SOLOMON ISLANDS

SOLOMON ISLANDS WATER AUTHORITY

THE PROJECT
FOR
IMPROVEMENT OF NON-REVENUE WATER REDUCTION CAPACITY
FOR
SOLOMON ISLANDS WATER AUTHORITY
IN SOLOMON ISLANDS

PROJECT FINAL REPORT
(MAIN REPORT)

AUGUST 2016

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

YOKOHAMA WATER CO., LTD.

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Exchange Rate applied in this Report

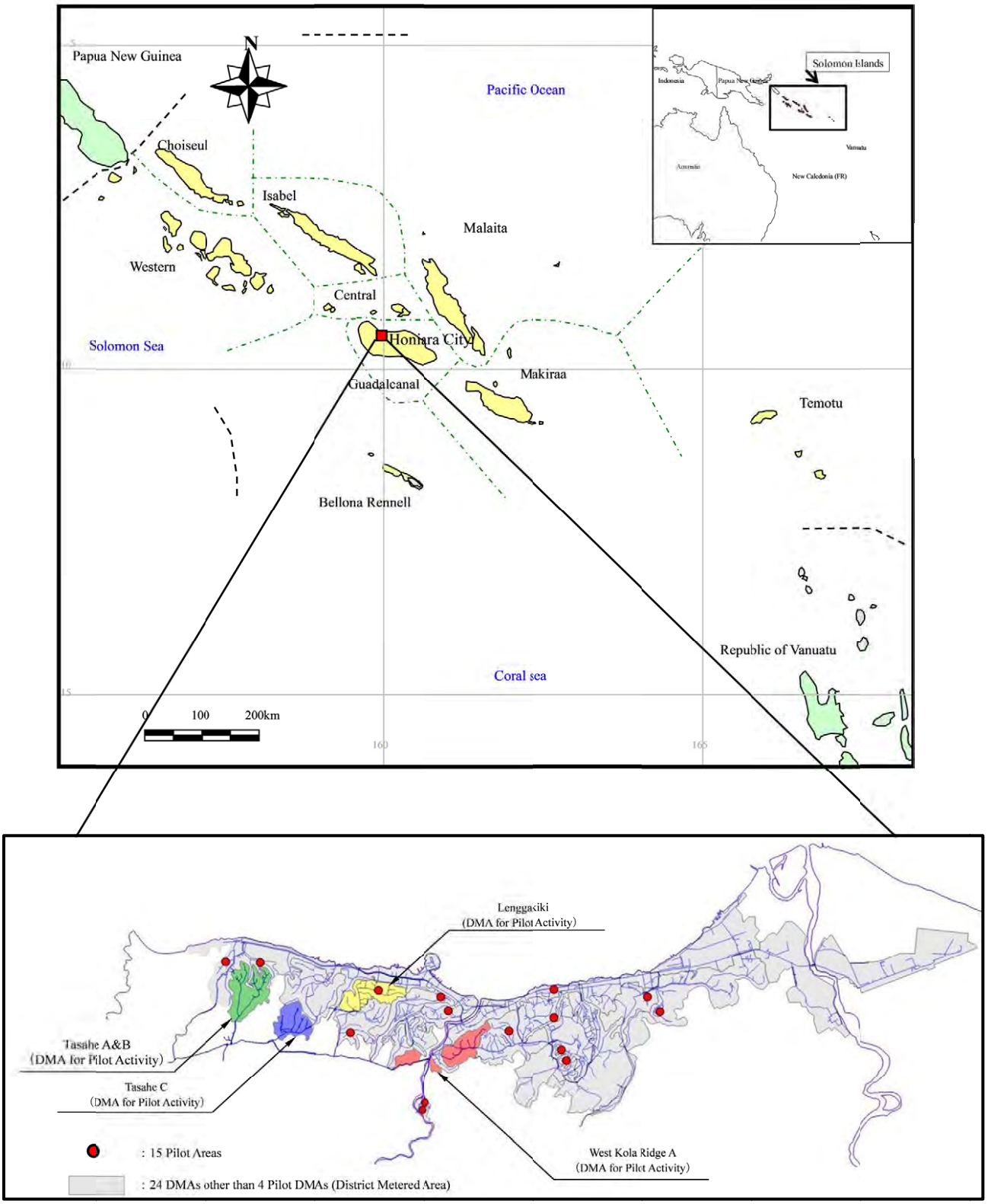
As of June 2016

USD 1.00 = JPY 110.333

SBD 1.00 = JPY 13.7916

USD 1.00 = SBD 8.000

(Source: JICA Official Website)



Location Map of the Project Area

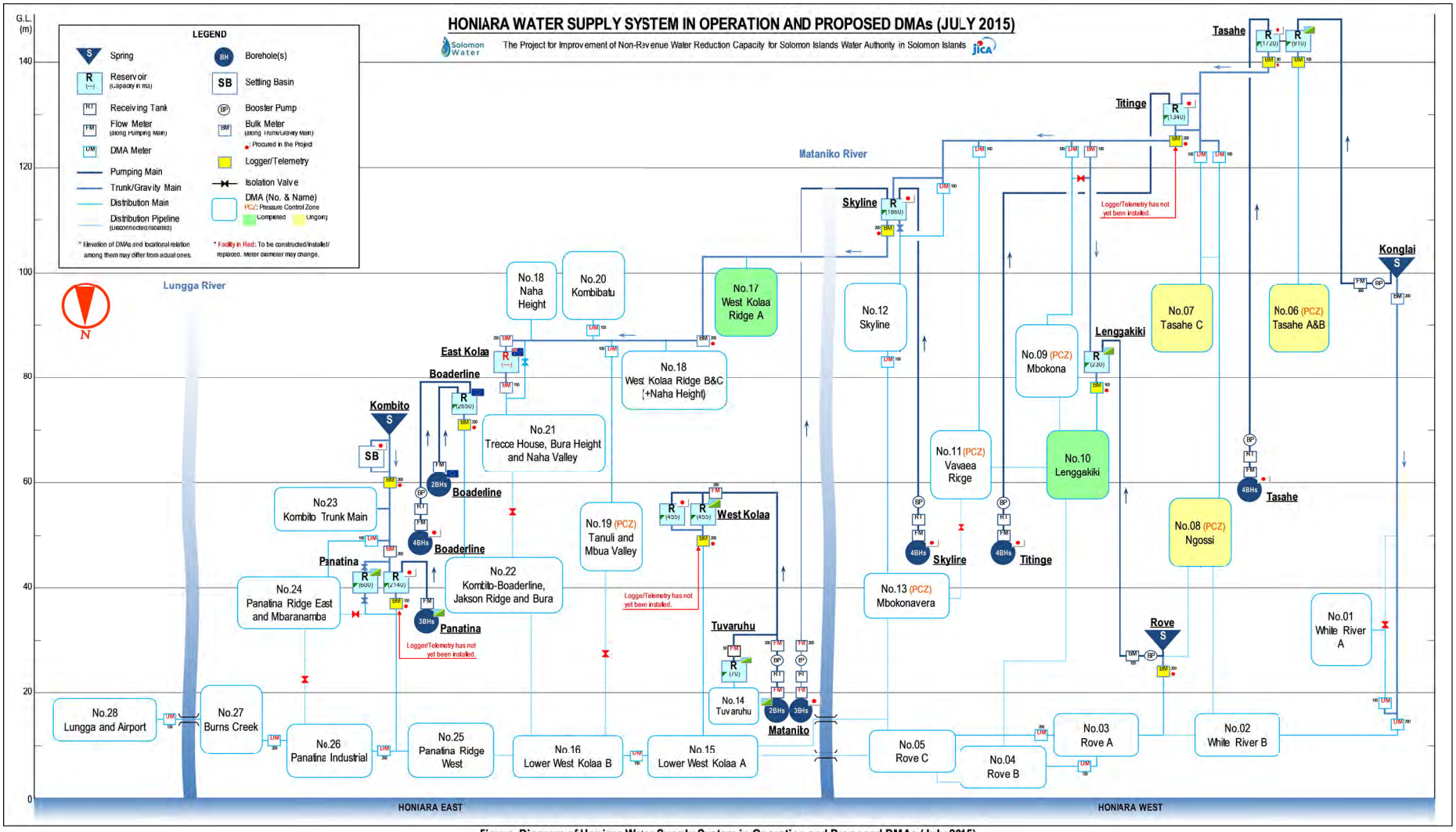


Figure. Diagram of Honiara Water Supply System in Operation and Proposed DMAs (July 2015)

PHOTOS 1

	
Leakage Detection in DMAs	Measuring of Minimum Night Flow in DMAs
	
OJT on GIS	Practical Training of Hydraulic Analysis
	
NRW Reduction Session	Leakage Data Processing

PHOTOS 2

	
Customer Service Session	Hydraulic Analysis Session
	
NRW Reduction Examination	GIS Examination
	
Hydraulic Analysis Examination	5th JCC Meeting

CONTENT

ATTACHMENT

LIST OF TABLES AND FIGURES

ABBREVIATION

AUS	Australia
CP	Counterpart
DMA	District Metered Area
DFAT	Department of Foreign Affairs and Trade, Australian Government
FAQ	Frequently Asked Questions
F/R	Final Report
GI	Galvanized Iron
GIS	Geographic Information System
GPS	Global Positioning System
HHT	Handheld Terminal
IAP	Individual Action Plan
IC/R	Inception Report
ID	Identification
IWA	International Water Association
JCC	Joint Coordinating Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
KG VI	King George Sixth School
LCZ	Leakage Control Zone
Max.	Maximum
Min.	Minimum
M/M	Minutes of Meeting
MMERE	Ministry of Mines, Energy and Rural Electrification, Solomon Islands
MNF	Minimum Night Flow
MoA	Memorandum of Agreement
MW	Miyakojima Waterworks
NRW	Non-Revenue Water
NWSB	Naha City Waterworks & Sewerage Bureau
OJT	On-the-Job Training
OPEB	Okinawa Prefecture Enterprise Bureau
NZ	New Zealand
PCZ	Pressure Control Zone
PDCA	Plan-Do-Check-Action
PDM	Project Design Matrix
PI	Performance Index
PN	Nominal Pressure
PO	Plan of Operations
PR	Public Relations
P/R	Progress Report
PRV	Pressure Reducing Valve
PVC	Polyvinyl Chloride
SBD	Solomon Dollar
SI	Solomon Islands
SIBC	Solomon Islands Broadcasting Corporation
SIV	System Input Volume
SMS	Short Message System
SOP	Standard Operating Procedures
SPC	Secretariat of the Pacific Community
SW	Solomon Water (Solomon Islands Water Authority: SIWA)
UPS	Uninterruptible Power Supply
US	United States
yec	Yachiyo Engineering Co. Ltd.
YWB	Yokohama Waterworks Bureau
YWC	Yokohama Water Co. Ltd.

Executive Summary

The Project Final Report contains all the activities and the achievements of the Project. The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands (the Project) was commenced in October 2012 and completed with successful outcomes and achievements in June 2016, under the cooperation between Japan International Cooperation Agency (JICA) and Solomon Water (SW) supported by the Australian Department of Foreign Affairs and Trade (DFAT) through the Two-Year Plan. Overall schedule and main activities are described in Figure S1.

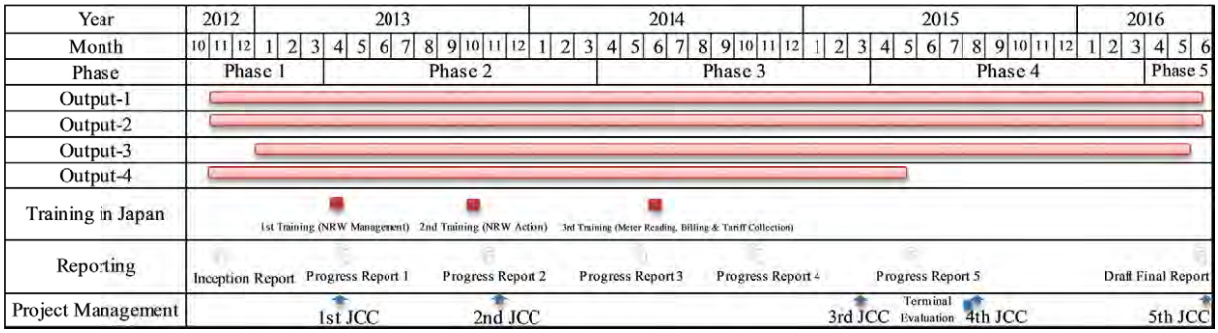


Figure S1 Overall Schedule and Main Activities

Overall goal, project purpose and outputs of the Project shown in Project Design Matrix (PDM) are as follows:

- Overall Goal: SW's service levels are improved and SW's revenue is increased.
- Project Purpose: SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30% by 2015.
- Output-1: Planning process of SW for Non-Revenue Water (NRW) reduction is systemized.
  Output-2: The Procedure of NRW Reduction is established through the Pilot Areas and LCZs.
  Output-3: NRW Reduction is implemented in accordance with the Procedure in Pilot project areas and/or LCZs in the selected District Metered Areas (DMAs), and then improved NRW Ratio is monitored and maintained.
  Output-4: Water meter reading and billing process management are improved.

Terminal Evaluation Team, dispatched in August 2015, has evaluated the progress of these overall goal, project purpose, and each output, and has evaluated the project from the viewpoint of DAC five criteria. According to the evaluation result, the Project had achieved significant capacity development of SW, however sustainability is concerned in terms of organizational, technical, financial and social aspects. As for improvement of technical and organizational sustainability, the Terminal Evaluation Team has pointed out that SW's capacity to monitor and maintain the improved NRW ratio should be developed. Thus, it is decided that the Project period was prolonged for additional eight months.

Since the Task Force Team comprehensively implements NRW reduction which consists of baseline activities and monitoring and maintenance activities, overall goal will be achieved. In addition, project purpose was achieved as shown in Table S2 and S3. Through the pilot projects, achievement levels on each Output are summarized as follows:

Table S1 Achievement for the Project at the Project Completion as of June 2016

Indicators (PDM_4)	Achievement at the Project Completion
Output-1: "Planning process of SW for NRW reduction is systemized."	

<table>
<tr><th>Indicators (PDM4)</th><th>Achievement at the Project Completion</th></tr>
<tr><td rowspan="4">1.1 Annual budget for NRW reduction is secured in the pilot project areas and LCZs.</td><td><u>Pilot Project Areas</u></td></tr>
<tr><td>- Actual cost incurred for the NRW reduction activities: About SBD2.23million (USD0.28million) in 15 pilot areas for cumulatively 38.7 months.</td></tr>
<tr><td><u>DMAs and/or LCZs</u></td></tr>
<tr><td>- Actual cost incurred for the NRW reduction activities: About SBD1.99million (USD0.25million) in four DMAs for cumulatively 24.2 months.</td></tr>
<tr><td rowspan="2">1.2 The strategic implementation (rolling-out) plan for NRW reduction is approved and reviewed as when it is necessary by management of SW.</td><td>- The strategic implementation (rolling-out) plan (hereinafter “the strategic plan”) prepared by SW was reviewed and approved in June 2016.</td></tr>
<tr><td>- The strategic plan will be utilized and reviewed afterwards by SW's own effort.</td></tr>
<tr><td colspan="2">Output 2: “The procedure for NRW reduction is established through the pilot project areas and LCZs.”</td></tr>
<tr><td rowspan="2">2.1 Manuals for NRW reduction measures are prepared and revised as when it is necessary, including workflow of DMA-based monitoring and maintenance for improved NRW ratio.</td><td>- Four components of the manuals for NRW reduction: Handbook for Operation & Maintenance of equipment on leak detection, NRW reduction measures, Rule book of database and O&M manual of database.</td></tr>
<tr><td>- The manuals were revised and completed in June 2016.</td></tr>
<tr><td rowspan="2">2.2 The number of authorizations and disconnections of illegal connections is increased in the Pilot Project areas and LCZs.</td><td><u>Pilot Project Areas</u>
<table>
<tr><th>Households</th><th colspan="2">Before-countermeasure</th><th colspan="2">After-countermeasure</th></tr>
<tr><td>Legalization</td><td>18*1</td><td>33.3%</td><td>38</td><td>27.1%</td></tr>
<tr><td>Disconnection</td><td>36*2</td><td>66.7%</td><td>102</td><td>72.9%</td></tr>
<tr><td>Total Illegal Conncetions</td><td>54</td><td>100%</td><td>140</td><td>100%</td></tr>
</table></td></tr>
<tr><td><u>DMAs and/or LCZs</u>
<table>
<tr><th>Households</th><th colspan="2">Before-countermeasure</th><th colspan="2">After-countermeasure</th></tr>
<tr><td>Legalization</td><td>15*3</td><td>32.6%</td><td>33</td><td>70.2%</td></tr>
<tr><td>Disconnection</td><td>31*4</td><td>67.4%</td><td>14</td><td>29.8%</td></tr>
<tr><td>Total Illegal Conncetions</td><td>46</td><td>100%</td><td>47</td><td>100%</td></tr>
</table></td></tr>
<tr><td rowspan="2">2.3 The number of new service connections and replacement of malfunctioning customer meters is increased in the Pilot Project areas and LCZs.</td><td><u>Pilot Project Areas</u>
<table>
<tr><th>Households</th><th colspan="2">Before-countermeasure</th><th colspan="2">After-countermeasure</th></tr>
<tr><td>Connected Households</td><td>1,196</td><td>81.7%</td><td>1,227</td><td>83.8%</td></tr>
<tr><td>Unconnected Households</td><td>268</td><td>18.3%</td><td>237</td><td>16.2%</td></tr>
<tr><td>Total Households</td><td>1,464</td><td>100%</td><td>1,464</td><td>100%</td></tr>
</table>
<table>
<tr><th>Households</th><th>At the commencement of the Project</th><th colspan="2">At the completion of the Project</th></tr>
<tr><td>Installed newly</td><td rowspan="2">54*5</td><td>378</td><td>38.8%</td></tr>
<tr><td>Replaced</td><td>596</td><td>61.2%</td></tr>
</table></td></tr>
<tr><td><u>DMAs and/or LCZs</u>
<table>
<tr><th>Households</th><th colspan="2">Before-countermeasure</th><th colspan="2">After-countermeasure</th></tr>
<tr><td>Connected Households</td><td>772</td><td>93.1%</td><td>808</td><td>97.5%</td></tr>
<tr><td>Unconnected Households</td><td>57</td><td>6.9%</td><td>21</td><td>2.5%</td></tr>
<tr><td>Total Households</td><td>829</td><td>100%</td><td>829</td><td>100%</td></tr>
</table>
<table>
<tr><th>Households</th><th>At the commencement of the Project</th><th colspan="2">At the completion of the Project</th></tr>
<tr><td>Installed newly</td><td rowspan="2">46*6</td><td>137</td><td>40.9%</td></tr>
<tr><td>Replaced</td><td>198</td><td>59.1%</td></tr>
</table></td></tr>
<tr><td colspan="2">Output 3 (PDM4): “NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs in the selected DMAs, and then improved NRW ratio is monitored and maintained.”</td></tr>
<tr><td rowspan="2">3.1 The number of pipe repairs is increased in the Pilot Project areas and LCZs.</td><td><u>Pilot Project Areas</u>
<table>
<tr><th>Items</th><th colspan="2">Before-countermeasure</th><th colspan="2">After-countermeasure</th></tr>
<tr><td>Non-repaired</td><td>108</td><td>56.5%</td><td>0</td><td>0.0%</td></tr>
<tr><td>Pipe Repair</td><td>83*7</td><td>43.5%</td><td>191</td><td>100.0%</td></tr>
<tr><td>Number of Leaks</td><td>191</td><td>100%</td><td>191</td><td>100%</td></tr>
<tr><td>Leakage Ratio</td><td colspan="2">42.80%</td><td colspan="2">15.10%</td></tr>
</table></td></tr>
<tr><td><u>DMAs and/or LCZs</u></td></tr>
</table>

Indicators (PDM4)	Achievement at the Project Completion
	Items / Before-countermeasure / After-countermeasure Non-repaired: 12 (14.6%) / 0 (0.0%) **Pipe Repair: 70[*8] (85.4%) / 82 (100.0%)** Number of Leaks: 82 (100%) / 82 (100%) Leakage Ratio: 51.30% / 19.70%
3.2 Data and records of DMA-based monitoring and maintenance for improved NRW ratio are accumulated to sustain NRW reduction activities in the selected DMA.	- Data for DMA-based monitoring and maintenance have been accumulated and analyzed for taking NRW reduction measures by graphing.
Output 4: "Water meter reading and billing process management are improved."	
4.1 Standard operating procedures (SOP) and training materials are formulated.	- SOP on customer meter reading and billing system was prepared in April 2013 and finalized with training materials based on know-how obtained through routine works.

*1 10places x 22km/220km x 18 months=18 places, *2 20places x 22km/220kmx18 months=36 places, *3 10places x 24km/220km x 14 months=15 places, *4 20places x24km/220kmx14 months=31 places, *5 30places x 22km/220km x 18 months=54 places, *6 30places x 24km/220km x 14 months=46 places, *7 46places x 22km/220km x 18 months=83places, *8 46places x 24km/220km x 14 months=70places

The NRW reduction activities were implemented in 15 pilot project areas from April 2013 to September 2014 as well as in four DMAs from September 2014 to June 2016. DMA-based monitoring and maintenance of improved NRW ratio have also been conducted in two DMAs. The following tables show reduction point of NRW reduction in 15 pilot project areas and four DMAs.

Table S2 Reduction Point of NRW Ratio before/after Countermeasure in Pilot Project Areas

No	Area No	Area	NRW Ratio (%)		Reduction (Percentage points)
			Before	After	
1	No.9	White River- Namo Ruka	86.5	32.2	54.3
2	No.10	Independence Valley	57.7	9.9	47.9
3	No.3	Lenggakiki	62.0	33.2	28.8
		After additional countermeasures		14.7	47.3
4	No.5	Mbokonavera-1	53.1	14.7	38.5
5	No.14	Tuvaruhu-1	65.4	41.4	24.0
		After additional countermeasures		11.0	54.4
6	No.15	Tuvaruhu-2	67.2	20.5	46.7
7	No.6	Vavaea Ridge	63.1	27.2	35.8
8	No.4	Mbokona	50.2	19.2	31.0
9	No.8	Mbaranamba	23.2	3.5	19.7
10	No.2	Mbua Valley	50.9	6.8	44.1
11	No.11	Bahai Kukum	58.6	16.2	42.4
12	No.7	Panatina Valley	37.9	6.7	31.2
13	No.12	Naha 2	51.7	15.6	36.1
14	No.13	Naha 3	60.9	25.8	35.1
15	No.1	FFA Kola Road	47.1	14.9	32.2

Note: Due to rounding process, value in the first decimal place of reduction point is not necessarily identical to the deference between after and before of NRW ratio.

Table S3 Reduction Point of NRW Ratio before/after Countermeasure in DMAs

No	DMA No.	DMA	NRW Ratio (%)		Reduction (Percentage points)
			Before	After	
1	No. 10	Lenggakiki	42.6	22.6	20.0
2	No. 6	Tasahe A&B[*1]	85.8	44.6	41.3
		After pressure control		32.7	53.1
3	No. 17	West Kola Ridge A[*1]	60.4	18.4	42.0
4	No.7	Tasahe C	38.1	7.5	30.6

Note: Due to rounding process, value in the first decimal place of reduction point is not necessarily identical to the deference between after and before of NRW ratio.

*1 In DMAs which were selected under SW-JICA commitment, NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

Through the NRW reduction activities in pilot project areas and DMAs, the reduction procedures were established in SW. In addition, manuals, handbook and rule book on leakage detection, equipment and database as well as Standard Operating Procedures (SOP) for meter reading and billing were prepared

by the Project Team. Moreover, the Project Team formulated the Strategic Implementation (Rolling-out) Plan for NRW Reduction which consists of implementation process, contents of overall activities, implementation schedule with budget allocation etc., so that SW will be able to take NRW reduction activities in the remaining DMAs efficiently which will be completed within two years.

In this Report, the Project Team analysed cost-effectiveness of NRW reduction activities. Table S4 shows initial cost which is composed of personnel, consumable and material equipment; volume of revenue water increased by NRW reduction activities and cost benefit.

Table S4 Cost Benefit Analysis for NRW Reduction Activities (for three years)

Area	Total No. of Household	Estimated Increased Revenue Water	Estimated Revenue Increase *1	Initial Cost incurred*2	Initial and Recurring Cost for 3 years*3	Ratio of C/B
	No. of Household	m^3/3yrs	SBD/3yrs	SBD	SBD/3yrs	%
15 Pilot Project Areas	1,464	1,538,784	**27,097,986**	2,231,364	**4,462,728**	**16.5%**
4 DMAs	829	1,598,184	**28,144,020**	1,987,330	**3,974,660**	**14.1%**

*1: Unit revenue per revenue water of SBD17.61/m^3as of 2015 was applied for increased revenue.

*2: Initial cost is composed of personnel, consumable and material cost.

*3: Recurrent cost for NRW reduction required to maintain conditions well for three years is estimated as 100% of the initial cost spent in the Pilot Projects.

Estimated increased revenue for three years in 15 Pilot Projects and four DMAs is estimated at about SBD27.10million (USD3.39million) and SBD28.14million (USD3.52million) respectively, greatly representing 6.1 and 7.1 times of the initial and three-year recurring cost of activities of NRW reduction. Therefore, NRW reduction is definitely beneficial to services and business of SW.

JICA sent the experts for 57.87 Man-Month to SW, invited 12 staff members (four members multiplied by three times) for two-week technical training in Japan and provided the Project with equipment such as potable ultra-sonic flowmeters, leak detectors, pick-up trucks, etc. Meanwhile, SW procured DMA flowmeters, pressure reducing valves, customer meters, concreate chambers, etc. Finally, SW spent about SBD1.5million (USD0.19million) for cost of procurement of equipment and fuel for vehicles.

At the beginning of the Project, JICA Expert Team (JET) and SW set up the capacity baselines at the organization and individual levels through assessment and drew up a capacity development plan based on the baselines. SW' Project Team annually prepared Individual Action Plan (IAP) which is composed of annual target, verifiable indicator, the measure to achieve target, and assessed by them. This was helpful measure to raise their own motivation to participate in the NRW reduction activities.
In order for SW to attain overall goal, the following points together with appropriate appointments for staff involved in the Project must be considered. Otherwise, NRW ratio will be deteriorated.

【Organization Level: Management】

■ **Ensuring Staff Motivation through Performance Award and Regular Acknowledgement**

It is significant that SW's staff analyzes the output of their NRW reduction activities and releases the result of analysis. Therefore, it is desirable that SW management selects the monthly most valuable staff based on their outputs and results, and commends those who take positive actions on their task in the monthly meeting.

■ **Capacity Development**

Based on the result of final capacity assessment, some approaches were suggested by JET. Those are establishment of regulation on water meter replacement, improvement of Standard Operating Procedure (SOP) on water meter reading, billing process, continuation of Performance Index preparation, regular report to MMER, etc., training for SW staff by persons trained through the Project and enhancement of PR activities.

■ **Securing vehicle required for Water Meter Reading**

Since meters readers are being dropped-off and picked-up from the various sites in Honiara using an allocated vehicle, transportation such as motor bikes, bicycles, cars and foot-reading required for water meter readers should be examined from the aspects of site location and geographical conditions.

【Organization Level: Policy & Plan】

■ **Revising Strategic Implementation Plan, etc. flexibly and Taking NRW reduction activities**

The strategic implementation plan and annual action plan should be revised flexibly based on any policies to be suggested by Management Team, and NRW reduction activities should be taken.

■ **Planning Procurement Schedule of Equipment and its Budget**

It is suggested that SW should prepare concrete activity plans and incurred cost estimation by September at least for the next fiscal year, so that equipment can be procured smoothly and on time.

■ **Reviewing Water Tariff System**

It is suggested that SW drastically reviews water tariff system based on household survey to be conducted in future, so that arrears and illegal connections may be reduced.

■ **Eliminating Illegal Connections**

Water loss due to illegal connection makes up about 10% of the whole NRW in Honiara. It is suggested that SW examines the current tariff system, enforcement of the penal regulation for illegal connections, introduction of social security system and continuation of PR activities.

【Individual Level】

■ **Improving the database for Daily Meter Reading**

It was observed that some customers were not billed monthly in times when they were passed by water meter readers due to inadequate database. This kind of meter readers' performance may cause arrears. It is suggested that staff in charge of registration of customers in Finance Division must feed-back customer's data to GIS staff to update database properly and promptly.

■ **Raising Knowledge of Water Meter Readers**

The meter readers have better opportunities to receive complaints and inquiries. Water meter readers should adequately be equipped to immediately answer general inquiries to ensure customers satisfaction and to develop trust toward SW. It is suggested that workshop for the water meter readers to learn FAQ, status-quo of supply service will take place in the frequency of at least twice a year.

■ **Compiling Data to be measured and Customer's Data Accurately**

It was observed that there is discrepancy between data. Therefore, it is suggested that not only data is compiled in the standard template but also relevant persons must have close-communication with each other, so that the data can be cross-checked.

CHAPTER 1 INTRODUCTION

1.1 Background of the Project

Solomon Islands has population of approximately 536,000 in 2010, and its Gross National Income per person was 1,030 US Dollars in 2010. The land area is 29,785 km^2.The ethnic tensions from 1998 to 2003 caused disruption to administrative services, consequently, Solomon Islands experienced severe economic losses. Today, even after the civil unrest was over, the basic infrastructures such as roads, electricity etc. remained underdeveloped.

Although Solomon Water (hereinafter "SW") is in charge of water supply and sewerage services in urban areas, it was running operations insufficiently. Water supply coverage in Honiara City was 72% in 2011, but in fact about two thirds of subscribers were suffering from rationing water supply. As for management, the account deficit in 2010 was SBD5,046,000 and operational revenue-to-expenditure ratio was 84.7%, due to reasons such as a high non-revenue water (hereinafter "NRW") ratio reaching 56% in 2011, high electricity bills and an inappropriate water tariff. As for NRW reduction measures as a key to financial improvement, SW had no systematic plan and repaired surface leaking pipes only if reported without scheduled leak detection activities. SW had a lack of human resources on NRW reduction including planning, leakage control and illegal connection regulation, etc.

Due to this situation, in August 2010, the Solomon Islands Government requested a technical cooperation project from the Japanese Government for the capacity development of SW on NRW reduction. In response to the request, the Japan International Cooperation Agency (hereinafter "JICA") and SW came to an agreement on the framework of the Project through the detailed design study in March 2012, and concluded the Record of Discussion (see Attachment-1) on the 27th of July 2012. In addition, the Record of Discussion (see Attachment-2) was amended based on result of the terminal evaluation on the 30th of October 2015.

Consequently, "the Project for Improvement of NRW Reduction Capacity for Solomon Islands Water Authority in Solomon Islands" (hereinafter "the Project") by SW and the JICA Expert Team (hereinafter "JET") was commenced in October 2012 and both agreed on scopes and contents the Project, and then concluded the Minutes of Meetings (see Attachment-3).

1.2 Project Area

The project area is located in Honiara City, which extends approximately four km north and south, and approximately 12 km east and west in the northern coast of Guadalcanal Island. Pilot projects were implemented in 15 areas particularly-selected through the Project and also in four of 28 District Metered Area (hereinafter "DMA")s designed through SW's Two-Year Plan.

See "Location Map of the Project Area" and "Diagram of Honiara Water Supply System in Operation and DMAs" at the beginning of this report.

1.3 Overall Goal, Project Purpose, Outputs and Activities

Overall goal, project purpose, outputs and activities of the Project are summarized in Table 1.1-1.

Table 1.1-1 Overall Goal, Project Purpose, Outputs and Activities (PDM_4)

Overall Goal	**SW's service levels are improved and SW's revenue is increased.** [*1] **Indicators** 1. NRW reduction activities are carried on by Task Force composed of relevant Departments or Units.
Project Purpose	**SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30% by 2015.** [*2] **Indicator** 1. The NRW ratio is reduced by 30 points in each pilot project area, selected DMAs and/or LCZs.[*3] 2. Regarding the pilot project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30%, the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated.
Outputs and Activities	**Output-1: Planning process of SW for NRW reduction is systematized.** **Indicators** 1-1. Annual budget for NRW reduction is secured in the pilot project areas and LCZs. 1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved and reviewed as when it is necessary by management of SW. **Activities** 1-1 Establish the NRW Management Team in SW. 1-2 Review the current NRW reduction activities done by SW. 1-3 Assist in hydraulic analysis including identification of problems in the existing network. 1-4 Select pilot project areas and DMAs. 1-5 Formulate an annual action plan on NRW reduction in the pilot project areas and LCZs. 1-6 Monitor the progress of NRW reduction activities in the pilot project areas and LCZs. 1-7 Analyze cost-effectiveness of NRW reduction activities. 1-8 Prepare strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City. 1-9 Feedback the results of DMA-based NRW reduction activities, including monitoring and maintenance for improved NRW ratio, to strategic implementation (rolling-out) plan, and then provide assistance in review of the plan as when it is necessary.
	Output-2: The procedure for NRW reduction is established through the pilot project areas and LCZs. **Indicators** 2-1. Manuals for NRW reduction measures are prepared and revised as when it is necessary, including workflow of DMA-based monitoring and maintenance for improved NRW ratio. 2-2. The number of authorizations and disconnections of illegal connections is increased in the pilot project areas and LCZs. 2-3. The number of new service connections and replacement of malfunctioning customer meters is increased in the pilot project areas and LCZs. **Activities** 2-1 Establish the NRW Action Team in SW. 2-2 Check existing flow meters and replace the malfunctioning meters with new ones at all the water sources. 2-3 Conduct training on NRW reduction for the NRW Action Team. 2-4 Provide assistance in the preparation of workflow for DMA-based monitoring and maintenance for improved NRW ratio, based on action criteria such as NRW ratio and DMA's features. 2-5 Feedback the results of DMA-based NRW reduction activities, including monitoring and maintenance for improved NRW ratio, to manuals, and then provide assistance in review of the manuals as when it is necessary.

	Output-3: NRW reduction is implemented in accordance with the procedure in the pilot project areas and/or LCZs in the selected DMAs, and then improved NRW ratio is monitored and maintained. **Indicators** 3-1. The number of pipe repairs is increased in the pilot project areas and LCZs. 3-2. Data and records of DMA-based monitoring and maintenance for improved NRW ratio are accumulated to sustain NRW reduction activities in the selected DMA. **Activities** 3-1 Provide assistance in the definition and creation of discrete DMA's and their boundaries. 3-2 Provide assistance in the creation of LCZ within the DMAs. 3-3 Update existing water distribution network drawings by using GIS in the pilot project areas and DMAs. 3-4 Install necessary valves for isolation of the pilot project areas and DMAs, install flow meters, and measure the NRW ratio before implementation of the pilot project. 3-5 Identify the causes of NRW (water leakage, illegal connections and meter-related losses) in the pilot project areas and DMAs through the OJT. 3-6 Implement NRW reduction measures such as legalization of users, leakage detection, leakage repair, water meter installation and optimization of water pressure in the pilot project areas and DMAs, and measure the NRW ratio after implementation of the pilot projects. 3-7 Prepare reports of results including cost and benefit. 3-8 Provide advice for the improvement of pipe system design, installation and network operation. 3-9 Convene the workshops to share the experiences, outcomes and etc. of the pilot projects. 3-10 Provide capacity development and training using the DMA's and LCZ's as the basis for NRW reduction activities. 3-11 Provide technical assistance in DMA-based monitoring and maintenance for improved NRW ratio after initial NRW reduction activities.
	Output-4: Water meter reading and billing process management are improved. **Indicator** 4-1. Standard operating procedures (SOP) and training materials are formulated. **Activities** 4-1 Formulate the work schedule and staff assignment plan for water meter readers. 4-2 Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers. 4-3 Promote PR activities on water conservation and saving, and water tariff for the customers. 4-4 Monitor the water meter reading and billing activities. 4-5 Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.
Note: Pilot project includes NRW reduction activities in not only pilot project areas but also DMAs. *1: SW is the abbreviation of Solomon Islands Water Authority, previously SIWA. *2: Indicator is based on the target of SW's Two-Year Plan (2013-2015). *3: District Metered Area (DMA) and Leakage Control Zone (LCZ) Source: PDM_4	

1.4 Solomon Water's Two-Year Plan

The Solomon Water Development Plan 2013-2015 (Two-Year Plan[1]) which is post- the Recovery and Action Plan (2011-2013) was formulated by SW and supported by the Australian Department of Foreign Affairs and Trade (currently "DFAT").

The objectives of the Two-Year Plan is to enable SW to provide the improved levels of water supply service in terms of quality, quantity and reliability to a larger proportion of the population in the

[1] It has been extended until June 2016.

existing service areas, and SW has identified the following five outputs to achieve the objectives:

Output 1: Improved levels of service for water supply

Output 2: Improved customer care and communications

Output 3: Strengthened financial management and administration

Output 4: Improved organizational capacity, and

Output 5: Improved strategic planning

The Output 1 "Improved levels of service for water supply" is strongly related to the Project of JICA. JICA, SW and AusAID (Current: DFAT) committed collaboration between the Project and Two-Year Plan in August 2013 with the Memorandum of Agreement (hereinafter "MoA") (see Attachment-4). The MoA resulted in the revision of Project Design Matrix (hereinafter "PDM") as PDM_2 and Plan of Operation (hereinafter "PO") as PO_2.

1.5 Japanese Grant Aid Project on Water Supply Sector

The Japanese grant aid project "The Project for Improvement of Water Supply System in Honiara and Auki (E/N concluded in June 2009)" was completed in August 2014. This grant aid project contributed to significant improvements in water services such as resolution of low water pressure in distribution networks and improvement of water quality (e.g. lowering high turbidity) at water sources. Construction is composed of water supply facilities such as 16 boreholes (Total production capacity: about 12,000m^3/day), turbidity reduction plant of 5,400m^3/day and transmission & distribution pipelies of about 30km in Honiara and two boreholes and some transmission pipelines in Auki.

After starting operation of water supply facilities by this grant aid project, leakage was found due to supplying water to ex-rationing areas, which resulted in increasing NRW ratio as a negative impact.

Meanwhie, it is desirable that the improvement of water services as a result of this grant aid project could enhance the willingness to pay of users and lead to reduction of NRW. Therefore, SW and JET are confident that the Project and this grant aid project were interdependent, and collaboration of both projects boosted effectiveness of cooperation by JICA.

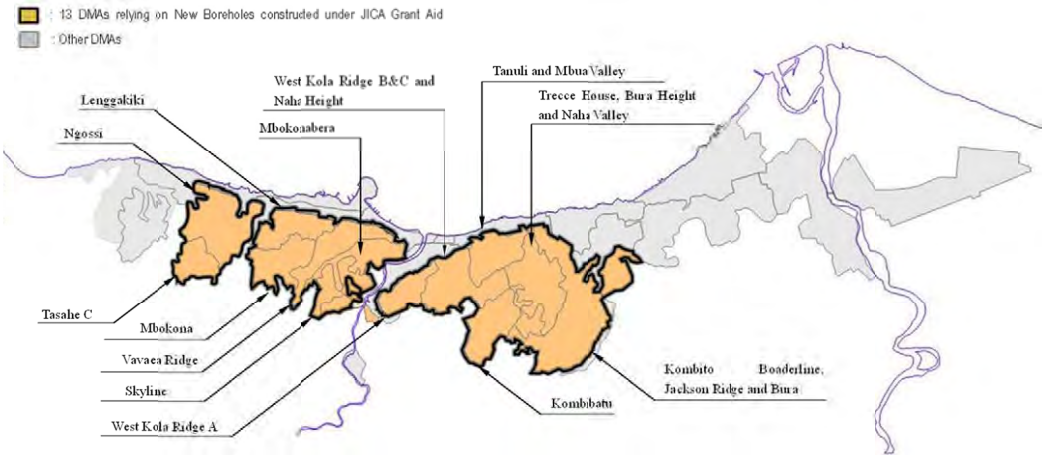


Figure 1.1-1 Location of DMAs relying on New Boarholes constructed under JICA Grant Aid Project

CHAPTER 2 PROJECT OPERATIONS AND MANAGEMENT

2.1 Project Design Matrix (PDM) and its Revisions

The Project was implemented in the framework of PDM. PDM has been revised three times during the project period as listed in Table 2.1-1.

These revisions reflect the information that was unexpected at the beginning but found during the project period so that the Project corresponded to the actual situation.

PDM_1 to PDM_4 are shown in Table 2.1-2 to Table 2.1-5 respectively.

Table 2.1-1 Revision of the PDM

Date	Contents of Revisions	Background
Jun. 2013 (proposed) Aug. 2013 (agreed) PDM_1 to PDM_2	- Revision of Project Purpose "Non-revenue water (NRW) ratio In Honiara City is reduced." =>"SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30% by 2015." - Revision of Indicators to Overall Goal "1. Water supply hours become longer. 2. The NRW ratio in Honiara City is reduced to XX % by 2018. 3. Ratio of current expense to current income becomes more than 100% by 2018." =>"1. The NRW ratio in Honiara City is reduced to 20% by 2018. 2. Ratio of operational revenue-to-expenditure is sustained at greater than 100%." - Revision of Indicators to Project Purpose "1. The NRW ratio is reduced to XX % in each pilot area and the NRW ratio in Honiara City is reduced to XX %." =>"1. The NRW ratio is reduced by 30 points in each Pilot Project area, selected DMAs and/or LCZs." - Addition of NRW reduction activities in DMAs to outputs and activities.	Reflecting DFAT's Two-year Plan (2013-2015)
Mar. 2015 PDM_2 to PDM_3	- Addition of Indicators to Project Purpose "2. Regarding the Pilot Project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30%, the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated."	A pilot area "Mbaranamba" was found having a NRW ratio less than 30% before starting the NRW reduction measures. It was decided to continue that the NRW reduction measures to study effectiveness of activities.
Oct. 2015 PDM_3 to PDM_4	- Revision of Indicators to Overall Goal "1. The NRW ratio in Honiara City is reduced to 20%* by 2018. 2. Ratio of operational revenue-to-expenditure is sustained at greater than 100%." => "1. NRW reduction activities are carried on by Task Force composed of relevant Departments or Units." - Revision of Outputs "3. NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs." => "3. NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs in the selected DMAs, and then improved NRW ratio is monitored and maintained." - Revision of Indicators to Outputs "1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved by management of SW." => "1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved and reviewed as when it is necessary by management of SW." "2-1. A manual for NRW reduction measures is prepared." => "2-1. Manuals for NRW reduction measures are prepared and revised as when it is necessary, including workflow of DMA-based monitoring and maintenance for improved NRW ratio." - Addition of Indicators to Outputs "3-2. Data and records of DMA-based monitoring and maintenance for improved NRW ratio are accumulated to sustain NRW reduction activities in the selected DMA."	As for Indicator 1, it is unfeasible due to several incidents that were hardly expected at the beginning of the project. For example, SW started its policy to disconnect arrear customers very strictly and thoroughly after 2013, and it negatively affect NRW ratio. As for Indicator 2, achievement of this indicator is affected not only by the outcome of the project, but also by other factors. For example, SW's water tariff has been almost doubled since the beginning of the Project, and it positively affects the ratio of operational revenue- to-expenditure.

Source: Terminal Evaluation Report and the JET

Table 2.1-2 PDM$_1$ (Original at the Discussion of Inception Report)

Project Design Matrix (PDM$_1$)

Project Title: The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands **Version 1 (Inception Report)**

Target Area: Honiara City **Target Group: SW Staff** **Project Period: November 2012 to October 2015 (3 years)** **Date: -- November 2012**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			
SIWA's service levels are improved and SIWA's revenue is increased.	1. Water supply hours become longer. 2. The NRW ratio in Honiara City is reduced to XX % by 2018. 3. Ratio of current expense to current income becomes more than 100% by 2018.	1. SIWA Annual Report 2. SIWA Annual Report 3. SIWA Annual Report	
Project Purpose			
Non-revenue water (NRW) ratio in Honiara City is reduced.	1. The NRW ratio is reduced to XX % in each pilot project area and the NRW ratio in Honiara City is reduced to XX %.	1. Project Report	
Outputs			
1. The planning process for NRW reduction is systematized.	1-1. Annual budget for NRW reduction is secured in the pilot project areas. 1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved by the executive board of SIWA.	1-1. Annual Budget Plans 1-2. Strategic implementation (rolling-out) plan for NRW reduction	The SIWA staff capacitated by the Project Budgetary and human resources necessary for stable water supply are continuously allocated by SIWA.
2. The implementation procedure of NRW reduction is established through the pilot projects.	2-1. A manual for NRW reduction measures is revised. 2-2. The number of pipe repairs is increased in the pilot project areas. 2-3. The number of authorizations and disconnections of illegal connections is increased in the pilot project areas. 2-4. The number of new service connections and replacement of malfunctioning customer meters is increased in the pilot project areas.	2-1. Project Reports 2-2. Project Reports 2-3. Project Reports 2-4. Project Reports	The SIWA staff capacitated by the Project continues working for their respective positions.
3. Billing process management is improved.	3-1. Standard of procedures (SOP) and training materials are formulated.	3-1. Project Reports	Natural disasters do not give a profound effect to the project activities.

Activities

1-1. Establish the NRW Management Team in SIWA.
1-2. Review the current NRW reduction activities done by SIWA.
1-3. Conduct hydraulic analysis of distribution network and water balance audit.
1-4. Select pilot project areas.
1-5. Formulate an annual operational plan on NRW reduction at the pilot project areas.
1-6. Monitor the progress of NRW reduction activities in the pilot project areas.
1-7. Analyze cost and benefit of NRW reduction measures.
1-8. Prepare the strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City.

2-1. Establish the NRW Action Team in SIWA.
2-2. Check the flow meters and replace the malfunctioning meters with new ones at all the water sources.
2-3. Conduct training on NRW reduction for the NRW Action Team.
2-4. Update the water distribution network drawings by using GIS at the pilot project areas.
2-5. Install necessary valves & flow meters and to measure the NRW ratio before the pilot projects.
2-6. Identify the causes of NRW (water leakage, illegal connection, meter-related losses) in the pilot project areas through the OJT.
2-7. Implement NRW reduction measures in the pilot project areas and measure the NRW ratio after the pilot projects.
2-8. Prepare reports of the pilot project results including the costs and benefits.
2-9. Update the manuals on pipe installation, leakage detection, etc.
2-10. Convene the workshops to share the experiences, outcomes, etc. of the pilot projects.

3-1. Formulate the work schedule and staff assignment plan for meter readers.
3-2. Conduct training on water meter-reading and reporting methods for anomalies and illegal connections for meter readers.
3-3. Promote PR activities on water conservation and tariff for the customers.
3-4. Monitor the meter reading activities and bill deliveries.
3-5. Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.

Inputs

Solomon Islands Side

1. Personnel
   - Project Director
   - Project Manager
   - Counterpart personnel
2. Provision of the project offices and facilities necessary for the project implementation
3. Expenses for implementing pilot projects in Honiara City: such as repair costs for distribution pipes, installation costs for valves ad meter, etc.
4. Administrative and operational expenses
   - Electricity, water, communication, etc.
   - Local traveling costs and daily subsistence allowance (DSA) for counterpart personnel
   - Others as necessary

Japanese Side (continued)

1. Expert
   - Chief Advisor / Water Supply Planning and Management
   - NRW Reduction Management
   - Leakage Detection Technology
   - GIS
   - Customer Services / PR
   - Others as necessary
2. Training of counterpart personnel in Japan and/or the Third Countries
3. Provision of machinery and equipment
   - Leakage detection equipment
   - Water flow meters
   - Customer meters
   - Valves
   - Handheld data-input device
   - GPS portable terminals
   - Office equipment
   - Others as necessary
4. Local expenses for the project activities
   - Teaching materials for training and workshops
   - Others

Precondition

Note: Original statements underlined were modified or deleted.

Table 2.1-3 PDM$_2$ (1st Revision)

Project Design Matrix (PDM$_2$)

Project Title: The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands **Version 13("PDM2, PO2Rev.13.xlsx")**

Target Area: Honiara City **Target Group: SW Staff** **Project Period: November 2012 to October 2015 (3 years)** **Date: 30 July 2013**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			
SW's service levels are improved and SW's revenue is increased.	1. The NRW ratio in Honiara City is reduced to 20% * by 2018. 2. Ratio of operational revenue-to-expenditure is sustained at greater than 100%.	1. SW Annual Operation Report 2. SW Annual Operation Report 3. SW Annual Operation Report	
Project Purpose			
SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30% * by 2015.	1. The NRW ratio is reduced by 30** points in each pilot project area, selected DMAs and/or LCZs.	1. Project Reports	
Outputs			
1. Planning process of SW for NRW reduction is systematized.	1-1. Annual budget for NRW reduction is secured in the pilot project areas and LCZs. 1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved by management of SW.	1-1. Annual Budget Plans 1-2. Strategic implementation (rolling-out) plan for NRW reduction	Budgetary and human resources necessary for stable water supply are continuously allocated by SW.
2. The procedure for NRW reduction is established through the pilot areas and LCZs.	2-1. A manual for NRW reduction measures is prepared. 2-2. The number of authorizations and disconnections of illegal connections is increased in the pilot project areas and LCZs. 2-3. The number of new service connections and replacement of malfunctioning customer meters is increased in the pilot project areas and LCZs.	2-1. Project Reports 2-2. Project Reports 2-3. Project Reports	SW staff trained by the Project continue to work in their respective positions. Natural disasters do not give a profound effect to the project activities.
3. NRW reduction is implemented in accordance with the procedure in pilot areas and/or LCZs.	3-1. The number of pipe repairs is increased in the pilot project areas and LCZs.	3-1. Project Reports	
4. Water meter reading and billing process management are improved.	4-1. Standard operating procedures (SOP) and training materials are formulated.	4-1. Project Reports	

Activities

1-1. Establish the NRW Management Team in SW.
1-2. Review the current NRW reduction activities done by SW.
1-3. Assist in hydraulic analysis including identification of problems in the existing network.
1-4. Select pilot project areas and DMAs.
1-5. Formulate an annual action plan on NRW reduction in the pilot project areas and LCZs.
1-6. Monitor the progress of NRW reduction activities in the pilot project areas and LCZs.
1-7. Analyze cost-effectiveness of NRW reduction activities.
1-8. Prepare strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City.

2-1. Establish the NRW Action Team in SW.
2-2. Check existing flow meters and replace the malfunctioning meters with new ones at all the water sources.
2-3. Conduct training on NRW reduction for the NRW Action Team.

3-1. Provide assistance in the definition and creation of discrete DMA's and their boundaries.
3-2. Provide assistance in the creation of LCZ within the DMAs.
3-3. Update existing water distribution network drawings by using GIS in the pilot project areas and DMAs.
3-4. Install necessary valves for isolation of the pilot project areas and DMAs, install flow meters, and measure the NRW ratio before implementation of the pilot project.
3-5. Identify the causes of NRW (water leakage, illegal connections and meter-related losses) in the pilot project areas and DMAs through the OJT.
3-6. Implement NRW reduction measures such as legalization of users, leakage detection, leakage repair, water meter installation and optimization of water pressure in the pilot project areas and DMAs, and measure the NRW ratio after implementation of the pilot projects .
3-7. Prepare reports of results including cost and benefit.
3-8. Provide advice for the improvement of pipe system design, installation and network operation.
3-9. Convene the workshops to share the experiences, outcomes and etc. of the pilot projects.
3-10. Provide capacity development and training using the DMA's and LCZ's as the basis for NRW reduction activities.

4-1. Formulate the work schedule and staff assignment plan for water meter readers.
4-2. Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers.
4-3. Promote PR activities on water conservation and saving, and water tariff for the customers.
4-4. Monitor the water meter reading and billing activities.
4-5. Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.

Inputs

Solomon Islands Side

1. Personnel
- Project Director
- Project Manager
- NRW Management Team (5 members)
- NRW Action Team (19 members)
  - Technical Sub-Team (8 members)
  - Customer Services Sub-Team (6 members)
  - GIS Sub-Team (2 members)
  - Leakage Detection Sub-Team (3 members)

2. Creation of discrete DMAs

3. Provision of the project offices and facilities necessary for the project implementation

4. Expenses for implementing pilot projects in Honiara City:
- Provide the necessary valves, meters, pipes fittings and other materials.
- Provide labor to implement the project including PR resources.
- Provide management support to facilitate successful implementation of the pilot project

5. Administrative and operational expenses
- Electricity, water, communication, etc.
- Local traveling costs and daily subsistence allowance (DSA) for counterpart personnel
- Others as necessary

Japanese Side

1. Expert
- Leader / Water Supply Planning, Operation and Management
- Deputy Leader / NRW Reduction Measures -1
- NRW Reduction Measures -2
- Leakage Detection Technology
- GIS
- Customer Services & Public Relations
- Coordinator
- GIS Adviser

Japanese Side (continued)

2. Training of counterpart personnel in Japan

3. Provision of machinery and equipment
<Equipment by JICA Expert Team>
- Ultrasonic flow meter
- Data logger
- DC battery
- Water leak detector (Leak noise correlator)
- Water leak detector (Acoustic type)
- Non-metal pipe locator
- Electronic acoustic rod
- Distance meter
- Hammer drill
- Drill bit
- Boring bar
- Generator
- Acoustic rod
- Residual chlorine analyzer
- Bulk flow meter
- Sluice valve (To isolate pilot areas)
- Water meter
- Test meter
- Handy Terminal (Data recorder of meter reading)
- GPS
- Personal computer
- Plotter
- Printer
- Multifunction copier
<Equipment by JICA offices>
- Small-size excavator
- Pick-up truck
- Customer meters

4. Local expenses for the project activities
- Teaching materials for training and workshops
- Others

Precondition

Note: Pilot Project includes NRW reduction activities not only in Pilot Area but also in DMAs.
* Indicators are based on SW's Two-year plan (2013-2015) target.
** The target figure is set temporarily based on the result of only one pilot project. Therefore, the figure might be changed in next JCC based on the progress of the pilot project.

Note: Statement was revised as PDM$_2$.

Table 2.1-4 PDM$_3$ (2nd Revision)

Project Design Matrix (PDM$_3$)

Project Title: The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands **Version 14**

Target Area: Honiara City **Target Group: SW Staff** **Project Period: November 2012 to October 2015 (3 years)** **Date: 19 March 2015**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			
SW's service levels are improved and SW's revenue is increased.	1. The NRW ratio in Honiara City is reduced to 20%* by 2018. 2. Ratio of operational revenue-to-expenditure is sustained at greater than 100%.	1. SW Annual Operation Report 2. SW Annual Operation Report 3. SW Annual Operation Report	
Project Purpose			
SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30%* by 2015.	1. The NRW ratio is reduced by 30** points in each pilot project area, selected DMAs and/or LCZs. 2. Regarding the pilot project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30% , the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated.	1. Project Reports	
Outputs			
1. Planning process of SW for NRW reduction is systematized.	1-1. Annual budget for NRW reduction is secured in the pilot project areas and LCZs. 1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved by management of SW.	1-1. Annual Budget Plans 1-2. Strategic implementation (rolling-out) plan for NRW reduction	Budgetary and human resources necessary for stable water supply are continuously allocated by SW.
2. The procedure for NRW reduction is established through the pilot areas and LCZs.	2-1. A manual for NRW reduction measures is prepared. 2-2. The number of authorizations and disconnections of illegal connections is increased in the pilot project areas and LCZs. 2-3. The number of new service connections and replacement of malfunctioning customer meters is increased in the pilot project areas and LCZs.	2-1. Project Reports 2-2. Project Reports 2-3. Project Reports	SW staff trained by the Project continue to work in their respective positions. Natural disasters do not give a profound effect to the project activities.
3. NRW reduction is implemented in accordance with the procedure in pilot areas and/or LCZs.	3-1. The number of pipe repairs is increased in the pilot project areas and LCZs.	3-1. Project Reports	
4. Water meter reading and billing process management are improved.	4-1. Standard operating procedures (SOP) and training materials are formulated.	4-1. Project Reports	

Activities

1-1. Establish the NRW Management Team in SW.
1-2. Review the current NRW reduction activities done by SW.
1-3. Assist in hydraulic analysis including identification of problems in the existing network.
1-4. Select pilot project areas and DMAs.
1-5. Formulate an annual action plan on NRW reduction in the pilot project areas and LCZs.
1-6. Monitor the progress of NRW reduction activities in the pilot project areas and LCZs.
1-7. Analyze cost-effectiveness of NRW reduction activities.
1-8. Prepare strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City.

