This report examines the effect of the first 20 months of pumping from the Cabbage Gum Basin and examines the level of the storage at July 1965. It is established that the 1961 evaluation of the addition of the basin is correct and that increased withdrawal rates must risk a decline in the quality of the water supplied to the reticulation.

EFFECT OF PUMPING

A. Water Level Reduction

As is expected when pumping continues from any groundwater storage the early effect is the creation of a zone of reduced water levels in the immediate vicinity of the pumped bore. The water levels in this drawdown zone would recover towards their original position if pumping ceased and the existence of such a zone is not regarded as a depletion of the storage but as a reduction of levels necessary to ensure water to flow to the bore.

It is the variation in storage level outside the drawdown zone that must be monitored.

Figure 1 is a plan of the Cabbage Gum pumping area showing the positions of the pumped bores and observation points relative to the zone of potable water. Under non-pumped conditions water flows along the path shown on the plan moving from the north west to the south east. The pumped bores are arranged along the centre of this major zone of potable water in such a way as to permit extraction of the available potable water with a minimal risk of attracting the saline water from either flank. New extraction points are used so that the drawdown at any one point will not be excessive.

Figure 2 portrays a longitudinal section along the centre of the potable zone and through the pumped bores. The drawdown seen in the vicinity of the pumped bores is clearly evident and toward the northern end of the section (Point 5) a small withdrawal from storage is shown. Most of this withdrawal took place during the first years pumping, the withdrawal during the last 6 months approximately being balanced by recharge to the area resulting from the February 1965 rainfall.
Of rather more significance is the situation depicted in Figure 3 which is a section across the potable zone. Again the drawdown zone is evident but it will be noted that the pumps are not extracting the high level storage of potable water towards the northern end of the section (Point C) but are drawing from the storage of saline water to the south (Point D). That this situation is consistent over most of the basin is shown in Figures 4 and 5. Figure 4, the longitudinal section along the northern edge of the potable zone shows that only small withdrawals have been made from anywhere along the northern "bank" while reference to Figure 5 reveals that the southern edge and the neighbouring saline zone have both yielded considerable water.

In general that part of the basin north of No.5 well has shown some benefit from the heavy rain during February 1965. A good response to recharge was recorded at observation bores 20/110, 210/110, 210/100 and at No.14 well.

The area in the vicinity of the pumped bores and as far to the east as observation bore 502 has declined steadily under the effect of the pumping and shows no recovery resulting from the rain, although there is definite reduction in the rate of decline of the water level since March 1965.

The upper part of the basin, to the east of the 210/- observation bores has shown no significant change in water level.

B. Salinity Changes.

Salinity variations with pumping have been monitored. As would be expected from the trend of water level movement the salinity showed an increase at all pumps except No.5 well during the first year of operation and during the last six months has remained steady except at the bore 203/102 which being distant to the area of higher salinity is recording a higher figure as this bore saline water is drawn in.

The following table shows salinity figures before pumping commenced and at February and August 1965. The figures quoted are water conductivity stated in microhms per square centimetre. To establish the order of the salinity it should be noted that a conductivity in excess of 1750 microhms would be regarded as suspect and bordering on unsuitability for human consumption.

<table>
<thead>
<tr>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Bore</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>110</td>
<td>100</td>
<td>670</td>
</tr>
<tr>
<td>9</td>
<td>886</td>
<td>1005</td>
<td>780</td>
</tr>
<tr>
<td>4</td>
<td>82</td>
<td>982</td>
<td>1030</td>
</tr>
</tbody>
</table>

Before Commencment of pumping (approximate average)

730  750  1000  670
846  846  1005  780
746  897  982  1030

Viewed at 06:02:06 on 18/02/2010 Page 2 of 10.
The pumping of the Cabbage Tarn Basin has been conducted subject to a limit of 1,000,000 gallons on the total pumped in any one week.

In general this quantity has proved to be in excess of the normal requirement with restrictions on unattended watering in force, but the consumption on three occasions (the second week in January 1962 and the last 2 weeks in February 1963) has exceeded the set limit.

The quantity pumped during the first seven months clearly was affected more by the increasing number of connections than by any other factor. Since June 1964 the consumption has varied in keeping with the maximum daily temperatures and the occurrence of rain.

The following table sets out the average weekly pumping rate for each month since June 1964.

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Weekly Rate (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1964</td>
<td>520,000</td>
</tr>
<tr>
<td>July 1964</td>
<td>518,000</td>
</tr>
<tr>
<td>August 1964</td>
<td>636,000</td>
</tr>
<tr>
<td>September 1964</td>
<td>582,000</td>
</tr>
<tr>
<td>October 1964</td>
<td>598,000</td>
</tr>
<tr>
<td>November 1964</td>
<td>763,000</td>
</tr>
<tr>
<td>December 1964</td>
<td>797,000</td>
</tr>
<tr>
<td>January 1965</td>
<td>905,000</td>
</tr>
<tr>
<td>February 1965</td>
<td>996,000</td>
</tr>
<tr>
<td>March 1965</td>
<td>555,000</td>
</tr>
<tr>
<td>April 1965</td>
<td>742,000</td>
</tr>
<tr>
<td>May 1965</td>
<td>703,000</td>
</tr>
<tr>
<td>June 1965</td>
<td>702,000</td>
</tr>
</tbody>
</table>

The total pumping for the year July 1964 to June 1965 was 36,724,000 gallons. The maximum week was 1,262,000 gallons and the maximum fortnight 2,104,000 gallons (1,180,000 gallons per week).

