



**REPORT OF VISIT TO EBEYE, KWAJALEIN
MARSHALL ISLANDS**

22 – 24 October 2001

October 2001

SOPAC Preliminary Report 134

TABLE OF CONTENTS

1.	PURPOSE OF VISIT	3
2.	FINDINGS.....	3
3.	FOLLOW UP	12
APPENDIX 1:	TRAVEL ITINERARY	13
APPENDIX 2:	CONTACTS.....	14
APPENDIX 3:	REFERENCES.....	15
APPENDIX 4:	MAP OF KWAJALEIN ATOLL AND EBeye.....	16

1. PURPOSE OF VISIT

Generally there has been next to no sanitation initiatives undertaken on the outer islands of the Marshall Islands by SOPAC's Water Resources Unit to date. This trip eventuated through a request put forward by the Marshall Islands Environmental Protection Agency based in Majuro (RMIEPA) indicating a need for assistance to residents of Ebeye, which is part of Kwajalein Atoll through their EPA Office on Ebeye.

Following on from this, Ebeye was visited by two members of the Water Resources Unit from 22 – 24 October 2001 to follow up on Task Profile MH 2000.004 Sanitation Assistance to Outer Islands. The task refers to the identification of sanitation problems in outer islands and assistance in improved development and awareness of the sanitation sector.

The main purpose of the trip was to identify:

- Current wastewater disposal methods in Ebeye
- On-going sanitation initiatives and projects
- Stakeholders in the sanitation sector
- The administration structures related to sanitation projects
- Avenues for SOPAC support

2. FINDINGS

2.1 General

Ebeye Island in Kwajalein Atoll is the second most populated island in the Republic of the Marshall Islands with 9,345 persons on a land area of 0.12 miles² (population density: 78,000 persons/mile²). (Beatty, 2001)

Kwajalein Island, 4 miles south of Ebeye, is leased to the United States military and is home to an extensive installation and military facilities established in 1951. Kwajalein is off limits for unofficial visitors except as a transit point to neighbouring Ebeye. In contrast, less than 2000 persons, consisting of US military personnel and contractors, are residing on Kwajalein Island (Patterson, 1986).



Figure 1: US Military base on Kwajalein Island

Over 1300 Marshallese labourers work on Kwajalein Island and live on Ebeye supporting relatives and friends. Average household sizes on Ebeye are extremely high and showed an increase from 9.8 in 1988 up to 12.5 persons per family in 1993 .



Figure 2: "North Camp" military caravans virtually on the Ebeye dumpsite

When the US military relocated Kwajalein's original inhabitants to Ebeye, the military constructed "Army Units" for their accommodation. As Ebeye's population grew residents added rooms to these units resulting in an overcrowded urban area existing of one-room shacks and lean-tos of plywood, tin and plastic sheeting. As a result of the high population density and limited availability of resources in addition to limited water supply and inadequate solid and sewage waste disposal, the occurrence of water-borne diseases became common. (Beatty, 2001)



Figure 3: Children playing on Ebeye rubbish dump

In early December 2000 a cholera outbreak was detected on Ebeye in the period between 1 December 2000 and 5 January 2001, resulting in 103 patients with symptomatic cholera infection of which 6 patients died. A cholera task force was established and the US Centre for Disease Control and Prevention (CDC) undertook a mission in January 2001 to determine the extent of the outbreak and to identify risk factors on Ebeye for cholera. The situation has since been under control but the sanitation facilities and practices on Ebeye remain poor and new outbreaks of water related diseases like cholera are likely to occur as *V. cholerae* 01 can survive in the environment indefinitely, and the threat of another outbreak still remains. (Beatty, 2001).

2.2 Ebeye Environmental Protection Agency

A visit was paid to Mr Harrington Dribo representative of Ebeye EPA. The visit made clear that the office in Ebeye is in urgent need of assistance. Financial as well as human resources are lacking to fulfil the mandate requirements of an environmental protection agency. The secretary assistant Ms Anta James had been on sick leave for the past several months and it was unknown when she would return.

