D' of Pelto (1954). A coherent but subjective interpretation of the areal variation in chemical character was obtained by contouring these values of 'D', within areas in which one or more anions were dominant constituents (Plate 3). They found that sodium was the dominant cation throughout the basin, but the analyses failed to show a systematic variation for the cation content. They recognized that changes in the hydraulic regime during the period 1954-64 were responsible for some changes in the areal variation but these had to be ignored because of the lack of data.

The data which are available does provide some information on the change with time of the chemical character of water in some areas. It is assumed that the addition of recharge water from the Todd River lowers the salinity of the groundwater and changes its composition until equilibrium has been re-established, and the diffusion of ions from the groundwater to the recharge water is an important mechanism in the process. The rates of diffusion are low, and a considerable time may ellapse between the start of river flow and the resultant changes in composition of the groundwater at some distance from the river. The changes can be expected to decrease with the distance from the river.

Jephcott (1958) concluded that the most sensitive indicators of the movement of recharge water through the basin are the sodium and bicarbonate ions. It would appear that the concentration of the bicarbonate, sodium, and potassium ions is less in floodwater than in groundwater which is in the vicinity of the river (Quinlan & Woolley, 1967). The bicarbonate or carbonate ion is not normally a component of the minerals in alluvium, and the most probable source appears to be the carbon dioxide in the air trapped in the pores of the alluvium. The additional sodium and potassium ions have presumably been derived from the minerals in the aquifer.

Recharge

Recharge to all aquifers originates as floodwater in the Todd River. Certain portions of the river bed are known to be recharge areas which are interconnected with aquifers within the basin. Observations on the rate of advance and recession of floodwaters in the recharge areas indicate that the rate of infiltration of water is significantly greater than in other parts of the channel. Wilson (1958) records initial infiltration rates for the Todd River as high as 180 gallons per hour per square foot, within 24 hours this rate had dropped to 0.5 gallons per hour per square foot. Factors which would inhibit infiltration are the swelling of the clay matrix following wetting and the presence of air trapped in the pore space. It is doubtful if the river ever continues to run for a sufficient period to dissipate the entrapped air.

The recharge mound in the piezometric surface adjacent to the Todd River encloses permeable alluvium in which recharge water is stored under unconfined conditions until it moves into confined aquifers.

Water Levels

Water level hydrographs for representative bores in each of the five Quaternary aquifers are shown on Plate 4. They show that the water level fluctuates after floods in the Todd River and in response to pumping near the observation bores. The magnitude and character of the fluctuation depends on the distance of the observation bore from the recharge areas, the crests of the hydrographs become rounded, and the rate of decline in water levels is much less.

The rise in water levels in response to a river flow which occurs within 3 months of a previous flow is generally not as great as the rise resulting from flows separated by a longer interval. A minimum period of 3 months is probably required for the recharge mound near the river to be sufficiently dissipated to permit significant quantities to infiltrate from subsequent flows.

Water levels in the basin fell during the period 1958-64, as a result of the increased withdrawal in the same period (Pl. 4 and Fig. 3). The rate of decline was greatest in the south and was not significant in the north. The decline has not apparently induced recharge to the basin as predicted by Wilson (1958). The water levels in the bores in the areas of greatest decline (J and 59/8) showed a much smaller response to river flow in 1962 than in previous years. Yet the river ran seven times in 1962. It follows that the rate of transfer of water from the recharge mound to the five aquifer systems must be less than the rate of movement of groundwater within the aquifers.