2-1. Establish the NRW Action Team in SW.
2-2. Check existing flow meters and replace the malfunctioning meters with new ones at all the water sources.
2-3. Conduct training on NRW reduction for the NRW Action Team.

3-1. Provide assistance in the definition and creation of discrete DMA's and their boundaries.
3-2. Provide assistance in the creation of LCZ within the DMAs.
3-3. Update existing water distribution network drawings by using GIS in the pilot project areas and DMAs.
3-4. Install necessary valves for isolation of the pilot project areas and DMAs, install flow meters, and measure the NRW ratio before implementation of the pilot project.
3-5. Identify the causes of NRW (water leakage, illegal connections and meter-related losses) in the pilot project areas and DMAs through the OJT.
3-6. Implement NRW reduction measures such as legalization of users, leakage detection, leakage repair, water meter installation and optimization of water pressure in the pilot project areas and DMAs, and measure the NRW ratio after implementation of the pilot projects .
3-7. Prepare reports of results including cost and benefit.
3-8. Provide advice for the improvement of pipe system design, installation and network operation.
3-9. Convene the workshops to share the experiences, outcomes and etc. of the pilot projects.
3-10. Provide capacity development and training using the DMA's and LCZ's as the basis for NRW reduction activities.

4-1. Formulate the work schedule and staff assignment plan for water meter readers.
4-2. Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers.
4-3. Promote PR activities on water conservation and saving, and water tariff for the customers.
4-4. Monitor the water meter reading and billing activities.
4-5. Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.

Inputs

Solomon Islands Side

1. Personnel
- Project Director
- Project Manager
- NRW Management Team (5 members)
- NRW Action Team (19 members)
  Technical Sub-Team (8 members)
  Customer Services Sub-Team (6 members)
  GIS Sub-Team (2 members)
  Leakage Detection Sub-Team (3 members)

2. Creation of discrete DMAs

3. Provision of the project offices and facilities necessary for the project implementation

4. Expenses for implementing pilot projects in Honiara City:
- Provide the necessary valves, meters, pipes fittings and other materials.
- Provide labor to implement the project including PR resources.
- Provide management support to facilitate successful implementation of the pilot project

5. Administrative and operational expenses
- Electricity, water, communication, etc.
- Local traveling costs and daily subsistence allowance (DSA) for counterpart personnel
- Others as necessary

Japanese Side

1. Expert
- Leader / Water Supply Planning, Operation and Management
- Deputy Leader / NRW Reduction Measures -1
- NRW Reduction Measures -2
- Leakage Detection Technology
- GIS
- Customer Services & Public Relations
- Coordinator
- GIS Adviser

Japanese Side (continued)

2. Training of counterpart personnel in Japan

3. Provision of machinery and equipment
<Equipment by JICA Expert Team>
- Ultrasonic flow meter
- Data logger
- Water leak detector (Leak noise correlator)
- Water leak detector (Acoustic type)
- Metal locator
- Non-metal pipe locator
- Distance meter
- Hammer drill
- Drill bits
- Boring bar
- Generator
- Acoustic rods
- Residual chlorine analyzer
- Bulk flow meters
- Sluice valves (To isolate pilot areas)
- Test meter
- Handy Terminals (Data recorder of meter reading)
- GPSs
- Personal computers
- Plotter
- Printer
- Multifunction copier
<Equipment by JICA offices>
- Small-size excavator
- Pick-up trucks
- Data loggers
- Customer meters

4. Local expenses for the project activities
- Teaching materials for training and workshops
- Others

Precondition

Note: Pilot Project includes NRW reduction activities not only in Pilot Area but also in DMAs.

* Indicators are based on SW's Two-year plan (2013-2015) target.

** The target figure is set temporarily based on the result of only one pilot project. Therefore, the figure might be changed in next JCC based on the progress of the pilot project.

Note: Statement was revised as PDM$_3$.

Table 2.1-5 PDM$_4$ (3rd Revision)

Project Design Matrix (PDM$_4$)

Project Title: The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands **Version 15**

Target Area: Honiara City **Target Group: SW Staff** **Project Period: November 2012 to June 2016 (3 years and 8 months)** **Date: October 2015**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			
SW's service levels are improved and SW's revenue is increased.	1. NRW reduction activities are carried on by Task Force composed of relevant Departments or Units.	1. SW Annual Operation Report	
Project Purpose			
SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30%* by 2015.	1. The NRW ratio is reduced by 30** points in each pilot project area, selected DMAs and/or LCZs. 2. Regarding the pilot project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30%, the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated.	1. Project Reports 2. Project Reports	
Outputs			
1. Planning process of SW for NRW reduction is systematized.	1-1. Annual budget for NRW reduction is secured in the pilot project areas and LCZs. 1-2. The strategic implementation (rolling-out) plan for NRW reduction is approved and reviewed as when is necessary by management of SW.	1-1. Annual Budget Plans 1-2. Strategic implementation (rolling-out) plan for NRW reduction	Budgetary and human resources necessary for stable water supply are continuously allocated by SW. SW staff trained by the Project continue to work in their respective positions. Natural disasters do not give a profound effect to the project activities.
2. The procedure for NRW reduction is established through the pilot areas and LCZs.	2-1. Manuals for NRW reduction measures are prepared and revised as when is necessary, including workflow of DMA-based NRW monitoring and maintenance. 2-2. The number of authorizations and disconnections of illegal connections is increased in the pilot project areas and LCZs. 2-3. The number of new service connections and replacement of malfunctioning customer meters is increased in the pilot project areas and LCZs.	2-1. Project Reports 2-2. Project Reports 2-3. Project Reports	
3. NRW reduction is implemented in accordance with the procedure in pilot areas and/or LCZs. and then NRW is monitored and maintained.	3-1. The number of pipe repairs is increased in the pilot project areas and LCZs. 3-2. Data and records of DMA-based NRW monitoring and maintenance are accumulated to sustain NRW reduction.	3-1. Project Reports 3-2. Project Reports	
4. Water meter reading and billing process management are improved.	4-1. Standard operating procedures (SOP) and training materials are formulated.	4-1. Project Reports	

Activities

1-1. Establish the NRW Management Team in SW.
1-2. Review the current NRW reduction activities done by SW.
1-3. Assist in hydraulic analysis including identification of problems in the existing network.
1-4. Select pilot project areas and DMAs.
1-5. Formulate an annual action plan on NRW reduction in the pilot project areas and LCZs.
1-6. Monitor the progress of NRW reduction activities in the pilot project areas and LCZs.
1-7. Analyze cost-effectiveness of NRW reduction activities.
1-8. Prepare strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City.
1-9. Feed back DMA-based NRW reduction activities to strategic implementation (rolling-out) plan, and then provide assistance in review of the plan as when is necessary.

2-1. Establish the NRW Action Team in SW.
2-2. Check existing flow meters and replace the malfunctioning meters with new ones at all the water sources.
2-3. Conduct training on NRW reduction for the NRW Action Team.
2-4. Provide assistance in the preparation of workflow for DMA-based NRW monitoring and maintenance, including action criteria such as NRW ratio and DMA's features.
2-5. Feed back DMA-based NRW reduction activities to manuals, and then provide assistance in revision of the manuals as when is necessary.

3-1. Provide assistance in the definition and creation of discrete DMA's and their boundaries.
3-2. Provide assistance in the creation of LCZ within the DMAs.
3-3. Update existing water distribution network drawings by using GIS in the pilot project areas and DMAs.
3-4. Install necessary valves for isolation of the pilot project areas and DMAs, install flow meters, and measure the NRW ratio before implementation of the pilot project.
3-5. Identify the causes of NRW (water leakage, illegal connections and meter-related losses) in the pilot project areas and DMAs through the OJT.
3-6. Implement NRW reduction measures such as legalization of users, leakage detection, leakage repair, water meter installation and optimization of water pressure in the pilot project areas and DMAs, and measure the NRW ratio after implementation of the pilot projects .
3-7. Prepare reports of results including cost and benefit.
3-8. Provide advice for the improvement of pipe system design, installation and network operation.
3-9. Convene the workshops to share the experiences, outcomes and etc. of the pilot projects.
3-10. Provide capacity development and training using the DMA's and LCZ's as the basis for NRW reduction activities.
3-11. Provide technical assistance in DMA-based NRW monitoring and maintenance after initial NRW reduction activities.

4-1. Formulate the work schedule and staff assignment plan for water meter readers.
4-2. Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers.
4-3. Promote PR activities on water conservation and saving, and water tariff for the customers.
4-4. Monitor the water meter reading and billing activities.
4-5. Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.

Inputs

Solomon Islands Side

1. Personnel
- Project Director
- Project Manager
- NRW Management Team (5 members)
- NRW Action Team (19 members)
  Technical Sub-Team (8 members)
  Customer Services Sub-Team (6 members)
  GIS Sub-Team (2 members)
  Leakage Detection Sub-Team (3 members)

2. Creation of discrete DMAs

3. Provision of the project offices and facilities necessary for the project implementation

4. Expenses for implementing pilot projects in Honiara City:
- Provide the necessary valves, meters, pipes fittings and other materials.
- Provide labor to implement the project including PR resources.
- Provide management support to facilitate successful implementation of the pilot project

5. Administrative and operational expenses
- Electricity, water, communication, etc.
- Local traveling costs and daily subsistence allowance (DSA) for counterpart personnel
- Others as necessary

Japanese Side

1. Expert
- Leader / Water Supply Planning, Operation and Management
- Deputy Leader / NRW Reduction Measures -1
- NRW Reduction Measures -2
- Leakage Detection Technology
- GIS
- Customer Services & Public Relations
- Coordinator
- GIS Adviser

Japanese Side (continued)

2. Training of counterpart personnel in Japan

3. Provision of machinery and equipment
<Equipment by JICA Expert Team>
- Ultrasonic flow meter
- Data logger
- Water leak detector (Leak noise correlator)
- Water leak detector (Acoustic type)
- Metal locator
- Non-metal pipe locator
- Distance meter
- Hammer drill
- Drill bits
- Boring bar
- Generator
- Acoustic rods
- Residual chlorine analyzer
- Bulk flow meters
- Sluice valves (To isolate pilot areas)
- Test meter
- Handy Terminals (Data recorder of meter reading)
- GPSs
- Personal computers
- Plotter
- Printer
- Multifunction copier
<Equipment by JICA offices>
- Small-size excavator
- Pick-up trucks
- Data loggers
- Customer meters

4. Local expenses for the project activities
- Teaching materials for training and workshops
- Others

Precondition

Note: Pilot Project includes NRW reduction activities not only in Pilot Area but also in DMAs.

* Indicators are based on SW's Two-year plan (2013-2015) target.

** The target figure is set temporarily based on the result of only one pilot project. Therefore, the figure might be changed in next JCC based on the progress of the pilot project.

Note: Statement was revised as PDM$_4$.

2.2 Performance Period of the Project

The Project was commenced in October 2012 and completed in June 2016. Table 2.2-1 shows performance period of project implementation. Project Final Report was completed in August 2016.

Table 2.2-1 Performance Period of Project Implementation

Phase	1	2	3	4	5
Period	(Oct. 2012 - Mar. 2013) 6 months	(Apr. 2013 - Mar. 2014) 12 months	(Apr. 2014 - Mar. 2015) 12 months	(Apr. 2015 - Mar. 2016) 12 months	(Apr. 2016 - Jun. 2016) 3 months
JCC		▲ 1st ▲ 2nd	▲ 3rd	▲ 4th	▲ 5th
Output-1					
Activity 1-1					
Activity 1-2					
Activity 1-3					
Activity 1-4					
Activity 1-5					
Activity 1-6					
Activity 1-7					
Activity 1-8					
Activity 1-9					
Output-2					
Activity 2-1					
Activity 2-2					
Activity 2-3					
Activity 2-4					
Activity 2-5					
Output-3					
Activity 3-1					
Activity 3-2					
Activity 3-3					
Activity 3-4					
Activity 3-5					
Activity 3-6					
Activity 3-7					
Activity 3-8					
Activity 3-9					
Activity 3-10					
Activity 3-11					
Output-4					
Activity 4-1					
Activity 4-2					
Activity 4-3					
Activity 4-4					
Activity 4-5					
Training in Japan		▲ 1st ▲ 2nd	▲ 3rd		
Project Reports	▲ IC/R	▲ P/R1 ▲ P/R2	▲ P/R3 ▲ P/R4	▲ P/R5	▲ Draft F/R

Source: Project Team
JCC: Joint Coordinating Committee
IC/R: Project Inception Report
P/R: Project Progress Report, Draft F/R: Project Draft Final Report

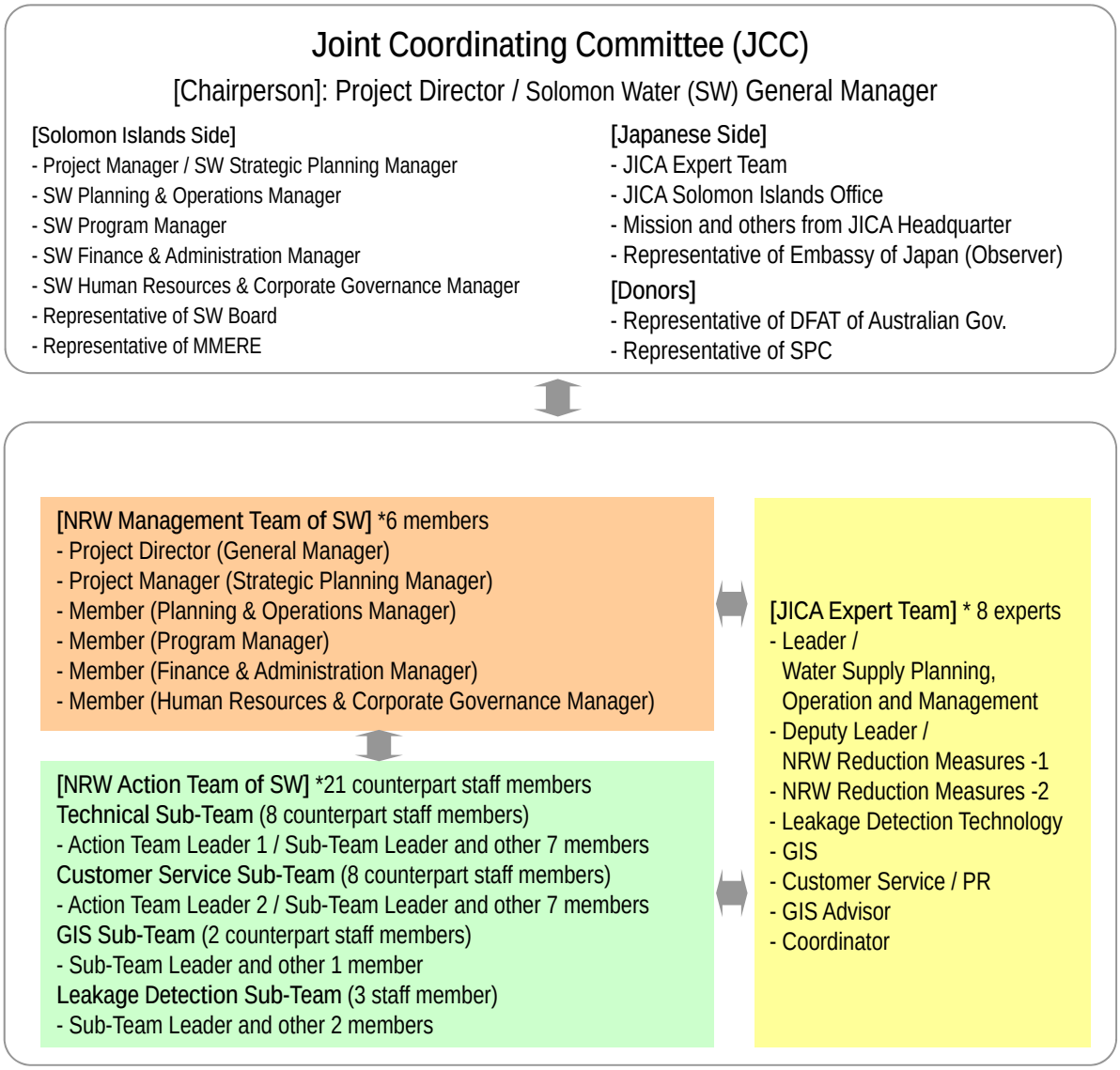
2.3 Implementation Structure

2.3.1 Project Implementation Structure

The Project appointed General Manager of SW as Project Director as well as Chairperson of Joint Coordinating Committee (hereinafter "JCC"), and in addition, Operation and Technical Manager of SW as Project Manager. The Project also involved counterpart staff and related parties in project implementation. Figure 2.3-1 shows project implementation structure.

Roles of the JCC were to approve the annual action plans, monitor, evaluate the Project, deliberate the major issues and advice and coordinate between Solomon Islands site and Japanese side

In addition, roles of the NRW Management Team are to make plans to reduce NRW and to supervise the NRW Action Team, while these of the NRW Action Team are to take actual activities such as IWA water balance analysis, identification of NRW causes, countermeasure, etc.



Note: Structure as of March 2016

Figure 2.3-1 Project Implementation Structure

2.3.2 Counterpart

(1) The Solomon Islands Side

Supervisory Ministry

- Ministry of Mines, Energy and Rural Electrification (hereinafter "MMERE")

Implementation Body

- Solomon Water: SW (Solomon Islands Water Authority)
  See the outline of restructured SW's organization in Figure 2.3-2.

As of July 2016

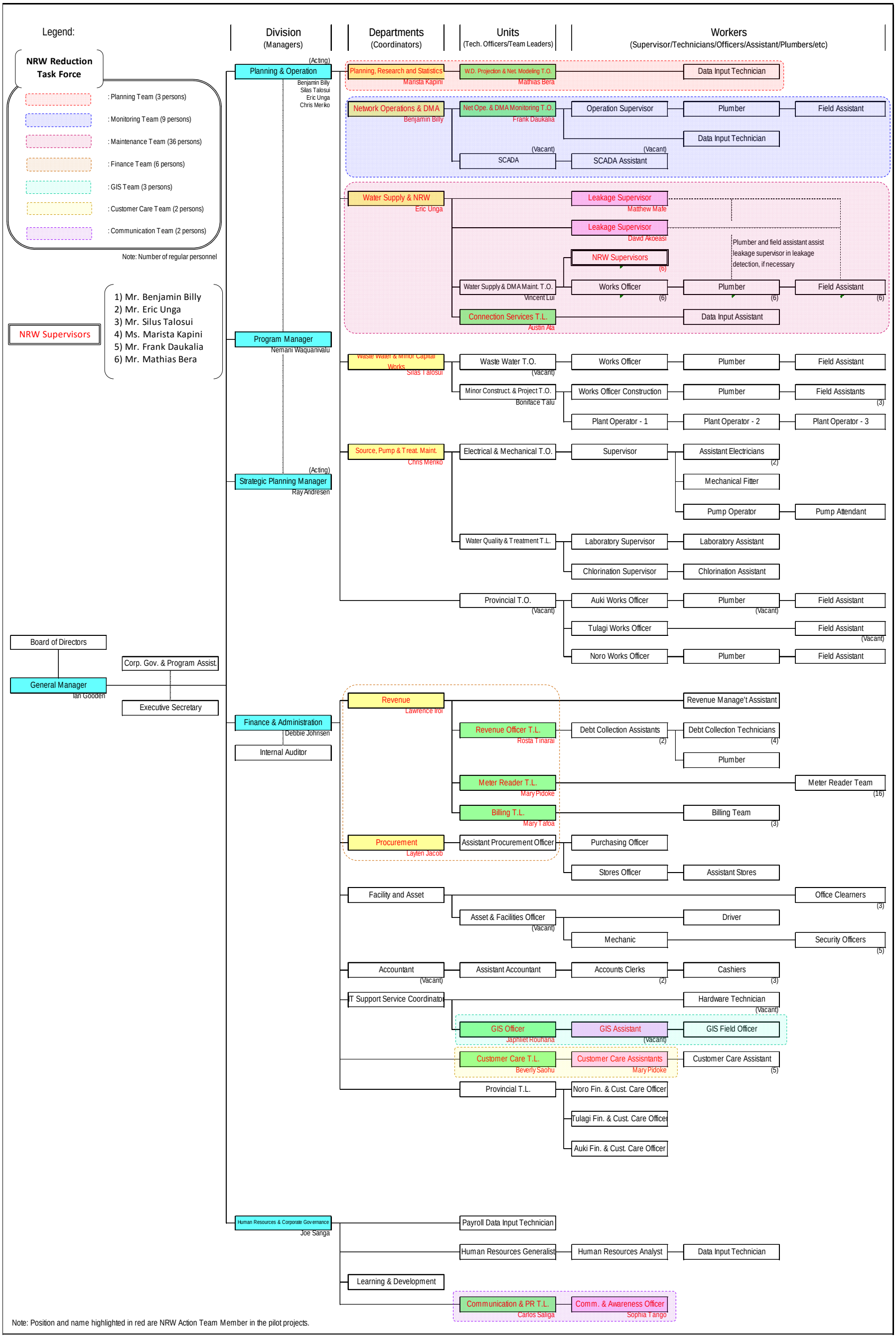


Figure 2.3-2 Outline of Restructured SW's Organization

Project Team

The Project Team of SW consists of NRW Management Team and NRW Action Team.

a) NRW Management Team

Table 2.3-1 shows members of NRW Management Team.

Table 2.3-1 Member List of NRW Management Team as of May 2016

Name	Position in the Project	Job Title in SW	Period
Mr. Ian GOODEN	Project Director	General Manager	Jul. 2015 to present
Mr. Ray ANDRESEN*1	Project Manager	Strategic Planning Manager (Former Operations & Technical Manager)	To present
Mr. Scravin TONGI	Planning & Operations Manager	Planning & Operations Manager	Mar. 2016 to present
Mr. Nemani WAGANIVALU	Program Manager	Program Manager	July 2015 to present
Ms. Debbie JOHNSEN	Finance & Administration Manager	Finance & Administration Manager	Jul. 2013 to present
Mr. Joe SANGA	Human Resources & Corporate Governance Manager	Human Resources & Corporate Governance Manager	Aug. 2015 to present

Source: SW
*1: The original members at the beginning of the Project as of November 2012.

Table 2.3-2 shows former members of NRW Management Team.

Table 2.3-2 List of Former Members of NRW Management Team

Name	Position in the Project	Job Title in SW	Period
Mr. Richard AUSTIN*1	Project Director	General Manager	To Dec. 2014
Ms. Naoko LAKA	Program Manager	Program Manager	To Nov. 2014
Mr. Ronald DAVIES*1	Finance & Administration Manager	Finance & Administration Manager	To Jun. 2013
Ms. Tima KOFANA*1	Human Resource Manager	Human Resource Manager	To Aug. 2015
Ms. Ellen MARUAROFA*1	Service Delivery & Communications Managers	Service Delivery & Communications Managers	To Dec. 2014

Source: SW
*1: The original members at the beginning of the Project as of November 2012.

b) NRW Action Team

Table 2.3-3 shows members of NRW Action Team.

Table 2.3-3 Member List of NRW Action Team as of May 2016

No.	Involved or Resigned	Name	Position in the Project	Job Title in SW	Division (Tentative)
Technical Sub-Team					
1		Mr. Benjamin BILLY	Action Team Leader 1 / Sub-Team Leader (NRW Taskforce Leader)	Network Operations Team Leader	Planning & Operations
2		Mr. Austin ATA	Deputy Sub-Team Leader (Customer Connections)	Service Coordinator	Planning & Operations

No.	Involved or Resigned	Name	Position in the Project	Job Title in SW	Division (Tentative)
3		Mr. Moses RAMO	(Customer Connections)	New Connections Works Officer	Planning & Operations
4		Mr. Silas TALOSUI	Deputy Sub-Team Leader (Network Maintenance & Repair)	Network Maintenance Team Leader	Planning & Operations
5		Mr. Mathias BERA	Pipe Repair (Network Pipe Maintenance & Repair)	Technical Assistant for Network Operations	Planning & Operations
6	Resigned in April 2016	Mr. Layten JACOB	Deputy Sub-Team Leader (Procurement)	Procurement Coordinator	Finance & Administration
7		Mr. Frank DAUKALIA	Meter Repair/Replacement (Pipe Materials Management & Procurement)	Technical Assistant for Network Operations	Planning & Operations
8		Mr. Chris MERIKO	Deputy Sub-Team Leader (Water Resources & Treatment)	Source Treatment & Plant Team Leader	Planning & Operations
Customer Service Sub-Team					
9		Ms. Beverly SAOHU	Deputy Sub-Team Leader (Customer Care)	Customer Care Team Leader	Finance & Administration
10		Mr. Carlos SALIGA	Deputy Sub-Team Leader (Community Relations & Media)	Communications & Public Relations Team Leader	Human Resources & Corporate Governance
11		Ms. Sophia TANGO	(Community Relations & Media Assistant)	Communications & Public Relations Assistant	Human Resources & Corporate Governance
12	Resigned in Apr. 2016	Ms. Daisy MENAGA	Deputy Sub-Team Leader (Meter Reading)	Meter Reading Team Leader	Finance & Administration
13		Ms. Mary TAFOA	Deputy Sub-Team Leader (Billing)	Billing Team Leader	Finance & Administration
14		Mr. Lawrence IROI	(Chief Accountant)	Accountant	Finance & Administration
15	Involved since Apr. 2014	Ms. Rosta TINARAI	Deputy Sub-Team Leader (Debt Collection)	Debt Collection Team Leader	Finance & Administration
16	Involved since Apr. 2014	Ms. Mary PIDOKE	Customer Care Officer	Customer Care Officer	Finance & Administration
GIS Sub-Team					
17	Resigned in Feb. 2016	Mr. Gavin BARE	Sub-Team Leader (GIS Technician)	GIS Technician for Network Operations	Finance & Administration
18		Mr. Japhliet ROUHANA	(IT Administration)	IT Technician	Finance & Administration
Leakage Detection Sub-Team					
19		Mr. Eric UNGA	Sub-Team Leader (Leakage)	Provincial & Leakage Operations Team Leader	Planning & Operations
20		Mr. Matthew MAFE	Plumber	Plumber for Provincial & Leakage Operations	Planning & Operations
21		Mr. David AKOEASI	Plumber	Plumber for Provincial & Leakage Operations	Planning & Operations
Consultant					
22		Ms. Marista KAPINI	In-house Consultant	In-house Consultant	-

Source: SW

(2) The Japanese Side

Table 2.3-4 shows members of the JET, which are all Japanese.

Table 2.3-4 Member List of the JET

Name	Expertise
Mr. Taketoshi FUJIYAMA	Leader /Water Supply Planning, Operation and Management
Mr. Akinori MIYOSHI	Deputy Leader / NRW Reduction Measures -1
Mr. Masatoshi SENO	NRW Reduction Measures -2
Mr. Akihiko OKAZAKI	Leakage Detection Technology
Mr. Masakazu ASAI	GIS
Mr. Yoshiharu WADA (Mr. Kenji KASAMATSU)	Customer Services & Public Relations * Mr. Wada has replaced Mr. Kasamatsu since April 2013.
Ms. Akiko SAKAMOTO	Coordinator (Support Member)
Mr. Kazutoshi MASUDA (Mr. Norio ISHIJIMA)	GIS Advisor (Support Member) * Mr. Masuda has replaced Mr. Ishijima since June 2014.

Source: JET

2.3.3 Joint Coordination Committee (JCC)

As a coordinating, deliberating and advisory body, Joint Coordinating Committee (JCC) was organized during the implementation of the Project. Roles and responsibilities of JCC are as follows:

- Coordination between Solomon Islands and Japan
- Deliberation of major issues and provision of advice
- Monitoring and evaluation of the Project
- Approval of Annual Action Plans prepared by the Project

JCC members are shown in Figure 2.3-1.

2.3.4 Task Force of NRW Reduction

Terminal Evaluation Team, which was dispatched in August 2015, pointed out the importance of capacity development in monitoring and maintenance for improved NRW ratio, but SW has no post that in charge of this duty in NRW Action Team. Based on the suggestions of the Terminal Evaluation Team, SW established monitoring and maintenance team in Task Force of NRW reduction to receive additional technical assistance on their activities.

In the Terminal Evaluation, SW stated to continue its efforts to reduce NRW in Honiara City after the Project is completed. SW is planning to keep the NRW Action Team, which was established by the Project, as “Task Force”. The current leader of the NRW Action Team will continuously have his leadership for this Task Force under the supervision of the Planning & Operation Manager. This will ensure most staff members who developed their capacities by the Project to utilize their experience in the next step of reducing the NRW. The Task Force will have the responsibility of the whole NRW reduction activities including monitoring, maintenance, metering, and utilization of the strategic plan.

Teams and their leaders of the Task Force for NRW Reduction are shown in Table 2.3-5.

Table 2.3-5 New Task Force for NRW Reduction

No.	Task Force for NRW Reduction	Team Leader	Last Position as the Project Team	No. of Total Staff	No. of dedicated Staff[2]
1	Planning Team	Ms. Marista KAPINI	NRW Action Team Member	3	1
2	Monitoring Team	Mr. Frank DAUKALIA	Technical Sub-Team	9	1
3	Maintenance Team	Mr. Silas TALOSUI	Technical Sub-Team	36	0
4	Finance Team	Mr. Lowrence IROI	Customer Service Sub-Team	6	0
5	GIS Team	Mr. Smith DAFE	GIS Sub-Team	3	0
6	Customer Care Team	Ms. Beverly SAOHU	Customer Service Sub-Team	2	0
7	Communication Team	Mr. Carlos SALIGA	Customer Service Sub-Team	2	0
Total				**61**	**2**

Source: NRW Reduction Project Team

[2] Dedicated staff are in charge of only NRW reduction activities, while non-dedicated staff are not only in charge of NRW reduction activities but also entire activities such as water supply facility operation, regular meter reading, general PR activities, general customer service, etc. of SW's water supply service.

CHAPTER 3 OUTCOMES AND ACHIEVEMENT

The Terminal Evaluation Tream suggested that SW tackle on monitoring and maintenance work to keep the improved NRW ratio. Therefore, the terminal evaluation and SW agreed on additional technical assistance on approach of monitoring and maintenance work after initial NRW reduction activities.

In order for SW to work on monitoring and maintenance continuously, SW restructured throughout organization and established Task Force required for NRW reduction activities, which resulted in that technical assistance had been carried out additionally as Activity 1-9, 2-4, 2-5 and 3-11 since March 2016.

In this chapter, attainment and its prospection on overall goal, project purpose and outputs at the terminal evaluation and at the completion of the Project are stated as follows:

In 14 April 2016, SW reported to the Two-Year program steering group that SW was close to being independent in successfully implementing NRW reduction activities systematically. Moreover, as SW's General Manager called for the importance of the continuation of the NRW reduction activities at the 5th JCC, it is expected that NRW reduction is sustained continuously in terms of SW's understanding on the influence of NRW on water supply service.

3.1 Overall Goal

Prospect of attainment of Overall Goal is shown as below:

Table 3.1-1 Prospect of Attainment of Overall Goal

Overall Goal: "SW's service levels are improved and SW's revenue is increased."	
Indicators (PDM_3)	**Prospect of Attainment at the Terminal Evaluation (August 2015)**
1. The NRW ratio in Honiara City is reduced to 20% by 2018.	- SW reported in March, 2015 that the NRW ratio in Honiara City is 62.8% as of the end of 2014. This is quite far from the target value of 20% in Indicator 1. - SW is planning to continue NRW reduction activities in the remaining DMA. However, it is uncertain that SW can continue massive and concentrated commitment like during the Project period. - The Team considers that this high value of 62.8% is due to the following, which were hardly expected at the beginning of the Project. - SW started its policy to disconnect arrear customers very strictly and thoroughly after 2013. - Water supply facilities have been remarkably improved in Honiara City by the Japanese grant aid 'The Project for Improvement of Water Supply System in Honiara and Auki.' While pressure and quantity of water are improved especially in 12 DMAs, this improvement caused increase in water leakage. - In 2014, only 80% of the customers were metered. The rest 20% are charged in flat rate (fixed bills), which is equivalent to the volumetric rate for $32m^3$ per month. Such flat rate customers seem to use much water or waste it after the completion of the grant aid project. Since water consumed beyond $32m^3$ per month is defined as NRW, such water consumption is a possible cause of increasing NRW ratio. - From the above, the Project considers that achievement of this indicator is not feasible.
2. Ratio of operational revenue-to-expenditure is sustained at greater than 100%.	- The ratio of operational revenue-to-expenditure is 77% in 2014 according to the 5^{th} progress report. The ratio is increased by 5 points. - However, there were several changes in external conditions which were not expected at the start of the Project: ➢ After the Project started, SW's water tariff continued to increase up to 1.7 times as expensive as the original. ➢ As described in the achievement of Indicator 2, the Japanese grant aid has made great increases in water supply area, supplied water quantity, and the number of customers. Thus, the improvement in the ratio of operational revenue-to-expenditure does not necessary reflect the Project Outputs. - From the above, the Project considers this indicator is inappropriate to evaluate the achievement of the Overall Goal.
Indicators (PDM_4)	**Prospect of Attainment at the Project Completion (June 2016)**
1. NRW reduction activities are carried on by Task Force composed of relevant Departments or Units.	- Task Force of NRW Reduction is composed of seven teams such as Program, Monitoring, Maintenance, Finance, GIS, Customer Care and Communication Team. - Task Force Team comprehensively implements NRW reduction which consists of primary NRW reduction activities (In other word, baseline activities) and monitoring and maintenance activities. - From the above, the JET assesses that Task Force will take NRW reduction activities routinely in order to sustain NRW ratio at low level.

Source: Terminal Evaluation Report and Project Team

3.2 Project Purpose

Achievement status of Project Purpose is shown as below:

Table 3.2-1 Achievement of Project Purpose

Project Purpose: "SW is assisted to achieve its target of reducing the NRW ratio in Honiara to 30% by 2015."	
Indicators (PDM_3)	**Achievement at the Terminal Evaluation (August 2015)**
1. The NRW ratio is reduced by 30 points in each pilot area, selected DMAs and/or LCZs[3]. 2. Regarding the Pilot Project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30%, the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated.	Pilot Project Areas - After the selection of 15 pilot project areas in March 2013, the Project implemented the pilot projects from April 2013 to September 2014 (see Table 4.7-1). - Indicator 1 was achieved in all the pilot project areas except for "Mbaranamba" where the initial NRW ratio was less than 30%. - In "Mbaranamba", the Project achieved conditions stipulated by Indicator 2. - Through the NRW reduction activities in "Mbaranamba", the Project found that leakage is not so high; around 20%, and decided to not only leakage detection, but to solve illegal connections and malfunctioning meters. - In "Lenggakiki" and "Tuvaruhu-1", the Project could not achieve the reduction target of 30 points initially during implementing the NRW reduction activities, therefore the Project had to take additional measures leading to successful results. DMAs and/or LCZs - After demarcation of 28 DMAs and the prioritization in September 2014, the Project started NRW reduction activities in DMAs in December, 2014. - Indicator 1 is achieved in two selected DMAs, even though pressure control in "Tasahe A&B" has not been started. SW will start pressure control in "Tasahe A&B", soon after installation of PRVs, which is expected in the mid-September 2015. From the above, Indicators 1 and 2 were achieved. (see details in Table 6.6-1 and Table 6.6-2)
Indicators (PDM_4)	**Achievement at the Project Completion (June 2016)**
1. The NRW ratio is reduced by 30 points in each pilot area, selected DMAs and/or LCZs. 2. Regarding the Pilot Project areas, selected DMAs, and/or LCZs where the NRW ratio before the implementation of NRW reduction measures are less than 30%, the NRW reduction measures are implemented in accordance with features of each area and/or zone, so that effectiveness of the NRW reduction measures are validated.	Pilot Project Areas - After the selection of 15 pilot project areas in March 2013, the Project implemented the Pilot Project from April 2013 to September 2014 (see Table 4.7-1). - Indicator 1 was achieved in all the pilot project areas except for "Mbaranamba" where the initial NRW ratio was less than 30%. - In "Mbaranamba" the Project achieved conditions stipulated by Indicator 2. - Through the NRW reduction activities in "Mbaranamba", the Project found that leakage is not so high; around 20%, and decided to not only leakage detection, but to solve illegal connections and malfunctioning meters. - In "Lenggakiki" and "Tuvaruhu-1", the Project could not achieve the reduction target of 30 points initially during implementing the NRW reduction activities, therefore the Project had to take additional measures leading to successful results. DMAs and/or LCZs - After demarcation of 28 DMAs and the prioritization in September 2014, the Project implemented NRW reduction activities in DMAs (Tasahe A&B and West Kola Ridge A) from November 2014 to November 2015 (see Table 4.7-2). - Indicator 1 was achieved in the two selected DMAs. From the above, Indicators 1 and 2 were achieved. (see details in Table 6.6-1 and Table 6.6-2)

Source: Terminal Evaluation Report and Project Team

[3] DMAs and LCZs are defined as District Metered Areas and Leakage Control Zones respectively. Refer to Section 6.1.1 and 6.2.1 for further details.

3.3 Outputs

Result of self-evaluation on Output is shown in Supporting Report S3.3-1.

3.3.1 Output 1

Achievement status of Output 1 is shown as below:

Table 3.3-1 Achievement of Output 1

Output-1: "Planning process of SW for NRW reduction is systemized."	
Indicators (PDM_3)	**Achievement at the Terminal Evaluation (August 2015)**
1.1 Annual budget for NRW reduction is secured in the pilot project areas and LCZs.	Pilot Project Areas - The NRW reduction activities were completed. Actual cost incurred for the NRW reduction activities is about SBD2.23million. DMAs and/or LCZs - The NRW reduction activities in DMAs[4] that include LCZs are in progress with the SW's budget for 2015, in which SBD4.62 million is allocated for the activities in DMAs. - Actual cost incurred for the NRW reduction activities in DMAs has not been calculated yet. From the above, Indicator 1.1 was achieved.
1.2 The strategic implementation (rolling-out) plan for NRW reduction is approved by management of SW.	- Based on the results of pilot projects, SW commenced preparation of the strategic implementation (rolling-out) plan (hereinafter "the strategic plan") with assistance of the JET from the first quarter of 2015. - The strategic plan will be finalized and approved by October 2015. - SW states that the strategic plan will be utilized and reviewed afterwards by its own effort. - From the above, Indicator 1.2 is likely to be achieved.
Indicators (PDM_4)	**Achievement at the Project Completion (June 2016)**
1.1 Annual budget for NRW reduction is secured in the pilot project areas and LCZs.	Pilot Project Areas - The NRW reduction activities were completed. Actual cost incurred for the NRW reduction activities is shown in Table 4.7-3. DMAs and/or LCZs - The NRW reduction activities in DMAs[5] that include LCZs were completed. Actual cost incurred for the NRW reduction activities in DMAs is shown in Table 4.7-4. From the above, Indicator 1.1 was achieved.
1.2 The strategic implementation (rolling-out) plan for NRW reduction is approved and reviewed as when it is necessary by management of SW.	- Based on the results of pilot projects, SW commenced preparation of the strategic implementation (rolling-out) plan (hereinafter "the strategic plan") with assistance of the JET from the first quarter of 2015. - The strategic plan was approved and reviewed in Phase 5. - SW states that the strategic plan will be utilized and reviewed afterwards by its own effort. - Planning & Operations Manager as management team is responsible for revision of the strategic Implementation (rolling-out) Plan. - From the above, Indicator 1.2 was achieved.

Source: Terminal Evaluation Report and JET

[4] SW divided water supply area of Honiara City into 28 DMAs and is in progress to establish them. DMAs are hydraulically separated sub-zones of water service area and LCZs are small zones in DMAs.

[5] SW divided water supply area of Honiara City into 28 DMAs and is in progress to establish them. DMAs are hydraulically separated sub-zones of water service area and LCZs are small zones in DMAs.

3.3.2 Output 2

Achievement status of Output 2 is shown as below:

Table 3.3-2 Achievement of Output 2

Output 2: "The procedure for NRW reduction is established through the pilot project areas and LCZs."	
Indicators (PDM_3)	**Achievement at the Terminal Evaluation (August 2015)**
2.1 A manual for NRW reduction measures is prepared.	- The manual for NRW reduction consists of three components: NRW reduction measures, leakage detection techniques and updating GIS database. SW has used, improved and updated the manual in consideration for user-friendliness. - The manual will be completed in Phase-4. - From the above, Indicator 2.1 is likely to be achieved.
2.2 The number of authorizations and disconnections of illegal connections is increased in the pilot project areas and LCZs.	<u>Pilot Project Areas</u> - 140 illegal connections including parasite users were identified which account for 9.6% of 1,464 households in total. Out of 140, 38 connections were legalized (authorized) and 102 connections were disconnected. This means that only 27.1% became valid customers while 72.9% were disconnected. - Before the Project, the monthly number of legalizations (authorizations) of illegal connections was about 10 in the whole Honiara City in November, 2011 in spite of the SW's campaign for encouraging legalization. The monthly number of disconnections of illegal connections was about 20 according to interviews to SW. These values are assumed as the baseline of the whole Honiara City. - Baselines in 15 pilot project areas are estimated at 18 for legalization (authorization) and 36 for disconnection respectively[6]. - As a result of the NRW reduction activities in 15 pilot project areas, the total number of legalizations (authorizations) and disconnections of illegal connections was increased from 54 (18+36) to 140, legalizations (authorizations) from 18 to 38, disconnections from 36 to 102. <u>DMAs and/or LCZs</u> - There is considerable increase in the number of legalizations (authorizations) and disconnections, but data are currently being processed. From the above, Indicator 2.2 is likely to be achieved.
2.3 The number of new service connections and replacement of malfunctioning customer meters is increased in the Pilot Project areas and LCZs.	<u>Pilot Project Areas</u> - There were 268 households unserved by SW, which accounted for 18.3% of 1,464 households in total. Out of 268, 31 households proceeded to be connected or re-connected and accounted for 11.6% of the total unserved households. - The number of valid customers decreased during the NRW reduction activities from 1,056 to 1,036, which may be due to strict disconnection for arrears and sharp rise in water tariff during the Project. - The Project installed 378 customer meters to new/unmetered/re-connected customers. In addition, 596 meters were replaced with new ones. These 974 meters, which were procured by JICA, were effectively used. - Before the Project, SW installed 30 meters per month for new connection, unmetered connection and replacement in the whole Honiara City according to interview to SW. This value is assumed as the baseline of the whole Honiara City. - Baseline in 15 pilot project areas is estimated at 54 customer meters[7] for installation

[6]Baseline for 15 pilot project areas (22 km pipe in total): Monthly performance in Honiara (220 km pipe length) is distributed in proportion to pipe length, and multiplied by 18 months (the entire pilot project period). Thus the formula is shown below:
Baseline value [cases/ 15 pilot project area] = (monthly value in Honiara [cases/month/Honiara]) × (Total pipeline length in 15 pilot project areas [km/15 pilot project areas]) ÷ (Total pipeline length in Honiara [km/Honiara]) × (the entire pilot project period [month])
= 10× 22÷ 220× 18 = 18 (*1) (*1) for authorization of illegal connection
= 20× 22÷ 220× 18 = 36 (*2) (*2) for disconnections of illegal connection

[7]Baseline for 15 pilot project areas (having 22 km pipe in total) : Monthly performance in Honiara (220 km pipe length) is distributed in proportion to pipe length, and multiplied by 18 months (the entire Pilot Project period). Thus the formula is shown below:

	in the pilot project period. - As a result of the NRW reduction activities in 15 pilot project areas, the number of new service connections and replacement of malfunctioning customer meters was increased from 54 to 974. DMAs and/or LCZs - There is considerable increase in the number of new service connections and replacement of malfunctioning customer meters, but the data are currently being processed. - The Two-Year Plan also procured about 3,000 meters. In DMAs, both these meters and the remaining 26 meters procured by JICA will be used. From the above, Indicator 2.3 is likely to be achieved.
Indicators (PDM_4)	**Achievement at the Project Completion (June 2016)**
2.1 Manuals for NRW reduction measures are prepared and revised as when it is necessary, including workflow of DMA-based monitoring and maintenance for improved NRW ratio.	- The manual for NRW reduction consists of four components: Manual of NRW Reduction Measures, Handbook for Operation and Maintenance of Equipment on Leak Detection, Rule Book of Database and O&M Manual of Database. SW has used, improved and updated the manual in consideration for user-friendliness. - The manual was revised and completed in Phase-5. - From the above, Indicator 2.1 was achieved.
2.2 The number of authorizations and disconnections of illegal connections is increased in the Pilot Project areas and LCZs.	Pilot Project Areas - 140 illegal connections including parasite users were identified which account for 9.6% of the total households of 1,464. Out of the 140, 38 of the connections were legalized (authorized) and 102 connections were disconnected. This means that only 27.1% became valid customers while 72.9% were disconnected. - Before the Project, the monthly number of legalizations (authorizations) of illegal connections was about 10 in the whole Honiara City in November, 2011 in spite of the SW's campaign to encourage legalization. The monthly number of disconnections of illegal connections was about 20 according to interviews to SW. These values are assumed as the baseline of the whole Honiara City. - Baselines in the 15 pilot project areas are therefore estimated at 18 for legalization (authorization) and 36 for disconnection respectively. - As a result of the NRW reduction activities in the 15 pilot project areas, the total number of illegal discovered, number of legalizations (authorizations) and disconnections of illegal connections were increased from 54 (18+36) to 140 illegals, legalizations (authorizations) from 18 to 38, and disconnections from 36 to 102 respectively. DMAs and/or LCZs - 47 illegal connections including parasite users were identified which account for 5.7% of 829 households in total. - 15 legalized households and 31 disconnected housholds were assumed as baselines in 4 DMAs.[8] - Out of 47, 33 connections were legalized (authorized) and 14 connections were disconnected. This means that 70.2% became valid customers while 29.8% were disconnected. From the above, Indicator 2.2 was achieved.
2.3 The number of new service connections and replacement of malfunctioning customer meters is increased in the Pilot Project areas and	Pilot Project Areas - There were 268 households unserved by SW, which accounted for 18.3% of 1,464 households in total. Out of 268, 31 households proceeded to be connected or re-connected which accounted for 11.6% of the total unserved households. - The number of valid customers decreased during the NRW reduction activities from 1,056 to 1,036, which may be due to strict disconnection for arrears and sharp rise in

Baseline value [pieces of customer meters/15 pilot project area] = (monthly value in Honiara [pieces of customer meters /month/Honiara]) × (Total pipeline length in the 15 pilot project areas [km/15 pilot project area]) ÷ (Total pipeline length in Honiara [km/Honiara]) × (the entire pilot project period [month])
= 30× 22÷ 220× 18 = 54

[8] 10places x 24km/220km x 14 months=15 places, *4 20places x24km/220kmx14 months=31 places,

LCZs.	water tariff during the Project. - The Project installed 378 customer meters to new/unmetered/re-connected customers. In addition, 596 meters were replaced with new ones. These 974 meters, which were procured by JICA, were effectively used. - Before the Project, SW installed 30 meters per month for new connection, unmetered connection and replacement in the whole Honiara City according to interview to SW. This value is assumed as the baseline of the whole Honiara City. - Baseline in 15 pilot project areas is estimated at 54 customer meters[9] for installation in the pilot project period. - As a result of the NRW reduction activities in 15 pilot project areas, the number of new service connections and replacement of malfunctioning customer meters was increased from 54 to 974. <u>DMAs and/or LCZs</u> - There were 57 households unserved by SW, which accounted for 6.9% of 829 households in total. Out of 57, 36 households proceeded to be connected or re-connected and accounted for 63.2% of the total unserved households. - It was assumed that 46 water meters were installed in four DMAs when the project was commenced.[10] - The number of valid customers increases during the NRW reduction activities from 725 to 766. - The Project installed 137 customer meters to new/unmetered/re-connected customers. In addition, 198 meters were replaced with new ones. - In DMAs, both 3,000 meters procured by the Two-Year Plan and the remaining 26 meters procured by JICA were effectively used. From the above, Indicator 2.3 was achieved.

Source: Terminal Evaluation Report and JET

[9]Baseline for 15 pilot project areas (having 22 km pipe in total) : Monthly performance in Honiara (220 km pipe length) is distributed in proportion to pipe length, and multiplied by 18 months (the entire Pilot Project period). Thus the formula is shown below:
Baseline value [pieces of customer meters/15 pilot project area] = (monthly value in Honiara [pieces of customer meters /month/Honiara]) × (Total pipeline length in the 15 pilot project areas [km/15 pilot project area]) ÷ (Total pipeline length in Honiara [km/Honiara]) × (the entire pilot project period [month])
= 30× 22÷ 220× 18 = 54

[10] 0places x 24km/220km x 14 months=46 places

3.3.3 Output 3: "NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs in the selected DMAs, and then improved NRW ratio is monitored and maintained."

Achievement status of Output 3 is shown as below:

Table 3.3-3 Achievement of Output 3

Output 3 (PDM_3): "NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs."	
Indicators (PDM_3)	**Achievement at Terminal Evaluation (August 2015)**
3.1 The number of pipe repairs is increased in the pilot project areas and LCZs.	Pilot Project Areas - 191 leak points were detected and then all repaired.. - Before the Project, the monthly number of pipe repairs by SW was 46 in the whole Honiara City in December, 2012. This value is assumed as the baseline of the whole Honiara City. - Baseline in 15 pilot project areas is estimated as 83[11]. - As a result of the NRW reduction activities in 15 pilot project areas, the number of pipe repairs was increased from 83 to 191. - Also, leakage ratio was reduced from 42.8% to 15.1% on average. DMAs and/or LCZs - There is considerable increase in the number of pipe repairs, but data are currently being processed. From above, Indicator 3.1 is likely to be achieved.
Output 3 (PDM_4): "NRW reduction is implemented in accordance with the procedure in pilot project areas and/or LCZs in the selected DMAs, and then improved NRW ratio is monitored and maintained."	
Indicators (PDM_4)	**Achievement at the Project Completion (June 2016)**
3.1 The number of pipe repairs is increased in the Pilot Project areas and LCZs.	Pilot Project Areas - 191 leak points were detected and repaired. - Before the Project, the monthly number of pipe repairs by SW was 46 in the whole Honiara City in December, 2012. This value is assumed as the baseline of the whole Honiara City. - Baseline in 15 pilot project areas is estimated at 83. - As a result of the NRW reduction activities in 15 pilot project areas, the number of pipe repairs was increased from 83 to 191. - Also, leakage ratio was reduced from 42.8% to 15.1% on average. DMAs and/or LCZs - Prior to countermeasure, number of repairs was 70 places in four DMAs,[12] while 82 leak points were detected and all repaired as countermeasure. - Also, leakage ratio was reduced from 51.3% to 19.7% on average. From above, Indicator 3.1 was achieved.
3.2 Data and records of DMA-based monitoring and maintenance for improved NRW ratio are	DMAs and/or LCZs - System Input Volume (inflow) and the totalized billed consumption (outflow) have been recorded monthly by telemetry (GSM) or manual reading. - System Input Volume (inflow) has been partially recorded by daily telemetry (GSM).

Source: Terminal Evaluation Report and JET

11Baseline for the 15 Pilot Project areas (having 22 km pipe in total) : Monthly performance in Honiara (220 km pipe length) is distributed in proportion to pipe length, and multiplied by 18 months (the entire Pilot Project period). Thus the formula is shown below:
Baseline value [cases/15 Pilot Project area] = (monthly value in whole Honiara [cases /month/Honiara]) × (Total pipeline length in the 15 pilot project areas [km/15 Pilot Project area]) ÷ (Total pipeline length in Honiara [km/Honiara]) × (the entire Pilot Project period [month])
= 46× 22÷ 220× 18 = 83

12 46places x 24km/220km x 14 months=70places

accumulated to sustain NRW reduction activities in the selected DMA.	- Data for DMA-based monitoring and maintenance have been accumulated and analyzed for taking NRW reduction measures by graphing. From the above, Indicator 3.2 was achieved.

3.3.4 Output 4: "Water meter reading and billing process management are improved."

Achievement status of Output 4 is shown as below:

Table 3.3-4 Outputs of the Project

Output 4: "Water meter reading and billing process management are improved."	
Indicators (PDM_3)	**Achievements at the Terminal Evaluation (August 2015)**
4.1 Standard operating procedures (SOP) and training materials are formulated.	- Draft of SOP on customer meter reading and billing system was prepared in April 2013 and finalized with training materials based on know-how obtained through routine works. - From the above, the Indicator 4.1 was achieved.
Indicators (PDM_4)	**Achievements at the Project Completion (June 2016)**
4.1 Standard operating procedures (SOP) and training materials are formulated.	- SOP on customer meter reading and billing system was prepared in April 2013 and finalized with training materials based on know-how obtained through routine works. - From the above, the Indicator 4.1 was achieved.

Source: Terminal Evaluation Report and JET

CHAPTER 4 ACTIVITIES FOR OUTPUT-1: Planning process of SW for NRW reduction is systematized.

4.1 Establish the NRW Management Team in SW. (Activity 1-1)

In November 2012, the NRW Management Team members were selected by the Project purposely to draw up plans and strategies to reduce NRW in the pilot project areas and to supervise the NRW Action Team.

The NRW Management Team consists of the General Manager, Planning & Operation Manager, Strategic Planning Manager, Program Manager, Finance & Administration Manager and Human Resources & Corporate Governance Manager as of June 2016.

4.2 Review the Current NRW Reduction Activities done by SW. (Activity 1-2)

4.2.1 Outline of Activity

The Project observed activities of SW while it conducted the activities of reducing NRW from December 2012 to January 2013. This observation was reflected in the implementation of the Pilot Project.

4.2.2 Result of Activity

The Project reviewed the previous activities of NRW reduction, and clarified noticeable issues on NRW reduction activity at organizational level as follows:

- No comprehensive work schedule and action plan on NRW reduction activities.
- No Performance Index (PI) developed
- A delay of water meter replacement and installation
- Insufficient leakage detection members
- Missing data of the existing pipeline location
- Lack of activities of water meter readers
- No staff appraisal system, and
- No trainer for training on NRW reduction

4.3 Assist in Hydraulic Analysis including Identification of Problems in the Existing Network. (Activity 1-3)

4.3.1 Outline of Activity

A software of hydraulic analysis, “Water CAD” which was provided in “The Study for Rehabilitation and Improvement of Solomon Islands Water Authority’s Water Supply and Sewerage System, 2006, JICA” has not been utilized because of an expiration of the license for long time. It is important to conduct hydraulic analysis for control of water flow rate and examination of facility’s performance.