The water quality monitoring programme of the EPA is hampered by insufficient funds to adequately maintain the equipment and perform laboratory analysis. A previous programme was in place in which pH, chloride, nitrate and coliform were tested but none of these parameters can currently be determined.

No supplies were available for chloride and nitrate analysis. Sample bottles were lacking and agents for the available HACH kits expired in 1989. The pH meter and sterilizer (Autoclave) have been broken for some time so sample bottles when available and other equipment cannot be properly sterilised. Leakage in the office is damaging documents and clean running water is not supplied through the taps (water is brought to the office in bottles). A request for appropriate training and additional assistance were expressed by the Ebeye EPA office (as was offered through previous valuable support provided by Barbara Barber, an in-country consultant for UNDP in the early 1990's).

Currently the whole monitoring programme is dormant and without substantial financial support, additional personnel and adequate training, the office cannot fulfil its role as an environmental protection agency.

After the cholera outbreak, water on Ebeye was sampled from three different locations of the Saltwater Reverse Osmosis desalination unit (groundwater well intake, after desalination at the unit, after chlorine treatment) by Mr Risen Tarbillin and Mr Komi Kintaro from RMIEPA Majuro 22nd -26th September 2001 (Bungitak, 2001).

Analysis of the samples showed that the quality of the water provided by the desalination unit was free from coliform bacteria. Coastal water samples taken at six sites in the lagoon of Ebeye and Quijique all showed a positive occurrence of pathogenic organisms. This resulted in all sites being considered not suitable for recreational activities (swimming and fishing). The results of the analysis are shown in Table 1.1 and Table 1.2.

Table 1.1 – Results RO Water Supply Tests.

Date	24/09/2001			25/09/2001			26/09/2001	
Ebeye SWRO unit	well	before treatment	after treatment	well	before treatment	after treatment	Before treatment	After treatment
pH	8.15	6.76	7.05	7.62	6.73	6.61	8.41	6.79
Oxygen (mg/l)	2.93	4.32	5.66	2.44	4.49	4.69	3.6	4.3
Oxygen (%)	37.4	58.5	76.9	38.4	47.6	64.0	49.9	59.7
Conductivity (mS/cm)	54900	1480	1200	64750	1360	1200	1670	1140
Salinity (ppt)	33.7	0.6	0.5	33.4	0.6	0.5	0.6	0.5
Total dissolved solids (mg/l)	650	540	580			540	560	510
Chlorine residual (mg/l)	0.0	0.0	0.6	0.0	0.0	0.5	0.0	1.0

Table 1.2 – Result of Coastal Water Tests.

Sites	Test Result
North Dump	P
Quijique	P
Peace Park	P
Central Ebeye Lagoon	P

P – Pathogenic Organisms present.

In October 2000 a database was developed by SOPAC for the Marshall Islands Environmental Protection Agency based in Majuro (RMIEPA). The database was designed to store water quality data and could potentially be used by the Ebeye EPA. The database allows storage of the following parameters: Conductivity; Turbidity; pH; Residual Chlorine; Total Coliform; Faecal Coliform; Nitrates; Total Hardness; Total Dissolved Solids.

Training is needed on Ebeye to set up a sampling, analysis and monitoring programme and use can be made of the database developed for RMIEPA provided that a desktop computer is made available.

2.3 Water supply, wastewater disposal and sanitation

Water supply

Municipal water supply through desalination

The water sources available to Ebeye residents are piped water on Kwajalein, municipal water from a multi-effect distillation desalinization unit (MED), commercial bottled water, rainwater and water from shallow wells. The term “barrel water” is used for water stored in the same vessel consisting of a mixture of rainwater harvested from roof catchments and municipal water (Barber, 1994).

The previous municipal water supply, which came from the (MED) unit produced about 180,000 gallons of freshwater a day (see figure 4 below) and constantly experienced malfunctions.

Water for the municipal system from the desalination units used to be supplemented by water collected on a 0.44 acre (1.8 ha) dilapidated and poorly maintained catchment basin at the southern tip of the island. The catchment basin is currently not used as an additional supply and is suffering from leakage.

