

Searching for Water on Christmas Island

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Abstract

A hundred years of searching for underground water supplies for the settlement and mine operations on Christmas Island has involved digging wells, drilling, cave exploration and geophysics. Water has been extracted from wells, drill holes, springs and caves. The main production at present is from a set of cave streams on the plateau.

Introduction

Although it has a high rainfall, Christmas Island lacks permanent surface water. Nearly all rainfall goes quickly underground to join a karst drainage system. Thus the search for water supplies has been entirely for underground sources, and has included extensive cave exploration.

Early sources

Water for the 1891 Clunies Ross settlement on Christmas Island was first obtained from wells excavated at the base of the cliff behind Flying Fish Cove, and extracted by steam pumps at about 1000 litres/minute (l/m). Later the supply to the mining settlement at South Point was operating in 1916 from the Grants Well shaft and cave stream in the centre of the island. The Ross Hill Gardens springs were developed in the late 1920s as a dry season supplement to Grants Well.

As water requirements grew, water for the Settlement was initially pumped overland from the Waterfall springs via the Phosphate Hill workers quarters, and then a new pipeline laid around the shore terrace to the Settlement in 1934.

Concern by the Christmas Island Phosphate Company about large dry season flow variations in the main Grants Well source led to the first known scientific water investigations on the island, a program of ground electrical resistivity measurements, by M.S. Crosbie in 1941. Interim reports indicate that he believed that he had located subsurface water, but both Crosbie and his records disappeared in Singapore in 1941 during the Japanese occupation.

Post-war developments and cave exploration

After transfer of the mine to the British Phosphate Commissioners (BPC) in 1949, a Mr Dulfer was commissioned to carry out resistivity surveys at Grants Well, South Point and Phosphate Hill. Dulfer confirmed Crosbie's findings, and although it is believed that some drill testing for water was done, no confirmatory results have been located. Later test bores near Grants Well bottomed on basalt at 24 m, a depth closely matching Crosbie's and Dulfer's "water tables".

A power cable and electric pump were installed in Runaway Cave in the late 1950s or early 1960s, but pumping of the initially fresh water led to salt water contamination, and it was abandoned. The cable and switch board still remain.

From the mid 1950s to the early 1960s cave and sinkhole exploration continued, as described by Paul Meek elsewhere in this volume. In December 1962 resident speleologists David Powell, Ray Bishop and Les Smith located and named Jedda Cave to the south-west of Grants Well. This important new source gave a flow of 1700 l/m from an underground stream running on basalt at the base of the limestone. Jedda Cave, when developed and connected to the water distribution network, provided a reliable addition to the supplies for the increasing demands of a growing population. An additional flow came from nearby Jane-Up sinkhole. Several more were located in caves along the northern coastline, but these were technically too difficult or expensive to exploit.

A proposal for a phosphate washing plant convinced the BPC in 1966 to drill twenty seven test holes in the Central, South Point and Phosphate Hill areas, but only minor freshwater traces were found.

Australian Government exploration

In 1958 Christmas Island became an Australian Territory. Technical assistance was subsequently obtained from the Bureau of Mineral Resources, Geology and Geophysics (BMR) in Canberra, and under their guidance BPC staff carried out extensive ground magnetic and electrical resistivity profiling throughout 1967 and 1968. BMR geophysicists selected five drill sites at Drumsite, all of which proved to be dry. Of a further thirteen drill holes in the Central Area, two yielded minor water, but one, Water Bore 30, produced 3000 to 5000 l/m after development. However this technical success was short lived when, in late 1969 a new flow developed at the base of Jane-Up was confirmed as the same underground stream that supplied Water Bore 30. Pumping from one site was competing with the other. Regardless of source, this additional 1200 to 1500 l/m was an important factor in allowing establishment of the South Point phosphate washing plant.