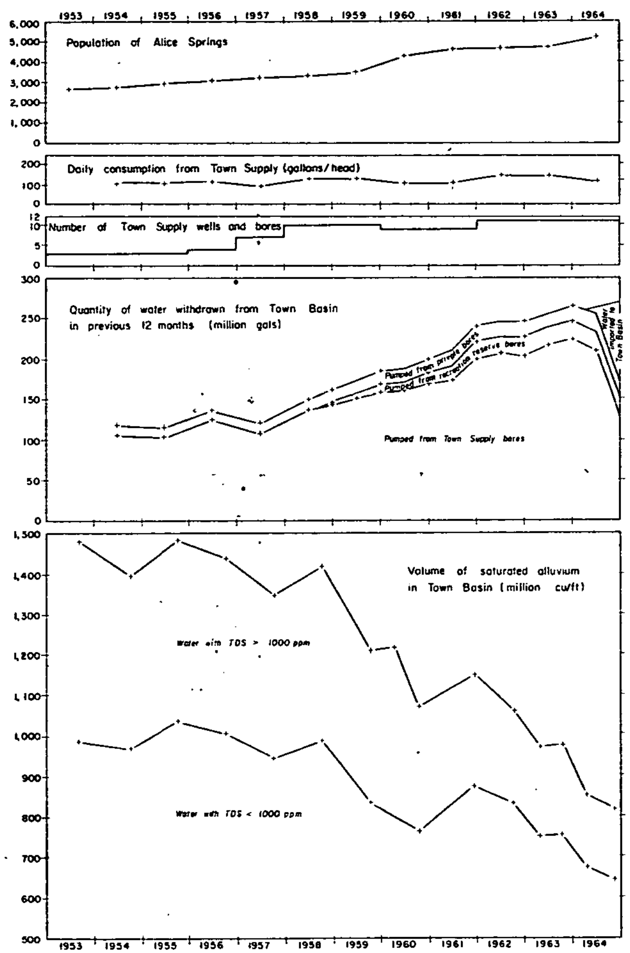

Fig.3. Consumption and withdrawal of groundwater

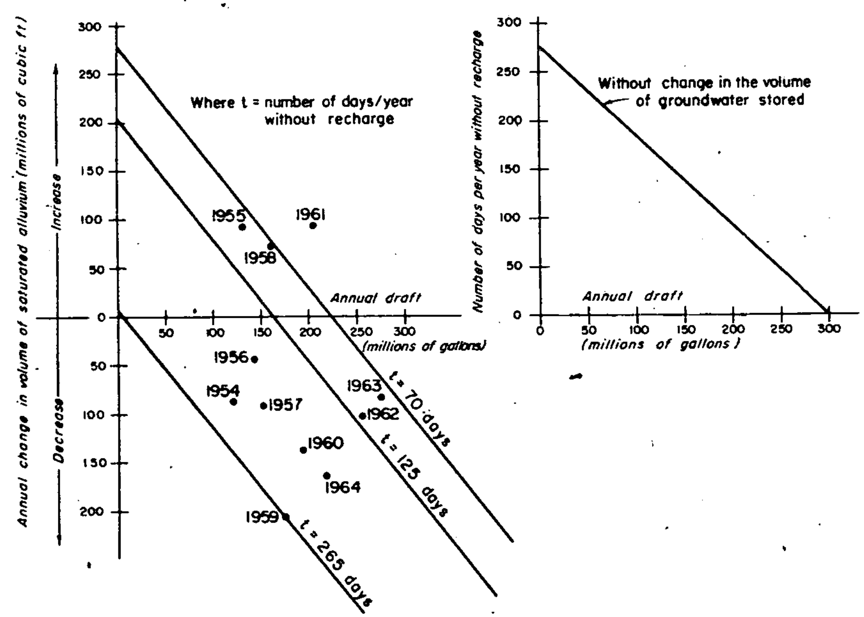

Fig.4. Calculation of safe yield

To accompany Records 1967/17

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TABLE 2

Coefficients Calculated from Aquifer Performance Tests

Bore	Non-Equilibrium Method			Equilibrium Method		
	Coefficient of Transmissibility in imperial gallons day/foot	Hydraulic Conductivity in feet/day	Coefficient of Storage	Coefficient of Transmissibility in gallons/day/ft.	Hydraulic Conductivity in feet/day	Coefficient of Storage
62/9				4750	109	0.05
Colocag Park 61/24				26,000	95	0.08
Bent Tree No. 1 60/14				38,000	187	0.13
Todd Bore 60/5				31,000	125	0.09
61/33				35,500	200	0.004
110	22,000	111	0.03	56,000	280	0.00014
Army Well No. 2	17,000-66,000	150	0.07	30,000	190	0.43
59				42,000	120	0.02
28	20,000	93	0.07			
59/11	5,000-42,000	130	0.002	17,000	-	0.0001-0.0001
Town Wells recalculated from (Wilson 1957)						
Bent Tree Well calculated from Wilson (1957)	12,000	92	0.17			

Values adopted are thought to be applicable to the Town Basin:

Coefficient of Transmissibility	=	30,000 gallons/day/foot
Hydraulic conductivity	=	150 feet/day
Coefficient of Storage	=	0.07

Aquifer Performance Tests

Wilson (1958) and Quinlan & Woolley (1962, 1967) carried out a number of aquifer performance tests on bores and wells. The former were of one or two days duration while the latter were run for as long as three months.

Quinlan and Woolley used bores which were pumping water for the town supply to avoid the installation of special pumps. Several factors increase the probable error of their results:

1. Tests were possible only during the winter months, when adjacent production bores could be shut down to avoid interference between bores. The time available for testing was seldom long enough to measure the recovery on completion of pumping.

2. The discharge may fluctuate by 5 percent, because of variations in head in the rising mains.

3. The observed drawdowns were adjusted to allow for the natural fall in water levels between recharge periods. These corrections were obtained by extrapolation from long-term trends in water levels at observation points, both inside and outside the area of influence.

Because of the irregular distribution and thickness of the channel sands it is not possible to treat them individually as confined aquifers, or more properly as infinite-strip leaky artesian aquifers, and a choice of an appropriate model must be made to interpretate the results.

Quinlan and Woolley assumed that on a long term basis, the withdrawal of water from the saturated alluvium can be considered to occur under unconfined conditions, and that it was expedient to assume that the alluvium is isotropic, homogeneous and of infinite areal extent. In which case the consistency of the results from one test can be taken as an indication of the differences between the ideal aquifer and the saturated alluvium. Both the Theis non-equilibrium formula (Wenzel, 1942) and the equilibrium formula (Jacob, 1950) were used (Plate 5) and the results are given in Table 2. The range in values calculated from drawdowns in several observation holes for a particular test was large, and can be taken as an indication of the poor agreement between the model and the saturated alluvium. The average values for the hydraulic conductivity for each test are more consistant, and this is considered to justify the application of one model to the whole basin.

Volume of Saturated Alluvium

A graphical method was used to estimate the volume of saturated alluvium in the basin from contoured maps of the piezometric surface. It was calculated for a date in October for each year from 1953-64 inclusive, and for April in 1963 and 1964.

Estimates of the volume of groundwater stored in the basin (Table 3) were based on the calculated volume of saturated alluvium and a specific yield of 0.07 (Table 2). They range from 357 million gallons in October 1964 to 649 million gallons in October 1955, compared with the 900 million gallons estimated by Owen (1952, 1954). 1,110 million gallons by Wilson (1958), and 300 million gallons by Jones (1957).

Safe Yield

It must be stressed that while it is desirable to estimate a safe yield to allow for reasonable planning for development, such an estimate can, in many cases, only be made without an adequate appreciation of the hydraulic behaviour of the basin. The estimates which have been made to date are based on data collected during a period of depletion. Until the water levels have recovered to a state comparable with that existing before 1957, there is no basis for comparison to determine if its hydraulic behaviour has been adversely affected by depletion.

Wilson (1958) considered that the yield of the basin could be maintained at 340 million gallons per year, providing that there were three average floods in the river and that the quantity of water received from recharge increased as the hydraulic gradient increased with depletion.