According to a Water and Sanitation Survey in 1988 up to 93 % of the households received municipal water (OPS 1988) whereas recent reports suggest only 70 %. (Beatty, 2001)

Water flow is intermittent in the municipal system and residents fill barrels and cisterns with municipal water for later use. Weekly testing by Kwajalein Hospital Laboratory has demonstrated coliform contamination at several locations in the distribution system, which can be attributed to illegal connections and the attachment of private water pumps to household lines (Beatty, 2001).

This situation changed with the construction of the new hospital on Ebeye over the last 5 years funded through a loan from the Asian Development Bank (ADB). The deadline for the completion of the hospital was meant to be early in 2002, although at the time of this visit it did not seem as if this would be accomplished. Due to the construction of the new hospital, a reliable water and power supply needed to be guaranteed and the American Samoa Power Authority (ASPA) was contracted to provide technical assistance to the Kwajalein Atoll Joint Utilities Resources (KAJUR). ASPA is now assisting in upgrading Ebeye's electricity, water supply and reticulated saltwater sewage system. A large team from ASPA, partly based in Ebeye, has been assisting KAJUR for the past year including Messrs Mareko, Tusi and Dworsky who are water supply and wastewater engineers responsible for the ASPA component of the project management and implementation in Ebeye.

System used in the Past

The old system was a multi effect distillation (MED) desalination unit that was using the excess heat of the Ebeye power plant, which provided 180,000 gal/day into municipal supply, rationed to just two 35-minute periods per day. Repair of the MED system is apparently not feasible and the installation should be properly disposed of or sold to an interested party.



Figure 4: Multi effect distillation (MED) desalination system



Figure 5: SWRO system (Hydropro Inc., Palm Beach, Florida)

Current System

As part of the ADB loan ASPA installed a new desalination unit in the first half of 2001. The unit is a Salt Water Reverse Osmosis system (Hydropro Inc., Palm Beach, Florida) with a production capacity of 200,000 gal/day.

Monitoring of the efficiency of the current SWRO desalination unit as well as measurements of residual chlorine in the reticulated system is done on a regular basis. Analysis of the samples is facilitated by the laboratory facilities of the hospital on Kwajalein Island.

It was suggested by SOPAC that ASPA, KAJUR and Ebeye EPA operate a joint monitoring programme on the quality of the reticulated system (residual chlorine) and request Kwajalein Island hospital for assistance in analysis and interpretation.

In general, the water supply provided on Ebeye previously, through the MED Desalination Unit was prone to frequent breakdowns as was established through conversations by SOPAC staff with Ebeye Public Works staff. Two other Reverse Osmosis desalination units are currently under repair and once they are operational they could be made available to the islands connected to Ebeye via the causeway (Quijigue).

Additional Water sources to Municipal Supply

A public tap (called "The Oasis") has been installed recently with treated water from the current SWRO Unit with free access for anyone to fill their containers during fixed times from morning till late afternoon. The facility is located near the desalination plant and the new hospital and a guard is responsible for security and proper use.



Figure 6 & 7: The Oasis, public water supply free of charge

The cholera outbreak that occurred on Ebeye in the period between 1 December 2000 and 5 January 2001, was found to be caused by the water supply situation. The survey carried out by the Centre for

Disease Control (CDC) found that the possible cause for the spread of the Cholera was due to Ebeye residents commuting to Kwaj to fill containers from the US military installation via hoses. The chlorinated water is hand-carried with buckets, coolers and jugs to Ebeye on free ferries that travel between Ebeye and Kwajalein, which left it open to contamination.

Ironically, the majority of patients who contracted cholera were reported to be using water from Kwajalein as their primary water source before onset of their diarrhoea. Despite the availability of good quality water at “The Oasis” free of charge there is apparently distrust in using this water as primary source, which was found out through conversations with several local Ebeye residents by SOPAC staff on this visit. Hence the reason why the practice of collecting water in Kwajalein by commuters is still being carried out.



Figure 8: Hauling water to Ebeye with containers, coolers and jugs



Figure 9: Water collection at Kwajalein Military base

Rainwater is sometimes collected from rooftop runoff into PVC or Ferro-cement water reservoirs. Tanks with a capacity of approximately 1000 gallon are available at local stores for 986 US \$ per unit (Triple 3 Wholesale). Most roofs however, are not suitable for rainwater harvesting systems and gutters are totally lacking or not maintained.



