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VILLAGE WATER SUPPLY INVESTIGATIONS, TERRITORY OF PAPUA AND NEW GUINEA, 1966

by

J.P. MacGregor and J.R.L. Read

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PREFACE

This paper was written for two purposes:

1. For submission for publication in "Engineering Geology", a quarterly journal published by the Elvesier Publishing Company, Amsterdam.

2. For presentation at the Groundwater School, conducted for the Australian Water Resources Council in Adelaide, May 1967.

Fuller accounts of the water supply surveys of the Milne Bay and East and West Sepik Districts appear as MacGregor (1966) and Read (1967). Only a few copies of Read's report have been issued in the Bureau Records Series because of their bulk. The report may be inspected at the Bureau of Mineral Resources, Canberra, or the Geological Office, Department of Lands, Surveys and Mines, Port Moresby.

SUMMARY

The Territory of Papua and New Guinea has water supply problems despite its relatively high rainfall. The population lives mostly in villages and obtains its drinking water from streams and wells that are subject to pollution and drought. In order to improve the standard of water supplies the Administration has set up a Village Water Supply Survey Team to review the present position District by District and make recommendations for the development of water supplies. The organisation of the Survey Team and the types of schemes considered are illustrated by reference to surveys which have been carried out in the Milne Bay and East and West Sepik Districts.

Any village water supply scheme recommended must be cheap to install and maintain and should provide an adequate supply of fresh water which cannot readily be polluted. Deep drilling is too expensive to provide a solution at this stage of development. It has been found that supplies of fresh water can be obtained in, or near, most villages and settlements by sinking a protected well or by tapping a sandy aquifer by a spear. Water from surface streams can be gravitated to a village in appropriate situations provided bacteriological contamination can be avoided. Where suitable ground water cannot be located an artificial rainwater catchment and storage is generally the best alternative.

The paper is presented because the problem of adequate, safe and cheap village water supplies has to be faced in many developing countries, and the approach adopted in Papua-New Guinea may be applicable elsewhere.

INTRODUCTION

The Territory of Papua and New Guinea comprises the eastern part of the mainland of New Guinea and the islands of the Bismarck Archipelago (Fig. 1). The Territory lies between Longitudes 141°E and 156°E and Latitudes 1°S and 10°S; the land area is 183,000 square miles. The population of 2,183,036 (Census 1966) mostly lives in small village communities spread throughout the Territory.

Administratively the Territory is divided into 18 Districts each of which is divided into several Sub-Districts. The Department of District Administration supervises the development of the rural areas through District Commissioners and their various assistants. The detailed improvement of the village amenities is the responsibility of the Local Government Councils which consist of elected representatives of the villages in the Council area. Council revenue is obtained from locally collected taxes.

This paper describes the method which is being used by the professional departments of the Administration to review and advise government field officers and Local Council officials on the improvement of village water supplies. The method may be of use to other developing countries.

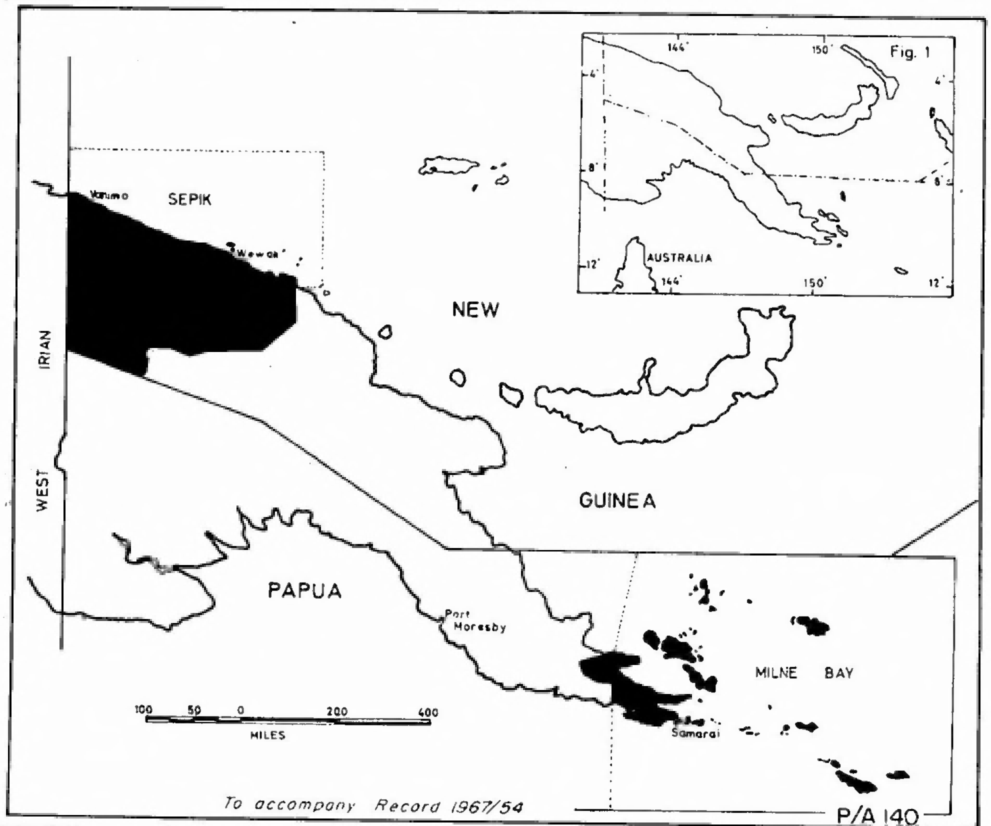


Fig. 1: Territory of Papua and New Guinea. Locality Map.

