POWER AND WATER AUTHORITY

GUL GUL AND MARIAH OUTSTATIONS

PRELIMINARY WATER RESOURCE ASSESSMENT

REPORT 33/1990

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Hydrology Branch
Water Resources Division
Darwin
July 1990
In July 1990 a preliminary water resource assessment was carried out for two outstations on the Coburg Peninsula for the Northern Territory Conservation Commission. The two outstations are Gul Gul, which is near Danger Point and Mariah, which lies on the western shore-line of Raffles Bay.

The hydrogeological settings which exist at both the outstations are not dissimilar to other outstations and developments on the peninsula. Potable water supplies should exist in shallow fresh water lenses which overlie brackish water which exists under most of the peninsula.

In order to successfully develop a potable water supply from these fresh water lenses it is recommended that infiltration galleries be installed at both sites. It is also recommended that the first consideration would be to conduct small geophysical surveys at each site in order to delineate the fresh water lenses and locate the most favourable position within the lenses to place the galleries.

A cost estimate for Water Resources to carry out the geophysical survey and design a suitable infiltration gallery is $2500.00 per site.
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</tr>
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<td>mm</td>
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</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
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</tr>
<tr>
<td>%</td>
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<tr>
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<tr>
<td>kL</td>
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Introduction
1. INTRODUCTION

At the request of the Northern Territory Conservation Commission a preliminary study for potable water supplies for two outstations within the Gurig National Park on the Coburg Peninsula has been completed. The two outstations, Gul Gul and Mariah are located on the peninsula immediately to the east of Smith Point. Gul Gul is to the north near Danger Point and Mariah is on the western shore-line of Raffles Bay. Refer Figure 1, for location map.

The preliminary study involved a short site visit and a desk top study, mainly based on previous work on Coburg Peninsula. The site visits were conducted by a groundwater engineer from Water Resources and a ranger from the Conservation Commission. Travel to the outstations was via an air charter to Smith Point and then by vehicle from the rangers station to the outstations.

Gul Gul outstation, which has previously been populated, has existing a dilapidated cabin, two Southern Cross water tanks in unknown operating condition (one at ground level and the other on an elevated tank stand) and the remains of a solar installation which was used to power a pump drawing water from a sand spear located in a soak 50-100 m behind the cabin.

The exact future location of Mariah outstation had not been determined at the time of the site visit, however the approximate stretch of coastline where the Conservation Commission thought the outstation would be located was inspected. Because no track existed into the area a four kilometre traverse through thick under-growth from the Danger Point track was required to reach the coast.

Whilst at the sites, a general reconnaissance of the area was conducted. The objective was to compare the hydrogeological settings of the two sites with those of other coastal water supplies on the peninsula. Limited levelling traverses were done in order to determine ground and water surface elevations with respect to the mean sea level. Water conductivities and samples were taken and collected from any significant water body.
Hydrogeology
2. HYDROGEOLOGY

Coburg Peninsula is comprised of sediments of the Bathurst Island Formation. This Cretaceous aged formation consists of sandstone, siltstone and mudstone, calcareous and laterised in part.

Chemical weathering, erosion and infill of the Cretaceous sediments has resulted in the Peninsula being a laterised plateau surrounded by beaches, dunal areas and swamps. The laterised sediments on the peninsula reach 40 m above sea level in places and slope down to below sea level reappearing as rocky reefs.

Bordering and overlying the laterite are areas of beaches and sand dune systems. These active geomorphological systems are constantly being moulded by wind and sea action with the most noticeable effect of this being the advancing of the beaches seaward. Behind the advancing shore-line a “sandy limestone” type rock is often found which was formed through the cementing of sand and shell.

Previous groundwater resource investigations on Coburg Peninsula ("Smith Point Groundwater Resource Evaluation 1988-1989") have identified reserves of freshwater stored in "freshwater lenses" in both the laterised sediments and coastal sand dunes and sandy limestone. Although it is estimated that there is a greater yield potential available from the aquifers developed in the laterite, these resources have not been utilised to date due to higher costs associated with developing the resource. Consequently, localised freshwater lenses within coastal sand dune systems have been the source of freshwater for developments on the Peninsula to date.

