ASIAN DEVELOPMENT BANK

PCR:RMI 26408

PROJECT COMPLETION REPORT

ON THE

MAJURO WATER SUPPLY AND SANITATION
(Loan1389-RMI[SF])

IN

THE MARSHALL ISLANDS

March 2004

CURRENCY EQUIVALENTS

The currency unit of the Republic of Marshall Islands is the US dollar.

ABBREVIATIONS

ADB	–	Asian Development Bank
DUD	–	Delap-Uliga-Darrit
IDC	–	interest during construction
MPW	–	Ministry of Public Works
MWSC	–	Majuro Water and Sewer Company
PIC	–	project implementation committee
PMO	–	project management office
PPTA	–	project preparatory technical assistance
RMI	–	Republic of the Marshall Islands
SDR	–	special drawing rights
SLA	–	subsidiary loan agreement
TA	–	technical assistance
US	–	United States

WEIGHTS AND MEASURES

m^3	–	cubic meter
m^3/day	–	cubic meter per day
km	–	kilometer
ha	–	hectare
mg/l	–	milligram per liter
ml/day	–	mega liters per day

NOTES

(i) The fiscal year (FY) of the Government ends on 30 September.
(ii) In this report, "$" refers to US dollars.

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BASIC DATA

A. Loan Identification

1.	Country	Republic of Marshall Islands
2.	Loan Number	1389-RMI(SF)
3.	Project Title	Majuro Water Supply and Sanitation Project
4.	Borrower	Republic of Marshall Islands
5.	Executing Agency	Ministry of Public Works
6.	Amount of Loan	
	(at approval)	SDR 6.062 (approximately $9.1 million)
	(at closing)	SDR 6.062 (approximately $8.3 million)
7.	Project Completion Report Number	PCR:RMI 768

B. Loan Data

1.	Appraisal	
	– Date Started	20 June 1995
	– Date Completed	3 July 1995
2.	Loan Negotiations	
	– Date Started	28 August 1995
	– Date Completed	31 August 1995
3.	Date of Board Approval	29 September 1995
4.	Date of Loan Agreement	19 February 1996
5.	Date of Loan Effectiveness	
	– In Loan Agreement	19 May 1996
	– Actual	30 September 1996
	– Number of Extensions	4
6.	Closing Date	
	– In Loan Agreement	30 September 2000
	– Actual	26 April 2002
	– Number of Extensions	3
7.	Terms of Loan	
	– Interest Rate	1% service charge per annum
	– Maturity (number of years)	30
	– Grace Period (number of years)	10
8.	Terms of Relending	
	– Interest Rate	6.9% per annum
	– Maturity (number of years)	20
	– Grace Period (number of years)	5
	– Second-Step Borrower	Majuro Water and Sewer Company
9.	Disbursements	

a. Dates

Initial Disbursement	Final Disbursement	Time Interval
8 Nov 1996	26 April 2002	66 months
Effective Date	**Original Closing Date**	**Time Interval**
30 September 1996	30 September 2000	48 months

b. Amount ($)

	Category	Original Allocation [a]	Last Revised Allocation [b]	Amount Canceled	Net Amount Available	Amount Disbursed	Undisbursed Balance
01	Civil Works	6,959,198	3,934,409	0	3,934,409	3,934,409	0
02	Equipment	94,898	3,286,851	0	3,286,851	3,286,851	0
03	Consultants	992,665	756,102	0	756,102	756,102	0
04	Service Charge	138,581	124,814	0	124,814	124,814	0
06B	LC-Project Support - PMO Salaries	36,152	201,781	0	201,781	201,781	0
06C	LC-Unallocated	909,817		0			0
	Total	**9,131,311**	**8,303,957**	**0**	**8,303,957**	**8,303,957**	**0**

[a] at time of approval

[b] $ equivalent at time of closing

LC = local currency, PMO = project management office.

C. Project Data

1. Project Cost ($ million)

Cost	Appraisal Estimate	Actual
Foreign Exchange Cost	7.95	7.38
Local Currency Cost	3.62	2.17
Total	11.58	9.55

2. Financing Plan ($ million)

Cost	Appraisal Estimate	Actual
Implementation Costs		
Borrower-Financed	0.99	1.25
ADB-Financed	8.96	8.17
Total	**9.95**	**9.42**
IDC Costs		
Borrower-Financed	1.41	0.00
ADB-Financed	0.24	0.13
Subtotal	1.65	0.13
Total Project Cost	**11.60**	**9.55**

ADB = Asian Development Bank, IDC = interest during construction.

3. Project Costs: Appraisal vs Actual ($ million)

Components	Appraisal Estimates			Actual Costs		
	Foreign	Local	Total	Foreign	Local	Total
A. Improvements to Airport Catchment	**0.250**	**0.070**	**0.320**	**0.227**	**0.066**	**0.293**
Civil Works	0.140	0.050	0.190	0.117	0.061	0.178
Materials and Equipment	0.110	0.020	0.130	0.110	0.005	0.115
B. Laura Well Field Development	**0.100**	**0.100**	**0.200**	**0.000**	**0.000**	**0.000**
Civil Works	0.060	0.090	0.150	0.000	0.000	0.000
Materials and Equipment	0.040	0.010	0.050	0.000	0.000	0.000
C. Raw Water and Treated Water Storage	**2.050**	**0.460**	**2.510**	**2.431**	**0.710**	**3.141**
Civil Works	1.330	0.420	1.750	1.253	0.658	1.911
Materials and Equipment	0.720	0.040	0.760	1.178	0.052	1.230
D. Freshwater Transmission and Distribution	**2.180**	**0.530**	**2.710**	**1.257**	**0.366**	**1.623**
Civil Works	1.140	0.480	1.620	0.648	0.339	0.987
Materials and Equipment	1.040	0.050	1.090	0.609	0.027	0.636
E. Improvements in Freshwater Treatment and Pumping Facilities	**0.340**	**0.290**	**0.630**	**0.671**	**0.194**	**0.865**
Civil Works	0.110	0.270	0.380	0.346	0.180	0.526
Materials and Equipment	0.230	0.020	0.250	0.325	0.014	0.339
F. Upgrading and Expansion of Seawater Distribution System	**0.780**	**0.250**	**1.030**	**1.166**	**0.340**	**1.506**
Civil Works	0.460	0.220	0.680	0.601	0.315	0.916
Materials and Equipment	0.320	0.030	0.350	0.565	0.025	0.590
G. Rehabilitation of the Sewerage System	**0.280**	**0.070**	**0.350**	**0.745**	**0.218**	**0.963**
Civil Works	0.050	0.040	0.090	0.384	0.202	0.586
Materials and Equipment	0.230	0.030	0.260	0.361	0.016	0.377
H. Institutional Support and Consulting Services	**1.100**	**0.140**	**1.240**	**0.756**	**0.280**	**1.036**
Consulting Services	1.000	0.000	1.000	0.756	0.000	0.756
Ministry of Public Works Staffing of PMO	0.000	0.100	0.100	0.000	0.280	0.280
Secretarial Support for PMO	0.000	0.040	0.040			
Service Vehicles	0.040	0.000	0.040			
Computers and Software	0.060	0.000	0.060			
Total Base Cost	**7.080**	**1.910**	**8.990**	**7.253**	**2.174**	**9.427**
Contingencies	**0.630**	**0.310**	**0.940**			
Physical Contingencies	0.460	0.180	0.640			
Price Contingencies	0.170	0.130	0.300			
Interest During Construction	**0.240**	**1.410**	**1.650**			
Service Charge on ADB Loan	0.240	0.000	0.240	0.125	0.000	0.125
Relending to MWSC	0.000	1.410	1.410			
Total Project Cost	**7.950**	**3.630**	**11.580**	**7.378**	**2.174**	**9.552**

ADB = Asian Development Bank, MWSC = Majuro Water and Sewer Company, PMO = project management office.

4. Project Schedule

Item	Appraisal Estimate	Actual
Date of Contract with Consultants		
Project Supervision Consultants	Oct 1996	Sept 1996
Completion of Engineering Designs	Oct 1996	Oct 1996
Civil Works Contract:		
Date of Award	Apr 1996	Oct 1996

Completion of Work	Dec 1999	Dec 1998
Equipment and Supplies:		
First Procurement		Nov 1996
Last Procurement (pump parts)		Nov 1998
Completion/Equipment Installation		Jan 1999
Start of Operations		
Completion of Tests and Commissioning		Jan 1999
Beginning of Start-Up		Jan 1999
Other milestones:		
1st extension of loan closing date		30 Jun 2001
2nd extension of loan closing date		31 Oct 2001
3rd extension of loan closing date		31 Dec 2001

5. Project Performance Report Ratings

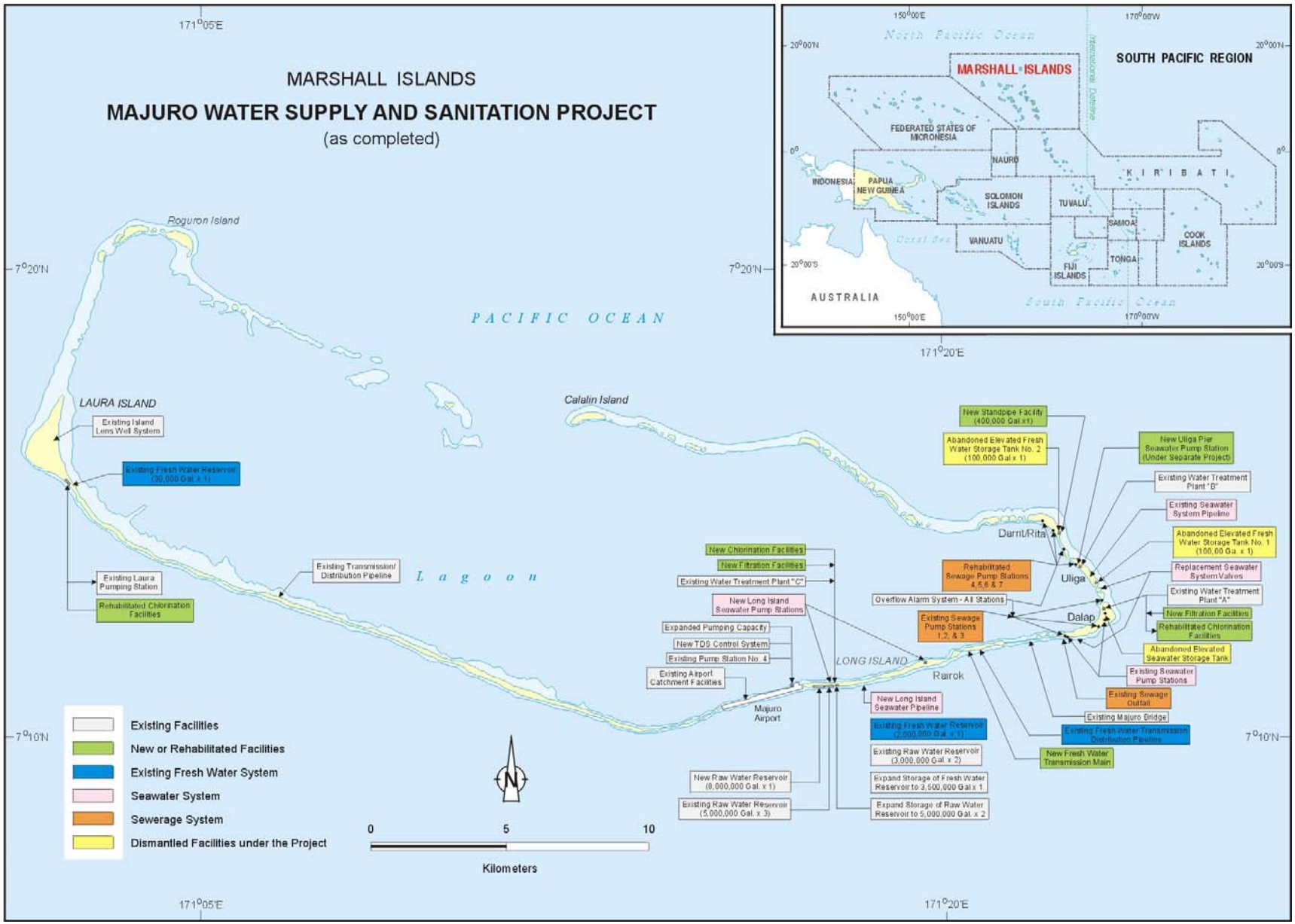
	Ratings	
Implementation Period	**Development Objectives**	**Implementation Progress**
From Oct 1995 to Dec 1996	AAA	AAA
From Jan 1997 to Dec 1997	AAA	AAA
From Jan 1998 to Oct 1998	AAA	AAA
From Nov 1998 to Dec 1998	Satisfactory	Satisfactory
From Jan 1999 to Dec 1999	Satisfactory	Satisfactory
From Jan 2000 to Dec 2000	Satisfactory	Satisfactory
From Jan 2001 to Dec 2001	Partly Satisfactory	Partly Satisfactory
From Jan 2001 to Apr 2002 (closing)	Partly Satisfactory	Partly Satisfactory

D. Data on Asian Development Bank Missions

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members[a]
Fact-Finding	18 Apr–5 May 1995	2	36	a, h
Appraisal	20–30 Jun 1995	2	23	a, h
Inception	8–11 Oct 1996	2	8	a, f
Loan Review 1	17 April 1997	1	1	a
Special Project Administration 1	10–13 May 1997	3	12	e, f
Midterm Review	30 Sept–10 Oct 1997	2	22	b, f
Loan Review 1	28 April–9 May 1998	1	6	b,
Special Loan Administration 2	9–10 Nov 1998	1	3	e,
Loan Review 3	11–15 Sept 1998	2	10	e, f
Special Review Mission	October 1999			
Special Review Mission	April 2000			
Loan Review 4	27 June–4 Jul 2001	2	4	d, f
Loan Review 5	12 Oct 2001	2	2	d, f
Loan Review 6	13 Feb 2002	2	2	d, f
Loan Review 7	10 July 2002	2	2	d, f,
Project Completion Review[b]	21Jul–1 Aug 2003	4	40	e, g, h, i

[a] a-engineer, b-senior project engineer, c-counsel, d-senior programs officer, e-senior project specialist/Project Administration Unit, f-assistant project analyst/associate analyst, g-senior budget administration specialist, h-operations officer, i-consultant

[b] The Mission comprised Amarnath Hinduja, Sr. Project Specialist, Tilak Sen, Principal Budget and Management Services Specialist, Susan I. Francisco, Operations Officer, and Ranjit Wirasinha, Staff Consultant/Water Supply Engineer. Amarnath Hinduja, assisted by the Mission members, prepared the Project Completion Report.


MARSHALL ISLANDS
MAJURO WATER SUPPLY AND SANITATION PROJECT
(as completed)
171°05'E
171°20'E
7°20'N
7°10'N
PACIFIC OCEAN
Lagoon
Roguron Island
LAURA ISLAND
Calalin Island
LONG ISLAND
Darrit/Rita
Uliga
Dalap
Rairok
Majuro Airport
Existing Island Lens Well System
Existing Fresh Water Reservoir (30,000 Gal. x 1)
Existing Laura Pumping Station
Rehabilitated Chlorination Facilities
Existing Transmission/ Distribution Pipeline
New Chlorination Facilities
New Filtration Facilities
Existing Water Treatment Plant "C"
New Long Island Seawater Pump Stations
Expanded Pumping Capacity
New TDS Control System
Existing Pump Station No. 4
Existing Airport Catchment Facilities
New Raw Water Reservoir (6,000,000 Gal. x 1)
Existing Raw Water Reservoir (5,000,000 Gal. x 3)
New Long Island Seawater Pipeline
Existing Fresh Water Reservoir (5,000,000 Gal. x 1)
Existing Raw Water Reservoir (3,000,000 Gal. x 2)
Expand Storage of Fresh Water Reservoir to 3,500,000 Gal x 1
Expand Storage of Raw Water Reservoir to 5,000,000 Gal. x 2
New Standpipe Facility (400,000 Gal.x1)
Abandoned Elevated Fresh Water Storage Tank No. 2 (100,000 Gal.x 1)
Rehabilitated Sewage Pump Stations 4,5,6 & 7
Overflow Alarm System - All Stations
Existing Sewage Pump Stations 1,2, & 3
New Uliga Pier Seawater Pump Station (Under Separate Project)
Existing Water Treatment Plant "B"
Existing Seawater System Pipeline
Abandoned Elevated Fresh Water Storage Tank No. 1 (100,00 Ga. x 1)
Replacement Seawater System Valves
Existing Water Treatment Plant "A"
New Filtration Facilities
Rehabilitated Chlorination Facilities
Abandoned Elevated Seawater Storage Tank
Existing Seawater Pump Stations
Existing Sewage Outfall
Existing Majuro Bridge
Existing Fresh Water Transmission Distribution Pipeline
New Fresh Water Transmission Main
Existing Facilities
New or Rehabilitated Facilities
Existing Fresh Water System
Seawater System
Sewerage System
Dismantled Facilities under the Project
N
0
5
10
Kilometers
03-mi 3190 RM
SOUTH PACIFIC REGION
MARSHALL ISLANDS
FEDERATED STATES OF MICRONESIA
NAURU
KIRIBATI
INDONESIA
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
SAMOA
COOK ISLANDS
VANUATU
TONGA
FIJI ISLANDS
AUSTRALIA
North Pacific Ocean
South Pacific Ocean
Coral Sea
150°00'E
170°00'W
20°00'N
20°00'S
0°

I. PROJECT DESCRIPTION

1. A severe drought from December 1991 to April 1992 almost totally depleted the supply of freshwater in Majuro, the capital of the Republic of the Marshall Islands (RMI). This triggered a request from the Government for urgent assistance from the Asian Development Bank (ADB) to help increase the water supply and sewerage capacity for Majuro. Following an ADB reconnaissance mission in July–August 1992, a small-scale project preparatory technical assistance (PPTA)[1] was carried out to prepare a suitable project for ADB assistance. Based on its findings, ADB, in September 1993 approved a technical assistance (TA) loan[2] to finance the necessary engineering work from detailed design through to contract awards. Together with the loan, an advisory TA[3] was also approved for institutional strengthening of the Majuro Water and Sewer Company (MWSC), which was responsible for supplying such services for Majuro.

2. Following the detailed engineering design, a loan fact-finding mission was fielded in April/May 1995 to develop the contour of a loan. An appraisal mission in June 1995 thereafter held discussions with the government agencies concerned on scope, implementation arrangements, environment, and the economic and financial costs of the Project. A policy dialogue was also conducted with the Government, leading to agreement on several reforms to enhance sector efficiency. The project loan was based on the understanding reached during discussions and the findings of the consultants on the TA 1946-RMI on Institutional Strengthening and Engineering Loan. This task was assigned to the same consulting group that had been contracted for the detailed engineering design.

3. The Project was to augment the freshwater supply from 2,700 cubic meters per day to 5,000 cubic meters per day and to increase its reliability and safety, thereby improving the health and living standards of about 56% of the nation's population or 27,000 people served by MWSC, which was the end user and the public utility on Majuro Atoll. Although the country's population growth had fallen from 4% a year at appraisal in 1995 to 3.6% as shown in 2000 census, the project design estimated the rate of population growth on Majuro at 6% a year as part of the overall trend toward urbanization. The work on the Project commenced in October 1996 and physical work was completed in December 1998. The work as carried out and details of the project components are provided in Appendix 1. The project components as appraised are broadly the following:

(i) improvement to the airport catchment area;
(ii) Laura well field development;
(iii) raw water and treated water storage;
(iv) water transmission and distribution;
(v) improvements to freshwater treatment and pumping facilities;
(vi) upgrading and expansion of the seawater distribution system;
(vii) rehabilitation of the sewerage system; and
(viii) institutional support and provision of consulting services

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[1] ADB. 1992. *Technical Assistance to the Republic of the Marshall Islands for the Majuro Water Supply Project*. Manila. (PPTA 1775-RMI approved 30 October 1992 for $100,000).

[2] ADB. 1993. *Report and Recommendation of the President to the Board of Directors for the Proposed Loan to the Republic of Marshall Islands for the Majuro Water and Sewer Project*. Manila. (TA Loan 1250-RMI approved 9 September 1993 for $700,000).

[3] (ADB. 1993. *Technical Assistance to the Republic of the Marshall Islands for Institutional Strengthening of Majuro Water Supply and Sanitation Company*. Manila. (AOTA 1946-RMI approved 9 September 1993 for $250,000).