Figure 10: Rainwater harvesting on Ebeye still on a moderate scale



Figure 11: Ferro cement storage tanks in Ebeye streets

Wastewater and Sanitation

Many households have indoor toilets connected to the reticulated sewage system, which are shared with several families. In the North Camp, US military engineers constructed public toilets located in a central area which can be locked when not in use by family caretakers.

Wastewater on Ebeye is collected through a reticulated saltwater sewage system leading to an oxidation pond for secondary treatment before it is discharged via a deep-water outfall to the lagoon. The wastewater treatment plant operated by the Department of Public Works has been known to suffer from consistent operational problems since 1997 (Beatty, 2001). As part of ASPA's assistance to KAJUR the wastewater system has been upgraded. There has been some concern expressed by nearby residents of the oxidation ponds. Apparently when there are strong winds, wastewater is being blown out of the pond into residential areas.



Figure 12: Wastewater treatment plant operational again

The construction of the causeway between Ebeye and Quijique disturbed the natural flushing of the lagoon by ocean water. This has caused increased pollution of the lagoon, which is extensively used for bathing, swimming and fishing. The solid waste dump near North Camp is virtually located in the lagoon adjacent to a housing area. Meant as temporary housing some 1040 people are living under conditions that are lacking functioning toilets resulting in considerable health risks.

An alternative to the discharge of effluent into the lagoon should be investigated making use of information on other successful raw sewage outfall designs that discharge to the ocean (e.g. Majuro). Hydrodynamic modelling and bathymetry are needed to determine the feasibility of such a venture and could be facilitated through the Coastal Management Unit of SOPAC.



Figure 13: Stagnant water in the street sometimes contain raw sewage

Other problems that have been reported include the occurrence of backwashing sewage through manholes covers. Standing water after heavy rainfalls essentially reconstitutes the dried sewage in pools in which children sometimes play. Most of the schools are without adequate functioning toilets and those that are working are not kept in sanitary condition. It is frequently reported that children have to go home or use houses of friends to go the bathroom during school time.

Children defecate along the shore especially in North Camp. Garbage collection is erratic but local community groups are effective in cleaning the streets and residential areas. The beaches are commonly used to dispose solid waste of all forms (cars, batteries, plastic).



Figure 14: Beaches used for defecation, rubbish dump and play ground

2.4 Ebeye Hospital Public Health sector

The Ebeye Hospital provides all health services for Ebeye residents and is plagued by shortages of essential supplies, equipment failures and inadequate electricity and water supply. As mentioned previously through an ADB loan a new hospital is currently being constructed and it is expected that it will be operational by early 2002.

The outbreak of cholera last year could only be confirmed after stool specimens had been analysed in reference laboratories in Guam and Honolulu. Restrictions on travel to Kwajalein Island, food exports and social gatherings were introduced. School lunch programmes were curtailed and burying of human remains was restricted.



Figure 15: There is limited space for graveyards on Ebeye

Although the situation normalised after January 2001 there are still chances of future outbreaks of cholera as toxigenic *Vibrio cholerae* O1 can survive in the environment indefinitely. There have been no previous outbreaks of cholera in RMI although the neighbouring nation to the west, the Federated States of Micronesia (FSM), experienced a large outbreak from April to November 2000.

Information was provided by Mr Tom Jack, Ms Oling de Brum and Mr Bremity of the Hospital Public Health Department on their public awareness activities related to last year's cholera epidemic. The awareness campaign proved successful resulting in a rapid decline of the hospital consults with watery diarrhoea after 25 December 2001. Visits to each of the 8 schools on Ebeye and village meetings facilitated through landowners and the church and youth-to-youth information campaigns were organised during the epidemic.