PHYSIOGRAPHY AND GENERAL GEOLOGY

The mainland of New Guinea consists of a central mountain chain trending approximately south-east and reaching an elevation of over 15,000 feet, flanked on the north and south by low-lying country and lesser mountain ranges. The northern ranges rise to 12,000 feet. The chain is composed of a core of metamorphic rocks, with large plutonic intrusions, overlain by a deeply eroded cover of folded marine sedimentary rocks and associated basic igneous rocks, deposited during the Mesozoic and Tertiary. The uplift of the mountain chain began in Pliocene time and was associated during the Pleistocene with widespread explosive volcanic activity.

In western Papua, south of the central mountain ranges, a wide, flat, low-lying plain, covered largely by swamps, is composed of poorly consolidated piedmont material and volcanic detritus, deposited largely during late Pleistocene times.

North of the central ranges, in New Guinea, are the roughly coaxial Sepik and Ramu-Markham Depressions, which are elongate, troughlike areas containing piedmont deposits and river alluvium.

North of the Sepik River, the coastal ranges are composed of a core of metamorphic and plutonic igneous rocks overlain by a cover of folded marine Tertiary sedimentary rocks and associated basic igneous rocks. North of the Ramu and Markham Rivers the basement rocks are not exposed.

Pre-Tertiary metamorphic and igneous basement rocks which crop out extensively in the mountain ranges of the island of New Britain, where they are overlain by Tertiary and Quaternary sedimentary and igneous rocks, have not been recorded from other islands off the coasts of Papua-New Guinea.

Widespread, extensive coral reef and shoal development took place in Pleistocene and Recent times. Continued instability has resulted in the emergence of some areas, exposing wide coral terraces and forming large and small coral limestone islands, and the submergence of other areas where extensive coastal alluvial deposits have built up.

Volcanic activity has continued to the present day, but is now confined largely to two areas, one of which includes the off-shore islands north of the New Guinea mainland and the volcanoes along the north coast of New Britain, and the second which extends north-westward from the British Solomon Islands Protectorate through Bougainville and New Ireland. There are four active volcanoes on the mainland of New Guinea. In these areas recent volcanic deposits are widespread, consisting largely of pyroclastic rocks with lava flows close to the cones.

EXISTING VILLAGE WATER SUPPLIES

The rainfall in the Territory varies from about 40 inches a year near Port Moresby to about 300 inches a year in parts of the central ranges of Papua-New Guinea and the islands. About 80% of the land area receives an average annual rainfall of over 110 inches. However, the rainfall variation is great and depends on the topographical and meteorological situation. The south-east trade winds prevail from May to October and the north-west monsoon from December to March. Over most of the Territory the south-east season corresponds to the dry period of the year, and some areas have several months with very small falls of rain. For example, in 1965, the Port Moresby area received about 2 inches of rain between the beginning of May and the end of November.

The most common sources of village water supplies are rivers and streams. In the Territory there are numerous rivers, both large and small, which, especially in the low-lying areas, are liable to pollution. Near the coast the rivers are tidal and the water is brackish for some distance inland.

Where there are no convenient rivers, water supplies are obtained from surface water found in swamps, soaks and springs. These often dry up in periods of drought and the villagers have to fetch water from alternative sources, often at a distance of several miles. For some small islands, the nearest dependable water supply may be on another island and during the south-east trades - the dry season - the strong wind makes a canoe journey across open water a perilous task.

As most of the village houses are constructed of bush materials (Plates 1A and 1B) roofs do not provide a suitable rainwater catchement. However, with the introduction of galvanized iron roofs the collection of rainwater for drinking and cooking has become more widespread. Storage is normally in 44-gallon drums, but occasionally 1000-gallon galvanized iron tanks have been installed. The Local Government Council buildings are nearly always constructed with iron roofs and tank storage.

In some of the coastal villages shallow open wells have been dug in the sand (Plate 2A). These wells are commonly badly sited, with little protection against bactereological pollution, although some are cased with steel drums and covered with a wooden lid.

In a few of the larger villages relatively sophisticated water supply systems have been installed using a well, windmill, tank storage and pipe reticulation to water points in the village. The Department of Public Works and the Department of Public Health have designed a standard sanitary shallow well (Plate 2B), and it is intended to install these in as many villages as possible provided a suitable source of water is available. Several villages in Papua and New Guinea obtain their water from bores equipped with hand pumps which supply good quality drinking water. Where topographic conditions are suitable small gravity water supply schemes have been built and one or two hydraulic rams are in operation. A recent development has been the introduction of solar distillation on offshore islands which have no alternative source of water.

DISTRICT VILLAGE WATER SUPPLY SURVEYS

Several government departments are actively engaged in water supply development. The Australian Commonwealth Department of Works is engaged in the investigation and construction of water supplies for towns and institutions; the Territory's Department of Public Works is concerned with large scale water investigations but, in addition, through the Local Government Engineer and his staff, provides advice and supervision on the construction of village water supply projects. The Department of Public Health subsidises village water supply schemes and also, through Health Inspectors and Medical Assistants, gives advice and guidance on the construction and protection of village water supplies. The Mines Division of the Department of Lands, Surveys and Mines has two drilling rigs which are almost exclusively used for village water supply investigations. Through its field officers, the Department of District Administration carries out the bulk of the supervision of minor water improvement schemes.