II. EVALUATION OF DESIGN AND IMPLEMENTATION

A. Relevance of Design and Formulation

4. The Project in most areas has relevance to ADB's country strategy and the Government's development objectives. However, projections of growth and revenue generation turned out to be extremely optimistic. The 1999/2000 census put the population of Majuro at 23,676, which was a reduction of 12% since appraisal as against an estimate of a 6% increase under the Project. These overstated estimates of population growth and water demand made by the PPTA were used during the detailed design stage carried out under the engineering loan, so producing an ambitious project design and a project that was financially beyond the capacity of the community to sustain.

5. MWSC had presented to the project preparatory team at the outset their view that the population and demand projections and the resulting sizing of the water supply system and revenue projections were excessive. The fact-finding and appraisal missions had also not given due recognition to local knowledge. MWSC ultimately was not prepared to accept the loan, understandably on the grounds that the Project had not only failed to achieve the expected line pressure in the distribution system, but also could not generate the revenue to meet the required obligations.

6. The Project encountered serious design problems and implementation difficulties during the entire project cycle, arising mainly from the lack of consultation between MWSC as the end user, the Executing Agency (EA), and ADB. A special review mission in October 1999 undertook a study of the system design and rectified the design defects. Following modifications to design of some project elements, changes in approach to tariff setting, and proactive work on metering and reducing illegal connections by MWSC, the relevance of the project to ADB's objectives improved considerably. The special mission also sought management approval for replacement of the subsidiary loan agreement (SLA) with a lease franchise agreement. This replacement of the SLA improved the financial sustainability of MWSC, but resulted in the Government having to bear the financial burden of the Project.

7. A greater degree of scrutiny at the time of appraisal by all parties could have resulted in (i) an implementation arrangement that was more consultative; and (ii) delivery of a project within the financial capacity of the community, thereby relieving the Government of an unforeseen future financial burden.

B. Project Outputs

8. In the final analysis, the project has been effective in improving the quality of water delivered. However, the total production of water remains at 3,469 cubic meters per day as against the target of 5,000 cubic meters per day. This reduction could mainly be attributed to cancellation of the Laura wells component. Further, even though the distribution capacity of the project has improved significantly it only covers approximately 14,550 people on the island of Majuro, which is about 65 percent of people on Majuro and 27 percent of the total population. The project outputs as described in para. 3 consisted of eight main components. The impact of these components and the changes made during implementation, which essentially enhanced the project objectives, were discussed with the government. While Appendix 1.A provides details of activities, a summary is given below.

1. Improvements to the Airport Water Catchment Area

9. The water transmission pumps from the airport rainwater catchment, along with pipeline from the catchment to the reservoir were replaced, thus improving the water pumping capacity to the main raw water reservoir. Some vital details, such as an automatic shutoff and an alarm system to prevent saltwater intrusion, had been overlooked by the project consultant, and were marked for replacement during the subsequent review in October 1999.

2. Laura Well Field Development

10. There had been inadequate consultation at the time of project preparation with the local community in Laura with regard to drilling additional wells for increased extraction. The local community had raised objections on water sharing and related issues. In addition, local geological conditions of the aquifer appeared not to retain sufficient water for increased extraction, especially during the dry season. The utility company had also expressed similar objections. After protracted negotiations between the EA, the utility company, and ADB, it was agreed to cancel the Laura well component and reallocate the funds to address leakages in the existing reservoirs.

3. Raw Water and Treated Water Storage

11. The construction of the new raw water storage reservoir and the raising of the height of the walls of two existing storage reservoirs were completed satisfactorily. The new lining for the existing treated water reservoir as designed was found unsuitable and was redesigned and replaced. With reallocated funds from the Laura well component, the linings of the two existing reservoirs were replaced, arresting major leaks. The utility company, as the end user, believes that this increased storage capacity has been one of the most significant contributions toward meeting the project objectives.

12. The elevated reservoir included in the original plan was not built. This was replaced by a reservoir (standpipe) at Delap-Uliga-Darrit (DUD) for pressure regulation as part of the new 14.6-kilometer (km) transmission system. This arrangement was expected to provide sufficient mains pressure for the Rita end water supply distribution system. However, the system suffered from low water pressure problem at the Rita end of the atoll and was only resolved after the implementation of the design changes recommended by the subsequent special review mission. The utility company at present has no use for this standpipe other than the possible use as a standby reservoir, and the Government considers this an unnecessary obligation to ADB.

4. Water Transmission and Distribution

13. The construction of the 14.6 km water transmission pipeline, with interconnections to the existing distribution main, has been useful in providing helpful operation and maintenance flexibility.

5. Improvements to Freshwater Treatment and Pumping Facilities

14. The various subcomponents related to the water treatment plant near the airport were completed, including the construction of a new operations and storage building. This did not include the replacement of the bulk flow meters and associated repair.

6. Upgrading and Expansion of the Seawater Distribution System

15. All subcomponents, including the 7 km of saltwater distribution pipeline, were completed satisfactorily and helped improve the saltwater distribution system in the Long Island section of Majuro. This has resulted in large savings of treated water otherwise used for flushing toilets.

7. Rehabilitation of the Sewerage System

16. Five pump houses were rehabilitated. The pumps were replaced and new pipe work was carried out. Subsequent design modifications were necessary.

8. Institutional Support and Provision of Consulting Services

17. The project management office (PMO) was established in time with qualified personnel. The project manager, who was the incumbent general manager of the Public Works Division of Ministry of Public Works, while performing satisfactorily failed to maintain a good working relationship with the end user, resulting in delays in resolution of issues arising.

C. Project Costs

18. The total project cost was estimated at $11.58 million equivalent at appraisal. ADB financing was envisaged to comprise $7.95 million in foreign exchange costs and $1.20 million in local currency costs for a total of $9.25 million, with the Government contributing $2.41 million equivalent (20% of project costs) as the balance of local costs. Due to significant depreciation of the SDR against the US dollar, the total US dollar amount available for the loan at closing fell to $8.3 million equivalent. At completion, the actual project cost was $9.55 million equivalent, comprising $7.38 million in foreign exchange costs and $0.93 million in local currency costs financed by ADB, and $1.25 million contributed by the Government. The proportion of ADB financing increased from 80% at time of appraisal to 87% at completion. The primary reason for the lower contribution by the Government is that the SLA did not materialize and therefore MWSC's contribution of $1.4 million as stated in the Report and Recommendation of the President was not booked.

19. As mentioned earlier, due to the depreciation of SDR there was a significant reduction in the available loan amount. The increase in cost from multiple change orders and rework due to deficiencies in the initial design had to be financed by the Government through increased allocation of counterpart funds. Notwithstanding the multiple change orders and design changes, the Project, at physical completion, had failed to achieve the expected results of 24-hour supply and acceptable line pressure at the Rita end of the atoll. Consequently, the funding of these change orders became the source of disagreement between the construction supervision consultants and the civil works contractor. The disputed payments were settled after protracted negotiations between the Government and the contractor. Outstanding technical and design issues were resolved following the study undertaken by the special review mission. Alternate resources were used to finance these changes.

D. Disbursements

20. The Project had two major contracts, one covering the civil works and equipment and the other one the supervising consultants. Disbursements against these contracts were made using direct payment procedures. To facilitate payments for small civil works contracts, equipment, and ADB-funded local expenditures for PMO support, ADB approved the

establishment of an imprest account for the Project. Initial disbursement of $250,000 to the imprest account was made in November 1996. The account was liquidated through the statement of expenditures procedures for payments not exceeding $50,000. The use of the imprest account and these procedures was extremely beneficial to implementation. Disbursements were carried out more or less on time. At loan closing, the total available loan amount of $8.30 million was fully disbursed.

E. Project Schedule

21. The physical completion of the Project as designed was achieved on schedule by late 1999. At completion, there was a detailed punch list prepared by the contractor, which was also completed before the original completion date of 30 March 2000. This additional work had led to a claim for almost $1.0 million. However, MWSC as the end user did not accept the Project, as the Project had failed to achieve the expected outputs. Nor did MWSC accept the subsidiary loan for the Project, as it considered that the Project cost was too high for the community to bear and that the revenues required to meet the loan obligations could not be generated. As an added problem the construction supervision consultants challenged the civil works contractor's claims for variation orders, resulting in a dispute. The loan closing date had to be extended three times, pending resolution of the disputed claims and the technical problems, as well as finding a workable solution for the SLA covenant under the loan. The dispute between the Government and the contractor was resolved out of court, while the SLA was replaced by a lease franchise agreement between the Government and the utility company (para. 25). The updated implementation schedule is attached in Appendix 2.

F. Implementation Arrangements

22. Implementation arrangements were as designed during appraisal. The Ministry of Public Works (MPW)—the Government's principal project management and construction agency—was the Executing Agency. A PMO was set up in MPW, headed by a project manager and supported by technical and administration personnel from MPW to supervise the ongoing ADB-financed TA loan project for carrying out detailed engineering design, tender evaluation, and contract awards for the Project.

23. On approval of the project loan, the Government established a project implementation committee (PIC) chaired by the Secretary of Public Works to oversee and coordinate all project activities and to ensure appropriate liaison among agencies involved in project implementation. The PIC was well constituted with representation at the decision-making level from all relevant agencies, namely the Office of the President, Ministry of Finance, MPW, MWSC, and other agencies as needed from time to time. The PMO was tasked to continue with the responsibility for construction supervision. For reasons of continuity and experience, the consultants recruited under the detailed engineering design component continued to assist the PMO with construction supervision. These implementation arrangements, having been used under other ADB-financed projects, had acceptance at ADB. The arrangements could have worked well if all involved parties, adhered to regular exchange of views toward consensus, as stipulated in Project Agreement Section 2.07(a) both in spirit and letter.

24. The PMO project manager and the construction supervision consultants appeared to have a difference of opinion with MWSC due to the reluctance on their part to review and reconfirm the basic assumptions that were shown to be inconsistent with available demographic information, growth of demand, local needs, and priorities, etc., which warranted a design change. While the PMO and the construction supervision consultants implemented several

design changes, they were not receptive to suggestions for changes that were more fundamental, presumably because they were responsible for the concepts and design during the planning stage. This seems to have led to a strained relationship between the PMO, consultants, contractor, and MWSC. However, corrections to design in some critical areas were eventually agreed on and carried out, with the desired results.

G. Conditions and Covenants

25. While the majority of the covenants relating to project implementation were complied with, the covenants relating to the SLA and associated Project Agreement were not. The revenue projections made under the PPTA and later accepted by the engineering loan consultants, which were based on unrealistic water sales and tariff increase assumptions, did not materialize. This, in conjunction with the weak overall financial status of MWSC, could not sustain the loan and interest costs under the onlending arrangements in the SLA. Apart from this, MWSC was also burdened with the TA loan for engineering design. Subsequently, with the approval of ADB Management, the SLA was replaced by a lease franchise agreement between MWSC and the Government, with the Government retaining the assets created under the loan. The detailed compliance status of the loan covenants is provided in Appendix 3**.**

H. Related Technical Assistance

26. The Project was conceived as a result of a small-scale PPTA[4] in 1992. The TA ascertained the need for improvements in both water and sanitation facilities in Majuro atoll. Having clearly identified the need and the problems, the TA paved the way for the subsequent loan. The overall performance of this TA is rated as successful. This was followed by a TA loan[5] to prepare the detailed design for the proposed loan and an advisory TA for institutional strengthening of MWSC.[6] The TA loan, which prepared the detailed design, carried out its mandate and was the basis for the ensuing loan. The completion status is shown in the TA completion report attached in Appendix 4. However, the premise and assumptions on which the designs were based were unrealistic. The design consultants failed to take into account the conditions on the ground or to check whether the design was acceptable to MWSC as the end user. As a result, the outputs of the TA loan should partly be held responsible for the subsequent problems with the loan as well as its inability to achieve any of the financial and economic returns expected. Therefore, while this TA was originally rated as successful, the PCR mission considered it as partly successful. However, a more detailed evaluation and analysis on a post facto basis could not be undertaken due to unavailability of any relevant data and/or people involved in the project at the time. The institutional strengthening TA referred to in para. 1 commenced well before the reorganization and the service delivery improvements in the utility had been carried out. Therefore, limited results were achieved from the recommendations arising from the TA since neither the improvements in water services nor the appropriate staffing of MWSC were in place.

I. Consultant Recruitment and Procurement

27. The consulting firm under the ADB-financed engineering TA Loan 1250-RMI (SF), which carried out the detailed engineering design, contract packaging, prequalification of contractors, bidding procedures, tender evaluation, and contract award for the Project, was nominated to

[4] Footnote 1.
[5] Footnote 2.
[6] Footnote 3.

continue as the consultants assisting the PMO on construction supervision. The decision resulted from a recommendation by the Borrower on the grounds of continuity and experience and was subsequently accepted by ADB. Continuation of the design consultants for construction supervision in this case led to difficulties that could be attributed to the designs being based on parameters that were overly optimistic and unacceptable to MWSC, as the end user, who was tasked with managing operations of the water and sewer system (paras. 21 and 24). The construction supervision consultants were reluctant to question the engineering design, which had earlier been done by their company.

28. In consideration of the difficulties of coordinating separate equipment supply and construction contracts on this small and relatively remote atoll of Majuro, one contract under international competitive bidding procedures was awarded for the civil works and supply of materials and equipment as approved during loan appraisal. This contract covered improvements to the airport water catchment facilities, water storage, water transmission and distribution, water treatment and pumping facilities, expansion of the seawater distribution system for sewerage, and rehabilitation of the sewerage system.

29. A contract for the construction of new wells at the Laura well field under local competitive bidding did not take place since the Laura well component was cancelled (para. 10). Two service vehicles, computers, special software for water supply and sanitation, and operation and maintenance data processing were procured under direct purchase orders. No major issues related to procurement were encountered on the above contracts, and implementation proceeded satisfactorily until the time when requests for settlement of payment for change orders were lodged.

J. Performance of Consultants, Contractors, and Suppliers

1. Consultants

30. It appears that local aspirations for the type of water supply system, financial and human resources capacity, and conditions did not find much sympathy with the consultants. This stemmed from their lack of adequate dialogue and consultation with the local community and with operational staff of the local utility at all levels except the highest decision-making level. The absence of adequate analysis of the available statistical information had led, under the PPTA, to unrealistic projections for sizing the system, tariffs, and levels of revenue generation. Assumptions and projections appear not to have been conditioned by the real situation in Majuro. Hence the result has been an over design, cost beyond the means of the community, and very optimistic projections for revenue generation. The need for some unavoidable modifications to designs during construction supervision created further difficulties.

31. Continuation of the same consultants for construction supervision exacerbated the issue. Notwithstanding the suggestions made, the consultants continued to adopt the projections made in the PPTA for detailed engineering designs. Continuation of the project management personnel on the government side from the design stage to the construction supervision stage may have also further aggravated the problem. These decisions became a recipe for the difficulties experienced during implementation and the refusal of the end user to accept the Project at the time of turnover. The performance of the consultants, both the PPTA and project supervision consultants, is rated as partly satisfactory, while that of the PMO is rated as satisfactory.

2. Contractors/Supplier

32. The capacity and commitment of the contractor as assessed by the ADB review missions were reported to be good. This is evidenced by the few claims on warranty that had to be made, which also were remedied by the contractor promptly. The quality of work was generally good. The contractor adhered reasonably to supply, installation, and construction schedules. Some delays occurred in the transport of filters due to a strike at the manufacturer and in the supply of reservoir liners due to complications of manufacture (materials from the United States and manufactured in Australia). Waiting for the right weather conditions to install the liners also caused some delay. However, these delays did not have any significant impact on the overall implementation schedule. The performance of the contractor is therefore, considered fully satisfactory.

K. Performance of the Borrower and the Executing Agency

1. The Borrower

33. The Government, as the Borrower, having met its obligations in the Loan Agreement, performed satisfactorily. It responded with understanding to the challenges resulting from the problems of project sizing and design. The arrangements for construction management and supervision, which presented difficulties, were in part the recommendation of the Government. It could have been more circumspect in reviewing the project concepts, designs, and demand and revenue projections, having a greater understanding than the design consultants of the realities in Majuro. A more proactive approach could have prevented the burden of the loan falling upon itself.

2. Executing Agency

34. MPW, through the PMO, managed project execution. The manager of the PMO was selected by MPW on the basis that having worked with them he was knowledgeable and experienced. However, liaison between the manager, the consultants, MWSC, and the contractor became problematic, leading to many issues. Changes to concept and design during construction, which were prompted to some extent by the need to appreciate local conditions and mainly to remedy design errors, contributed to an environment of poor rapport amongst them. MWSC, as the end user, should have had a greater involvement at both the design and implementation stage. A more participatory approach with proactive and constructive effort in liaising between the consultants and the project manager and sharing of the utility company's operational data could have improved the final output. The project manager should have ensured that submissions for design change received due attention and recognition. Overall management of the project activities, with the primary objective of completing the work on schedule, was good. The EA maintained reasonably good records. Its overall performance is rated as partly satisfactory.

L. Performance of ADB

35. ADB has for the most part met its Loan and Project Agreement obligations. However, ADB should be more circumspect when dealing with development financing in small island locations. Majuro has less sophisticated institutions for development and management of services (utilities) and the community has only a limited financial base for growth or revenues. Considering the limitations that could only support a moderate investment, a more conservatively sized system with a loan size to suit the aspirations and capability of the recipient

community should have been the guiding factor for the Project. The emphasis on institutional strengthening was the correct approach, although the timing of the advisory TA could have been better planned. Before agreeing to the Government's recommendation for continuing with the same consultants for construction supervision, a more in-depth review and analysis of the projections made by the PPTA consultants on the system proposed, its size, and its cost should have been undertaken. A critical review of the work of the consultants by the initial review missions, in light of the issues raised by MWSC, might have helped in redefining the project components and design.

36. Subsequent to the analysis and recommendations made by the special review mission, ADB responded favorably. The details of the findings are contained in the staff consultant's report attached in Appendix 5. The special review missions, though they successfully addressed most of the problems identified, faced a rather difficult time finding solutions to many of the problems at such a late stage of the Project with limited or no available funds under the loan. The innovative changes in approach and design to ameliorate some of the impending difficulties, along with intense negotiations undertaken by the October 1999 special review mission to achieve outcomes acceptable to all parties, helped in bringing the matters to a final close. This proactive approach taken rectified many of the earlier shortcomings, thus improving ADB's performance. Under the circumstances, ADB's overall performance can at best be rated as partly satisfactory.

III. EVALUATION OF PERFORMANCE

A. Relevance

37. The component under the loan related to increasing the rainwater harvesting storage and improving the water treatment facilities at the airport was carried out satisfactorily and has become a boon for the water supply to DUD and Rita. At appraisal and detailed design stage, breaches in the liners resulting in leakage had not been identified. The liners and the necessary repairs to the tanks had to be redesigned by using external expertise and the savings from cancellation of Laura well were reallocated for actual repair work. These repairs resulted in a saving of an estimated 25,000 gallons per day (±100m^3/d) of water that was previously lost through leakage. If left unattended, the leakage would have increased with time, effectively diminishing the benefits of the new reservoir. Therefore, including these components under the loan has proven to be extremely beneficial.

38. The absence of consensus on the safe capacity of the Laura well field particularly in the dry season, on water rights, and on water sharing with those outside the Laura well field area showed that not enough consultation with all stakeholders had taken place. The shift of priorities from Laura wells to optimum management of available water resources at the airport catchment proved to be of greater benefit. Subsequently, MWSC achieved a significant increase in the output from the existing wells by a simple modification to the pumping and transmission arrangements using alternate funding. Following these changes, the groundwater investigation was not undertaken and the design engineer (6 person-months) was not recruited as originally planned.

39. The project design was subject to frequent changes during construction. Such changes were the cause of frequent change orders, which resulted in claims that led to arbitration and extensions of the loan closing date. Surprisingly, the existing pumps at the airport water works, which had reached the end of their useful life and were not suited for the new transmission configuration, were not identified for replacement by the project design consultants. A new

pump set (three pumps including one standby) and a pumping arrangement within the same pump house were redesigned and installed under the study conducted by the subsequent special review mission. This arrangement provided an increased and satisfactory supply and pressure to DUD and Rita.

40. The elevated reservoir (standpipe) constructed to regulate pressure to DUD and Rita, as part of the original design, did not achieve the desired results. It is currently idle and the numerous bolts are in state of corrosion. The transmission main on the other hand has been useful in providing additional supply and flexibility in operations. The flow meters fitted at the interconnections between the new transmission main and the existing distribution main, are battery-powered digital meters. The chambers they are fitted in are prone to flooding during the rainy season and are currently out of operation. The selection of the meters should have taken into account the climatic conditions and their robustness.