Rainfall on the peninsula has been estimated in the report by R Britten and D Chin, Reference 2, based on data from Croker Island and Cape Don. This data indicates that the average annual rainfall on the peninsula is 1250 mm. The lowest annual
total from 50 years of record from Cape Don is 860 mm. The significance of annual rainfall is the reliance of freshwater lenses on recharge. The mechanism of rainfall and infiltration is the only source of recharge to these freshwater lens systems in the coastal sand dunes.

The quality of the water from freshwater lenses in coastal sand dune systems varies with depth. From drilling and water sampling of coastal dune aquifer systems on Coburg Peninsula the water from such systems has pH approximately 7.4, TDS between 100 and 300 mg/L and hardness of the order of 150 mg/L. The relatively high hardness is predominantly carbonate or temporary hardness derived from the carbonate and bicarbonate from coral and shell remnants in the dunal sands.
2.1 Gul Gul

Gul Gul outstation is located on a flat sandy plain behind a large sand dune system. The following photos taken during the site visit show the extent of the sand dune system from the outstation looking north-east (Plate 1), the height of the main coastal sand dune looking north-east along the beach (Plate 2), the cabin and two water tanks from the south-west side (Plate 3) and the remains of the solar installation with the soak in the background (Plate 4).

The development of the sand dune system is very much similar to the sand dunes at Smith Point. The distance from the outstation to the laterite plateau (4 to 5 kms) excludes the development of that resource. It would seem highly likely however that a freshwater lens of some size would exist within the sand dune sediments. The deposit of sand is extensive but limiting the size of the lens is the small elevation above sea level and the close proximity of a large saline estuary inland of the sand dune system.

The existing soak at Gul Gul from which previous water was supplied is thought to be a surface expression of a freshwater lens and is indicative of the water table of the lens at this site. A surface water sample taken from the soak was analysed in the laboratory. The result of the analysis was that the water was fresh (TDS 260 mg/L and NaCl (cal. from chloride) 18 mg/L) with high hardness. The hardness is predominantly carbonate or temporary hardness derived from carbonate and bicarbonate taken into solution from the coral and shell remnants in the dunal sands. This is in contrast to saline waters which have high hardness due to non-carbonate hardness derived from calcium and magnesium chloride.

From the topographical cross-section shown in Figure 2, levelled whilst on site, the water table is approximately 1.50 m above the local mean sea level. This indicates that the theoretical depth of the freshwater lens is of the order of 60 m (from Ghyben-Herzberg Concept). Whilst this may seem to be a very large store of freshwater the usable store of water is only that above the local mean sea level. This is because the
Ghyben-Herzberg Concept states that due to the relative densities of fresh and salt water, every unit of freshwater above the sea level requires 40 units of freshwater below the sea level. Therefore if the level of the freshwater lens is lowered by 1 m the freshwater/saltwater interface will rise by 40 m and once the lens level reaches the sea level the lens will no longer exist.

The sustainable yield of this system, as mentioned earlier, is totally dependent on annual recharge from rainfall. An initial estimate of the sustainable yield of this system can be made based on an annual rainfall of 860 mm, 25% infiltration and an area of 200 000 m² (200 m x 1000 m). The total volume of water recharged to the system in a year would be 43 000 m³ and if extracted over 365 days would equate to a rate of 120 kL/day.

2.2 Mariah

The area of coast-line on which Mariah outstation is to be located (in the area of D'Urville Point) is shown in Plates 5 to 8. The first shows the view looking south (Plate 5) and the second looking north (Plate 6). Inland of the coastal dune to the north is a small grassed sandy clearing (Plate 7). Immediately behind the grassed clearing is a small freshwater swamp (conductivity 250 us/cm) supporting large paper-bark trees (Plate 8). Laterite extends down to the coast, and in places outcrops as rocky reefs and rocky points. The laterite plateau country supports medium density timber and undergrowth with the treeline stretching down to the beaches.

Aquifer development is likely to have occurred within both the laterite plateau and the sediments of the sand dunes and sandy clearing. Approximately 200 m from the coast, near the swamp, a small 1.5 m deep cave-in was found. The water level in the cave-in was about 1.0 m below ground level and the strata consisted of tan sandy clay and cream and white poorly cemented sand and shell. It is thought that the cave-in is a window to the water table of a freshwater lens within the sand dunes and sandy limestone clearing. The topographic cross section shown in Figure 3 shows the water table relative to the sea level.
At the time of levelling the tide was rising and it was estimated to be on the high side of the local mean sea level. So although the levelling indicated that the water table was only 0.025 m above the sea level, the difference when the water table is compared to the local mean sea level is of the order of 1.0 to 1.5 m. This would indicate a freshwater lens of theoretical depth between 40 to 60 m (from Ghyben-Herzberg Concept). As with Gul Gul though, the drawdown of the lens water level should be limited to 0.5 to 1.0 m in order to prevent the upconing of brackish water.