The Engineering Geology Unit of the Resident Geological Section (which is staffed at professional level by geologists seconded from the Bureau of Mineral Resources, Canberra, and attached to the Department of Lands, Survey and Mines, Port Moresby) provides advice on the geological aspects of water supply investigations. This normally involves on-site inspection and advice on possible aquifer properties and depth, the mechanical analysis of sand samples for selection of screen sizes, and the testing of the chemical quality of the water in conjunction with the laboratory of the Department of Agriculture, Stock and Fisheries.

With the development of the Territory, the Local Government Councils have had more funds available for the construction of improved water supplies, but in most cases do not have the necessary knowledge of the geological and engineering problems connected with the work to use the money to best advantage. During 1964 and 1965 an increasing number of requests from Councils and villages for advice on water supply problems were received by the various Administration departments. The cost of a visit to an individual village is not normally in proportion to the benefit gained, and it was decided that the best way to deal with the numerous requests was to establish a Village Water Supply Survey Team which would cover each District in turn. The team, consisting of an engineering geologist, an engineer and a health official, is designed to cover all aspects and types of water supply and to recommend to Councils a development programme which will enable them to plan their expenditure for some years ahead. It is not practicable for the team to visit every village in a District but itineraries are arranged to include examples of all known problems; the team is accompanied by an officer of the local District Administration staff, who can subsequently apply procedures recommended to other villages with a similar water supply problem.

It was agreed that, if the initial survey should prove successful, at least two Districts would be covered each year; further, all requests would be handled by the Department of District Administration which would allocate priorities so that areas with the greatest need would obtain preferential treatment.

The first survey was carried out in the Milne Bay District of Papua in March-April 1966 (MacGregor, 1966), and the second, covering the East and West Sepik Districts of New Guinea, was completed in October-November, 1966 (Read, 1967). In 1967 it is hoped to cover the Gulf and Western Districts of Papua.

Organisation of Surveys

The detailed programme and organisation of transport for the Milne Bay and Sepik Districts surveys were arranged by the District Commissioners of the respective Districts. In the Milne Bay District most of the villages are located along the mainland coast or on islands and, except in the Trobriand Islands where the villages can be visited by Landrover, an Administration trawler and speed-boat were used to travel from place to place. In the Sepik District the survey team travelled by light aircraft, landrover, power canoe, trawler, speed-boat and shallow-draft jet-propelled boat.

Before each survey was started details of the location, population, rainfall and present water supply of each village to be visited were collected by officers of the Department of District Administration and forwarded to the Geological Office in Port Moresby.

On arrival in each village the existing water supply was first inspected. In coastal areas and on islands the salinity of the water was tested with a portable conductivity meter. If the location and quality of the existing supply proved suitable recommendations for the improvement and protection of the supply against pollution were prepared. If the supply proved to be unsuitable a survey of the area around the village was carried out to locate a site for a better supply. In some cases an auger hole was sunk to determine the depth to groundwater. If a surface scheme was proposed, preliminary engineering measurements were made in order to estimate quantities of materials and costs. To assist in the future identification of sites selected photographs were taken which included recognisible features and either the Local Government Councillor or a well-known villager, who would remember the site.

Details of the existing supplies and recommendations for improvement, which include lists of material and estimated costs, were prepared as soon as possible after leaving each village. The report (an example of which is given in Appendix 1) was given to the Assistant District Commissioner for each Sub-District and copies were sent to the Local Government Council and the District Commissioner. At the end of the surveys the original copies of the recommendations, specifications and photographs were duplicated and bound into volumes which were distributed, together with a written report summarizing all aspects of each survey, to all bodies concerned with the surveys.

Types of schemes

Although expenditure on water supply development in the Territory is subsidized by the Department of Public Health, the gross income of the Local Government Councils is low and must be divided to cover the various requirements of the community. Therefore, where alternatives are possible, the main factor in determining what type of scheme should be used in a village water supply has been the cost which the Council must bear.

Seven types of schemes have been considered for village water supplies in the Milne Bay and Sepik Districts. They are: dug wells, rainwater catchments, drilled bores, supply pumped from storage, gravity supply from streams or surface storage, hydraulic rams from streams, and solar distillation plants.

In places where the water table is not more than 25 feet below the surface, dug wells or, in sandy aquifers, spear points, provide the cheapest and most satisfactory way of providing a good water supply. The wells can be dug by local labour, lined with concrete pipes constructed in moulds owned by the Local Government Council, sealed with a cover and fitted with a hand pump (Plate 2B). A recent development in the Territory has been the introduction of fibreglass liners in place of concrete pipes. The liners have the advantage of being light and easy to handle and can provide a considerable saving in cost in areas where airfreight charges are high.

Rainwater catchments can be used in those areas where there is no good or readily available supply of groundwater. The catchment consists of a polythene sheet, erected on a wooden framework and draining into a storage tank. The greatest difficulty is in providing adequate storage to supply the needs of the population in times of drought. For instance, a village of 150 people consuming one gallon per day per person requires a storage of 10,000 gallons to cover a 70-day drought. Types of storage at present available are galvanized iron tanks of capacity ranging from 1000 to 5000 gallons and steel 'squatter' tanks which have a minimum capacity of 2000 gallons. Recent additions still under development include fibreglass tanks, manufactured in sizes of either 1000 or 2000 gallon capacity, polythene tanks of 10,000 gallon capacity and concrete tanks which can be constructed on the site in capacities ranging up to 40,000 gallons.