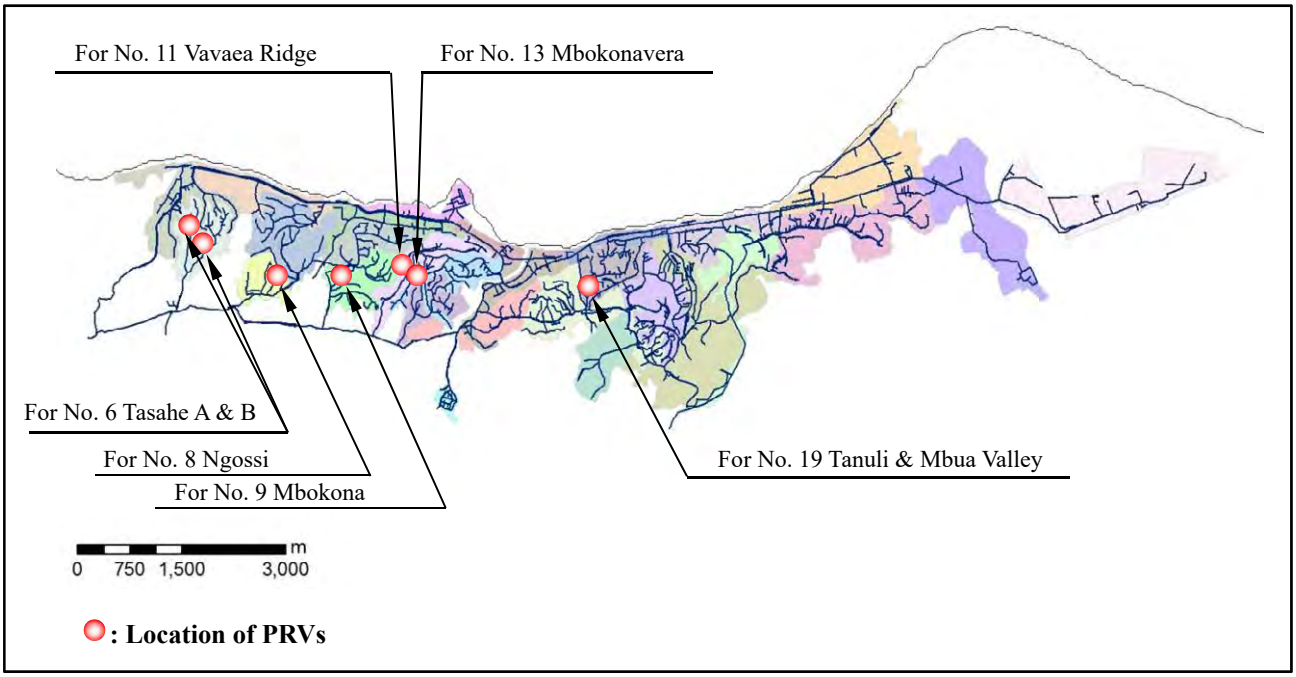
SW desires to own software for hydraulic analysis.

A hydraulic specialist was recruited by SW under the Two-Year Plan. Based upon the specialist's advice, a hydraulic modelling software was procured by the fund of DFAT. The preferred software was Bentley Water Gems because of its user friendly nature and compatibility with other software. This software enables SW to have a good understanding on the performance of the network, identify anomalies within the system and devising solutions to these problems.

The JET assists in DMA creation activities with the advice from the hydraulic specialist.

4.3.2 Result of Activity

The Water Gems software arrived in July 2014. This software was then used to analyze the distribution network of seven DMA's out of 28 DMAs by the NRW Technical Sub-Team. Seven DMA's were provisionally proposed by the hydraulic specialist as DMA's with Pressure Control. Afterward, optimal locations to install Pressure Reducing Valves (hereinafter "PRVs") and its specification were determined by the Sub-Team in cooperation with the JET. Location of PRVs and their specification summaries are shown in Figure 4.3-1 and Table 4.3-1 respectively, and its hydraulic analysis statement is attached in Supporting Report S4.3-1. The JET especially assisted Sub-Team in sorting-out input data for analysis. In addition, other serious problems such as lack of a pipe capacity, low/very high pressure areas were also identified within the network for each DMA using this hydraulic analysis soft-ware.



Source: Project Team

Figure 4.3-1 Location Map of PRVs

Table 4.3-1 Specification of PRVs and Bulk Flow Meter

DMAs	Area	Proportion of Population	Range of Flow Rate (m^3/hr) [in Case of **NRW 30%**]			ID No. of PRVs	Size of PRVs	Existing Pipelines		By-pass Pipelines		Tee (Cast Iron)	90 Bend (PVC)	Bulk Flow Meter	Sluice Valve		Pressure Relief Valve & Strainer	To be replaced with larger size pipes in the whole network
		1)	2)		3) =1) x 2)			Diamter A.	Material	Diamter B.	Material				On the Existing	On the By-pass	On the By-pass	Existing to New
No.6 Tasahe A&B	Tasahe A	35%	Min	6.9	2.4	PRV-H12	40mm	80mm	PVC	40mm	PVC	80 x 40mm	40mm	-	80mm	40mm	40mm	
			Max.	16.2	5.7		x 1					x 2	x 2		x 1	x 1	x 1 (each)	
	Tasahe B	55%	Min	6.9	3.8	PRV-H01	40mm	100mm	PVC	40mm	PVC	100 x 40mm	40mm	-	100mm	40mm	40mm	
			Max.	16.2	8.9		x 1					x 2	x 2		x 1	x 1	x 1 (each)	
No.8 Ngossi	All areas	100%	Min	20.2	20.2	PRV-H13	80mm	100mm	PVC	80mm	PVC	100 x 80mm	80mm	80mm	100mm	80mm	80mm	100mm -> 150mm
			Max.	47.2	47.2		x 1					x 2	x 2	x 1	x 1	x 1	x 1 (each)	L=1,051m
No. 9 Mbokona	All areas	30%	Min	18.3	5.5	PRV-H02	40mm	80mm	PVC	40mm	PVC	80 x 40mm	40mm	-	80mm	40mm	40mm	
			Max.	42.8	12.8		x 1					x 2	x 2		x 1	x 1	x 1 (each)	
No.11 Vavaea Ridge	Upper area	85%	Min	20.0	17.0	PRV-H03	50mm	100mm	PVC	50mm	PVC	100 x 50mm	50mm	-	100mm	50mm	50mm	100mm -> 150mm
			Max.	46.7	39.7		x 1					x 2	x 2		x 1	x 1	x 1 (each)	L=542m
No.13 Mbokonavera	All areas	100%	Min	20.0	20.0	PRV-H05	80mm	100mm*	PVC	80mm	PVC	100 x 80mm	80mm	80mm	100mm*	80mm	80mm	
			Max.	46.6	46.6		x 1					x 2	x 2	x 1	x 1	x 1	x 1 (each)	
No.19 Tanuli & Mbua Valley	Western area	100%	Min	17.7	17.7	PRV-H11	50mm	100mm	PVC	50mm	PVC	100 x 50mm	50mm	50mm	100mm	50mm	50mm	25mm -> 50mm
			Max.	41.2	41.2		x 1					x 2	x 2	x 1	x 1	x 1	x 1 (each)	L= 161m

Note: Minor fitting such as spigot pipes are not listed in the table.

Source: Project Team

4.4 Select Pilot Project Areas and DMAs. (Activity 1-4)

4.4.1 Outline of Activity

SW aims at the sustained improvement of NRW in water supply system. This leads to the identification of 23 pilot project areas as part of the Phase-1 activity to implement the NRW reduction activities. In addition, creating District Metered Area (DMA) is very important to determine more precisely and more preferentially where and when it is most beneficial to undertake NRW reduction activities. Therefore, the five areas out of 20 pilot project areas were transferred to at least two DMAs in PDM_2. The activities in DMAs were commenced after the completion of the works to install PRVs. DMA is defined as a discrete area of a distribution system usually created by the closure of valves or complete disconnection of pipelines. Water flow rate of water inflowing and outflowing is metered in DMAs. The water flow rate is analyzed to quantify the level of leakage.

Pilot projects target mainly residential areas where 40 to 70 households were served through distribution network of approximate 25 to 150 mm in pipe diameter and 1.0 to 1.5 km in length, where minimum night flow survey can be conducted efficiently.

The Project Team selected the areas suitable for the implementation of Pilot Project and DMAs. Figure 4.4-1 shows the selection procedures of Pilot Project areas and DMAs.

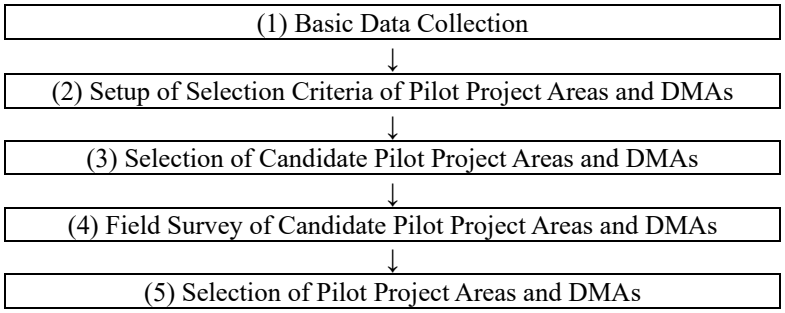


Figure 4.4-1 Selection Procedures of Pilot Project Areas and DMAs

4.4.2 Result of Activity

Basic data such as pipe material, diameter, location, base map on water distribution networks, and number of households, etc. were collected at the beginning of the selection of Pilot Project areas and/or DMAs.

15 Pilot Project areas were selected based on the following criteria:

1) Easy isolation from surrounding area with existing valves.
2) Drawings or GIS maps are available to show location of the valves.
3) Distribution flow is enough and stable.

4) Size of the areas is suitable for easy monitoring.
5) Residential areas where 100 households as optimum size are located are preferable to count easily.
6) Dendritically-expanded distribution networks are preferable.
7) Distribution pipelines are 250 mm or less in diameter and around 1.0km in length.

The two DMAs were selected and prioritized based on the selection criteria which were composed of estimated data and the operating knowledge as shown in Table 4.4-2.

1) Serious NRW situation (leakage, burst, etc.)
2) System Condition (bulk flow meter installed, etc.)
3) SW's Finance (amounts of Revenue)
4) Number of Beneficiaries (total number of users)
5) Easy Isolation from surrounding area with existing valves (numbers of the places to be isolated)
6) Hydraulic design of network (dendritic network, raising capacity, etc.)

Twenty-three candidate Pilot Project areas were selected according to the above selection criteria, including 10 candidate areas proposed by the JET in 2010.

The Project conducted field surveys to verify the number of households, valves and their locations and functionality for area isolation and pipeline routes in the candidate Pilot Project areas. Based on the outcome of the field survey, the Project selected 15 areas out of 23 candidate areas for implementation of Pilot Projects on NRW reduction. The results of the field surveys are shown in Table 4.4-1. Figure 4.4-2 shows location of 15 pilot project areas.

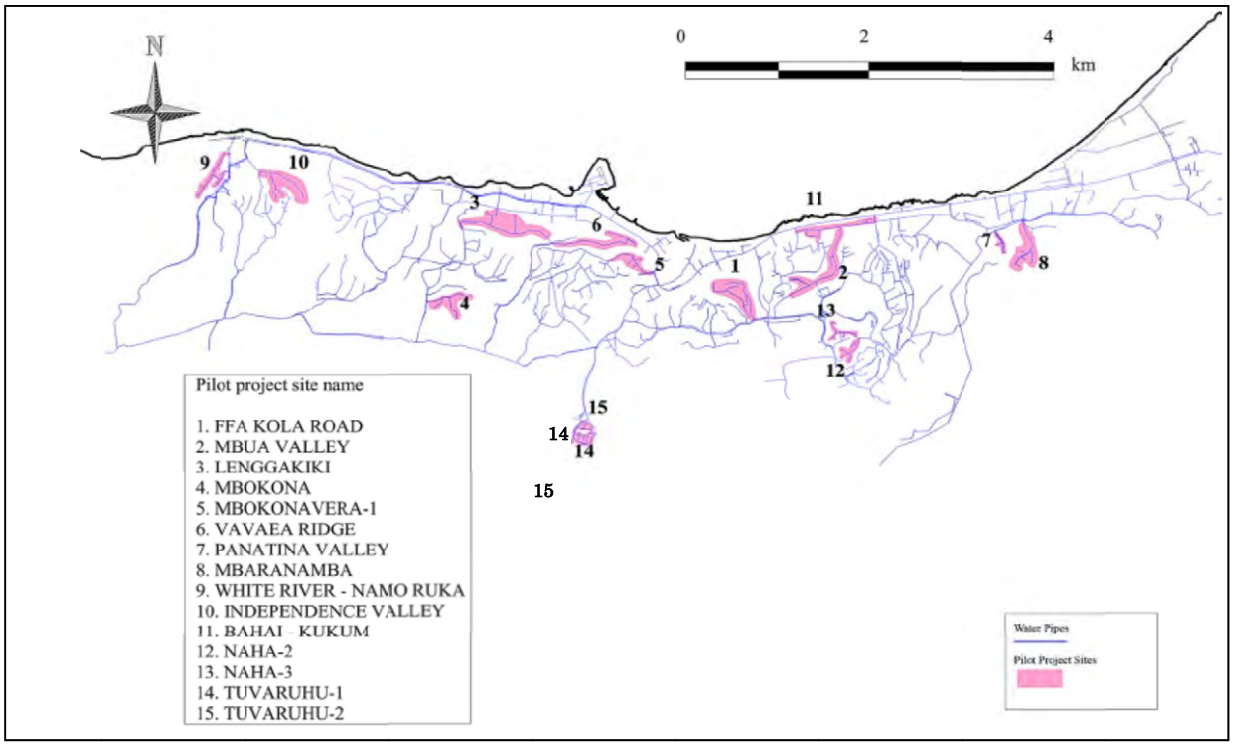
As shown in Figure 4.4-3, the Project setup 28 DMAs with considerations taken on how easy it is to operate the water supply system, location of the existing valves, cost saving and balance of static head. Of 28 DMAs, the Project selected No.6 Tasahe A&B as a DMA with pressure control and No.17 West Kola Ridge A without pressure control in September 2014 based on the criteria shown in Table 4.4-2.

Table 4.4-1 Results of Field Survey in Candidate Pilot Project Areas

No	Name	Pipe Diameter	Pipe Length (Original Data)	No. of Household (Original Data)
1	FFA Kola Road	D25-D75	1.6 km	83
2	Mbua Valley	D40-D75	2.0 km	137
3	Lenggakiki	D40-D75	1.8 km	119
4	Mbokana	D30-D75	1.5 km	100
5	Mbokonavera 1	D25-D75	0.9 km	78
6	Vavaea Ridge	D50-D100	1.3 km	130
7	Panatina Valley	D40-D75	0.6 km	53
8	PanatinaMbaranamba	D40-D75	1.4 km	53
9	White River- Namo Ruka	D40-D75	1.1 km	78

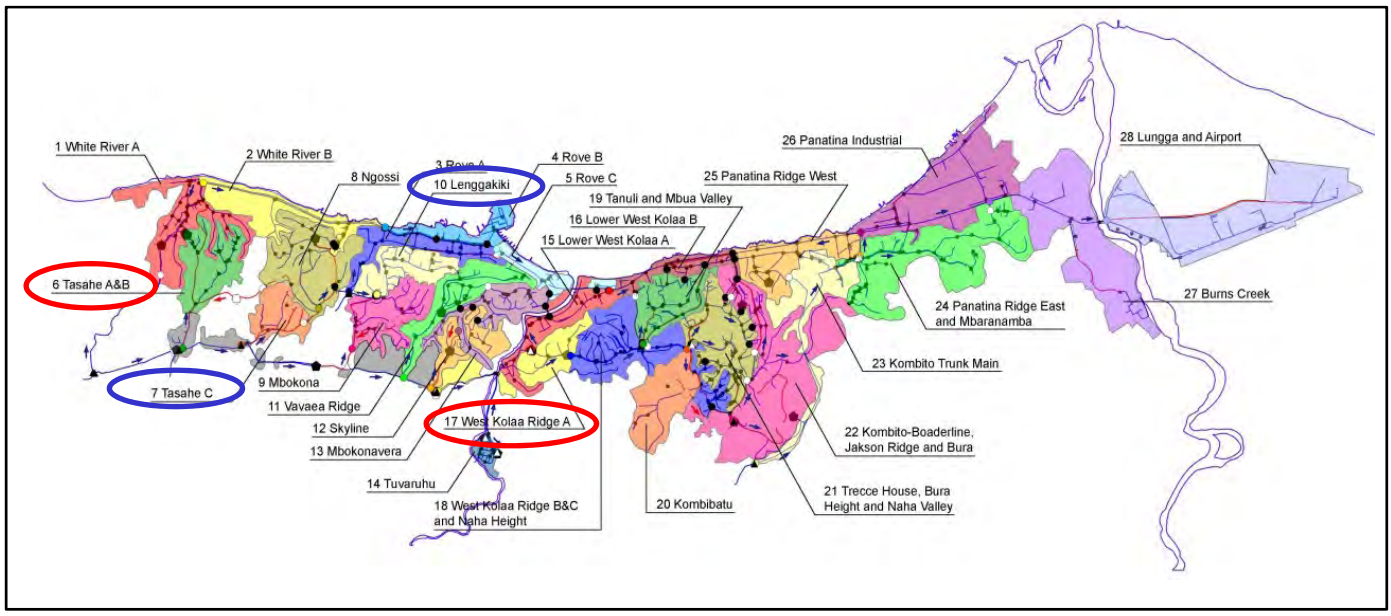
No	Name	Pipe Diameter	Pipe Length (Original Data)	No. of Household (Original Data)
10	White River Windy Valley	D30-D63	1.1 km	110
11	Bahai Kukum	D50-D100	1.3 km	100
12	Naha 2	D40-D100	0.6 km	78
13	Naha 3	D25-D100	0.7 km	56
14	Tubruhu-1	D40-D75	1.0 km	42
15	Tubruhu-2	D25-D75	0.5 km	63
16	Mbua Valley	Disqualified (difficulty in demarcation to proper size)		
17	Mbokonavera 2	Disqualified (inadequate water flow and distribution time)		
18	Panatina Ridge	Disqualified (difficulty in clarification of pipeline routes)		
19	White River Windy Valley	Disqualified (inadequate water flow and distribution time)		
20	Matevale St - Point Cruz	Disqualified (not residential area)		
21	Tasahe A & B	Disqualified (inadequate water flow and distribution time)		
22	Vura 3-2	Disqualified (inadequate water flow and distribution time)		
23	Ranadi Industrial	Disqualified (not residential area)		

Source: Project Team



Source: Project Team

Figure 4.4-2 Location of 15 Pilot Project Areas



: DMAs were selected under SW-JICA commitment and NRW reduction activities were completed by the Project.
: NRW reduction activities were completed by SW as of March 2016.

Source: Project Team

Figure 4.4-3 Demarcation of 28 DMAs and the DMAs where NRW reduction was completed

Table 4.4-2 Selection Criteria for DMAs

No.	DMAs	NRW serious situation							System Condition					SW's Finance			Number of Beneficiaries					Easy Isolation			Hydraulic design of network					Total Score	Pressure Control
		-	A	B	C	D	-		E	F	G	-		-	H		-	-	-	I		J			K	L	M				
		Illegals (%)	Score	Leakages	Direct Connections	Frequent Bursts	Total Score	Weighting Factor (x 45%)	Bulk Flow Meter installed	Pilot projects including the past projects have been done.	Number of Cascading	Total Score	Weighting Factor (x 25%)	Amounts of Revenue in Sep. '14 (SBD/mon.)	Score	Weighting Factor (x 10%)	Domestic	Commercial & Institutes	Total Number of Users	Total Score	Weighting Factor (x 10%)	Numbers of the places to be Isolated	Total Score	Weighting Factor (x 5%)	More Simple Network	Dendritic Network	Raising Capacity	Total Score	Weighting Factor (x 5%)		
1	White River A	20	3	3	2	2	10	4.50	1	2	3	6	1.50	96,874	1	0.10	294	1	295	3	0.30	2	2	0.10	1	3	2	6	0.30	**6.80**	
2	White River B	20	3	3	3	2	11	4.95	1	3	2	6	1.50	331,577	2	0.20	277	12	289	3	0.30	4	2	0.10	2	2	1	5	0.25	**7.30**	
3	Rove A	5	1	2	1	2	6	2.70	1	3	1	5	1.25	605,584	3	0.30	72	74	146	1	0.10	2	2	0.10	3	1	2	6	0.30	**4.75**	
4	Rove B	5	1	1	1	2	5	2.25	1	3	1	5	1.25	450,379	3	0.30	12	59	71	1	0.10	2	2	0.10	2	2	2	6	0.30	**4.30**	
5	Rove C	5	1	2	1	1	5	2.25	1	3	1	5	1.25	489,043	3	0.30	12	60	72	1	0.10	3	2	0.10	3	1	1	5	0.25	**4.25**	
6	Tasahe A&B	20	3	3	3	3	12	5.40	3	3	3	9	2.25	37,366	1	0.10	103	0	103	1	0.10	1	3	0.15	3	1	2	6	0.30	**8.30**	✔
7	Tasahe C	10	2	2	1	1	6	2.70	1	3	2	6	1.50	31,635	1	0.10	135	1	136	1	0.10	3	2	0.10	2	2	2	6	0.30	**4.80**	
8	Ngossi	10	2	2	2	2	8	3.60	2	3	1	6	1.50	178,693	2	0.20	297	5	302	3	0.30	1	3	0.15	2	3	2	7	0.35	**6.10**	✔
9	Mbokona	5	1	2	2	2	7	3.15	2	1	1	4	1.00	150,963	2	0.20	285	7	292	3	0.30	4	2	0.10	1	2	3	6	0.30	**5.05**	✔
10	Lenggakiki	10	2	2	2	1	7	3.15	3	1	3	7	1.75	115,907	1	0.10	192	16	208	2	0.20	0	3	0.15	3	1	2	6	0.30	**5.65**	
11	Vavaea Ridge	10	2	2	2	2	8	3.60	1	1	3	5	1.25	224,109	2	0.20	276	25	301	3	0.30	2	2	0.10	2	2	2	6	0.30	**5.75**	✔
12	Skyline	20	3	2	2	1	8	3.60	2	3	2	7	1.75	54,023	1	0.10	172	1	173	2	0.20	0	3	0.15	2	2	1	5	0.25	**6.05**	
13	Mbokonavera	10	2	3	2	3	10	4.50	2	1	2	5	1.25	144,818	1	0.10	311	13	324	3	0.30	2	2	0.10	2	2	3	7	0.35	**6.60**	✔
14	Tuvaruhu	20	3	3	1	2	9	4.05	1	1	3	5	1.25	16,821	1	0.10	35	1	36	1	0.10	0	3	0.15	2	2	3	7	0.35	**6.00**	
15	Lower West Kolaa A	20	3	3	3	2	11	4.95	1	2	2	5	1.25	269,932	2	0.20	191	104	295	3	0.30	2	2	0.10	2	2	2	6	0.30	**7.10**	
16	Lower West Kolaa B	5	1	2	1	2	6	2.70	1	3	2	6	1.50	276,919	2	0.20	186	67	253	3	0.30	7	1	0.05	3	1	2	6	0.30	**5.05**	
17	West Kolaa Ridge A	20	3	3	3	3	12	5.40	1	3	2	6	1.50	42,624	1	0.10	149	4	153	2	0.20	1	3	0.15	2	1	2	5	0.25	**7.60**	
18	West Kolaa Ridge B&C and Naha Height	20	3	3	3	3	12	5.40	1	3	1	5	1.25	200,066	2	0.20	509	5	514	3	0.30	5	2	0.10	1	3	2	6	0.30	**7.55**	
19	Tanuli and Mbua Valley	10	2	2	2	2	8	3.60	1	1	2	4	1.00	175,672	2	0.20	321	16	337	3	0.30	4	2	0.10	2	2	2	6	0.30	**5.50**	✔
20	Kombibatu	20	3	3	3	2	11	4.95	1	3	2	6	1.50	63,282	1	0.10	216	1	217	2	0.20	1	3	0.15	3	1	2	6	0.30	**7.20**	
21	Trecce House, Bura Height and Naha Valley	10	2	2	2	1	7	3.15	1	1	2	4	1.00	183,242	2	0.20	439	9	448	3	0.30	8	1	0.05	2	3	2	7	0.35	**5.05**	
22	Kombito-Boaderline, Jakson Ridge and Bura	20	3	3	3	3	12	5.40	1	3	3	7	1.75	242,448	2	0.20	437	2	439	3	0.30	4	2	0.10	1	3	2	6	0.30	**8.05**	
23	Kombito Trunk Main	20	3	3	3	3	12	5.40	1	3	2	6	1.50	107,913	1	0.10	154	2	156	2	0.20	2	2	0.10	3	1	1	5	0.25	**7.55**	
24	Panatina Ridge East and Mbaranamba	10	2	2	2	1	7	3.15	1	1	2	4	1.00	378,593	3	0.30	296	18	314	3	0.30	2	2	0.10	2	2	2	6	0.30	**5.15**	
25	Panatina Ridge West	5	1	2	1	1	5	2.25	1	3	2	6	1.50	322,114	2	0.20	157	2	159	2	0.20	6	1	0.05	2	3	2	7	0.35	**4.55**	
26	Panatina Industrial	20	3	3	2	2	10	4.50	1	3	3	7	1.75	563,848	3	0.30	80	169	249	2	0.20	1	3	0.15	1	2	2	5	0.25	**7.15**	
27	Burns Creek	20	3	3	3	1	10	4.50	1	3	1	5	1.25	16,036	1	0.10	103	21	124	1	0.10	0	3	0.15	3	1	1	5	0.25	**6.35**	
28	Lungga and Airport	20	3	3	3	1	10	4.50	1	3	1	5	1.25	2,513	1	0.10	76	3	79	1	0.10	0	3	0.15	2	1	2	5	0.25	**6.35**	
-	Other than DMA (Small areas supplied by trank main between Konglai Spring and Skyline Res.)	20	3	3	3	3	12	5.40	1	-	-	1	0.25	-	-	-	141		141	1	0.10	0	3	0.15	1	1	1	3	0.15	-	

Note:
A: 20%: 3, 10%: 2, 5%: 1
B to D, L, M: High: 3, Midium:2 , Low:1
E: Bulk flow meter was installed in the isolated DMA: 3, Bulk flow meter was installed at the upstream but there is no bulk flow meter in cascaded DMA at the down stream: 2, There is no bulk flow meter.: 1
F: Pilot projects have not been done so far: 3, Pilot projects other than this Technical Cooperation Project have been done in the past five years.: 2, Pilot Projects have been done in this technical assistance project.: 1
G: No cascading: 3, One cascading: 2, More than one cascading: 1
H: >SND350,000/month: 3, SBD150,000 to 350,000/month: 2, <SBD150,000/month: 1
K: Simple: 3, Medium: 2, Dificult:1
I: Number of At least 250: 3, 150 to 250: 2, Less than 150:1
J: 0 to 1: 3, 2 to 5: 2, at least 6: 1

Source: Project Team

4.5 Formulate an Annual Action Plan on NRW Reduction in the Pilot Project Areas and LCZs. (Activity 1-5)

4.5.1 Outline of Activity

The Project formulates annual action plans on NRW reduction in pilot project areas and DMAs at the end of each Phase in order to ensure that the implementation are carried out effectively and in a planned manner. The action plan includes;

- Details of activities
- Schedule of activities
- Cost estimation
- Pilot Project report (completion) and workshop, and
- Record form and log sheet
- Individual Action Plan (hereinafter "IAP") of Counterpart (hereinafter "CP")s

4.5.2 Result of Activity

The Project prepared an Annual Action Plan 2013 and 2014 in at the beginning of Phase 2 and Phase 3 respectively. Annual Action Plan 2014 was formulated based on the constructive lessons learned from Phase 2. Annual Action Plan 2014 was supposed to complete in April 2014 but was delayed due to the flood disaster at the beginning of April. Two annual action plans (2013 & 2014) on NRW reduction were shown in the Supporting Report S4.5-1 and S4.5-2 respectively.

Annual Action Plan 2014 also contains the second IAP of NRW Action Team, which is formulated based on activities required for capacity needs and each staff's approach to effectively implement the NRW reduction activities or other relevant SW activities. The first IAP was set in the beginning of Phase 2. The purpose of IAP is to raise motivation and the work sustainability. IAP is composed of the following heading and subheadings:

a. Individual plan (main activities)
   - Role and contribution to SW
   - Role and contribution to the Project
   - Challenging targets (voluntary)
   - Self-development or enlightening activities (voluntary)

b. Verifiable indicator (criteria of assessments)
   e.g. Over goal: A, Goal or equivalent: B, Less than goal: C, Much less than goal: D

c. Method of implementation and its schedule

d. Goal of achievement

Annual Action Plan (2013 and 2014) and result of self-evaluation on Individual Action Plan is

attached as Supporting Report S4.5-1, S4.5-2 and S4.5-3 respectively.

4.6 Monitor the Progress of NRW Reduction Activities in the Pilot Project Areas and LCZs. (Activity 1-6)

4.6.1 Outline of Activity

As part of project management, the Project Team including NRW Management Team and the JET is responsible for progress management through monitoring of NRW reduction activities and for recording and reviewing inputs quantitatively; manpower, working time, materials and cost.

4.6.2 Result of Activity

The Project has monitored and shared routinely the progress of activities by the use of the purpose-designed forms, while also preparing the Project Progress Reports bi-annually which contain the overview of the progress of the activities.

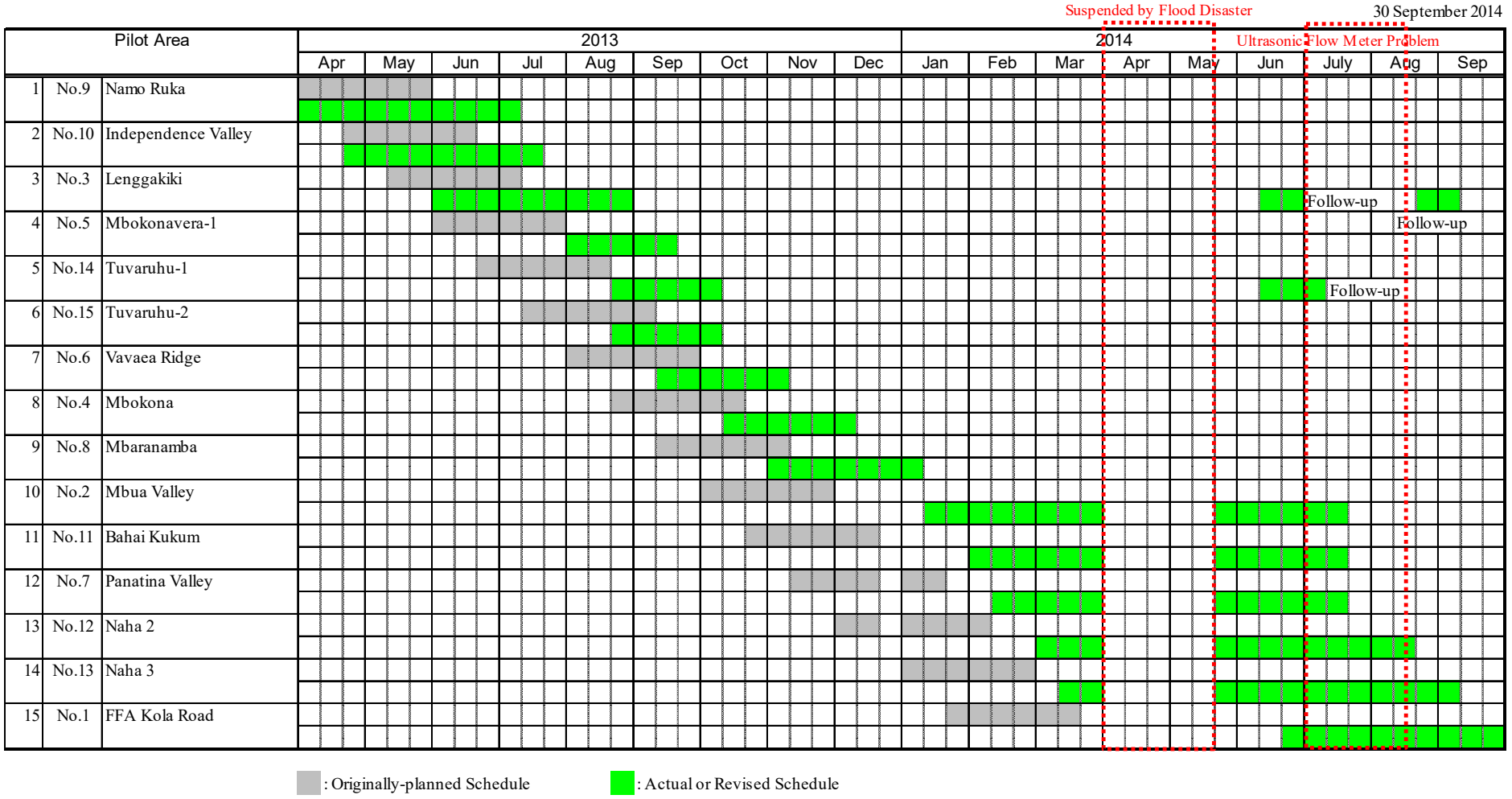
Cost of carrying out NRW reduction activities has been determined based on the track record, composed of personnel, consumable items such as fuel, and material & equipment. The actual costs is described in Section 4.7.

Pilot Project Areas

Figure 4.6-1 shows the plan and track record of NRW reduction activities. Figure 4.6-2 shows the sheet to monitor detail progress of each activity. The Progress of the activities was reported in the weekly meeting based on this sheet.

DMAs and/or LCZs

Figure 4.6-3 shows the plan and track record of NRW reduction activities. Figure 4.6-4 shows the sheet to monitor detail progress of each activity. The Progress of the activities was reported in the weekly meeting based on this sheet like the activities in the Pilot Project Areas.



Source: Project Team

Figure 4.6-1 Timeline of Plan & Track Record of NRW Reduction in Pilot Project Areas

NWR Reduction Activities	Team in charge										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
											No.9	No.10	No.3	No.5	No.14	No.15	No.6	No.4	No.8	No.2	No.11	No.7	No.12	No.13	No.1
	TL	NM	CCo	Pro	CCa	PR	MR	BL	GIS	LD	Namo Ruka	Independence Valley	Lenggakiki	Mbokonavera-1	Tuvaruhu-1	Tuvaruhu-2	Vavaea Ridge	Mbokana	Mbaranamba	Mbua Valley	Bahai Kukum	Panatina Valley	Naha 2	Naha 3	FFA Kola Road
Project Implementation Status																									
Before Countermeasures																									
Preparation of network drawings	○	○							◎		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Field survey (valve check, visual leakage detection, etc.)		◎	◎							◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Preparation of isolation and step test (valve installation)		◎		◎						○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Preparation of customer list	○							◎			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
On-site public awareness					○	◎					■	–	–	–	–	–	–	–	–	–	–	–	■	■	■
Distribution of public awareness pamphlet					○	◎					–	–	■	■	■	■	■	■	■	■	■	■	■	■	■
Connection identification and verification		○	◎		○		○			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Customer meter functioning check		○	◎				○			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Measurement of visibly-detected leakage		○								◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Notification letter to illegal users						◎					■	■	■	■	■	■	–	■	■	■	■	–	■	■	■
Customer meter reading of 24 hours consumption		○	○				◎			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MNF & Pressure measurement		○								◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Customer meter inaccuracy test (all meters)		○	◎				○			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Calculation of NRW ratio	◎										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Countermeasures																									
Step test		○								◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Leakage detection		○								◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Pipe repair		◎		◎							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Legalization of illegal connection			○		◎						■	■	■	■	■	■	–	■	■	■	■	–	■	■	■
Disconnection of illegal connection			◎		○						■	■	■	■	■	■	–	■	■	■	■	–	■	■	■
Customer meter raising (newly-installation / replacement)		○	◎	◎						○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
After Countermeasures																									
Customer meter reading of 24 hours consumption		○	○				◎			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MNF & Pressure measurement		○								◎	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Customer meter inaccuracy test (random sampling)		○	◎				○			○	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Calculation of NRW ratio	◎										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Routine Activities																									
Update of drawings and attributes (GIS database)	○	○								◎	■	■	■	■	■	■	■	■	■	■	☒	■	☒	☒	☒
Update of customer list	○							◎			■	■	■	■	■	■	■	■	■	■	☒	☒	■	■	☒
Update of billing system							◎				■	■	■	■	■	■	■	■	■	■	☒	☒	■	■	☒

◎ : Leading Team ○ : Supporting Team □ : Not yet ☑ : Next week's activities ☒ : Ongoing ■ : Completed – : Unexecuted

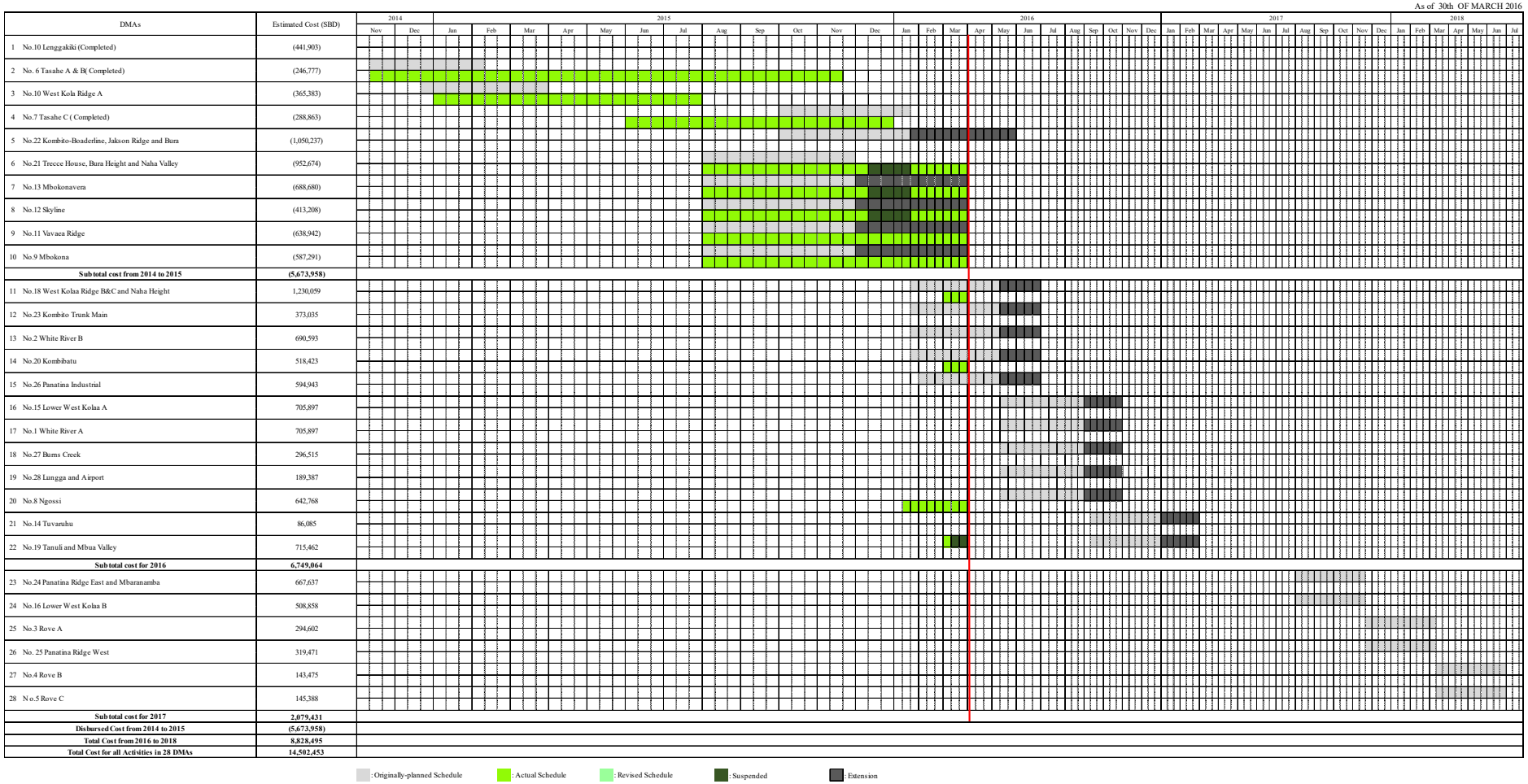
NRW Action Taskforce Team
TL: Taskforce Leaders
Tech: Technical Sub-Team
NM: Network Maintenance & Repair CCo: Customer Connection Pro: Procurement
CS: Customer Services Sub-Team
CCa: Customer Care PR: Public/Community Relations MR: Meter Reading BL: Billing
GIS: GIS Sub-Team
LD: Leakage Detection Sub-Team

Source: Project Team

Figure 4.6-2 Progress of NRW Reduction Activities in Pilot Project Areas

As of 30th OF MARCH 2016

DMAs	Estimated Cost (SBD)
1 No.10 Lenggakiki (Completed)	(441,903)
2 No. 6 Tasahe A & B(Completed)	(246,777)
3 No.10 West Kola Ridge A	(365,383)
4 No.7 Tasahe C (Completed)	(288,863)
5 No.22 Kombito-Boaderline, Jakson Ridge and Bura	(1,050,237)
6 No.21 Trecce House, Bura Height and Naha Valley	(952,674)
7 No.13 Mbokonavera	(688,680)
8 No.12 Skyline	(413,208)
9 No.11 Vavaea Ridge	(638,942)
10 No.9 Mbokona	(587,291)
Sub total cost from 2014 to 2015	**(5,673,958)**
11 No.18 West Kolaa Ridge B&C and Naha Height	1,230,059
12 No.23 Kombito Trunk Main	373,035
13 No.2 White River B	690,593
14 No.20 Kombibatu	518,423
15 No.26 Panatina Industrial	594,943
16 No.15 Lower West Kolaa A	705,897
17 No.1 White River A	705,897
18 No.27 Bums Creek	296,515
19 No.28 Lungga and Airport	189,387
20 No.8 Ngossi	642,768
21 No.14 Tuvaruhu	86,085
22 No.19 Tanuli and Mbua Valley	715,462
Sub total cost for 2016	**6,749,064**
23 No.24 Panatina Ridge East and Mbaranamba	667,637
24 No.16 Lower West Kolaa B	508,858
25 No.3 Rove A	294,602
26 No. 25 Panatina Ridge West	319,471
27 No.4 Rove B	143,475
28 No.5 Rove C	145,388
Sub total cost for 2017	**2,079,431**
Disbursed Cost from 2014 to 2015	**(5,673,958)**
Total Cost from 2016 to 2018	**8,828,495**
Total Cost for all Activities in 28 DMAs	**14,502,453**



Source: Project Team

Figure 4.6-3 Timeline of Plan & Track Record of NRW Reduction in DMAs

30th March 2016

NWR Reduction Activities	Team in charge										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
											No.10	No. 6	No.17	No.7	No.8	No.9	No.11	No.13	No.12	No.18	No.19	No.20	No.21	No.22	No.23	No.26	No.28	No.24	No.25	No.27	No.15	No.16	No.14	No.01	No.02	No.03	No.04	No.05	
	TL	NM	CCo	Pro	CCa	PR	MR	BL	GIS	LD	Lengikki	Tasahe A & B	West Kola A	Tasahe C	Ngossi	Mbokona	Vavae Ridge	Mokonavera	Skyline	West Kolaridge B&C	Tanuli	Kombivatu	Naha Valley	Kombito Borderline	Kombito Trunk	Panatina Industrial	Lugga and Airport	Panatina Ridge	Panatina West	Burnscreek	Lower wet Kola A	Lower west Kola B	Tuvaruhu	White river A	White river B	Rove A	Rove B	Rove C	others
Project Implementation Status																																							
Before Countermeasures																																							
Preparation of network drawings	○	○							◎		■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
Field survey (valve check, visual leakage detection, etc.)		◎	◎							◎	■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
Preparation of isolation and step test (valve installation)		◎		◎						○	■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
Preparation of customer list	○							◎			■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
On-site public awareness					○	◎					-	-	-	-	□	-	-	-	-	□	□	□	-	□														
Distribution of public awareness pamphlet					○	◎					■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
Connection identification and verification		○	◎		○		○			○	■	■	■	■	☒	■	■	■	■	☒	□	☒	■	□														
Customer meter functioning check		○	◎				○			○	■	■	■	■	☒	■	■	■	■	□	□	☒	■	□														
Measurement of visibly-detected leakage		○								◎	■	■	■	■	☒	■	■	■	■	□	□	□	■	□														
Notification letter to illegal users						◎					■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Customer meter reading of hours consumption monthly		○	○				◎			○	■	■	■	■	□	■	■	■	■	□	□	□	■	□														
MNF & Pressure measurement		○								◎	■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Customer meter inaccuracy test (all meters)		○	◎				○			○	■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Calculation of NRW ratio	◎										■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Countermeasures																																							
Step test		○								◎	■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Leakage detection		○								◎	■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Pipe repair		◎		◎							■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Legalization of illegal connection			○		◎						■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Disconnection of illegal connection			◎		○						■	■	■	■	□	■	■	■	■	□	□	□	■	□														
Customer meter raising (newly-installation / replacement)		○	◎	◎						○	■	■	■	■	□	■	■	☒	☒	□	□	□	☒	□														
After Countermeasures																																							
Customer meter reading of 24 hours consumption		○	○				◎			○	■	■	■	■	□	□	□	□	□	□	□	□	□	□														
MNF & Pressure measurement		○								◎	■	■	■	■	□	□	□	□	□	□	□	□	□	□														
Customer meter inaccuracy test (random sampling)		○	◎				○			○	■	■	■	■	□	□	□	□	□	□	□	□	□	□														
Calculation of NRW ratio	◎										■	■	■	■	□	□	□	□	□	□	□	□	□	□														
Construction of Chamber												■	□	■	■	□	□	□	□	□	□	□	□	□														
INSTALLATION OF PRV																																							
Customer Meter reading of 24 hours consumption without PRV											-	■	-		□	□	□	□			□																	
MNF & Pressure Measurement with PRV											-	■	-		□	□	□	□			□																	
Customer Meter laccuracy Test(Random Sampling)											-	■	-		□	□	□	□			□																	
Calculation NRW Ratio											-	■	-		□	□	□	□			□																	
Routine Activities																																							
Update of drawings and attributes (GIS database)	○	○								◎	■	☒	☒	■	□	☒	☒	☒	☒	□	□	□	□	□														
Update of customer list	○							◎			■	☒	☒	■	□	☒	☒	☒	☒	□	□	□	□	□														
Update of billing system							◎				■	☒	☒	■	□	☒	☒	☒	☒	□	□	□	□	□														
Monitoring Activites																																							
Step test											☒	□	□	□	□	□	□	□	□	□	□	□	□	□														
Legalised of Illegal connections											☒	☒	☒	□	□	□	□	□	□	□	□	□	□	□														
Disconnections of Illegal Connections											☒	☒	☒	□	□	□	□	□	□	□	□	□	□	□														
MNF & Pressure Measurement(Using Loggers)											☒	□	□	□	□	□	□	□	□	□	□	□	□	□														
New Connections											☒	□	□	□	□	□	□	□	□	□	□	□	□	□														
Monthly Consumption data/System Input (NRW Ratio)											☒	□	□	□	□	□	□	□	□	□	□	□	□	□														

◎ : Leading Team ○ : Supporting Team □ : Not yet ☑ : Next week's activities ☒ : Ongoing ■ : Completed

NRW Action Taskforce Team - : Unexecuted

TL: Taskforce Leaders GIS: GIS Sub-Team LD: Leakage Detection Sub-Team

Tech: Technical Sub-Team CS: Customer Services Sub-Team

NM: Network Maintenance & Repair CCo: Customer Connection Pro: Procurement CCa: Customer Care PR: Public/Community Relations MR: Meter Reading BL: Billing

Source: Project Team

Figure 4.6-4 Progress of NRW Reduction Activities in DMAs

4.7 Analyze Cost-effectiveness of NRW Reduction Activities. (Activity 1-7)

4.7.1 Outline of Activity

Cost-effectiveness of NRW reduction activities particularly in pilot project areas including four DMAs should be well learned for SW's services and then utilized for formulating a Strategic Implementation (rolling-out) Plan for NRW reduction in the whole Honiara City. Therefore, the Project analyzes the cost incurred for the activities and the benefits from the activities.

4.7.2 Result of Activity

(1) Performance Period of NRW Reduction Activities

Pilot Project Areas

Performance period of NRW reduction activities in 15 pilot project areas are shown in Table 4.7-1.

Table 4.7-1 Performance Period of NRW Reduction Activities in Pilot Project Areas

No.	No.	Pilot Project Areas	Performance Period of Activities
1	No.9	White River- Namo Ruka	1 April - 10 July 2013 (3.3 months)
2	No.10	Independence Valley	20 April - 20 July 2013 (3.0 months)
3	No.3	Lenggakiki	1 June - 31 August 2013 (3.0 months)
4	No.5	Mbokonavera-1	1 August - 20 September 2013 (1.6 months)
5	No.14	Tuvaruhu-1	20 August - 10 October 2013 (1.6 months)
6	No.15	Tuvaruhu-2	20 August - 10 October 2013 (1.6 months)
7	No.6	Vavaea Ridge	10 September - 10 November 2013 (2.0 months)
8	No.4	Mbokona	15 October - 10 December 2013 (1.8 months)
9	No.8	Mbaranamba	01 November 2013- 10 January 2014 (2.3 month)
10	No.2	Mbua Valley*1	20 January - 10 July 2014 (3.5 months)
11	No.11	Bahai Kukum*1	1 February - 20 May 2014 (3 months)
12	No.7	Panatina Valley*1	20 February - 20 July 2014 (2.5 months)
13	No.12	Naha 2*	1 March - 10 September 2014 (3 months)
14	No.13	Naha 3*	20 March - 20 September 2014 (3 months)
15	No.1	FFA Kola Road	20 July - 30 September 2014 (3.5 months)
Total			1 April 2013 - 30 September 2014 (cumulatively 38.7 months)

Source: Project Team

*1 The flood in April 2014 and defective ultra-sonic flow meter disrupted the activities for almost four months.

DMAs and/or LCZs

Performance period of NRW reduction activities in four completed DMAs are shown in Table 4.7-2.

Table 4.7-2 Performance Period of NRW Reduction Activities in DMAs

No.	No.	DMAs	Performance Period of Activities
1	No.10	Lenggakiki	4 September - 28 October 2014 (1.8 months)
2	No.6	Tasahe A& B*1	6 November 2014 - 26 November 2015 (8.5 months) *2
3	No.17	West Kola Ridge A*1	22 December 2014 - 23 July 2015 (7.0 months)
4	No.7	Tasahe C	6 June - 31 December 2015 (6.9 months)
Total			4 September 2014 - 31 December 2015 (cumulatively 24.2 months)

Source: Project Team

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

*2 It took time for chamber construction and procurement of PRV.

(2) Initial Cost incurred in NRW Reduction Activities

NRW reduction activities are classified according to the following three activities.

- Baseline survey of NRW ratio before countermeasures
- Countermeasures activities (repair of pipes, disconnection, legalization, installation of water meter, etc.)
- Survey of NRW ratio after countermeasures

Initial cost incurred in the NRW reduction activities includes the following:

- Personnel cost for SW staff
- Consumable cost of fuel for vehicle and excavator
- Cost of material and equipment such as valves, pipes and water meters to be installed for isolation, repair, replacement and new installation

Breakdown of initial cost incurred in the NRW reduction activities is shown in Supporting Report S4.7-1.

Pilot Project Areas

The actual cost incurred for the NRW reduction activities in 15 pilot project areas is shown in Table 4.7-3. Total initial cost is about SBD2.23million (USD0.28million), which equates to cost per pilot area to be about SBD148,800 (USD18,600), cost per household to be SBD1,525 (USD191) and cost per km of pipeline to be SBD100,400 (USD12,550).

Table 4.7-3 Initial Cost for NRW Reduction Activities in Pilot Project Areas

No	Area No	Area Name	Pipeline Length (m)	Total No. of Household	Personnel Cost (SBD)*1	Consumable Cost (SBD)	Material & Equipment (SBD)*2	Total Initial Cost (SBD)
			[1]	[2]	[3]	[4]	[5]	[6]=[3]+[4]+[5]
1	No.9	White River-Namo Ruka	1,063	83	74,710	2,306	22,673	99,689
2	No.10	Independence Valley	2,184	91	78,825	2,207	32,889	113,921
3	No.3	Lenggakiki	2,481	161	55,087	971	59,810	115,868
4	No.5	Mbokonavera-1	1,104	76	48,515	269	32,138	80,922
5	No.14	Tuvaruhu-1	1,206	48	43,084	884	32,769	76,737
6	No.15	Tuvaruhu-2	1,371	62	45,669	942	43,438	90,049
7	No.6	Vavaea Ridge	1,298	163	56,752	4,081	104,816	165,649
8	No.4	Mbokona	1,419	110	91,461	7,417	146,267	245,145
9	No.8	Mbaranamba	1,512	100	39,498	5,959	38,764	84,221
10	No.2	Mbua Valley	1,990	122	125,706	6,701	175,856	308,263
11	No.11	Bahai Kukum	1,692	182	95,068	6,349	180,944	282,361
12	No.7	Panatina Valley	885	60	82,801	6,033	41,097	129,931

No	Area No	Area Name	Pipeline Length (m)	Total No. of Household	Personnel Cost (SBD)*1	Consumable Cost (SBD)	Material & Equipment (SBD)*2	Total Initial Cost (SBD)
			[1]	[2]	[3]	[4]	[5]	[6]=[3]+[4]+[5]
13	No.12	Naha 2	786	57	92,066	6,289	32,058	130,413
14	No.13	Naha 3	960	67	100,337	6,495	24,927	131,759
15	No.1	FFA Kola Road	2,276	82	101,699	4,831	69,906	176,436
Total			**22,227**	**1,464**	**1,131,278**	**61,734**	**1,018,264**	**2,231,364**

Source: Project Team

*1 Personnel cost of JET is not included in the Personnel Cost.

*2 Cost of material & equipment which was provided by the fund of DFAT and JICA is included in the Material & Equipment.

DMAs and/or LCZs

The actual cost incurred for the NRW reduction activities in four completed DMAs is shown in Table 4.7-4. Total initial cost for four DMAs is about SBD1.99 million, which equates to cost per household to be SBD2,397 and cost per km of pipeline to be SBD83,950.

Table 4.7-4 Initial Cost for NRW Reduction Activities in DMAs

No	Area No	Area Name	Pipeline Length (m)	Total No. of Household	Personnel Cost (SBD)*2	Consumable Cost (SBD)	Material & Equipment (SBD)*3	Total Initial Cost (SBD)
			[1]	[2]	[3]	[4]	[5]	[6]=[3]+[4]+[5]
1	No.10	Lenggakiki	4,035	215	177,039	11,044	264,737	452,819
2	No.6	Tasahe A&B*1	6,719	202	239,040	23,103	415,388	677,531
3	No.17	West Kola Ridge A*1	9,060	225	155,955	11,474	169,949	337,377
4	No.7	Tasahe C	3,859	187	181,672	11,890	326,041	519,603
Total			**23,673**	**829**	**753,706**	**57,511**	**1,176,115**	**1,987,330**

Source: Project Team

Note: Initial cost incurred for the NRW reduction activities in "No.10: Lenggakiki" does not include one in pilot area "Lenggakiki" which is a part of the DMA.

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

*2 Personnel cost of JET is not included in the Personnel Cost.