TABLE ~~2~~ 3: STORAGE AND WITHDRAWAL OF GROUNDWATER, ALICE SPRINGS TOWN BASIN

Year Ending	Volume of Saturated Alluvium (10^6 cu. ft.)	Estimated Volume of Groundwater in Storage (million gals for Specific yield = 7%)	Estimated Volume of Groundwater Pumped from Basin (million gals)	Change in Volume of Saturated Alluvium (10^6 cu. ft.)			Estimated Period without Recharge (days)	Predicted Safe Yield (million gals)
				Calculated	Predicted	Difference		
1st Sept. 1953	1480	647.5					80	264
October 1954	1392	609.0	120	-88	-94	6	236	43
October 1955	1483	648.8	130	+91	117	-26	70	278
October 1956	1440	630.0	141	-43	1	-44	146	176
16th Oct. 1957	1349	590.2	152	-91	-75	-16	192	107
October 1958	1420	621.2	160	+72	+35	+36	103	233
October 1959	1213	530.7	175	-208	-20	-7	265	14
October 1960	1074	469.9	192	-139	-182	43	235	55
14th Oct. 1961	1167	510.6	206	+93	+15	+78	76	269
11th Oct. 1962	1065	465.9	256	-102	-80	-22	101	236
18th Oct. 1963	980	428.7	276	-82	-57	-25	66	283
2nd October 1964	817	357.4	219	-166	-143	-23	182	126
TOTAL				-665	-670			

Forbes (1962) used the Hills method (Todd, 1959) to obtain an estimate of 120 million gallons per year. This was based on the position of the zero change in water level on the straight line of best fit to a plot of the quantity of water withdrawn from the basin and the rate of decline of water levels in bore HC. He recognized the limitations of the method as applied to small basins. These are significant in this case, as the bore HC is close to the western margin of the saturated alluvium.

Quinlan and Woolley (1967) adapted the method by using the annual change in volume of the saturated alluvium instead of the change in water level. In addition they included a second variable, the estimated number of days in each year when there was no recharge, on the assumption that recharge will continue for 100 days, which is the average duration of the rise in water levels after a river flow (pl. 4). Using an analysis of multiple regression they obtained the relation

$$y = 372 - 1.23x - 1.35t,$$

where y is the change in the volume of saturated alluvium, x is the amount of water pumped from the basin in the year, and t is the estimated number of days during the year without recharge. The basic assumption that a linear relation exists between the variables is probably not realistic, and the relation was considered to be an approximation.

The value obtained for the multiple correlation coefficient was relatively high (0.89) and there was reasonable agreement between the total of the predicted change (668 million cubic feet) and the observed change (665 million cubic feet) for the years 1953 to 1964. Both these facts indicate that this equation would be reasonably effective in predicting the changes over long periods. The differences between the observed and the predicted changes in volume for each year indicate the limitations of the method for the prediction of short term changes.

They believed that a single value cannot be assigned to the annual safe yield, as it is largely dependant on the number of river flows, separated by more than 100 days, which have occurred during the year. The safe yields which can be expected are illustrated in Table 2 and Figure 4. On this basis there are three possible approaches to the management of the basin.

1. Within a period of 100 years, the Todd River will flow at least once during 91 of the years. If this is the level of probability at which the basin is managed, then a value for the annual safe yield is insignificant. This is obviously impracticable as a basis for management.

2. Management at the 50 percent level of probability (i.e. depletion would occur in 50 years of a 100 year period, and water would be added to storage during the other 50 years) would allow the withdrawal of groundwater at a rate of 156 million gallons per year. This estimate is based on the probability distribution of the number of days per annum when recharge does not occur, for which the median is 126 days.

3. The third and recommended method would take advantage of each recharge period as it occurred. This could be achieved by the withdrawal of groundwater at a rate of 20 million gallons per month for a period of 2 months following recharge, then reducing the withdrawal rate by 3.5 million gallons in each succeeding month, until the next period of recharge. The probability of failure of such a policy was not given, but it could be expected to be low.

CONCLUSIONS

Much information concerning the geology of the Alice Aprings Town Basin and on the occurrence of groundwater in it, has become available as a result of the work undertaken by a number of organizations during the period 1952-64.

The analysis and interpretation of water level measurements and pumping test data has not provided a satisfactory model which could be used to describe and predict its hydraulic behaviour. Further work is in progress to resolve this problem.