Christmas Island: Searching for Water

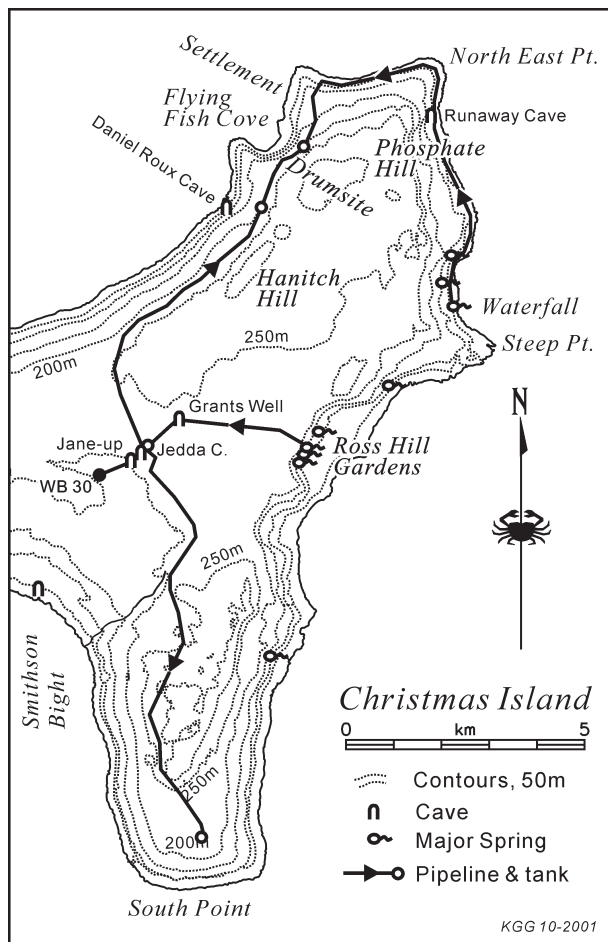


Figure 1: Water sources and pipelines

In the late 1960s, pumping from Ross Hill Gardens ceased, and the (mostly superannuated) pump station attendants were relocated.

Still with BMR guidance, a dry hole was drilled behind Ross Hill Gardens in late 1969, and a program of regular water flow and level measurements was carried out at all known sources until 1974, then intermittently until 1979.

More BMR magnetic and resistivity surveys in 1970/71 were the basis for targeting of seven holes above the Golf Course at Phosphate Hill in an unsuccessful attempt to trace the source of the Waterfall Springs. Further south, seven more holes then profiled the top of the subsurface basalt between Hanitch Hill and Ross Hill Gardens. Returning to the area of the “successful” Water Bore 30, thirteen holes encountered water, but although the field was systematically developed only 380 l/m was confirmed as a reliable wet season supplement.

A party from the BMR Engineering Geology Group led by Dr Ed Polak visited the island early in 1973 and conducted magnetic, resistivity, gravity and seismic surveys with more sensitive instruments in conjunction with the drilling of six stratigraphic calibration bores in the vicinity of Water Bore 30. This work, which provided information on the profile of the island’s

volcanic core, the configuration of major volcanic dyke systems and the distribution of potentially water bearing caves and cavities in the cap limestone, was published as BMR Record 1976/100.

From 1973 to 1976 consistently high rainfall and a high groundwater availability from all sources precluded the need for exploration.

Dr. Polak’s group returned in 1976 to extend previous surveys, but apart from a stratigraphic bore at Ross Hill Gardens and an unsuccessful attempt to develop Water Bore 66 at Grants Well, the only other water program was the resumption of collection and pumping of water from Ross Hill gardens to Grants Well.

Attention then turned to the reliable but difficult to access 1500 l/m flow in Daniel Roux Cave below the Drumsite dryers complex where, after detailed engineering and feasibility work, the project was abandoned after a rock fall in the cave in 1978.

Later exploration

Plans by the Phosphate Mining Company of Christmas Island Ltd. (PMCI) to expand the phosphate washing plant led to an investigation and report from WLP Consultants in 1982 recommending construction of a dam at Ross Hill Gardens to collect and store runoff from the springs there plus surplus flows from Grants Well – Jedda Cave, but this proposal did not proceed.

In 1985 P. Barrett, for PMCI, drilled seven small diameter water exploration holes on the lower terrace at Smithsons Bight, all of which intersected a fresh water lens above saline water and yielded between 110 and 170 l/m. Six similar holes drilled into basalt at Ross Hill Gardens found no significant flows.

By 1985 plans for the expanded phosphate washing plant were abandoned, and the existing plant closed



Figure 2: A captured spring at Ross Hill Gardens. (photo by K. Grimes)

down when mining ceased in 1989. Since resumption of mining in 1991, phosphate production has mainly been “B-grade” material for the Asian market.

The Present Situation

With the cessation of mining in 1989 the Commonwealth Government, through the local Administration, assumed responsibility for supply of water to the island community, and this activity is now the responsibility of local government.

Up to that time, the search for water on this limestone-capped seamount had continued for almost 100 years and utilized methods ranging from investigation and excavation of sinkholes and underground caves, through drilling and setting of bore casing up to 400mm diameter, to advanced geophysics.

However, in 1990 the Grants Well – Jedda cave system was still the mainstay of Christmas Island’s water supply, but has been supplimented by the more recently-developed source at Daniel Roux Cave.

In the last decade, a network of piezometers has been installed to monitor groundwater levels and especially water quality given the potential for human contamination of the underground systems.

The conclusions from this lengthy and expensive program are that there are no significant perched water tables or confined aquifers on Christmas island, only seasonally charged underground streams flowing in limestone cave systems on or above a basalt floor, together with a fresh water density separation lens within the limestone at favourable locations at or near sea level around the margins of the island.

The proposed Christmas Island spaceport, if it proceeds, will need large quantities of water for each launch, and the 200 or so additional staff will also require domestic supplies.

Somehow, I doubt that the search for water on the island is over yet!