*3 Cost of material & equipment which was provided by the fund of DFAT and JICA is included in the Material & Equipment.

(3) Benefit from the NRW Reduction Activities

Honiara's unit water supply price[13] of SBD17.61/m^3 is applied based on operational and financial data of SW in 2015.

In consideration of rationing water supply in most of Honiara, the Project regards the benefit of NRW reduction activities as "increase in revenue" only.

[13] Unit water supply price = "Annual income" / "Annual billed water" in Honiara (SBD72,946,294 / 4,142,234m^3)

Pilot Project Areas

The calculated results of the increased revenue water volume resulting from NRW reduction activities in each Pilot Project area are shown in Table 4.7-5. Water of about 1,425m^3/day in total increased by NRW reduction activities in the 15 pilot project areas. Annual increased revenue is estimated at SBD9.16 million to be generated by NRW reduction.

Table 4.7-5 Increase in Revenue Water and Revenue by NRW Reduction Activities in Pilot Project Areas

No	Area No	Area Name	Revenue Water (m^3/day)		Estimated Daily Increased Revenue Water (m^3/day)	Estimated Revenue Increase (SBD/day)
			Before	After*1		
			[1]	[2]	[3]=[2]-[1]	[4]=[3] x Unit Price
1	No.9	White River-Namo Ruka	47.0	235.2	188.3	3,316
2	No.10	Independence Valley	67.5	144.0	76.4	1,345
3	No.3	Lenggakiki	224.9	504.5	279.7	4,926
4	No.5	Mbokonavera-1	83.7	152.5	68.7	1,210
5	No.14	Tuvaruhu-1	36.6	94.2	57.6	1,014
6	No.15	Tuvaruhu-2	37.4	90.6	53.2	937
7	No.6	Vavaea Ridge	185.6	365.5	179.9	3,168
8	No.4	Mbokona	61.8	100.3	38.5	678
9	No.8	Mbaranamba	122.5	153.9	31.4	553
10	No.2	Mbua Valley	146.2	277.3	131.1	2,309
11	No.11	Bahai Kukum	135.2	273.6	138.4	2,437
12	No.7	Panatina Valley	58.0	87.1	29.2	514
13	No.12	Naha 2	46.8	81.8	35.0	616
14	No.13	Naha 3	53.6	101.9	48.2	849
15	No.1	FFA Kola Road	113.8	183.0	69.2	1,219
Total			**1,420.6**	**2,845.4**	**1,424.8**	**25,091**
						SBD9.16million/annual

Source: Project Team

*1 To make before-after conditions consistent each other, these are calculated by the formula "(System input volume before NRW measures) / (System input volume after NRW measures) × (Volume of actual revenue water after NRW measures)"

DMAs and/or LCZs

Water of about 1,479m^3/day in total increased by NRW reduction activities in four completed DMAs. Annual increased revenue is estimated at SBD9.51 million to be generated by NRW reduction (see Table 4.7-6).

Table 4.7-6 Increase in Revenue Water and Revenue by NRW Reduction Activities in DMAs

No	Area No	Area Name	Revenue Water (m^3/day)		Estimated Daily Increased Revenue Water (m^3/day)	Estimated Revenue Increase (SBD/day)
			Before	After*1		
			[1]	[2]	[3]=[2]-[1]	[4]=[3] x Unit Price
1	No.10	Lenggakiki	446.9	602.9	156.0	2,747
2	No.6	Tasahe A&B*2	241.4	1,147.5	906.0	15,955
3	No.17	West Kola Ridge A*2	256.4	528.7	272.3	4,795
4	No.7	Tasahe C	294.4	439.9	145.5	2,562

No	Area No	Area Name	Revenue Water (m^3/day)		Estimated Daily Increased Revenue Water (m^3/day)	Estimated Revenue Increase (SBD/day)
			Before	After*1		
			[1]	[2]	[3]=[2]-[1]	[4]=[3] x Unit Price
Total			**1,239.1**	**2,719.0**	**1,479.8**	**26,059**
						SBD9.51million/annual

Source: Project Team

*1 To make before-after conditions consistent each other, these are calculated by the formula "(System input volume before NRW measures) / (System input volume after NRW measures) × (Volume of actual revenue water after NRW measures)"

*2 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

(4) Result of Cost-Effectiveness Analysis

The Project applies the following conditions to cost-benefit analysis:

After initial NRW reduction activities, the improved NRW ratio will be maintained through monitoring and maintenance activities. Monitoring and maintenance activities for three years are assumed as same as the initial cost spent in the NRW reduction activities.

Pilot Project Areas

As a result of cost-benefit analysis based on the above-mentioned conditions, revenue increase in the 15 Pilot Projects is estimated at about SBD27.10millions (SBD18,509 per household) as shown in Table 4.7-7. This greatly exceeds about SBD4.46millions (SBD3,048 per household) of the initial and three-year recurrent activities of NRW reduction, which means 6.1 times. Therefore, NRW reduction is definitely beneficial to services and business of SW.

Table 4-7.7 Cost-Effectiveness of NRW Reduction Activities in Pilot Project Areas

No	Area No.	Area Name	Estimated Increased Revenue Water		Estimated Revenue Increase*1		Initial Cost incurred*2	Initial and Recurring Cost for 3 years*3	Ratio of C/B
			(m^3/day)	(m^3/3yrs)	(SBD/day)	(SBD/3yrs)	(SBD)	(SBD/3yrs)	%
1	No.9	White River - Namo Ruka	188.3	203,364	3,316	3,581,240	99,689	199,378	5.6
2	No.10	Independence Valley	76.4	82,512	1,345	1,453,036	113,921	227,842	15.7
3	No.3	Lenggakiki	279.7	302,076	4,926	5,319,558	115,868	231,736	4.4
4	No.5	Mbokonavera-1	68.7	74,196	1,210	1,306,592	80,922	161,844	12.4
5	No.14	Tuvaruhu-1	57.6	62,208	1,014	1,095,483	76,737	153,474	14.0
6	No.15	Tuvaruhu-2	53.2	57,456	937	1,011,800	90,049	180,098	17.8
7	No.6	Vavaea Ridge	179.9	194,292	3,168	3,421,482	165,649	331,298	9.7
8	No.4	Mbokona	38.5	41,580	678	732,224	245,145	490,290	67.0
9	No.8	Mbaranamba	31.4	33,912	553	597,190	84,221	168,442	28.2
10	No.2	Mbua Valley	131.1	141,588	2,309	2,493,365	308,263	616,526	24.7
11	No. 11	Bahai Kukum	138.4	149,472	2,437	2,632,202	282,361	564,722	21.5
12	No.7	Panatina Valley	29.2	31,536	514	555,349	129,931	259,862	46.8
13	No.12	Naha 2	35.0	37,800	616	665,658	130,413	260,826	39.2
14	No. 13	Naha 3	48.2	52,056	849	916,706	131,759	263,518	28.7
15	No.1	FFA Kola Road	69.2	74,736	1,219	1,316,101	176,436	352,872	26.8
		Total	**1,424.8**	**1,538,784**	**25,091**	**27,097,986**	**2,231,364**	**4,462,728**	**16.5**

Source: Project Team
*1: Unit revenue per revenue water of SBD17.61/m^3as of 2015 was applied for increased revenue.
*2: Initial cost is composed of personnel, consumable and material cost.
*3: Recurrent cost for NRW reduction required to maintain conditions well for three years is estimated as 100% of the initial cost spent in the Pilot Projects.

DMAs and/or LCZs

In the same way, As a result of cost-benefit analysis based on the above-mentioned conditions, revenue increase in four completed DMAs is estimated at about SBD28.14millions (SBD33,949 per household) as shown in Table 4.7-8. This greatly exceeds about SBD3.97millions (SBD4,794 per household) of the initial and three-year recurrent activities of NRW reduction, which means 7.1 times. Therefore, NRW reduction is definitely beneficial to services and business of SW.

Table 4-7.8 Cost-Effectiveness of NRW Reduction Activities in DMAs

No	Area No.	Area Name	Estimated Increased Revenue Water		Estimated Revenue Increase*1		Initial Cost incurred*2	Initial and Recurring Cost for 3 years*3	Ratio of C/B
			(m^3/day)	(m^3/3yrs)	(SBD/day)	(SBD/3yrs)	%	(SBD/3yrs)	%
1	No.10	Lenggakiki	156.0	168,480	2,747	2,966,933	452,819	905,638	30.5
2	No.6	Tasahe A&B	906.0	978,480	15,955	17,231,033	677,531	1,355,062	7.9
3	No.17	West Kola Ridge A	272.3	294,084	4,795	5,178,819	337,377	674,754	13.0
4	No.7	Tasahe C	145.5	157,140	2,562	2,767,235	519,603	1,039,206	37.6
		Total	**1,479.8**	**1,598,184**	**26,059**	**28,144,020**	**1,987,330**	**3,974,660**	**14.1**

Source: Project Team
*1: Unit revenue per revenue water of SBD17.61/m^3as of 2015 was applied for increased revenue.
*2: Initial cost is composed of personnel, consumable and material cost.
*3: Recurrent cost for NRW reduction required to maintain conditions well for three years is estimated as 100% of the initial cost spent in the Pilot Projects.

4.8 Prepare Strategic Implementation (Rolling-Out) Plan for NRW Reduction in the Whole Honiara City (Activity 1-8)

4.8.1 Outline of Activity

As an output of the Project, the Project formulated the Strategic Implementation (Rolling-out) Plan (hereinafter “the Plan”) which includes the long-term goal of NRW reduction and the approach for sustainability of the NRW Management and Action Team to expand and sustain NRW reduction activities into the whole of Honiara City.

It is with the hope that the Strategic Implementation Plan contributes to decision making by SW’s management, and also to see that SW’s staff can perform the activities reliably and efficiently, on the condition that SW’s management provides the necessary support and sufficient budget allocation for sustainability of NRW reduction.

4.8.2 Result of Activity

The Project formulated Strategic Implementation Plan based on the results and lessons learned through

the initial activity in the pilot areas and DMAs. It indicates overall goal on NRW ratio of 25% by the end of 2025 as the mid-term (the next 10years from now on). The Plan set forth strategy and the detail schedule of NRW reduction activities until the year of 2017. Strategic Implementation Plan is attached in Supporting Report S4.8-1.

This plan consists of the following 10 items:

- Objective of NRW Reduction: Background, objectives and overall goal
- Definitions of Terms: DMA, LCZ and PCZ
- Result of the Pilot Projects and Lessons Learnt: Results, issues, feature of pilot project areas & causes of NRW in their areas
- Implementing Structure: Implementing structure and role of the team
- Target Areas of NRW Reduction Activities: Creation of DMAs and their feature
- Implementation Process: Priority of implementation and it process
- Contents of Overall Activities: Formulation of action plan, procurement of equipment, primary NRW reduction activities and monitoring & maintenance work
- Cost-Effectiveness Analysis: Cost estimate for NRW reduction activities and budget allocation and estimation of benefit
- Implementation Schedule: Implementation schedule until the end of 2017
- Project Management: Plan-Do-Check-Action (PDCA), monthly meeting, periodical workshop and annual report

4.9 Feedback the Results of DMA-Based NRW Reduction Activities, including Monitoring and Maintenance for Improved NRW Ratio, to Strategic Implementation (Rolling-Out) Plan, and then Provide Assistance in Review of the Plan as when it is necessary. (Activity 1-9)

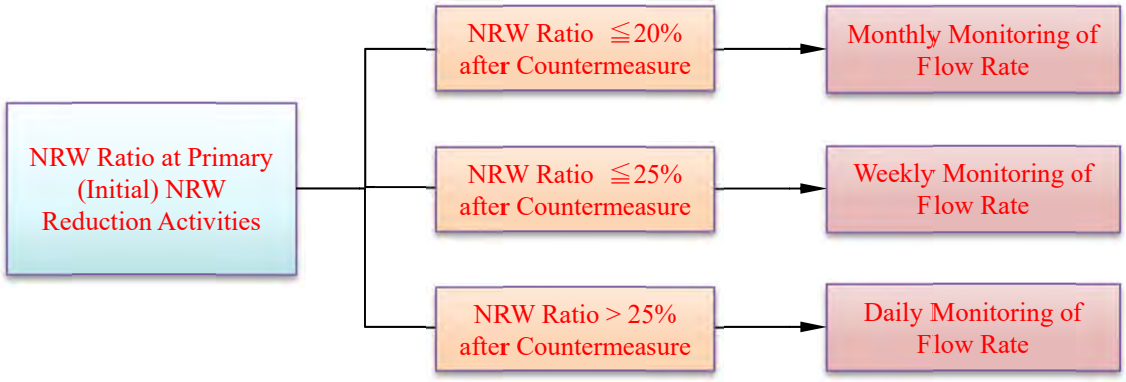
4.9.1 Outline of Activity

As mentioned above, Strategic Implementation Plan was formulated based on the results of the Pilot Project which were carried out as primary NRW reduction activities and that of monitoring and maintenance work after primary NRW reduction activities. Especially, practical information such as cost incurred for all the activities, period of the activities, feature of the areas and staffing is very useful to future plan of NRW reduction activities.

4.9.2 Result of Activity

Additional technical assistance on monitoring and maintenance work as NRW reduction activities also commenced in the beginning of March 2016, completing in the middle of June 2016. The Project updated Strategic Implementation Plan in terms of lessons through the monitoring and maintenance activities in the DMAs. Especially, work flow of the NRW reduction activities indicated in Strategic Implementation Plan was revised through examination on efficient measure of monitoring. The result of revision is shown in Figure 4.9-1. Monthly water flow monitoring is sure to be applied for all the

DMAs but weekly and daily water flow depend on a tendency of monthly IWA water balance. Strategic Implementation Plan attached in Supporting Report S4.8-1 was reviewed based on activities of monitoring and maintenance work.



Source: Project Team

Figure 4.9-1 Approach of Water Flow Monitoring

CHAPTER 5 ACTIVITIES FOR OUTPUT-2: The Procedure of NRW Reduction is established through the Pilot Areas and LCZs.

5.1 Establish the NRW Action Team in SW. (Activity 2-1)

In the beginning of the Project, the NRW Action Team was established purposely to implement the pilot project activities and improve water meter reading and billing process. As of June 2016, the NRW Action Team has a total of 22 members including one in-house consultant as key staff. The Action Team consists of Technical Sub-Team (eight members), Customer Service Sub-Team (eight members), GIS Sub-Team (two members) and Leakage Detection Sub-Team (three members). Refer to Section 2.3 for details.

5.2 Check existing Flow Meters and replace Malfunctioning Meters with New Ones at All the Water Sources. (Activity 2-2)

5.2.1 Outline of Activity

SW did not conduct IWA water balance analysis due to absence or malfunctioning bulk flow meters before commencement of this Project. To accurately measure the daily flow rate of water produced, the Project has taken the initiative to install bulk flow meters at the outlet of service reservoirs and pump stations. This will enable SW to compare with actual water produced to actual revenue water.

SW planned to have the flow rate data obtained from the bulk flow meters transferred to the main computer in SW office through 10 data loggers which were procured by JICA Solomon Islands Office.

5.2.2 Result of Activity

The Project conducted an inspection to check conditions of the service reservoirs and pump stations, and consequently, 10 bulk flow meters were recommended to be installed or replaced as shown in Table 5.2-1. All the bulk flow meters which had been donated by the budget of JET were installed until February 2015.

Table 5.2-1 Location of Bulk Flow Meters

No.	System	Location	Size (mm)
1	White River Pumping	Tasahe Tank	300
2	Titinge	Titinge Tank	200
3	Rove Gravity	Rove Pump House	200
4	Panatina	Panatina Tank	150
5	Lenggakiki Tank	Lenggakiki Ridge	100
6	White River Pumping	Skyline Tank	200
7	Mataniko SIWA	Low West Tank	200
8	Kombito Spring	Kombito Pumps	200
9	Gilbert Camp Pumping	Boarder Tank Outlet	200
10	Skyline	West Kolaa Ridge B & C and Naha Height DMA	200

Source: Project Team

5.3 Conduct training on NRW reduction for the NRW Action Team. (Activity 2-3)

5.3.1 Outline of Activity

As a result of the capacity assessment in November 2012, the JET realized that the NRW Action Team did not have adequate skill on IWA water balance analysis, Minimum Night Flow (hereinafter "MNF") measurement, step-test, leakage detection, NRW analysis, GIS utilization, hydraulic analysis, meter reading and experience of operating their equipment and so on.

Therefore, the JET conducted technical trainings for SW's counterparts mainly on isolation of areas, IWA water balance analysis, measurement of MNF, leakage detection, arrangement of customer list and database development by using GIS and network analysis in the Project so as to carry out NRW reduction efficiently.

5.3.2 Result of Activity

The technical trainings for NRW Technical and Leakage Detection Sub-Teams and GIS Sub-Team as shown in Table 5.3-1 were conducted under the Project. The trainings for Customer Service Sub-Team are shown in Chapter 7.

Table 5.3-1 Technical Trainings conducted from December 2012 to June 2016

NRW Technical and Leakage Detection Sub-Teams		GIS Sub-Team	
1) Analysis of IWA Water Balance		1) Using Global Positioning System (GPS) devices	
2) Ultrasonic Flow Meter		・Preparation of background (Raster/Vector)	
・Input data of the location of existing pipes for the flow measurement		・Precautions of observation	
・Save data to a memory card		・File format conversion (native format -> SHP)	
・ Download data to excel sheet		2) Importing GPS log files into the desktop PC and checking the imported data on software of MapInfo (GIS software)	
3) Water Pressure Logger		・File format conversion (SHP -> TAB)	
・Setup the initial conditions of logger for saving data to a memory card		・Projection setting	
・Download data to excel sheet		3) Building a point data from Excel spreadsheet	
4) Data processing		・Create a point from X and Y values	
・Draw up the graph from some data		4) Creating the GIS dataset	
5) Leakage detection		・Open the data and classify by attributes	
・Workshop		5) Formulating work flow	
・Demonstration by using test pipe		・Discussion for the information form and rules	
・Check leak sound by using listening stick at site			
・Check leak sound by using leak detector at site			
6) Hydraulic analysis			
・Water demand projection of DMAs			
・Clarification of water flowing system			
・Water demand allocation			
・Development of network model			
・Identification of PRV's location			
NRW Technical Sub-Team:	**14 sessions**	**GIS Sub-Team**	**10 sessions**
Leakage Detection Sub-Team:	**5 sessions**		

Source: JET

Note: Session does not include exams, OJT in the field and the workshop by SW itself.

5.4 Provide Assistance in the Preparation of Workflow for DMA-Based Monitoring and Maintenance for improved NRW Ratio, based on Action Criteria such as NRW Ratio and DMA's Features. (Activity 2-4)

5.4.1 Outline of Activity

In 15 pilot project areas where initial NRW reduction activities were completed by September 2014, illegal connections appeared again and leaks recovered. Therefore, it is important flexibly to monitor water flow rate and patrol in the sites periodically based on its flow rate in the 28 DMAs after completion of initial NRW reduction activities.

5.4.2 Result of Activity

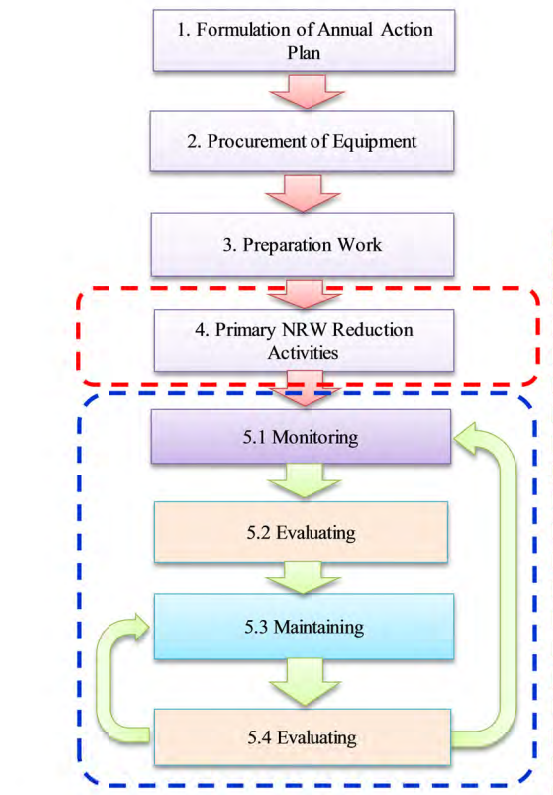
DMA-based monitoring and maintenance have been practically carried out in four DMAs, that is, Lenggakiki, Tasahe A&B, West Kola Ridge A and Tasahe C, where primary NRW reduction activities were completed. Tasahe A&B and West Kola Ridge A are the selected two DMAs under SW-JICA commitment in the Project.

Monitoring is conducted by either one manner as shown in Table 5.4-1 based on the result of NRW ratio after countermeasure in the primary NRW reduction activities. From aspect of cost and time saving, daily or weekly monitoring of water flow rate is not necessary in case of low NRW ratio, while daily & weekly monitoring is definitely necessary in case of high NRW ratio. NRW ratio should be considered so as to implement monitoring and maintenance work efficiently. Overall workflow on monitoring and maintenance work is shown in Figure 5.4-1, which is also indicated in Strategic Implementation Plan.

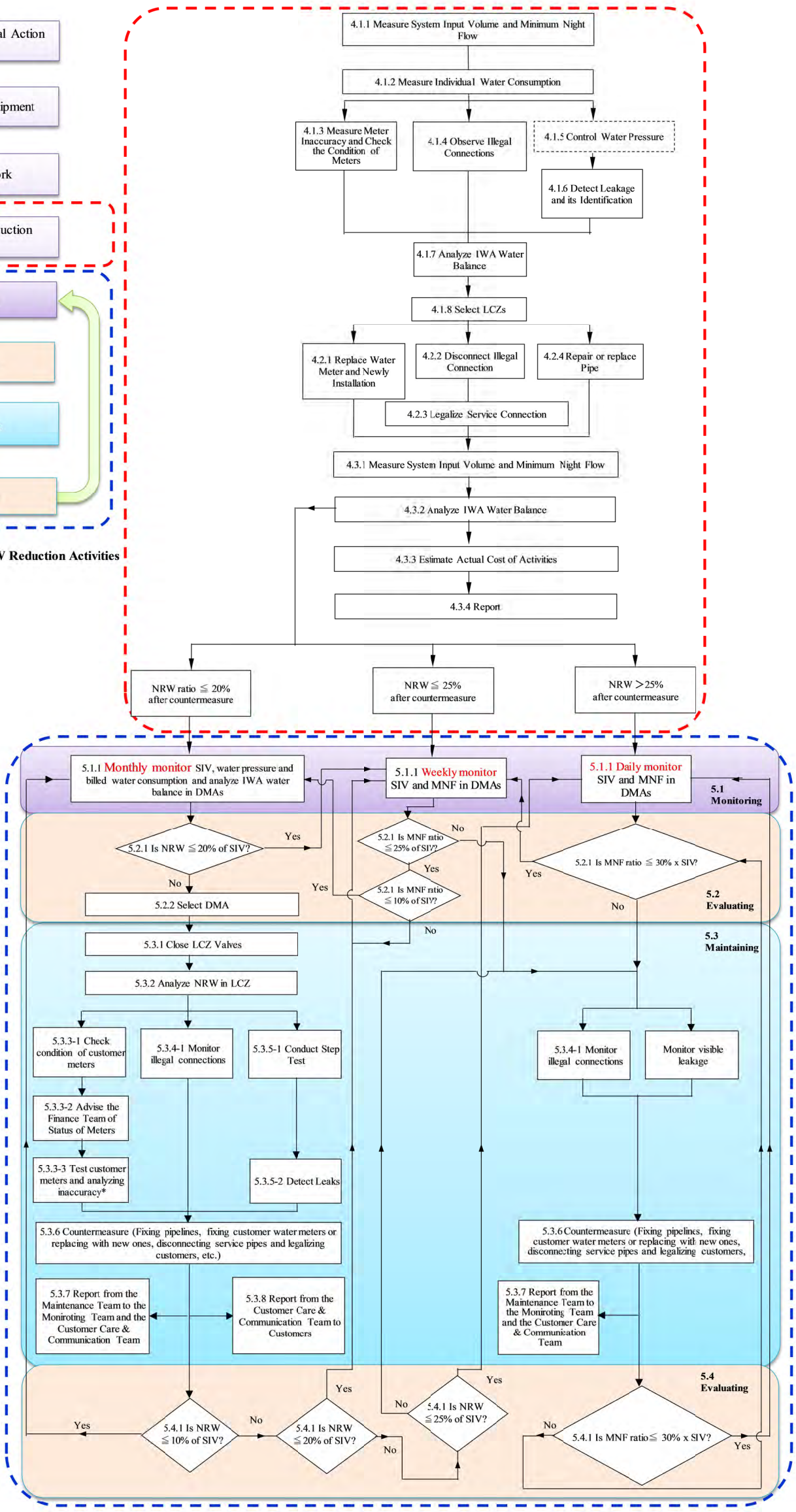
Table 5.4-1 Manners of Monitoring by NRW Ratio of Primary NRW Reduction Activity

After countermeasure in the primary NRW reduction activities		Manner of Monitoring
NRW ratio ≦ 20% (Low)	->	Monthly monitoring of water flow rate
NRW ratio ≦ 25% (Moderate)	->	Weekly monitoring of water flow rate
NRW ratio ＞25% (High)	->	Daily monitoring of water flow rate

Source: Project Team



Overview of Flow Chart of Practical NRW Reduction Activities



Detail Flow Charts of Practical NRW Reduction Activities

Note:
SIV = System Input Volume (or Distribution Volume)
: Activities only for DMAs with pressure control
: Primary NRW Reduction Activites
: Monitoring & Maintenance Work
*: Every six months for meter inaccuracy

Figure 5.4-1 Flow Charts for Practical NRW Reduction Activities

The following Figure 5.4-2 to Figure 5.4-6 show comparison of monthly monitoring results among four DMAs, and Figure 5.4-7 to Figure 5.4-14 show them in each DMA.

(1) Lenggakiki DMA

No monthly monitoring data exist before the NRW reduction activities. Since the activities at the end of 2014, NRW ratio has been monitored and maintained monthly at mostly less than 30%. A large pipe-burst occurred in October 2015 (see Figure 5.4-7 and Figure 5.4-8).

Increase in NRW ratio may happen in the future, so SW needs further attention.

(2) Tasahe A&B DMA

By the two NRW reduction activities taken in August 2015 (w/o PRV) and November 2015 (with PRV), NRW ratio was reduced. A large pipe-burst occurred in September 2015 and water scarcity in October, November and December 2015 due to water source problem of Konglai spring (see Figure 5.4-9 and Figure 5.4-10).

In spite of the activities, results of monitoring show that NRW ratio has been higher at 40% - 50%. According to SW, there is a challenge at PRV, particularly relief valve in Tasahe B. So, SW needs to repair it and take the NRW reduction measures again if necessary.

(3) West Kola Ridge A

Since monthly monitoring started before the NRW reduction activities, larger pipe bursts have occurred often in February, April and November 2015, and January and February 2016. By the NRW reduction activities in August 2015, NRW ratio was reduced but has been not stable due to the above pipe bursts. Unless pipe bursts occurs, NRW ratio seems to be less than 30% (see Figure 5.4-11 and Figure 5.4-12).

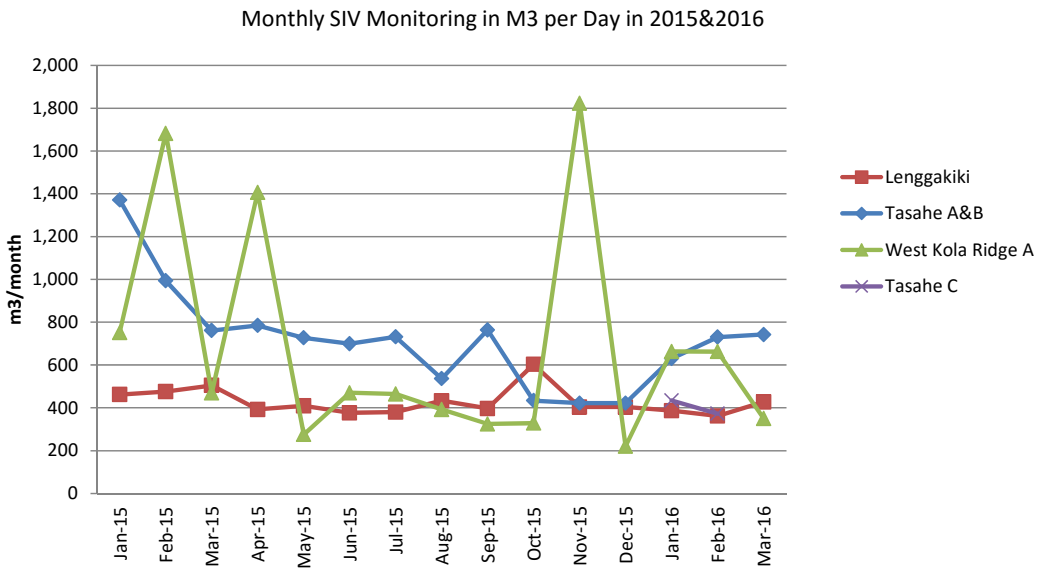
Increase in NRW ratio may happen in the future, so SW needs further attention and replacement of existing deteriorated pipelines.

(4) Tasahe C

No monthly monitoring data exist before the NRW reduction activities. After the completion of activities at the end of 2015, NRW ratio has been monitored and maintained monthly at less than 20% (see Figure 5.4-13 and Figure 5.4-14).

In the DMAs where NRW ratio is still higher than 25% as of March 2016 such as Lenggakiki and Tasahe A&B, daily monitoring of NRW ratio and active maintenance activities should be conducted.

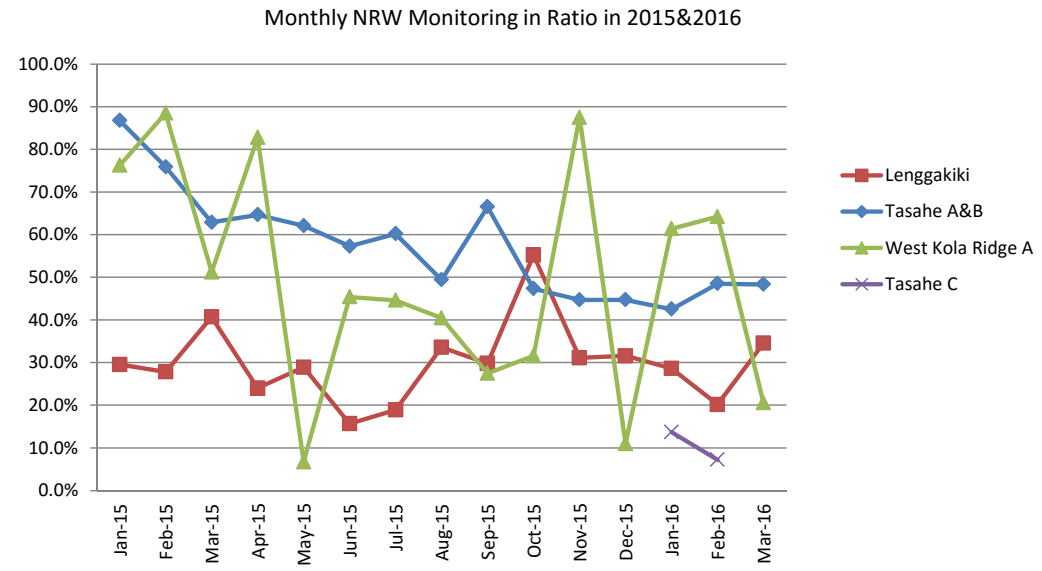
Figure 5.4-2 shows comparison of monthly monitoring results of system input volume in m^3 among four DMAs. Tasahe A&B is higher than other DMAs and West Kola Ridge A have increased sharply in some months due to pipe bursts.



Source: Project Team

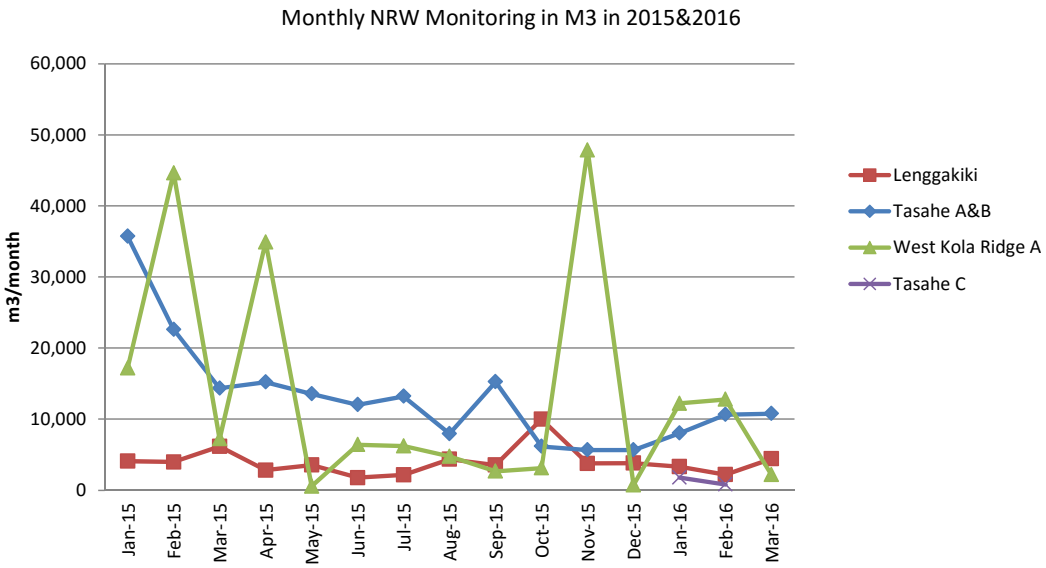
Figure 5.4-2 Monthly SIV Monitoring in M^3 per Day in 2015&2016 (Four DMAs)

Figure 5.4-3 shows comparison of monthly monitoring results of NRW in ratio (percentage) among four DMAs, while Figure 5.4-4 shows the results in m^3. Those of West Kola Ridge A have increased sharply in some months due to pipe bursts, but except those months, NRW is lower. Those of Tasahe A&B are higher than other DMAs at more than 40% because of challenge of an air relief valve.



Source: Project Team

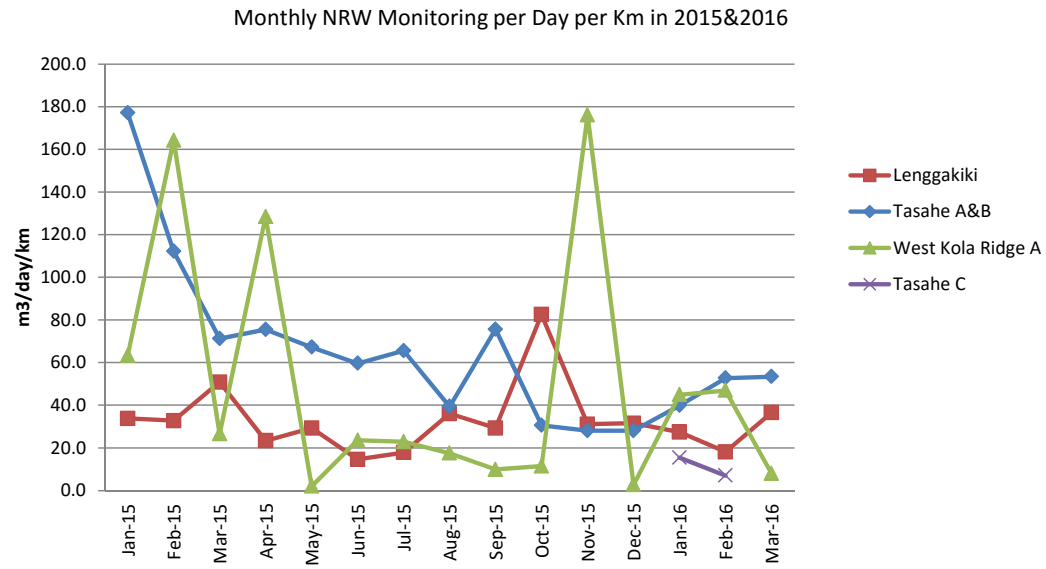
Figure 5.4-3 Monthly NRW Monitoring in Ratio in 2015&2016 (Four DMAs)



Source: Project Team

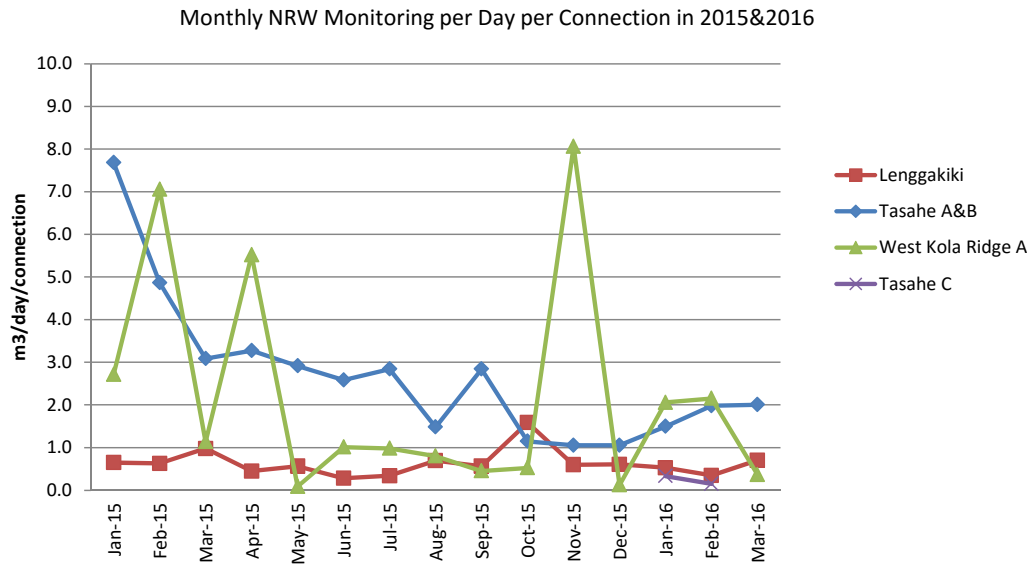
Figure 5.4-4 Monthly NRW Monitoring in M^3 in 2015&2016 (Four DMAs)

Figure 5.4-5 shows comparison of monthly monitoring results of NRW per day per kilometer of pipeline among four DMAs. Those of Tasahe A&B and Lenggakiki are relatively high. Figure 5.4-6 shows the results per day per connection in m^3. Except Tasahe A&B, those of other DMAs are less than 1.0 m^3/day/connection.



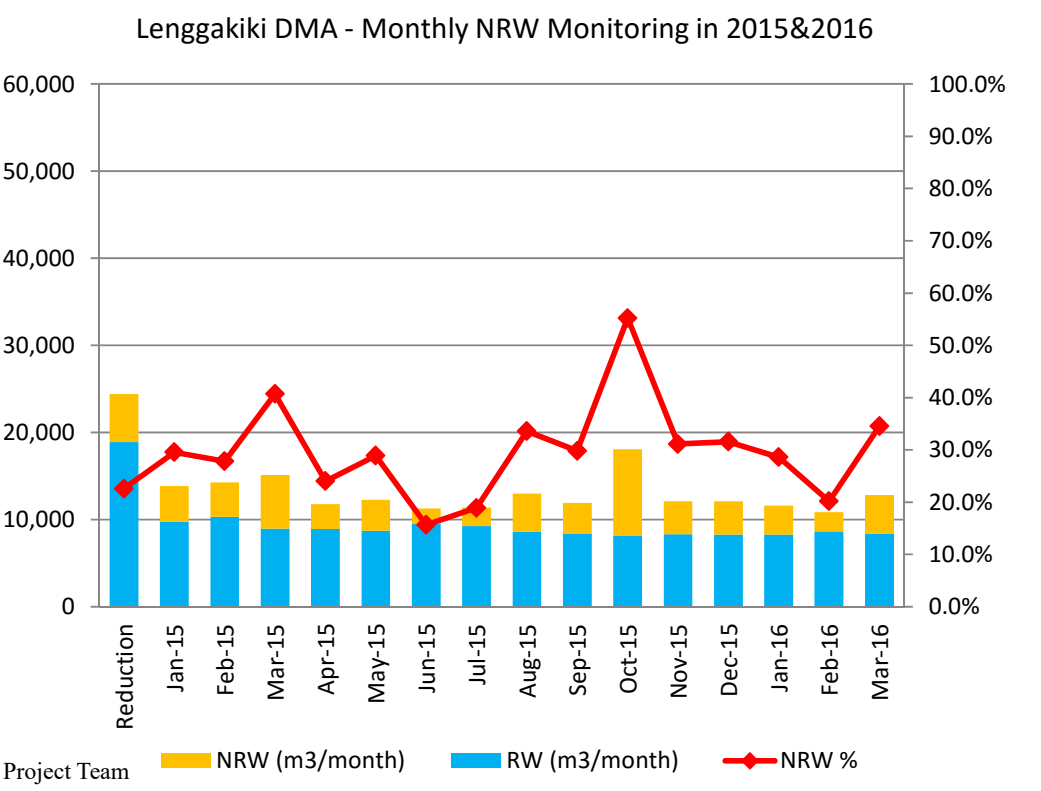
Source: Project Team

Figure 5.4-5 Monthly NRW Monitoring per Day per Km in 2015&2016 (Four DMAs)



Source: Project Team

Figure 5.4-6 Monthly NRW Monitoring per Day per Connection in 2015&2016 (Four DMAs)



Source: Project Team

Figure 5.4-7 Monthly NRW Monitoring in 2015&2016 (Lenggakiki)

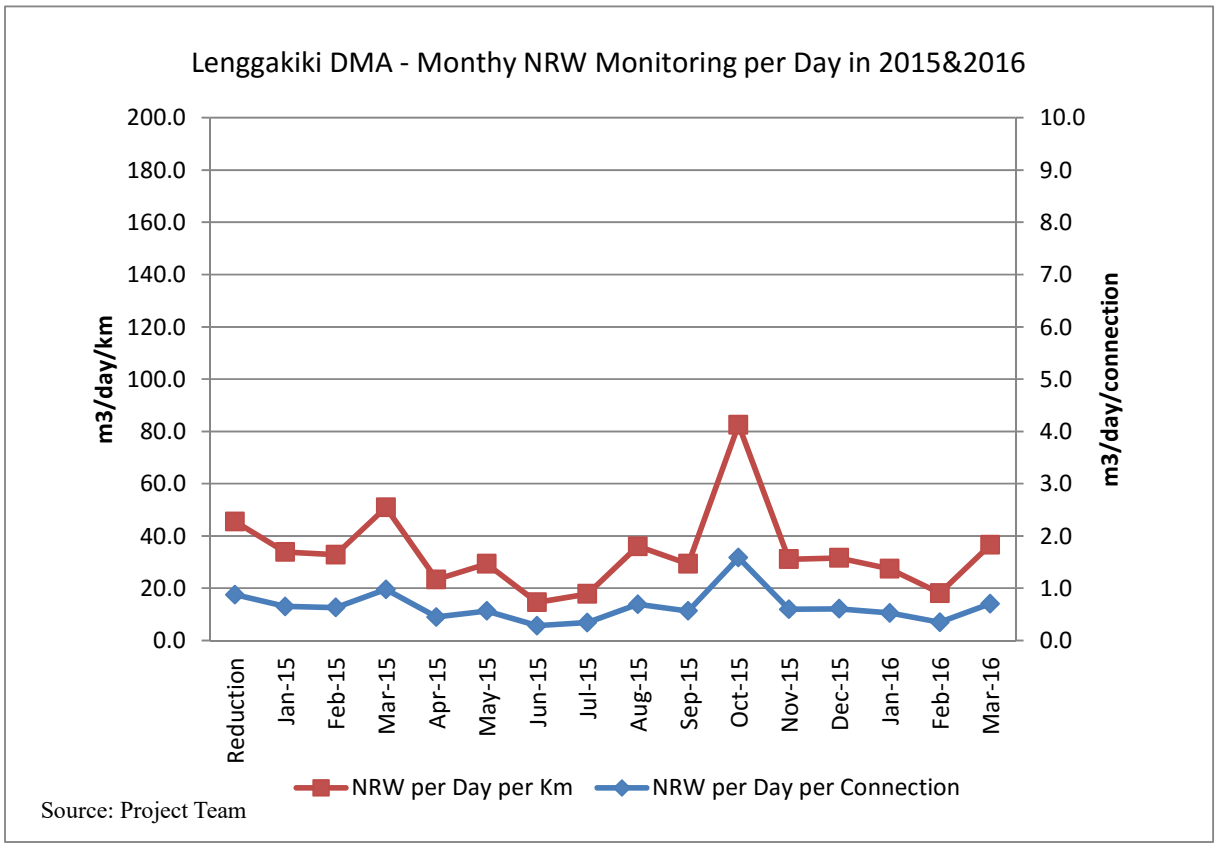


Figure 5.4-8 Monthly NRW Monitoring per Day in 2015&2016 (Lenggakiki)

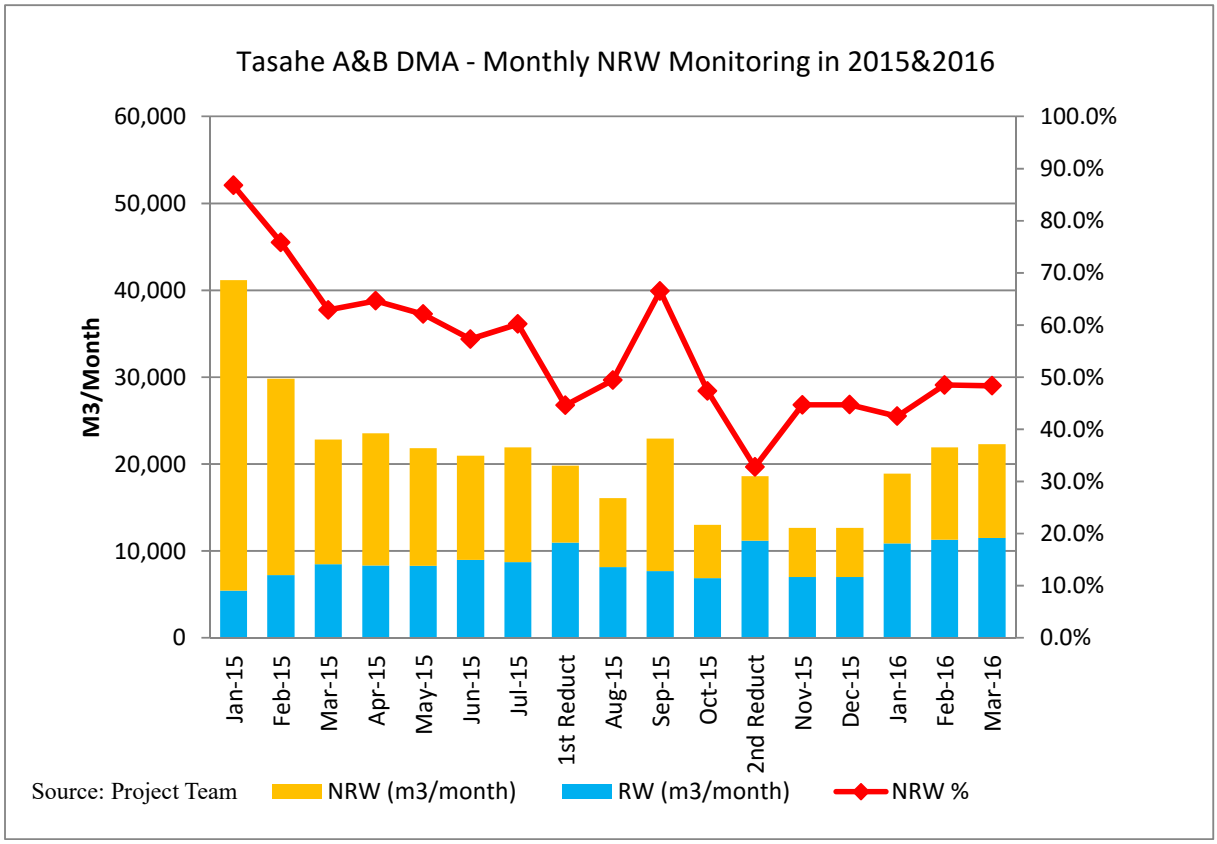


Figure 5.4-9 Monthly NRW Monitoring in 2015&2016 (Tasahe A&B)

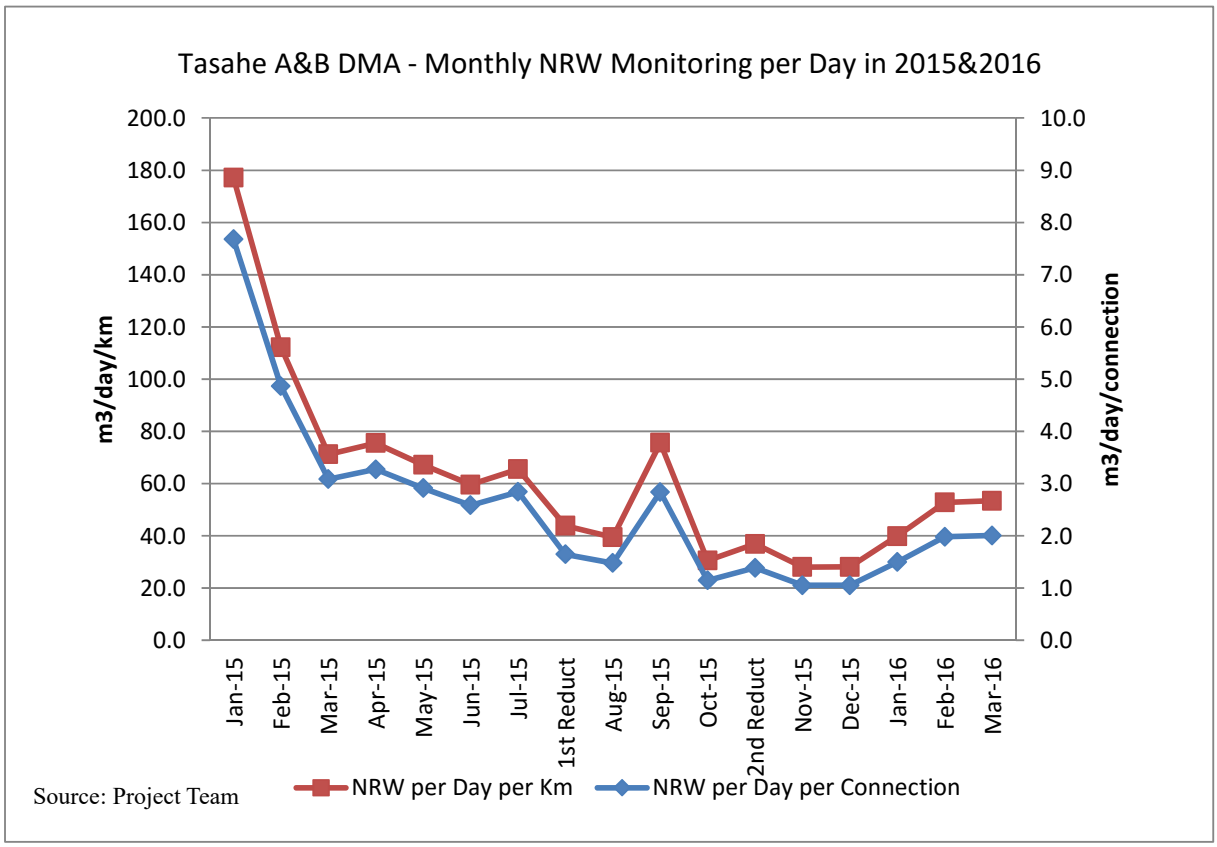


Figure 5.4-10 Monthly NRW Monitoring per Day in 2015&2016 (Tasahe A&B)

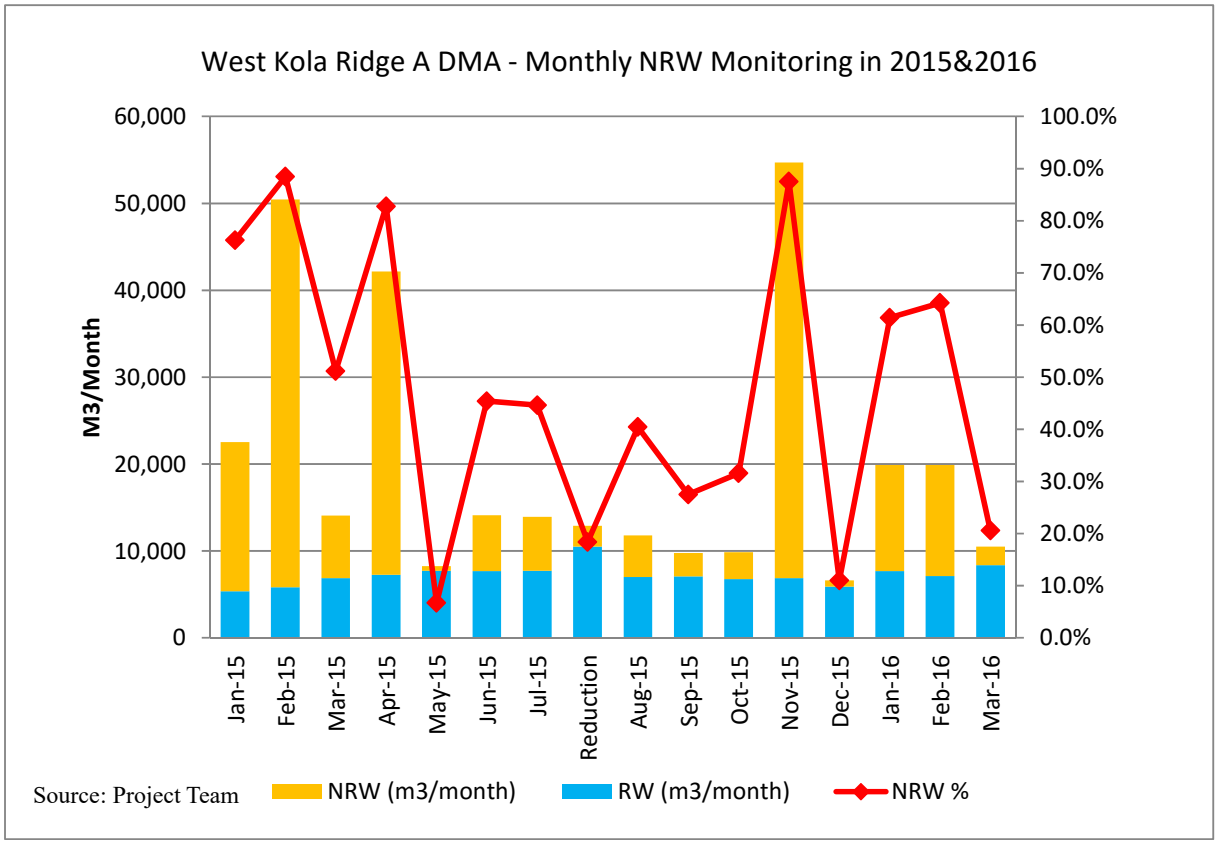


Figure 5.4-11 Monthly NRW Monitoring in 2015&2016 (West Kola Ridge A)