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GEOLOGICAL MAP OF THE TOWN AND INNER FARM BASINS, ALICE SPRINGS

To accompany Records 1967/17

F53/A14/55

GEOLOGY AND SALINITY OF GROUNDWATER, QUATERNARY AQUIFERS, TOWN BASIN, ALICE SPRINGS

PLATE 2

To accompany Records 1967/17

F53/A14/56

CHEMICAL CHARACTER (ANIONS) OF GROUNDWATER, QUATERNARY AQUIFERS, TOWN BASIN, ALICE SPRINGS

PLATE 3

To accompany Records 1967/17

F53/A14/57

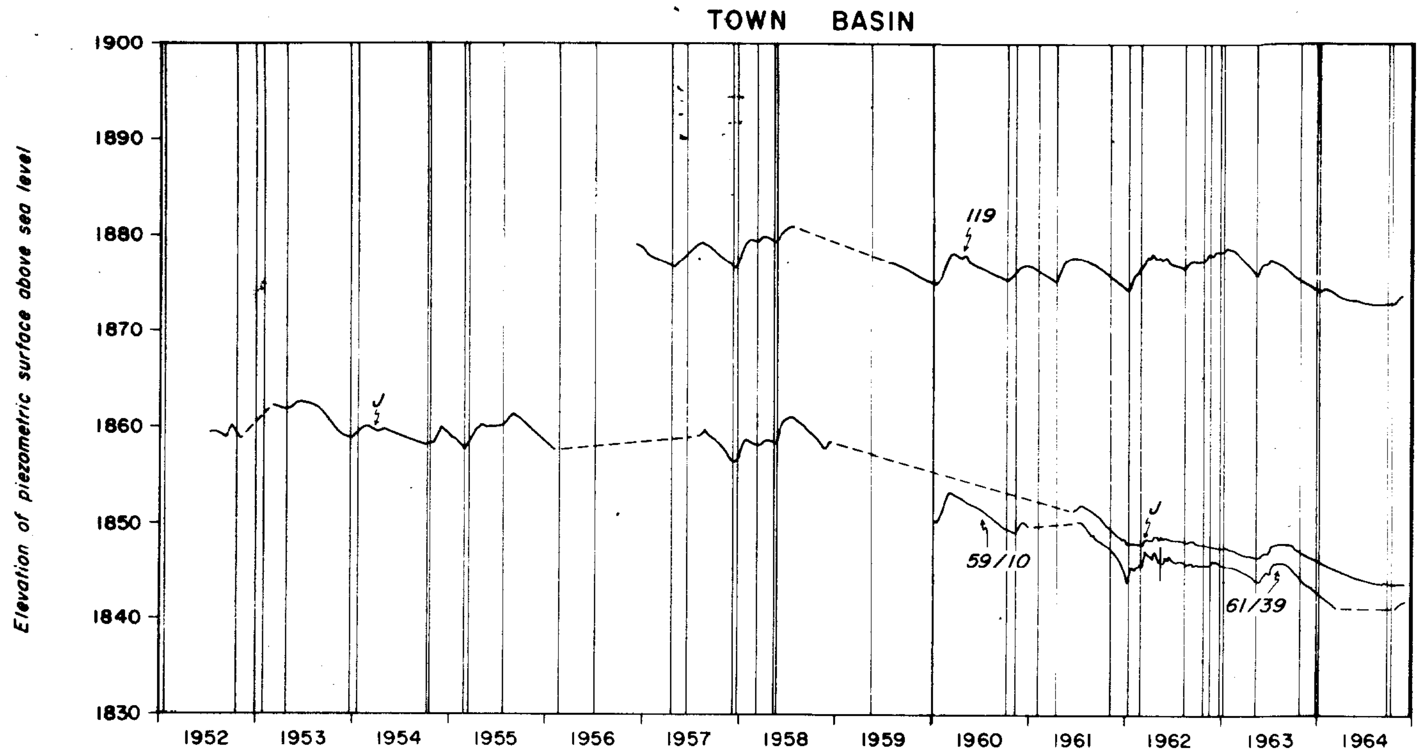
PLATE 4

FLUCTUATIONS IN THE PIEZOMETRIC SURFACE

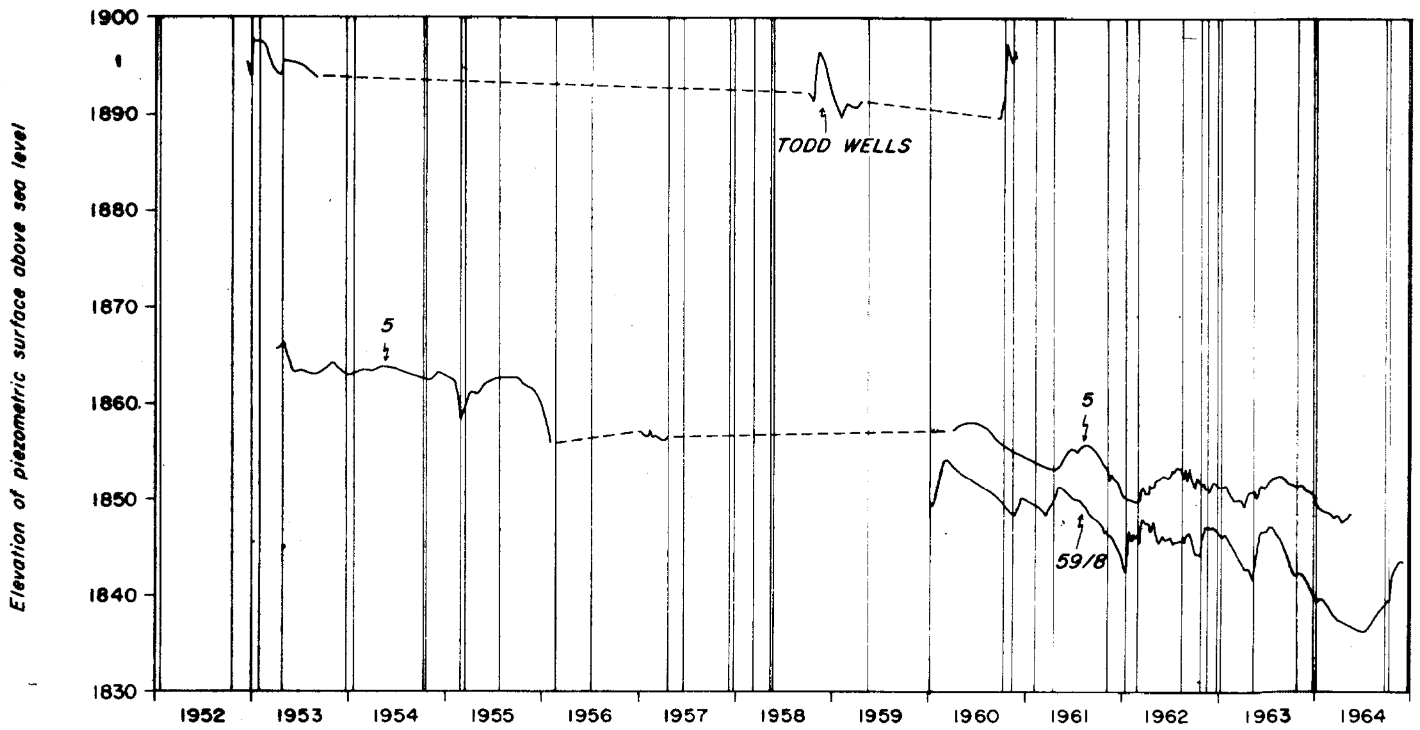
TOWN AND INNER FARM BASINS

ALICE SPRINGS

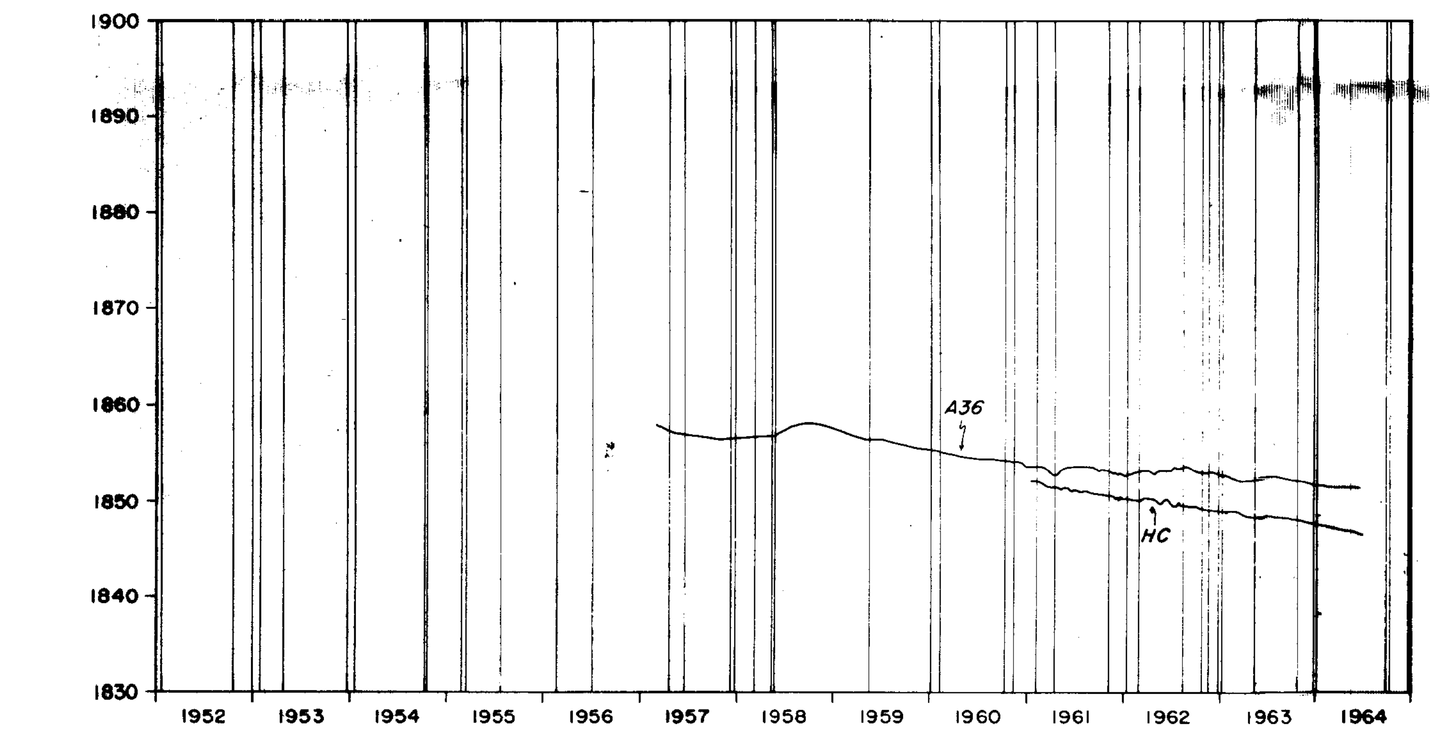
TOWN BASIN



FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE '1820' AQUIFER

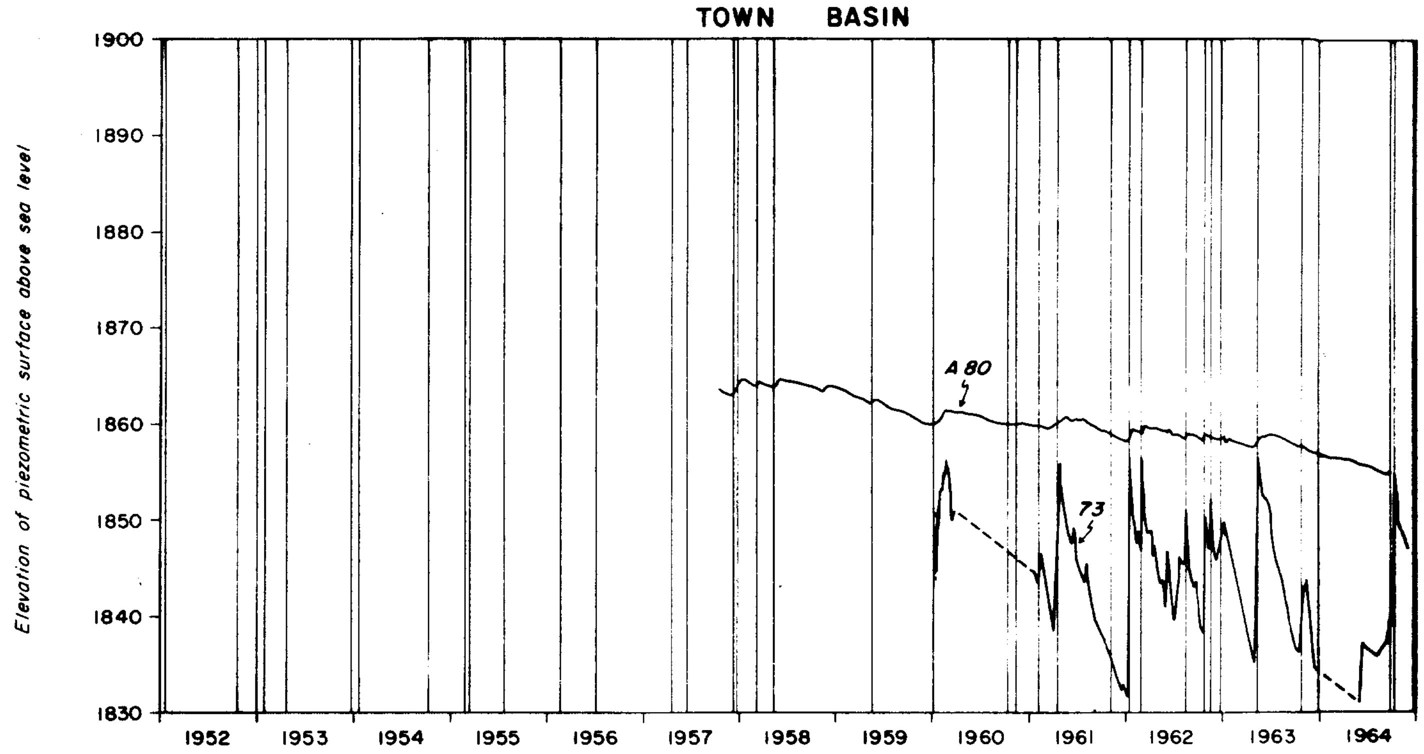


FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE '1810' AQUIFER

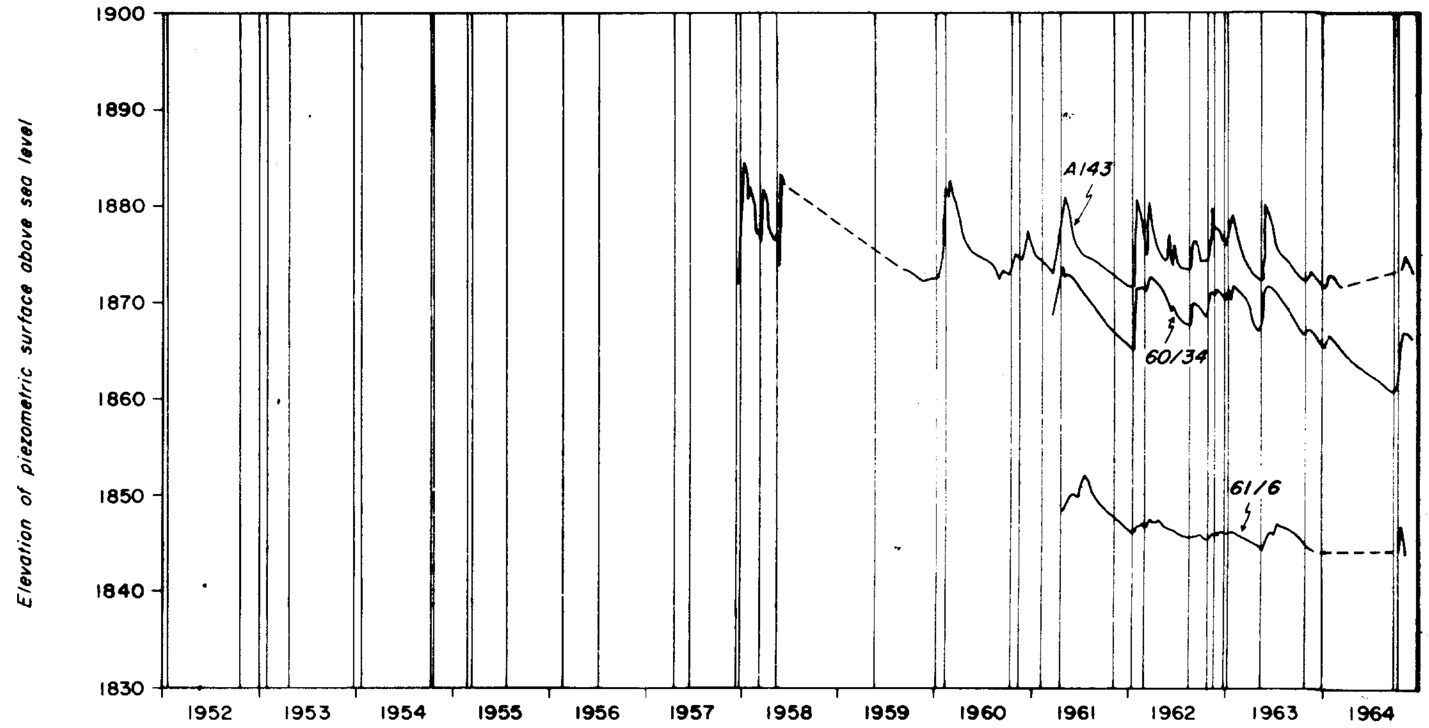


FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE PRECAMBRIAN ROCKS

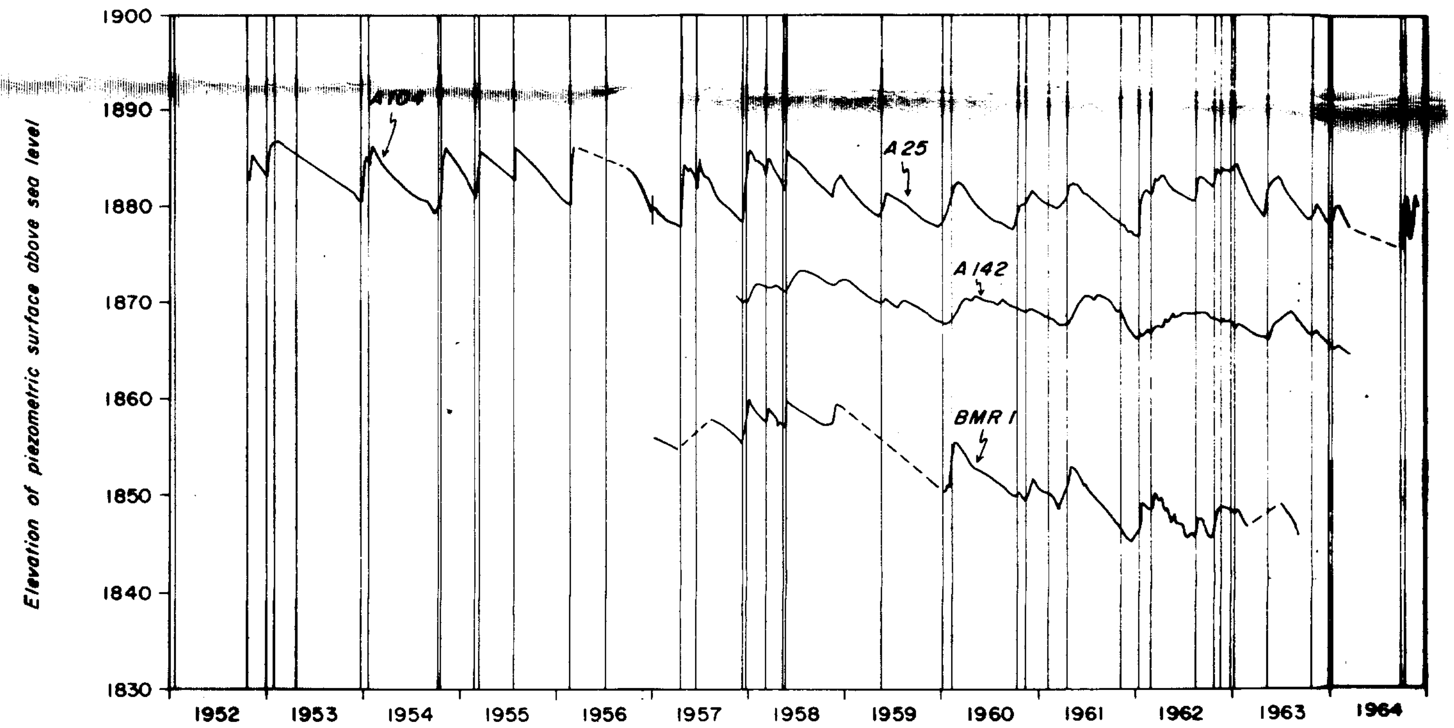
TOWN BASIN



FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE '1850' AQUIFER



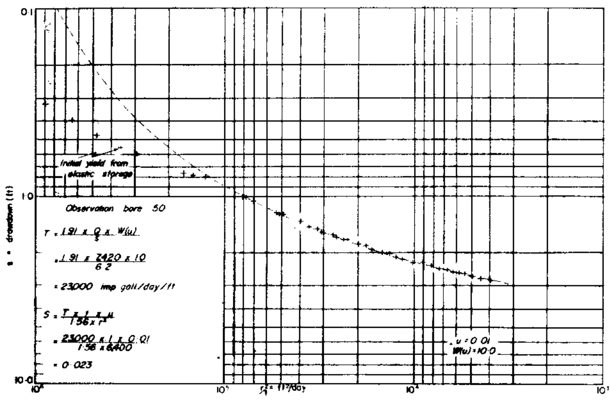
FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE '1840' AQUIFER