In places where the groundwater is below 25 feet an alternative to rainwater catchment and storage is a bore drilled by percussion rig. For village water supplies it is considered that a 4-inch diameter hole fitted with a deep well hand pump would be sufficient. However, the difficulty of shifting the rig to the site emphasises the need for good access. This is rare in either the Sepik or Milne Bay Districts and few places were found where the combination of deep groundwater, good access and the need for several bores in the same area warranted a recommendation for drilling.

The use of a pumped supply from storage involves the use of a mechanical pump operated by an engine or a windmill. The capital expense of these items combined with the difficulty of maintenance in outlying areas makes such a scheme impracticable in most cases.

By building a small dam across a perennial stream a permanent supply of water can be provided cheaply for a nearby village. The construction of a storage sufficient to last through the dry season would be very expensive; the one to two feet high dam acts merely as a collecting point. For villages near moderately large streams this type of scheme was recommended. A major difficulty is the prevention of pollution.

The use of a hydraulic ram instead of an engine-driven pump eliminates running costs and reduces maintenance but, for the ram to work, it is necessary to have a nearby stream with a constant flow and a steep gradient to provide power for the ram. No suitable areas were found in any of the three Districts.

The use of solar distillation plants has been considered and an experimental unit has been set up near Port Moresby. However, at this stage of their development, it is considered that the cost of installation and maintenance is excessive for the yield obtained, and further development will be awaited before any decision is made as to their general use.

MILNE BAY DISTRICT

The Milne Bay District covers the eastern extremity of the mainland of Papua and the adjacent offshore islands including the D'Entrecasteaux Islands, the Trobriand Islands, Woodlark Island and the islands of the Calvados Chain (Fig. 2). The average annual rainfall varies within the district from less than 60 inches to over 200 inches; most of the rain falls during the north-west monsoon. Almost all the population of over 100,000 live in coastal villages and obtain their water supply from small streams and open wells. In several villages small galvanized iron catchments with 1000-gallon storage tanks have been erected but these are not capable of supplying the village needs through the dry season. Several attempts have been made to construct small gravity schemes but none was working when visited.

Throughout the survey an attempt was made to keep the water quality of the recommended supply within a limit of 1000 parts per million (ppm) of dissolved salts. It was found that in many cases present village supplies were extremely salty; water with a salinity as high as 7000 ppm was being used for drinking. In such cases the water is often mixed with rainwater or coconut juice to improve its quality. On some islands it is unlikely that the salt content of the best available groundwater is much lower than 2000 ppm but this water would be preferable to the extremely saline water being used at present.

It had been hoped that a portable kit for determining the bacteriological content of the water could be obtained but this was not available and recommendations had to be based on a rough assessment of the pollution risk in the area.