The sustainable yield of the system, again reliant on annual rainfall, based on 860 mm annual rainfall, 25% recharge and an area of 100 000 m$^2$ (200 m x 500 m), would be 21 500 m$^3$ per year. This equates to an extraction rate of 60 kL/day.

A freshwater lens within the laterite plateau is probable. Significant stores of freshwater have been estimated to exist in laterite lenses on the Smith Point peninsula (Britten and Chin 1989, Reference 2) and it would be expected that similar stores of freshwater would exist in the laterised sediments adjacent to the coast here as well. Further geophysics and drilling would be required to establish this.
Demand
3. DEMAND

The envisaged domestic water demands at each of the outstations are based on proposed development for Coburg outstations as outlined in a Ministerial Memorandum dated 12 December 1988 (Reference 5). In this memorandum the future Aboriginal housing needs, as investigated by the Department of Lands and Housing, of the two outstations are as follows:-

Gul Gul - Two cabins. Population 15


Based on these estimates of population in the future and a daily per capita domestic consumption rate of 1.2 kL, Gul Gul outstation would require 18 kL/day and Mariah outstation 30 kL/day. For a continuously pumped supply this equates to a maximum instantaneous rate of 0.21 L/s for Gul Gul and 0.35 L/s for Mariah. However if solar installations are utilised the pumping time is reduced to approximately six hours per day which equates to maximum instantaneous pumping rates of 0.8 L/s for Gul Gul and 1.4 L/s for Mariah.
Development Options
4. DEVELOPMENT OPTIONS

4.1 Gul Gul

Potable groundwater supply development options are very limited for this area. The only significant store of freshwater would be in the freshwater lens developed within the coastal sand dunes and sandy plains. Initial estimates of the size of the resource indicate that it can sustain a development of this size (sustainable yield 120 kL/day > daily demand 18 kL/day).

Development of a resource of this nature is critically reliant on the nature of extraction and annual recharge. Annual recharge is required to replenish the resource after extraction so as to maintain the volume of freshwater to preserve the lens. The nature of extraction is important to avoid the local upconing of brackish water rendering the supply unpotable. The ideal method of extraction from a freshwater lens is many small extraction points spread over a large area to reduce the drawdown at any single point. Shallow bores in this situation, being point extractions, are not the most effective means of extraction. If drilled too deep they will induce brackish water and if over pumped they will induce brackish water.

Infiltration galleries are a more effective means to extract water from freshwater lenses. Essentially an infiltration gallery is a "horizontal bore". A certain length of screen is laid down horizontally a specified depth below the water table with a collector sump at one end. Water then draining into the screens is skimmed from the top of the lens and pumped out of the sump. Advantages of the gallery are that with the screens at a specified depth the water table cannot be drawn down below this level thus providing a safeguard against inducing upconing due to over pumping. Also the horizontal screen provides a far greater area over which the water is extracted which reduces the drawdown at any single point, minimising the chances of local upconing of brackish water.
Before installation of the gallery it is recommended that a geophysical investigation be conducted. This would involve the use of electromagnetic instruments in order to delineate the freshwater lens and to determine the optimum position of the gallery within the lens.

Design of the gallery itself involves the selection of the size of the screen (diameter and slot size) and the length of the screen. Screen slots are sized according to the size distribution of the natural material (i.e., sand grain size and distribution) as determined from a sieve analysis of a sample of the natural material. Length of screen is dependent on the slot size and the required extraction rate.

Installation of the infiltration gallery involves the digging of a trench, placement of the gallery and backfilling of the trench.

As with the infiltration gallery installed at Araru Point on Coburg Peninsula, Water Resources Branch of PAWA can be contracted to design and locate the gallery. Installation of the gallery at Araru Point was undertaken by Conservation Commission staff.

Other water supply options besides a groundwater supply are also limited. A surface water extraction system could be set up from the soak behind the cabin. However, its small depth would limit extraction after low recharge years, not making it very reliable and it would also be susceptible to bacteriological and biological contamination.

