1. INTRODUCTION.

Alice Springs in Central Australia depends on the groundwater under the Todd River for its main water supply. The Todd River flows on average about twice a year and then only for very short periods. It is during these periods of flow that the water beds become recharged and Alice Springs is then assured of a continued water supply for a further period of time.

With the growth of the town the demand for water increased so that it became necessary to investigate the potential of the underground basin. In connection with these investigations an assessment is required of the amount of water that is lost from the river to groundwater during the periods of flow. This loss of water through the river bed is sometimes obvious when the river can be seen flowing over a section of its length and disappearing rapidly into the bed some distance downstream.

The catchment of the river above Heavitree Gap is 232 square miles and could be classed as moderately steep. The fall between Wigley Gorge and the township is 157 feet and between the Township and Heavitree Gap 15 feet (See fig. 1).

The width of the river bed increases rapidly as the slope flattens out and at the township the sandy bed is nearly 700 feet wide. It is over these large areas of river bed that most of the intake to groundwater occurs.

2. STREAM GAUGING STATIONS.

Investigations into the flow of the Todd River commenced in 1952 when a gauge board was installed on the Todd near the Alice Springs Causeway, this was known as G.S.9 (See fig. 1). In 1958, two other gauging stations were added, one to Wigley Gorge, G.S.46 and the other on the Charles River which is a tributary of the Todd, G.S.47. These two latter stations were both installed on the upper reaches where it was thought to be well above the intake section for the recharge to the aquifer. In 1959, a fourth gauging station was established, this one at Heavitree Gap which is some distance downstream of the township and thought to be the lower limit of the intake section to the groundwater basin.
RAINFALL AND RUN-OFF.

A study of the weather patterns that produce rainfall in Central Australia show that there are three common types: (a) the convergence of south-easterly and north-westerly air masses; (b) the passage of a cold front; and (c) the convective storm.

No detailed investigations of variations in intensities of rainfalls of various storm origins have yet been carried out in the Alice Springs region, nevertheless, from the existing rather scanty pluviograph records it can be assumed that convergent storms seldom exceed the intensity of 0.10 inches per hour whenever a continuous rain of the order of 24 hours is involved.

The cold-front rains are usually of the order of 0.25 inches per hour, but may have initial downpours from the squall clouds of 1.0 to 1.5 inches per hour. The convective storms show a varied pattern of intensities within each of them, starting with light rain at the fringes rising to deluges at the centre with intensities between 5 and 10 inches per hour. The average annual rainfall for Alice Springs is just over 10 inches.

All three rainfalls produce run-off in varying quantities and rates. The convergent storms are usually wide spread and of long duration and produce a fair run in the river which may continue for up to 90 hours depending on the storm length. The frontal storm may or may not produce run-off; if it does, the river rises and falls more rapidly than during a convergent storm. The convective storms that occur frequently during the summer months are widely scattered and have limited areal distribution. The time of occurrence is usually late afternoon or evening, and when occurring over the catchment, the time of concentration is such to produce the peak of the flood at the gauging stations late at night or early morning. Consequently, when depending on gauge readers these peaks are frequently missed.

INSTRUMENTATION OF STATIONS.

In 1959 four Bristol Pressure Recorders were installed, one at each gauging station. At this stage these instruments had not been thermo-compensated.
It was soon very obvious that with the high diurnal temperature variation that these recorders were not at all suitable for these inland streams. As soon as thermo-compensated recorders were available they were used to replace the others. These functioned quite well during dry conditions but after two separate river flows had occurred it became obvious that the pressure pack type of recorder was not suitable for this work. It was found difficult with the limited trained staff to maintain a Bristol Recorder during a dry season and still have it functioning satisfactorily when the river was in flow. The rubber bulbs were one cause of trouble and zero setting was difficult when the bulbs were not immersed in water; Special provision for protecting the rubber bulbs proved useless against the large quantities of sand and silt that packed up when the river was flowing.