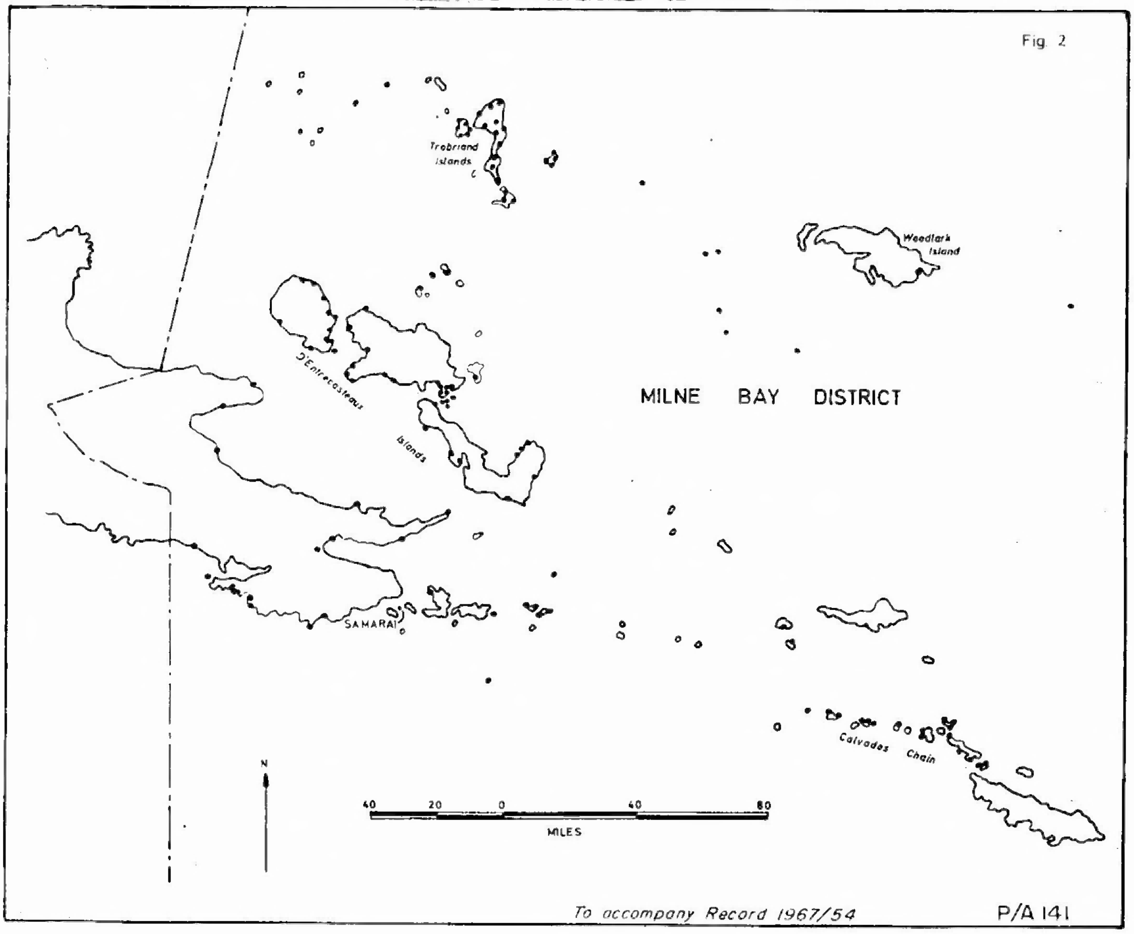


Fig. 2. Milne Bay District showing locations of villages visited.

The villages in the Milne Bay District can be divided into four groups: villages on the Papuan mainland; villages on the larger offshore islands; villages on the smaller islands composed of volcanic and metamorphic rocks; and villages on coral islands.

The villages on the mainland are built either on coastal plains composed of silt, sand and gravel or on sand bars at the base of volcanic and metamorphic hills. Natural catchments are large and little difficulty was found in locating groundwater at shallow depths close to the villages.

On the larger islands underlain by volcanic and metamorphic rocks, villages are built on coastal plains of gravel and pumice. Good water can be obtained from both formations, but care had to be taken in some locations to avoid pollution from nearby hot springs. In some areas the villages consist of groups of small hamlets, each of a few houses, built on narrow coastal shelves and obtaining their water supplies from small streams that flow swiftly from the mountains in the centre of the island. The chances of pollution are few and in many cases recommendations were restricted to the construction of wells and simple gravity schemes in areas of possible future development, such as Council Headquarters and schools.

The smaller volcanic and metamorphic islands are relatively high and well-wooded, with one or two villages on each island. Water is obtained from soaks and springs at the base of the hills (Plate 2A). The construction of properly protected shallow wells and one or two gravity schemes will adequately provide for the village requirements.

Many of the islands, especially in the Trobriand and Woodlark island areas, are composed of a raised coral reef (Plate 1A). The villages are built on reef material which may range from only a few feet to several hundred feet above sea level. Water supplies are almost exclusively from caves and springs close to the shore. Owing to the high permeability of the coral formation, the groundwater level is almost everywhere close to sea level, and mostly the water is salty. On the lower islands, where sand bars overlie the coral, shallow wells should provide a reasonably economic supply of water of moderate quality. However, on the higher islands it may be several hundred feet to the water table and the water may be too salty to use. Percussion drilling was recommended where there was a likelihood of obtaining fresh water within 80 feet of the surface and where access was good. Where the conditions were not satisfactory water of good quality would best be supplied by adequate rainwater catchment and storage.

SEPIK DISTRICT

The inhabitants of the Sepik District (Fig. 3) have traditionally relied on rivers, streams, swamps and open soaks for water supply. These are extremely vulnerable to pollution and the quantity of water commonly decreases markedly in the dry season. The dry season varies from place to place but generally occurs between May and October. The driest regions are along the coasts and in the Sepik River plains; average rainfall in these areas is about 80 inches, most of which falls in the wet season. In the coastal and inland ranges, and along the West Irian Border, average rainfall ranges from 100 to 250 inches. In general, where the average rainfall is high, the rainfall is more evenly spread through the year. Some attention was paid to the catchment and storage of rainwater from the roofs of European style buildings, but as such buildings are largely confined to the District and Sub-District headquarters, Patrol Posts, Missions and Schools, this source of water is not generally available to the villages.

Problems encountered by the survey team can be divided on a regional basis into five types requiring, in general, one of two types of improvement. In villages located on the coast or on the coastal plain, on offshore islands and on river banks, dug wells were recommended. In villages situated along the crests of high ridges artificial rainwater catchments were recommended, and in those villages in inland plains and alluvial valleys recommendations were made for either dug wells or artifical rainwater catchment.

Few real problems of water supply were encountered on the coast or on the coastal plain. In this environment the groundwater table is high and conditions are ideal for the development of water supply from dug wells or, where the aquifer consists of beach or dune sand, spear points. In these areas water supply problems have been experienced in the past because reliance was placed on supplies of surface water which may or may not persist throughout the five-months dry season.