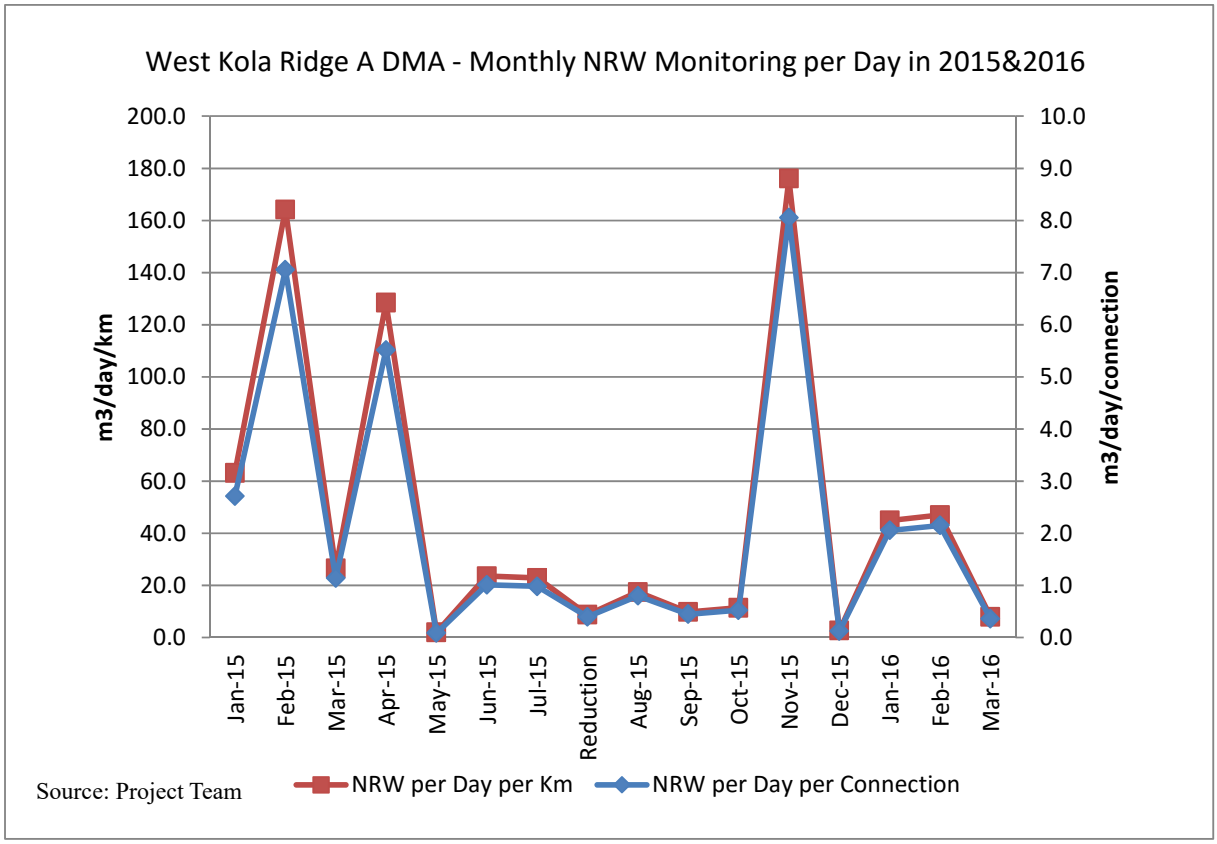


Figure 5.4-12 Monthly NRW Monitoring per Day in 2015&2016 (West Kola Ridge A)

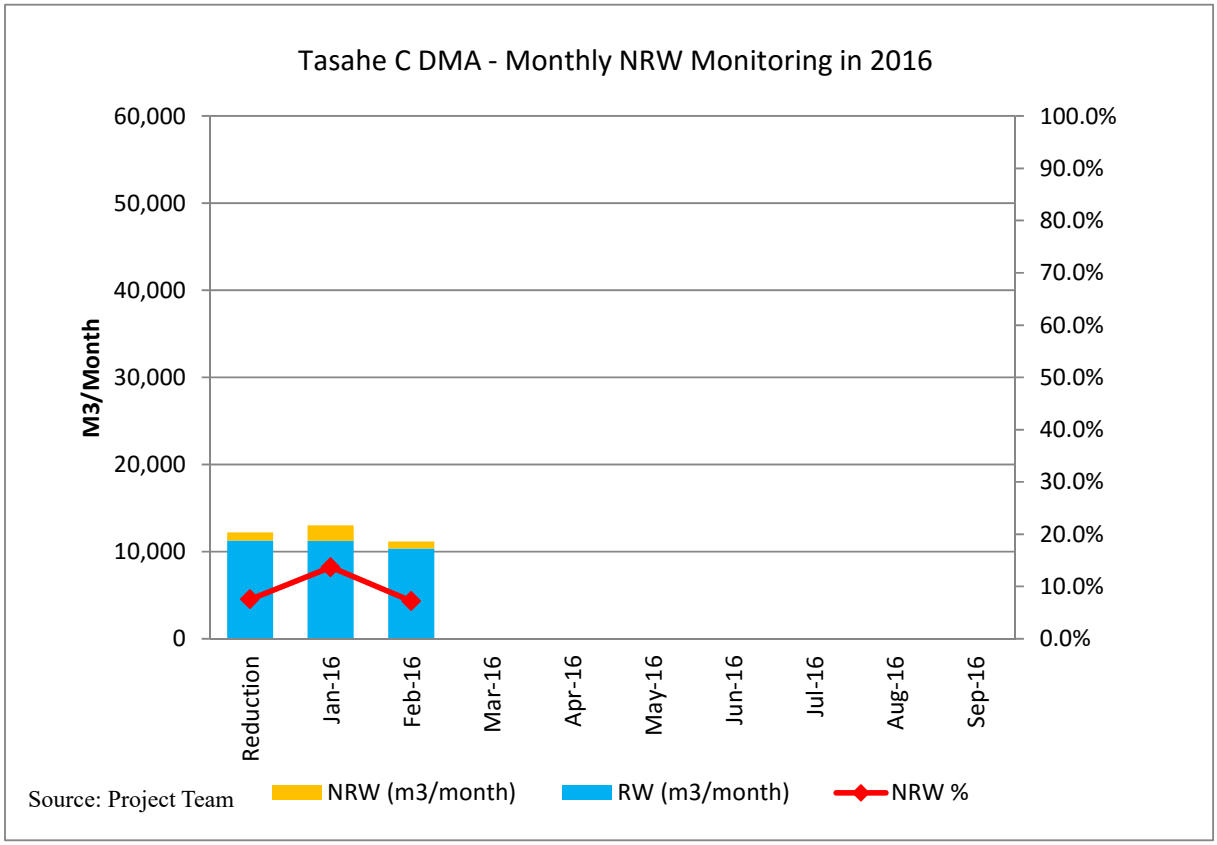


Figure 5.4-13 Monthly NRW Monitoring in 2016 (Tasahe C)

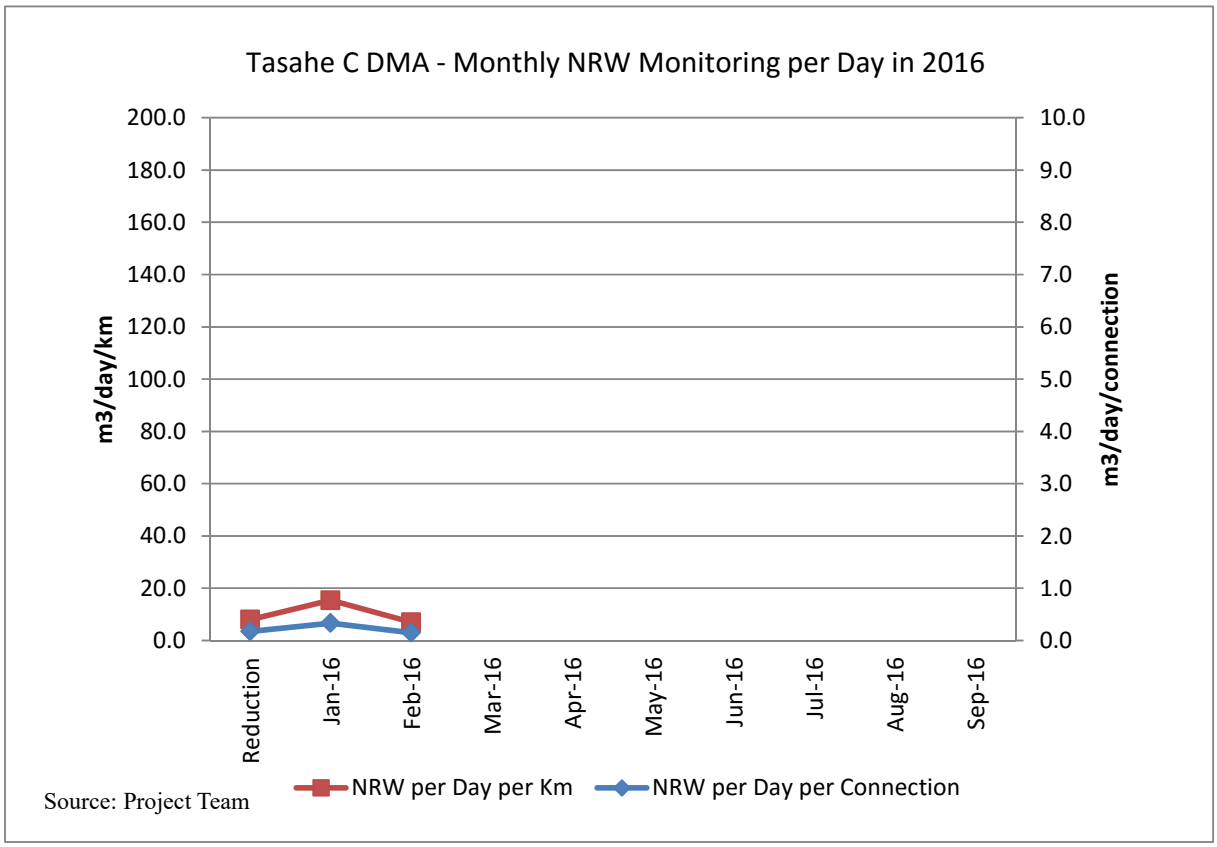


Figure 5.4-14 Monthly NRW Monitoring per Day in 2016 (Tasahe C)

5.5 Feedback the results of DMA-based NRW reduction activities, including monitoring and maintenance for improved NRW ratio, to manuals, and then provide assistance in review of the manuals as when it is necessary. (Activity 2-5)

5.5.1 Outline of Activity

Manuals on NRW reduction activities including monitoring and maintenance contain approaches to the NRW reduction and its measures which were introduced to the teams through the Project. Manuals contribute to NRW reduction activities by SW' staff even after the Project is completed. The manuals will bring back the measure of NRW reduction for SW staff.

5.5.2 Result of Activity

The manuals which are composed of Manual of NRW Reduction Measures, Handbook for Operation and Maintenance of Equipment on Leak Detection, Rule Book of Database and O&M Manual of Database were prepared. Their contents are shown in Table 5.5-1 to Table 5.5-4.

Workflow of overall NRW reduction activities such as the primary NRW reduction activities and monitoring & maintenance work was also set forth in manual. Manual is attached in Supporting Report S5.5-1 to S5.5-4.

Through DMA-based NRW monitoring and maintenance activities, items fed back to the manuals are

as follow:

- Handling and processing the collected data
- Graphing time-series variation of monitoring data such as NRW ratio
- Unifying monitoring data

Table 5.5-1 Contents of Manual of NRW Reduction Measures

1. Definition in Revenue Water and Non-Revenue Water
2. Effective NRW Reduction Method
2-1. Plan of DMA
2-2. DMA Creation and Installation of Boundary Valves
2-3. Procedure of DMA Creation
2-4. Type of Flow Measurement
2-5. Concept of NRW Reduction
2-6. Procedure of NRW Reduction
3. DMA-based NRW Monitoring and Maintenance
3-1. Overall Workflow of DMA-based Monitoring and Maintenance
3-2. Monitoring Data
3-3. Handling and Processing the collected Data
3-4. Graphing Time-Series Variation of Monitoring Data
3-5. Unifying Monitoring Data
4. Leak Detection Measures
4-1. Method of Leak Detection
5. Importance of Recording Leakage Information

Table 5.5-2 Contents of Handbook for Operation and Maintenance of Equipment on Leak Detection

1. Flow & Water Pressure Survey
1-1. Ultrasonic Flow Meter (Porta Flow-C /Fuji Electric /Japan)
1-2. Water Pressure Logger (Text log /Ash ridge Engineering /UK)
2. Leakage Detection Survey
2-1. Listening Stick (LSP-1.5 /Fuji Tecom /Japan)
2-2. Electronic Listening Stick (FSB-8D /Fuji Tecom /Japan)
2-3. Water Leak Detector (HG-10A Ⅱ /Fuji Tecom /Japan)
2-4. Leak Noise Correlator (LC-2500 /Fuji Tecom /Japan)
3. Pipe Location & Valve Survey
3-1. Metal Locator (PL-960 /Fiji Tecom /Japan)
3-2. Non-metal Pipe Locator (Tokio Rhythm Sankei /Japan)
3-3. Metal Box locator (F-90M /Fuji Tecom /Japan)
4. Maintenance
5. Maintenance Record
6. Equipment of SW
7. Contact for Repair
8. Keys of Maintenance

Table 5.5-3 Contents of Rule Book of Database [How to Update to Develop Database]

1. Introduction
2. GIS Database Operational Structure
2.1 Database Operational Structure
2.2 Member of the GIS Database Committee
3. GIS Database Management Policy
3.1 Database Composition
3.2 Database Update
3.3 Data Backup Policy
3.4 Operation Workflow

4. GIS Database Update Method
4.1 Type of Method
4.2 Update Procedure
5. Database Update Details
5.1 Target Items to be Updated
5.2 Update Procedures and Matters to be noted
5.3 Management of Update History
6. Recommendation

Table 5.5-4 Contents of O&M Manual of Database

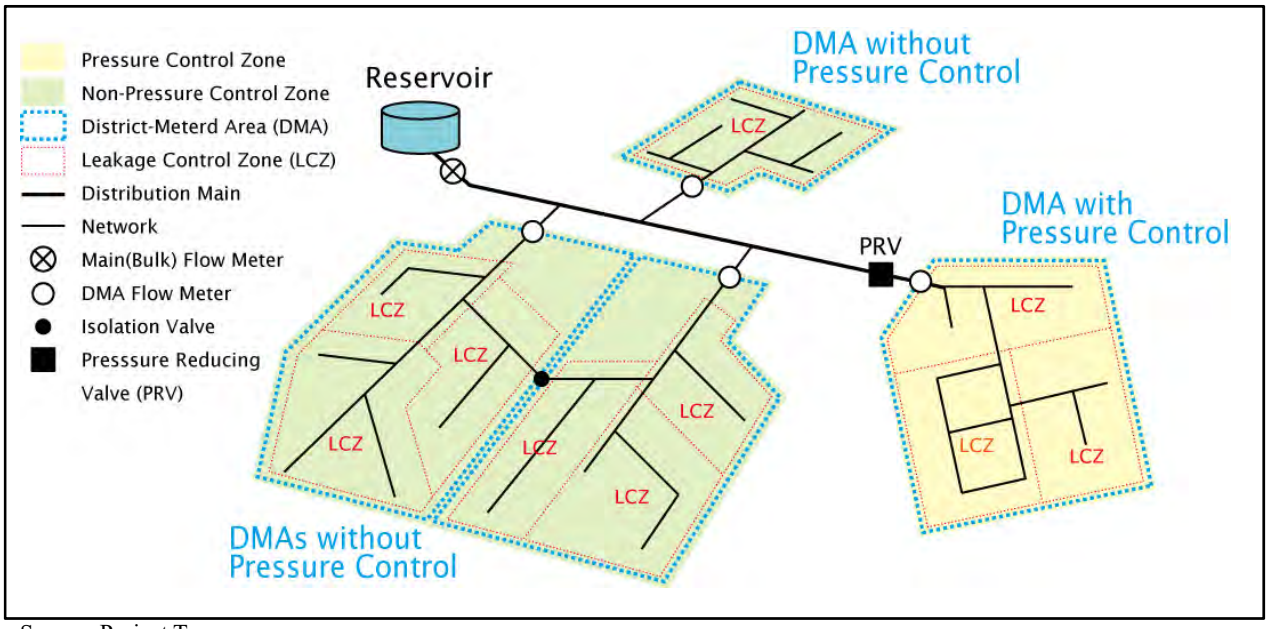
1. Outline of the Water Supply Facility Database Maintenance
1.1 Outline
1.2 Target water supply facility and information
2. GPS Measurement
2.1 Setting of GPS device
2.2 Observation of GPS signals
2.3 Survey map
2.4 Field note
3. GIS Database Management
3.1 Data file export from GPS device
3.2 Conversion of data format
3.3 Checking GIS data by Mapinfo 11.5
3.4 Editing GIS database
4. Troubleshooting
4.1 GPS devices fail
4.1.1 License
4.1.2 Function
4.2 Database relation
Appendix
Appendix-1 Specifications of GIS Database
Appendix-2 TerraSync software GETTING STARTED GUIDE
Appendix-3 MapInfo Professional® v11.5 USER GUIDE

CHAPTER 6 ACTIVITIES FOR OUTPUT-3: NRW Reduction is implemented in accordance with the Procedure in Pilot project areas and/or LCZs in the selected DMAs, and then improved NRW Ratio is monitored and maintained.

6.1 Provide assistance in the Definition and Creation of Discrete DMA's and their Boundaries. (Activity 3-1)

6.1.1 Definition of DMA

District Metered Area (DMA) is defined as a discrete area of a distribution system permanently created by isolation or the complete disconnection of pipe work in which the quantities of water inflow and outflow are metered (see Figure 6.1-1). The water flow is analyzed to quantify NRW. In this way, it is possible to determine more precisely where and when it is most beneficial to undertake NRW reduction activities.



Source: Project Team

Figure 6.1-1 Conceptual Drawing of DMA and LCZ

6.1.2 Creation of DMA

The Project supported creation of 28 DMAs in the whole of Honiara. Implementation of the NRW reduction activities are supposed to be done according to priority areas where there are serious issues of high NRW ratio among 28DMAs. SW selected Lenggakiki and Tasahe C considering appropriate scale for the staff training as well as the prioritized DMAs of Tasahe A&B and West Kola Ridge A. Table 6.1-1 shows list of DMAs.

Table 6.1-1 Overview of DMAs

No.	DMAs	Number of Beneficiaries		
		Domestic	Commercial & Institutes	Total Number of Users
1	White River A	294	1	295
2	White River B	277	12	289
3	Rove A	72	74	146
4	Rove B	12	59	71
5	Rove C	12	60	72
6	**Tasahe A&B*1**	103	0	103
7	**Tasahe C*2**	135	1	136
8	Ngossi	297	5	302
9	Mbokona	285	7	292
10	**Lenggakiki*2**	192	16	208
11	Vavaea Ridge	276	25	301
12	Skyline	172	1	173
13	Mbokonavera	311	13	324
14	Tuvaruhu	35	1	36
15	Lower West Kola A	191	104	295
16	Lower West Kola B	186	67	253
17	**West Kola Ridge A*1**	149	4	153
18	West Kola Ridge B&C and Naha Height	509	5	514
19	Tanuli and Mbua Valley	321	16	337
20	Kombibatu	216	1	217
21	Trecce House, Bura Height and Naha Valley	439	9	448
22	Kombito-Boaderline, Jakson Ridge and Bura	437	2	439
23	Kombito Trunk Main	154	2	156
24	Panatina Ridge East and Mbaranamba	296	18	314
25	Panatina Ridge West	157	2	159
26	Panatina Industrial	80	169	249
27	Burns Creek	103	21	124
28	Lungga and Airport	76	3	79
	Total	**5,787**	**698**	**6,485**

Source: Project Team

Note: Illegal households are not included in the list.

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project.

*2 DMAs in which NRW reduction activities were completed by SW as of March 2016.

6.2 Provide Assistance in the Creation of LCZ within the DMAs. (Activity 3-2)

6.2.1 Definition of LCZ

"Leakage Control Zone (LCZ)" introduced specially in SW is defined as a discrete zone of a distribution system tentatively created for implementation of countermeasures such as active leakage control against leakage (rather NRW) (see Figure 6.1-1).

6.2.2 Creation of LCZ

LCZ was created based on the following criteria.

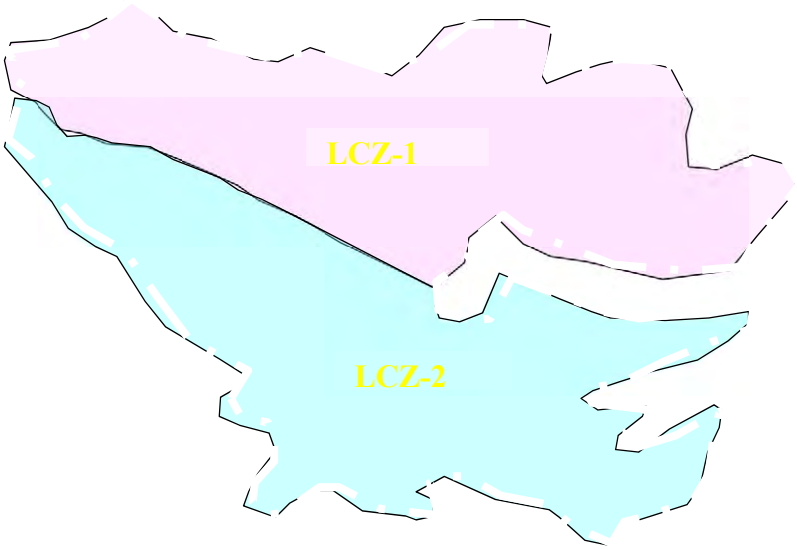
Table 6.2-1 Criteria and its Basis

Criteria	Basis of Criteria
● Number of households in a LCZ is about 100.	As some of pipelines are laid in non-public road and pipe

Criteria	Basis of Criteria
	length of service connections is very long in some places, it is efficient to find leak points and illegal users in small scale areas of about 100 households (almost equivalent to pilot Area).
● There exist the functioning valves at inlet of particular area.	SW has to consider saving expenses for equipment as much as possible.

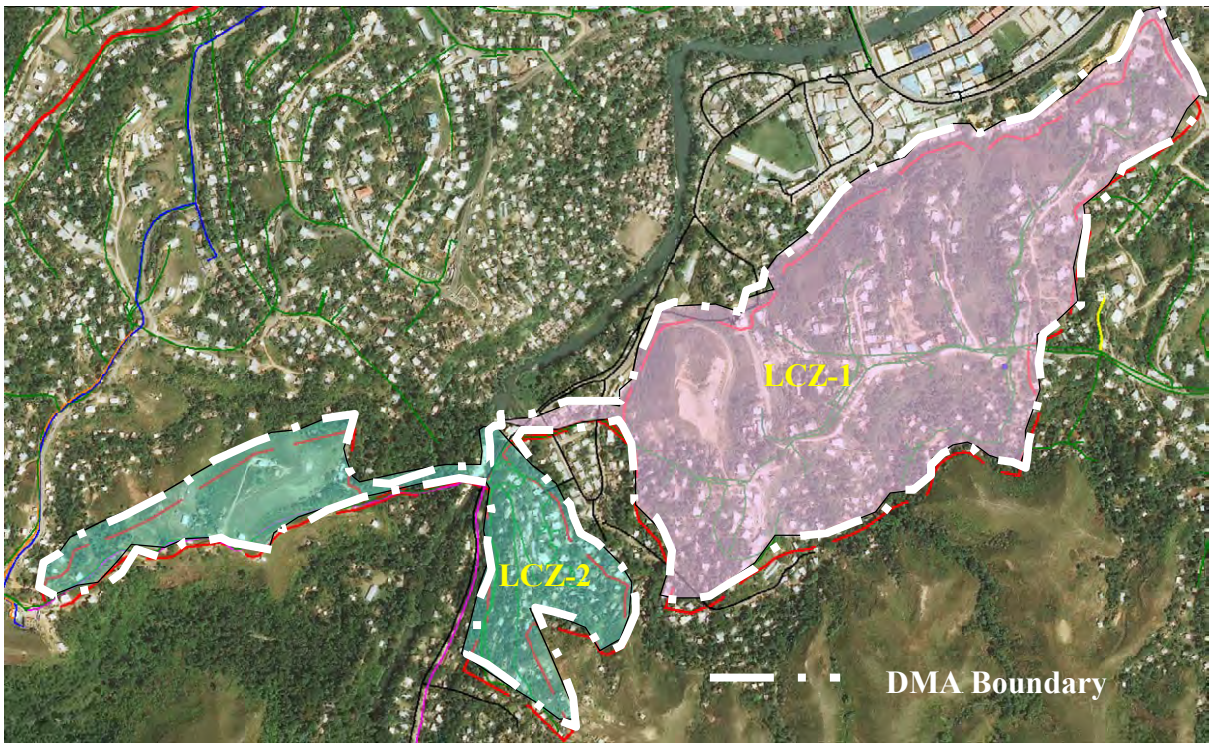
Source: Project Team

Figure 6.2-1 and Figure 6.2-2 show LCZs in Tasahe A&B and West Kola Ridge A.



Source: Project Team

Figure 6.2-1 LCZ in DMA: Tasahe A&B



Source: Project Team

Figure 6.2-2 LCZ in DMA: West Kola Ridge A

6.3 Update existing Water Distribution Network Drawings by using GIS in the Pilot Project Areas and DMAs. (Activity 3-3)

6.3.1 Outline of Activity

In order to operate and maintain the water supply facilities appropriately, the Project proposed the need to frequently update the database of the water supply facilities and the use of the database in all the office of SW. Database must be updated according to current and actual situation of water supply facilities. Otherwise, it is too difficult for SW to find out pipelines to be repaired located underground in terms of leak detection.

6.3.2 Result of Activity

GIS Sub-Team collected location data of water distribution facilities using GPS in 15 pilot project areas, as well as three DMAs, namely Lenggakiki, Tasahe A&B and West Kola Ridge A. The following activities were carried out by GIS Sub-Team in cooperation with the JET as part of their basic trainings for GIS and data management of water distribution network.

(1) Data Collection using GPS in the Pilot Project Areas and DMAs

GIS Sub-Team completed data collection in 15 pilot project areas and three DMAs by the end of March 2015. Location of the existing meters, valves, leakage points, etc. were measured with GPS in each pilot project area and DMA.

(2) Current Situation of Various Data and its Update

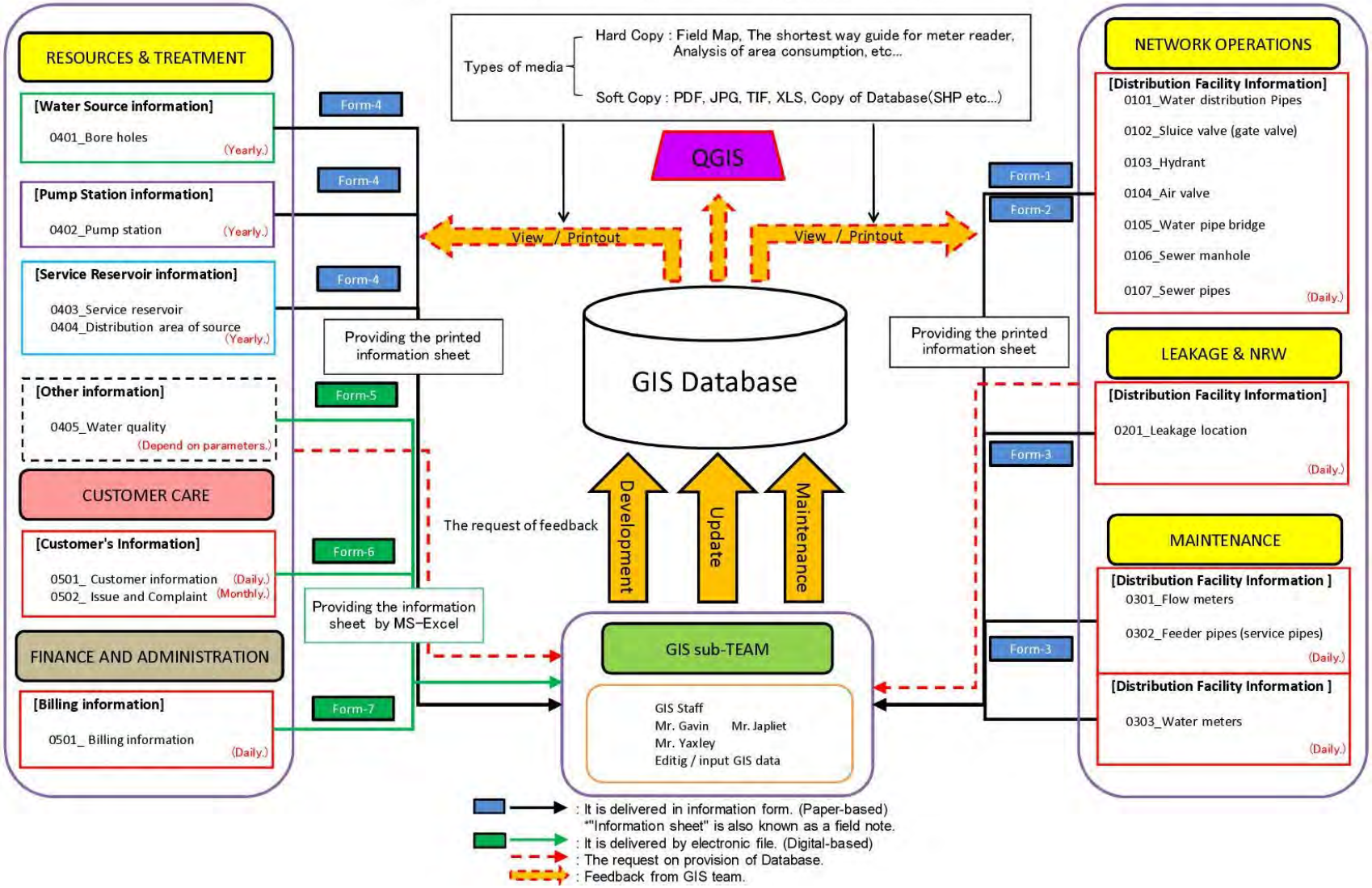
GIS Sub-Team will have been updating Honiara town-wide data of all the water distribution facilities and customer's status (active or disconnected).

Updated items of the database in 15 pilot project areas and three DMAs as of September 2015 are shown in Supporting Report S6.3-1. The maps of the updated results in each pilot project area and DMAs are shown in Supporting Report S6.3-2.

(3) Workflow of Database Development

The Rule Book of Database for updating GIS database, including procedure and database workflow was completed at the end of April 2016. Workflow which is significant for developing database and utilizing it is shown in Figure 6.3-1.

The workflow for database development and data



Source: Project Team

Figure 6.3-1 Workflow to develop and update Database

6.4 Install Necessary Valves for isolation of the Pilot Project Areas and DMAs, install Flow Meters, and Measure the NRW Ratio before Implementation of the Pilot Project. (Activity 3-4)

6.4.1 Outline of Activity

NRW ratio is calculated as the balance between the System Input Volume (hereinafter "SIV") and revenue water (billed water) in the Pilot Project area after being isolated from other service areas. In the Projects, valves are used to isolate pilot project areas including DMAs in order to appropriately measure water flow rate and the NRW ratio of particular pilot project areas. The main activities before countermeasure of NRW are shown in Table 6.4-1.

Table 6.4-1 Main Activities and their Objectives

Main Activities	Objective
● **Isolation for the Pilot Project Areas and DMAs**	
➢ Selecting the Pilot Project area and the two DMAs	Identification of the Pilot Project areas
➢ Installing new valves to isolate the areas and replacing malfunctioning valves with new ones	Creation of the Pilot Project areas, DMAs and LCZs
● **Measurement of Water Flow and Water Pressure**	
➢ Surveying the current condition of customer meters	Examination of water meter installation and/or replacement to measure individual water consumption
➢ Measuring MNF and water pressure	Measurement of the system input volume and assumption of the amount of leakage
➢ Measuring water consumption of each customer	Measurement of revenue water and identification of NRW

Source: Project Team

6.4.2 Result of Activity

(1) Isolation for Pilot Project Areas and the DMAs

NRW Action Team checked the functionality of existing valves to isolate 15 pilot project areas and four DMAs. Malfunctioning valves were replaced with new ones. Leakage Detection Sub-Team was called in to assist in detecting buried valves using metal locator and at the same time checking to ensure their functionality. Pipe positions were located using non-metal pipe locator prior to excavation works.

Valve conditions were recorded in the Valve Record Sheet containing diameter, types of valves, number of rotation, depth of valve position, location, existence of a valve box and cover.

(2) Measurement of Water Flow and Water Pressure

Prior to performing countermeasure activities against NRW in 15 pilot project areas and four DMAs, NRW Action Team measured the SIV and water pressure for 24 hours in order to find MNF. At the

same time, water consumption was measured at each customer to analyze balance between SIV and total water consumption in each pilot project area or DMA, that is, NRW. The results of the measured water consumption for about 24 hours and conceptual data of MNF, etc. are shown in Supporting Report S6.4-1.

The summary data for the SIV, MNF and water pressure are shown in Table 6.4-2 and Table 6-4.3.

Table 6.4-2 System Input Volume and MNF in 15 Pilot Project Areas

No.	Area No.	Pilot Project Area	Length of Distribution Pipe (m)	No. of House	System Input Volume (SIV)		MNF (m^3/hr.)	Water Pressure (MPa)
					(m^3/day)	(m^3/hr.)		
1	No.9	White River –Namo Ruka	1,063	83	4-5/03/2013			
					346.73	14.45	15.54	0.22
2	No.10	Independence Valley	2,184	91	19-20/03/2013			
					159.73	6.66	4.39	0.22
3	No.3	Lenggakiki (1st Implementation)	2,481	161	2-3/07/2013			
					591.46	24.64	18.18	0.25
		Lenggakiki (2nd Implementation)			1-209/2014			
					353.5	14.73	8.78	0.27
4	No.5	Mbokonavera	1,104	76	7-8/08/2013			
					178.67	7.44	5.81	0.49
5	No.14	Tuvaruhu-1 (1st Implementation)	1,206	48	10-11/09/2013			
					105.82	4.41	1.97	0.20
		Tuvaruhu-1 (2nd Implementation)			23-24/06/2014			
					46.98	1.96	0.36	0.39
6	No.15	Tuvaruhu-2	1,371	62	09-10/2013			
					113.86	4.74	1.90	0.21
7	No.6	Vavaea Ridge	1,298	163	30/09-1/10/2013			
					502.35	20.93	20.17	0.28
8	No.4	Mbokona	1,419	110	17/10-18/10/2013			
					124.10	5.17	3.33	0.83
9	No.8	Mbaranamba	1,512	100	25/11-26/11/2013			
					159.40	6.64	3.20	0.40
10	No.2	Mbua Valley	1,990	122	26-2702/2014			
					297.5	12.40	5.86	0.43
11	No.11	Bahai Kukum	1,692	182	27-28/03/2014			
					326.6	13.61	11.80	0.09
12	No.7	Panatina Valley	885	60	23-24/06/2014			
					93.40	3.89	3.11	0.19
13	No.12	Naha 2	786	57	20-21/06/2014			
					96.93	4.04	2.55	0.28
14	No.13	Naha 3	960	67	3-4/07/2014			
					137.30	5.72	3.80	0.28
15	No.1	FFA Kola Road	2,276	82	21-22/07/2014			
					215.00	8.96	5.00	0.25

Source: Project Team

Note: Water pressure gauge was set on the pipes which an ultra-sonic flow meter was equipped with. Therefore, water pressure is less than that in service area theoretically.

Table 6.4-3 System Input Volume and MNF in DMAs

No.	Area No.	DMA	Length of Distribution Pipe (m)	No. of House	System Input Volume		MNF (m^3/hr.)	Water Pressure (MPa)
					(m^3/day)	(m^3/hr.)		
1	No.10	Lenggakiki	4,035	215	28-29/09/2014		-	
					778.90	32.45	22.78	0.25
2	No.6	Tasahe A&B*1	6,719	202	8-9/12/2014		-	
					1,706.00	71.08	70.21	0.18
3	No.17	West Kola Ridge A*1	9,060	225	10-11/02/2015		-	
					647.85	26.99	36.86	0.45
4	No.7	Tasahe C	3,859	187	28-29/09/2015		-	
					475.70	19.82	14.96	0.58

Source: Project Team

Note: Water pressure gauge was set on the pipes which an ultra-sonic flow meter was equipped with. Therefore, water pressure is less than that in service area theoretically.

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

Most usually volume of leakage on the pilot project areas and DMAs can be assumed based on MNF and water pressure at MNF.

It is noticeable point that there are customers who have water continuously running for 24 hours from end of pipes without faucets while only paying water tariff on a flat rate charge. The excessive water consumption more than the monthly 32m^3 per household is one of the NRW factor. The NRW Action Team would normally measure the excess volume with a measuring cup.

(3) Leakage Detection

Leakage Detection Sub-Team performed leakage detection survey using leakage detection equipment in 15 pilot project areas and four DMAs after measurements of the MNF. The Sub-Team built upon their skills and experiences in leakage detection by carrying out continuous measurements using the leakage detection equipment. It is obvious that the Sub-Team has been able to detect leakage more easily compared to the time when the project was newly started at the beginning of 2013.

1) Step test

Since the actual location of pipes in Honiara was not clear in the field, it was very difficult to identify leakage points on the pipelines. Therefore, leaked pipelines can be identified gradually based on water flow rate in each route through the step test. After the possible leakage routes are assumed by this test, the exact leak points will be identified using leak detection survey.

The step test was performed by measuring the rate of water flowing in each pipeline between junctions and or junction and the end of pipeline by closing the series of step valves one by one in principle when each valve was closed successively, in a perfect pipe condition, the flow should decrease accordingly. However, if water flow rate in the pipeline in which the step valve is closed does not change, leaks are suspected.

NRW Action Team recorded the number of the closed valves, operating time, and the change of flow

rate of pilot project areas and DMAs in the Step Test Record Sheet. Data of water flow and water pressure was automatically recorded by the ultrasonic flow meter and water pressure logger. The results of the step test are shown in Supporting Report S6.4-2.

2) Surface Leakage and Acoustic Survey

NRW Action Team investigated the entity of surface leakage and underground leakage through the use of acoustic in the pilot project areas and DMAs. The Team sometimes used residual chlorine tester whether water that comes out from underground, is from SW system or other natural sources (see Figure 6.4-1). At the same time, NRW Action Team checked for leakage sounds at customer meters, valves and fire-hydrants using listening stick. The result of survey indicated that, most of the leaks were found on the service pipes (see Figure 6.4-2).

NRW Action Team recorded leakage information including pipe material, size, leakage location, leakage condition and the causes of the leak of pilot project areas and DMAs in the Leakage Record Sheet (see Supporting Report S6.4-3).

Figure 6.4-1 Surface Water measured by using Rresidual Chlorine Tester

Figure 6.4-2 Leak sound checked by using Listening Stick

3) Pinpointing Survey

NRW Action Team also carried out actual leak point survey in pilot project areas and DMAs by water leakage detector. This normally takes place late in the night or past mid-night. Since most of the pipelines in pilot project areas and DMAs are buried by the road side or within vegetated areas or bush, it is difficult to detect the leakage points from the ground surface. In this case the NRW Action Team would use a leak noise correlator to narrow down on the actual leak points on the pipe (see Figure 6.4-3).

Underground leakage positions are usually confirmed using a hammer-drill or a boring bar to get close enough to the underground pipe and use a listening stick through the narrow cavity to get a clearer sound of the leaks (see Figure 6.4-4).

Figure 6.4-3 Identifying Leak Points by a Leak Noise Correlator

Figure 6.4-4 Hammer-drill or a Boring Bar

6.5 Identify the Causes of NRW (Water Leakage, Illegal Connections and Meter-related Losses) in the Pilot Project Areas and DMAs through the OJT. (Activity 3-5)

6.5.1 Outline of Activity

Identification of causes of NRW is of extreme importance through pilot projects to review approaches to reduce NRW. NRW Action Team has studied common causes of NRW in pilot projects and pointed out main causes including; leakage, illegal use, water meter inaccuracy and others.

6.5.2 Result of Activity

The components of NRW in 15 pilot project areas and four DMAs include real loss like leakage, illegal connection, meter inaccuracy and unbilled authorized loss as shown in Table 6.5-1 and Table 6.5-2 respectively. Real loss in both pilot project areas and DMAs makes up each about 76.9% and 88.6% of SIV.

In DMA Tasahe A&B, visible leakage always occurs frequently since this area is a high pressure area. Therefore, SW required a PRV to be installed in that area to maintain optimal water pressure in order to avoid leakage.

Table 6.5-1 Composition of NRW before Countermeasures in Pilot Project Areas

No.	Area No.	Pilot Project Area	Unbilled Authorized*1 (%)	Illegal (%)	Meter Inaccuracy (%)	Real Loss like Leakage, etc. (%)	NRW Ratio before Countermeasure (%)
1	No.9	Namo Ruka	13.80	22.30	1.10	49.20	86.50
2	No.10	Independence Valley	31.40	7.60	3.00	15.70	57.70
3	No.3	Lenggakiki (1st)	0.00	6.30	3.60	52.10	62.00
4	No.5	Mbokonavera-1	0.00	1.20	1.90	50.10	53.10
5	No.14	Tuvaruhu-1 (1st)	0.00	6.00	0.00	59.40	65.40
6	No.15	Tuvaruhu-2	3.90	10.20	0.20	52.80	67.20
7	No.6	Vavaea Ridge	0.00	0.00	2.40	60.70	63.10
8	No.4	Mbokona	0.00	3.60	2.00	44.70	50.20
9	No.8	Mbaranamba	0.00	1.30	0.50	21.30	23.20

No.	Area No.	Pilot Project Area	Unbilled Authorized*1 (%)	Illegal (%)	Meter Inaccuracy (%)	Real Loss like Leakage, etc. (%)	NRW Ratio before Countermeasure (%)
10	No.2	Mbua Valley	0.00	4.60	6.50	39.70	50.90
11	No.11	Bahai Kukum	0.00	4.50	11.40	42.70	58.60
12	No.7	Panatina Valley	0.00	0.00	13.20	24.80	37.90
13	No.12	Naha 2	0.00	2.20	7.00	42.50	51.70
14	No.13	Naha 3	0.00	7.70	11.10	42.10	60.90
15	No.1	FFA Kola Road	0.00	0.00	2.60	44.50	47.10
Average			**3.27**	**5.17**	**4.43**	**42.82**	**55.70**
Rate of Composition in NRW (%)			**5.8**	**9.3**	**8.0**	**76.9**	**100**

Source: Project Team
Note: NRW Ratio before Countermeasure is not necessarily the same as a sum of unbilled authorized, illegal meter inaccuracy and real loss due to fractional figure.
*1 Excessive water more than assumed water of ($32m^3$/month/household) in flat rate

Table 6.5-2 Composition of NRW before Countermeasures in DMAs

No.	DMA No.	DMA	Unbilled Authorized (%)	Illegal (%)	Meter Inaccuracy (%)	Real Loss like Leakage, etc. (%)	NRW Ratio before Countermeasure (%)
1	No.10	Lenggakiki	0.0	0.0	7.6	35.0	42.6
2	No.6	Tasahe A&B*1	0.0	1.1	1.7	83.1	85.8
3	No.17	West Kola Ridge A*1	0.0	0.2	4.7	55.5	60.4
4	No.7	Tasahe C	0.0	6.5	0.0+	31.6	38.1
Average			**0.0**	**2.0**	**4.7**	**51.3**	**56.7**
Rate of Composition in NRW (%)			**0.0**	**3.4**	**8.1**	**88.6**	**100**

Source: Project Team
Note: NRW Ratio before Countermeasure is not necessarily the same as a sum of unbilled authorized, illegal meter inaccuracy and real loss due to fractional figure.
*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

(1) Illegal Use

NRW Action Team checked all service pipelines within 15 pilot project areas and four DMAs, and identified illegal users and conditions of water meters. Water meter conditions and illegal connections were surveyed based on the customer list for 15 pilot project areas and four DMAs only.

Illegal users were identified comparing with the customer list obtained from billing system. The Team also came across instances where there were water still flowing when the stop valves of the actual service had been closed. This indicates that the users have the bypassed service pipe before the stop valves and water meters.

Some households who obtained water from paying registered customer were found within 15 pilot project areas. The problem was that the registered customers were imposed with flat rate charges. The some households are considered as parasite customers. This is one form of illegal connections which have contributed to the high NRW. NRW Action Team has disconnected illegal connections upon finding them though the NRW activity.

Condition of service connections in 15 pilot project areas and four DMAs is shown in Table 6.5-3 and Table 6.5-4 respectively.

Table 6.5-3 Breakdowns of Service Connections in 15 Pilot Project Areas

No.	Area No.	Pilot Project Area	RW		NRW						
			A) Registered Customer (Metered-Rate)	B) Registered Customer (Flat-Rate / Direct Line)	C) Registered Customer (Flat-Rate / Direct Line) Open-End /Excess Use	D) Unregistered Users, Direct Open-End	E)Unregistered Users, Direct Closed-End	F)Unregistered Users, Indirect / Parasite dependent on Register Customer (Flat-Rate)	I)Unconnected House	J) Total	K) Percentage of Illegal Use (%) (D)+E)+F)) /(J)-I))
1	No.9	White River - Namo Ruka	13	31	(5)	4	13	11	11	83	38.9
2	No.10	Independence Valley	35	33	(5)	1	1	5	16	91	9.3
3	No.3	Lenggakiki	93	22	(0)	0	6	29	11	161	23.3
4	No.5	Mbokonavera	34	30	(0)	0	2	0	10	76	3.0
5	No.14	Tuvaruhu-1*	18	20	(0)	0	6	0	4	48	13.6
6	No.15	Tuvaruhu-2	19	22	(1)	0	11	0	10	62	21.2
7	No.6	Vavaea Ridge	57	37	(0)	0	0	0	69	163	0.0
8	No.4	Mbokona	45	43	(0)	0	10	0	12	110	10.2
9	No.8	Mbaranamba	69	9	(0)	0	2	0	20	100	2.5
10	No.2	Mbua Valley	67	26	(0)	0	13	0	16	122	12.3
11	No.11	Bahai Kukum	61	54	(0)	0	14	0	53	182	10.9
12	No.7	Panatina Valley	36	15	(0)	0	0	0	9	60	0.0
13	No.12	Naha 2	36	6	(0)	0	2	0	13	57	4.5
14	No.13	Naha 3	48	7	(0)	0	10	0	2	67	15.4
15	No.1	FFA Kola Road	53	17	(0)	0	0	0	12	82	0.0
Total			**684**	**372**	**(11)**	**5**	**90**	**45**	**268**	**1,464**	**10.3**

Source: Project Team

Note: - 'C)' is included 'B)'.

- Alphabets such as A), B), etc. are interfaced with that shown in IWA Water Balance Sheet.

* Data measured in the 1st Implementation

Table 6.5-4 Breakdowns of Service Connections in DMAs

No.	Area No.	Pilot Project Area	RW		NRW						
			A) Registered Customer (Metered-Rate)	B) Registered Customer (Flat-Rate / Direct Line)	C) Registered Customer (Flat-Rate / Direct Line) Open-End /Excess Use	D) Unregistered Users, Direct Open-End	E)Unregistered Users, Direct Closed-End	F)Unregistered Users, Indirect / Parasite dependent on Register Customer (Flat-Rate)	I)Unconnected House	J) Total	K) Percentage of Illegal Use (%) (D)+E)+F)) /(J)-I))
1	No.10	Lenggakiki	204	6	(0)	0	0	0	5	215	0.0
2	No.6	Tasahe A&B*1	112	43	(0)	0	17	0	30	202	9.9
3	No.17	West Kola Ridge A*1	178	33	(0)	0	1	0	13	225	0.5
4	No.7	Tasahe C	140	9	(0)	0	29	0	9	187	16.3
Total			**634**	**91**	**(0)**	**0**	**47**	**0**	**57**	**829**	**5.7**

Source: Project Team

Note: - '3)' is not counted in Total, because of numbers out of '2)'.

- Alphabets such as A), B), etc. are interfaced with that shown in IWA Water Balance Sheet.

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

According to the field survey, about 10.3% of the total household in 15 pilot project areas were found to be using water or connected illegally, while about 5.7% in the four DMAs. Illegal households make up about 39% in White River - Namo Ruka, whereas in the rest of the pilot project areas, illegal households make up between 0.0 to 23.3%.

(2) Water Meter Inaccuracy

NRW Action Team also performed meter inaccuracy tests on all metered customers in the pilot project areas and DMAs. A test meter provided by JICA was used for the water meter inaccuracy test. The results of water meter inaccuracy test are shown in Table 6.5-5 and Table 6.5-6. Conceptual detailed data is shown in Supporting Report S6.4-1.

Meter inaccuracy tests were done twice to avoid measuring error and the average of the two records was used as inaccuracy ratio in respective before and after countermeasures. The average meter inaccuracy ratio in 15 pilot project areas and four DMAs account for about 12% and 9% each of the actual water consumption measured by a test meter before water meters are replaced. Composition rate of meter inaccuracy in 15 pilot project areas and DMAs makes up about 8.0% and about 8.1% of the entire NRW as shown in Table 6.5-1 and Table 6.5-2 respectively. However, since high sediments in water meters were reported, it is recommended that all water meters are equipped with strainers.

Table 6.5-5 Average Meter Inaccuracy before Countermeasures in Pilot Project Areas

No	Area No	Pilot Project Area	No. of Metered Customer	Average of Inaccuracy (%)	Remarks
1	No.9	White River-Namo Ruka	13	21.29	High water turbidity from Konglai gravity source and aging water meters contributes to high inaccuracy (%) of water meters
2	No.10	Independence Valley	35	12.90	High water turbidity from Konglai gravity source and some aging water meters contributes to inaccuracy (%) of meters
3	No.3	Lenggakiki	93	9.46	Lengakiki tank act as sedimentation point before passing through water meters. However, some water meters were old contributes to inaccuracy.
4	No.5	Mbokonavera	34	6.00	Water supply from Tasahe, Titinge tank act as sedimentation point before reaching water meters. Only some water meters at end of supply at Fijian Qtrs. with high inaccuracy.
5	No.14	Tuvaruhu-1	18	0.02	Low water turbidity of Tuvaruhu boreholes and sedimentation function at the Tuvaruhu storage tank contribute low meter inaccuracy although meters were aging meters.
6	No.15	Tuvaruhu-2	19	1.49	Low water turbidity of Tuvaruhu boreholes and sedimentation function at the Tuvaruhu storage tank contribute low meter inaccuracy although few meters were aging meters.
7	No.6	Vavaea Ridge	57	7.62	Water supply from Tasahe tank, Titinge tank act as sedimentation point before reaching water meters. Only some aging water meters contribute to meter inaccuracy.
8	No.4	Mbokona	45	5.42	Water supply from Titinge tank, Lengakiki tanks act as sedimentation points before passing through water meters. However, some aging water meters contribute to meter inaccuracy.
9	No.8	Mbaranamba	69	0.69	Most water meters just replaced before start of NRW activities in this area contribute to low inaccuracy of water meters.
10	No.2	Mbua Valley	67	14.08	Most aging meters contribute to high meter inaccuracy.
11	No.11	Bahai Kukum	61	32.32	Aging meters and meter tapering results in high meter

No	Area No	Pilot Project Area	No. of Metered Customer	Average of Inaccuracy (%)	Remarks
					inaccuracies.
12	No.7	Panatina Valley	36	22.61	High turbidity from Kombito gravity results in high sediments build up and resulting in high meter inaccuracies
13	No.12	Naha 2	36	14.40	Mostly aging meters contributes to high meter inaccuracy, also due to meters become dry for all day creating sediments to clog the impeller during intermittent Supply to this area.
14	No.13	Naha 3	48	24.83	Mostly aging water meters contributes to high meter inaccuracy, also due to meters become dry for all day creating sediments to clog the impeller during intermittent Supply to this area.
15	No.1	FFA Kola Road	53	5.42	Most aging meters contribute to high meter inaccuracy.
Total or Average			**45.6**	**11.90**	

Source: Project Team

Table 6.5-6 Average Meter Inaccuracy before Countermeasures in DMAs

No	Area No	DMA	No. of Metered Customer	Average of Inaccuracy (%)	Remarks
1	No.10	Lenggakiki	204	11.91	The reasons of high meter inaccuracy are aging meters as well as sediments due to high turbidity from Rove springs.
2	No.6	Tasahe A&B[*1]	112	12.90	The reasons of high meter inaccuracy are aging meters.
3	No.17	West Kola Ridge A[*1]	178	12.15	The reasons of high meter inaccuracy are aging meters.
4	No.7	Tasahe C	140	0.05	A lot of new meters were installed prior to the NRW reduction activities, so meter inaccuracy was low.
Average			**159**	**9.25**	

Source: Project Team

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

(3) Leakage Information

NRW Action Team conducted a series of leakage detection survey in 15 pilot project areas and four DMAs, and identified leak points. The leakage information was recorded on the record sheet including the following information shown in Table 6.5-7.

Table 6.5-7 Contents of Leakage Record Sheet

No.	Item	Attribute
1	Location	- Pilot project area or DMA/LCZ - Street - House number - Customer's name and ID
2	Pipe information	- Material (CIP, GP, PVC, PE, Others) - Diameter - Depth - Distance from boundary
3	Leakage information	- Location (Pipe, Connection, Valve, Meter, Tap, Reservoir tank, Others) - Condition (Hole, Crack, Breakage, Packing, Loose connection, Overflow, Unknown, etc.) - Cause (Corrosion, Deterioration, Traffic load, Wrong construction, Less adhesive, Pressure fluctuation, Defective valve, Vandalism, Other construction, Unknown, Others) - Leakage size(Large, Medium, Small / Measured or Estimated volume) - Ground condition(Asphalt, Concrete, Gravel, Grass, Soli, Others) - Detected method(Patrol, Customer informing, Acoustic, Pinpointing survey)

No.	Item	Attribute
4	Leakage point	- Location on the sketch(Service pipe, Main pipe)
5	Location map and photos	
6	Remarks	(e.g. Request from customer)
7	Leakage repair information	- Size of excavation - Number of worker (Worker, Plumber, Supervisor, Engineer) - Machine of excavation (Backhoe, Generator, Drainage pump, Lightning equipment)
8	Material used	- Fixed material (Pipe, Joint, Meter, Packing, Saddle)

Source: Project Team

The followings outline cause of leakage and their characteristic are shown in Table 6.5-8 and Table 6.5-9 for 15 pilot project areas and four DMAs respectively. Noticeable points indicate that most leaks occur on polyethylene pipe, defective pipes/valves or by vandalism. Polyethylene pipes are mainly used as the service pipelines. To protect service pipelines against the damages, several defections, it is recommended that the actions against following matters are taken immediately:

- Exposed service pipelines
- Damaged water meter and gate valves due to their exposure
- Vandalism, defective equipment

Table 6.5-8 Outlines of Characteristic of Leakage in 15 Pilot Project Areas

Category	Causes	Rate (%)
Material	Polyethylene pipe	60
Location	Pipe & Valve	35
Condition	Loose	29
Cause	Other (Vandalism, defective valves, etc.)	41

Source: Project Team

Table 6.5-9 Outlines of Characteristic of Leakage in four DMAs

Category	Causes	Rate (%)
Material	Polyethylene pipe	88
Location	Pipe & Valve	95
Condition	Loose	83
Cause	Other (Vandalism, defective valves, etc.)	88

Source: Project Team

(4) Estimation of Initial NRW Ratio

NRW Action Team estimated initial NRW ratio in a 24-hour period, that is, NRW ratio before countermeasures, by measuring SIV, revenue water volume consisting of measured consumption of metered customers and estimated consumption of flat-rate (direct line) customers based on 32m^3/household/month. The results in 15 pilot projects areas and four DMAs are shown in Supporting Report S6.5-1.