When it was realised that the Bristol Pressure Recorder would never give the results desired in a sufficiently accurate manner, it was decided to use float type recorders. The installation of float type recorders on a river with a sandy bed 500/600 feet wide presented many problems, however, by designing a special installation for each station and equipping them with Leupold Stevens "F" Type Water Level Recorders (see fig. 6), costs were kept down to a minimum and as was later proved these recorders worked satisfactorily. The "F" Type Recorder was selected for these stations because of a number of factors. All four recorders were within easy access of the District Office and could be attended to each week. In a case such as this, it was preferable that a weekly visit be made so that it always ensured that recorders were ready to go when the river flowed. It was argued that the fitting of a long-term recorder would have saved the labour of a weekly visit but on a river whose flows were so sporadic and unpredictable the use of a long-term recorder would have been leaving too much to the dependability of the instrument which in the case of long-term recorders are not always as reliable as we would like them. By using the "F" type instrument, the necessity for a weekly visit established a routine that ensured the instrument was always in working order.
At G.S.126 Heavitree Gap there was the problem of recording flow in a sandy river bed of 500 feet wide where the low flows were sometimes confined to the centre 100 feet. After a number of designs had been prepared it was finally decided to install the instrument on 8" bore casing driven 30 feet into the bed of the river with sufficient length projecting above the bed to clear the highest flood (See fig.3). This instrument has since recorded two separate flows.

In Alice Springs at G.S.9 a 15" diameter pipe was attached to the bridge pier (See fig.5), and at the two upper sites 15" diameter pipes were concreted into the rocks that formed the bank of the river (See figs.9 & 10).

During recent flows all four recorders worked effectively but silting is still a problem, particularly in the 15" pipes. Sand screens have been made up for the intakes but are not completely successful. The solution at present is to de-silt the wells after every flow.

5. RATING THE GAUGES.

Calibration of these gauges is still one of the difficult tasks. Where a river flows infrequently as the Todd every opportunity must be taken to secure gaugings. The problem in Alice Springs is to have available when the river flows trained hydrographers who can carry out this work, but because the Todd River only flows three or four times a year and sometimes only once a year, it is impracticable to keep hydrographic staff in Alice Springs. Neither is it practicable to rush staff from the Darwin area whenever the river flows. For these reasons, staff from the associated sections of the Branch already working in Alice Springs have been trained to carry out the gaugings. As these officers are not as familiar with this work as those working full time on hydrographic measurement, the stations have been prepared to make the task as straightforward as possible.

Wading gaugings can be made at all four stations up to about one or two feet; after that the current becomes too swift. At G.S.9 a travelling crane had been designed and built to operate along the length of the foot bridge (See fig.8). This has enabled gaugings to be made at all stages with speed and accuracy.
At the two stations on the upper reaches G.S.46 and 47 medium span stream gauging travellers have been installed, and at G.S.126 (Heavitree Gap) it is planned to erect an OTT stream gauging traveller where the span will be approximately 600 feet.

When all four stations are fully equipped, there still remains the problem of carrying out the gaugings. With the rapid rates of rise and fall, the infrequent flows and the limited staff, the task of fully rating all four stations looks like being a long and tedious one. Efforts to date have been concentrated at G.S.9 which is now rated to about half stage. Low flow gaugings have also been made at the other stations. With future flows efforts will be concentrated on each station in turn until all four are fully rated.

6. CONTROLS.

The question of controls has fortunately been solved at G.S.126 and G.S.9 by the existence of concrete causeways running across the bed of the river (See figs 4 & 7). Although these are not as sensitive as would be preferred for normal stream gauging work they do give permanency to the bed which would be extremely difficult to obtain in this river by any other means. At G.S.46 and 47 small concrete weirs have been constructed between the rock outcrops in the river (See fig.12). These sanded up to spillway level soon after they were installed but still give permanent cease-to-flow level.

7. CONCLUSION.

If, in the near future we are fortunate enough to have good flows down the Todd River and it does appear at present that the 1960/61 drought has eased, then the information obtained on stream flow will make a useful contribution to the study of groundwater recharge which will in turn assist in the assessment of how much water can be made available from the groundwater basin for Alice Springs future needs.
TODD RIVER AT ALICE SPRINGS. G.S. 9.

FIG. 5.
15" Diameter steel pipe attached to bridge pier. Lower inlet pipe is below sand.
Note de silting door open.

FIG. 6.
Leupold Stevens "F" type recorder being prepared at G.S. 9.

FIG. 7.
Small flow over causeway. This is control of G.S. 9.
FIG. 2.
Drilling rig at work in Todd River bed.

FIG. 3.
Completed recorder. Small pipe is for counterpoise. Lower inlet pipe is hidden from view.

FIG. 4.
Causeway acting as control at this station.
FIG. 8.
Travelling streamgaging crane mounted on the footbridge. Track is built of angle iron.

FIG. 9.
15" diameter steel pipe set in concrete base and supported by ladder. Bristol recorder box can be seen on crest.
FIG. 10.
15" diameter steel pipe set in concrete. Ladder gives additional support. Lower inlet pipe is several feet below ground level at this point.

FIG. 11.
 Erecting anchor for stream gauging traveller.

FIG. 12.
General view upstream at the gorge. Note control on right.