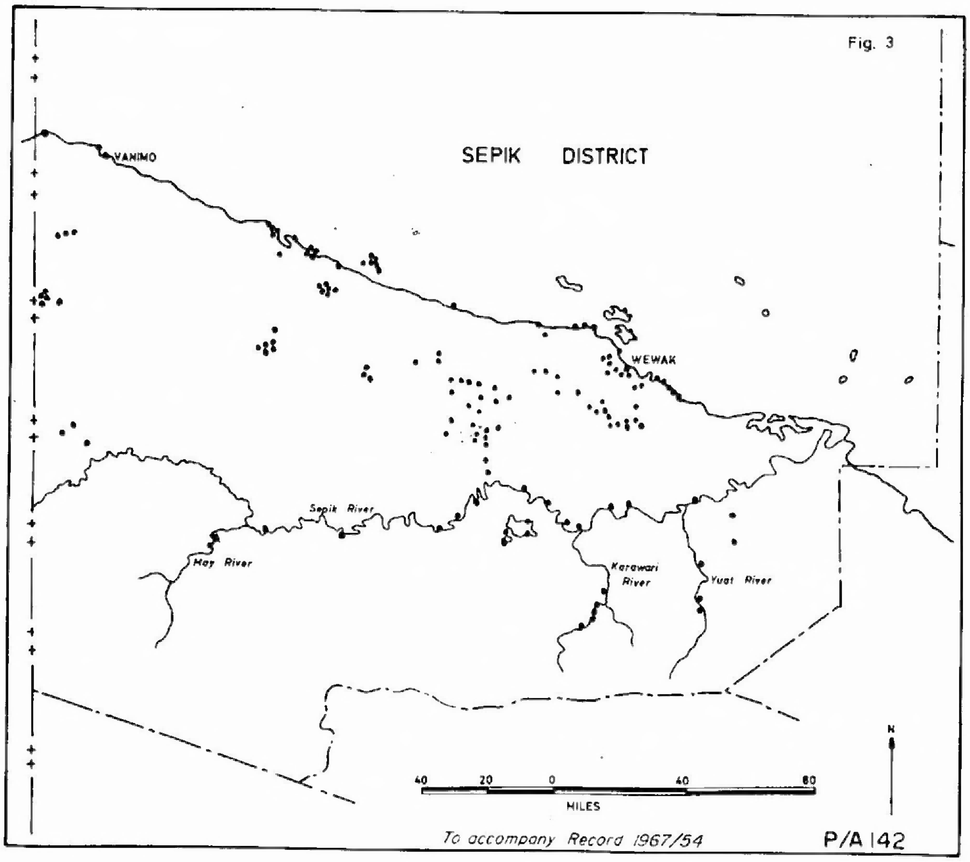


Fig. 3. Sepik District showing locations of villages visited.

With the exception of one island, which is of volcanic origin and provided with water from a permanent lake in the extinct volcanic crater, the islands visited are coralline and have a good supply of potable water close to the surface. Saltwater contamination was detected in one instance only, where much of the village is flooded at high tide. It is not expected that the demands made on this type of supply will disturb the freshwater-seawater balance to an extent which could lead to saltwater pollution of the wells recommended.

Numerous villages are located along the banks of the Sepik River and its tributaries. The river banks consist of sandy silt, support a high water table and provide good aquifers. However, two problems were found which required slight modifications to the standard design for a dug well. In the first case, flood levels during the wet season required that the well top and fittings should be extended above maximum flood level; an appropriate design was made using fibreglass. In the second case, the low cohesion of the aquifer when unsupported lead to caving of the walls of the well around the base of the liner; this could result in collapse where the liners were made of concrete. The use of light fibreglass liners, supported above ground, provided a type of casing which should hang from the ground support and not tilt or collapse in the event of caving within the aquifer.

Villages located along the tops of ridges (Plate 1B) are the most difficult to provide with an adequate water supply. The areas most affected are along the inland margins of the coastal ranges between Wewak and Vanimo and in the hilly areas along the West Irian Border. Villages in these locations draw their water supply from ridge-side soaks, which normally dry up in the dry season, and small, perennial streams flowing round the base of the ridges. Not only do the soaks dry up after prolonged periods without rain, but they are open to pollution. The permanent streams are always a considerable distance from the village, and the water table beneath the villages is deep. The drilling of deep bores is impracticable because access is poor; the only solution was to recommend artificial rainwater catchments and storage tanks.

Villages in the inland plains and alluvial valleys include many along the West Irian Border, and between the Sepik River and the inland margins of the coastal ranges. In alluvial valleys there is commonly a high water table in swampy ground which characteristically supports a dense vegetation of sago palms and associated flora. Aquifers consist of beds of sand and gravel which occur sporadically through the predominantly finer-grained alluvial deposits. Conditions are most suitable for the development of dug wells (Plate 2B). The inland plains have a low relief and everywhere slope toward the Sepik River. On the higher ground, away from the river, the drainage channels are well incised and the groundwater table is correspondingly low; it is therefore difficult to locate wells except where the villages are located close to natural drainage features. These areas could be well served by drilled bores but again poor access makes this solution impracticable. Therefore, where suitable well sites could not be located, rainwater catchment and storage systems were recommended. Closer to the river, the groundwater table is sufficiently close to the surface to make practical the siting of dug wells.

CONCLUSIONS

During the surveys of the Milne Bay and East and West Sepik Districts, the Village Water Supply Survey Team visited some 280 places and prepared a summary and recommendation for each location. As a result of the surveys several points emerged:

(1) The survey is a useful method of examining the regional problems of water supply, and of recommending solutions to specific problems.

(2) Present village water supplies are generally inadequate. They are open to pollution, thus providing a health hazard and, despite a relatively high rainfall, many supplies dry up in the dry season.

(3) Local Government Council income is low and the deciding factor in the type of scheme chosen must be the cost which will fall on the Council.

(4) On most coral islands, coastal areas, and inland basins groundwater can be found at shallow depth and an adequate supply of drinking water can be obtained by sinking a properly protected shallow well, or spear point.