Some of the recommendations from the efforts of the Centre for Disease Control (CDC) public education mission include:

- Treat (disinfect) all drinking water by boiling or adding bleach
- Store treated drinking water in safe containers
- Wash hands with soap and clean water after defecating, before preparing food, and eating meals
- Cook all food, especially seafood thoroughly
- Reheat leftover foods (e.g. cooked rice) thoroughly before eating

According to the Centre for Disease Control report continuing reinforcement is necessary to bring about sustained behaviour changes.

SOPAC through the World Water Day public awareness campaigns can contribute to this reinforced attention. The campaign of 2001 was focused on "Water and Health" and it was suggested that publication material be translated into Marshallese for further use on Ebeye's campaigns.



Figure 16: World Water Day 2001 Publication material.

Campaigns should consider brief daily reminders broadcast by radio, school-based education programs and routine distribution of focused information pamphlets. Use can be made of facilities provided by KAJUR such as "The Oasis" or information stands provided through the new hospital.

Besides promoting the safe use of water provided in Ebeye, instructions should be disseminated to commuters to Kwajalein on safe transport and storage of home drinking water.

Additional information can be obtained via:

<http://www.sopac.org.fj/Secretariat/Units/Wru/WorldWaterDay2001/wwd2001.html>

or <http://www.cdc.gov/safewater>

3. FOLLOW UP

Prepare with the Public Health sector of Ebeye Hospital and KAJUR education and awareness material in Marshallese to be used by schools and meetings that are targeted at the general public.

Look at feasibility study for placing sewage outfall on the ocean side. Propose hydrodynamic modelling around Ebeye.

Further assistance to be provided to RMIEPA for the Water Quality Database, which would also be used by KAJUR through ASPA. Update or modify database according to Ebeye requirements.

Follow up with ADB on future sustainability of intervention. Continued training, technical assistance. Project to be reviewed before new loans distributed.

Follow events on hospital and additional assistance of Kwajalein military base.

APPENDIX 1: TRAVEL ITINERARY

Monday 22 October: Depart Majuro for Kwajalein (Air Marshalls)

Wednesday 24 October: Depart Kwajalein for Majuro (Continental)

APPENDIX 2: CONTACTS

Mr Harrington Dribo, Ebeye Environmental Protection Agency (via RMIEPA) eparmi@ntamar.com

Mr John Bungitak, Marshall Islands Environmental Protection Agency (RMIEPA) eparmi@ntamar.com

Mr Abraham Hicking, Water Quality Monitoring Lab, Marshall Islands Environmental Protection Agency (RMIEPA) eparmi@ntamar.com

Mr Komi Kintaro, Mr Risen Tarbillin, Water Quality Assistants, Marshall Islands Environmental Protection Agency (RMIEPA)

Mr Terry Keju, Marshall Islands Marine Resources Authority tkeju_1990@yahoo.com

Mr Tom Jack, Ebeye Hospital administrator

Ms Oling de Brum and Mr Bremity, Ebeye Hospital Public Health Department

Mr Terry Keju, Marshall Islands Marine Resources Authority tkeju_1990@yahoo.com

Mr Neemia Mareko, American Samoa Power Authority (ASPA) PO Box PPB Pago Pago, American Samoa, 96799, Ph 684 633 5200, Fax 684 633 5451, neemia@hotmail.com

Mr Michael Dworsky (ASPA) American Samoa Power Authority (ASPA) PO Box PPB Pago Pago, American Samoa, 96799, Ph 684 633 5200, Fax 684 633 5451, miked@aspower.com