Pilot Project Areas

The Project identified initial NRW ratio between 23.2% and 86.5% in 15 pilot project areas. Main causes of NRW in five out of 15 pilot project areas were real loss, which made up more than about 77% of NRW (see Table 6.5-1). Illegal usage was one of the NRW causes, but the rate or causes of

illegal usage depend on the pilot project area. Rate of composition of illegal users was about 9.3% of NRW ratio (see Table 6.5-1), while that of meter inaccuracy was about 8.0%.

DMAs and/or LCZs

The Project identified initial NRW ratio between 38.1% and 85.8% at four DMAs. Main causes of NRW were real loss, which made up about 89% of NRW ratio. Much leakage was caused by an increase of water quantity as a result of additional water sources developed by the JICA Grant Aid Project. Rate of composition of illegal users was about 3.4% of NRW ratio (see Table 6.5-2), while that of meter inaccuracy was about 8.1%. Tasahe A&B was topographically a high pressurized area. Therefore, reduction of such leakage was attempted by water pressure control with a PRV.

6.6 Implement NRW Reduction Measures such as Legalization of Users, Leakage Detection, Leakage Repair, Water Meter Installation and Optimization of Water Pressure in the Pilot Project Areas and DMAs, and measure the NRW Ratio after Implementation of the Pilot Projects. (Activity 3-6)

6.6.1 Outline of Activity

The Project measures the NRW ratio before and after countermeasures against the NRW reduction activities implemented in the Pilot Project areas and DMAs, and verify the effectiveness of the NRW reduction activities. The countermeasures include pipe repair, conversion of illegal connection users into registered customers, disconnection of illegal connections, installation of new water meters, and replacement of defective water meters. The NRW ratio is determined from the balance between water production and water consumption of registered customers. In a particular case where static water pressure is found to be more than 0.70Mpa in DMAs, the water pressure should be controlled by PRVs to be newly installed.

6.6.2 Result of Activities

Since April 2013, several countermeasures for reducing NRW were implemented by SW in cooperation with the JET. The outcomes of NRW reduction activities in 15 pilot project areas and four DMAs are summarized in Table 6.6-1 and Table 6.6-2, and the detailed basis and breakdown of figures are shown in Supporting Report S6.5-1.

Pilot Project Areas

NRW ratio before and after countermeasure is 54.8% and 19.2% (15.9% as result of re-measurement in Lenggakiki and Tuvaruhu-1) on average respectively resulting in the achievement of the significant reduced point of NRW ratio by 35.6 points (38.9 points as result of re-measurement there). The number of the legalized customers was usually less than the number of illegal users initially found in each pilot area. For example, only 37 households were legalized, which made up about 26% of 140 illegal households (see Table 6.5-3). That means that not all illegal users actually have their accounts

validated, instead their service lines get disconnected if they do not comply with SW procedures. The likely reasons why their accounts were not validated are as follows:

- Unaffordability to pay water tariff during the two weeks grace period
- Unwillingness to pay water tariff for defect water supply service

DMAs and/or LCZs

NRW ratio before and after countermeasure with pressure control is 56.7% and 20.3% on average respectively resulting in the achievement of the significant reduced point of NRW ratio by 36.4 points. The number of the legalized customers was usually less than the number of illegal users initially found in each pilot area. For example, 42 households were legalized, which made up about 89.4% of 47 illegal households.

Table 6.6-1 Results of NRW Reduction Countermeasures in Pilot Project Areas

Pilot Project Site			Total HH (Nos.)	Major Leakage point (Nos).	Repaired place (Nos.)	Meter Replacement (Nos.)	Newly installed Meter (Nos.)	Newly/Re-Registered HH (Nos.)	Legalized HH (Nos.)	Disconnected illegal HH (Nos.)	NRW Ratio		
No.	Site ID No.	Site Name									Before CM (%)	After CM (%)	Reduction (Per. points)*1
1	No.9	Namo Ruka	83	13	13	12	37	2	6	11	86.5	32.2	54.3
2	No.10	Independence Valley	91	12	12	35	37	3	1	1	57.7	9.9	47.8
3	No.3	Lengikiki (1st)	161	24	24	91	23	1	1	5	62.0	33.2	28.8
3.1		Lengikiki (2nd)	161	31	24	89	29	7	1	5	62.0	14.7	47.3
4	No.5	Mbokonavera-1	76	13	13	32	30	0	0	2	53.1	14.7	38.4
5	No.14	Tuvaruhu-1 (1st)	47	9	9	12	14	2	2	4	65.4	41.4	24
5.1		Tuvaruhu-1 (2nd)	48	9	9	11	16	4	2	3	65.4	11.0	54.4
6	No.15	Tuvaruhu-2	62	9	9	16	16	1	3	8	67.2	20.5	46.7
7	No.6	Vavayea Ridge	163	11	11	57	36	8	0	0	63.1	27.2	35.9
8	No.4	Mbokona	110	25	25	30	38	6	5	5	36.8	19.2	17.6
9	No.8	Mbaranamba	100	12	12	43	7	0	2	0	23.2	3.5	19.7
10	No.2	Mbua Valley	122	19	19	58	34	1	7	6	50.9	6.8	44.1
11	No.11	Bahai Kukumu	182	20	20	53	44	1	8	6	58.6	16.2	42.4
12	No.7	Panatina Valley	60	3	3	35	15	0	0	0	37.9	6.7	31.2
13	No.12	Naha 2	57	2	2	36	6	0	0	2	51.7	15.6	36.1
14	No.13	Naha 3	67	10	10	46	9	0	2	8	60.9	25.8	35.1
15	No.1	FFA Kola Road	82	5	5	49	13	0	0	0	47.1	14.9	32.2
Total (1st)			**1,463**	**187**	**187**	**605**	**359**	**25**	**37**	**58**	**54.8**	**19.2**	**35.6**
Total (2nd)			**1,464**	**194**	**187**	**602**	**367**	**33**	**37**	**57**	**54.8**	**15.9**	**38.9**

HH: Household
CM: Countermeasure
Note: No.3.1 & No.5.1 are 2nd implementation (re-test).
*1 Per. Points: Percentage Points

Source: Project Team

Table 6.6-2 Results of NRW Reduction Countermeasures in DMAs

DMA			Total HH (Nos.)	Major Leakage point (Nos).	Repaired place (Nos.)	Meter Replacement (Nos.)	Newly installed Meter (Nos.)	Newly/Re-Registered HH (Nos.)	Legalized HH (Nos.)	Disconnected illegal HH (Nos.)	NRW Ratio		
No.	DMA ID No.	DMA Name									Before CM (%)	After CM (%)	Reduction (Per. points)*1
1	No.10	Lenggakiki	215	10	10	69	6	0	9	0	42.6	22.6	20.0
2	No.6	Tasahe A&B (without pressure control)	205	24	24	40	72	28	5	12	85.8	44.6	41.2
2.1		Tasahe A&B (with pressure control)									85.8	32.7	53.1
3	No.17	West Kola Ridge A	225	17	17	56	36	5	1	0	60.4	18.4	42.0
4	No.7	Tasahe C	187	31	31	33	23	3	27	2	38.1	7.5	30.6
Total (Without Pressure Control)			**832**	**82**	**82**	**198**	**137**	**36**	**42**	**14**	**56.7**	**23.3**	**33.5**
Total (With Pressure Control)											**56.7**	**20.3**	**36.4**

Source: Project Team

6.7 Prepare Reports of Results including Cost and Benefit. (Activity 3-7)

6.7.1 Outline of Activity

Upon completion of each Pilot Project on NRW reduction, the Project Team prepared the summary report covering the following contents shown in Table 6.7-1 with cost and benefit:

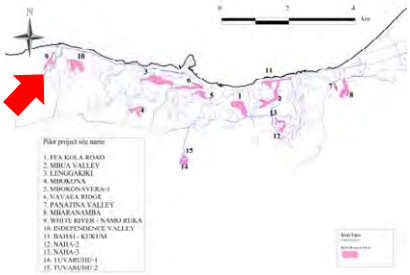
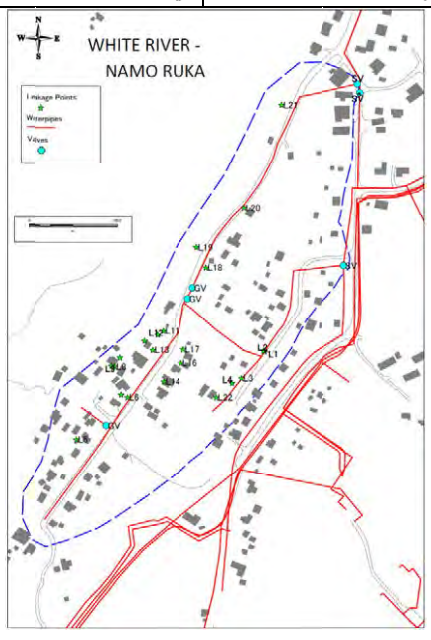
Table 6.7-1 Contents of Summary Report of Pilot Project

Field	Contents
1. Overall Technical	1) Numbers of population and households in project area 2) Both planned and actual work schedules 3) Input manpower by work item 4) NRW ratio before and after measures 5) Total cost on NRW reduction measurement, including personnel, fuel and pipe material costs 6) Issues and problems arising from measurement 7) Suggestions for future improvement
2. GIS	1) Location of Pilot Project area 2) Information on distribution network
3. Leakage Detection and meter inaccuracy, etc.	1) Result of minimum night flow survey 2) Result of water meter survey 3) Result of illegal connection survey
4. Pipe Maintenance & Repair	1) Pipe repairing (location, number of cases)
5. Service Pipe Connection	1) Number of newly-registered connection
6. Service Pipe Disconnection	1) Number of disconnection
7. Water Meter Reading, Billing and Tariff Collection	1) Result of illegal connection survey 2) Result of water meter survey 3) Income from collection (before and after measures)
8. Pipe Materials Management and Procurement	1) Procured materials and number, etc.

6.7.2 Result of Activity

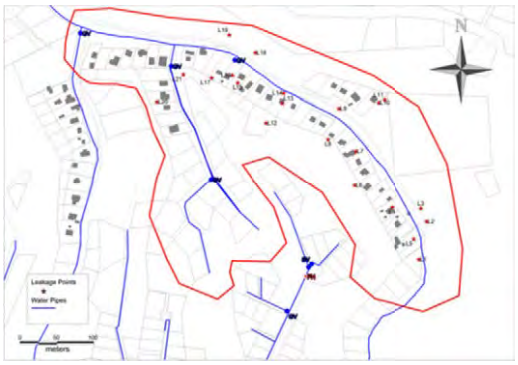
Primary NRW reduction activities in 15 pilot project areas and four DMAs were completed as of November 2015. Summary reports for NRW reduction activities in 15 pilot project areas and four DMAs are attached as Table 6.7-2 to Table 6.7-19.

Table 6.7-2 Summary Report of Pilot Project for White River - Namo Ruka (ID No.9)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		581	581
	Number of Households		83	83
	Work Schedule	Plan	From 1 Apr, 2013 to 31 May, 2013	
		Actual	From 1 Apr, 2013 to 10 Jul, 2013	
	Location of the Pilot Project Area (Pipe Length: 1,028m, Pipe material: GP, PVC, PE, Others)			
	Development of Information on Distribution Network (m)		1,063.23	1,028.67
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		346.73	125.24
	Hourly System Input Volume (m^3/hour)		14.45	5.22
	Minimum Night Flow (m^3/hour)		15.54	3.53
	Time at MNF		1:31AM	3:41AM
	Water Pressure at MNF (Mpa)		0.216	0.138
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**44**	**52**
	Metered [2]		13	50
	Unmetered/Flat [3]		31	2
	(Open-end/Excess) [4]		5	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**28**	**0**
	Direct (Open-end) [6]		4	0
	Closed-end (Closed-end) [7]		13	0
	Indirect/Parasite ((Closed-end) [8]		11	0
	Unconnected [9]		**11**	**31**
	Total [10]=[1]+[5]+[9]		**83**	**83**
	Meter Inaccuracy (%)		21.29	2.10
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 13)			

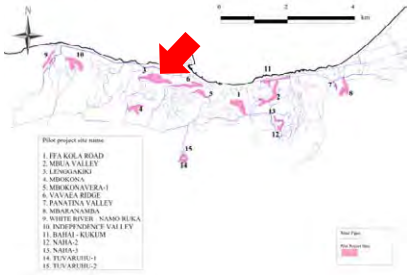
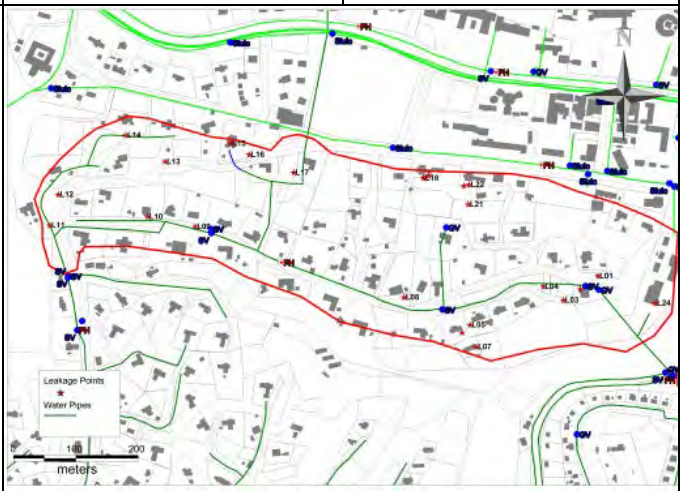
Items		Data	
		Before Countermeasures	After Countermeasures
Activities for Measures	Number of Repaired Leakage		13
	Number of Meters Replaced (Raised)		12
	Number of Meter Newly-installed		37
	Number of Newly/Re-Registered Connection		2
	Number of Legalized User		6
	Number of Disconnected Illegal User		11
	Number of Eliminated Illegal Indirect/Parasite User		11
NRW Ratio	NRW Ratio (%)	86.5	32.2
	Ratio of Real Loss (%)	49.2	30.7
	NRW Reduction (Percentage Point)		54.3
Public Relations	Number of Pamphlet Distributed		0 (*Awareness meeting was held.)
	Number of Illegal Users Received the Notice		11
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		420
	Estimated Revenue in Three Years (SBD)		2,456,510
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		199,378
Findings	Issues arising from initial NRW reduction activities	1. Illegal connections 2. Lack of capacity to conduct field test. 3. Lack of coordination between billing and Meter reading team on customer registration. 4. Insufficient monitoring of disconnected customers	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal connections** ● Collect information of illegal connection users ● Conduct awareness targeting the community needs ● Conduct awareness to school kids in school within or near the community ● Finance & Management & NRW team to apply fee and arrears with clear bargain lines to legalise users. **2. Lack of capacity to conduct field test** ● Training on capacity of staff to take conduct field test with confidence ● Before implementation of activities in the pilot area. Staff must have been orientated beforehand as to what data they are expected to collect and who to report the data to. **3. Lack of coordination between billing and Meter reading team on customer registration** ● Step up coordination between billing and meter reading for updates and monitoring of customer changes. **4. Insufficient monitoring of disconnected customers** ● Proper delegate a team with schedules of monitoring disconnected customer at all pilot sites once a week ● Proper disconnection to avoid reconnections.	

Table 6.7-3 Summary Report of Pilot Project for Independence Valley (ID No.10)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		637	637
	Number of Households		91	91
	Work Schedule	Plan	From 20 Apr, 2013 to 20 Jun, 2013	
		Actual	From 20 Apr, 2013 to 20 Jul, 2013	
	Location of the Pilot Project Area (Pipe Length: 2,468m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		2,184.45	2,468.15
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		159.73	114.83
	Hourly System Input Volume (m^3/hour)		6.66	4.78
	Minimum Night Flow (m^3/hour)		4.39	2.10
	Time at MNF		10:20PM	11:21PM
	Water Pressure at MNF (Mpa)		0.218	0.212
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**68**	**72**
	Metered [2]		35	72
	Unmetered/Flat [3]		33	0
	(Open-end/Excess) [4]		5	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**7**	**0**
	Direct (Open-end) [6]		1	0
	Closed-end (Closed-end) [7]		1	0
	Indirect/Parasite ((Closed-end) [8]		5	0
	Unconnected [9]		**16**	**19**
	Total [10]=[1]+[5]+[9]		**91**	**91**
	Meter Inaccuracy (%)		12.90	1.39
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 12)			

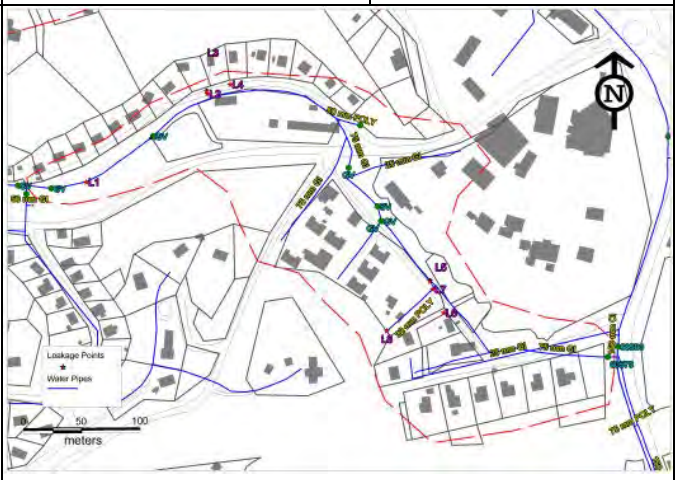
Items		Data	
		Before Countermeasures	After Countermeasures
Activities for Measures	Number of Repaired Leakage		12
	Number of Meters Replaced (Raised)		35
	Number of Meter Newly-installed		37
	Number of Newly/Re-Registered Connection		3
	Number of Legalized User		1
	Number of Disconnected Illegal User		1
	Number of Eliminated Illegal Indirect/Parasite User		5
NRW Ratio	NRW Ratio (%)	57.7	9.9
	Ratio of Real Loss (%)	15.7	8.6
	NRW Reduction (Percentage Point)		47.9
Public Relations	Number of Pamphlet Distributed		75
	Number of Illegal Users Received the Notice		2
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		466
	Estimated Revenue in Three Years (SBD)		1,051,952
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		227,842
Findings	Issues arising from initial NRW reduction activities	1. Delay of procurement of meters & accessories 2. Inappropriate leak detection and documentation 3. Insufficient documentation of field data and coordination of the data	
	Suggestions for Future improvement of NRW Reduction	**1. Delay of procurement of meters & accessories** ● Provide customer listing some 6 months before hand to enable of procurement meters and its accessories to arrive before implementation of activities. ● Order bulk fittings for meter stands over sea /Local. **2. Inappropriate leak detection & documents** ● Conduct training on leakage detection and measures using cups & containers ● Conduct leakage detection using acoustics , noise detections for invisible leaks ● Field staff must learn to properly identify and classify leaks properly and differentiate that with excess flow from direct line services when completing leak clarification table. **3. Insufficient documentation of field data and coordination of the data** ● Documentation and field data need to be check regular by the action team and verified by technical personnel to qualify the final data. ● Forms for data collection must be prepared before work starts. Also training is required on how to complete the forms accurately.	

Table 6.7-4 Summary Report of Pilot Project for Lenggakiki (ID No.3)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1,127	1,127
	Number of Households		161	161
	Work Schedule	Plan	From 10 May, 2013 to 10 Jul, 2013	
		Actual	From 1 Jun, 2013 to 31 Aug, 2013	
	Location of the Pilot Project Area (Pipe Length: 2,344m, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network(m)		2,481.38	2,344.84
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		591.46	491.43
	Hourly System Input Volume (m^3/hour)		24.64	20.48
	Minimum Night Flow (m^3/hour)		18.18	13.64
	Time at MNF		0:41AM	3:00AM
	Water Pressure at MNF (Mpa)		0.247	0.228
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**115**	**116**
	Metered [2]		93	116
	Unmetered/Flat [3]		22	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**35**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		6	0
	Indirect/Parasite ((Closed-end) [8]		29	0
	Unconnected [9]		**11**	**45**
	Total [10]=[1]+[5]+[9]		**161**	**161**
	Meter Inaccuracy (%)		9.46	0.48
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 24)			
Activities	Number of Repaired Leakage		24	

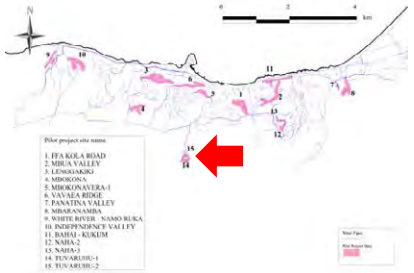
Items		Data	
		Before Countermeasures	After Countermeasures
for Measures	Number of Meters Replaced (Raised)	91	
	Number of Meter Newly-installed	23	
	Number of Newly/Re-Registered Connection	1	
	Number of Legalized User	1	
	Number of Disconnected Illegal User	5	
	Number of Eliminated Illegal Indirect/Parasite User	29	
NRW Ratio	NRW Ratio (%)	62.0	14.7
	Ratio of Real Loss (%)	52.1	14.3
	NRW Reduction (Percentage Point)	47.3	
Public Relations	Number of Pamphlet Distributed	153	
	Number of Illegal Users Received the Notice	4	
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)	315	
	Estimated Revenue in Three Years (SBD)	2,216,488	
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)	231,736	
Findings	Issues arising from initial NRW reduction activities	1. No proper isolation of system 2. No customer registration done properly 3. Insufficient documentation of leakages 4. No proper cost documentation for each pilot site	
	Suggestions for Future improvement of NRW Reduction	**1. No proper Isolation of System** ● Service distribution lines need to be properly identified for all sites. ● Prepare documentation of network pipeline and its features showing clear route of the supply. ● Do not work on assumptions and check the situation in the field. **2. No customer registration done properly** ● Customer status in the filed against the billing data must be cross-checked by meter reading section and billing sections. **3. Insufficient documentation of leakages** ● When completing leakage record sheet and the leak summary table, it is important to unify information on leakage between leakage record sheet and leak summary table. **4. No proper cost documentation for each pilot site.** ● Recoding the cost incurred for NRW reduction activities periodically	

Table 6.7-5 Summary Report of Pilot Project for Mbokonavera-1 (ID No.5)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		532	532
	Number of Households		76	76
	Work Schedule	Plan	From 1 Jun, 2013 to 31 Jul, 2013	
		Actual	From 1 Aug, 2013 to 20 Sep, 2013	
	Location of the Pilot Project Area (Pipe Length: 1,196m, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network (m)		1,104.12	1,196.89
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		178.67	138.32
	Hourly System Input Volume (m^3/hour)		7.44	5.76
	Minimum Night Flow (m^3/hour)		5.81	2.74
	Time at MNF		AM0:32	AM2:32
	Water Pressure at MNF (Mpa)		0.486	0.578
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**64**	**64**
	Metered [2]		34	64
	Unmetered/Flat [3]		30	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**2**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		2	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**10**	**12**
	Total [10]=[1]+[5]+[9]		**76**	**76**
	Meter Inaccuracy (%)		6.00	4.51
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 13)			
Activities for	Number of Repaired Leakage			13

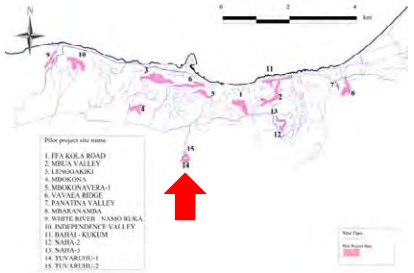
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		32
	Number of Meter Newly-installed		30
	Number of Newly/Re-Registered Connection		0
	Number of Legalized User		0
	Number of Disconnected Illegal User		2
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	53.1	14.7
	Ratio of Real Loss (%)	50.1	10.6
	NRW Reduction (Percentage Point)		38.5
Public Relations	Number of Pamphlet Distributed		73
	Number of Illegal Users Received the Notice		3
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		299
	Estimated Revenue in Three Years (SBD)		1,024,067
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		161,844
Findings	Issues arising from initial NRW reduction activities	1. Insufficient training for new team 2. Leak measurement and identification	
	Suggestions for Future improvement of NRW Reduction	**1. Insufficient training for new team** ● Provide training over view of what the project wants to achieve and hence the activities that will be carry out and how to achieve it. **2. Leak measurement and identification.** ● Leak measurement and techniques need to be demonstrated to officers and reinforced the documentation process.	

Table 6.7-6 Summary Report of Pilot Project for Tuvaruhu-1 (ID No.14)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		329	329
	Number of Households		47	47
	Work Schedule	Plan	From 20 Jun, 2013 to 20 Aug, 2013	
		Actual	From 20 Aug, 2013 to 15 Oct, 2013	
	Location of the Pilot Project Area (Pipe Length: 997m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		1,205.88	997.23
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		105.82	64.26
	Hourly System Input Volume (m^3/hour)		4.41	2.68
	Minimum Night Flow (m^3/hour)		1.97	0.99
	Time at MNF		AM1:35	AM2:48
	Water Pressure at MNF (Mpa)		0.197	0.357
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**38**	**26**
	Metered [2]		18	26
	Unmetered/Flat [3]		20	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**6**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		6	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**3**	**21**
	Total [10]=[1]+[5]+[9]		**47**	**47**
	Meter Inaccuracy (%)		0.02	0.00
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 9)			
Activities for	Number of Repaired Leakage			9

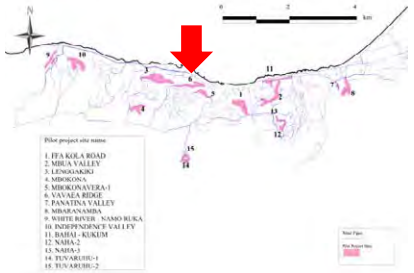
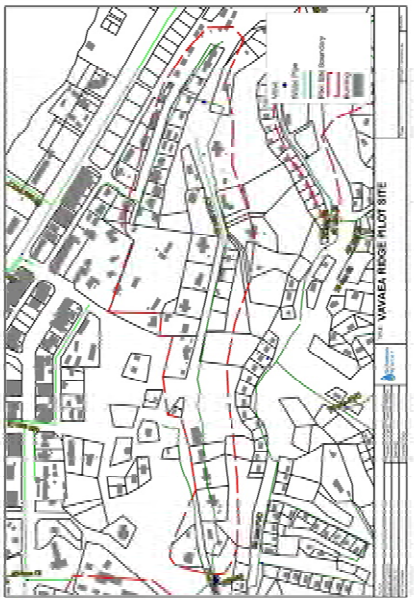
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		12
	Number of Meter Newly-installed		14
	Number of Newly/Re-Registered Connection		2
	Number of Legalized User		2
	Number of Disconnected Illegal User		4
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	65.4	11.0
	Ratio of Real Loss (%)	59.4	11.0
	NRW Reduction (Percentage Point)		54.4
Public Relations	Number of Pamphlet Distributed		40
	Number of Illegal Users Received the Notice		0
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		301
	Estimated Revenue in Three Years (SBD)		624,552
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		87,936
Findings	Issues arising from initial NRW reduction activities	1. Illegal users and disconnection of customers with arrears. 2. No proper coordination of activities by supervisors.	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal users and disconnection of customers with arrears.** ● Proper coordinating with finance and NRW team and communicating with each other to get one approach to address this issue. **2. No proper coordination of activities by supervisors.** ● Proper delegating task to specific team members to account for the data accuracy. ● Reviewing each pilot site with action team and see which sites are reoccurring.	

Table 6.7-7 Summary Report of Pilot Project for Tuvaruhu-2 (ID No.15)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		434	434
	Number of Households		62	62
	Work Schedule	Plan	From 10 Jul, 2013 to 10 Sep, 2013	
		Actual	From 20 Aug, 2013 to 15 Oct, 2013	
	Location of the Pilot Project Area (Pipe Length: 1,325m, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network (m)		1,371.31	1,325.15
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		113.86	55.25
	Hourly System Input Volume (m^3/hour)		4.74	2.30
	Minimum Night Flow (m^3/hour)		1.90	0.61
	Time at MNF		AM3:37	AM2:46
	Water Pressure at MNF (Mpa)		0.210	0.361
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**41**	**32**
	Metered [2]		19	32
	Unmetered/Flat [3]		22	0
	(Open-end/Excess) [4]		1	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**11**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		11	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**10**	**30**
	Total [10]=[1]+[5]+[9]		**62**	**62**
	Meter Inaccuracy (%)		1.49	1.30
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 9			
Activities for	Number of Repaired Leakage			9

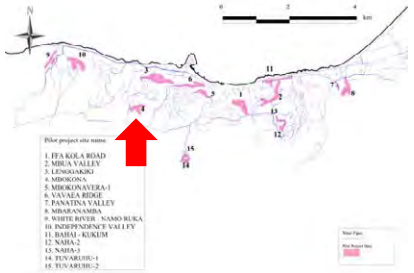
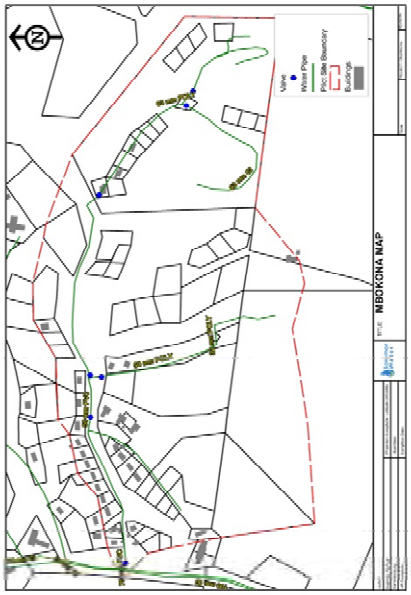
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		16
	Number of Meter Newly-installed		16
	Number of Newly/Re-Registered Connection		1
	Number of Legalized User		3
	Number of Disconnected Illegal User		8
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	67.2	20.5
	Ratio of Real Loss (%)	52.8	19.4
	NRW Reduction (Percentage Point)		46.7
Public Relations	Number of Pamphlet Distributed		62
	Number of Illegal Users Received the Notice		11
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		322
	Estimated Revenue in Three Years (SBD)		694,526
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		93,222
Findings	Issues arising from initial NRW reduction activities	1. Illegal users and disconnection of customers with arrears. 2. No Proper documentation of leaks, inaccuracy meters and customer registration.	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal users and disconnection of customers with arrears**. ● Proper coordinating with finance and NRW team and communicating with each other to get one approach to address this issue. **2. No proper documentation of leaks, inaccuracy meters and customer registration.** ● Preparing documents of data with templates properly and delegating task to each responsible staff to provide data in accuracy. ● Supervising the work and monitoring specific task progress and address issues. ● Reviewing each pilot site with action team and see which sites are reoccurring.	

Table 6.7-8 Summary Report of Pilot Project for Vavaea Ridge (ID No.6)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1,141	1,141
	Number of Households		163	163
	Work Schedule	Plan	From 1 Aug, 2013 to 30 Sep, 2013	
		Actual	From 20 Sep, 2013 to 10 Nov, 2013	
	Location of the Pilot Project Area (Pipe Length: 1,576m, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network (m)		1,298.15	1,576.57
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		502.35	497.47
	Hourly System Input Volume (m^3/hour)		20.93	20.73
	Minimum Night Flow (m^3/hour)		20.17	19.09
	Time at MNF		AM4:28	AM1:54
	Water Pressure at MNF (Mpa)		0.284	3.570
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**94**	**93**
	Metered [2]		57	93
	Unmetered/Flat [3]		37	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**0**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		0	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**69**	**70**
	Total [10]=[1]+[5]+[9]		**163**	**163**
	Meter Inaccuracy (%)		7.62	3.38
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 11)			
Activities for	Number of Repaired Leakage		11	

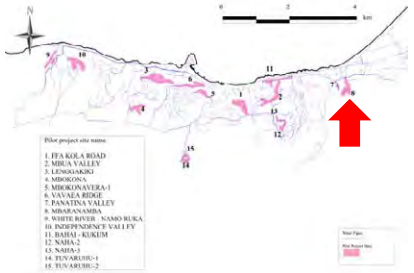
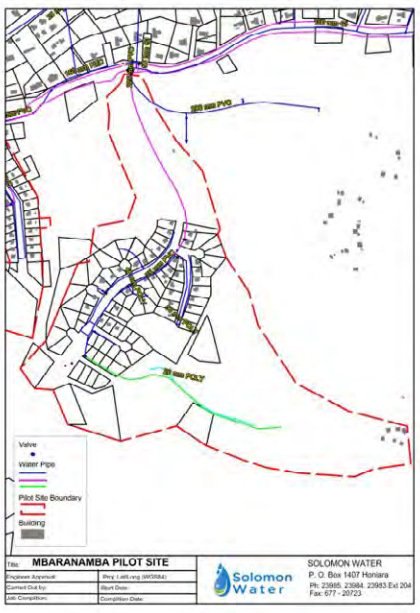
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		57
	Number of Meter Newly-installed		36
	Number of Newly/Re-Registered Connection		8
	Number of Legalized User		0
	Number of Disconnected Illegal User		0
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	63.1	27.2
	Ratio of Real Loss (%)	60.7	24.7
	NRW Reduction (Percentage Point)		35.8
Public Relations	Number of Pamphlet Distributed		163
	Number of Illegal Users Received the Notice		0
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		273
	Estimated Revenue in Three Years (SBD)		2,345,881
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		331,298
Findings	Issues arising from initial NRW reduction activities	1. Large percentage of real loss after countermeasure. 2. Difficulty in identifying different connection types. 3. Not field data collection done properly and not records kept properly	
	Suggestions for Future improvement of NRW Reduction	**1. Large percentage of real losses after countermeasure.** • Ensuring that pilot sire is properly isolated and all Households must be visited to be checked. • Detecting visible leaks entirely. • Ensuring that all illegal users are detected. **2. Difficulty in identifying different connection types.** • All field staff must go through workshop in identifying different connection type and must be trained to continue in field. **3. Field data collection not properly done and records not properly kept.** • All field staff to go through training on how to collect data from field. This should include relevant and informative short notes, photos and proper labeled sign boards. • Preparing proper templates for data collection with ease.	

Table 6.7-9 Summary Report of Pilot Project for Mbokona (ID No.4)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		770	770
	Number of Households		110	110
	Work Schedule	Plan	From 20 Aug, 2013 to 20 Oct, 2013	
		Actual	From 15 Oct, 2013 to 10 Dec, 2013	
	Location of the Pilot Project Area (Pipe Length: 951m, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network (m)		1,418.66	951.33
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		124.10	147.20
	Hourly System Input Volume (m^3/hour)		5.17	6.13
	Minimum Night Flow (m^3/hour)		3.33	2.30
	Time at MNF		AM4:29	AM2:37
	Water Pressure at MNF (Mpa)		0.829	0.091
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**88**	**86**
	Metered [2]		45	86
	Unmetered/Flat [3]		43	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**10**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		10	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**12**	**24**
	Total [10]=[1]+[5]+[9]		**110**	**110**
	Meter Inaccuracy (%)		5.42	0.19
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 25)			
Activities for	Number of Repaired Leakage		25	

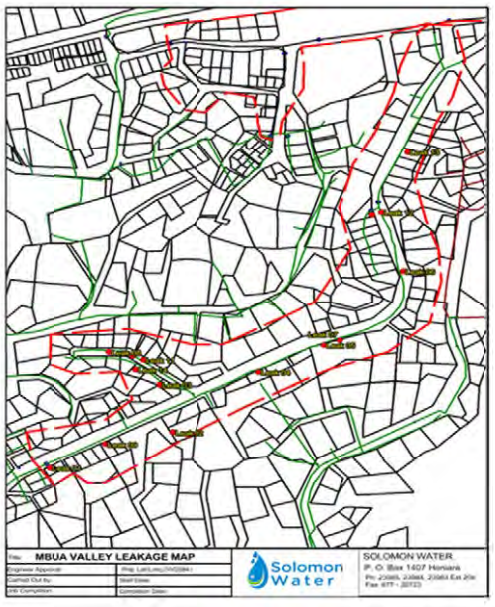
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		30
	Number of Meter Newly-installed		38
	Number of Newly/Re-Registered Connection		6
	Number of Legalized User		5
	Number of Disconnected Illegal User		5
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	50.2	19.2
	Ratio of Real Loss (%)	44.7	19.0
	NRW Reduction (Percentage Point)		17.6
Public Relations	Number of Pamphlet Distributed		110
	Number of Illegal Users Received the Notice		8
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		606
	Estimated Revenue in Three Years (SBD)		403,685
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		490,290
Findings	Issues arising from initial NRW reduction activities	1. Difficulty in identifying different connection types. 2. Not field data collection done properly and not records kept properly	
	Suggestions for Future improvement of NRW Reduction	**1. Difficulty in identifying different connection types.** • All field staff must go through workshop in identifying different connection type and must be trained to continue in field. **2. Field data collection not properly done and records not properly kept.** • All field staff to go through training on how to collect data from field. This should include relevant and informative short notes, photos and proper labeled sign boards. • Preparing proper templates for data collection with ease.	

Table 6.7-10 Summary Report of Pilot Project for Mbaranamba (ID No.8)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		700	700
	Number of Households		100	100
	Work Schedule	Plan	From 20 Sep, 2013 to 10 Nov, 2013	
		Actual	From 01 Nov, 2013 to 10 Jan, 2014	
	Location of the Pilot Project Area (Pipe Length: 1,496m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		1,512.29	1,496.10
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		159.40	127.7
	Hourly System Input Volume (m^3/hour)		6.64	5.32
	Minimum Night Flow (m^3/hour)		3.20	2.37
	Time at MNF		AM5:19	AM3:21
	Water Pressure at MNF (Mpa)		0.403	0.045
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**78**	**80**
	Metered [2]		69	80
	Unmetered/Flat [3]		9	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**2**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		2	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**20**	**20**
	Total [10]=[1]+[5]+[9]		**100**	**100**
	Meter Inaccuracy (%)		0.69	0.19
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 12)			
Activities for	Number of Repaired Leakage			12

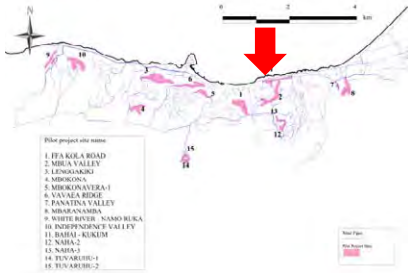
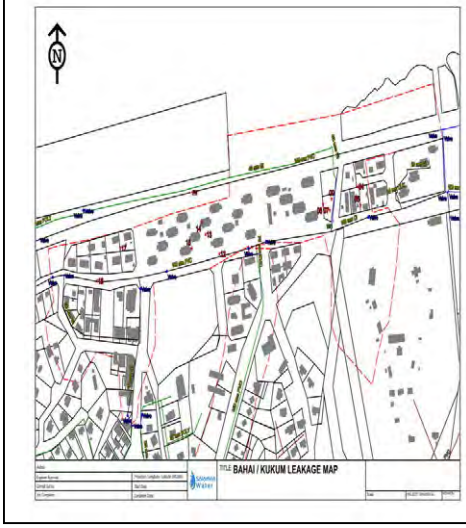
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		43
	Number of Meter Newly-installed		7
	Number of Newly/Re-Registered Connection		0
	Number of Legalized User		2
	Number of Disconnected Illegal User		0
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	23.2	3.5
	Ratio of Real Loss (%)	21.3	3.3
	NRW Reduction (Percentage Point)		19.7
Public Relations	Number of Pamphlet Distributed		98
	Number of Illegal Users Received the Notice		2
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		261
	Estimated Revenue in Three Years (SBD)		403,424
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		157,097
Findings	Issues arising from initial NRW reduction activities	1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply 2. Abnormality in initial measurements of MNF	
	Suggestions for Future improvement of NRW Reduction	**1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply** ● Prior to NRW reduction activities, condistion of water supply must be checked carefully. **2. Abnormality in initial measurements of MNF** ● MNF after countermeasure was repeated.	

Table 6.7-11 Summary Report of Pilot Project for Mbua Valley (ID No.2)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		854	854
	Number of Households		122	122
	Work Schedule	Plan	From 1 Oct, 2013 to 30 Nov, 2013	
		Actual	From 20 Jan, 2014 to 10 Jul, 2014	
	Location of the Pilot Project Area (Pipe Length: 1,028m, Pipe material: GP, PVC, PE, Others)			
	Development of Information on Distribution Network (m)		1,989.95	2,095.71
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		297.5	229
	Hourly System Input Volume (m^3/hour)		12.40	9.54
	Minimum Night Flow (m^3/hour)		5.86	4.23
	Time at MNF		5:21AM	1:49AM
	Water Pressure at MNF (Mpa)		0.43	0.44
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**93**	**100**
	Metered [2]		67	100
	Unmetered/Flat [3]		26	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**13**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		13	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**16**	**22**
	Total [10]=[1]+[5]+[9]		**122**	**122**
	Meter Inaccuracy (%)		14.08	0.09
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 18)			

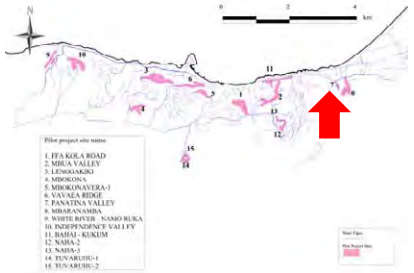
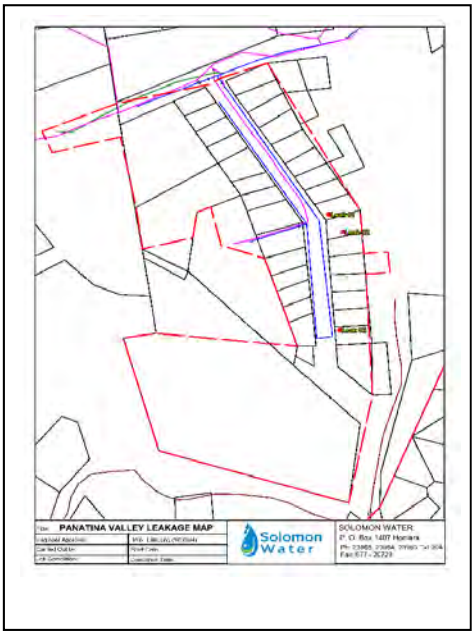
Items		Data	
		Before Countermeasures	After Countermeasures
Activities for Measures	Number of Repaired Leakage		19
	Number of Meters Replaced (Raised)		58
	Number of Meter Newly-installed		34
	Number of Newly/Re-Registered Connection		1
	Number of Legalized User		7
	Number of Disconnected Illegal User		6
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	50.9	6.8
	Ratio of Real Loss (%)	39.7	6.7
	NRW Reduction (Percentage Point)		44.1
Public Relations	Number of Pamphlet Distributed		93
	Number of Illegal Users Received the Notice		13
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		657
	Estimated Revenue in Three Years (SBD)		1,708,239
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		586,659
Findings	Issues arising from initial NRW reduction activities	1. Illegal Connections 2. Lack of capacity to record field data 3. Insufficient measuring Devises	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal Connections** ● Conducting awareness programs for the schools and communities. **2. Incapacity to record Field Data.** ● Need to establish appropriate process and guideline (SOP) to collect accurate data from site e.g. meter IDs. **3. Insufficient Measuring Devises.** ● Need one more than test meter devices.	

Table 6.7-12 Summary Report of Pilot Project for Bahai Kukum (ID No.11)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1274	1274
	Number of Households		182	182
	Work Schedule	Plan	From 20 Oct 2013 , to 20 Dec, 2014	
		Actual	From 1 Feb , 2014 to 20 May , 2014	
	Location of the Pilot Project Area (Pipe Length:1540, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		1,691.80	1,899.75
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		326.6	239.94
	Hourly System Input Volume (m^3/hour)		13.61	10.00
	Minimum Night Flow (m^3/hour)		11.799	7.290
	Time at MNF		4:39AM	5:20AM
	Water Pressure at MNF (Mpa)		0.09	0.11
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**115**	**97**
	Metered [2]		61	97
	Unmetered/Flat [3]		54	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**14**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		14	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**53**	**85**
	Total [10]=[1]+[5]+[9]		**182**	**182**
	Meter Inaccuracy (%)		32.32	0.00
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes:18)			
2Activities for Measures	Number of Repaired Leakage			20
	Number of Meters Replaced (Raised)			53
	Number of Meter Newly-installed			44

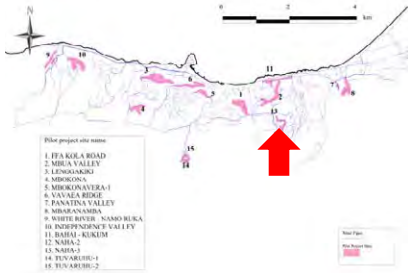
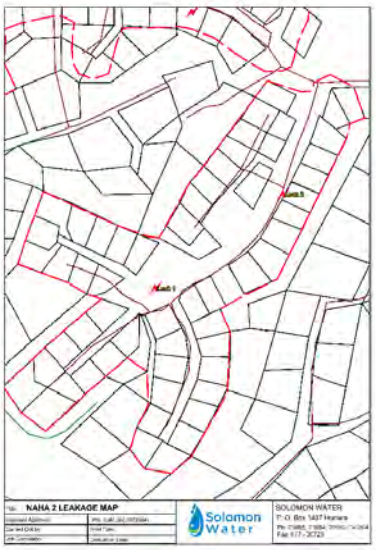
Items		Data	
		Before Countermeasures	After Countermeasures
	Number of Newly/Re-Registered Connection		1
	Number of Legalized User		8
	Number of Disconnected Illegal User		6
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	58.6	16.2
	Ratio of Real Loss (%)	42.7	16.2
	NRW Reduction (Percentage Point)		42.4
Public Relations	Number of Pamphlet Distributed		115
	Number of Illegal Users Received the Notice		14
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		537
	Estimated Revenue in Three Years (SBD)		1,803,891
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		524,679
Findings	Issues arising from initial NRW reduction activities	**1.** Difficulty of water meter installation in concrete slab **2.** No monthly bill payment because of change of tenants and accounts	
	Suggestions for Future improvement of NRW Reduction	**1. Difficulty of water meter installation in concrete slab** ● Re- pipe construction on site to relocate water meters in correct locations. **2. No monthly bill payment because of change of tenants and accounts** ● The billing team and meter reading team should cross-check customer accounts and make necessary changes in billing system.	

Table 6.7-13 Summary Report of Pilot Project for Panatina Valley (ID No. 12)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		420	420
	Number of Households		60	60
	Work Schedule	Plan	From 11 Nov, 2013 to 11 Jan, 2014	
		Actual	From 20 Feb, 2014 to 20 July, 2014	
	Location of the Pilot Project Area (Pipe Length: 600m, Pipe material: PVC, PE, GI)			
	Development of Information on Distribution Network (m)		885.12	822.34
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		93.40	111.09
	Hourly System Input Volume (m^3/hour)		3.89	4.63
	Minimum Night Flow (m^3/hour)		3.11	3.11
	Time at MNF		3:24AM	2:11AM
	Water Pressure at MNF (Mpa)		0.19	0.22
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**51**	**50**
	Metered [2]		36	50
	Unmetered/Flat [3]		15	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**0**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		0	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**9**	**10**
	Total [10]=[1]+[5]+[9]		**60**	**60**
	Meter Inaccuracy (%)		22.61	0.59
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes:3)			
Activities for	Number of Repaired Leakage		3	

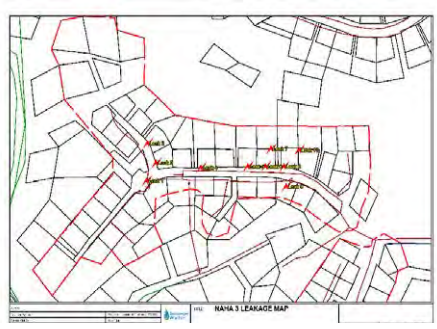
Items		Data	
		Before Countermeasures	After Countermeasures
Measures	Number of Meters Replaced (Raised)		35
	Number of Meter Newly-installed		15
	Number of Newly/Re-Registered Connection		0
	Number of Legalized User		0
	Number of Disconnected Illegal User		0
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	37.9	6.7
	Ratio of Real Loss (%)	24.8	6.1
	NRW Reduction (Percentage Point)		31.2
Public Relations	Number of Pamphlet Distributed		51
	Number of Illegal Users Received the Notice		0
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		509
	Estimated Revenue in Three Years (SBD)		380,343
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		252,469
Findings	Issues arising from initial NRW reduction activities	1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply because of high altitude **2.** Abnormality in initial measurements because of defective ultrasonic flow meter	
	Suggestions for Future improvement of NRW Reduction	**1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply because of high altitude** ● Prior to NRW reduction activities, condition of water supply must be checked carefully. **2. Abnormality in initial measurements because of defective ultrasonic flow meter** ● Purchasing additional ultrasonic flow meter to avoid delay of measurements	

Table 6.7-14 Summary Report of Pilot Project for Naha 2 (ID No.13)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		399	399
	Number of Households		57	57
	Work Schedule	Plan	From 11 Dec,2013 to 11 Feb, 2014	
		Actual	From 1 March, 2014 to 10 Sept, 2014	
	Location of the Pilot Project Area (Pipe Length: 398m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		785.93	771.53
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		96.93	75.80
	Hourly System Input Volume (m^3/hour)		4.04	3.16
	Minimum Night Flow (m^3/hour)		2.55	0.84
	Time at MNF		12:48AM	1:31AM
	Water Pressure at MNF (Mpa)		0.28	0.32
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**42**	**42**
	Metered [2]		36	42
	Unmetered/Flat [3]		6	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**2**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		2	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**13**	**15**
	Total [10]=[1]+[5]+[9]		**57**	**57**
	Meter Inaccuracy (%)		14.40	0.89
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 2)			
Activities for Measures	Number of Repaired Leakage		2	
	Number of Meters Replaced (Raised)		36	
	Number of Meter Newly-installed		6	

Items		Data	
		Before Countermeasures	After Countermeasures
	Number of Newly/Re-Registered Connection		0
	Number of Legalized User		0
	Number of Disconnected Illegal User		2
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	51.7	15.6
	Ratio of Real Loss (%)	42.5	14.9
	NRW Reduction (Percentage Point)		36.1
Public Relations	Number of Pamphlet Distributed		52
	Number of Illegal Users Received the Notice		2
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		552
	Estimated Revenue in Three Years (SBD)		455,409
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		252,242
Findings	Issues arising from initial NRW reduction activities	1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply because of high altitude	
	Suggestions for Future improvement of NRW Reduction	**1. Inaccuracy of NRW ratio calculation in the areas of less than 24 hr.-supply because of high altitude** ● Prior to NRW reduction activities, condition of water supply must be checked carefully.	

Table 6.7-15 Summary Report of Pilot Project for White River –Naha 3 (ID No.3)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		469	469
	Number of Households		67	67
	Work Schedule	Plan	From 1 Jan , 2014 to 28 February , 2014	
		Actual	From 20 March , 2014 to 20 Sept 2014	
	Location of the Pilot Project Area (Pipe Length: 1,0750m, Pipe material: GP, PVC, PE, Others)			
	Development of Information on Distribution Network (m)		959.63	939.84
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		137.3	88.80
	Hourly System Input Volume (m^3/hour)		5.72	3.70
	Minimum Night Flow (m^3/hour)		3.80	1.57
	Time at MNF		1:34AM	1:55AM
	Water Pressure at MNF (Mpa)		0.28	0.33
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**55**	**56**
	Metered [2]		48	56
	Unmetered/Flat [3]		7	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**10**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		10	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**2**	**11**
	Total [10]=[1]+[5]+[9]		**67**	**67**
	Meter Inaccuracy (%)		24.83	0.02
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 10)			
Activities for Measures	Number of Repaired Leakage			10
	Number of Meters Replaced (Raised)			46
	Number of Meter Newly-installed			9
	Number of Newly/Re-Registered Connection			0
	Number of Legalized User			2
	Number of Disconnected Illegal User			8
	Number of Eliminated Illegal Indirect/Parasite User			0
NRW Ratio	NRW Ratio (%)		60.9	25.9
	Ratio of Real Loss (%)		42.1	25.8

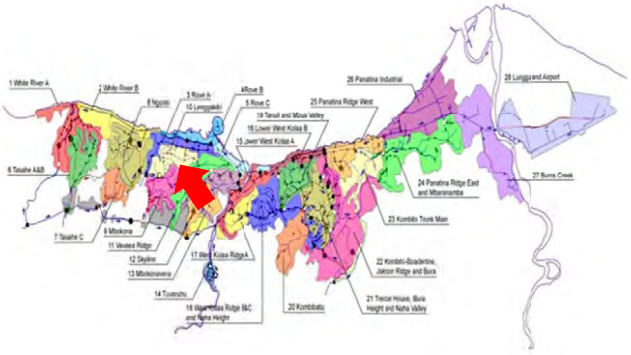
Items		Data	
		Before Countermeasures	After Countermeasures
	NRW Reduction (Percentage Point)		35.1
Public Relations	Number of Pamphlet Distributed		55 (*Awareness meeting was held.)
	Number of Illegal Users Received the Notice		10
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		601
	Estimated Revenue in Three Years (SBD)		628,354
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		250,661
Findings	Issues arising from initial NRW reduction activities	1. Illegal connections 2. Lack of capacity to conduct field test 3. Lack of communication and coordination between billing & meter reading team on customer registration. 4. Disconnected customers	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal connections** ● Collecting information of the illegal connection users. ● Conducting awareness meeting targeting the community. **2. Lack of capacity to conduct field test** ● Training staff to take conduct field test with confidence ● Orientating staff who will be part of the pilot site to identify. **3. Lack of communication and coordination between billing & meter reading team on customer registration.** ● Step up coordination between billing and meter reading for updating and monitoring of customer changes. **4. Disconnected customers** ● Delegating a team with schedules of monitoring disconnected customer at all pilot sites once a week ● Proper disconnection to avoid reconnections.	

