BESWICK WATER SUPPLY

REASSESSMENT OF AVAILABLE DATA

1991

REPORT 31/91

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CONTENTS

1. SUMMARY
2. RECOMMENDATIONS
3. HYDROGEOLOGY
   (i) Geology
   (ii) Aquifer Parameters
   (iii) Groundwater Movement and Recharge
4. WATER DEMAND
   (i) Current Consumption
   (ii) Projected Demand
5. WATER SUPPLY OPERATION
   (i) Water Supply System
   (ii) Borefield Operation and Management

APPENDIX A
Cost Estimates for Recommended Work

LIST OF FIGURES

3.1. BORE LOCATIONS and LOCAL GEOLOGY MAP
3.3.1. WATER LEVEL DATA for BORE 21688
3.3.2. WATER LEVEL DATA for BORE 21689
3.3.3. WATER LEVEL DATA for BORE 20766
3.3.4. WATER LEVEL DATA for BORE 9586
3.3.5. RAINFALL DATA 1983 - 1991

LIST OF TABLES

4.2. WATER DEMAND
5.2. CURRENT BORE STATUS
1. SUMMARY

Beswick Water supply is provided by two bores 21710 and 21711. They are equipped to produce approximately 12.5 L/s and 12.8 L/s with pump settings at 15.5m and 17.6m respectively.

Resource investigation was conducted initially in 1982 resulting in the establishment of the borefield at its current location. A carbonate formation in this area was exposed under tectonic conditions, and subsequently weathered to form a karstic aquifer of high permeability. To the north, the formation has been exposed under presumably natural erosional conditions. Its permeability has only been indicated by the existence of karstic weathering features such as sinkholes on the surface. Economic limitations at the time did not permit comprehensive field investigation to establish the resource's extent and continuity. The assessment was therefore based largely on postulated aquifer extent and continuity, and test pumping which indicated the aquifer to be a viable water supply. It was recommended however, that both bores be restricted to a pumping rate of 5 L/s. This was expected to provide for foreseeable demands as well as standby.

Water level data obtained subsequent to the commissioning of the borefield indicates the sustainable yield of the resource is much less than initially calculated. Extraction has since effectively dewatered the aquifer storage due to the narrow nature of the aquifer and location of the borefield in it. This has resulted in a gradually declining water level.

The water level in bore 21689 provides the best indication of borefield performance and should be monitored to determine whether the system will perform adequately until the end of the 1991 dry season. Enough information should be available by August to enable this prediction to be made. The deepening of the pumping level in the borefield to 30m is recommended as an interim measure to extend the life of the borefield. This option can be effected immediately for bore 21710 whilst a workover of bore 21711 will be required. However, based on current trends, borefield life could only be extended by four to five years at this pumping level.

Further investigation of the resource should be conducted on a regional basis to establish continuity and assess the viability of expanding the borefield to the north.
2. RECOMMENDATIONS

The following work should be considered a matter of priority.

(i) The pump in bore 21710 should be lowered to a maximum depth of 30m.
(ii) Bore 21711 should be deepened and reconstructed to enable a pumping level of 30m to be attained.

The minimum work recommended is that the pump which was dropped in bore 21711 be retrieved to enable the bore to be operated more efficiently. This will also allow the pump setting to be increased slightly in order to extend the operational status of the bore for approximately six months. However, it is expedient that the reconstruction of this bore be conducted at the same time since a drilling rig will be required. A re-test of this bore should then be conducted.

The estimated costs for the above options are tabulated in Appendix A.
(iii) Both bores 21710 and 21711 should be equipped to produce 5 L/s. Only one bore need be operated to meet current average day demands and should be pumped continuously. The other bore should be maintained as a standby unit. This regime will reduce instantaneous drawdown in the pumped bore which is critical at low water levels.
(iv) The borehead of each production bore should be sealed to prevent the ingress of contaminants and bacteriological pollutants.
(v) The monitoring and maintenance of record of community consumption and bore production should be improved. This should commence with the repair or replacement of the existing bulk meter.
(vi) There is a reliability problem with the telemetry system currently installed. This should be examined and/or repaired. The tank overflow problems should consequently be arrested.
(vii) Community consumption should be reduced where possible and efficient and economic practices in water usage engaged.
In the interests of securing long term continuity of water supply.