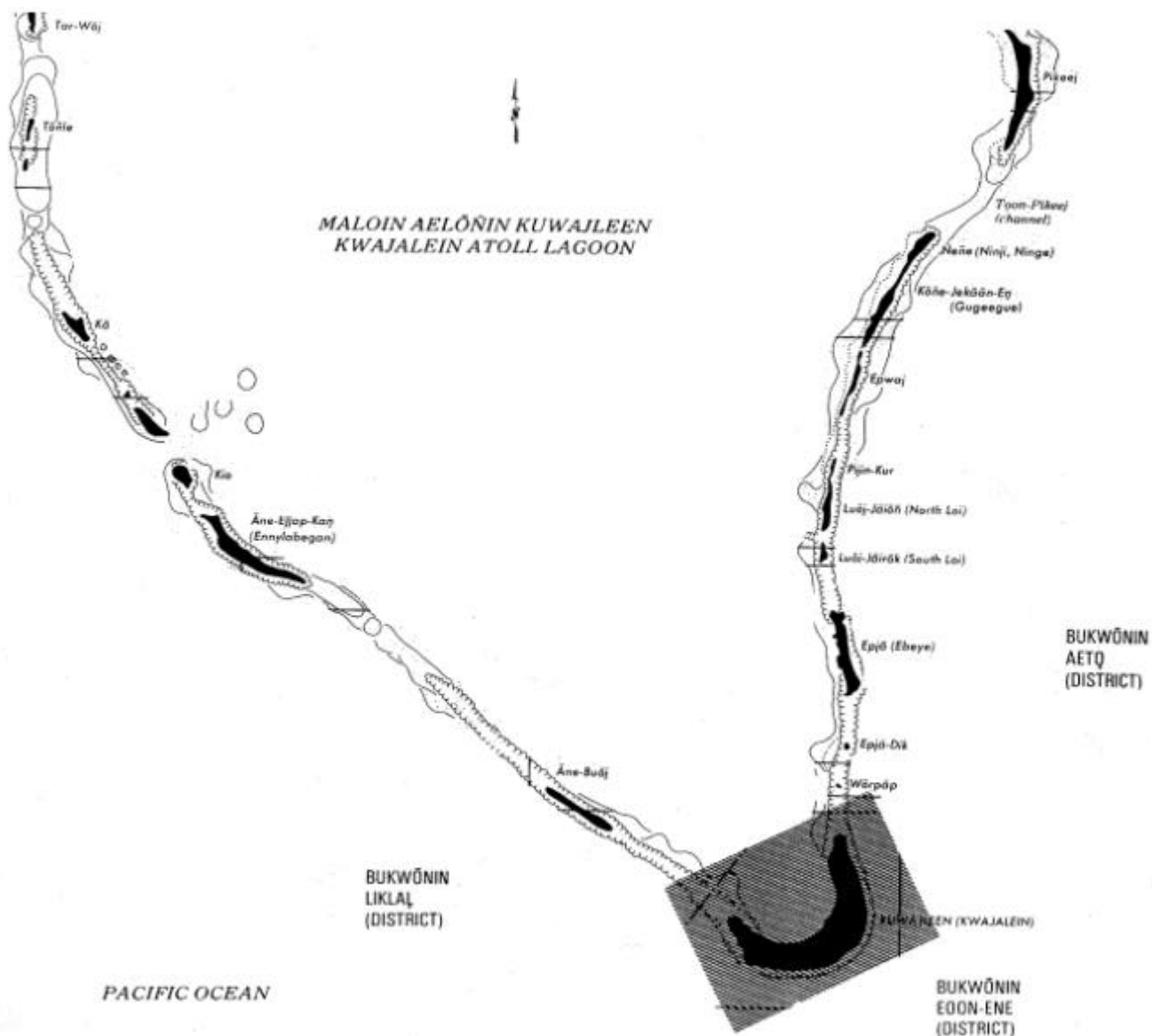
Ms Diane Myazoe, Community Liaison Extension Agent, College of the Marshall Islands
dmyazoe@elele.peacesat.hawaii.edu

APPENDIX 3: REFERENCES

1. Barber, B. 1994. Rural and Urban Water and Sanitation Review (Draft Position Statement), Republic of the Marshall Islands.
2. Beatty, M. 2001. Preliminary Trip Report Epi-Aid 22-01: Outbreak of toxigenic *Vibrio cholerae* 01 Infections, Ebeye Island, Kwajalein Atoll, Republic of the Marshall Islands.
3. Bungitak, J. 2001. RMIEPA Trip Report, Ebeye RO Test Results.
4. Patterson, C. B. 1986. In the Far Pacific, At the Birth of Nations. *National Geographic*, Volume 170, No. 4: 460-499.

APPENDIX 4: MAP OF KWAJALEIN ATOLL AND EBEYE

Map of Kwajalein Atoll



Map of Ebeye