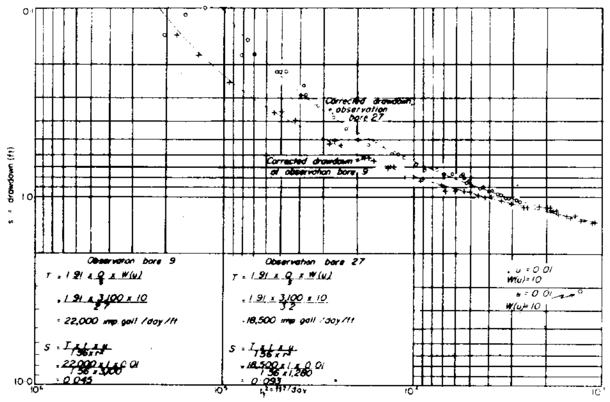
FLUCTUATIONS IN THE PIEZOMETRIC SURFACE OF THE '1830' AQUIFER

To accompany Records 1967/17

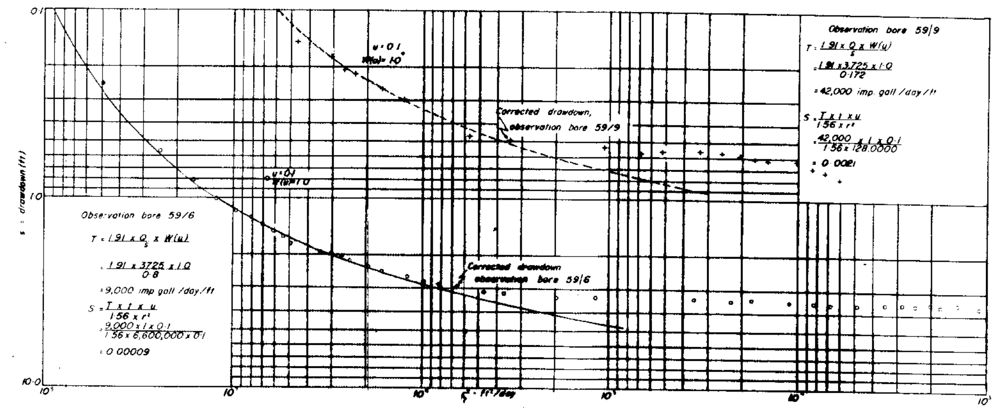
F53/A14/58



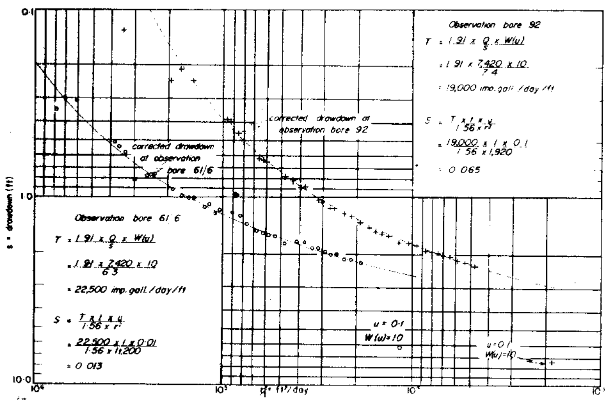
Drawdown curve at bore 50 for aquifer test of bore 110



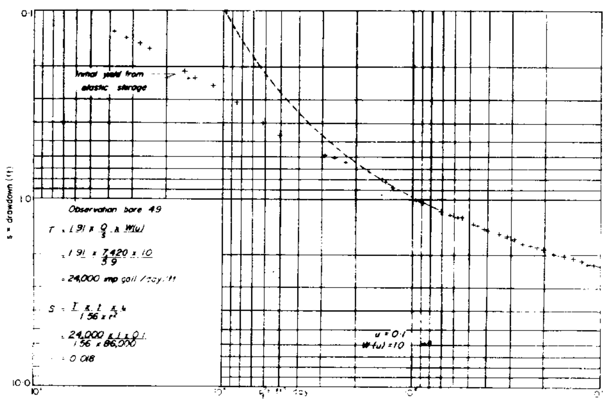
Drawdown curves at bores 9 and 27 for aquifer test of bore 28