41. Provision of saltwater to toilets for flushing has contributed to significant savings in the use of freshwater, particularly since the main source for freshwater is rainwater, which is susceptible to dry spells. However, the saltwater supply system did not take into account the corrosive effects of saltwater on meters. As a result the system is not metered. Further, following a severe drought, from December 1991 to April 1992, the administration had distributed rainwater storage tanks to all households (which reduced the incentive to be connected to paid-water supply system of MWSC). The project design consultants when assessing the system design did not consider these factors. While such design issues were not considered, the overall Project is assessed as relevant.

B. Efficacy in Achievement of Purpose

42. The physical objectives as set in the original design have been met in that Majuro has a better storage, treatment, and distribution network for water than before the Project. However, the improvements in the water supply service were achieved after some essential modifications were incorporated. Arrangements for sewerage, though they do not cover the entire population, have been expanded and improved, and are working well. Institutional strengthening, while not very effective, left behind documentation that has brought about some improvements. Further interventions will be necessary to achieve the envisaged impacts. To derive the best health and economic benefits from water and sanitation and promote livelihood and environmental improvements, a more intensive program for raising awareness amongst the people of Majuro on hygiene and within the government and the management of MWSC on policy issues is needed. Overall, the Project met its objectives and therefore is assessed as efficacious. The updated framework on objectives and components is provided in Appendix 6.

C. Efficiency in Achievement of Outputs and Purpose

43. The two loans with their onlending arrangements would have compounded MWSC's financial difficulties. MWSC was to assume the foreign exchange risk on both loans, and pay a mark-up to the Government of 5.6% and 5.9% respectively on the TA Loan 1250-RMI (SF) and Loan 1389-RMI (SF). The first TA loan financed the consulting services for the detailed design of the components constructed under the second loan. No fixed assets were created under this loan. At present, MWSC does not have adequate revenue generation to pay the debt service due on TA Loan 1250-RMI (SF). Technically MWSC is in default, although the Government has not yet invoiced MWSC for payment. Under Loan 1389-RMI (SF), the Project provided the infrastructure and improved the water delivery system but has provided limited opportunities to increase revenues without tariff adjustments. Actual water consumption and billed charges for

FY1997 were only about 51% of those projected. The number of active connections actually decreased from 1,466 in 1996 to 1,455 in 2002. Inactive connections increased from 1,193 in 1996 to 1,609 in 2002. It is very probable that many of those disconnected are among the poorer segment of the community. The objective of serving the poor therefore, is perhaps not being achieved at present. Those disconnected meet their needs mostly through rainwater harvesting.

44. Some of those who were disconnected indicated that they would progressively pay up their arrears and would likely consume water carefully when reconnected. The high tariff may fortuitously conserve water. The water tariff adopted in Majuro is provided in Appendix 7 while Appendix 8 provides a brief account on the findings of the PCR Mission on the impacts of this tariff. Appendix 9 shows a comparison between raw water available versus treated water.

45. Under the new lease franchise agreement, MWSC is now responsible for operation and maintenance as well as improvement of the government-owned assets for water supply and sewer/saltwater systems as an operating concessionaire. The Government will retain the assets created under this project loan. Along with the assets, the Government will also retain the debt-servicing arrangements and schedules as contained in the Loan Agreement. MWSC pays an agreed fee per annum to the Government. This arrangement is expected to strengthen the independence of MWSC from the Government and facilitate privatization at a future date, and is therefore considered satisfactory.

46. The reorganization of MWSC requires further attention. The organization chart is presented in Appendix 10. From the board of directors, the line of command passes vertically down through the acting general manager, to the manager, to the administration manager, and only divides thereafter. No post or job descriptions and classifications have been carried out or qualifications and experience identified for a post. Record keeping has improved. However, retrieving information, and reviewing progress and the financial health of the operations appear to be stymied, perhaps due to limitations in interest and capacity of staff. If not remedied, improvement in the quality of service provided by MWSC and growth in revenue generated will also be halted (para. 50).

47. In terms of a financial and economic evaluation, MWSC has consistently had severe liquidity problems, having incurred net losses from well before commencement of the Project. Independent audit reports have repeatedly given the view that MWSC has suffered recurring losses from operations and has a net capital deficiency that raise substantial doubt about its ability to continue as a going concern. An independent review conducted by ADB with the help of a staff consultant[7] in June of 1998 confirmed that MWSC was in a precarious financial position with negative equity and operating at a substantial loss. The study went on to state: “The financial problems of MWSC are serious and warrant radical solutions being undertaken by the Government and management.”

48. The staff consultant in the June 1998 report recommended that MWSC be converted into a company, tasked to operate, maintain, and improve the government-owned water supply and sewer/saltwater system under a franchise or concession arrangement with the Government. The loan and assets created should remain with the Government with MWSC paying only the leasing/rental charges for use of the assets. A subsequent ADB mission reinforced these findings, and also confirmed that while MWSC had instituted the tariff increases, the average annual revenue had failed to show any improvement.

[7] Staff consultant's report (J. Block), Loan Review, June 1998.

49. With the actual population of Majuro having fallen, as evidenced by the recently conducted census, it is obvious that there is no likelihood of MWSC achieving the projections made during the appraisal in the foreseeable future. As discussed in the economic and financial analysis provided in Appendix 11, MWSC for the past several years has incurred financial losses even without paying for the loan charges in accordance with the SLA. MWSC is unlikely to make any significant financial returns in the next 5 to 7 years. At best, only breakeven on expenses can be expected. In this light, the project is assessed as inefficient.

D. Preliminary Assessment of Sustainability

50. The infrastructure installed under the Project has helped provide a better service in water supply and sewerage. However, the system was designed for a much larger population and greater demand than can possibly be seen in the medium term. MWSC for now will have to process and distribute only the volume of water required. While the distribution system now has greater capacity than before the Project, it is not supported by adequate capacity of the treated water reservoir. This limited reservoir capacity is a bottleneck in the distribution system, as all treated water has to be distributed immediately. Further, during the 1991–92 droughts the US Government's Federal Emergency Management Agency (FEMA) provided most households with rainwater catchment tanks, reducing the incentive to pay for the connection to the MWSC supply system.

51. For financial sustainability, MWSC needs to keep costs down and be efficient in billing and collection and in containing water leakages. The percentage of unaccounted-for metered treated water is approximately 39.5%. However, if the losses in the section from Laura to the treatment plant C. were taken into account the estimated unaccounted-for water would be as high as 50%. Metering of consumers in the section to Laura must be completed and some bulk meters need to be installed to obtain a measured figure of unaccounted-for water. The overall collection efficiency at present is about 73%. The wage bill represents 52% of the operating costs. Staff per 1,000 connections (water and sewerage) is high at 18. The Asian average is about 12. Staff economies need to be keenly pursued.

52. Electricity represents about 16% of costs. Due to the flat terrain of Majuro and the nature of the catchments, every gallon of water distributed needs to be pumped four or five times from point to point before it reaches the consumer. Pumping arrangements are energy efficient when discharging against a constant pressure. The two major pumping arrangements in Majuro discharge directly into the distribution system that is known to have continuously varying pressure. To be energy efficient and efficient in operations, the recommended approach for pumping is to use elevated storage tanks, strategically located in the distribution area from which the distribution system would be gravity fed. From the available information, while the option of elevated tanks appears to have been reviewed, it was dismissed by the consultants in preference over the current system. Further analysis of the pumping arrangements is necessary.

53. The updated project benefits and evaluation framework are provided in Appendix 12. The overall sustainability of the Project depends on several factors, some of which are external to MWSC, such as economic conditions, population growth, ability to raise tariffs, etc. Aside from these there are also questions of capacity within the management, which depends heavily on individual performance. Therefore, the sustainability of the Project is assessed as less likely unless further measures are taken to strengthen management and financial capability, leading toward ultimate privatization.

E. Environmental, Sociocultural, and Other Impacts

54. Despite preparatory activities and prior notices issued for public meetings to inform, discuss, and educate on water use and conservation, water tariffs, and affordability and rights of access to water resources, the response from the local population was poor. There are apparently cultural impediments to such gatherings. After considerable effort, the community has accepted metered billings and most active connections are now metered.

55. The design and civil works had no adverse environmental impact on Majuro. To ensure that there were no environmental issues raised during construction of the treated water storage reservoir and raising of the reservoir walls, all prior clearances needed from the Environmental Protection Authority were obtained and the work was carried out without hindrance.

56. With the installation of the new filters in the airport area and near the hospital treatment plant, the old filters are now in disuse and corrosion has set in. These have remained in their original location occupying space, have become an eyesore, and could become an environmental hazard. These should be dismantled and removed.

57. The roof of the treated water reservoir that was installed as a project component is of plastic material. It dips in the center and so collects rainwater, which has to be pumped out. A leak in this roof could allow intrusion of untreated water. With some redesign, the roof could be used as a good catchment source for raw water, allowing rainwater to flow down the roof slopes by gravity into the raw water tanks. The same could apply to the Laura water tank roof which is much smaller and easier to rectify within the means of MWSC.

58. The rehabilitation of the sewerage system has been helpful in arresting sewage overflows, which were causing health hazards and degrading the environment. The households that are not connected to a sewer but have toilets flushed with saltwater into a septic tank could have saltwater soaking into the soil and groundwater. Whether this would have a major adverse environmental impact on the soil and groundwater over time requires review.

59. As a water supply utility, MWSC is expected to conduct its business in accordance with sound administrative, financial, environmental, and water and sewerage practices. While these practices were sometimes compromised, the staff of MWSC have decided to work toward this goal in earnest and have included it as an activity to be monitored at regular progress meetings. In general, the Project has significantly improved sanitation though it has been unable to cover the entire atoll. Improved sanitation, together with improved availability of water, is expected to improve the quality of life on the atoll. Overall, the other impacts of the project are significant.

IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

A. Overall Assessment

60. The basic objective of the Project—enhancing water supply and sewerage for Majuro—has been achieved, albeit using an overdesigned and high-cost technical solution. The supply of saltwater for flushing toilets has brought environmental benefits but also saved the limited freshwater resources for freshwater needs. All project components have been carried out except for the development of new groundwater wells at Laura well field. The funds saved were reallocated for a higher priority need for arresting the leaks in the existing reservoirs and in enhancing the pumping capacity at the waterworks near the airport.

61. MWSC is better organized than it was before the Project in relation to systems and procedures, including preparation and storing of records, billing and collection, leakage detection, control of illegal connections, and attending to customer requests and complaints. There is, however, more to be done organizationally, in staffing and human resources development and reduction of operating costs.

62. The expansion of the water supply and sanitation facilities for Majuro have helped improve the quality and delivery of water and have significantly improved the sanitation by removing environmental nuisances. However, this came at a too high cost, and the use made is too inefficient and unsustainable. Appendix 13 lists recommendations that may help improve project performance. The Project is rated as partly successful.[8]

B. Lessons Learned

63. One of the major problems facing the implementation of this Project was lack of adequate consultation by the consultants and ADB both with the local community and the utility company. Most of the issues resulting from the projections that were highly optimistic could have been addressed if some effort had been made to verify the details through consultation during implementation. Some of the lessons learned are:

(i) Lack of adequate consultation at project preparatory stage and at design stage with the end user and other stakeholders can reduce the impact of a project. Consultations that cover type and level of proposed facilities, size, costs involved, probable tariffs, affordability, and willingness to pay are vital for the sustainability of the project;

(ii) Better understanding of local conditions, the operational setup of the utilities concerned, and the cultural environment in which the project will operate, are vital to proper design and implementation;

(iii) Applying the principles of full cost recovery and determining onlending rates must be properly evaluated, especially for small utilities with limited financial capacity;

(iv) The assumptions on revenue growth and tariff increases must be based on social indicators that are not unrealistically high;

(v) The project design and the consequent loan size must take into consideration the size of the utility and population of the project location. Over ambitious projects can become a burden of the government and the community;

(vi) When designing future assistance, the selection of the reservoirs and other materials to be used should take into account local knowledge on atmospheric conditions (which is highly corrosive in locations like Majuro);

(vii) In transferring water resources to other locations from areas where there are resource limitations, better understanding of political climate and in-depth consultations leading to proper agreements should be in place prior to project formulation;

[8] This PCR is part of a sample of PCRs independently reviewed by the Operations Evaluation Department. The review has validated the methodology used and the rating given.

(viii) A single turnkey contract, while easier to implement, is not always the most effective and efficient way to implement a multiple component project such as this;

(ix) In the absence of such an in-depth review and analysis, accepting the continuation of detailed design consultants to continue with supervision of construction must be made with much circumspection; and

(x) For smaller communities, much greater analysis is required before designing tariffs, particularly when alternative sources of water are accessible.

C. Recommendations

1. Project-Related

64. MWSC is not in a position to bear any further loan financing but still requires further improvements to the system, if only to enhance the effectiveness of the Project. Such assistance needs to be financed under a TA grant, either by ADB or alternate sources. Some of the areas where such assistance can be used are:

(i) Redesign and correction of the treated water reservoir roof and the storage tank at Laura;

(ii) Review and evaluate the possibility of obtaining better value from the reservoir (standpipe) constructed and is presently unutilized and corroding;

(iii) Monitor and analyze environmental impact of saltwater from septic tanks to the soil and groundwater;

(iv) The roof of the Laura pump house needs to be modified to enable the pumps to be removed without the need for removal of the present roof when such repairs are necessary;

(v) A proper storeroom at Laura to store the bleaching powder is needed;

(vi) Dismantling and removal of abandoned filters at the airport and hospital treatment plants;

(vii) Clearance of some of the valve chambers, on the new transmission line to Rita now covered by a new road; and

(viii) A separate distribution line from the airport to the Laura pump house area should be considered. At present, water is distributed through the transmission (pumping) main.

(ix) MWSC staff would greatly benefit from a capacity-building intervention under their present operations.

2. General

(i) For small communities with a limited financial base and institutional support framework, movement from first assessment (PPTA) to detailed design should be after careful review and analysis, particularly on sizing of the project and projections of demand and revenue generation. ADB should also verify the veracity of the findings of the consultants.

(ii) While there is some merit in assigning the consultants for detailed design to continue to assist with construction supervision, this should be done with much circumspection. It is important to be adequately confident that the project as designed is commensurate with the project location (small, medium, or large town, strength of financial base) and the community to be served; and

(iii) A review mission should be fielded at the end of project construction and before the disbanding of the implementing organization and staff, in order to ensure that all the information and knowledge needed to carry out a PCR and if needed, a PPAR, are available.

PROJECT COMPONENTS AS APPRAISED AND AS CARRIED OUT

	As Appraised	As Carried Out
A	**Improvements to the Airport Water Catchment Facilities**	
(1)	Construction of a larger capacity delivery pipeline from the airport rainwater catchment to the raw water storage reservoirs at the airport area	Done
(2)	Replacement of existing water transmission pumps from the airport rainwater catchment to the raw water storage reservoirs to double the present capacity	Done
(3)	Installation of an automatic pump shutoff and alarm system to be activated in the event of saltwater detection in the airport rainwater catchment by the existing monitoring system	Done
B	**Laura Well Field Development**	
(1)	Construction of three new wells	Not done. Funds transferred instead for expansion of raw water storage and pumping at Airport waterworks
(2)	Installation of two new pumps to increase the transmission pumping capacity'	Done, but carried out outside the loan
C	**Rain water and Treated Water Storage**	
(1)	Construction of a new water storage reservoir	Done
(2)	Raising the height of two existing reservoirs to provide additional storage of about 45,000 cubic meters (m^3)	Done
(3)	Raising the height of the new treated water reservoir to provide additional storage of about 5,700 m^3 Provide a cover for the reservoir to prevent contamination	Done. Designed liner unsuitable and a liner suitable for the need substituted successfully
(4)	Construction of a new elevated water storage tank at Delap-Uliga-Darrit (DUD)	Done but not used. Designed and constructed to perform as a pressure regulating reservoir but did not serve the purpose. Presently idling
(5)	Demolition of three deteriorated and unsafe water towers at DUD/Rita	Done
(6)	Review of the water storage at DUD to optimize or increase the available storage through the extension of existing facilities or construction of new facilities	Done
(7)	Not included in appraisal of loan	Liners of two existing storage tanks replaced to arrest leaks with unused funds from Laura well field

	As Appraised	As Carried Out
D	**Water Transmission and Distribution**	
(1)	Construction of about 14.6 kilometers (km) of water transmission pipeline ranging from 200 to 300 millimeters (mm) in diameter from the water treatment plant at airport to DUD	Done
(2)	Interconnection of the existing distribution mains to the above transmission main	Done
(3)	Distribution bulk meters	Done. However the type of meter installed requires watertight chambers. Constructed chambers fill up during rains and so the meters are inoperative. More robust type meters needed
E	**Improvements to Freshwater Treatment and Pumping Facilities:**	
(1)	Rehabilitation of the water treatment plant near the Airport including two new filters, and replacement of filter feed pumps	Done
(2)	Construction of new operations and storage building	Done
(3)	Replacement of bulk flow meters	Done
(4)	Repair, upgrading, and replacement of pipe work, electrical equipment and instrumentation	Done
(5)	Rehabilitation of the water treatment plant near the hospital with installation of a new filter, replacement of deteriorated pump control equipment, and replacement of filter feed pumps	Done
(6)	New chlorination equipment at existing water treatment plants at the Laura well field	Done
(7)	Not included in appraisal of loan	Existing water transmission pumps replaced with new higher capacity pumps with unused funds from Laura well field
F	**Upgrading and Expansion of the Seawater Distribution System:**	
(1)	Replacement of isolating valves	Done
(2)	Construction of two pumping stations	Done
(3)	Construction of about 7 km of new distribution pipelines	Done
(4)	Installation of service connections	Done
(5)	Installation of fire hydrants	Done

	As Appraised	As Carried Out
G	**Rehabilitation of the Sewerage System:**	
(1)	Replacement of submersible pumps and communitors at four sewage-pumping stations with self priming centrifugal pumps	Done
(2)	Construction of protective sheds to house the new pumping equipment	Done
H	**Institutional Support and Consulting Services**	
(1)	Institutional support to the project management office	Provided
(2)	Consulting services to assist in project supervision	Provided
(3)	Initiatives to improve cost recovery	Done and continuing as it is a continuous activity
(4)	Development of groundwater resources	Not done. Funds instead used for higher priority needs at Airport waterworks
(5)	Support services	Provided
(6)	Service vehicles and equipment	Provided

PROJECT OUTPUTS

1. The Mission concluded that the Project has achieved its main objective of enhancing safe and reliable water supply and improved sewerage for Majuro. Most of the components of the project have achieved the expected impacts. However, the project encountered serious design problems and implementation difficulties arising from the lack of consultation between the end-user, the EA and ADB during the entire project cycle.

(a) Improvements to the Airport Water Catchment Area

2. Existing water transmission pumps were replaced improving the water pumping capacity to the reservoirs. The pipeline was replaced to further augment the delivery capacity. However, the Mission noted that the automatic shutoff and alarm system to prevent saltwater intrusion to the raw water storage tank were not replaced. Subsequently, the automatic shutoff and saltwater alarm system were separately installed outside of the loan. The need for this component was confirmed by the end-user. The project inputs under this component were found to be generally satisfactory.

(b) Laura Well Field Development

3. There was an unresolved technical issue as to the ability of the lenses in Laura to support additional wells and consequent increased extraction. Local geological conditions of the aquifer appeared not to retain sufficient water for increased extraction during the dry season when water was most needed. The utility company was also of the view that optimum extraction of the water from the Laura lenses could be achieved by suitable modifications to the pumping arrangements without drilling additional wells. Additionally, increasing the storage capacity near the airport and arresting major leaks occurring in existing reservoirs at this location were considered by the utility to be of much higher priority and value than more wells at Laura (see para. 9)

4. There had also been inadequate consultation at the time of project preparation with the local community in Laura with regard to drilling of additional wells for increased extraction. As a result, when the Laura wells were to be constructed, objections were raised by the local community on water sharing and related issues. Government was also unwilling to proceed with the development. After protracted negotiations between the EA, the utility company and the ADB, the Laura well component was cancelled and the funds were reallocated.