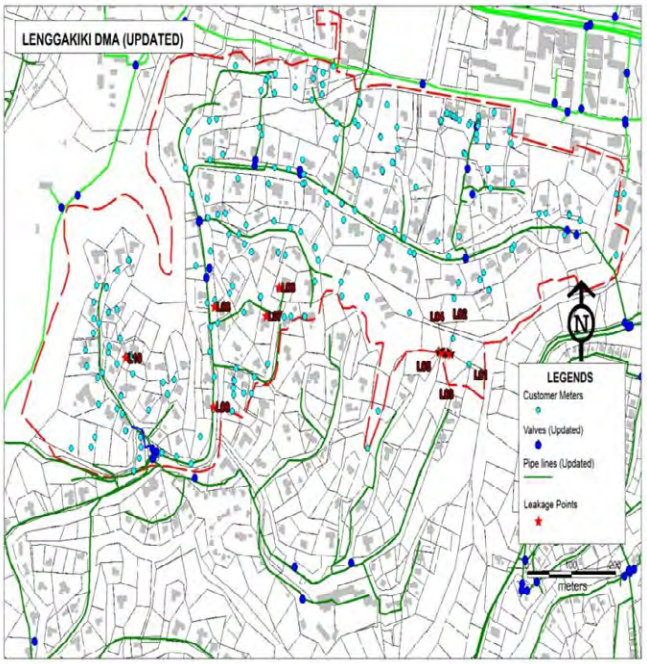
Table 6.7-16 Summary Report of Pilot Project for FFA Kola (ID No.1)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		574	574
	Number of Households		82	82
	Work Schedule	Plan	From 1 Feb , 2014 to 1 April , 2014	
		Actual	From 20 July , 2014 to 30 September , 2014	
	Location of the Pilot Project Area (Pipe Length:1157m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		2,275.52	2,244.55
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		215.00	175.98
	Hourly System Input Volume (m^3/hour)		8.96	7.33
	Minimum Night Flow (m^3/hour)		5.00	4.31
	Time at MNF		2:55AM	4:02AM
	Water Pressure at MNF (Mpa)		0.25	0.27
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**70**	**64**
	Metered [2]		53	64
	Unmetered/Flat [3]		17	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**0**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		0	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**12**	**18**
	Total [10]=[1]+[5]+[9]		**82**	**82**
	Meter Inaccuracy (%)		5.42	0.01
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 5)			
Activities for Measures	Number of Repaired Leakage		5	
	Number of Meters Replaced (Raised)		49	
	Number of Meter Newly-installed		13	
	Number of Newly/Re-Registered Connection		0	
	Number of Legalized User		0	
	Number of Disconnected Illegal User		0	

Items		Data	
		Before Countermeasures	After Countermeasures
	Number of Eliminated Illegal Indirect/Parasite User		0
NRW Ratio	NRW Ratio (%)	47.1	14.9
	Ratio of Real Loss (%)	44.5	14.9
	NRW Reduction (Percentage Point)		32.2
Public Relations	Number of Pamphlet Distributed		78
	Number of Illegal Users Received the Notice		2
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)		574
	Estimated Revenue in Three Years (SBD)		902,081
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)		352,871
Findings	Issues arising from initial NRW reduction activities	1. Delay of procurement of water meters & accessories. 2. Inappropriate leakage detection & documents. 3. Insufficient documentation of field data and coordination of the data.	
	Suggestions for Future improvement of NRW Reduction	**1. Delay of meters & accessories** ● Prepare lists of customers who need water meters at least six months before installation. **2. Inappropriate leakage detection & documents** ● Conduct training on leakage detection and measures leaks using cups & containers ● Conduct leakage detection using acoustics, noise detections for invisible leaks. **3. Insufficient documentation of field data and coordination of the data** ● Documentation and field data need to be checked regular by the action team and verified by technical personnel to qualify the final data. ● Provide templates for all data and develop the process.	

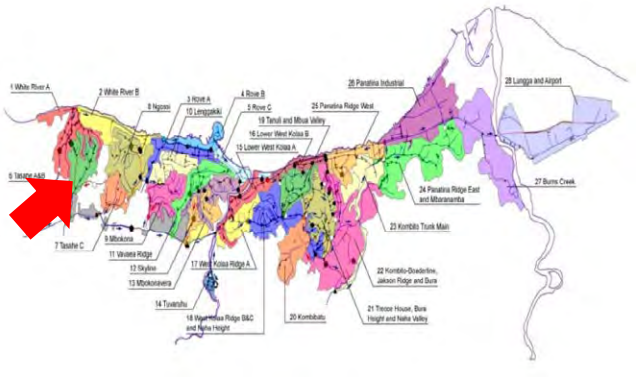
Table 6.7-17 Summary Report of Pilot Project for Lenggakiki (ID No.10)

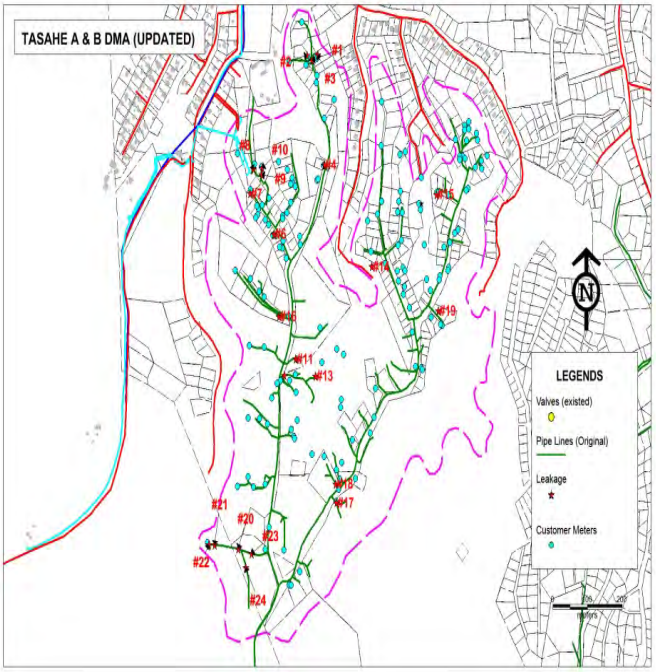
Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1505	1505
	Number of Households		215	215
	Work Schedule	Plan		
		Actual	4 September 2014 – 28 October 2014	
	Location of the Pilot Project Area (Pipe Length:, Pipe material: GP, PVC, PE)			
	Development of Information on Distribution Network(m)		3550.85 m	4035.08 m
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		778.9	813.30
	Hourly System Input Volume (m^3/hour)		32.45	33.89
	Minimum Night Flow (m^3/hour)		22.80	22.80
	Time at MNF		2.45AM	2.00AM
	Water Pressure at MNF (Mpa)		0.245	0.245
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**210**	**210**
	Metered [2]		204	210
	Unmetered/Flat [3]		6	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**0**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		0	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**5**	**5**
	Total [10]=[1]+[5]+[9]		**215**	**215**
	Meter Inaccuracy (%)			

Items		Data	
		Before Countermeasures	After Countermeasures
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 13)		
Activities for Measures	Number of Repaired Leakage	13	
	Number of Meters Replaced (Raised)	69	
	Number of Meter Newly-installed	6	
	Number of Newly/Re-Registered Connection	0	
	Number of Legalized User	1	
	Number of Disconnected Illegal User	1	
	Number of Eliminated Illegal Indirect/Parasite User	0	
NRW Ratio	NRW Ratio (%)	42.6	22.6
	Ratio of Real Loss (%)	35	22.4
	NRW Reduction (Percentage Point)	20.0	
Public Relations	Number of Pamphlet Distributed	0	
	Number of Illegal Users Received the Notice	11	
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)	1189	
	Estimated Revenue in Three Years (SBD)	2,966,933	
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)	905,638	
Findings	Issues arising from initial NRW reduction activities	1. No proper isolation of service areas 2. Not customer registration done properly 3. Measurement of inaccuracy meters	
	Suggestions for Future improvement of NRW Reduction	**1. No proper isolation of service areas** ● Service distribution lines need to be identified for Lengakiki and to ensure that all customers that are feed from Lengakiki are identified.	

Items		Data	
		Before Countermeasures	After Countermeasures
		● Proper documentation of Network pipeline and its features that shows the supply route is important. ● Do not work on assumptions and check out the situation in the field and confirm. **2. Not customer registration done properly** ● Confirmation of customer status between field and billing is important to ensure that billing data is accurate. ● All active services in DMA must be photographed with proper labels. Illegal users and parasites must also be photographed. This is to provide a good basis for the baseline. ● Parasite users and unconnected household must be clearly identified and recorded. **3. Measurement of inaccuracy meters** ● For large DMAs, meter inaccuracy will only be carried out randomly and they contribute only a little percentage to the total NRW.	

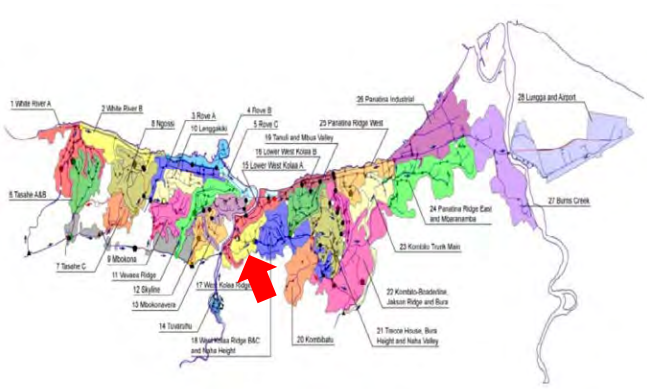
Table 6.7-18 Summary Report of Pilot Project for Tasahe A&B (ID No.6)

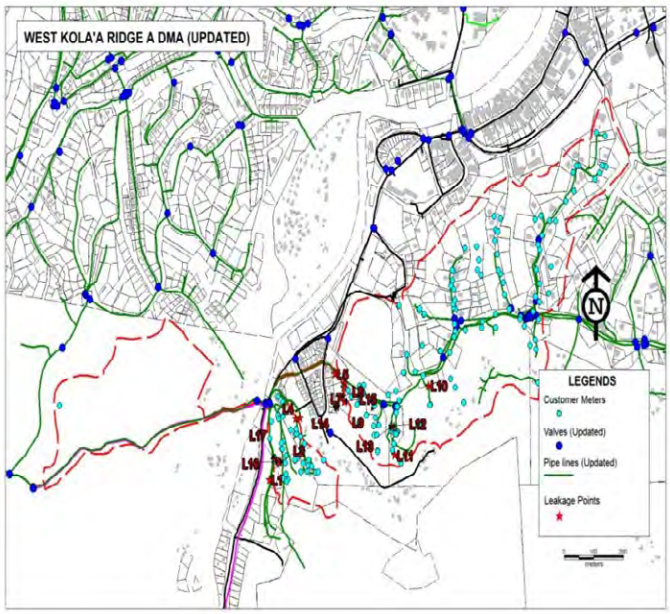
Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1218	1414
	Number of Households		174	202
	Work Schedule	Plan	From 1 Nov, 2014 to 10 Feb, 2015	
		Actual	From 1 Nov, 2014 to 30 Nov, 2015	
	Location of the Pilot Project Area (Pipe Length: 6718.8m, Pipe material: PVC, PE)			
	Development of Information on Distribution Network (m)		4153.96 m	6718.8 m
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m3/day)		1706	553.63
	Hourly System Input Volume (m3/hour)		71.08	23.07
	Minimum Night Flow (m3/hour)		70.205	13.18
	Time at MNF		01.28 AM	04.34AM
	Water Pressure at MNF (Mpa)		0.176	0.15
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**155**	**179**
	Metered [2]		112	179
	Unmetered/Flat [3]		43	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**17**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		17	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**2**	**23**
	Total[10]=[1]+[5]+[9]		**174**	**202**
	Meter Inaccuracy (%)		12.9	0.2

Items		Data	
		Before Countermeasures	After Countermeasures
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 24)		
Activities for Measures	Number of Repaired Leakage	24	
	Number of Meters Replaced (Raised)	40	
	Number of Meter Newly-installed	72	
	Number of Newly/Re-Registered Connection	2	
	Number of Legalized User	0	
	Number of Disconnected Illegal User	14	
	Number of Eliminated Illegal Indirect/Parasite User	7	
NRW Ratio	NRW Ratio (%)	85.8	32.7
	Ratio of Real Loss (%)	83.1	32.6
	NRW Reduction (Percentage Point)	53.1	
Public Relations	Number of Pamphlet Distributed	131	
	Number of Illegal Users Received the Notice	22	
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)	1123	
	Estimated Revenue in Three Years (SBD)	17,231,033	
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)	1,355,062	
Findings	Issues arising from initial NRW reduction activities	1. Delay in procurement of PRV system resulting in delay in the installation based on initial schedule 2. Insufficient field data and coordination of the data 3. Inappropriate location of the existing pipelines	
	Suggestions for Future improvement of NRW Reduction	**1. Delay in procurement of PRV system resulting in delay in the installation based on initial schedule** ● To start procurement processes much earlier to avoid delays. ● Proper communication between procurement team and the two year plan project coordinator is necessary to ensure that	

Items		Data	
		Before Countermeasures	After Countermeasures
		procurement is smooth. **2. Insufficient field data and coordination of the data** ● Documents and field data need to be check regular by the action team and verified by technical personnel to qualify the final data. ● Provide templates for all data and develop the process. **3. Inappropriate location of the existing pipelines** ● Distribution mains must be properly laid along access ways.	

Table 6.7-19 Summary Report of Pilot Project for West Kola Ridge A (ID No.17)

Items			Data	
			Before Countermeasures	After Countermeasures
Basic Information	Number of Population		1575	1575
	Number of Households		225	225
	Work Schedule	Plan	From 20 Dec, 2014 to 31 March, 2015	
		Actual	From 1Jan, 2013 to 20 Jul, 2015	
	Location of the Pilot Project Area (Pipe Length: 6000, Pipe material: GP, Cast Iron, PVC, PE, Others)			
	Development of Information on Distribution Network (m)		3617.66 m	9059.7 m
Minimum Night Flow (MNF)	System Input Volume for 24 Hours (m^3/day)		647.75	429.40
	Hourly System Input Volume (m^3/hour)		27.00	17.90
	Minimum Night Flow (m^3/hour)		36.64	15.74
	Time at MNF		3:05AM	3.55 AM
	Water Pressure at MNF (Mpa)		0.453	0.163
Connection (Water Meter) Survey	**Registered [1]=[2]+[3]**		**211**	**200**
	Metered [2]		178	200
	Unmetered/Flat [3]		33	0
	(Open-end/Excess) [4]		0	0
	Unregistered (Illegal) [5]=[6]+[7]+[8]		**1**	**0**
	Direct (Open-end) [6]		0	0
	Closed-end (Closed-end) [7]		1	0
	Indirect/Parasite ((Closed-end) [8]		0	0
	Unconnected [9]		**13**	**25**
	Total[10]=[1]+[5]+[9]		**225**	**225**
	Meter Inaccuracy (%)		12.15	0.48

Items		Data	
		Before Countermeasures	After Countermeasures
Leakage Survey	The Location of Leakages (Number of Leakages from Main and Service Pipes: 17)		
Activities for Measures	Number of Repaired Leakage	17	
	Number of Meters Replaced (Raised)	48	
	Number of Meter Newly-installed	43	
	Number of Newly/Re-Registered Connection	2	
	Number of Legalized User	1	
	Number of Disconnected Illegal User	1	
	Number of Eliminated Illegal Indirect/Parasite User	14	
NRW Ratio	NRW Ratio (%)	60.4	18.4
	Ratio of Real Loss (%)	55.5	18.0
	NRW Reduction (Percentage Point)	42.0	
Public Relations	Number of Pamphlet Distributed	153	
	Number of Illegal Users Received the Notice	4	
Revenue & Expenditure	Total Manpower Input in the Pilot Project (Man x days)	797	
	Estimated Revenue in Three Years (SBD)	5,178,819	
	Estimated Cost of NRW Activities (Personnel, Transportation & Materials) in Three Years (SBD)	674,754	
Findings	Issues arising from initial NRW reduction activities	1. Illegal connections 2. Insufficient coordination and communication on customer registration between billing & meter reading team. 3. Lack of DMA monitoring	
	Suggestions for Future improvement of NRW Reduction	**1. Illegal connections** ● Illegal users at each DMA must be take note of as the same people tend to repeat the offense of connecting illegally.	

Items		Data	
		Before Countermeasures	After Countermeasures
		● Conducting awareness meeting targeting communities that is more likely to connect illegally, especially low income communities. ● Conducting school program targeting primary and secondary school. ● Finance & Management & NRW team to apply fees clear bargain lines to legalise users. **2. Insufficient coordination and communication on customer registration between billing & meter reading team.** ● Stepping up coordination between billing, meter reading and NRW Action team for updating and monitoring customer changes. ● Disconnection team must inform NRW Action Team of serviced disconnected in DMAs. ● The dedicated billing and customer care staff should join the DMA team. **3. Lack of DMA monitoring** ● Creating schedules for monitoring of illegal users and leakage in the completed DMAs. Teams/staff must be clearly assigned to each DMA. ● Delegating teams with schedules of monitoring disconnected customer in the completed DMAs. ● Carrying on updating database on new customers in DMAs.	

6.8 Provide Advice for the Improvement of Pipe System Design, Installation and Network Operation. (Activity 3-8)

6.8.1 Outline of Activity

There are lots of the distribution network pipes in insufficient size like 25mm and40mm in Honiara City. In order to supply enough water to the service areas, it is important for SW to replace the existing pipes in small size with one in larger size. In addition, there are lots of areas where static head is high. In such a case, static head must be reduced by PRV appropriately to protect the network against damaging high pressures and to provide water at more appropriate water pressure to customers. The following activities were conducted to improve the pipe system.

- Introduction of comprehensive water pressure management
- Renovation, replacement or re-design of the small diameter network for improved hydraulic capacity

6.8.2 Result of Activity

Results of PRV planning and designing for the seven DMAs out of 28 DMAs were reported in Section 4.3.2. The NRW Technical Sub-Team analyzed network models for the remaining 21 DMAs to examine the replacement of pipelines and propose their pipeline list as shown in Table 6.8-1.

Table 6.8-1 List of the Pipes to be replaced

Diameter	Material	Length (m)		PN (Nominal Pressure)	Remarks
		Existing	To be replaced		
15mm	PVC	0	0		
	GI	30	0		
	Poly	55	0		
	DuX*	0	0		
	DCI	0	0		
20mm	PVC	0	0		
	GI	56	0		
	Poly	346	0		
	DuX	54	0		
	DCI	0	0		
25mm	PVC	0	0		
	GI	144	0		
	Poly	260	0		
	DuX	0	0		
	DCI	0	0		
40mm	PVC	20	0		
	GI	0	30	10	
	Poly	85	140	10	
	DuX	0	0		
	DCI	0	0		
50mm	PVC	0	0		
	GI	310	200	10	
	Poly	165	521	10	
	DuX	0	54	10	
	DCI	0	0		
75mm	PVC	49	0		
	GI	485	310	10	
	Poly	0	170	10	
	DuX	0	0		
	DCI	0	0		

Diameter	Material	Length (m)		PN (Nominal Pressure)	Remarks
		Existing	To be replaced		
100mm	PVC	1219	49	12	For Skyline
	GI	0	485	10	
	Poly	16	80	10	
	DuX	0	0		
	DCI	0	0		
150mm	PVC	0	827	10	
	GI	0	0		
	Poly	0	0		
	DuX	0	0		
	DCI	0	0		
200mm	PVC	0	412	10	
	GI	0	0		
	Poly	0	16	10	
	DuX	0	0		
	DCI	0	0		
Total	**Total**	**3294**	**3294**		
	PN10	**-**	**3245**		
	PN12	**-**	**49**		

Source: SW

* DuX is one of manufacturer name. Pipe material is something like plastic.

6.9 Convene the Workshops to Share the Experiences, Outcomes and etc. of the Pilot Projects . (Activity 3-9)

6.9.1 Outline of Activity

The Project Team organizes workshops at intervals purposely to share information among SW staff and make them understand NRW reduction activities. In the workshops, the following are introduced:

- Schedules to implement the pilot activities
- Progress of the NRW reduction activities
- Cost incurred and cost effectiveness of the NRW reduction activities in the pilot project areas
- Results of the activities including NRW reduction
- Expected outcomes of the Project
- Lessons learnt
- Recommendations to improve NRW reduction activities in order to secure sustainability.

6.9.2 Result of Activity

The workshops and intensive lecture, etc. were held to share the overall results of the Pilot Project activities, as shown in Table 13.3-1. The workshop were mainly prepared and presented by NRW Action Team in cooperation with the JET.

6.10 Provide Capacity Development and Training using the DMA's and LCZ's as the Basis for NRW Reduction Activities. (Activity 3-10)

The Project conducted On-the Job Training (hereinafter "OJT") and lecture on NRW reduction through the Pilot Projects. Work activities implemented in 15 pilot projects areas were applied to NRW reduction activities in the DMA as a basis for NRW reduction activities.

Capacity development was especially focused on creation of DMAs and LCZs, pressure control, leakage detection, IWA balance analysis, hydraulic network analysis

6.11 Provide Technical Assistance in DMA-based Monitoring and Maintenance for improved NRW ratio after Initial NRW Reduction Activities. (Activity 3-11)

6.11.1 Outline of Activity

SW's skill to implement the following NRW reduction activities has been improved through the pilot project. In future SW will continue the NRW reduction activities in DMAs following outcomes of the NRW reduction activities.

■ Planning of NRW Reduction	■ Measuring water inaccuracy
■ IWA Water Balance Analysis	■ Estimating cos-effectiveness
■ Measuring MNF and analyzing it	■ Observing leaks and illegal connections efficiently
■ Assuming quantity of leaks	
■ Conducting step-test to identify leak point.	■ Developing database of the existing water supply facilities
■ Detecting leaks	

Meanwhile, recovery of leaks and increase of illegal connections were already observed in 15 pilot project areas where the initial NRW reduction activities were completed. These occurrences were caused by increase of water pressure due to operation of water supply facilities which were constructed under grant aid project, and strict disconnection against arrear. After countermeasures in NRW reduction, prompt and efficient monitoring works are required in the 28 DMAs.

6.11.2 Result of Activity

Routine activities on NRW reduction are very important so as to keep NRW ratio at low level. Therefore, the JET assisted in development of workflow on a series of NRW reduction activities, as well as techniques for data processing, graph representation and key perspective of data analysis through OJT. Figure 5.4-1 shows final workflow revised through monitoring and maintenance activities in Tasahe A&B and West Kola Ridge A.

CHAPTER 7 ACTIVITIES FOR OUTPUT-4: Water meter reading and billing process management are improved.

7.1 Formulate the Work Schedule and Staff Assignment Plan for Water Meter Readers. (Activity 4-1)

7.1.1 Outline of Activity

To ensure meter reading work properly, the Performance Sheet which is composed of the work schedule and staff allocation plan for the meter readers was required to be formulated based on the Standard Operating Procedures (hereinafter "SOP") (see Supporting Report S7.1-1) introduced for meter reading and billing teams. Meter readers and members of billing team are clearly able to learn the purpose and process of their activity with the SOP to improve their performance.

7.1.2 Result of Activity

(1) Meter Reading

In order to fulfill the meter reading work as scheduled, the Performance Sheet for meter readers regulates meter readers to do work from 1st or 2nd of the month. Meter readers started the work as scheduled based on the Performance Sheet shown in the SOP. The SOP indicates that the monthly schedule of water meter reading should be completed within 15 business days. It is very essential that the work of water meter reading is strictly done according to the work schedule to cater for the timely process of bills and collection of water tariff.

(2) Other Tasks

As stated in the SOP, two daily tasks include providing proper reports for illegal connections and surface leakage observed as part of the roles of the water meter readers. Therefore, the Project added these two daily tasks in addition to the reading of water meters to the Performance Sheet for Meter Readers. The team members easily understood and could take note when coming across incidents of illegal connection and surface leakage. Every meter reader and other staff could access the above information on the Sheet in the office of the water meter readers. The Performance Sheet has been useful for coping with repairing of pipelines and the disconnection of illegal connections in a timely manner.

7.2 Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers. (Activity 4-2)

7.2.1 Outline of Activity

(1) Calculation Practice

Water meter readers usually use Handheld Terminals (hereinafter 'HHT') to read water meters. However, they are forced to read water meters manually without HHTs. This is because HHTs are not

normally charged enough due to the occasional power cuts in the office. Water meter readers must read water meters accurately and report the results of meter reading to the billing section regularly.

In order to improve meter reader's calculation ability, the Project introduced the training on water meter reading work, so that meter readers were able to do basic calculations. As the next step for further improving their calculation ability, training for calculation was implemented.

(2) Assembly/Disassembly of Water Meter

It is very difficult to maintain the conventional water meters used in SW due to their mechanism. Therefore, to easily maintain the water meters, the Project plans to introduce the water meters which are widely used in Japan. Compared to the existing meters of SW, the Japanese water meters has two types of different function as used in the Pilot (e.g. 1L/10L indicators) and detachable strainer built into the water meters.

About 70 water meters in Japanese types which had been procured by JICA was installed in the particular pilot project areas. Suitability of their permanent introduction in SW' service area should be examined in the light of ease of installation, easy of reading, cost, security, etc.

(3) Reporting Methods for Anomalies and Illegal Connections

Meter readers must understand abnormal situation of water consumption. Abnormal situation means anomalies of water meter readings or illegal connections.

When the meter readers recognize anomalies as well as illegal connections, they have to report to Ms. Mary Pidoke (Customer Care Officer: Acting Meter Reading Team Leader) and input these on the Performance Sheet. Leakage which is found by meter readers is immediately reported by using HHT which can also take the photo of the leak.

(4) Meter Reading

Improving water meter reading is one of the most important activities for reducing NRW. The Project conducted the practical training in order to ensure an accurate calculation of meter reading at any time. Lectures include basic information of water supply system and practice to calculate leaked volume water.

(5) 1st and 2nd Role-Play in the Work of Meter Reading

Most of water meter readers had only a short experience as a reader at the beginning of this Project. Inquiries and complaints regarding meter reading or anomalies from the customer is still in frequent situation. Meter readers, Billing team and Customer Care are required to understand basic knowledge on water supply management to give appropriate answers to customers.

In order for meter readers to improve their communication skill, in-house Role-Play was conducted as part of their skill and capacity development. In the Role-Play, every meter reader played a reader as

well as water users in front of an audience of SW staff. The audience made an assessment of their performances and provides comments on how they should improve on their communication skills with the water user. It was expected that such training would improve the confidence and the ability of water meter reader to carry out their work properly.

7.2.2 Result of Activity

(1) Calculation Practice

In order to ensure an accurate calculation of meter reading at any time, the Project conducted the practical training for two weeks every day by using the exercise materials shown in Supporting Report S7.2-1. Taking into consideration common water consumption of around 15m^3 to 30m^3 by a family in a month, water meter readers were trained by using calculation practice sheet. As a result, performance of meter readers was improved in their calculation ability and accurate reading.

(2) Assembly/Disassembly of Water Meter

Japanese water meters of sizes 13mm/20mm were used in the training to disassemble/assemble water meter during the OJT for two weeks by using handout shown in Supporting Report S7.2-2. Having learnt how to assemble and disassemble water meters, Water meter readers can recognize instances of internal leakage and/or illegal water consumption through the Pilot and to be equipped with the skill to clean meter strainers off floating material during construction and were able to clean water meters to avoid mechanical troubles.

(3) Reporting Methods for Anomalies and Illegal Connections

Regarding anomalies on water meter reading, meter readers were trained on calculation practice on meter reading. They learned to recognize discrepancy between realistic water consumption and water consumption error of plus or minus more than 30%. Photos of leakage sites were printed and sent to responsible teams on the same day. The Project has monitored these activities after they have understood reporting methods.

(4) Meter Reading

Prior to exams for interim evaluation of capacity of Customer Services Sub-Team, the Project convened intensive lectures on Meter Reading, Billing and Customer Care on 18 February 2014.

After the exams, the Project organized a follow-up lecture for the same teams to review the outcome of the exam and to further explains certain areas that the staff still have difficulties on. This review lecture was held on 20 February 2014. These lectures intend to reach the understanding of the Meter Readers Billing and Customer Care staff on their required activities as well as to help them understand the basics to water supply, water quality and water saving techniques.

(5) 1st and 2nd Role-Play in the Work of Meter Reading

It is of vital importance that meter readers can communicate efficiently with customers. However, the following issues were raised by meter reading leader and staff members of customer service;

- Limited skills to appropriately communicate and respond to customer's query.
- Display of unprofessional behaviour in front of customers

The JET held 1st role plays for the meter readers on 28 June 2013 (see Figure 7.2-1), since they had only a few appropriate opportunities to learn to communication with customers. Experienced meter readers showed good performance. Young less experienced meter readers also learned good skills to communicate well with customers through role plays. The 2nd role play was held on 29 November 2013 to confirm progress of readers' communication skills with customers based on Supporting Report S13.3-10 (see Figure 7.2-2). The JET played the role of a customer and other SW field staff also took part in this play as the following customers.

- Complaints against no water, water meter reading and other complaints
- A customer who cannot pay water charge.
- Why water charge is high?

Meter readers who have experience the 1st role play were able to support these calmly. There was no scene that provoke customer was seen as last time, by the clumsy corresponding. Communication skills of meter readers progressed in comparison with the previous role play.

Figure 7.2-1 1st Role Play in Jun. 2013

Figure 7.2-2 2nd Role Play in Nov. 2013

【Current Status of Meter Reading Activities】

The following attitudes were displayed by the meter readers during the role-play.

- They kept quiet when customers expressed their frustrations
- They displayed a conceited behaviour toward the customers.
- They were not able to sufficiently respond to customers in a manner that would ensure that they fully understand the issue.

【Comments from Water Meter Reading Leader】

Water meter reading leader pointed out some of the leading causes of the challenges faced by the

meter reading team.

- Meter readers were not given the entire schedule for pipe maintenance and water rationing; therefore the water meter readers were not equipped with adequate information to explain issues to customers.
- Water meter readers do not understand the work flow between meter reading and billing sufficiently.
- Water meter readers are not aware of their work position as one of SW's staff members

【Proposal on the above Comments】

- Prepare a manual for customer communication
- Improve communication skill for customer care
- Share information such as construction and rationing schedule to water meter reading so that they can be equipped to answer customer's queries.
- Discuss issues which are questioned and commented from customer in SW headquarter
- Be aware of work position as SW's staff member in communication with customers
- Take note of comments and claims from customers, which will be useful for improvement of water supply service
- Meter readers must maintain calmness and communicate with customers politely at any case.

【Other Issues in Water Meter Reading which should be solved】

- As some water meters are located within locked private premises water meter readers cannot read these water meters. In such cases, flat rate charges are normally imposed. This is a source of complaint from some customers.
- Those households within areas that are under heavy water rationing normally uses water less than 32m^3/household on monthlybasis but they are being charged the flat rate of monthly 32m^3/household. These customers also complain to SW.
- There are customers who can be very rude and just refused to understand what has been explained to them by the meter reader team and sometimes shouted at the SW staff.

7.3 Promote PR activities on water conservation and saving, and water tariff for the customers. (Activity 4-3)

7.3.1 Outline of Activity

(1) Awareness Meeting

Customers visit Customer Care Centre to pay their water bills. Customer queries are also answered at the customer care center. Complaints on meter reading, billing and others are also received and addressed at the customer care centre. One of the main causes of complaint is a lack of dialogue with customers. However, customers who never visit Customer Center have no opportunities to communicate with SW.

Awareness Meeting is one good solution. Awareness Meeting provides communication between residents and SW. SW knows their needs and residents understand many things such as water tariff, tips and importance on saving water and water supply system by Awareness Meeting.

(2) School Program

The latest statistics report shows that young people make up nearly 60 percent of total population in Honiara. This projected that children and teenagers make up a high percentage of users of the water services. Residents who have high awareness on saving water and water supply system pay much attention to leakage and illegal connection. When they find leakage on the ground and illegal connection, they immediately report it to SW. This contributes to reduce NRW.

The NRW Action Team conducts School Program with the support of the JET purposely to raise the children's awareness on saving water and importance of water. These children who took part in the School Program will grow up to support SW's activities for reducing NRW in Honiara.

(3) Photo Reading System

A half of the complaints from customers were related to meter readings at the initial phase of the Project as follows:

- "A meter reader has not come to read my meter, yet I still receive water bill."
- "Billing is very higher even though I do not use much water,"
- "Meter readers do not read accurately."

Customer Care Report July 2014 says inquiries and complaints from customers, accounts for 75% of the total number of customers seen. Some customers want to know more on water tariff, bill, meter accuracy and meter reading and other customers complain on above-mentioned matters. SW can cope with some enquiries and complaints from customers. However, once there are inquiries about meter, the usual practice was to send meter readers back to the site to confirm readings again. This practice consumes a lot of time and increases meter readers' working time.

Consequently, meter readers were given HHT to input data on meter reading which also have a camera function.

(4) FAQ

Number of enquires and complaints from customers reaches near a thousand every month. This has taken up almost all of the customer care time and effort.

Customer Care Team has decided to develop FAQ since most of enquires are similar such as application for new installation, bill and water quality. FAQ can support reducing Customer Care Team business volume and better management of inquiries.

(5) Public Relations using Various Medias

The radio program and brochures are the main stream public relations media.

(6) Request on Rehabilitation of the Internal Service Pipelines to the Relevant Organization

King George Sixth (KG VI) School, a government national secondary school situated in the east of Honiara had been experiencing serious issues of very high water bills. At the beginning of July 2014, SW proceeded to disconnect the service to the school after numerous reminder notices were sent for non-payment of bills.

In August of 2014, the Project Director (General Manager) of SW requested the support of the JET together with the NRW action team to make an assessment of the pipeline system within the school. The JET and NRW Action Team did a rapid assessment of the pipeline system and have suspected leakages but agreed that further studies is necessary to find out the baseline water usage in the school.

As a case study, NRW Action Team inspected the causes of high water bills of the KG VI in August 2014 and planned suggest countermeasures to the school and Ministry of Education and Human Resources Development.

7.3.2 Result of Activity

(1) Awareness Meeting

Honiara has the largest base of customers accessing SW's services and operations. The NRW Action Team organized visits to communities in and around Honiara. Updating, informing and educating customers is necessary as not all customers frequently visit the Customer Care Center of SW to access bill statements, new application information's and requirements, meter readings, payment plans, launch complaints and general enquiries on the water service they received. Furthermore, in the eight communities that were visited within the last six months as of March 2015 (see Figure 7.3-1 and Figure 7.3-2), customers learned they can help improve the service of SW when they report bursts, illegal connections and respect the facilities of SW. The awareness program provides the solution to link SW with its customers more efficiently. In fact, customers and SW' staff had question-and-answer session in the awareness meeting as shown in Table7.3-1.

Table 7.3-1 Cases of Questions and Answer in the Awareness Meeting

Questions	Answer
Former resident did not pay for water tariff, so I cannot use water because of disconnection.	A house owner should be responsible for that. The house owner is required to consult with SW office if a tenant moves out without any payment of water tariff.
Billing is so high in spite of not being supplied with water for a week. Why? I wonder why the meter reader does not come to read.	Please come to Customer Center and fill out the form. SW will assign a water meter for confirming meter reading.
Water is disconnected because former tenant did not pay water tariff. What do I do?	Come to SW office and we can discuss ways to manage the bills or who to pay for the bills. First of all, try to reconnect and pay water tariff little by little.

Source: Project Team

Figure 7.3-1 Awareness Meeting on 4 April 2013

Figure 7.3-2 Question & Answer in the Awareness Meeting on 17 August 2014

(2) School Program

Organizing school visits are necessary to inform and educate the young generation to be responsible water users by reporting leakages, illegal connections, bursts and tariff charges of SW. The NRW Action Team organized school visits on a monthly basis and a total of at least ten community high schools were visited from October 2014 to promote the message of good water citizen (see Figure 7.3-3 and Figure 7.3-4). The Solomon Islands household name and comedian "Nati" was also part of those visits. His inclusion to the good water citizen campaign drawn more attention and sets the agenda for children to discuss and openly share their views on saving water, understand the tariff prices and responsibility to report leakages, illegal connections and bursts. Moreover, they also learned to understand that illegal connection would be unacceptable and would be an offense which is punishable by law, because illegal connections would affect management on water supply service, water use of community and social environment negatively.

Figure 7.3-3 School Program in August 2014

Figure 7.3-4 School Program in March 2015

(3) Photo Reading System

Photo reading system was introduced in August 2014. Meter readers took photos of water meters when they visited to read water meters using HHT. Each of the photos taken was recorded with the date and time and the coordinates of the water meter. When returning to the SW head office, the meter readers

cross-check the meter reading results with another meter reader using photo reading data.

After introducing Photo Reading System, the numbers of complaints reading meter reduced. When a customer asks of billing amount (usually billing is too high in spite of not using too much water), billing section can check a customer's inquiry within several minutes using Photo Reading System. Consequently, a sum of inquiries and complaints from customers was reduced by 34% between July 2014 and March 2015 (see Table 7.3-2).

Table 7.3-2 Effectiveness by introducing Photo Reading System

Date	Total No. [1]=[2]+[3]	Complaint [2]	Enquiries		
			Sub-Total [3]=[4]+[5]	Enquiries on meter reading [4]	Other enquiries [5]
b. July 2014	997	283	714	463	251
c. August 2014	659	187	472	354	118
d. Reduction Rate (a.- b.) / a.	33.9%	33.9%	33.9%	23.5%	53.0%

Source: Project Team

(4) FAQ

The JET supported Customer Care Team to develop FAQ sheet. FAQ consist of several parts based on customer's inquires. The FAQ has a similar format like other brochure making it easy to distribute to customers. FAQ is attached in Supporting Report S7.3-1.

(5) Public Relations using Various Medias

1) Radio Program

The radio program proved to be a very effective medium for sharing important information's regarding the services and operations of SW as shown in Table 7.3-3. SW broadcasts about theme on service connections for six months a year. Broadcasted on the national airwaves with a coverage that is nationwide, the thirty-minute program came on the airwaves fortnightly and used to inform and educated customers of SW service on the water tariff, services rates and charges, disconnections, reconnections, illegal connections and the non-revenue water project (see Figure 7.3-5).

Table 7.3.3 Radio Program Outline for the Year of 2015

Period	Main Topics
Jan. Feb. Mar.	■ Introduction of topic: Customer Service, locations if necessary and important services Solomon water offers - New Connections - Disconnections - Reconnections - Illegal Users - Changes of Address - Relocations of Meter
Apr. May. Jun.	■ Different Units - Network Operations & NRW - Network Maintenance - Source Treatment and Pump Maintenance - Provincial Operations and Leakage - Water Quality - GIS
Jul. Aug. Sep.	■ Different Units - Debt Recovery - Meter Reading

Period	Main Topics
Oct. Nov. Dec.	■ Introduction of topic: Customer Service, locations if necessary and important services Solomon water offers - New Connections - Disconnections - Reconnections - Illegal Users - Changes of Address - Relocations of Meter

SW radio program featuring Network and Mr. Benjamin Billy (Task force leader of NRW Project)
Date: 14 October 2014
Location: Solomon Islands Broadcasting Corporation News Room (SIBC)
Photo: NRW Action Team

Figure 7.3-5 Radio Program

2) Facebook Social Page

SW has more than 1000 social media users subscribing to its Facebook page. Since Facebook has been a popular page for online interaction, this medium has been used to update and inform our customers of their bill statements, tariff and new connection applications, planned and unplanned interruptions; NRW Project updates as well as the host to feedbacks of general complaints, queries, faults, bursts, illegal connections and SW's service rates and charges.

3) Web Site and Newspaper

SW NRW Action Team created cartoon strips for the public audiences. SW advertised on the front page of Island Sun and Solomon Star three times a week for a period of one month in February 2015 and daily on the SW Web site (http://www.solomonwater.com.sb/index.php). The cartoon strips shares information's on the need for customers to be responsible for their bills (see Figure 7.3-6).

Source: Project Team

Figure 7.3-6 Cartoon Strip on the SW Web Site

(6) Request on Rehabilitation of the Privately-owned Service Pipelines to the Relevant Organizations

In August of 2014, the former GM at the time has suggested that Solomon Water should provide technical assistance to KG VI School at no cost following the schools ongoing issue with high water bills. The JET provided expert advice and in cooperation with the SW side performed a MNF measurement for the school and surveyed the existing pipe network of the school. Physical observation of the existing pipe network within the school was very old and leaking at many at several sections which is evident by the high MNF of 4.8m^3/h or 5.8m^3/km/h measured on 16 September 2014. In actual fact the flow was almost consistent over the one day period when measurements were taken at above 5m^3/h even during the early hours of the morning. Also the pipe type in the school was predominantly imperial which is not compatible with the metric types that are widely available in Honiara resulting in leakages that went unfixed. Leakages in the internal plumbing were also an issue at that time.

Following the assessment, the former GM has agreed that SW should render help to the school in replacing the pipelines following requests from the Ministry of Education which was planned for December 2014 or January 2015 during the school holidays. The Ministry has agreed to meet the cost of materials and all necessary items for the replacement work and SW on its part prepared a material breakdown for the replacement work and costing. Shortly after in around December, the GM resigned.

In January 2015 when the Ministry pursued with a contract to sign with SW being the proposed contractor, the Board's chairman of SW stepped in and disallowed SW to take part in this project which also ends any further involvement by SIWA on the above matter.

The Ministry resorted to do an opening bidding for interested companies to do the replacement work which eventually took place in the later part of 2015.

7.4 Monitor the water meter reading and billing activities. (Activity 4-4)

7.4.1 Outline of Activity

Water meter reading and billing teams started their activities in March 2013 according to the SOP which had also been prepared in the same month of 2013. The Project monitored the meter reading and billing team's activities and outputs through the Pilot Project areas and DMAs.

7.4.2 Result of Activity

The Project monitored the meter reading and billing team's activities and outputs across Honiara.
Their activities have continuously being monitored by the Project since June 2013. Meter readers and billing team performed well based on the SOP.

On the other hand, SW has serious problems on illegal users and arrears. Customer who does not pay their water bills have their water supply disconnected by SW. In this case SW loses its income and the customers are disadvantaged by not receiving water. Recently SW took the following actions with the exception of disconnection of service pipelines to eliminate them.

1) Illegal Connections

First action was to exempt from the payment of penalty and or unpaid tariff for illegal connection users if illegal users declared on illegal connection within a few weeks after SW notified users. On the other hand, if the illegal connection is discovered by SW, billing amount dating back over the past two years is forced to be collected.

2) Arrears

Of total arrear of SBD39million, an exemption of SBD26million was approved by SW board members in January 2015 but exemption has not been fulfilled yet because SW is struggling to setup precondition of the exemption for users.

In addition, the JET has suggested that a welfare policy must be considered in order not to cause arrear again (see Table 7.4-1).

Table 7.4-1 Welfare Policy on Water Charges Payment (Draft)

<table>
<tr><th colspan="3">Yokohama Waterworks Bureau</th><th colspan="3">SW</th></tr>
<tr><td>No</td><td>Classification</td><td>Reduction/exemption</td><td></td><td>Classification</td><td>Amnesty</td></tr>
<tr><td rowspan="4">1</td><td>People with disability (disable mentally ill, intellectual disability, etc.)</td><td>Water/sewage basic charges equivalent (Continuation)</td><td rowspan="4">1</td><td>Illegal user</td><td>Water charges</td></tr>
<tr><td colspan="2">● 0-8 m^3/m 1,490 yen (SBD108)</td><td colspan="2" rowspan="3">Plan
● Illegal user should inform within 2/3 weeks, after SW declares this amnesty.
● Illegal user should pay last two-year-illegal fee except above case.
● Applies to pilot project areas and DMA area only.
● Only domestic user is applied.</td></tr>
<tr><td>Facility: Social welfare facility, Kindergarten</td><td>Water/sewage water charges; -10% (Continuation)</td></tr>
<tr><td>Medical facility</td><td>Water/sewage water charges; -6% (Continuation)</td></tr>
<tr><td>2</td><td>Leakage after water meter</td><td>Reduction on the part of the leakage amount (One time/amnesty)</td><td>2</td><td>Disconnection user</td><td>Water tariff applied is 80 % off.</td></tr>
</table>

Yokohama Waterworks Bureau			SW		
	● Condition: Submit certification of repaired leakage			● Disconnection user has to pay 20 % of water charges and reconnection charges. ● Only applied to domestic users..	
3	One water meter with (more than) two households	Calculation as two water meters (Continuation)			

Source: Project Team

7.5 Report the monitoring results, such as anomalies and illegal connections, to the responsible sections. (Activity 4-5)

7.5.1 Outline of Activity

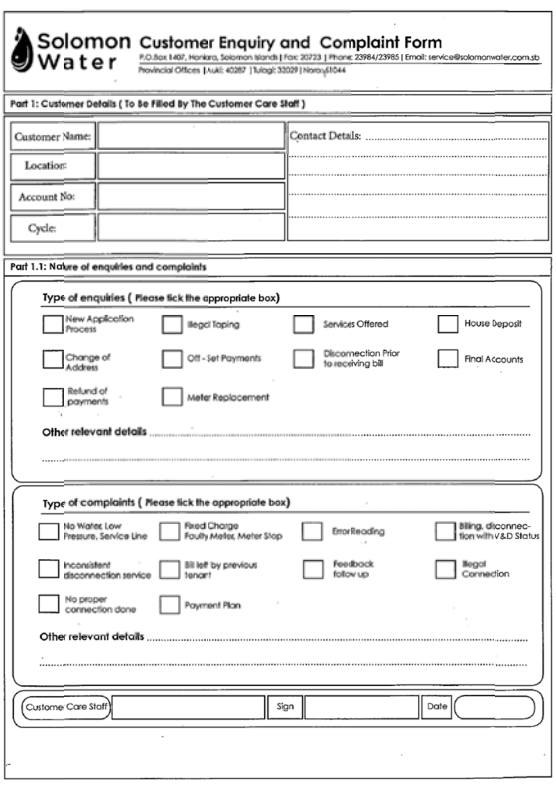
When the pilot project started in March 2013, it became evident illegal connections is a serious ongoing social issue SW faces. Water meter readers were directed as part of their responsibility to identify illegal connections and/or surface leakage, etc. and to report these issues to the responsible team such as new/disconnection and repair teams.

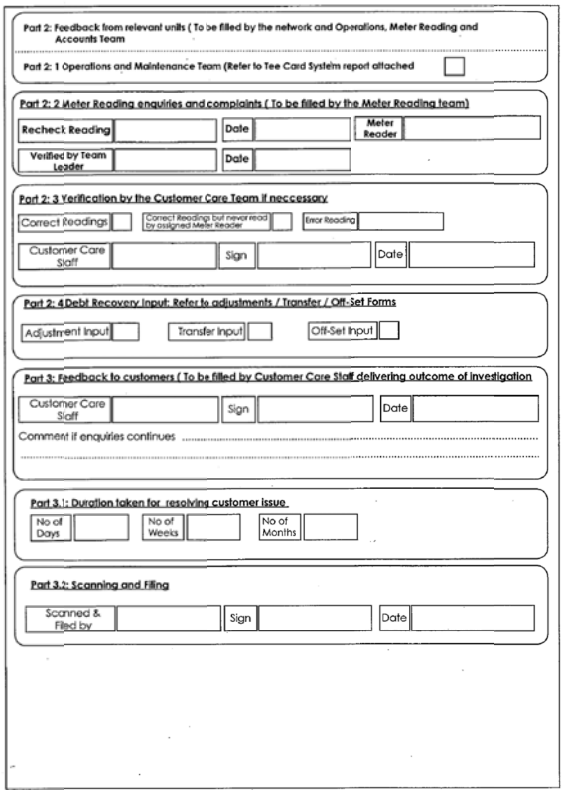
In order to properly record activities such as disconnections of illegal connections, pipe replacement and meter replacement for defective meters, the Project introduced a proper reporting procedure in the SOP. Furthermore, when a meter reader finds illegal connection or leakage at the site, he/she must make attempts to take photos of them. The meter readers then record the findings in relevant forms, and submit them to the responsible section with the photos. The responsible section can confirm the location of illegal connection/leakage using the photo.

7.5.2 Result of Activities

“Enquiry and Complaint Form” was revised in October 2014. It was required that Customer Care Team completes Part 1 of the form and Technical Team fills in Part 2 as shown in Figure 7.5-1. After returning the forms back to customer care, they fill in Part 3. This process enables SW to respond quickly to customer complaints.

- Part 1: Customer Details
- Part1-1 Feature of Enquiries and Complaints
- Part 2: Feedback from relevant units
- Part 2-1 Operations and Maintenance Team
- Part 2-2 Meter Reading enquiries and complaints
- Part 2-3 Verification by the Customer Care Team
- Part 2-4 Debt Recovery Input
- Part 3: Feedback to customers





Part 1 **Part 2 & Part 3**

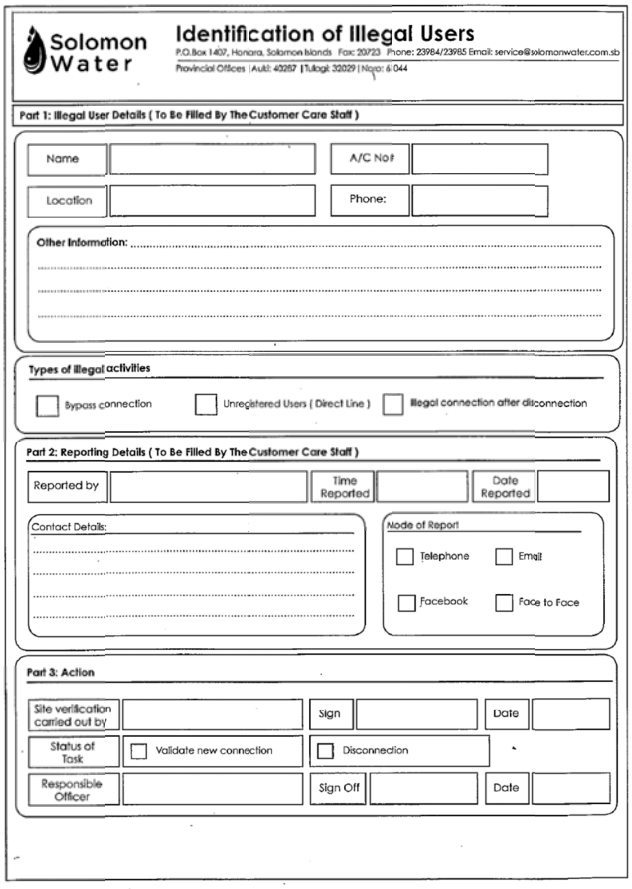
Source: SW

Figure 7.5-1 Enquiry and Complaint Form

The form is filled in by responsible sections (see Figure 7.5-2)

- Part 1: Illegal User Details
- Part 2: Reporting Details
- Part 3: Action

Each meter reader brings HTT to record meter reading data and take photos of the meter. Once a meter reader finds illegal connection, it was required that the photo of the illegal connection is taken and submitted to the responsible section with the illegal connection report. The location of the illegal connection site was recorded in the photo data by HHT's GPS function and GIS Team records this on the System. Related section on illegal connection can access data of illegal connection sites by GIS, so that they will be able to monitor illegal users with those data efficiently.



Solomon Water

Identification of Illegal Users

P.O.Box 1407, Honiara, Solomon Islands Fax: 20723 Phone: 23984/23985 Email: service@solomonwater.com.sb
Provincial Offices | Auki: 40287 | Tulagi: 32029 | Noro: 61044

Part 1: Illegal User Details (To Be Filled By The Customer Care Staff)

Name		A/C No?	
Location		Phone:	

Other Information: .....

.....

.....

.....

Types of Illegal activities

☐ Bypass connection ☐ Unregistered Users (Direct Line) ☐ Illegal connection after disconnection

Part 2: Reporting Details (To Be Filled By The Customer Care Staff)

Reported by		Time Reported		Date Reported	

Contact Details:

.....

.....

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Mode of Report

☐ Telephone ☐ Email

☐ Facebook ☐ Face to Face

Part 3: Action

Site verification carried out by		Sign		Date	
Status of Task	☐ Validate new connection	☐ Disconnection			
Responsible Officer		Sign Off		Date	

Source: SW

Figure 7.5-2 Form of Identification of Illegal Users

CHAPTER 8 INPUTS

8.1 Input by Japanese Side

8.1.1 JICA Experts

The track records of the JET are shown in Figure 8.1-1 to Figure 8.1-5.

	Title	Name	Organization	Rank	2012 Phase-1 10	11	12	2013 Phase-1 1	2	3	Total (Man/Month) Solomon	Japan
Works in Solomon Islands / Japan	Leader/Water Supply Planning, Operation & Management	Taketoshi FUJIYAMA	YEC	2	(2) □ 3	(28) 30	(31) 1 31		(2) 27 28	(31) 1 31	3.07	0.07
	Deputy Leader/NRW Reduction Measures - 1	Akinori MIYOSHI	YEC	3					(15) 14 28	(16) 1 16	1.03	-
	NRW Reduction Measures - 2	Masatoshi SENO	YEC	3		(5) 26 30	(31) 1 31	(31) 1 31	(23) 1 23		3.00	-
	Leakage Detection Technology	Akihiko OKAZAKI	YEC (Sub-contract)	3		(7) 24 30	(22) 1 22		(15) 14 28	(9) 1 9	1.77	-
	GIS	Masakazu ASAI	YEC (Sub-contract)	4		(7) 24 30	(22) 1 22		(15) 14 28	(16) 1 16	2.00	-
	Customer Service & Public Relations, Management of training in Japan	Kenji KASAMATSU, Yoshiharu WADA	YWC	3/5*		(12) 19 30	(18) 1 18		(22) 7 28	(9) 1 9	2.03	-
	GIS Adviser	Norio ISHIJIMA, Kazutoshi MASUDA	YEC (Sub-contract)	-		(7) 24 30	(8) 1 8					
	Coordinator	Akiko SAKAMOTO	YEC	-		(28) 3 30	(1) 1			(6) 26 31		
											12.90	0.07
Report	Time of Submission				(1) I/CR							
	Work in Japan				Preparation □							
	(Man/Month Total)				0.13							
Total					■						12.90	0.07
											12.97	

<Legend> ■: Work in Solomon Islands □: Work in Japan ⁘: Unauthorized

YEC: Yachiyo Engineering Co., Ltd. YWC : Yokohama Water Co., Ltd.

(1): Inception Report (IC/R)

*: 3 for work in Solomon, 5 for work in Japan

Figure 8.1-1 Result of Dispatch of JICA Experts (Phase-1: October 2012 - March 2013)

	Title	Name	Organization	Rank	2013 Phase-2 4	5	6	7	8	9	10	11	12	2014 1	2	3	Total (Man/Month) Solomon	Japan
Works in Solomon Islands / Japan	Leader/Water Supply Planning, Operation & Management	Taketoshi FUJIYAMA	YEC	2	(27) 1 27	(10) 22 31	(30) 1 30	(15) 1 15			(29) 3 31	(30) 1 30	(6) 1 6				4.90	-
	Deputy Leader/NRW Reduction Measures - 1	Akinori MIYOSHI	YEC	3					(29) 3 31	(21) 1 21				(16) 16 31	(28) 1 28	(1) 1	3.17	-
	NRW Reduction Measures - 2	Masatoshi SENO	YEC	3	(15) 16 30	(27) 1 27				(15) 16 30	(31) 1 31	(5) 1 5					3.10	-
	Leakage Detection Technology	Akihiko OKAZAKI	YEC (Sub-contract)	3					(29) 3 31	(2) 1 2		(21) 9 29					1.73	-
	GIS	Masakazu ASAI	YEC (Sub-contract)	4					(24) 3 26					(7) 25 31	(14) 1 14		1.50	-
	Customer Service & Public Relations, Management of training in Japan	Kenji KASAMATSU, Yoshiharu WADA	YWC	3/5*	(16) (8) (23)		(25) 6 30	(5) 1 5			(16) (7) (22)	(12) 19 30	(5) 1 5		(17) 8 24		3.20	1.07
	GIS Adviser	Norio ISHIJIMA, Kazutoshi MASUDA	YEC (Sub-contract)	-														
	Coordinator	Akiko SAKAMOTO	YEC	-	(27) 1 27													
																	17.60	1.07
Report	Time of Submission				(2) P/R1						(3) P/R2							
	Domestic Work (Man/Month Total)				Training in Japan 0.53						Training in Japan 0.53							
Total																	17.60	1.07
																	18.67	

<Legend> ■: Work in Solomon Islands □: Work in Japan ⁘: Unauthorized

YEC: Yachiyo Engineering Co., Ltd. YWC : Yokohama Water Co., Ltd.