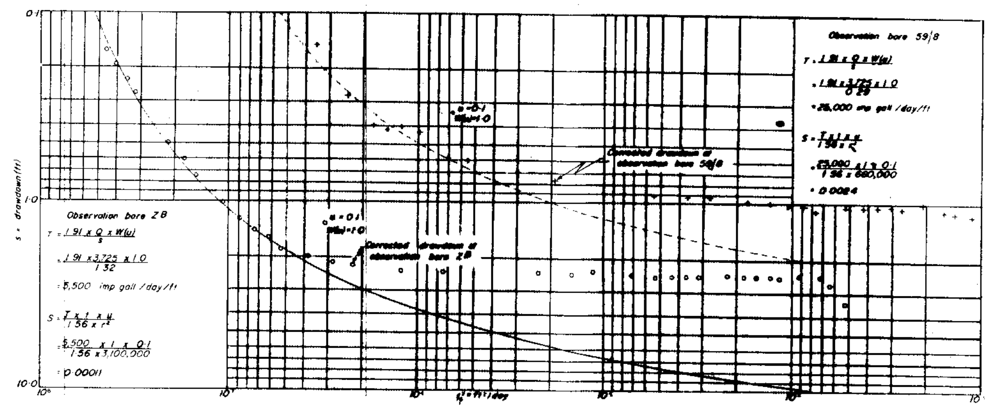
Drawdown curves of bores 59/6 and 59/9 for aquifer test of bore 59/11



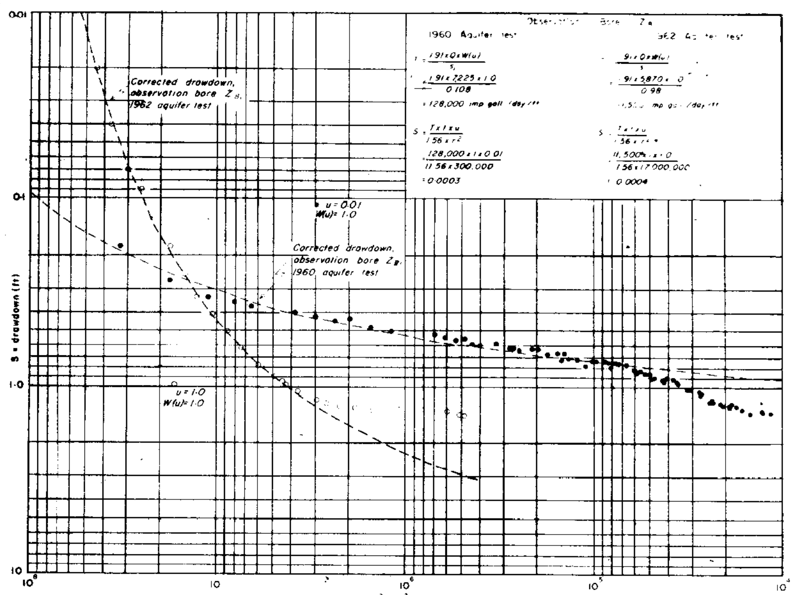
Drawdown curves at bores 61/6 and 92 for aquifer test of bore 110



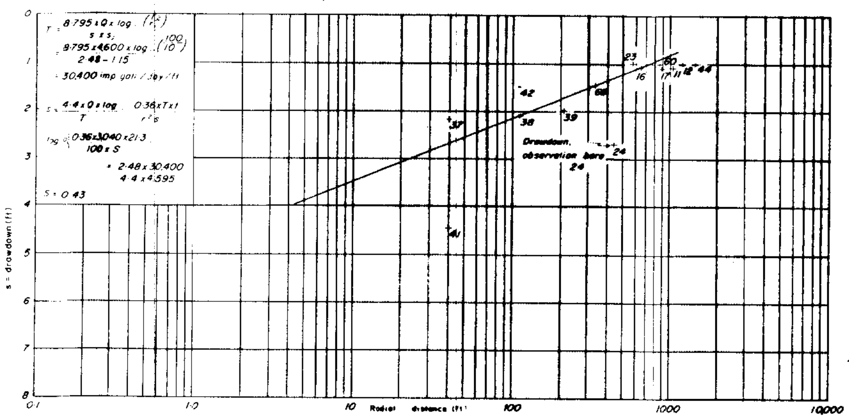
Drawdown curve at bore 49 for aquifer test of bore 110



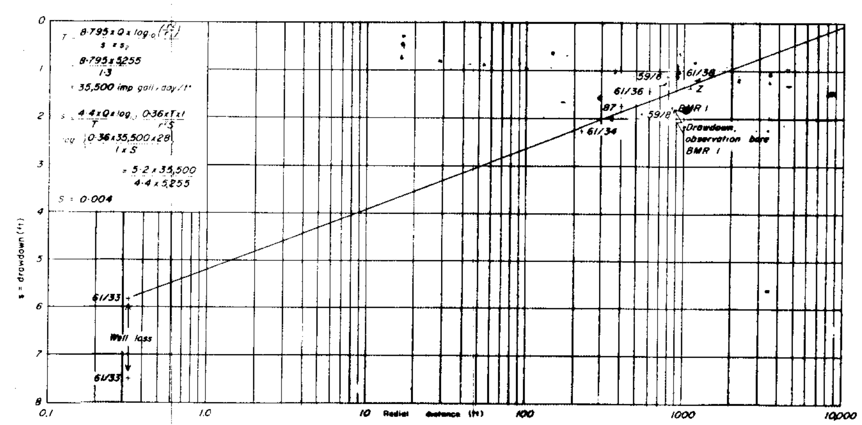
Drawdown curves of bores Z8 and 59/8 for aquifer test of bore 59/11



Drawdown curves at bore Z8 for aquifer tests of bore 59 in 1960 and 1962



Equilibrium analysis army well No 2



Equilibrium analysis bore 61/33

DRAWDOWN CURVES FOR AQUIFER PERFORMANCE TESTS

TOWN BASIN – ALICE SPRINGS

To accompany Records 1967/17

F53/A14/59