5. In consideration of the above, the ADB agreed to the cancellation of this component.

(c) Raw Water and Treated Water Storage

6. The new raw water storage reservoir and raising the height of the walls of two existing storage reservoirs was completed satisfactorily. The lining of the new treated water reservoirs as designed was unsuitable and was also redesigned and replaced. With the funds reallocated, the linings of two of the existing reservoirs were also replaced arresting major leaks. The Utility as the end-user is of the opinion that this increased storage capacity has been one of the most significant contributions towards meeting the project objectives.

7. The elevated reservoir included in the original plan was abandoned. It was subsequently replaced by a reservoir (standpipe) for pressure regulation as part of the new 14.6 km

transmission system. This arrangement did not solve the low water pressure problem at Rita. Investigations and consultations undertaken by water distribution experts eventually confirmed the findings of the local utility that the use of this standpipe would not resolve the low water pressure problem at the Rita end of the atoll. Finally the pressure problem of the water supply to Rita was resolved by simply changing the main distribution pumps and disconnecting the standpipe at Delap-Uliga-Darrit (DUD).

(d) Water Transmission and Distribution

8. The construction of the 14.6 km water transmission pipeline which by then had been completed with interconnections to the existing distribution main now provides helpful operational and maintenance flexibility.

(e) Improvements to Freshwater Treatment and Pumping Facilities

9. The various subcomponents related to the water treatment plant near the airport were completed including the construction of a new operations and storage building. However, the replacement of the bulk flow meters and associated repair were not undertaken under the loan. This was later accomplished through separate funding. The mission noted that the facilities under this component were operational and met the project objectives. This was also confirmed by the utility company.

(f) Upgrading and Expansion of the Seawater Distribution System

10. All subcomponents including the 7 km. of saltwater distribution pipeline was completed satisfactorily and helped to improve the saltwater distribution system in Long Island. This resulted in large savings of treated water otherwise used for flushing toilets.

(g) Rehabilitation of the Sewerage System

11. Five pump houses were rehabilitated. The pumps were replaced and new pipe work was carried out. However, these changes did not achieve the stated results and had to undergo design modifications. The rectification was done through variation orders for which the contractor subsequently submitted additional claims.

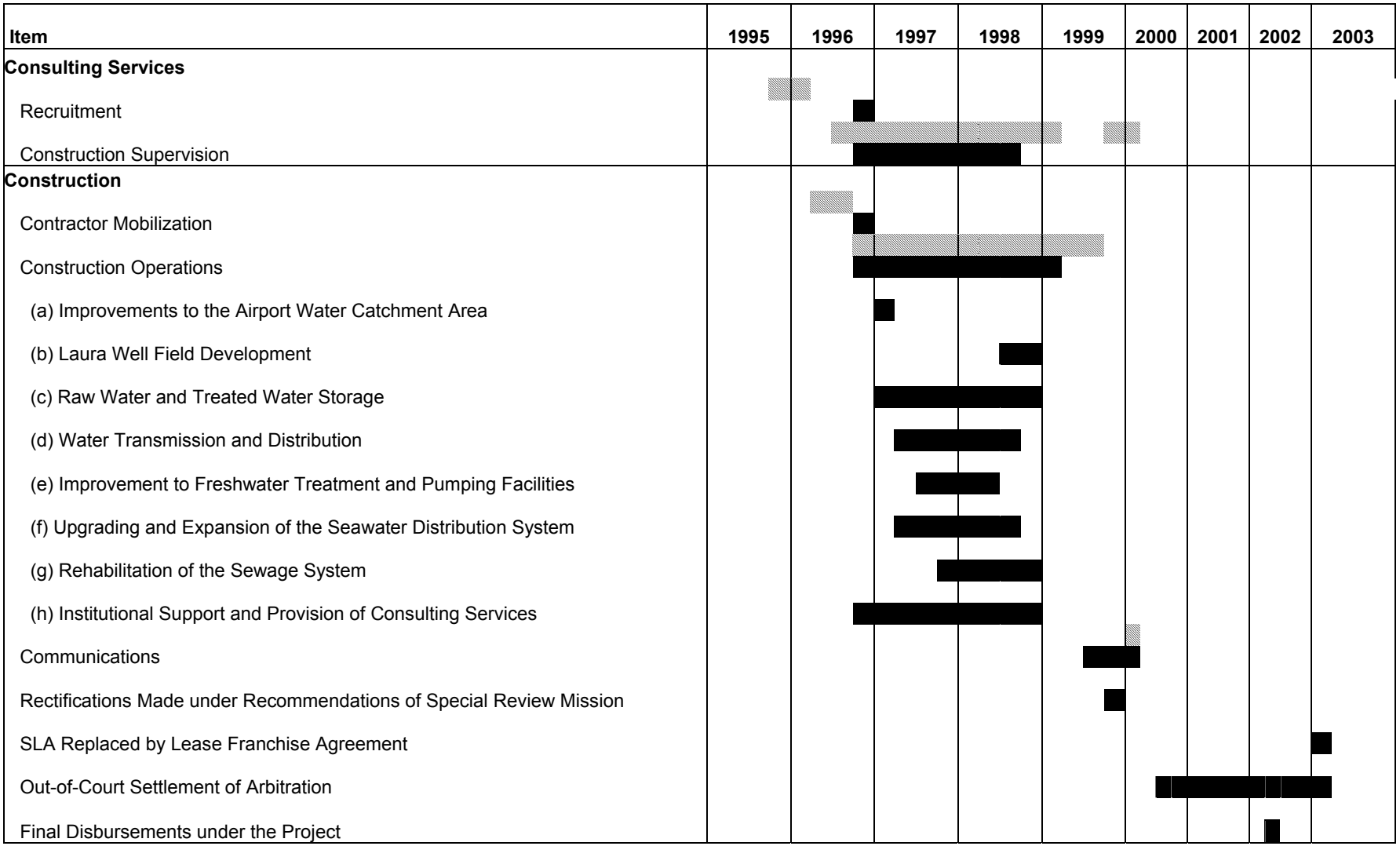
(h) Institutional Support and Provision of Consulting Services

12. The PMO was established in time with qualified personnel. The project manager appointed was the incumbent general manager for the MPW and therefore was expected to have first hand knowledge of the working conditions in Majuro. However, his overall performance especially in terms of relationship with the end-user could have been better. Many of the technical issues and subsequent problems could have been resolved at an earlier stage.

13. The consultants for groundwater investigation and design, a total of 8 person-months, were not engaged due to the cancellation of the Laura well field development component. For construction supervision, the service of a full-time construction supervision engineer was retained for the entire duration of the project. The inspector, who was supposed to assist the supervision engineer, was not recruited. Instead, the service of the construction engineer was extended over a period of 40 person-months.

IMPLEMENTATION SCHEDULE

(Loan Effective: 30 September 1996; Loan Closed: 20 April 2002)



SLA = subsidiary loan agreement.

Legend: Appraisal Actual

DETAILED STATUS OF COMPLIANCE WITH LOAN COVENANTS

Description	Status
1. The Borrower shall cause the MRD and Majuro Water and Sewer Company (MWSC) to carry out the Project with due diligence and efficiency and in conformity with sound administrative, financial, engineering, environmental, and health service delivery practices. L.A. Section 4.01 (a).	Complied with
2. In carrying out of the Project and operation of the project facilities, the Borrower shall perform, or cause to be performed, all obligations set forth in Schedule 6 to this Loan Agreement. L.A. Section 4.01 (b).	Partly complied with
3. The Borrower shall make available to MWSC, promptly as needed, and on terms and conditions acceptable to the Asian Development Bank (ADB), the funds, facilities, services, land, and other resources which are required, in addition to the proceeds of the loan, for the carrying out of the Project. L.A. Section 4.02.	Complied with
4. The Borrower shall ensure that the activities of its departments and agencies with respect to the carrying out of the Project and operation of the project facilities are conducted and coordinated in accordance with sound administrative policies and procedures. L.A. Section 4.03.	Complied with
5. The Borrower shall maintain, or cause to maintained, records and accounts adequate to identify the goods and services and other items of expenditure financed out of the proceeds of the loan, to disclose the use thereof in the Project, to record the progress of the Project (including the cost thereof) and to reflect in accordance with consistently maintained sound accounting principles, the operations and financial condition of the agencies of the Borrower responsible for the carrying out of the Project and operations of the project facilities, or any part thereof. L.A. Section 4.04 (a).	Partly complied with. While project costs by loan category was maintained, records do not provide sufficient details to identify costs by components
6. The Borrower shall (i) maintain, or cause to be maintained, separate accounts for the Project; (ii) have such accounts and related financial statements audited annually, in accordance with appropriate auditing standards consistently applied by independent auditors whose qualifications, experience and terms of reference are acceptable to ADB: (iii) furnish to ADB, as soon as available but in any event not later than nine	Complied with

Description	Status
months after the end of each related fiscal year, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto (including the auditor's opinion on the use of the loan proceeds and compliance with the procedures for imprest account and statement of expenditures), all in the English language: and (iv) furnish to ADB such other information concerning such accounts and financial statements and the audited thereof as ADB shall from time to time reasonably request. L.A. Section 4.04 (b).	
7. The Borrower shall enable ADB, upon ADB's request, to discuss the Borrower's financial statements for the project and its financial affairs related to the Project from time to time with the Borrower's auditors, and shall authorize and require any representative of such auditors to participate in any such discussions requested by ADB, provided that any such discussions shall be conducted only in the presence of an authorized officer of the Borrower unless the Borrower shall otherwise agree. L.A. Section 4.04 (c)	The Government had confirmed its commitment
8. The Borrower shall furnish, or cause to be furnished, to ADB all such reports and information as ADB shall reasonably request concerning (i) the loan, and the expenditure of the proceeds and maintenance of the service thereof; (ii) the goods and services and other items of expenditure financed out of the proceeds of the loan; (iii) the Project; (iv) the administration, operations and financial conditions of MWSC and MRD and other agencies of the Borrower responsible for the carrying out of the Project and operation of the project facilities, or any part thereof; (v) financial and economic conditions in the territory of the Borrower and the international balance-of-payments position of the Borrower; and (vi) any other matters relating to the purposes of the loan. L.A. Section 4.05.	Complied with
9. The Borrower shall enable ADB's representatives to inspect the Project, the goods financed out of the proceeds of the loan, and any Relevant records and documents. L.A. Section 4.06.	Complied with
10. The Borrower shall take all action which shall be necessary on its part to enable MWSC to perform its obligation under the Project Agreement, and shall not take or permit any action which would interfere with the performance of such obligations. L.A. Section 4.07.	Complied with

Description	Status
11. The Borrower shall exercise its rights under the subsidiary loan agreement (SLA) in such a manner as to protect the interests of the Borrower and ADB and to accomplish the purposes of the loan. L.A. Section 4.08 (a).	Not complied with. The SLA was substituted with a lease franchise agreement which was determined to be more appropriate
12. No rights or obligations under the SLA shall be assigned, amended, abrogated, or waived without the prior concurrence of ADB. L.A. Section 4.08 (b).	Complied with
13. It is the mutual intention of the Borrower and ADB that no other external debt owned a creditor other than ADB shall have the priority over the loan by way of lien on the assets of the Borrower. To that end, the Borrower undertakes (i) that, except as ADB otherwise agree, if the lien shall be created on any assets of the Borrower as security for any external debt, such lien will ipso facto equally and ratably secure the payment of the principal of, and service charge and any other charge on, the loan; and (ii) that the Borrower, in creating or permitting the creation of any such lien, will make express provision to that effect. L.A. Section 4.09 (a).	Complied with
14. The provisions of para. (a) of this Section shall not apply to (i) any lien created on property, at the time of purchase thereof, solely as security for payment of the purchase price of such property; or (ii) any lien arising in the ordinary course of banking transactions and securing a debt maturing not more than 1 year after its date. L. A. Section 4.09 (b).	Complied with
15. The term “assets of the Borrower” used in para. (a) of this Section includes assets of the Borrower and assets of any political subdivisions or any agency of the Borrower and assets of any agency of any such political subdivision, including the Central bank made established by the Borrower and such term includes assets held on behalf of the Borrower with any foreign or local commercial bank or institutions for the time being performing the functions of a central bank for the Borrower. L.A. Section 4.09 (c).	Complied with
16. The following are specified as an additional event for suspension of the right of the Borrower to make withdrawals from the loan Account for the purposes of Section 8.02 (1) of	Not complied with. MWSC was in default, however, ADB did not impose

Description	Status
the loan Regulations: MWSC shall have failed to perform any of its obligations under the SLA. L.A. Section 5.01	suspension. The SLA was replaced with a lease franchise agreement.
17. The following is specified as an additional event for acceleration of maturity for the purposes of Section 8.07 (d) of the loan Regulations: the event specified in Section 5.01 of this Loan Agreement shall have occurred. L.A. Section 5.02	Not complied with. Not enforced
18. The Minister of Public Works shall bear overall responsibility for project execution. Under the supervision of the Minister, the General Manager of MWSC shall implement the Project with the assistance of a project manager. L.A. Schedule 6, para. 1	Complied with
19. Pursuant to arrangements established under the TA Loan Agreement, the Borrower shall continue to cause MPW to utilize a project management office (PMO) and continue the appointment of a qualified and experienced project manager as the head of the PMO and at least one technical and one administrative officer to serve in the PMO under the supervision of the project manager. L.A. Schedule 6, para. 2	Complied with
20. The Borrower shall continue to utilize a project implementation committee (PIC) chaired by the Minister of MPW and with membership consisting of the Administrative Manager and representative of the board of directors of MWSC, the General Manager and senior staff of MPW, and representatives of the Office of the President and the Ministry of Finance and other agencies appointed by the Borrower. The project manager shall be the secretary of the PIC. The PIC shall meet as required but at least once every three months. L.A. Schedule 6, para. 3	Complied with
21. Except as ADB may otherwise agree, the Borrower shall ensure that land required for the construction of the new water storage reservoir, sea water pumping stations, and ancillary works is made available before 30 April 1996 and that land required for the construction of new water wells at Laura is made available before 31 January 1997. L.A. Schedule 6, para. 4	Delayed compliance
22. Except as ADB may otherwise agree, the Borrower shall ensure that before 30 April 1996 new enabling legislation for MWSC is introduced in the Nitjela with provisions strengthening	Complied with

Description	Status
the financial structure of MWSC and permitting appointment of the new members of MWSC's board of directors representatives of the private sector. L.A. Schedule 6, para. 5	
23. Except as the Borrower and ADB otherwise agree, the Borrower and MWSC shall, after an exchange of view among the Borrower, MWSC and ADB, but prior to the Effective Date, provide evidence satisfactory to ADB demonstrating that the Laura landowners and their families annually receive only limited amounts of free water for their personal use or some other form of royalty, that such landowners and their families pay for amounts of water exceeding such limited amount for personal use purposes, and that MWSC is adequately compensated for all free water and, if applicable, royalties provided by MWSC to such landowners an their families. L.A. Schedule 6, para. 6 (a)	Complied with. Free water was provided to Laura landowners but government's compensation to MWSC was delayed
24. The Borrower and MWSC shall continue to take all necessary action, including consultations with ADB and timely approval of retail tariffs, to ensure that the revenues MWSC are sufficient to satisfy the conditions specified in para. 7 of Schedule 6 to the Loan Agreement. L.A. Schedule 6, para. 6 (b)	Not complied with. While the tariffs were periodically reviewed the tariffs were not raised as they were already very high compared to most countries in the region
25. Commencing in fiscal year 1996/97, the Borrower shall cause MWSC to review tariffs annually to ensure the operating and maintenance, excluding depreciation and applicable loan financing costs are met and the Borrower shall annually adjust tariffs accordingly. L.A. Schedule 6, para. 7(a)	Not complied with. Same as in para. 24
26. Before 31 December 1997, the Borrower shall cause MWSC to introduce stepped or appropriate sliding scale tariffs. L.A. Schedule 6, para. 7(b)	Not complied with. Sliding scale not considered appropriate for the local conditions
27. Commencing in fiscal year 1996/97, the Borrower shall cause MWSC to establish a system classifying its customers as residential, commercial, or governmental, making provision to write off overdue accounts more than 2 years old and setting aside each year funds to cover losses attributable to estimated uncollectible payments within one month of the Effective Date. L. A. Schedule 6, para. 8 (a)	Complied with
28. The Borrower shall cause MWSC to take all necessary measures to improve its collection efficiency to achieve the	

Description	Status
following targets:	
(i) more than 75% of current monthly billings before 30 September 1996;	Complied with
(ii) more than 85% of current monthly billings before 30 September 1997; and	Complied with
(iii) (iii) more than 90% of current monthly billings before September 1998.	Not complied with. Considered unrealistic by MWSC
L.A. Schedule 6, para. 8 (b)	
29. The Borrower shall cause MWSC to take all the necessary measures to reduce its account receivable to less than three months of the current billings before 30 September 1998. L.A. Schedule 6, para. 9	Complied with
30. The Borrower shall cause MWSC to update annually MWSC's Capital Investment Program and Financial Plan (the Plan), provide ADB an opportunity to comment thereon within 1 year of the completion of the Plan for fiscal year 1996/97, and subsequently take ADB comments into account in implementing the Plan. L.A. Schedule 6, para. 10	Not complied with. The size and the cash flow of MWSC does not warrant a Capital Investment Program and Financial Plan
31. The Borrower shall cause MWSC to furnish to ADB by 30 June 1996 for comment a Plan to reduce unaccounted for water and take into account ADB comments on the Plan in taking all necessary measures to: (a) improve efficiency of its saltwater distribution system in order to reduce unaccounted-for-water to less 30% of production before 31 March 2000; and (b) improve the efficiency of its freshwater distribution system to reduce unaccounted-for-water to less than 25% of production before 30 September 2003. L.A Schedule 6, para. 11	Complied with but the formal plan was not submitted to ADB
32. The Borrower shall cause MWSC to take all necessary measures to ensure that all other targets established under the agreed upon Institutional, Operational and Financial Action Plan for MWSC are achieved as scheduled. L.A. Schedule 6, para. 12	Partly complied with. See attached list of compliance
33. MWSC shall second two technical staff to the PMO for training in the operation and maintenance of the facilities provided under the Project. L. A. Schedule 6, para. 13	Complied with

Description	Status
34. The Borrower shall continue to cause MWSC to hold participatory public meetings to discuss issues related to the Project, including health aspects of water use, water conservation, rights of access to water resources, water tariffs and affordability. In addition, the Borrower shall cause MWSC to inform ADB annually of steps taken by MWSC to improve community acceptance of the meterized billings and willingness to pay. L. A. Schedule 6, par. 14	Complied with but limited participation
35. During the preparation and implementation of the Project, the Borrower shall cause MWSC to comply with ADB's environmental requirements and with all applicable environmental laws, including obtaining necessary approvals with respect to environmental impact assessments. L.A. Schedule 6, para. 15 (a)	Complied with
36. Except as ADB may otherwise agree, the Borrower shall cause MWSC to prepare and furnish to ADB for comment by 30 June 1996 an Action Plan dealing with any involuntary resettlement issues which may arise during implementation of the Project. In implementing any such Action Plan, the Borrower shall cause MWSC to take ADB comments into account. L.A. Schedule 6, para. 15 (b)	Not applicable. There were no resettlement issues
37. Prior to implementing any reorganizations of MWSC, the borrower shall consult with ADB and take ADB comments into account in implementing any such reorganization. L.A. Schedule 6, para. 16	Not applicable
38. Within 15 months of the Effective date, the Borrower shall conduct a comprehensive Midterm Review in consultation with Representatives of ADB and consultants. The Borrower shall ensure that the Midterm Review (i) critically evaluates the Project's progress, the project implementation procedures, procurement, benefit monitoring and evaluation activities, the project consultant's performance, community participation activities, and the implementation of institutional improvements in MWSC: and (ii) formulate measures to remedy identified weaknesses, to ensure successful implementation and achievement of project objectives. The Borrower shall take into account ADB comments on the result of the Midterm review. L.A. Schedule 6, para. 17	Complied with. Midterm review undertaken 30 September – 10 October 1997
Note: The compliance status of the covenants under the Project Agreement is as indicated below. However, the activities as indicated were undertaken by the MPW/PMO as	