(i) Further investigation be conducted in the vicinity of the borefield to establish the extent of the aquifer in terms of area and depth. The options available to extend its serviceability can then be assessed. A monitoring bore located at site A (see Figure 3.1) should be drilled in the interim if a drilling rig is available in the area. Based on available data this is most favourable location for a future production bore. The estimated cost of this work is listed in Appendix A.

(ii) Investigation of the postulated resource to the north should be conducted to establish its potential as an option for future water supply augmentation. This area is marked on Figure 3.1. A regional water level monitoring network should be established simultaneously to enable information on its natural behavior to be gained. This will enable a more accurate assessment of its viability and sustainable yield.

The estimated cost to conduct the work recommended in (i) and (ii) above is tabulated in Appendix A.

(iii) The peak water levels in both bores 21688 and 21689 are of a dubious nature and may not be indicative of the aquifer. The possibility of workover to effect an appropriate seal in these bores to ascertain unique water levels should be considered if a drilling rig is engaged in any future work in the area. Monitoring bore 21688 should be also cleaned and reconstructed to total depth.

(iv) The current status of water level monitoring in both the current water supply aquifer and alluvial aquifer underlying the community should be maintained.

(v) All observation bores should be survey levelled.
3. **HYDROGEOLOGY**

(i) Geology

The borefield is situated in an area underlain by the Dook Creek Formation. The lithologies encountered are cherts and dolomitic limestones overlain by shales, siltstones and fine sandstones. (see Fig. 3.1 and Report 8/1983 for a detailed description of lithology) Tectonic disturbance of the area in the form of vertical displacement and rotation has exposed the lower karstic members as a narrow almost vertically dipping strip. Dissolution of the formation enhancing strike orientated fractures and shears resulted in an aquifer of high permeability immediately adjacent to the fault zone. Approximately 600m to the south of the borefield, geological mapping and drilling has indicated the disturbance to these beds have terminated or 'pinched'. Bores in this area indicate the impermeable fine upper units of the Dook Creek Formation are undisturbed to within 50m of the upthrust scarp. Development of permeability in the area to the north has been postulated due to the presence of sinkholes and other karstic features on the surface. Its extent and connection with the borefield has not yet been established.

(ii) Aquifer parameters

Test pumping of the two production bores 21710 and 21711 in 1982 indicated the transmissivity of the aquifer in the immediate area to be in the order of 700m²/d. For the short term, the storage coefficient was calculated to be $2.5 \times 10^{-4}$. However, for long term calculations, the aquifer will behave as unconfined and a value of the order of 2% is likely to be indicative of the specific yield. This value may be more accurately evaluated in the future with comprehensive analysis and modelling using long term borefield performance and accompanying resource monitoring data.

Reinterpretation of the existing data could provide more information as to the existence of boundaries. However, more detailed analysis is not warranted at this stage without confirmation of other information such as aquifer width and thickness, and its continuity or otherwise to the north.
LEGEND

- Geological Boundary
- Fault

Where location of boundaries and faults are approximate, line is broken; when inferred, queried

Dip and Strike

Vertical Strata

Mullaman Beds

Chambers River Formation

Beswick Creek Formation

Dook Creek Formation

Bone Creek Formation

Kombolgie Formation

Postulated Aquifer Extent

Bore and Registered Number

Production Bore and Registered Number

Profile

- Area of Proposed Future Investigation

SITE A Proposed Investigation Bore Site

metres 400 800 1200 metres

FIGURE 3.1

Bore Locations and Local Geology Map
(iii) Groundwater Movement and Recharge

Monitoring of the resource has been conducted since August 1985. The existing water level data thus collated are presented in Figures 3.3.1 to 3.3.4.