**DISCUSSION**

The pattern of withdrawal varies slightly from that expected with the area to the east of Wells Nos. 9 and 10 supplying the majority of the water drawn from storage.

This withdrawal pattern is the result of unexpectedly large variations in the permeability of the aquifer series. It is now apparent that the fresh water existing at points along the northern
boundary of the potable zone derived from fresh recharge at those points while the major flow of fresh water through the basin is concentrated in a part of higher permeability which runs along the line of the potable zone and some 3000 feet to the north of the southern boundary of the zone as marked on Figure 1.

A calculation to determine the rate of flow of fresh water along the higher permeability path has confirmed the 1961 estimate placing the "safe-yield" of the basin at 110,000 gallons per day (770,000 gallons per week).

In line with the recommendation made in 1961 the basin is being pumped at a maximum rate of 1,950,000 gallons per week, the estimate being that this increased rate can be maintained over at least two annual peaks and probably five.

A maximum rate set at 1,950,000 gallons per week does not suggest that the draft will hold at or about this figure throughout the year. Rather, the maximum is set in full knowledge that this will be a peak consumption probably occurring during January-February and that for the greater part of the year the draft will remain close to 75% of the peak which is approximately the safe yield of 770,000 gallons per week. An examination of the pumping figures shows this expectation to be valid.

On a very long term basis the Cabbage Gum basin will behave as a single storage with a free water table in permeable material but since the basin is actually sub-artesian, that is early releases of water are controlled by pressure variations rather than drainage characteristics, then short term of high rate pumping can initiate movement of saline water at points remote from the pumped area. For example, in the zone of higher permeability a period of sixty weeks pumping at a high rate would cause pressure variations and initiate water movement at points in excess of one mile distant from the point of pumping. The movement of the water itself would be much slower and the increase in salinity was being observed at bore 203/102 could be the result of pressure changes during the two week period of high pumping rates at the end of February 1965.

Although the withdrawal of saline water is larger than expected the increase in salinity remains within safe limits and can be expected to stabilize at about the present figures unless considerable increases in draft are permitted. It is by accepting a slow inflow of saline water that the present maximum draft of 1,950,000 gallons per week (130,000 g.p.d.) is sustained and a longer period of observation of the behavior of the saline storage is desirable. From the point of view of the hydrological investigation of the basin these would be an advantage in a small increase in draft.

It is appreciated that any increase in the draft must increase the risk of saline water inflow but provided that the present monitoring of salinity and level changes continues a small increase in draft which would ensure the supply to Tamworth Creek on the present terms for at least another two years and provide useful knowledge on permeability variations over a larger area would not cause any undetected movements of saline water.
Early recognition of saline water movement will allow the position to be retaken by reduction of draft if necessary.

It is possible that an additional extraction point could be established which would draw on the higher level storages of fresh water and at the same time enable greater flexibility in the overall management of the basin.

RECOMMENDATION

It is recommended that the limit of pumping from the Cabbage Tree Basin be 1,500,000 gallons per week, subject to review at mid 1967.

The possibility of establishing an additional extraction point to draw more heavily on the area to the north and east of Bore 201/102 should be investigated.

CONCLUSIONS

The small increase recommended should cover natural expansion of the requirements of the reticulation. The evidence presented shows quite clearly that the basin could not support the requirements of an unrestricted water supply.

(R. E. BRIDGEGATE)
Senior Engineer, Groundwater
GARBAGE GUM BASIN
CENTRAL LONGITUDINAL SECTION
SHOWING REDUCED WATER LEVELS
SECTION A - B

- WATER LEVEL AT SEPTEMBER 1960
- WATER LEVEL AT JULY 1964
- WATER LEVEL AT JULY 1965
* INDICATES PUMPED BORE OR WELL

FIG. 2
GARBAGE GUM BASIN
TRANSVERSE LONGITUDINAL SECTION
SHOWING REDUCED WATER LEVELS
SECTION C - D

WATER LEVEL AT SEPTEMBER 1960
WATER LEVEL AT JULY 1964
WATER LEVEL AT JULY 1965
* INDICATES PUMPED BORE OR WELL

SALINE WATER EXCEEDING 1000 RPM T.D.S.

HEALTH IN FEET ABOVE MSL.

FIG. 3
GABBAGE GUM BASIN
NORTHERN LONGITUDINAL SECTION
SHOWING REDUCED WATER LEVELS
SECTION E-F

- = WATER LEVEL AT SEPTEMBER 1960
-- = WATER LEVEL AT JULY 1964
--- = WATER LEVEL AT JULY 1965

FIG. 4
GABBAGE GUM BASIN
SOUTHERN LONGITUDINAL SECTION
SHOWING REDUCED WATER LEVELS
SECTION G-H

--- WATER LEVEL AT SEPTEMBER 1960
--- WATER LEVEL AT JULY 1964
--- WATER LEVEL AT JULY 1965

BORE 197/95
WELL No 4
BORE MM 2
BORE 210/100

HEIGHT IN FEET ABOVE MEAN SEA LEVEL

FIG. 5