Description	Status
the Executing Agency and not MWSC. MWSC had no direct involvement in the implementation of the Project.	
39. MWSC shall, under the overall supervision of MPW, carry out the Project with due diligence and efficiency, and in conformity with sound administrative, financial, engineering, environmental and water and sewer utility practices. P.A. Section 2.01 (a)	Complied with
40. In carrying out of the Project and operation of the project facilities, MWSC shall perform all obligations set forth in Schedule 6 to the Loan Agreement to the extent that they are applicable to MWSC. P.A. Section 2.01 (b)	Complied with
41. MWSC shall make available, promptly as needed, the funds, facilities, services, equipment, land and other resources which are required, in addition to the proceeds to the loan, for the carrying out of the Project. P.A. Section 2.02	Complied with
42. In the carrying out the Project, MWSC shall employ competent and qualified consultants and contractors, acceptable to ADB, to an extent and upon terms and conditions satisfactory to ADB. P.A. Section 2.03 (a)	Complied with
43. Except as ADB may otherwise agree, all goods and services to be financed out of the proceeds of the loan shall be procured in accordance with the provisions of the Schedules 4 and 5 of the Loan Agreement. ADB may refuse to finance a contract where goods or services have not been procured under procedures substantially in accordance with those agreed between the Borrower and ADB or where the terms and conditions of the contract are not satisfactory of ADB. P.A. Section 2.03 (b)	Complied with
44. MWSC shall carry out the project in accordance with plans, design standards, specifications, work schedules, and construction methods acceptable to ADB. MWSC shall furnish, or cause to be furnished, to ADB, promptly after their preparation, such plans, design standards, specifications and work schedules, and any material modifications subsequently made therein, in such detail as ADB shall reasonably request. P.A. Section 2.04	Complied with
45. MWSC shall take out and maintain with reasonable insurers, or	Not complied with

Description	Status
make other arrangements satisfactory to ADB for, insurance of the project facilities to such extent and against such risks and in such amounts as shall be consistent with sound practice. P.A. Section 2.05 (a)	
46. Without limiting the generality of the foregoing, MWSC undertakes to insure, or cause to be insured, the goods to be imported for the Project and to be financed out of the proceeds of the loan against hazards incident to the acquisition, transportation and delivery thereof to the place of use or installation, and for such insurance any indemnity shall be payable in a currency freely usable to replace or repair such goods. P.A. Section 2.05 (b)	Not complied with
47. MWSC shall maintain, or cause to be maintained, records and accounts adequate to identify the goods and services and other items for expenditure financed out of the proceeds of the loan, to disclose the use thereof in the Project, to record the progress of the Project (including the cost thereof) and to reflect, in accordance with consistently maintained sound accounting principles, its operations and financial condition. P.A. Section 2.06	Partly complied with. While project costs by loan category was maintained, records do not provide sufficient details to identify costs by components
48. ADB and MWSC shall cooperate fully to ensure that the purposes of the loan will be accomplished. P.A. Section 2.07 (a)	Partly complied with. Limited interaction between MWSC and ADB
49. MWSC shall promptly inform ADB of any conditions which interferes with, or threatens to interfere with, the progress of the Project, the performance of its obligations under this Project Agreement or the SLA, or the accomplishment of the purposes of the loan. P.A. Section 2.07 (b)	Complied with
50. ADB and MWSC shall from time to time, at the request of either party, exchange views through their representatives with regard to any matters relating to the Project, MWSC and the loan. P.A. Section 2.07 (c)	Partly complied with. There had been expressions of views but adequate attempts to reach consensus seems to have been lacking
51. MWSC shall furnish to ADB all such reports and information as ADB shall reasonably request concerning (i) the loan and the expenditure of the proceeds thereof; (ii) the goods and services and other items of expenditure financed out of such proceeds; (iii) the Project; (iv) the administration, operations and financial condition of MWSC; and (v) any other matters relating to the	Complied with

Description	Status
purposes of the loan. P.A. Section 2.08 (a)	
52. Without limiting the generality of the foregoing, MWSC shall furnish to ADB quarterly reports on the execution of the Project and on the operation and management of the project facilities. Such form and in such detail and within such a period as ADB shall reasonably request, and shall indicate among other things, progress made and problems encountered during the quarter under review, steps taken or proposed to be taken to remedy these problems, and proposed program of activities and expected progress during the following quarter. P.A. Section 2.08 (b)	Complied with
53. Promptly after physical completion of the project, but in any event not later than three (3) months thereafter or such later date as ADB may agree for this purpose, MWSC shall prepare and furnish to ADB a report, in such form and in such detail as ADB shall reasonably request, on the execution and initial operation of the Project, including its cost, the performance by MWSC of its obligation under this Project Agreement and the accomplishment of the purposes of the loan. P.A. Schedule 2.08 (c)	Draft Construction Completion/Interim Report prepared by the PMO in January 1999
54. MWSC shall (i) maintain separate accounts for the Project and for its overall operations; (ii) have such accounts and related financial statements (balance sheet, statements of income and expenses, and related statements) audited annually, in accordance with appropriate auditing standards consistently applied, by independent auditors whose qualifications, experience and term of reference are acceptable with ADB; and (iii) furnish to ADB, promptly after their preparation but in any event not later than (9) months after the close of the fiscal year to which they relate, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto (including the auditor's opinion on the use of the loan proceeds and compliance with the covenants of this Loan Agreement as well as on the use of the procedures for imprest account and statement of expenditures), all in the English language. MWSC shall furnish to ADB such further information concerning such accounts and financial statements and the audited thereto as ADB shall from time to time reasonably request. P.A. Section 2.09 (a)	Complied with
55. MWSC shall enable ADB, upon ADB's request, to discuss MWSC's financial statements and its financial affairs from time	The Government had confirmed its commitments

Description	Status
to time with MWSC's auditors, and shall authorize and require any representative of such auditors to participate in any such discussions requested by ADB, provided that any such discussions shall be conducted only in the presence of an authorized officer of MWSC unless MWSC shall otherwise agree. P.A. Section 2.09 (b)	
56. MWSC shall enable ADB's representative to inspect the Project, the goods financed out of the proceeds of the loan, all other plants, sites, works, properties and equipment of MWSC any relevant records and documents. P. A. Section 2.10	Complied with
57. MWSC shall, promptly as required, take all action within its powers to maintain its corporate existence, to carry on its operations, and to acquire, maintain and renew all rights, properties, powers, privileges, and franchises which are necessary in the carrying out of the Project or in the conduct of its business. P.A. Section 2.11 (a)	Complied with
58. MWSC shall at all times conduct its business in accordance with sound administrative, financial, environmental, and water and sewer utility practices, and under the supervision of competent and experienced management and personnel. P.A. Section 2.11 (b)	Partly complied with. Environmental, water, and sewer utility practices were sometimes compromised
59. MWSC shall at all times operate and maintain its plants, equipment and other property, and from time to time, promptly as needed, make all necessary repairs and renewals thereof, all in accordance with sound administrative, financial, engineering, environmental, water and sewer utility, and maintenance and operational practices. P.A. Section 2.11 (c)	Complied with
60. Except as ADB may otherwise agree, MWSC shall not sell, lease or otherwise dispose of any of its assets which shall be required for the efficient carrying on of its operations or the disposal of which may prejudice its ability to perform satisfactorily of any of its obligations under this Project Agreement. P.A. Section 2.12	Complied with
61. Except as ADB may otherwise agree, MWSC shall apply the proceeds of the loan to the financing of expenditures on the Project in accordance with the provisions of the Loan	Complied with

Description	Status
Agreement and this Project Agreement, and shall ensure that all goods and services financed out of such proceeds are used exclusively in the carrying out of the Project. P.A. Section 2.13	
62. Except as ADB may otherwise agree, MWSC shall duly perform all its obligations under the SLA, and shall not take, or concur in, any action which would have the effect of assigning, amending, abrogating, or waiving any rights or obligations of the parties under the SLA. P.A. Section 2.14	Not complied with. SLA was never enforced and subsequently was replaced by a lease franchise agreement
63. MWSC shall promptly notify ADB of any proposal to amend, suspend or repeal any provisions of its Article of Incorporation and shall afford ADB and adequate opportunity to comment on such proposal prior to taking any action thereon. P.A. Section 2.15	Not applicable

TECHNICAL ASSISTANCE COMPLETION REPORT

Division: Pacific Operations Division

TA NO. AND NAME TA Loan No. 1250-RMI(SF) – Majuro Water Supply				**TA AMOUNT APPROVED:** $700,000 (SDR 503,000) **Revised Amount:** SDR 478,496	
EXECUTING AGENCY: Majuro Water Supply				**TA AMOUNT UNDISBURSED:** —	**TA AMOUNT UTILIZED:** $723,087
DATE:	**APPROVAL:** 9 Sep 1993	**SIGNING:** 17 Nov 1993	**FIELD** 22 Dec 1994	**CLOSING** **ORIGINAL:** 31 Mar 1995	**ACTUAL:** 30 Nov 1996

TA Description (Background and rationale)

Following years of underinvestment and a drought in 1992, the Government requested Asian Development Bank (ADB) assistance to meet urgent needs in the water supply sector for short- and medium-term improvement. Detailed engineering work had to be carried out in order to ensure a firm and cost-effective basis for a future loan project. In addition to critical measures concerning the organization and operation of MWSC, there were pending technical, legal and institutional issues to be resolved before ADB financing of construction facilities would be appropriate. The institutional issues were dealt with under TA 1946-RMI (Institutional Strengthening of MWSC) for $250,000.

TA Objectives And Scope

The objective of the TA was to assist the Government, through consulting services, in carrying out detailed design, environmental impact assessment, and contract documentation for an investment project in the water supply sector. The scope covered (i) assessment of the capacity of existing facilities, estimation of future water demand and determination of water storage requirements; (ii) necessary surveying and geotechnical investigations; (iii) detailed engineering design including preparation of cost estimates; (iv) preparation of prequalification and tender documents; (v) assistance in prequalification and tender evaluation; and (vi) preparation of an environmental impact assessment.

TA Inputs Evaluation

The inputs were carefully considered, planned and designed under the previous ADB TA 1775-RMI (Majuro Water Supply) for $100,000, which gave an initial analysis of both technical and financial issues. It was supplemented by missions and discussions with national authorities in order to formulate the TA loan. This step-by-step approach was necessary after a long period of neglect in the sector. A total of 32 person-months of consulting services was financed, including 2 person-months of a chief technical advisor, 20 person-months of engineering experts and 10 person-months of technicians. The Ministry of Public Works supplemented this by 24 person-months technical and administrative services by its own staff, for instance in surveying and geotechnical investigations. At the same time, institutional issues were addressed under an attached TA 1946-RMI which finished in May 1995.

TA Outputs Evaluation

The consultants satisfactorily completed the design work, preparation of cost estimates, and prequalification evaluation and tender documents. This included hydrogeological investigation work at Laura well fields, the only freshwater source on the atoll.

TA Overall Assessment/Rating

The TA loan is assessed as generally successful. It accomplished its purpose essentially as an elaborate PPTA and resulted in Loan No. 1389-RMI(SF): Majuro Water Supply and Sanitation for $9.2 million, approved in September 1995.

Major Lessons Learned

Though a small country, the Marshall Islands and its capital have severe institutional capacity problems, which needed to be addressed along with project-specific technical issues. Due to the low level of administrative capability, projects take longer to implement than foreseen. A relatively heavy TA component, using international consultants, was necessary to offset this.

Follow-Up Action and Recommendations

Recommendations under the TA loan were mainly incorporated in the new Water Supply Loan which is presently under administration. These aspects were studied, quantified, and costed under the TA loan, which was essentially to orderly progress the sector.

Prepared by: Paul McCabe Designation: Programs Officer/Economist

Staff Consultant Water Distribution Engineer's Report
October 1999

I. EXECUTIVE SUMMARY

1. A loan from the Asian Development Bank has been utilized for financing water supply and sewerage improvements in the atoll of Majuro, in the Republic of the Marshall Islands. The project is complete but there have been problems with lack of pressure in the upgraded freshwater distribution system. A staff consultant water supply engineer was commissioned by the Bank to investigate the reason for the lower pressures, recommend solutions to rectify the problem, and give an overview of the project with respect to design, specification, and quality standards. Information and support in country was given by the Majuro Water and Sewer Company (MWSC) who manage the system, and Mc Connell Dowell who were the contractors for the project.

2. Over the last few months the main urban area has been supplied freshwater 3 days per week for 14–16 hours each day. Residents at the Rita (eastern) end of the line tend to receive no water for the first 6–8 hours of pumping, and then low pressures for the later half of the pumping period while people in Long Island (near Treatment Plant C beside the airport) have enjoyed good pressure for most of the pumping period. If water was supplied to the main line (airport to Rita) on a continuous basis, demand for freshwater would be significantly greater than supply. A limited supply regime as is being practiced by MWSC is necessary.

3. A second water distribution line from Treatment Plant C (near airport) to within 1.3 km from the end of the line was constructed as part of the Project in 1998 together with a 400,000 gal storage tank at the end of the new line (referred to as the Rita stand pipe). There are 6 cross connections between the old water main and the new one, but no other connections to the new line.

4. Tests of the new distribution system by the Project Engineer in January and April 1999 resulted in lower pressures at Rita than anticipated.

5. Hydraulic analysis and testing by this consultant showed that the low pressure at Rita was being caused partly by flow being diverted to the Rita stand pipe, and partly through a lack of capacity of the existing pumps. With the stand pipe closed, acceptable pressures can be achieved with the existing pumps if the distribution system is divided into two and only half the system supplied at once. MWSC have been advised how to operate to achieve good pressure to both zones.

6. Recommendations include:

- Modifications to the operation of the system to achieve better pressure and flow distribution immediately. Including dividing the system into two pressure zones, and closing the valves to the stand pipe;
- Replace and upgrade the pumps at Treatment Plant C;
- Install a pressure sustaining valve at the stand pipe, and complete corrosion protection works;
- Repair the saltwater detection and diversion system at the airport catchment as intended in the Project;
- Continue with the intended expansion of the Laura well field with careful monitoring and management;

- Replace the bulk flow meter at Treatment Plant C as intended in the Project;
- Continue to encourage the use of individual rain water catchments;
- Develop strategies and systems for water resource management in dry periods as intended in the Institutional Strengthening Project;
- MWSC to plan for replacement of the old main distribution pipe line over the coming years;
- MWSC to finalize and adopt good asset management and maintenance systems.

7. A number of issues regarding the objectives, design and project management of the Project have been raised and discussed in Section III.

II. TECHNICAL REPORT

A. Introduction

8. A loan from the Asian Development Bank has been utilized for financing water supply and sewerage improvements in the atoll of Majuro, in the Republic of the Marshall Islands. Majuro is the principal port, seat of Government, and commercial center of the Marshall Islands. The atoll comprises a narrow strip of low lying land about 60 km long and accommodates about 28,000 people.

9. The project included improvements to the sewerage system, seawater reticulation system, freshwater catchment system, storage reservoirs, treatment and distribution systems. The issue addressed in this report relates to the freshwater distribution system. During the testing of the upgraded distribution system by the Project Engineer, it was reported that pressures in some areas of the supply network were lower than those delivered by the original system. These areas have had inadequate water pressure for some years now, and were expecting a significant increase in pressure from the new system.

10. A staff consultant water supply engineer was commissioned by the Bank to investigate the reason for the lower pressures, recommend solutions to rectify the problem, and give an overview of the project with respect to design, specification, and quality standards. The Terms of Reference for the consultant are summarized as follows:

- Familiarization with the Majuro water distribution system;
- Hydraulic analysis of the distribution system;
- Flow and pressure testing the distribution system;
- Determining the cause of the low pressure area and recommending modifications to the system or its operation to rectify the problem;
- Review the project with respect to design, specification and quality standards.

11. The investigation and reporting was undertaken by David Bouma of Tonkin & Taylor Ltd contracted to Fraser Thomas Ltd (New Zealand) from 2nd to 13th October 1999. A verbal briefing was received in Majuro from Tilak Sen (Senior Project Specialist, ADB), and assistance in Majuro was provided by management and staff of the Majuro Water and Sewer Company, and McConnell Dowell (The construction company who built the new system).

B. Water Availability and Demand

12. There are three main sources of freshwater available in Majuro:

(i) Groundwater lens at Laura (at the opposite end of the atoll from the main town). There are currently seven production wells of which four were in use in August 1999. Together they are capable of providing about 350,000 gpd[1] (1325 m^3/d) into the supply network. The water drawn from this source is varied by MWSC. Less is drawn during rainy periods and more during dry periods with the aim of allowing the groundwater lens to recover in the rainy periods. In August 1999 11.2" (284 mm) of rain fell, and MWSC drew on average 106,470 gpd (403 m^3/d) from the Laura wells. In 1995 the Project Consultants (Mink) carried out a hydrogeological study of the Laura lens and recommended that the well field be expanded to yield 600,000 gpd (2,270 m3/d). This expansion has not yet been done. In October 1998 the US Geological Survey reviewed the condition of the Laura lens and compared data with 1984 results. Their study indicates that the lens has shrunk in some places, and increased in others (away from the wells).

(ii) Airport rainwater catchment. The average yield from this catchment is estimated at about 660,000 gpd[i] (2,500 m3/day). The average volume pumped from the catchment to the reservoirs in August 1999 was 684,800 gpd. Rainfall for the month was 11.2" (284 mm).

(iii) Roof catchments. An estimated 2,800 households have some form of rainwater harvesting and storage. The estimated yield from these systems is 126,000 gpd[l] (475 m3/day). The efficiency of household collection systems is poor. If collection systems were improved, and more houses and institutions fitted with catchment and storage systems, the yield from this source could more than double. A number of large institutions and commercial facilities have significant roof catchment and storage facilities including the hospital and capitol building (which drain to the reservoir at treatment station A), and the Outrigger Hotel.

13. The total from these three sources is about 1,136,000 gpd, 69% from rainwater sources.

14. The demand for freshwater in the year 2000 was estimated by the Project Engineer at 1,349,000 gpd[2], and by Brockman & Block[i] at 1,140,000 gpd (4,300 m3/d).

15. Flow meter readings at the pump stations for August 1999 indicate the average daily demand pattern as follows:

• Laura to Airport	85,200 gpd
• Airport (meter unserviceable) estimate	40,000 gpd
• Airport to Rita	360,800 gpd
• To tankers	800 gpd
Total	**486,800 gpd**

However, the following factors must be taken into consideration:

- Rain fell frequently in August. Rain reduces demand due to private rainwater catchments.

[1] ADB. 1998. Review Report on Loan No. 1389-RMI (ADB. 1995. *Proposed Loan–Majuro Water Supply and Sanitation Projects (Marshall Islands*. Manila.), Manila.

[2] ADB. 1995. Majuro Water Supply Project Draft Design Report. Manila.

- Storage in the reservoirs increased by 1 million gallons over the month.
- There were only 13 days in the month when water was supplied to the main line (airport to Rita) for 14–16 hours per day. This gives an average demand on pumped days of 1,050,000 gpd.
- On October 2nd and 3rd the supply to the main line was left on continuously (i.e. 24 hour pumping) and the daily consumption on that line was 1.4 million gpd.
- There has been doubt cast over the accuracy of the flow meter measuring flow in the main line. The Project Engineer reported[3] that they had worked with MWSC staff to re-calibrate the meter.

16. If water was supplied to the main line (airport to Rita) on a continuous basis, demand for freshwater would be significantly greater than supply. A limited supply regime as is being practiced by MWSC is necessary.

C. Description of System Components and Operation

17. The Laura well field at the western end of the atoll pumps to a small storage reservoir from where it is distributed to Laura Island residents. Water not required in Laura is pumped to the storage reservoirs immediately east of the airport (distance approx. 35 km). Residents living between Laura and the airport draw water from this line.

18. Rainwater runoff from the airport is drained to a sump at Pump Station 4 from where it is pumped to the raw water storage reservoirs at the eastern end of the airport.

19. Raw water is treated at Treatment Plant C (located beside the reservoirs) and pumped to the airport (6” line), and to the main town including Long Island, Dalip, Uliga and Darrit/Rita through a 12""- 8” line (length 9,4 m or 15km).

20. A second water distribution line from Treatment Plant C (near airport) to within 1.3 km from the end of the line was constructed in 1998 together with a 400,000 gal storage tank at the end of the new line (referred to as the Rita stand pipe). There are 6 cross connections between the old water main and the new one, but no other connections to the new line.

21. A number of government buildings including the hospital and the capitol building have roof catchments draining to a reservoir, treatment plant, and pump station at Treatment Plant A. This system supplies water back to these buildings. Supply to the reservoir is supplemented through the main line from Treatment Plant C.

22. Four of the six wells in the Laura well field have been operated continuously. The other 2 wells are reported to be unserviceable.