Desalinisation equipment is available to remove salt from brackish water. A previous report by R Britten, Reference 1, has in Appendix B, information concerning some of the latest technology in this area. This technology may become more applicable if the extent of the freshwater lens does not exist as suggested above.

A rainwater tank would be an obvious supplement to any of the water supply options mentioned above.
4.2 Mariah

There are two options available for the development of a groundwater supply for Mariah outstation. The first is the development of the freshwater lens within the sediments of the sand dunes and sandy limestone clearing. The sustainable yield of this system (60 kL/day) is adequate to supply the daily requirement of the outstation (30 kL/day). Development of this lense would be the same as that for the lense at Gul Gul. All details pertaining to freshwater lenses and infiltration galleries mentioned in the previous sub-section are relevant here.

The other groundwater supply option would be to develop a freshwater lens within the laterised sediments adjacent to the coast. Drilling would be required to substantiate the existence of a freshwater lens. If identified the lens would be more than able to sustain any development for the outstation due to the areal extent of such a system. This option is a far more expensive option than the first due to the need for drilling and extra reticulation to the point of use. It would only be justified if option one fails for some reason or there is a large increase in the demand of the development.

As with Gul Gul there are no suitable surface water sources available to supply a reliable and potable water supply.

The desalinisation option is also available but requires more investigation in terms of applicability and economics.

Again a rainwater tank would be an obvious supplement to any of the water supply options mentioned.
Summary and Recommendations
5. SUMMARY AND RECOMMENDATIONS

The Coburg Peninsula is comprised of sediments of the Cretaceous aged Bathurst Island Formation. Chemical weathering, erosion and infill of the formations sandstone, siltstone and mudstone has resulted in the Peninsula being a laterised plateau surrounded by beaches, dunal areas and swamps. Previous studies on the Peninsula have identified groundwater resources within the laterised sediments and, more importantly, within the sediments of the coastal sand dunes and sandy limestone plains. To date all development on the Peninsula has relied on water from freshwater lenses within the local coastal sediments.

Preliminary field visits and a desk top study have identified the hydrogeological settings of Gul Gul and Mariah outstation to be similar to other known groundwater source areas. It is therefore considered likely that freshwater lenses exist within the local coastal sediments at both outstation sites to provide potable water for the outstations. A sample of the natural aquifer material would also be required in order to successfully design the infiltration gallery.

It is recommended that infiltration galleries be installed to extract water from the freshwater lenses at both sites. A geophysical investigation would be required at each site prior to installation to determine the optimum positions of the galleries. A sample of the natural aquifer material would also be required in order to successfully design the infiltration gallery.

Although there is likely to be potable water within the laterised sediments adjacent to the coast at Mariah outstation, because the supply required is only small the most cost effective option is to develop the aquifer within the local coastal sediments.

Desalinisation plants are not recommended at this stage of supply development of each site. Further study is required as to the long term applicability of such plant in these
situations, however initial studies would indicate the high initial outlay and advanced technology in a remote area to be significant detracting factors for their use.

Rainwater tanks catching the runoff from the cabin roofs should be installed to supplement the groundwater supply.

Water Resources would be available on a consulting basis to design and locate the infiltration galleries, as has been done for the gallery at Araru Point. The cost to do such work would be $2500 per site (see Appendix A).
References
6. REFERENCES


5. POWER AND WATER AUTHORITY - Internal File Number 468/02/0013 - "Water Supply Investigation - Smith Point". Folios 74 and 75.
Appendix A

Cost Estimate for Design and Locating of Infiltration Galleries
APPENDIX A

Cost Estimate For Design and Locating of Infiltration Galleries

Gul Gul

Geophysical Survey .................................... $1800.00
Gallery Design .................................... $ 700.00

$2500.00

Mariah

Geophysical Survey .................................... $1800.00
Gallery Design .................................... $ 700.00

$2500.00
Appendix B

Infiltration Gallery Araru Point
DETAIL A: CROSS SECTION OF INFILTRATION GALLERY

NOTE 1: All dimensions in millimetres

NOTE 2: Not to scale

POWER and WATER AUTHORITY

TITLE: INFILTRATION GALLERY

ARARU POINT

DRAWN BY: DNC

SCALE: 1:20

DATE: 10/03/89