The water level decline in both monitored bores 21688 & 21689 (Figures 3.3.1 and 3.3.2) indicates the resource has undergone a dewatering process during its monitoring history. Other bores 9586 & 20766 (Figures 3.3.3 and 3.3.4) situated in the alluvial aquifer underlying the community and not affected by pumping have also been monitored. These have also shown a similar declining water level pattern over the same period which could possibly indicate a poor period of recharge for the region. However, examination of rainfall data for the period 1986 to 1991 (Figure 3.3.5) suggests otherwise.

The unusually prominent responses detected in the above average rainfall years of 1987, 1988 and 1991 (Figures 3.3.1 and 3.3.2) are primarily the effects of a direct recharge event coupled with decreased community water usage (i.e. decreased pumping). However, the magnitude and highly attenuated nature of the peaks in these instances suggest the possibility of other factors corrupting the integrity of the data (e.g. effects of a perched water table). These features are superimposed over a continued recession representing the ongoing dewatering due to pumping and the possible long term natural decline in water levels after the very much above average rainfall (hence recharge) in the 1970's as indicated by data from other areas.

The initial resource assessment in 1982 based the estimate of sustainable yield on the assumption the aquifer was areally extensive to at least that indicated on Figure 3.1, and that the average annual rainfall of 986 mm was 30% effective over this area. A figure of 400 Ml/annum was hence derived as a first order estimate.

Water level data shown in Figures 3.3.1 and 3.3.2, available since this assessment indicates the postulated geological model should be revised. With consideration to this data, the aquifer in the vicinity of the borefield is now postulated to behave as a narrow strip with a truncated end (to the south) and limited throughflow. Given this scenario, first order calculations replicate aquifer response under the current extraction. An upper estimate of yield is represented by a continuous supply equating to less than 5 L/s. Computer modelling would need to be conducted to more accurately establish the sustainable yield. However, a detailed analysis at this stage could not be justified owing to absence of data to establish the natural throughflow gradient, aquifer continuity to the north, and down-dip or even the up-dip flow component.
The information available suggests that the current borefield as constructed is poorly placed to exploit the known resource. The borefield is likely to fail due to its inability to intercept adequate throughflow from the resource to the north. Superficially, this circumstance appears to have been compounded by apparent below average recharge events although rainfall data does not support this. The remedial measure thus recommended is a deepening of bores in the borefield to prolong the life of the existing infrastructure. This option should provide adequate supply for up to four or five years if a pumping level of 30m is achievable.

Further resource investigation needs to be conducted immediately to secure a viable long term water source.
Fig. 3.3.1  WATER LEVEL DATA for BORE 21688

YEAR

S.N.L. (m below T.O.C.)
Fig 3.3.2 WATER LEVEL DATA for BORE 21689
Fig. 3.3.3  WATER LEVEL DATA for BORE 20766
Fig. 3.3.4  WATER LEVEL DATA for BORE 9586
Fig. 3.3.5 RAINFALL DATA (Chambers Creek)
4. WATER DEMAND

(i) Current Consumption

The current community consumption cannot be accurately gauged since records pertaining to general water production and usage are either non-existent or scant. The bulk meter from the elevated tank has been unserviceable since 1988 with a 30 month period of no record prior to this. Existing bore production figures are in conflict with expected water requirements for a community of this size and have not been considered in this exercise.

An estimate of consumption was obtained by using transfer pump data. Some record exists to enable determination of hours of operation, and since it is known these are Southern Cross units capable of about 5 L/s, an average transfer rate (directly equating to consumption) was calculated to be 6 L/s.

Visual inspection of the community has verified that significant lawning and gardening activities have been initiated recently.

(ii) Projected Demand

The community population as determined by the 1986 Northern Territory census was 316 while a figure of 304 was provided by the local council in 1988. The design population figure was 330 for 1991, and the projected population is 380 for 1996.

Table 4.2 below represents total community water demands based on a design average day demand (ADD) per capita of 1.2 KL, and peak day demand (PDD) per capita of 1.8 KL.