23. MWSC has chosen not to operate the well field to its full capability during periods of frequent rain as many people have access to private rainwater catchments, and MWSC wish to allow the groundwater lens to recover during wet periods to ensure maximum yield during dry periods.

24. The distribution system from Treatment Plant C is being operated on an intermittent basis out of necessity (the demand for water is greater than supply). The new distribution line and stand pipe have not been used for other than testing purposes. Over the last few months

[3] ADB.1995. Majuro Water Supply Project Inception Report. Manila.

the main urban area has been supplied 3 days per week for 14–16 hours each day. Residents at the Rita end of the line tend to receive no water for the first 6–8 hours of pumping, and then low pressures for the later half of the pumping period while people in Long Island have enjoyed good pressure for most of the pumping period.

25. Most connections to the distribution system are metered. There are an unknown number of unauthorized connections.

D. Testing of Distribution System

26. The new distribution line was tested at up to 150 psi pressure for leakage during and after construction according the Specifications of the Contract. We understand that these tests were witnessed and approved by the Project Engineer.

27. The effectiveness of the new line and stand pipe was tested by the Project Engineer in January 1999, and again in April 1999. The documentation we have of these tests does not explain exactly which valves were open/closed and the number of pumps operating. However, we understand from MWSC that the initial test in January resulted in lower than normal water pressure in the problem area of Rita with the new system in use. The subsequent tests in April tried various combinations of valve settings and all three pumps running rather than the normal two. In the April test, the stand pipe was filled by pumping into it overnight, and the tests carried out with the stand pipe full at the start of testing. We understand that despite the additional pump, pressures remained inadequate at Rita.

28. A number of tests have been carried out as part of this study as described below:

(i) On 6th October 1999, the performance of the main delivery pumps at Treatment Plant C were tested by recording flow rate against pressure over a range from 30 to 100 psi. This information was used in the hydraulic model of the system (refer to Section E). It was hoped to also compare the performance of the pumps with the performance stated by the manufacturer. However, we were unable to find the technical manuals for the pumps in the MWSC files, and were unable to get the correct performance curve from the manufacturer.

(ii) On 8th October, the pressure distribution in the old supply line was measured at the beginning and end of the line and three places in between (McConnell Dowell yard, MEC power plant, and at the stand pipe) at two different flow rates. This information was used to calibrate the hydraulic model. The pressure at Rita reached 11 psi by 1:50 pm. Results are summarized in Table D.1 below.

(iii) The new distribution line was opened at the pump station (open GV-TPCN) during a normal pumping day and kept closed at the Rita stand pipe. The pressure meter at the stand pipe almost immediately recorded similar pressure to the pump station. This confirmed that the new line had remained filled with water since the last testing in April, and had no significant losses or open connections to the old line.

(iv) The old distribution line was then divided into two pressure zones by closing GV-X5OR at Kirt Pinho's apartments. Pressure at Rita dropped to zero. The new line was then used to supply the section from Rita to Kirt Pinho's apartments by opening GV-X6X. The valves into the stand pipe were kept closed. The pressure

at PG-Rita then rose to 13 psi with 20 at the stand pipe (PG-MHS). The flow rate at FM-TPC increased from 927 to 1052 gpm with the pressure in PG-TPC dropping from 50 to 34 psi. The pressure at the power station (PG-MEC) dropped slightly from 22 to 20 psi. Results are summarized in Table D.1 below. This result shows an improvement to the supply at the Rita end of the line.

(v) It was apparent from the previous test result that the significant increase in the capacity of the distribution system with the new line open caused a large increase in flow, and corresponding reduction of pressure at Treatment Plant C. This is because with only two pumps running, the pumps are struggling to keep up with the demand. The same configuration of two separate pressure zones was then tested with three pumps running. This resulted in 22 psi at PG-Rita, and 58 psi in PG-TPC. Refer to Table D.1 below.

(vi) At times it will not be possible to run three pumps simultaneously, and it may be desirable to supply one pressure zone at a time rather than both at once. To test this scenario the old line was closed at GV-TPCO and the Rita pressure zone supplied via the new line. This resulted in 32 psi at PG-Rita, 42 at PG-MHS, and 80 psi at PG-TPC with two pumps running.

(vii) To test the effect of the stand pipe on the supply pressures, the valves into the stand pipe were opened. At the time the tank was about 2/3rds full (about 10m depth). The pressure in the supply line at PG-MHS duly dropped to 18 psi (123 kPa).

(viii) One of the problems with the old distribution system was that the consumers at the Rita end of the line did not receive reasonable pressure until the pumps at TPC had been running for some 6–8 hours. On Monday 11 October, two pumps were started at 6:30 am with only the old supply lines open. At 9:30 the new line was also opened. This caused the pressure to drop to 20 psi at PG-TPC, but resulted in 6 psi at PG-Rita by 12:00. Although some pressure reached Rita perhaps earlier than it would have, it was clear that with only two pumps running, it was not possible to meet demand, and pressurize the whole system simultaneously. It will be necessary to either use three pumps to charge the system until pressure builds up to say 55 psi at TPC, and then cut back to two, or to only supply one pressure zone at a time with two pumps.

(ix) On 13 October, three pumps were used to pump to both lines simultaneously from start up. The pressure at Rita was 8 psi one hour after the pumps were started, and had built up to 14 psi after 4 hours. This shows a significant improvement to the supply at Rita but requires 3 pumps to achieve this result. Pressure in the old distribution line at the power plant had reached 18 psi, and at Treatment Plant C 46 psi. The flow rate over this period was 1320 gpm.

Table A5: Test Results, 10 October 1999

Test	Time	Configuration	No. of Pumps	Flow FM-TPC gpm	Pressure				
					PG-TPC psi	PG-MCD psi	PG-MEC psi	PG-MHS psi	PG-Rita psi
b1	11:30	Old distribution line	2	947	46	22	16	12	8
b2	2:00	Old distribution line	2	927	50		22	17	11
d	3:30	Both lines, two zones	2	1052	34	22	20	20	13
e	4:30	Both lines, two zones	3	1375	58	39	35	30	22
f	6:00	New line, Rita zone only	2	645	80	0	0	42	32
g	6:10	As f with stand pipe open	2	—	—	0	0	18	—
h	3:00	Starting with two lines open	2	1025	28	0	12	14	9
i	10:30 am	Starting with two lines open	3	1320	46	—	18	—	14

fm = flow meter, gpm = gallons per minute, MCD = Majuro Commercial District, MEC = Majuro Electric Company, MHS = Majuro High School, PG = pressure gauge, psi = pounds per square inch, TPC = Treatment Plant C.
There were discrepancies in flow meter readings at this station

E. Analysis of System

29. The main distribution system from Treatment Plant C to Rita has been modeled using CYBERNET software. The data used to create the model includes:

(i) Flow data derived from individual meter readings and TPC flow meter readings. Note that flow distribution information is probably not particularly accurate as it relies on MWCS meter information which is not easily sorted into distance down the Atoll;
(ii) Physical system data extracted from tender drawings (as-built drawings not available) and MWSC staff knowledge;
(iii) Pump test results (6 October 1999).

30. It is clear from flow and pressure data at the pump station that when the system is first started up after being off for a day or more, the demands on the system start off very high, and gradually decrease as storage tanks are filled. Some six hours after the pumps were started the system appears to reach a relatively steady state, with water being supplied throughout the system. We have not attempted to model the change in demand over time, but have focused on the supply pressures when the system is at a steady state.

31. The model was initially calibrated with flow and pressure data measured with only the old distribution line in use. With this regime the pressures are high at the Long Island end of the system (50 psi), and low at Rita (11 psi). The model calibrated well with the physical readings.

32. The model was then used to predict changes in the pressure distribution with the new line open, and the stand pipe closed. The model predicted significant increase in pressure at Rita with the new line open. However, the demands on the system had been set up to reflect the demand pattern recorded by the MWSC meters. As the Rita end of the system is typically only supplied for about half to two thirds of the pumping period, and at half the pressure, the recorded demand is significantly less than the actual demand. The demand pattern in the model was adjusted accordingly to increase the proportion of the demand at the Rita end of the system, and reduce the proportion at the Long Island end. The model then predicted a less

significant increase in the pressure rise at the Rita end. This was confirmed by field tests carried out on 8 October 1999.

33. The model results were compared with the scenario of three pumps running and higher pressures throughout the system, and the calibration adjusted slightly to suit.

34. The model was used to predict the effect of having the stand pipe open with various water levels. As expected, the model showed that with the stand pipe open, and not completely full, pressures in the Rita area are controlled by the water level in the tank. As the highest water level is about 55' (17 m), the maximum pressure that can be delivered with the stand pipe open and almost full is about 25 psi. Once the stand pipe is completely full, and the altitude valve closes, the pressure will increase. With the system being operated intermittently, the stand pipe will empty itself after the pumps are switched off by continuing to supply the Rita area. When the pumps are switched on for the next supply day, the pressure in Rita will increase only very slowly as most of the flow in the new line will initially go to filling the stand pipe. Tests carried out on October 8 1999 confirmed that the stand pipe has this effect on the system.

35. The old distribution line was closed at the cross connection at Kirt Pinho's apartments, and two pumps used to supply the Rita end of the system only. The model agreed well with the results achieved of higher pressures in Rita.

36. The model was then used to estimate the effect of various operating scenarios, and various modifications to the system as described below:

(i) Rita is supplied by a 6" diameter water main configured in a loop. The old main distribution line supplies the loop. It would be relatively in-expensive to join the new line near the stand pipe to the loop line in Rita thereby providing two routes for water to flow to Rita. The model predicts that this additional connection would increase the pressure in Rita by about 10%.

(ii) The field tests and model calibration were undertaken with only the one cross connection at the High School open. The model predicts that if a second cross connection is opened at Kirt Pinho's, and the old line still closed on the airport side of the cross connection, pressure at Rita will increase by about 30%. With a third cross connection open at the Assumption Church, and the pressure zones divided at that point, the pressures increase in the Long Island Zone, and decrease in the Rita zone.

F. Recommendations to Improve System Performance

37. The new distribution line should be utilized to improve the pressure distribution in the system. The best configuration for even pressure distribution appears to be to divide the main distribution line in two by closing GV-X5OA, and using the new line to supply the Dalip/Rita area. Cross connections 1 to 4 should be kept closed, with 5 and 6 open. The gate valves into the stand pipe should be kept closed. Some more trial and error is needed to optimize the division of the two zones. MWSC have been briefed on these trials.

38. With the modified distribution system capable of carrying much greater flows, the 2 duty pumps are inadequate to supply good pressure to all consumers simultaneously. It is not good practice to rely on the stand-by pump for daily use. The pumps at Treatment Plant C are 26 years old, and have had no maintenance for at least 10 years (according to MWSC staff). Now

would be a good time to replace and upgrade the pumps. New pumps will need to be carefully selected to match the demands of the upgraded distribution network. Perhaps this should have been part of the water supply upgrade project. An alternative option which should be considered in the design / selection of new pumps is to have smaller pumps at Treatment Plant C, and new booster pumps at the former Treatment Plant B (an old treatment and pumping station located in Uliga). It is difficult to estimate the cost before a design has been carried out and pump specifications decided on. Allow $200,000 at this stage.

39. Tests so far indicate that to provide good pressure with the existing pumps without having to run all three pumps simultaneously, the two pressure zones will need to be supplied alternately. The supply regime will need to be altered from 16 hours every three days to some other combination that allows alternate supply to the two zones, and stays within the limitations of the available water. This is likely to result in the customers at the Long Island end of the system getting similar pressure for shorter periods, with people at the Rita end getting improved pressure for similar, or perhaps slightly longer periods than they are used to. This is a more equitable distribution of water than the previous system.

40. For the Rita stand pipe to be used as designed without causing pressure reductions in the area, a pressure sustaining valve should be fitted in line with the altitude meter. It should be set at about 40 psi (275 kPa) to ensure residents in Rita receive reasonable pressure (pressures in the line may not often reach this level with the existing pumps so the stand pipe would not be effectively utilized). Alternatively, the stand pipe could simply be used as a reserve storage tank. It would be useful in the event of a serious failure in the pumped system at Treatment Plant C to have a reserve supply of water at Rita. Allow $2,500.

41. The zinc coated nuts on the Rita stand pipe are rapidly corroding. They need to be protected by capping as soon as possible. MWSC have quotations for this work varying from $35,000 to $95,000.

42. During storms, waves can break over the sea wall on the southern side of the runway resulting in seawater draining into the airport catchment. The automatic system to stop the pumps has not been working since the new pumps were installed last year. This could result in seawater being automatically pumped into the freshwater reservoirs. This could be extremely serious if it happens at the start of a dry period. The automatic system should be reinstated as soon as possible. A quick inspection of the system indicates that the conductivity sensor is still working but the wiring between the meter and the new pump control systems is not working. Steve Wakefield from McConnell Dowell suggests that part of the electrical control system was damaged in a power surge. A good electrician should be able to identify where the problem lies, and fit new parts if necessary. Allow $1,500. Note that in Section 2.3.4 of the Institutional Strengthening Inception Report the Consultants mention that the saltwater detection and diversion system is not working correctly, needs modification, and that “the parallel design consultancy project provides for the installation of a TDS monitor at Pump Station No 4”.

43. Another issue with the salinity control system is that the sensor is located in a small diameter pipe which draws water from the main pumped line and discharges it back into the wet well. When the pumps are not operating, water drains through the sensor pipe by gravity from the reservoirs back into the wet well and then is pumped back into the reservoir again. This gives a false reading on the flow meter. It should be possible to separate the sensor unit from the meter itself, locate the sensor in the wet well near the inflow pipe, and run a cable from the sensor back to the meter. A new conductivity meter with its sensor on the end of a cable should be purchased and installed in parallel to the existing meter for additional security. Allow $1,500.

44. The demand for water is greater than the available supply. The two unserviceable wells at Laura should be repaired. Continuation of the expansion of the Laura well field as recommended by the Project Engineers, and the Loan Review Team should proceed as soon as possible. Even if the full capacity of the system is not used in periods of rain, the well field will be vital in a drought. Increased monitoring will need to accompany increased pumping to ensure the freshwater lens is not over pumped. The works for this expansion were scoped and costed as part of the original Project.

45. In the Majuro Water Supply Inception Report, the Consultant stated, “We have also worked with MWSC staff to recalibrate the bulk flow meters on both the freshwater and seawater systems”. However, in the Draft Design Report it is stated that “It has now been field verified that the bulk system meters both at Laura and at Treatment Plant C are not reading accurately.” A similar conclusion is reached in the Loan Review Report. However, the bulk flow meter at Treatment Plant C has not been replaced. This should have been done as part of the project and should be done now. Allow $2,500.

46. Initial inspection indicated that there is no air valve on the old line under the bridge. MWSC should confirm this and install one. Allow $1,500.

47. The encouragement or enforcement of the use of individual rain water catchments off all roofs as a primary supply should continue. There are still many large buildings, notably churches, with no rain water catchment system.

48. MWSC should develop and adopt a formal strategy for management of the available water resources, particularly for the event of prolonged dry periods. This was supposed to be done as part of the Institutional Strengthening TA Project in 1995.

49. MWSC need to plan for an ongoing program of replacement of the old asbestos cement main distribution pipes, and simultaneous elimination of leakage and illegal connections. The replacement program should follow a leak detection program aimed at isolating the areas with the worst losses. Non return valves should be fitted on feeder lines and direct connections to minimize the chance of contaminated water flowing back into the main line.

50. The five in-line flow meters installed on the old distribution line as part of the upgrade project should be removed and put into safe storage. At least three of the digital meters are currently underwater as the meter boxes have no drainage, and have filled with rain water. They are also installed too close to the tee junction and gate valve so are unlikely to give accurate readings due to turbulent flow associated with the fittings. MWSC have not taken any readings from them since they were installed. These meters should be used according to the manufacturers instructions in a leak detection / illegal connection investigation program.

51. An asset management plan including a regular maintenance program and long term strategy for upgrades and replacement should be developed. Progress is apparently being made in this area with the Operation and Maintenance Improvement Program (OMIP) run by the Department of the Interior. A Maintenance Management manual has been prepared this year by Arasmith Consulting Resources Ltd but is not complete or functional. The asset management system needs to include the development of a full inventory and set of plans for the whole water supply system.

III. PROJECT OVERVIEW

52. The following section provides some general comment on particular design and project management issues that this consultant has become aware of during the course of this assignment. There has not been the time or in some cases the access to previous files and reports, to carry out a thorough review of the project which includes two TA assignments (Institutional Strengthening, and Design), and a Construction project. The comments given have been based on a brief review of the reports made available, and analysis of the water distribution system that was built through the loan.

53. Objective (iii) of TA No 1946 –RMI Institutional Strengthening of the Majuro Water and Sewer Company (MWSC), Republic of the Marshall Islands was to "improve the reliability and availability of the freshwater supply in Majuro in time of drought"[4]. In the Final Project Report[5], May 1995, Section 1.2, Operations and Maintenance, the report states "The project provided for the establishment of operating rules and development of other measures necessary to optimize the operations of MWSC's freshwater and seawater systems including...Operating rules for all freshwater pumping and availability of supply, particularly during critical periods." This issue is critically important to the supply of freshwater. However, the report does not provide the "operating rules" or any discussion or analysis of system optimization. When asked about this, MWSC staff were not aware of any such operating guidelines being provided or discussed through the Project.

54. In an Aide Memoire dated 7 February 1995, the ADBP Project Engineer Gordon Fox states "The consultants have been requested to examine the need for, and assess the optimum size and location of, service reservoirs in the DUD area. The need to include such reservoirs in the Project works at reasonable cost, for flow and pressure balancing, and the requirement for consequent additional detailed design input, would be considered when the analysis has been completed". In the Majuro Water Supply Project Draft Design Report,[6] the scope of the project is stated as " augmenting, rehabilitating, and upgrading several components of the freshwater supply, seawater supply, and sewerage systems of the Majuro Atoll". The scope of works included the new water distribution line, but no mention of storage reservoirs or stand pipes. The hydraulic modeling carried out by the consultant and reported in the draft design report includes the previously existing high level reservoirs but does not include analysis of the Rita stand pipe. There is no mention in the design report of any need for storage as part of the project works.

55. There appears to be no reference in the Draft Design Report to any requirement for upgrading the main supply pumps at Treatment Plant C. The same pressure (150' or 67 psi) from the pumps has been assumed for flow rates varying from 330 gpm to 1160 gpm. No mention is made of the number of pumps assumed running. The assumptions made in the hydraulic modeling do not accurately reflect the actual performance of the existing pumps.

56. The Institutional Strengthening Inception Report[7] states in Section 2.3.4 that the steel elevated storage tanks "have proven prohibitively expensive to maintain" and that "serious

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[4] ADB. 1994. Contract for Consultant's Services for TA No 1946-RMI (ADB. 1993. *Institutional Strengthening of the Majuro Water and Sewer Company (MWSC).* Manila).

[5] ADB. 1995. Final Project Report on TA No 1946-RMI (ADB. 1993. *Institutional Strengthening of the Majuro Water and Sewer Company (MWSC).* Manila).