(5) Shallow aquifers consist of coral, beach or dune sand and Recent silty and sandy alluvium.

(6) Deep drilling for village groundwater supplies is not economic unless there is satisfactory access and little chance of an alternative supply.

(7) Where the groundwater is too deep to be developed, as on high coral islands and at villages on ridge-tops, the rainfall is normally sufficient to provide an adequate supply of drinking water, provided sufficient catchment and storage is constructed.

(8) A cheap, sturdy, long-lasting catchment and storage system is needed before this method of water supply will be economically feasible for the smaller, more isolated villages.

(9) Where a perennial stream is located close to a village it is often possible to construct a simple gravity supply.

ACKNOWLEDGEMENTS

Permission to present this paper has been received from the Director, Bureau of Mineral Resources, Geology and Geophysics, Canberra and from the Director, Department of Lands, Surveys and Mines, Port Moresby.

REFERENCES

BUREAU OF STATISTICS, TERRITORY OF PAPUA AND NEW GUINEA, 1966 - Population of Papua and New Guinea. Census of Papua and New Guinea 1966. Prelim. Bull. 19 (unpubl.).

MACGREGOR, J.P., 1966 - Village water supply survey Milne Bay District. Territory of Papua and New Guinea. Resident Geological Section. Note on investigation 65424 (unpubl.). Also issued, without detailed recommendations, as Bur. Min. Resour. Aust. Rec. 1966/180.

READ, J.R.L., 1967 - East and West Sepik Districts water supply survey. Territory of Papua and New Guinea, Resident Geological Section. Note on Investigation 66405 (unpubl.). Also issued as Bur. Min. Resour. Aust. Rec. 1967/ .

APPENDIX 1

Specimen report on village water supplies -

Waramin Village, East Sepik District

TERRITORY OF PAPUA & NEW GUINEA

SURVEY OF VILLAGE WATER SUPPLIES ....EAST SEPIK........DISTRICT

VILLAGE ....WARAMIN....

COUNCIL ....Wewak But....

CENSUS DIVISION ....Wewak But....

SUB-DISTRICT ....Wewak....

POPULATION ....200....

ACCESS ..Road. 2 miles from Wewak

....

COUNCILLOR ....Kumasi....

....

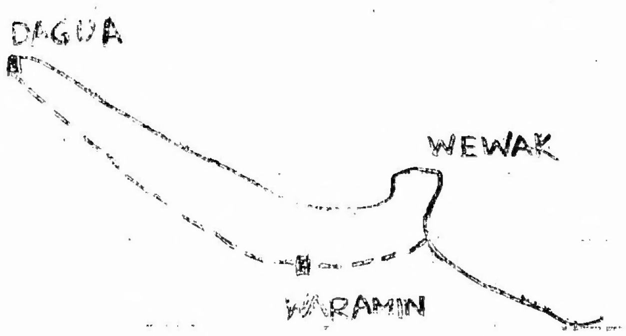
WATER USE - Domestic/Government School/Mission/Mission School/Hospital/First Aid/Stock/Irrigation

PROJECTED DEVELOPMENT ....

....

ESTIMATED DEMAND ....

LOCATION MAP



PRESENT SUPPLY

RAINFALL....88"....

WET SEASON From ....Nov.... to ....April....

TYPE ....Small stream....

DISTANCE FROM VILLAGE ....Central....

TRANSPORT ....Road....

YIELD/RATE OF FLOW..............

QUALITY - Chemical ....

Bacteriological....Polluted....

PROTECTION ....None....

REMARKS ....

....

....

....

DRY SEASON From ....May....to....Oct....

TYPE ....As above....

DISTANCE FROM VILLAGE ....

TRANSPORT ....

YIELD/RATE OF FLOW ....

QUALITY ....Chemical......

Bacteriological......

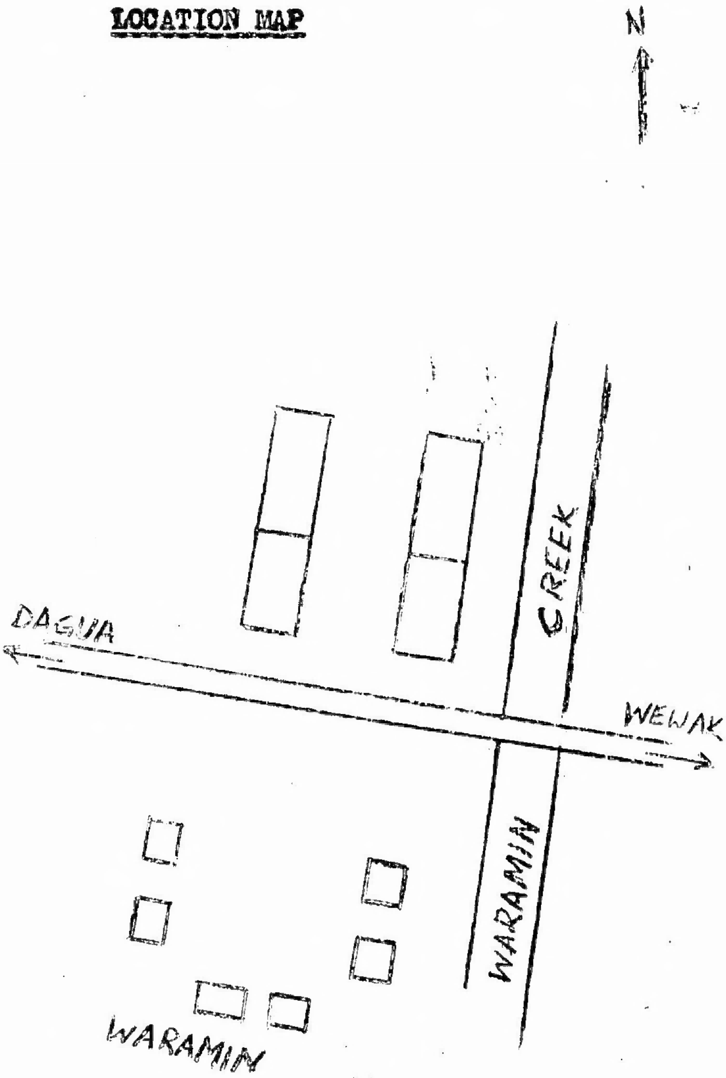
PROTECTION ....