<table>
<thead>
<tr>
<th>Year</th>
<th>ADD (KL)</th>
<th>PDD (KL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>396 (4.5 L/s)</td>
<td>594 (5.9 L/s)</td>
</tr>
<tr>
<td>1996</td>
<td>456 (5.3 L/s)</td>
<td>684 (7.9 L/s)</td>
</tr>
</tbody>
</table>
5. WATER SUPPLY OPERATION

(i) Water Supply System

Water is pumped approximately 4 Kms from the borefield via a 150mm NB pvc pipeline to either a 200 KL or a 100 KL ground level tank. Two transfer pumps are available to feed a 25 KL elevated tank. There is a telemetry system in place which enables either one or two bores to be activated once a predetermined level has been reached in one of the ground level tanks. There is a problem with reliability in this system and often the bores are operated manually. Furthermore, overflow of the tanks will occur when the rising level has not been monitored.

(ii) Borefield Operation and Management

The water supply is provided by two bores 21710 and 21711. They are situated approximately 3.8 Km to the east. Bore 21711 was first commissioned in April 1986 to augment the existing supply provided by three bores which were in proximity to the community. Production figures indicate that this bore was probably only used as standby during at least the first year of operation. The second bore was commissioned some time after this, although records indicate it was equipped in October 1985.

The current status of each bore is summarised in Table 5.2. The bores are each equipped with Southern Cross PDJ helical rotor pumps.

<table>
<thead>
<tr>
<th>Bore RN</th>
<th>Curr. Pumping Rate (L/s)</th>
<th>Curr. Rec. Rate (m)</th>
<th>Rec. Pumping Rate (L/s)</th>
<th>Rec. Revised Rate (m)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>21710</td>
<td>12.5</td>
<td>15.5</td>
<td>5</td>
<td>15</td>
<td>Pump worn, used mainly as standby</td>
</tr>
<tr>
<td></td>
<td>(max)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21711</td>
<td>12.8</td>
<td>17.6</td>
<td>5</td>
<td>15</td>
<td>Old pump stuck @ 17.6m</td>
</tr>
<tr>
<td></td>
<td>(max)</td>
<td></td>
<td></td>
<td></td>
<td>New pump and column</td>
</tr>
</tbody>
</table>

TABLE 5.2. CURRENT BORE STATUS
The current operating policy requires both bores to operate for approximately equal periods. This strategy is employed to develop even wear characteristics in the pumps in both installations. This may be acceptable where bores are similar in performance. However, in this instance the performance in bore 21711 is currently hindered by the presence of a pump which has been dropped in the bore. The inefficiency caused by this results in its forking towards the end of the dry season. This pump should be removed to reinstate this bore to its original performance level.

The long term implication of maintaining this borefield at its current status is that bore failure as a result of declining water levels is expected. The short term remedial option to enable the borefield's continued operation is to increase the current pump setting in bore 21710 to a maximum of 30m, and to deepen and reconstruct bore 21711 to cater as a standby unit.

Since the community requirement is in excess of the sustainable yield of the borefield, an alternative resource should be sought and exploited to augment current supply and meet projected demand.
APPENDIX A

Cost Estimates for Recommended Work

The estimated costs associated with the work options presented below are 'order of cost' figures only and should be revised to obtain a firm quote once a work proposal has been developed.

$ 000's

(i) Attempt to retrieve pump from bore 21711 only
   New screens
   Re-test bore

   4.9
   1.8
   5.1

*(ii) Deepen and reconstruct 21711 (assuming successful pump retrieval)
    Re-test bore

   13.8
   5.1

**(iii) Construct new bore as replacement or addition to 21711 (assuming failure to retrieve pump from 21711)
    Test bore

   17.5
   5.1

(iv) Construct investigation/monitoring bore at site A

   9.4

(v) Resource investigation including geophysics, drilling test pumping and project management

   213.2

* Due to the proximity of this bore to bore 21710 it is advised that bore 21710 not be operated for the duration of the workover and an alternative supply be sought. The possibility of a temporary recommissioning of the former water supply bores should be investigated.

** A replacement bore for bore 21711 should be located as close as practical to it to enable cost effective integration into the existing infrastructure.

An additional bore constructed to exploit the aquifer to a similar depth as the existing borefield should be placed at a distance of no less than 1000m. Closer placement of bores would be possible if it is proven that the aquifer is extensive at depth.