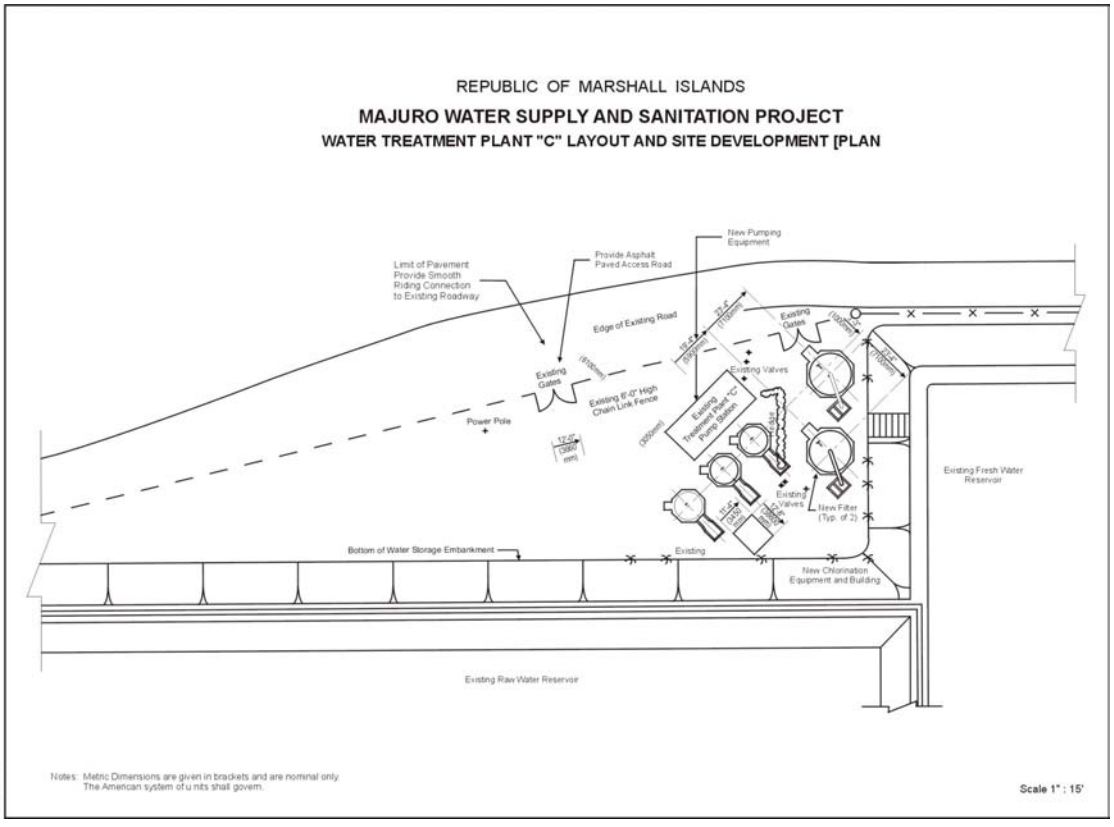
[6] ADB. 1995. Majuro Water Supply Project Draft Design Report. Manila.

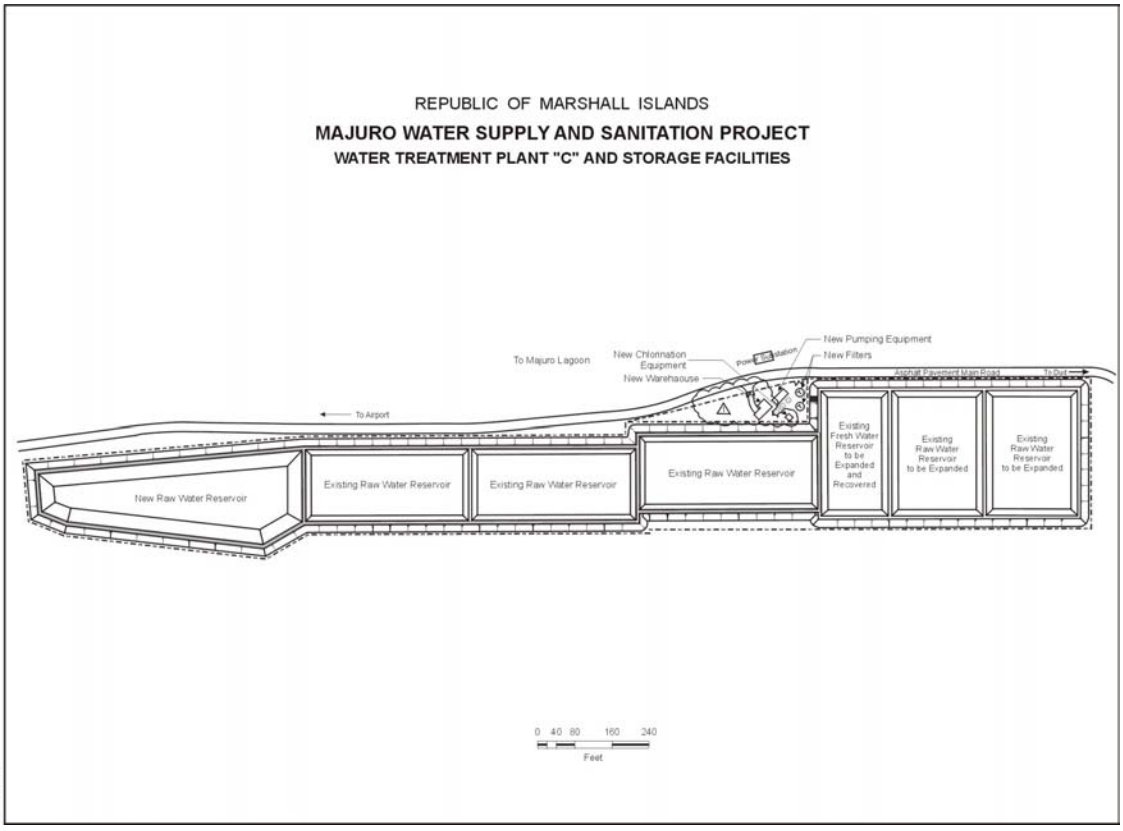
[7] ADB. 1995. Inception Report for TA No 1946-RMI (ADB. 1993. *Institutional Strengthening of the Majuro Water and Sewer Company (MWSC)*. Manila).

consideration needs to be given to storage structures made of non corrosive materials such as concrete wherever possible". It appears this advice was not followed for the Rita stand pipe which is of steel construction and after one year it has a corrosion problem requiring immediate and expensive attention.

57. There is no mention in the above-mentioned reports of any requirement or expectation for the freshwater supply system to be run on a 24 hour basis. Mention is made in the Institutional Strengthening study of the need for operating rules in a drought situation. Such rules should involve rationing and intermittent supply. Any water supply system in Majuro should be capable of running on an intermittent basis.

58. It appears to this consultant that some of the above mentioned problems (such as the stand pipe not working correctly, and pumps requiring upgrades) could perhaps have been avoided through a thorough peer review of the design and institutional strengthening reports prior to preparing tender documents. Other problems (such as flow meters and TDS meters not being installed) could perhaps have been identified and rectified through thorough project management, and improved communications between ADB, the Project Engineers and MWSC throughout the project.




REPUBLIC OF MARSHALL ISLANDS
MAJURO WATER SUPPLY AND SANITATION PROJECT
WATER TREATMENT PLANT "C" AND STORAGE FACILITIES
To Majuro Lagoon
New Chlorination Equipment
New Warehouse
New Pumping Equipment
New Filters
Asphalt Pavement Main Road
To Dud
To Airport
New Raw Water Reservoir
Existing Raw Water Reservoir
Existing Raw Water Reservoir
Existing Raw Water Reservoir
Existing Fresh Water Reservoir to be Expanded and Recovered
Existing Raw Water Reservoir to be Expanded
Existing Raw Water Reservoir to be Expanded
0 40 80 160 240
Feet

FRAMEWORK ON OBJECTIVES AND COMPONENTS

Summary of Objectives (in hierarchical levels)
1. Country Strategy / Sector Objectives – long-term objectives, identified in the Asian Development Bank (ADB) 1996 Country Assistance Plan (CAP) and the Memorandum of Understanding of the ADB 1997 Country Programming Mission (CPM), to which the Project will contribute.
1.1. Achievement of sustainable, self-reliant, economic growth (CAP para. 3.1) 1.2. Strengthening institutional capacity building (CAP para. 3.1 and CPM para. 34) 1.3. Improving policy reform measures (CAP para. 3.2)
1.4. Improve infrastructure through investments supported by policy dialogue (CAP para. 3.3) 1.4.1. Make infrastructure operations efficient and self-financing (CAP para. 3.3) 1.4.2. Assist in the commercialization and privatization of government enterprises, including public utilities (CAP para. 3.5)
1.5. Address key factors contributing to economic growth (CAP para. 3.2 and CPM para. 5) which include 1.5.1. Poor water supply and sewerage (CPM para. 15) 1.5.2. Poor public sector management (CPM para. 18), with inefficient delivery of public services (CPM para. 19), overstaffing (CPM para. 19), and lack of communication and coordination between ministries and other responsible public institutions (CPM para. 25)
1.6. Help avoid or mitigate environmental degradation (CAP para. 3.5)

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
2. The Project's Development Objectives					
2.1. Conservation of Potable Water					
2.1.1. Conservation of the atoll's groundwater resources	Monitoring of quality and quantity of water drawn from the Laura groundwater resource	Progress reports prepared by the Majuro Water and Sewer Company (MWSC) and submitted through the project management office (PMO)	Ensure the sustainability of the atoll's only natural reservoir of freshwater	Objections from landowners may render control of private wells ineffective	Monitoring of water quality carried out on ongoing basis by MWSC and Environmental Protection Agency. New wells not undertaken under loan
2.1.2. Introduce demand management practices	All consumers metered, with realistic sliding scale tariff structure in place; water consumption recorded by user group	MWSC's management information system (MIS), summarized in progress reports prepared by MWSC and submitted through the PMO	Ensure appropriate and sustainable use of water drawn from Laura and from artificial catchments (including the airport runway)	Public objections may lead to non adoption of sliding scale tariffs	Most connections metered and consumption recorded by user group. Sliding scale tariffs not adopted. See PCR text.
2.1.3. Ensure public understanding of the need for demand management practices	Continuing public education program under implementation	Progress reports prepared by MWSC and submitted through the PMO	Ensure public understanding of the need for wise use of water, the need to pay for water, and the need to report supply and leakage problems	Public participation measures may be too onerous to implement	Radio interviews carried out on subject. Awareness raising and information carried out on World Water Day (22 March)
2.1.4. Minimize operation and maintenance water losses	Optimal filter backwashing and mains flushing put into practice	Recorded in daily operating reports	Minimization of operational water losses	Operator training and supervision too onerous	Operator training carried out on continuing basis under Operation and Maintenance Improvement Program of the United States Department of the Interior (see PCR text)
2.1.5. Ensure adequate service from the saltwater distribution system	Water quantity produced, service disruptions, and adherence to preventive maintenance schedules	Progress reports prepared by MWSC and submitted through the PMO	Ensure sustainable saltwater supply as an alternative to the piped freshwater supply	Saltwater supply may be regarded as relatively unimportant leading to the neglect of maintenance and repairs	Satisfactorily carried out

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
2.2. Improvement of Service Levels					
2.2.1. Improve the availability of potable water	Water production, water sales, and hours of service	Progress reports prepared by MWSC and submitted through the PMO	Removal of constraints to development caused by inadequate water supplies	Lack of financial and other resources to achieve a sustainable reliable supply of potable water	Supply improved and better managed. Not 24 hr. supply. See PCR text. Supply – 6 hours per day 3 days per week Increased during rainy season
2.2.2. Adopt effective preventive maintenance practices	Adoption of, and compliance with, an integrated preventive maintenance program	MWSC's MIS, summarized in progress reports prepared by MWSC and submitted through the PMO	Improvement of the efficiency of infrastructure operations, by optimizing maintenance expenditure	Maintenance program may be too onerous and expensive to implement	Operation and Maintenance Improvement Program assisted maintenance program in force
2.2.3. Ensure rapid and effective repair of leaks and plant breakdowns	Adoption of leakage reporting, inspection, and repair measures	MWSC's MIS, summarized in progress reports prepared by MWSC and submitted through the PMO	Improvement of the efficiency of infrastructure operations, through reduction of the danger of water contamination; and enhancement of water conservation	Lack of resources of personnel and equipment may lead to delays and deferred maintenance	Metering in place. Leak detection ongoing. Repairs and calibration in force
2.2.4. Ensure that pipelines, plant, and other assets are replaced or improved as necessary	Adoption of, and adherence to, a capital improvement program	Progress reports prepared by MWSC and submitted through the PMO	Improvement of the efficiency of infrastructure operations by optimizing expenditure on capital improvements and replacements	Lack of financial and other resources may result in postponement of capital improvements	Basic maintenance in force but no capital improvement program due to lack of funds
2.2.5. Improve response to customers' complaints	System in place for recording complaints and action taken	Response time on complaints recorded in MWSC's MIS, and summarized in progress	Improvement of customers willingness to pay, through speedy and	Follow-up of complaints may be too onerous	Complaints being heard and attended to by relevant sections of MWSC

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
		reports prepared by MWSC and submitted through the PMO	efficient attention to complaints		
2.3. Improve the Legislative Framework and Accountability of Majuro Water and Sewer Company (MWSC)					
2.3.1. Clearly define MWSC's role, responsibilities, and regulation	New enabling legislation for MWSC introduced and adopted	Progress reports prepared by MWSC and submitted through the PMO	Clear indication of the commercialization of MWSC's operations	Introduction of new enabling legislation may be too onerous and open to interference	MWSC's role and responsibilities defined. See PCR text. Strict billing and collection performed
2.3.2. Ensure adequate consumer representation in the management of MWSC	New board of directors appointed, incorporating representatives of consumer groups	Progress reports prepared by MWSC and submitted through the PMO	Enable the benefits of commercialization to be passed on to all consumer groups	Under representation of some consumer groups, leading to unequal distribution of benefits	Board of directors appointed. Representation of consumers included
2.4. Achieve Self-Financing by MWSC					
2.4.1. Adopt an appropriate tariff structure, with periodic review	Tariffs reviewed annually	Audited financial statements; monthly balances reported by MWSC and included MIS and progress reports	Avoid operating benefits and contribute to water conservation	Insufficient will to ensure regular review of tariffs	Reviews undertaken. No significant changes made, due to present high level of tariff
2.4.2. Increase the efficiency of customer billing and revenue collection	Billing and revenue collection reviewed at monthly intervals	Monthly balances reported by MWSC and included in MIS and progress reports	Generate adequate cash flow and avoid operating deficits	Meter reading and billing too onerous; inadequate resources to maintain billing and collection services	Substantial progress made
2.4.4. Ensure timely action against defaulters	Monthly review of actions taken	Actions reported by MWSC and included in MIS and progress reports	Reduce accounts receivable	Lack of will to take action against defaulters	Good progress being made. Disconnections also made
2.4.5. Eliminate illegal connections	Monthly review of quantity of non revenue water and legal action taken against illegal connections	Non revenue water and actions reported by MWSC and included in MIS and progress reports	Increase revenue by increase of water sales	Lack of resources and will to take action against illegal water consumers	Good progress made

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
2.5. Improve the Environment of Majuro					
2.5.1. Prevent sewage overflows	Monthly review of number of overflows and clearance of blocked sewers	MWSC records numbers of overflows and blockages in MIS, and summarizes in progress reports	Mitigation of environmental degradation caused by sewage spills and odors	Lack of resources for timely attention to blockages and overflows	Attended to satisfactorily
2.5.2. Protect groundwater resources from pollution	Policies and conditions of Laura sewerage and sanitation in place	MWSC progress reports	Prevention of pollution of the island's only natural reservoir of freshwater	Lack of resources and will to prepare and enforce environmental and planning standards	Environmental Protection Agency monitors quality
2.5.3. Improvement of public health	Annual statistics of waterborne diseases	Annual reports of the Ministry of Health	Improvement in economic conditions through disease reduction	Inadequate resources to collect and disseminate health statistics	Carried out by Ministry of Health and Environmental Protection Agency
3. The Project's Major Outputs					
3.1.2. Freshwater Supply and Distribution					
3.1.2. Improvements to the airport water catchment area	Replacement of water transmission pumps Construction of a larger capacity delivery pipeline Installation of an automatic pump shutoff alarm system	Project progress reports prepared by PMO	Increase the amount of rainwater collected from the airport runway	Construction difficulties and delayed supply of materials and equipment may delay project implementation	Work completed with redesigned larger capacity pumps
3.1.3. Laura well field development	Construction of 10 new wells	Project progress reports prepared by PMO	Increase the amount of freshwater available from the Laura groundwater source	Objections to land use and water abstraction could disrupt this key component	No new wells constructed. See PCR text.
3.1.4. Expansion of untreated and treated water storage	Increasing the capacity of untreated water storage by 45,000 cubic meters	Project progress reports prepared by PMO	Increase the holding capacity of storage reservoirs, to increase the	Objections to use of land may delay project implementation.	Carried out successfully

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
	(m^3) by construction of a new reservoir and by raising the height of the walls of the existing reservoir. Raising the height of the existing treated water storage reservoir to increase storage capacity by about 5,700 m^3. Construction of a new elevated water storage tank. Demolition of three unsafe and unused elevated water storage tanks		reliability of the freshwater supply during periods of low rainfall	Construction difficulties and delayed supply of materials and equipment may delay project implementation	Constructed but not in use (see PCR text) Carried out. Replacements could have brought greater efficiency in arranging distribution of water
3.1.5. Improvement of transmission and distribution	Construction of about 14.6. kilometers (km) of water distribution pipeline. Interconnection of distribution mains to the new transmission pipeline	Project progress reports prepared by PMO	Improve the supply of water to the more remote parts of the distribution system	Construction difficulties and delayed supply of materials and equipment may delay project implementation	Carried out. However difficulties encountered in maintaining pressure at end of distribution area. Problem resolved through redesign and installation of new pumping facilities
3.1.6. Improvement of treatment and pumping facilities	Rehabilitation of the water treatment plants near the airport and hospital. Provision of new chlorination facilities at Laura	Project progress reports prepared by PMO	Protection of public health by ensuring that freshwater is safe to drink	Delayed supply of materials and equipment may delay project implementation	Carried out
3.2. Seawater Supply and Distribution					
3.1.7. Improvement of	Replacement of	Project progress reports	Improve the	Delayed supply of	Carried out

Summary of Objectives (in hierarchical levels)	Key Performance Indicators	Monitoring and Reporting	Contribution to the Next Higher Level of Objectives	Risks	Remarks
the seawater distribution system	valves. Construction of two new pumping stations, including supply of pumps. Construction of about 7 km of distribution mains. Installation of fire hydrants	prepared by PMO	conservation of freshwater by expanding and rehabilitating the alternative seawater supply	materials and equipment may delay project implementation	
3.3. Sewerage					
3.3.1. Improvement of the sewage pumping system	Replacement of sewage pumps and communitors at four sewage pumping stations. Construction of protective sheds to house the new pumping equipment	Project progress reports prepared by PMO	Protection of public health and the environment by reducing the frequency of sewage spills	Delayed supply of materials and equipment may delay project implementation	Carried out
3.4. Institutional Support and Consulting Services					
3.4.1. Support for the Project Management Office (PMO)	Support for remuneration of PMO personnel. Engagement of consultants. Provision of five service vehicles. Provision of computer hardware and software, including maintenance program software	Project progress reports prepared by PMO	Assurance of effective project management and reporting	Delayed recruitment of consultants may delay project implementation. Vehicles and equipment may be diverted for nonproject use	Carried out (see PCR text)

WATER TARIFF STRUCTURE FOR MAJURO

	($ per month)
A. Unmetered Connections	8
B. Metered Connections	
Supply from Airport Waterworks to Laura	5
Supply from Airport Waterworks to Delap-Uliga-Darrit/Rita	6
Supply to Government	5
Supply to Commercial and Industrial	10
	($ per delivery)
C. Tanker Supplies:	
Airport to Rita	20
Airport to Woja	40
Woja to Laura	50
Commercial and Government	30
If supplied after working hours, all tanker supplies cost an additional $10 per 1,000 gallons.	
Supply of Saltwater for Toilets	$10

All costs are in $ per 1,000 gallons unless otherwise stated.

PROJECT COMPLETION REVIEW MISSION FINDINGS ON THE IMPACTS OF THE MAJURO WATER AND SEWER COMPANY TARIFFS

1. The appraisal mission recommended the setting up of a sliding scale of tariffs as adopted in many countries. However, local knowledge holds that such a system will not apply in Majuro for the following reasons:

(i) those who can afford have adequate facilities to harvest rainwater and are not likely to consume high levels of water from the system except during periods of drought;

(ii) the use of saltwater in toilets for flushing reduces considerably the per capita consumption of water, including those who can afford it; and

(iii) the more cumbersome billing, collection, and monitoring required would be too sophisticated and too much for the staff of the Majuro Water and Sewer Company (MWSC) at present, and the little extra revenue expected to be earned through a sliding scale tariff would not be worth the effort.

2. Approval of tariffs is made by the board of directors on submission of a proposal by MWSC. The last increase in MWSC tariffs was in May 1994. Although the revenues increased as a result, the major impact of the tariff increase was the rapid decrease in the number of active accounts. Before the tariff increase, there were no inactive accounts. Typical payment history shows that an increasing number of customers did not pay their monthly bills.

3. Disconnections are made when the arrears amount to $150. The public is periodically informed of this policy through the newspapers and the radio. Nonpayment of bills for a period of 90 days also qualifies for disconnection but occurs rarely. A warning notice for disconnections is provided in the bill issued and the period provided for payment is a few days. For reconnection, arrears need to be paid up in full and a further $75 for a reconnection.