REMARKS ....

....

....

LOCATION MAP



G.S. Form 6
(Rev. 22/8/66)

TERRITORY OF PAPUA & NEW GUINEA

SURVEY OF VILLAGE WATER SUPPLIES ....EAST SEPIK...............DISTRICT

VILLAGE ....WARAMIN............ **RECOMMENDATIONS**

TYPE OF RECOMMENDED SCHEME - Pumped/Gravity/Well/Bore/Hydraulic Ram/Rainwater Catchment

LOCATION OF NEW SUPPLY ....Village central, 50 feet south of main road....

....

DISTANCE FROM VILLAGE ....Central.................................

ACCESS ....Road..

SITE KNOWN TO ....Kumasi..

TYPE OF AQUIFER ....Medium - fine grained sand....................

DETAILS OF SCHEME ...Standard sanitary well. Top pipe to stand 3 feet above ground level to avoid contamination during local flooding and well to be 3 feet deep.......................................

....

MATERIALS REQUIRED ....As per standard drawing.............................

....

LABOUR REQUIRED ....As per standard drawing.............................

SUPERVISION .....Local...

ESTIMATED COST ($) .100...

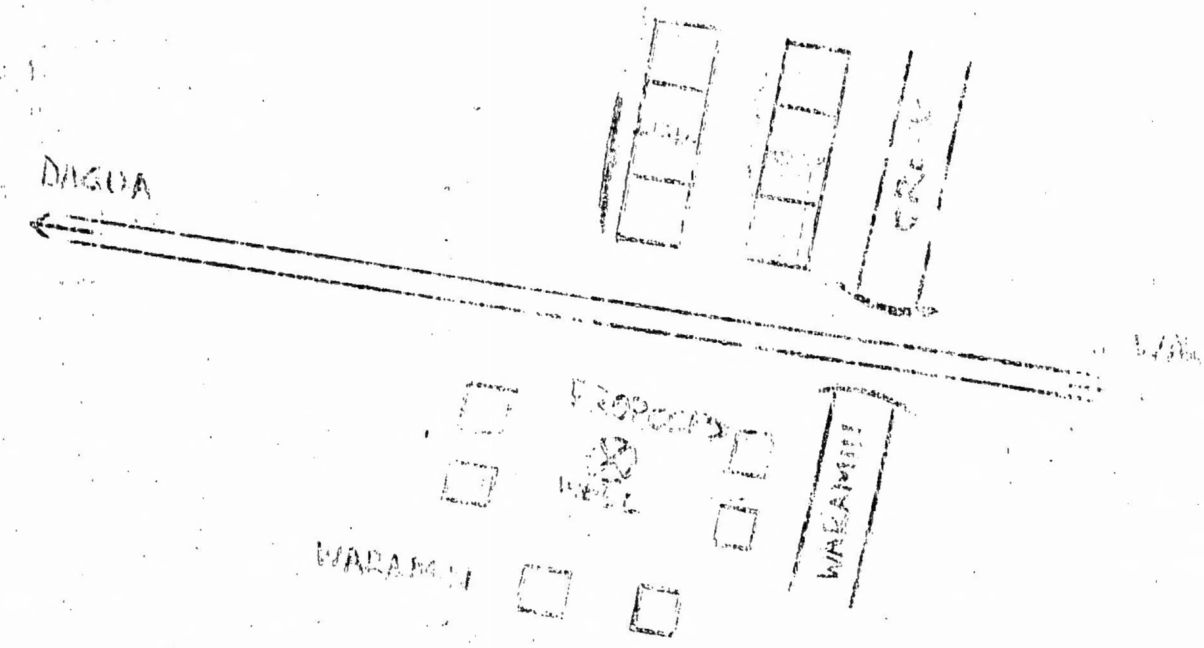
ALTERNATIVE SCHEME ....-.......................................

....

PRIORITY ....Moderate..........Signed ...J.R.L. Read..........Date 2/10/66..

LOCATION MAP

Film 1, photos 9 & 10



G.S. Form 7

Plate 1A. EBANAHINA, Milne Bay District - a typical island village.

Plate 1B. DUMAN, East Sepik District - a typical ridge-top village.

Plate 2A. Waterhole at YAUVITAN village, Milne Bay District.

Plate 2B. Standard Sanitary Well at IDOLI village, West Sepik District. The cement cover for the well has been removed for inspection.