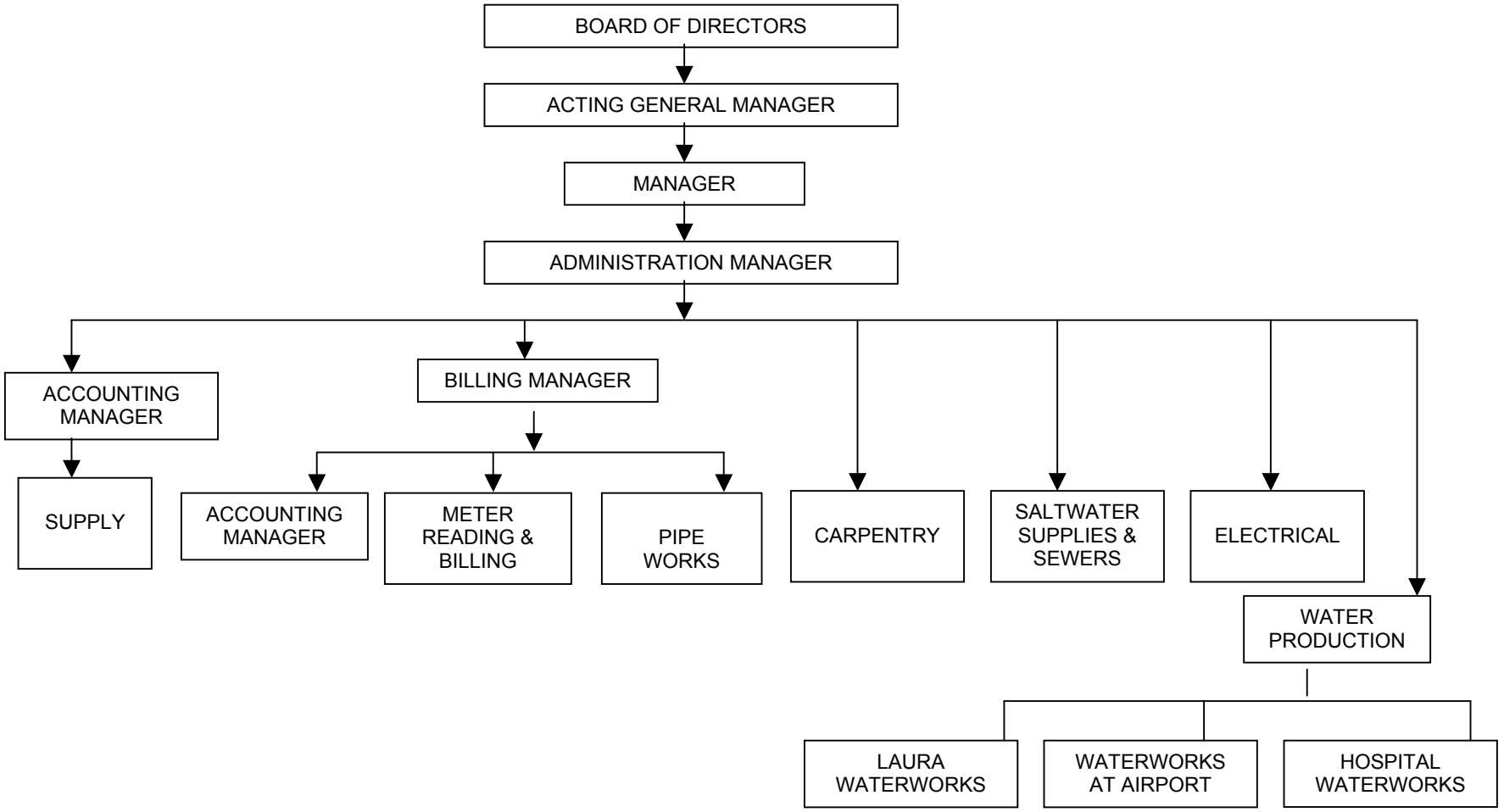
4. Nearly all known connections have been metered. Non-metered connections are now down to 20. The number of active metered connections has increased by eight since 1996, from 1,466 to 1,474 in June 2003. MWSC has become very strict on billing and collection. Those in arrears of payments have been disconnected and as of June 2003, the inactive connections stood at 1,663. While MWSC indicated that those disconnected are gradually clearing their arrears to qualify for reconnection, the number has not changed much in the past few years. Many houses harvest rainwater for needs other than consumption. The availability of supplies through tanker trucks also discouraged reconnection. A tanker truck adds a further cost to water produced and ought to be used only for emergency needs. In order to increase sales and earn more revenue, MWSC needs to review the position to give more encouragement for reconnections.

COMPARISON BETWEEN RAW WATER AND TREATED WATER

Year	Total Raw Water Collected	Total Water Treated	Water Utilized Percentage
1997	178,724,483	120,892,496	67.64
1998	118,929,307	79,004,959	66.43
1999	—	—	—
2000	489,288,323	102,317,053	20.91
2001	206,922,938	132,066,340	63.82
2002	221,854,612	183,252,452	82.60
2003	121,778,732	92,206,865	75.72
Total	**1,337,498,395**	**709,740,165**	**53.06**
Average % of raw water available for treatment			53.00

Source: MWSC internal reports.

ORGANIZATION CHART OF MAJURO WATER AND SEWER COMPANY



FINANCIAL AND ECONOMIC EVALUATION

A. Financial Evaluation

1. At appraisal, the financial analysis conducted under the Project worked on the basic assumption of a 10% revenue increase of Majuro Water and Sewer Company (MWSC) and the results of an affordability analysis that showed the tariff at the time was below 5% of the income of low-income families. Unfortunately, the Project Completion Review showed that the project consultants had failed to adequately verify the assumptions made for the analysis. As a result the financial projections made proved to be extremely optimistic. This eventuated into a project that has been over designed and required too heavy a burden of financing.

2. MWSC, with its history of recurring operational losses, did not have the financial capacity to assume the debt imposed upon it by the two loan projects. The financial limitations of MWSC were clearly established by the comments contained in the successive audit reports doubting the utility's ability to operate as a going concern. A subsequent independent review conducted closer to completion of the Project confirmed that the utility was not in a position to operate as originally projected and that there was a need for a radical solution for it to continue operations. One of the radical solutions recommended was for the Government to retain the assets and let MWSC operate, maintain, and improve the water supply and sewerage system under a franchise or concession arrangement

3. A review of the tariff structure showed that the last increase in MWSC tariffs was in May 1994. Although the revenues increased as a result, when compared to the projections made there was an average reduction of nearly 40% as seen in Table A11. Further, contrary to the affordability analysis, the major impact of the tariff increase was the rapid increase in the number of inactive accounts. There were no reported inactive accounts before this tariff increase, which also instituted a policy against unpaid accounts.

4. The payments history shows that increasing numbers of customers did not pay their monthly bills. At 31 October 1995, some 18 months after the increase, there were 486 inactive accounts as against 2,128 active water supply accounts. This increase in inactive accounts was the result of MWSC management's enforcement of sanctions on nonpaying customers. There have been no further increases in tariff since 1994. To maintain parity in real terms today, tariffs would have to increase by about 31%.

5. While there has been no increase in the tariffs, MWSC tariffs are relatively high by developing country and Pacific island standards. Current domestic tariff rates of $6 per 1,000 gallons ($1.60 per cubic meter [m^3]) are above those of most utility concerns in the region. Only Male ($4.86 per m^3) and Mandalay ($1.2 per m^3) are similar. Other islands in the Asia and Pacific regions are well below $1 per m^3—Nuku'alofa (Tonga) $0.63 per m^3, Cebu (Philippines) $0.66 per m^3, and Port Vila (Vanuatu) $0.49 per m^3. When the tariff was increased there was a drop in the number of active water connections; there have been only eight new connections since 1996. The number connected for water is about half the number for electricity. There is therefore evidence that the water tariff is high for the community, creating a reluctance to be connected.

6. The Project Completion Review (PCR) mission reinforced the findings. This mission also confirmed that while MWSC had instituted some tariff increases, the average annual revenue had not seen any significant improvement. MWSC has incurred financial losses even without

paying for the loan charges in accordance with the subsidiary loan agreement (SLA). The losses are covered by arbitrary government subsidy. This can be seen from the details shown in Table A11, which provides a comparison between the figures for the revenue projection made by the project preparatory technical assistance (PPTA) consultants against the actual revenue in 1997 to 2001 (not including any loan service payments), showing that the projections were significantly overrated, especially since MWSC only attained 41% of the projections made by the PPTA consultants. The figures would be much worse if MWSC was required to pay loan service payments.

Table A11: Majuro Water and Sewer Company, Projected Revenue Versus Actual ($)

Year	Projected Revenue	Actual Revenue	Actual/Projected Percentage
1997	1,828,918	938,237	51.30
1998	2,112,314	819,933	38.82
1999	2,304,368	782,859	33.97
2000	2,514,181	1,027,834	40.88
2001	2,743,412	1,042,268	37.99
2002	3,267,547	—	—
Average percentage for period 1997–2001			40.59

Notes: 1. Projections are as per Report and Recommendation of the President.

2. Actual revenue is as per audit statements.

3. Revenue figures are after adjusting for bad debts.

Source: MWSC internal reports

7. Over the last few years, MWSC has formalized the policy on disconnections trying to ease the pressure on the community. Arrears amounting to $150 result in disconnections. The policy is well publicized periodically through newspapers and radio. Nonpayment of bills for a period in excess of 90 days, also qualifies for disconnection, but the occurrences are rare. The policy includes adequate measures of warning notice for disconnections as part of the bills issued. The customers are given a period of few days to make the payments. For reconnection, arrears need to be paid up in full and a further $75 as a reconnection fee.

8. With ADB Management's approval to replace the SLA with a lease franchise agreement, the basic parameters for comparison changed. The Project Completion Review Mission also found that adequate and reliable data for calculation of the financial internal rate of return was unavailable. The above analysis was therefore deemed to be adequate.

B. Economic Evaluation

9. The PCR Mission not only had difficulty in quantifying the soft benefits, as at appraisal, it also found it extremely difficult to get any adequate and reliable data. However, notwithstanding the over design of the project elements, there was no doubt that the Project was relevant to ADB's strategy and has succeeded in achieving its basic objective of providing safe water and sanitation to the community.

10. During the early 1990s, sanitation and health were a concern on the atoll of Majuro. However, although availability of safe piped water and sanitation has improved since the completion of the Project, the PCR Mission could not establish a relationship between the incidence of disease and the availability of sanitation and piped water due to lack of available data. Based on the data that could be secured from MWSC, it was noted that the projected increase in the demand for piped water as a result of the Project had not been realized. The figures recorded show only eight additional connections since the start of the project in 1996. A large number of people are still extensively dependent on rainwater catchment tanks distributed to the households by the US Government's Federal Emergency Management Agency (FEMA) during the severe drought from December 1991 to April 1992. Apart from such droughts, Majuro generally receives rainfall almost all year. MWSC's records showed that there have been an increasing number of people who prefer to have water delivered on an as-needed basis by tankers at a cost of $20/tanker of 3,000 gallons filling their rainwater catchment tanks as against being tied sown to a monthly charge of $6/1,000 gallons for piped water.

11. Several assumptions made at the time of the project design could not be substantiated. A significant proportion of those connected to the water system also have individual rainwater catchment tanks. These include large commercial customers like the hotels and businesses. Even this segment of the population uses the piped water system mainly as a back up for their catchments. This reduces the incentive to be connected to the paid water supply system of MWSC. There are no available data to ascertain the exact number or proportion of this segment of population and collection of such data would possibly require conducting a house-to-house survey.

12. In addition, most of the population living at the Laura end of the atoll are unmetered direct connections to the main transmission pipeline from the Laura wells to the raw water tank at the main treatment plant near the airport. This is evident from the large variation between the water pumped from the Laura end and the water available for treatment. The percentage of unaccounted-for water remains high and is estimated to be in excess of 50%.

13. The objective of the project was to enhance the water supply and sewerage for Majuro. The consultants had designed the project to provide a 24-hour supply of water. The special review missions confirmed that if water was supplied to the main line (airport to Rita) on a continuous basis, demand for fresh water would be significantly greater than the system could supply. The project therefore has failed in this objective supposedly because of an inadequacy in raw water resources and high operating costs. Further, due to limited raw water storage capacity in the dry season, when the water demand is high, both the airport catchment and the Laura wells are unable to provide adequate supply necessary for 24-hour operation. While with greater control on leakage, demand-side management, and modification in the distribution system, a 24-hour supply may be feasible during periods of high rainfall, the utility believed that in view of excessive dependence on individual catchments there was no real demand for such 24-hour supply periods. This, coupled with high operating costs due to the system that requires every gallon to be pumped, makes 24-hour operation uneconomical. A study will be necessary to ascertain the feasibility.

14. Since the system was designed to operate as a pressurized closed loop to be operated on a 24-hour basis, the intermittent operation of the system had failed to produce the projected supply and line pressures, notwithstanding the significant number of design variations. Following the special review missions in October 1999 and April 2000, further design changes had to be incorporated to produce the acceptable line pressures.

15. With revenues falling to less than 40% of those projected, and with the SLA having been replaced by a lease franchise agreement where the Government has retained all assets and associated liabilities, and with the lack of adequate and reliable data, it was determined that calculating the EIRR was neither necessary nor feasible.

BENEFIT MONITORING AND EVALUATION PROGRAM AND CRITERIA

Objective	Evaluation Criteria	Achievement Indicator(s) and Achievements
Delivery of Improved quality of water	Water quality vs predefined standards. Measured by systematic and regular water testing and recording after treatment and throughout the distribution system.	Numbers of failed tests per month; severity of test results; trend. 25 to 40 samples collected each month and about 8 parameters tested. Severity: adequate. Violations sometimes above 5%. Greater operational care needed.
Delivery of improved quality of service	Average water availability per day (hours) meets target. Minimum water availability per day meets target. Adequate pressure and delivery is maintained for all users, i.e., uniform distribution. Customer complaints are addressed and reviewed.	Hours operating per month: 72 Days in month: 12 (Higher during rainy period) Daily hours of operation per day for each area logged, lowest monthly are reported. 6 hours per day 3 days/week Periodic checking and pressure testing at problem points in the system. Yes. No problems. Customer problems logged and resulting action/response noted. Yes.
Delivery of adequate quantity of water	Total population served = target Target in 2002 was 45,191 Daily water production = target ±4,519 m^3 for 2002 Total connections = target 4,519 for 2002 Population served by HC = target, new connection rate = growth rate Average production per capita per day = target: 136 lpcd	Number of HC connections x average persons per HC + Number of SP x Persons per SP: 14,550 persons. Monthly water production: 104,070 m^3 Number of supply days in month: 12 (Dec 2002) Daily water production in 2002=3,469 m^3 Actual number of total connections in 2002: 1,455 (32%) Number of domestic connections x average household size: ±14,550 persons in Dec 2002 Daily water production: 975,47 m^3 Population served: 14,550 (in 2001/2002)

Objective	Evaluation Criteria	Achievement Indicator(s) and Achievements
	Average consumption per capita per day = target: 100 lpcd	Metered water sold in month: 42,005 m^3 Population served x days in month: Consumption = 96 lpcd
Affordability	HC tariff for basic needs (not exceeding target)	Average household size x minimum m^3 per capita x tariff: $19 per month
	Actual tariff affordable	Billings for all HC Consumption for all HC = $1.57/$m^3$
	Active connections as an indicator of satisfaction and ability to pay.	Active HC 1,455 47% Total HC 3,064
Cost effectiveness	Unit production cost vs target	O&M Costs (monthly) $1.48/$m^3$ Production volume per month
	Cost per user vs target	O&M Costs (monthly) $45 per month per household Active Connections
	Unaccounted water ratio < target	100% - Water sold (metered) 39.5% Treated Water produced Estimated total water delivered 50% Total Water Produced
	Revenues sufficient for target cost recovery	Monthly comparison of actual to budget in financial statements, and variances.
	Billing efficiency = target	Meters read and billed in month 100% Total metered connections
Operational Efficiency	Staff per 1,000 connections within target	Staff (full time equivalent) 18 Total connections/1000
	Operations (connections, meter maintenance, on/offs) are completed promptly.	Work orders completed in month 100% Work orders initiated in month
	Preventive maintenance program is developed and maintained.	Maintenance completed should be logged daily, reviewed monthly
Financial Sustainability	Accounts receivable rate of current collections is stable, within target	Accounts Receivable Or Current Collections Average Day Sales Current Billings

Objective	Evaluation Criteria	Achievement Indicator(s) and Achievements
	Budget sufficient to cover cost of operations, and greater of finance charges, or interest plus depreciation	Budget prepared annually. Long range planning undertaken at least every 5 years; updated annually. Annual budget submitted to government budget committee.
	Actual operations meet budget	Monthly comparative financial statements produced with major variances noted and addressed
	Cash flow sufficient to maintain operations	Cash-flow plan, including capital budget, prepared annually and updated quarterly
Governance Issues and Accountability	The utility company maintains a forum for public input into decision-making process. If not through direct representation on the board of directors, liaison committees to be developed through the village councils.	▪ Public annual general meeting held within 4 months of year end; ▪ Public meetings held on a regular basis—3 per year mostly through radio questions and answers; ▪ Surveys or other assessments of the utility services is conducted periodically and reviewed. Yes
	The utility communicates its plans and results of operations to client groups.	Reporting and public relations initiatives planned and reviewed regularly.
	The utility is sensitive to parties whose interests may not be adequately represented through normal channels.	Corporate policies reviewed regularly to ensure they are nondiscriminatory and take appropriate opportunities to include women, lower-income, or other groups in their application.

HC = household connection, lpcd = liters per capita per day, m^3 = cubic meter, O&M = operation and maintenance, SP = stand pipe.

GENERAL RECOMMENDATIONS TO HELP IMPROVE PROJECT PERFORMANCE

A. Project Related

1. The following recommendations could enhance the value of the Project.

(i) Further institutional strengthening of Majuro Water and Sewer Company (MWSC) and training of staff will be helpful. The staff contingent needs further review to achieve staff economies.

(ii) The General Manager of the Majuro Electric Company provides part-time managerial support to MWSC as Acting General Manager. Engaging a full-time General Manager with requisite qualifications and experience would be beneficial.

(iii) The reservoir at Delap-Uliga-Darrit (DUD) (standpipe) is not being effectively utilized and the bolts used are in a state of corrosion. Arresting of the corrosion around bolts in the tank should be carried out without delay.

(iv) A major shortcoming of the distribution system is the lack of distribution reservoirs at appropriate elevation. As a result, excessive amount of electricity is used to pump every cubic meter of water. The standpipe, which is presently under the custody of the Ministry of Education, is an elevated tank of 400,000 galloons capacity originally designed to operate as a pressure regulator reservoir but is currently used as a stand by storage tank. A study should be conducted to review if it could be better utilized as an elevated storage tank in the system after necessary modifications to the pipe work and valves. This would likely improve the operating efficiency of the pumps and reduce power costs.

(v) The bulk flow meters fitted on the new transmission main to DUD at the intersections require to be repaired and the chambers modified or the meters replaced with more robust meters.

(vi) Reduction of unaccounted for water needs to be pursued with more work on metering, leakage control, and arresting of illegal use.

(vii) The roof of the treated water reservoir as constructed retains rainwater, which has to be constantly pumped out. It can become a health hazard and the water could also place undue loads on the roof. The roof requires redesign and modification.

(viii) Saltwater flushing of toilets in areas not sewered must be monitored for adverse environmental impact over time on the soil around the septic tank and ground water.

(ix) The present organizational structure of MWSC is very much an operations and maintenance arrangement, i.e., one that can maintain the status quo but would not spawn planned growth. It needs a structure that would include continuous monitoring and evaluation and planning to achieve well-defined targets.

(x) The present technical staff at MWSC, who have had limited tertiary education receive in-service training in operational skills from the Operation and Maintenance Improvement Program (OMIP) of the United States Department of the Interior. This has been a very useful support for MWSC staff.

(xi) For MWSC to operate efficiently and be sustainable, all of these factors must be commensurate with its the size and sophistication.

B. Important Factors for a Utility to Operate Efficiently

2 To provide a reliable service to its customers while maintaining the economic value of its assets, a utility requires:

(i) infrastructure of a size and cost within the financial capability of the community to support;

(ii) an organizational structure which is sympathetic to the various activities to be performed;

(iii) a staff contingent from management to operations with the necessary education and training to attend to the various functions from planning through operations to monitoring of customer satisfaction; and

(iv) interest and ability to monitor its financial health and take steps as necessary to be financially viable.