(2): Progress Report 1 (P/R1), (3): Progress Report 2 (P/R3)

*: 3 for work in Solomon, 5 for work in Japan

Figure 8.1-2 Result of Dispatch of JICA Experts (Phase-2: April 2013 - March 2014)

	Title	Name	Organization	Rank	2014 Phase-3 4	5	6	7	8	9	10	11	12	2015 1	2	3	Total (Man/Month) Solomon	Japan
Works in Solomon Islands / Japan	Leader/Water Supply Planning, Operation & Management	Taketoshi FUJIYAMA	YEC	2	(30) 1 30	(21) 1 21			(29) 3 31	(1) 1 (3) 28 30	(31) 1 31	(7) 7		(18) 14 31	(18) 1 18		5.27	-
	Deputy Leader/NRW Reduction Measures - 1	Akinori MIYOSHI	YEC	3		(17) 15 31	(30) 1 30	(4) 1 4	(21) 11 31	(8) 1 8					(19) 10 28	(31) 1 31	4.33	-
	NRW Reduction Measures - 2	Masatoshi SENO	YEC	3													0.00	-
	Leakage Detection Technology	Akihiko OKAZAKI	YEC (Sub-contract)	3			(30) 1 30	(2) 1 2							(20) 9 28	(21) 1 21	2.43	-
	GIS	Masakazu ASAI	YEC (Sub-contract)	4			(21) 1 21				(18) 4 21						1.30	-
	Customer Service & Public Relations, Management of training in Japan	Kenji KASAMATSU, Yoshiharu WADA	YWC	3/5*			(16) (3) (18)			(4) 27 30	(13) 1 13						1.10	0.53
	GIS Adviser	Norio ISHIJIMA, Kazutoshi MASUDA	YEC (Sub-contract)	-			(20) 1 20											
	Coordinator	Akiko SAKAMOTO	YEC	-														
																	14.43	0.53
Report	Time of Submission				(4) P/R3						(5) P/R4							
	Domestic Work						Training in Japan											
	(Man/Month Total)						0.53											
Total																	14.43	0.53
																	14.96	

<Legend> ■: Work in Solomon Islands □: Work in Japan ⁘: Unauthorized

YEC: Yachiyo Engineering Co., Ltd. YWC : Yokohama Water Co., Ltd.

(4): Progress Report 3 (P/R3), (5): Progress Report 4 (P/R4)

*: 3 for work in Solomon, 5 for work in Japan

Figure 8.1-3Result of Dispatch of JICA Experts (Phase-3: April 2014 - March 2015)

	Title	Name	Organization	Rank	2015 Phase-4 4	5	6	7	8	9	10	11	12	2016 1	2	3	Total (Man/Month) Solomon	Japan
Works in Solomon Islands / Japan	Leader/Water Supply Planning, Operation & Management	Taketoshi FUJIYAMA	YEC	2	(12) 19 30	(20) 1 20	(13) 18 30	(8) 1 8	(22) 10 31		(24) 8 31	(4) 1 4				(26) 6 31	4.30	-
	Deputy Leader/NRW Reduction Measures - 1	Akinori MIYOSHI	YEC	3	(9) 1 9			(17) 15 31	(12) 1 12		(7) 24 30	(24) 1 24				(12) 20 31	2.70	-
	NRW Reduction Measures - 2	Masatoshi SENO	YEC	3													0.00	-
	Leakage Detection Technology	Akihiko OKAZAKI	YEC (Sub-contract)	3			(30) 1 30	(11) 1 11	(13) 19 31	(19) 1 19							2.43	-
	GIS	Masakazu ASAI	YEC (Sub-contract)	4	(5) 26 30	(13) 1 13					(11) 20 30	(7) 1 7 10					1.20	-
	Customer Service & Public Relations, Management of training in Japan	Kenji KASAMATSU, Yoshiharu WADA	YWC	3/5*		(17) 2 18											0.57	-
	GIS Adviser	Norio ISHIJIMA, Kazutoshi MASUDA	YEC (Sub-contract)	-		3 20					27 14							
	Coordinator	Akiko SAKAMOTO	YEC	-														
																	11.20	0.00
Report	Time of Submission				(6) P/R5													
	Domestic Work (Man/Month Total)																	
Total																	11.17	0.00
																	11.17	

<Legend> ■: Work in Solomon Islands □: Work in Japan ⋯: Unauthorized

YEC:Yachiyo Engineering Co., Ltd. YWC : Yokohama Water Co., Ltd.

(6): Progress Report 5 (P/R5)

*: 3 for work in Solomon, 5 for work in Japan

Figure 8.1-4 Result of Dispatch of JICA Experts (Phase-4: April 2015 - March 2016)

	Title	Name	Organization	Rank	2016 Phase-5 4	5	6	Total (Man/Month) Solomon	Japan
Works in Solomon Islands / Japan	Leader/Water Supply Planning, Operation & Management	Taketoshi FUJIYAMA	YEC	2	(1) 1	(3) 29 31	(27) 1 27 (1)	1.03	0.03
	Deputy Leader/NRW Reduction Measures - 1	Akinori MIYOSHI	YEC	3	(18) 1 18			0.60	-
	NRW Reduction Measures - 2	Masatoshi SENO	YEC	3				0.00	-
	Leakage Detection Technology	Akihiko OKAZAKI	YEC (Sub-contract)	3				0.00	-
	GIS	Masakazu ASAI	YEC (Sub-contract)	4				0.00	-
	Customer Service & Public Relations, Management of training in Japan	Kenji KASAMATSU, Yoshiharu WADA	YWC	3/5*				0.00	-
	GIS Adviser	Norio ISHIJIMA, Kazutoshi MASUDA	YEC (Sub-contract)	-					
	Coordinator	Akiko SAKAMOTO	YEC	-					
								1.63	0.03
Report	Time of Submission						(7) F/R		
	Domestic Work (Man/Month Total)						Documentation 0.03		
Total								1.67	0.03
								1.70	

<Legend> ■: Work in Solomon Islands □: Work in Japan
YEC: Yachiyo Engineering Co., Ltd. YWC :Yokohama Water Co., Ltd.
(7): Final Report (F/R)
*: 3 for work in Solomon, 5 for work in Japan

Figure 8.1-5 Result of Dispatch of JICA Experts (Phase-5: April 2016 - June 2016)

8.1.2 Training of Counterpart Personnel in Japan

(1) Participants

CP members who participated in the Training in Japan are listed as shown in Table 8.1-1.

Table 8.1-1 Participants on Counterpart Trainings in Japan

No.	Name	Field in the Project	Affiliation*2
1st Training (NRW Management) in 8 - 24 April 2013*1			
1	Ms. Ellen Maruarofa	Service Delivery & Communications Manager	Service Delivery & Comm. Div.
2	Mr. Benjamin Billy Bulao	Action Team Leader 1 / Sub-Team Leader (NRW Taskforce Leader)	Technical Division
3	Mr. Austin Ata	Deputy Sub-Team Leader (Customer Connections)	Service Coordinator, Customer Care & Communication Division,
4	Ms. Daisy Rose Menaga	Deputy Sub-Team Leader (Mater Reading)	Meter Reading Team
2nd Training (NRW Action) in 7 - 25 October 2013*1			
1	Mr. Mathias Vau Chenga Bera	Pipe Repair (Network Pipe Maintenance & Repair)	Technical Division
2	Mr. Frank Daukalia	Meter Repair/Replacement (Pipe Materials Management & Procurement)	Technical Division
3	Mr. Mathew Mafe Tevasa	Leak. Detection Sub-Team	Technical Division
4	Mr. Gavin Basiori Bare	Sub-Team Leader (GIS Technician)	Technical Division
3rd Training (Meter Reading, Billing and Tariff Collection) in 3 - 18 June 2014*1			
1	Ms. Kofana Tima B.	Human Resources Manager	Human Resources Division
2	Mr. Iroi Lawrence Fadaua	Chief Accountant	Revenue Collector, Finance Division
3	Ms. Tinarai Roster Ihodi	Deputy Sub-Team Leader (Debt Collection)	Debt Collection, Finance Division
4	Ms. Pidoke Marilyn Boke	Customer Care Officer	Service Delivery & Comm. Div.

Source: JET

*1 Training period does not include travel days. *2 Affiliation at the time of the training.

(2) 1st Training (Training for NRW Management)

1) Objective

The trainees are to acquire knowledge, improve their skills on NRW reduction activities and understand management of NRW reduction considering water supply business in order to contribute to the Project and improvement of SW's water supply service.

2) Schedule and Contents of the Training

Table 8.1-2 shows schedule and contents of the 1st training (Solomon Training for NRW Management).

3) Achievement by the Training

The trainees gained the following knowledge and improved skills:

- Theory, measures and plan strategy of management on Japanese water supply service.

- Measures on NRW reduction in Yokohama city and Okinawa prefecture from the perspective of Water Supply Management
- Preparation of action plan on NRW reduction activities
- Practical work on NRW reduction
- Practical work on meter reading, billing and tariff collection, and customer services

(3) 2nd Training (Training for NRW Action)

1) Objective

The trainees are to acquire knowledge and improve their skills on NRW reduction activities in order to contribute to the Project and improvement of SW's water supply service.

2) Schedule and Contents of the Training

Table 8.1-3 shows schedule and contents of the 2nd training (Solomon Training for NRW Action).

3) Achievement by the Training

The trainees gained the following knowledge and improved skills:

- Measures on NRW reduction in Yokohama city and Okinawa prefecture from the perspective of Water Supply Management
- Practical work on NRW reduction
- Practical work on meter reading, billing and tariff collection, and customer services

(4) 3rd Training (Training for Meter Reading, Billing and Tariff Collection)

1) Objective

The trainees are to acquire knowledge and improve their basic skills on NRW reduction activities and water meter reading, billing tariff collection in order to contribute to the Project and improvement of SW's water supply service.

2) Schedule and Contents of the Training

Table 8.1-4 shows schedule and contents of the 3rd training (Training for Meter Reading, Billing and Tariff Collection).

3) Achievement by the Training

The trainees gained the following knowledge and improved skills:

- Measures on NRW reduction in Yokohama city and Okinawa prefecture from the perspective of Water Supply Management
- Practical work on meter reading, billing and tariff collection, and customer service

Table 8.1-2 The First Training in Japan: Solomon Training for NRW Management

Name	Ms. Ellen INAHIA		Service Delivery and Communications Manager, Action Team Leader 2 / Sub-Team Leader (Customer Care and Communications Manager					
	Mr. Benjamin Billy BULAO		Action Team Leader 1 / Sub-Team Leader (NRW Taskforce Leader)					
	Mr. Austin ATA		Deputy Sub-Team Leader (Customer Connections)					
	Ms. Daisy Rose MENAGA		Deputy Sub-Team Leader (Meter Reading)					
Training Area	Water Supply (Yokohama City and Okinawa Prefecture Enterprise Bureau (OPEB)), Outline of Waterworks in Naha and Miyakojima, NRW Reduction Measures/Leakage Measures, Water Charge Management and so on.							
Duration	From 8th April, 2013 until 24th April, 2013							
Venue	JICA Yokohama, Yokohama Water Company (YWC), Yokohama Waterworks Bureau (YWB), Okinawa Prefecture Enterprise Bureau (OPEB), Miyakojima Waterworks (MW), Naha City Waterworks & Sewerage Bureau (NWSB), and other relevant organisations							
Outline	Water supply utilities in Japan tackle NRW Reduction. The first training in Japan was conducted at YWB, Naha City in Okinawa and Miyakojima City for the following topics: ▪Yokohama City: Introduction of general policies and approaches on NRW countermeasures. ▪Okinawa Prefecture: Visit of a dam that OPEB manages to distribute water to each community and conduct of practical training for water quality analysis. ▪Miyakojima City: Experience of leak detection and repair leaks at sites and introduction of measures against water theft and ones for water purification and conservation of water resources. ▪Naha City: Visit of monitoring facility of the water supply and service reservoir and introduction of water tariff system.							
Contents	8th Apr.		▪ Briefing ▪Courtesy Call to the YWC ▪Program Orientation (Outline of Waterworks in Japan and Yokohama City)	JICA Yokohama YWC	17th Apr.	Lecture Practical Training	▪NRW Reduction Activities of Miyakojima City ▪Leak Detection and Repair	MW
	9th Apr.	Lecture	▪ Water Supply / Distribution Plan ▪ NRW Reduction Basic Plan (1)	YWC	18th Apr.	Lecture Practical Training	▪Conservation of Water Resources ▪Biological Purification Method ▪ Sand-used Slow Filtration Apparatus at Water Purification Plant	Miyakojima City Sodeyama Water Purification Plant
	10th Apr.	Lecture Practical Training	▪ NRW Reduction Basic Plan (2) ▪ NRW Reduction and Leak Detection	YWB	19th Apr.	Observation	▪ Water Theft Countermeasures and Process of Meter Reading, Billing Activities, Rate Collection and Disconnection	MW
	11th Apr.	Practical Training	▪ Mapping System ▪ Leak Repairing Works	YWB	20th Apr.	Practical Training	▪Review of Trainings	
	12th Apr.	Lecture Practical Training	▪Awareness Activity at a Primary School ▪Policies and Procedures on Meter Reading, Billing Activities, Rate Collection in Yokohama City	Yokohama City Kikuna Water Plaza JICA Yokohama	21st Apr.	Practical Training	▪ Preparation of Final Presentation	
	13th Apr.	Practical Training	▪Review of Trainings		22nd Apr.	Lecture	▪Outline of Waterworks , Water Supply Facility and Distribution Monitoring System of Naha City ▪NRW Reduction Activities of Naha City	NWSB
	14th Apr.	Practical Training	▪Review of Trainings		23rd Apr.	Lecture	▪Management and Revision of Water Tariff ▪Question and Answer Session	NWSB
	15th Apr.	Lecture Observation	▪Outline of Waterworks of OPEB ▪Water Source Development in Small Rivers ▪Mapping System /Management of Drawings	OPEB	24th Apr.		▪Preparation of Final Presentation and Departure ▪Final Presentation , Evaluation Session and Conferment of Completion Certificate	JICA Yokohama
	16th April	Lecture Observation	▪Water Quality Management at OPEB ▪Water Resource Visit (Kurashiki Dam)	OPEB Water Quality Control Office Kurashiki Dam, Okinawa Pref.				

Table 8.1-3 The Second Training in Japan: Solomon Training for NRW Action

Name	Mr. Mathias Vau Chenga BERA	Head of Pipe Repair (Network Pipe Maintenance and Repair)
	Mr. Frank DAUKALIA	Head of Meter Repair / Replacement (Pipe Materials Management and Procurement)
	Mr. Gavin Basiori BARE	GIS Technician, GIS Sub-Team
	Mr. Matthew Mafe TEVASA	Plumber, Leakage Detection Sub-Team
Training Area	Water Supply (Yokohama City and Okinawa Prefecture Enterprise Bureau (OPEB)), Outline of Waterworks in Naha and Miyakojima, NRW Reduction Measures/Leakage Measures, Water Charge Management and so on.	
Duration	From 7th October, 2013 until 25th October, 2013	
Venue	JICA Yokohama, Yokohama Water Company (YWC), Yokohama Waterworks Bureau (YWB), Okinawa Prefecture Enterprise Bureau (OPEB), Miyakojima Waterworks (MW), Naha City Waterworks & Sewerage Bureau (NWSB), and other relevant organisations	
Outline	Water supply utilities in Japan tackle NRW Reduction. The second training in Japan was conducted at YWB, Naha City in Okinawa and Miyakojima City for the following topics: ▪Yokohama City: Introduction of general policies and approaches on NRW countermeasures, meter reading, billing and mapping system. ▪Okinawa Prefecture: Visit of a dam that OPEB manages to distribute water to each community and introduction of leak judgement. ▪Miyakojima City: Experience of leak detection and repair leaks at sites and introduction of measures against water theft and ones for water purification and water resources conservation. ▪Naha City: Visit of monitoring facility of the waterworks and distribution reservoir and introduction of water charge system.	

Contents	7th Oct.		▪Briefing ▪Courtesy Call to President of YWC ▪Introduction of Yokohama Waterworks and Water Supply Act	JICA Yokohama YWC	17th Oct.	Lecture Practical Training	▪NRW Reduction Activities of Miyakojima City ▪Leak Detection and Repair	MW
	8th Oct.	Lecture	▪ Water Supply Designing / Distribution Plan ▪ NRW Reduction Basic Plan	YWC	18th Oct.	Lecture	▪ Securing Drinking Water Using Simple Filtration Device ▪ Exchange of Opinions on NRW Reduction Countermeasures	Miyakojima City Sodeyama Water Purification Plant
	9th Oct.	Practical Training	▪ Leakage Repair Works	YWB	19th Oct.	Practical Training	▪ Review of Trainings and Preparation of Final Presentation	
	10th Oct.	Practical Training Lecture	▪Reduction of NRW and Leakage Detection ▪Process of Meter Reading, Billing, Rate Collection	YWB	20th Oct.	Practical Training	▪ Review of Trainings and Preparation of Final Presentation	
	11th Oct.	Practical Training	▪Maintenance of Water Meters ▪Mapping System	YWB	21st Oct.	Lecture	▪Outline of Waterworks , Water Supply Facility and Distribution Monitoring System of Naha City ▪NRW Reduction Activities of Naha City	NWSB
	12th Oct.	Practical Training	▪Review of Trainings		22nd Oct.	Lecture	▪ Management and Revision of Water Tariff Revision ▪ Question and Answer Session	NWSB
	13th Oct.	Practical Training	▪Review of Trainings		23rd Oct.	Observation Lecture	▪Visit of Technical Museum to Study Development of Leak Detection Equipment ▪Monitoring for Water Supply Facilities and Efficient Operation of Distribution Reservoirs	Yokohama City Nishiya Water Purification Plant
	14th Oct.	Practical Training	▪Review of Trainings		24th Oct.		▪ Question and Answer Session ▪ Preparation for Action Plan	JICA Yokohama
	15th Oct.	Lecture Observation	▪Outline of Waterworks of OPEB ▪Water source Development in Small Rivers ▪Mapping System and Management of Drawings	OPEB	25th Oct.		▪Final Presentation, Evaluation Session and Conferment of Completion Certificate ▪ Preparation for Departure	JICA Yokohama
	16th Oct.	Lecture Observation	▪Leakage Judgment by Water Quality Examination ▪Water Resources Visit (Kurashiki Dam)	OPEB Water Quality Control Office Kurashiki Dam				

Table 8.1-4 The Third Training in Japan: Training for Meter Reading, Billing and Tariff Collection

Name	Ms. Timaima Baleidramea KOFANA	Human Resources Manager
	Mr. Lawrence Fadaua IROI	Chief Accountant
	Ms. Roster Ihodi TINARAI	Deputy Sub-Team Leader (Debt Collection)
	Ms. Marilyn Boke PIDOKE	Customer Care Officer
Training Area	Efficient and Effective Conduct on Meter Reading, Customer Services and Public Relationship in Yokohama City, Okinawa Prefecture Enterprise Bureau (OPEB) and Naha City	
Duration	From 2nd June, 2014 until 19th June, 2014	
Venue	JICA Yokohama, Yokohama Water Company (YWC), Yokohama Waterworks Bureau (YWB), Okinawa Prefecture Enterprise Bureau (OPEB), Naha City Waterworks & Sewerage Bureau (NWSB), and other relevant organisations	
Outline	Topics introduced in this training are not only basic NRW reduction approaches but also important services such as customer services, PR activities, water tariff and billing management were introduced through the training. Customer service centre and other services were taken as examples besides study of main approaches in Yokohama City. Newsletter, mail magazines and Twitter as PR activities in Yokohama City were also introduced. Water Museum has been taking a role of PR activities through use of the facility by many people as an oasis as well as a place to study water system. Water Museum in Naha City was also shown during the training.	

Contents

3rd Jun.		▪ Briefing ▪ Program Orientation ▪ Introduction of Yokohama Waterworks	JICA Yokohama YWC	11th Jun.	Observation	PR Activity: Water Saving Measures, Visit PR Facility, Water Museum	NWSB
4th Jun.	Observation Lecture	▪ Customer Service Centre ▪Outline of CS, Customer Questionnaire, Complaints and Inquiries ▪Meter Reading, Billing and Measures for Unpaid Bills	YWB JICA Yokohama	12th Jun.	Lecture	▪ NRW Reduction Basic Plan ▪ Water Supply and Distribution Plan	YWC
5th Jun.	Lecture	▪Human Resources Development ▪PR Activities: PR (Newsletters, Mail Magazines, Twitter, etc.)	JICA Yokohama	13th Jun.	Observation Lecture	▪Visit Water Museum to Study History and current situation of NRW reduction and Measures for Disaster ▪History of Service Expansion Especially Measure for NRW and Disaster	Yokohama City Technical Museum and Water Museum Yokohama City Nishiya Water Purification Plant
6th Jun.	Lecture	▪ Awareness Activity at a Primary School ▪Profit Management	Yokohama City JICA Yokohama	14th Jun.	Practical Training	▪ Review of Trainings and Preparation of Final Presentation	
7th Jun.	Practical Training	▪ Review of Trainings		15th Jun.	Practical Training	▪ Review of Trainings and Preparation of Final Presentation	
8th Jun.	Practical Training	▪ Review of Trainings		16th Jun.	Lecture Practical Training	▪Risk Management by Water Safety Plans ▪ Preparation of Water Safety Plans as a Risk Management	YWC
9th Jun.	Lecture	▪Introduction of Okinawa Prefecture Waterworks and the History of OPEB ▪ Budget, Settlement of Account and Profit Management	OPEB	17th Jun.	Lecture	▪ Question and Answer Session ▪ Preparation for Action Plan	JICA Yokohama
10th Jun.	Lecture	▪ Outline, PR, and Management of NWSB ▪Rate Management: Meter Reading, Billing, Bill Collection, and Customer Care	NWSB	18th Jun.		▪Final Presentation, Evaluation Session and Conferment of Completion Certificate ▪ Preparation for Departure	JICA Yokohama

8.1.3 Provision of Machinery and Equipment

(1) Summary of Machinery and Equipment

NRW is divided into commercial loss and physical loss. Most of physical loss is caused by leakage in the distribution and service pipelines. In order to reduce NRW, it is important to learn status-quo of NRW ratio, measuring water flow rate of inlet of Project areas and their water consumptions.

The Project introduced the equipment which is required for identifying leak points, measuring water flow rate and office supplies (see Table 8.1-5). In addition, Supporting Report S8.1-1 shows the more detail information on the provided equipment.

Table 8.1-5 Machinery, Vehicle and Equipment procured and handed over to SW

No	Items	Qty	Place of Purchase			Date of Purchase (or Agreement)
			Japan	SI	AUS and or NZ	
Equipment by the JET						
1	Portable ultra-sonic flow meter	1	X			10 Jan. 2013
		1	X			Mar. 2015
2	Accessory (Detector) of ultrasonic flow meter	1	X			Jan. 2013
		1	X			Mar. 2015
3	DC battery adaptor	1	X			Jan. 2013
		1	X			Mar. 2015
4	Data logger	1	X			10 Jan. 2013
5	Water leak detector (Leak noise correlator)	1	X			4 Jul. 2013
6	Water leak detector (Acoustic type)	1	X			4 Jul. 2013
7	Metal locator	1	X			4 Jul. 2013
8	Non-metal pipe locator	1	X			4 Jul. 2013
9	Distance meter	1	X			4 Jul. 2013
10	Hammer drill	1		X		3 Jul. 2013
11	Drill bit	5		X		3 Jul. 2013
12	Boring bar	1	X			4 Jul. 2013
13	Generator	1		X		3 Jul. 2013
14	Acoustic rod	2	X			4 Jul. 2013
15	Residual chlorine analyzer	1	X			4 Jul. 2013
16	Bulk flow meter	10			X	21 Jan. 2013
17	Sluice valve (including gate valve)	12			X	21 Jan. 2013
		17			X	Dec. 2013
18	Flange adapter	32			X	May 2013
		34			X	Dec. 2013
19	Supa coupling	12			X	May 2013
		9			X	Dec. 2013
20	Concentric reducer	6			X	May 2013
21	Gasket and bolt set	50			X	May 2013
		34			X	Dec. 2013
22	Test meter	1	X			10 Jan. 2013
23	Handy terminal	9			X	10 Jan. 2013
24	GPS	2	X			10 Jan. 2013
25	Personal computer	3		X		21 Nov. 2012
26	UPS	3		X		Nov. 2012
27	Anti-virus software	6		X		Nov. 2012

No	Items		Qty	Place of Purchase			Date of Purchase (or Agreement)
				Japan	SI	AUS and or NZ	
28	Plotter		1		X		21 Nov. 2012
29	Printer		1		X		21 Nov. 2012
30	Multifunction copier		1		X		21 Nov. 2012
Machinery, vehicle and Equipment by JICA							
31	Small-size excavator		1		X		Feb. 2013
32	Pick-up truck		2		X		Oct. 2012
33	Data logger (additional)		10			X	Apr. 2013
34	Customer meter	Products of Japan	70	X			Apr. 2014
		Products of Australia	930	X			May 2014

Source: JET

Portable ultra-sonic Flowmeter

Portable ultrasonic flowmeters are necessary for incoming / outgoing flow measurements for a Pilot Project Area and DMA in case of checking NRW for 24hours.

1) Accessory (Detector) of Ultrasonic Flowmeter

Accessories (detector) of ultrasonic flowmeters are a sensor to detect ultrasonic.

2) DC Battery Adaptor

DC Battery Adaptors are used for potable ultrasonic flowmeter.

3) Data Logger

Data loggers are used for the measurement of pressure and flow rate during the continuous monitoring for 24hours.

4) Water Leak Detector (Leak Noise Correlator)

Water leak detector (Leak Noise Correlator) is used for the leaking point detection. One set is provided for NRW Action Teams of SW. This equipment can search the leaking area automatically by input piping data.

5) Water Leak Detector (Acoustic Type)

Water leak detector (Acoustic Type) is used for the leaking point detection. One (1) set is provided for NRW Action Teams of SW. Acoustic type is used for detecting leak points from road surface.

6) Metal Locator

Metal locators are used for searching valve location.

7) Non-Metal Pipe Locator

Non-metal pipe locator is used for searching pipe (non-metal like plastic) location.

8) Distance Meter

Distance meter is used for measuring distance between valves, etc.

9) Hammer Drill

Hammer drill is used for making a hole on road to check the exact leak point.

10) Drill Bit

Drill bits are necessary parts for the hammer drill to make a hole on road.

11) Boring Bar

Boring bar is inserted to the hole made by the hammer drill to secure enough size of hole for investigation by acoustic rod.

12) Generator

Generator is required for electricity source of hammer drill.

13) Acoustic Rod

Acoustic rods are used for detecting leaking sound directly from pipe, valves, hydrants, etc.

14) Residual Chlorine Analyzer

Residual chlorine analyzer is used for checking if surface water is the supplied water or groundwater

15) Bulk flow meter

Bulk flowmeters are necessary for measuring flow rate of distributed water daily, monthly and yearly.

16) Sluice valve (including gate valve)

Sluice valves, including gate valves are used for isolating the Pilot Project areas and for conducting step-test.

17) Flange Adapter

Flange adapters are used as fittings for installing valves.

18) Supa Coupling

Supa couplings are used as fittings for installing valves.

19) Concentric Reducer

Concentric reducers are used as fittings for installing valves.

20) Gasket And Bolt Set

Gasket and bolt sets are used as fittings for installing valves.

21) Test Meter

Test meter is used for checking error in measurement of water meters.

22) Handy Terminal

Handy terminals are used for reading water meters and taking coordinate of the water meter location.

23) GPS

GPSs are used for measuring coordinates of location of valves, fire-hydrant, water meters, air valves, etc.

24) Personal Computer

In order to analyze the collected data, establish a database and analyze the hydraulic conditions, a desk top computer is necessary.

25) UPS

UPSs are used to supply power to desktop computer for the limited time, when commercial power supply is shot down.

26) Anti-Virus Software

Anti-virus software is used for personal computers.

27) Plotter

Plotter is used for printing drawings of the existing network which is useful for NRW reduction activities.

28) Printer

Printer is used for printing documents required for NRW reduction

29) Multifunction Copier

In order to prepare the required documents for the Project, equipment for copy is necessary.

30) Small-Size Excavator

Small-size excavator is used for fixing, replacing and or newly laying the pipelines.

31) Pick-Up Trucks

Pickup trucks are used for transportation for the field work by NRW Action Teams.

32) Data Loggers (Additional)

Data loggers are used for the measurement of flow rate at the service reservoirs during the continuous monitoring for 24hours.

33) Customer Meters

Customer meters are used for measuring water consumption of users.

(2) Delivery Status of Machinery and Equipment

Delivery of the equipment was completed as shown in Supporting Report S8.1-1.

8.1.4 Administrative and Operational Expenses of the JET for Project Implementation

The Administrative and Operational Expenses of Japanese Yen 23.1millions (about SBD1.68millions) that JET spent is shown in Table 8.1-6.

Table 8.1-6 Administrative and Operational Expenses of the JET

Date	General Operational Cost						Donated Equipment	Other Freight	Report Preparation (Printing & Binding)	Monthly Cost
	Facilitator	Consumables	Communication & Freight	Copy	Vehicle / Workshop	Monthly General Operational Cost				
Currency	JPY	JPY	JPY	JPY	JPY	JPY	JPY	JPY	JPY	JPY
Nov. 2012	3,186.00	17,645.49	59,451.71	-	104,928.67	185,211.87	-	39,069.84		224,281.71
Dec. 2012	55,834.80	96,326.76	17,156.88	-	125,208.72	294,527.16	1,885,017.00	-		2,179,544.16
Jan. 2013	75,512.80	14,243.04	7,375.86	-	57,747.90	154,879.60	5,522,469.00	-		5,677,348.60
Feb. 2013	72,832.00	155,967.52	41,015.68	-	89,384.50	359,199.70	-	-		359,199.70
Mar. 2013	80,819.20	10,487.88	20,975.76	-	98,819.84	211,102.68	-	-		211,102.68
Sub-total	288,184.80	294,670.68	145,975.89	-	476,089.63	1,204,921.00	7,407,486.00	39,069.84	-	8,651,476.84
Apr. 2013	79,119.60	247,475.87	10,693.72	-	88,152.33	425,441.52	-	-		425,441.52
May. 2013	86,099.20	8,224.63	3,370.75	-	66,353.21	164,047.79	2,754,975.00	-		2,919,022.79
Jun. 2013	80,824.00	26,486.54	15,023.88	-	78,565.15	200,899.58	-	-		200,899.58
Jul. 2013	-	119,130.61	7,432.15	-	33,931.14	160,493.90	3,930,213.00	-		4,090,706.90
Aug. 2013	141,264.00	19,764.02	18,004.21	-	94,430.05	273,462.28	-	89,696.25		363,158.53
Sep. 2013	62,745.60	10,047.73	28,769.13	-	55,656.10	157,218.56	-	-		157,218.56
Oct. 2013	102,221.60	22,335.30	11,167.65	67.28	78,169.51	213,961.34	-	-		213,961.34
Nov. 2013	86,460.00	69,945.20	11,164.33	-	96,009.20	263,578.73	-	-		263,578.73
Dec. 2013	16,350.40	46,115.98	-	-	9,928.43	72,394.81	688,988.00	-		761,382.81
Jan. 2014	41,884.00	9,847.20	21,484.80	-	29,332.72	102,548.72	-	-		102,548.72
Feb. 2014	98,361.60	21,592.84	20,138.40	-	55,135.86	195,228.70	-	-		195,228.70
Mar. 2014	-	-	-	-	-	-	-	-		-
Sub-total	795,330.00	600,965.92	147,249.02	67.28	685,663.72	2,229,275.94	7,374,176.00	89,696.25	-	9,693,148.19
Apr. 2014	63,748.40	3,254.04	23,627.16	-	74,814.62	165,444.22	-	-		165,444.22
May. 2014	92,322.00	41,114.08	27,705.78	-	85,050.96	246,192.83	-	-		246,192.83
Jun. 2014	77,276.80	84,667.34	34,583.61	-	114,737.03	311,264.78	-	-		311,264.78
Jul. 2014	10,341.00	16,147.92	-	-	7,262.37	33,751.29	-	-		33,751.29
Aug. 2014	83,959.80	57,731.09	30,448.00	-	141,473.68	313,612.57	-	-		313,612.57
Sep. 2014	33,206.40	8,716.20	-	-	27,121.91	69,044.51	-	-		69,044.51
Oct. 2014	107,261.00	119,506.50	14,223.40	-	101,345.47	342,336.37	-	-		342,336.37
Nov. 2014	17,449.60	3,250.94	-	-	12,412.68	33,113.22	-	-		33,113.22
Dec. 2014	-	-	-	-	-	-	-	-		-
Jan. 2015	62,649.60	12,103.29	22,970.90	-	39,248.56	136,972.34	-	-		136,972.34
Feb. 2015	103,778.40	11,940.39	24,501.06	-	103,493.72	243,713.57	-	-		243,713.57
Mar. 2015	123,791.20	91,040.96	37,772.81	-	145,266.95	397,871.91	712,000.00	-		1,109,871.91
Sub-total	775,784.20	449,472.76	215,832.71	-	852,227.94	2,293,317.61	712,000.00	-	-	3,005,317.61
Apr. 2015	71,784.00	3,413.74	8,534.35	-	44,498.10	128,230.19	-			128,230.19
May. 2015	76,134.40	68,074.86	7,519.54	-	101,337.31	253,066.11	-			253,066.11
Jun. 2015	99,168.00	10,377.41	11,262.30	-	55,083.91	175,891.61	-			175,891.61
Jul. 2015	98,192.00	22,488.14	17,401.54	-	56,881.78	194,963.46	-			194,963.46
Aug. 2015	104,336.40	50,314.75	8,685.75	-	69,658.15	232,995.05	-			232,995.05
Sep. 2015	112,065.20	4,907.20	11,884.63	-	59,855.57	188,712.60	-			188,712.60
Oct. 2015	119,770.00	14,051.45	16,270.10	-	69,261.82	219,353.37	-			219,353.37
Nov. 2015	12,093.00	5,601.80	6,510.20	-	5,450.40	29,655.40	-			29,655.40
Dec. 2015	-	-	10,416.92	-	-	10,416.92	-			10,416.92
Jan. 2016	-	-	1,503.70	-	-	1,503.70	-			1,503.70
Feb. 2016		-	730.25	-	-	730.25	-	-	-	730.25
Mar. 2016						-	-			-
Sub-total	693,543.00	179,229.35	100,719.28	-	462,027.03	1,435,518.65	-	-	-	1,435,518.65
Apr. 2016							-			
May. 2016							-			
Jun. 2016							-			
Jul. 2016							-			
Sub-total		-	-	-	-	-	-	-	-	-
Grand-total	2,552,842.00	1,524,338.71	609,776.90	67.28	2,476,008.32	7,163,033.20	15,493,662.00	128,766.09	-	22,785,461.29

* Expense of "Donaded Equipment" only includes the cost of equipment procured by JICA Expert Team.

Source: JET

8.2 Input by SW Side

8.2.1 Counterpart Personnel

Counterparts of SW are shown in Table 2.3-2 to Table 2.3-4.

8.2.2 Provision of Equipment for Pilot Projects and DMA-based Projects

SW provided the Project Team with the following equipment to carry out NRW reduction in 15 pilot project areas and DMAs:

Table 8.2-1 Equipment required for NRW Reduction in Pilot Project Areas and DMAs

Items	Purpose	15 Pilot Project Areas	DMAs			
			Lenggakiki	Tasahe A&B*1	West Kola Ridge A*1	Tasahe C
Pilot Project Area						
Isolation Valve		17	-	-	-	-
Casing Block	For valve	17	-	-	-	-
DMAs						
DMA Flowmeter (mechanical type)	Measuring inflow rate	-	1	1	1	1
DMA Flowmeter (mechanical type)	Measuring outflow rate	-	0	0	1	0
Isolation Valve	Isolation of DMA and LCZ	-	2	3	1	1
Control Valve	Step-test	-	11	9	13	5
PRV	Pressure control	-	0	2	0	0
Concrete Chamber	For Flowmeter	-	1	1	2	1
Concrete Chamber	For PRV	-	0	2	0	0
Casing Block	For valve	-	2	0	1	4
Water meter including service pipe stand	Measuring water consumption	-	210	179	198	179

Source: Project Team

Note: The equipment includes fitting and other accessories.

*1 DMAs in which were selected under SW-JICA commitment and NRW reduction activities were completed by the Project. In other two DMAs, NRW reduction activities were completed by SW as of March 2016.

974 out of 1,000 water meters procured by JICA were installed in 15 pilot project areas. The remaining 26 and the meters procured by SW have been installed in four DMAs..

8.2.3 Provision of the Project Offices and Facilities

SW provided the Project office, furniture and WiFi system etc. to the JET.

8.2.4 Expense of SW Side

The direct expense of about SBD1.6million borne by SW to implement NRW reduction during this Project is shown in Table 8.2-2.

Table 8.2-2 Expenses by SW

No.	Item	Quantity	Unit	SBD
1.	**Equipment required for 15 Pilot Project Areas**			

No.	Item	Quantity	Unit	SBD
1.1	Isolation Valve	17	Nr.	40,470
1.2	Casing Block	17	Nr.	2,533
2.	**Equipment required for DMAs**			
2.1	DMA Flowmeter (mechanical type) for measuring inflow rate	4	Nr.	13,224
2.2	DMA Flowmeter (mechanical type) for measuring outflow rate	1	Nr.	3,306
2.3	Isolation Valve	7	Nr.	16,660
2.4	Control Valve	38	Nr.	55,250
2.5	PRV	2	Nr.	11,982
2.6	Concrete Chamber for Flowmeter	5	Nr.	325,000
2.7	Concrete Chamber for PRV	2	Nr.	130,000
2.8	Casing Block for valve	7	Nr.	1,050
2.9	Water meter including service pipe stand	766	Nr.	738,654
3.	**Fuel of Vehicle and its Maintenance**			
3.1	Fuel	11,800	Liter	139,240
3.2	Maintenance (30% x fuel)	1	Ls	41,772
4.	**Other Expenses**			
4.1	Workshop and JCC, etc.	1	Ls	50,000

Source: SW

CHAPTER 9 TRACK RECORD OF THE PROJECT

Track record which is compared with an original plan of the Project is shown in Figure 9.1-1.

Monitoring Sheet based on Plan of Operations (PO_4)

As of June 2016

Project Title: The Project for Improvement of Non-Revenue Water Reduction Capacity for Solomon Islands Water Authority in Solomon Islands

Target Area: Honiara City **Target Group: SW Staff** **Project Period: October 2012 to June 2016 (3 years and 9 months)**

Originally planned / Originally planned (non full-time) / Actually implemented/involved / Actually implemented/involved (non full-time)

Phase 1 | Phase 2 | Suspended by Flood Disaster | Phase 3 | Phase 4 | Phase 5

		Year	2012			2013											2014											2015											2016						Monitoring	
		Month	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	Progress	Remarks (Issue, Solution, etc.)
Input from Solomon Islands (SW's Personnel)		Output in charge	1	2	3	4																																								
	NRW Management Team																																													
1	Mr. Richard AUSTIN / Mr. Ian Gooden, Project Director (General Manager)		●	●	●	●																																							35.5/35MM	
2	Mr. Ray ANDRESEN, Project Manager (Operation & Technical Manager)		●	●	●	●																																							42.5/35MM	
3	Mr. Ronald DAVIES / Ms. Debbie JOHNSEN (Finance & Administration Manager)		●	●	●	●																																							42.5/35MM	
4	Ms. Tima KOFANA / Mr. Joe Sanga, (Human Resources Manager)		●	●	●	●																																							42.5/35MM	
5	Ms. Ellen MARUAROFA (Service Delivery & Communications Manager)		●	●	●	●																																							24.5/35MM	
	NRW Action Team (Technical Sub-Team)																																												
1	Mr. Benjamin BILLY, Action Team Leader 1 / Sub-Team Leader (NRW Taskforce Leader)			●	●																																							41.5/34MM	
2	Mr. Austin ATA , Deputy Sub-Team Leader (Customer Connections & Manager)			●	●																																							41.5/34MM	
3	Mr. Moses RAMO (Customer Connections & Metering Management Assistant)			●	●																																							41.5/34MM	
4	Mr. Silas TALOSUI, Deputy Sub-Team Leader (Network Maintenance & Repair)			●	●																																							41.5/34MM	
5	Mr. Mathias BERA, Head of Pipe Repair Team (Pipe Maintenance & Repair)			●	●																																							41.5/34MM	
6	Mr. Layten JACOB, Deputy Sub-Team Leader (Procurement)			●	●																																							41.5/34MM	
7	Mr. Frank DAUKALIA, Head of Meter Repair/Replacement Team (Pipe Materials Management & Procureme			●	●																																							41.5/34MM	
8	Mr. Chris MERIKO, Deputy Sub-Team Leader (Water Resources & Treatment)			●	●																																							--/34MM	
	NRW Action Team (Customer Service Sub-Team)																																												
9	Ms. Ellen MARUAROFA, Action Team Leader 2 / Sub-Team Leader (Service Delivery & Communication Ma				●																																							23.5/28MM	
10	Ms. Beverly SAOHU, Deputy Sub-Team Leader (Customer Care)				●																																							41.5/28MM	
11	Mr.Calros SALIGA, Deputy Sub-Team Leader (Community Relations & Media)				●																																							37.5/24MM	
12	Ms. Sophia TANGO (Community Relations & Media Assistant)				●																																							41.5/28MM	
13	Mr. Lawrence IROI (Chief Accountant)				●																																							41.5/28MM	
14	Ms. Mary TAFOA, Deputy Sub-Team Leader (Billing)				●																																							41.5/28MM	
15	Ms. Daisy MENAGA, Deputy Sub-Team Leader (Meter Reading)				●																																							41.5/28MM	
	NRW Action Team (GIS Sub-Team)																																												
16	Mr. Gavin BARE, Sub-Team Leader (GIS Technician, Operations & Technical Maintenance)			●	●																																							40.5/33MM	
17	Mr. Japhliet ROUHANA (IT Administration)			●	●																																							41.5/34MM	
	NRW Action Team (Leakage Detection Sub-Team)																																												
18	Mr. Eric UNGA, Sub-Team Leader (Leakage Detection)			●	●																																							41.5/34MM	
19	Mr. Matthew MAFE (Plumber, Leakage Detection)			●	●																																							41.5/34MM	
20	Mr. David AKOEASI (Plumber, Leakage Detection)			●	●																																							35.5/34MM	
Input from Solomon Islands (Offices, Facilities and Expenses)		Relevant Output	1	2	3	4																																							
1	Provision of project offices and faciliticis		●	●	●	●																																							
2	Expenses for implementing pilot projects				●	●																																							
3	Administrative and operational expenses		●	●	●	●																																							
Input from Japan (JICA Expert Team)		Output in charge	1	2	3	4																																					56.16/53.3MM	
1	Mr. Taketoshi FUJIYAMA, Leader / Water Supply Planning, Operation and Management		●	●	●	●																																					18.56/14.8MM	
2	Mr. Akinori MIYOSHI, Deputy Leader / NRW Reduction Measures -1		●	●	●	●																																					11.83/10.6MM	
3	Mr. Masatoshi SENO, NRW Reduction Measures -2		●	●	●																																							6.10/8.2MM	His assignment from April 2014 is transferred to Miyoshi and Fujiyama
4	Mr. Akihiko OKAZAKI, Leakage Detection Technology			●	●																																							8.37/8.4MM	
5	Mr. Masakazu ASAI, GIS			●	●																																							6.00/6.0MM	
6	Mr. Kenji KASAMATSU / Mr. Yoshiharu WADA, Customer Services & Public Relations				●	●																																					5.30/5.3MM	
7	Mr. Norio ISHIJIMA / Mr. Kazutoshi MASUDA, GIS Adviser			●																																							-	Support member
8	Ms. Akiko SAKAMOTO, Coordinator		●																																							-	Support member
Input from Japan (Equipment by JICA Expert Team)		Quantity Plan	Quantity Actual	Relevant Output 1	2	3	4	P: Procurement H: Handover																																				
1	Ultrasonic flow meter	1	2			●					P	H																												P	H				Completed	
2	Data logger	1	1			●					P	H																																Completed	
-	DC battery	1	0			●																																						-	Cancelled because SW has batteries.
3	Water leak detector (Leak noise correlator)	1	1			●								P	H																												Completed	
4	Water leak detector (Acoustic type)	1	1			●								P	H																												Completed	
5	Metal locator	1	1			●								P	H																												Completed	
6	Non-metal pipe locator	2	1			●								P	H																												Completed	
-	Electronic acoustic rod	1	0			●																																						-	Cancelled because SW has a rod.
7	Distance meter	2	1			●								P	H																												Completed	
8	Hammer drill	2	1			●								PH																													Completed	
9	Drill bit	10	5			●								PH																													Completed	
10	Boring bar	2	1			●								P	H																												Completed	
11	Generator	2	1			●								PH																													Completed	
12	Acoustic rod	2	2			●								P	H																												Completed	
13	Residual chlorine analyzer	2	1			●								P	H																												Completed	
14	Water flow meter	28	10		●	●							P	H																													Completed	
15	Gate valve	48	29			●							P	H					P	P		H																					Completed	
16	Test meter	1	1			●	●				P	H																															Completed	
17	Handy terminal (Data recorder of meter reading)	6	9				●				P	H																															Completed	
18	GPS	2	2			●					P			H																													Completed	
19	Personal computer	3	3	●	●	●	●			P		H																															Completed	
20	Plotter	1	1	●	●	●	●				P	H																															Completed	
21	Printer	1	1	●	●	●	●			P		H																															Completed	
22	Multifunction copier	1	1	●	●	●	●			P		H																															Completed	
Input from Japan (Equipment by JICA Solomon Office)		Quantity Plan	Quantity Actual	Relevant Output 1	2	3	4	P: Procurement H: Handover																																				
23	Small-size excavator	1	1			●					P			H																													Completed	
24	Pick-up truck	1	2			●	●	P						H																													Completed	
-	Cart for small-size excavator	1	0																																								-	Cancelled because the procured excavator is self-propelled.
25	Data logger (additional)	0	9		●	●							P				H																											Completed	

Figure 9.1-1 Track Record of the Project

Input from Japan (Equipment by JICA Headquarter)		Quantity		Relevant Output				P: Procurement H: Handover	
		Plan	Actual	1	2	3	4		
26	Water meter	500	1,000			●	●	P P H	Completed

Training of Counterparts in Japan		Output in charge					
		1	2	3	4		
	NRW Management						
1	Ms. Ellen MARUAROFA (Customer Care & Communications Manager)	●	●	●	●		Completed
2	Mr. Benjamin BILLY, Action Team Leader 1 / Sub-Team Leader (NRW Taskforce Leader)		●	●			Completed
3	Mr. Austin ATA , Deputy Sub-Team Leader (Customer Connections & Manager)		●	●			Completed
4	Ms. Daisy MENAGA, Deputy Sub-Team Leader (Meter Reading)				●		Completed
	NRW Action (Technical, GIS, Leakage Detection)						
5	Mr. Mathias BERA, Head of Pipe Repair Team (Pipe Maintenance & Repair)		●	●			Completed
6	Mr. Frank DAUKALIA, Head of Meter Repair/Replacement Team (Pipe Materials Management		●	●			Completed
7	Mr. Gavin BARE, Sub-Team Leader (GIS Technician, Operations & Technical Maintenance)		●	●			Completed
8	Mr. Matthew MAFE (Plumber, Leakage Detection)		●	●			Completed
	NRW Action (Meter Reading, Billing and Tariff Collection)						
9	Ms. Tima KOFANA (Human Resources Manager)	●	●	●	●		Completed
10	Mr. Lawrence IROI (Chief Accountant)				●		Completed
11	Ms. Tinarai Roster IHODI (Debt Collection, Finance Division)				●		Completed
12	Ms. Pidoke Marilyn BOKE (Service Delivery & Communication Division)				●		Completed

Capacity Assessment and Capacity Development Plan									
								Initial Interim Interim Final -1	

Output-1	Planning process of SW for NRW reduction is systemized.								
Activity 1-1	Establish the NRW Management Team in SW.								Completed
Activity 1-2	Review the current NRW reduction activities done by SW.								Completed
Activity 1-3	Assist in hydraulic analysis including identification of problems in the existing network.								Completed
Activity 1-4	Select pilot project areas and DMAs.								Completed
Activity 1-5	Formulate an annual action plan on NRW reduction in the pilot project areas and DMAs/LCZs.								Completed
Activity 1-6	Monitor the progress of NRW reduction activities in the pilot project areas and DMAs/LCZs.								Completed
Activity 1-7	Analyze cost-effectiveness of NRW reduction activities.								Completed
Activity 1-8	Prepare strategic implementation (rolling-out) plan for NRW reduction in the whole Honiara City.								Completed
Activity 1-9	Feed back the results of DMA-based NRW reduction activities, including monitoring and maintenance, to strategic implementation (rolling-out) plan, and then provide assistance in review of the plan as when it is necessary.								Completed
Output-2	**The procedure for NRW reduction is estabilised through the pilot areas and DMAs/LCZs.**								
Activity 2-1	Establish the NRW Action Team in SW.								Completed
Activity 2-2	Check existing flow meters and replace the malfunctioning meters with new ones at all the water sources.								Completed
Activity 2-3	Conduct training on NRW reduction for the NRW Action Team.								Completed
Activity 2-4	Provide assistance in the preparation of workflow for DMA-based monitoring and maintenance for NRW ratio, based on action criteria such as NRW ratio and DMA's features.								Completed
Activity 2-5	Feed back the results of DMA-based NRW reduction activities, including monitoring and maintenance, to manuals, and then provide assistance in review of the manuals as when it is necessary.								Completed
Output-3	**NRW reduction is implemented in accordance with the procedure in pilot areas and DMAs/LCZs.**								
Activity 3-1	Provide assistance in the definition and creation of discrete DMA's and their boundaries.								Completed
Activity 3-2	Provide assistance in the creation of LCZ within the DMAs.								Completed
Activity 3-3	Update existing water distribution network drawings by using GIS in the pilot project areas and DMAs.								Completed
Activity 3-4	Install necessary valves for isolation of the pilot project areas and DMAs, install flow meters, and measure the NRW ratio before implemetation of the pilot project.								Completed
Activity 3-5	Identify the causes of NRW (water leakage, illegal connection and meter-related losses) in the pilot project areas and DMAs through the OJT.								Completed
Activity 3-6	Implement NRW reduction measures such as legalization of users, leakage detection, leakage repair, water meter installation and optimization of water pressure in the pilot project areas and DMAs, and measure the NRW ratio after implemetation of the pilot project.								Completed
Activity 3-7	Prepare reports of results including cost and benefit.								Completed
Activity 3-8	Provide advice for the improvement of pipe system design, installation and network operation.								Completed
Activity 3-9	Convene the workshops to share the experiences, outcomes and etc. of the pilot projects and DMAs/LCZs.								Completed
Activity 3-10	Provide capacity development and training using the DMA's and LCZ's as the basis for NRW reduction activity.								Completed
Activity 3-11	Provide technical assistance in DMA-based monitoring and maintenance for NRW ratio after initial NRW								Completed
Output-4	**Water meter reading and billing process management is improved.**								
Activity 4-1	Formulate the work schedule and staff assignment plan for water meter readers.								Completed
Activity 4-2	Conduct training on water meter reading and reporting methods for anomalies and illegal connections for water meter readers.								Completed
Activity 4-3	Promote PR activities on water conservation and saving, and water tariff for the customers.								Completed
Activity 4-4	Monitor the water meter reading and billing activities.								Completed
Activity 4-5	Report the monitoring results, such as anomalies and illegal connections, to the responsible sections.								Completed

Figure 9.1-1 Track Record of the Project

Pilot Project and DMA/LCZ						
1	No.9	White River - Namo Ruka	(Pilot Project Area)		Completed	NRW ratio: 86.5% (before) to 32.2% (after), -54.3 pt.
2	No.10	Independence Valley	(Pilot Project Area)		Completed	NRW ratio: 57.7% (before) to 9.9% (after), -47.8 pt.
3	No.3	Lenggakiki	(Pilot Project Area)		Completed	NRW ratio: 62.0% (before) to 1st: 33.2% , 2nd: 14.7% (after), 1st: -28.8 pt., 2nd: -47.3pt.
4	No.5	Mbokonavera-1	(Pilot Project Area)		Completed	NRW ratio: 53.1% (before) to 14.7% (after), -38.4 pt.
5	No.14	Tuvaruhu-1	(Pilot Project Area)		Completed	NRW ratio: 65.4% (before) to 1st: 41.4%, 2nd: 11.0% (after), 1st: -24.0 pt., 2nd: -54.4pt.
6	No.15	Tuvaruhu-2	(Pilot Project Area)		Completed	NRW ratio: 67.2% (before) to 20.5% (after), -46.7 pt.
7	No.6	Vavaea Ridge	(Pilot Project Area)		Completed	NRW ratio: 63.1% (before) to 27.2% (after), -35.9 pt.
8	No.4	Mbokona	(Pilot Project Area)		Completed	NRW ratio: 50.2% (before) to 19.2% (after), -31.0 pt.
9	No.8	Mbaranamba	(Pilot Project Area)		Completed	NRW ratio: 23.2% (before) to 3.5% (after), -19.7 pt.
10	No.2	Mbua Valley	(Pilot Project Area)		Completed	NRW ratio: 50.9% (before) to 6.8% (after), -44.1 pt.
11	No.11	Bahai Kukum	(Pilot Project Area)		Completed	NRW ratio: 58.6% (before) to 16.2% (after), -42.4 pt.
12	No.7	Panatina Valley	(Pilot Project Area)		Completed	NRW ratio: 37.9% (before) to 6.7% (after), -31.2 pt.
13	No.12	Naha 2	(Pilot Project Area)		Completed	NRW ratio: 51.7% (before) to 15.6% (after), -36.1 pt.
14	No.13	Naha 3	(Pilot Project Area)		Completed	NRW ratio: 60.9% (before) to 25.8% (after), -35.1 pt.
15	No.1	FFA Kola Road	(Pilot Project Area)		Completed	NRW ratio: 47.1% (before) to 14.9% (after), -32.2 pt.
16	No.10	Lenggakiki	(DMA)		Completed	NRW ratio: 42.6% (before) to 22.6% (after), -20.0 pt.
17	No.6	Tasahe A&B	(DMA)		Completed	NRW ratio: 85.8% (before) to 32.7% (after), -53.1 pt.
18	No.17	West Kola Ridge A	(DMA)		Completed	NRW ratio: 60.4% (before) to 18.4% (after), -42.0pt.
19	No. 7	Tasahe C	(DMA)		Completed	NRW ratio: 38.1% (before) to 7.5% (after), -30.6pt.
Two-Year Plan by SW						
		Procure PRVs/Flow-Meters, construct and install in chambers	(DMA)		Completed	SW started procuring PRVs and bulk flow meter but suspended the order because of review of spec.
Joint Coordinating Committee (JCC)				1st, 2nd, 3rd, 4th, 5th	5/4 times	
Revision of PDM				PDM_1, PDM_2, PDM_3, PDM_4	PDM_4	
Evaluation				Terminal Evaluation		
Project Reports and Documents				IC/R, P/R1, P/R2, P/R3, P/R4, P/R5, F/R	6/7 times	

Figure 9.1-1 Track Record of the Project

CHAPTER 10 PRACTICAL EFFORTS, FINDINGS AND LESSONS LEARNED

Practical efforts and lessons on the Project management and implementation are as follows:

10.1 Practical Efforts

10.1.1 Preparation Stage

(1) Task force leader

It is important for SW to have ownership on NRW reduction activities. Conventionally, the Project Team appointed a staff who had a leadership to lead the Project as a Task Force Leader. Consequently, other Sub-Team Leader followed the Task Force Leader and contributed to realization of the project operation and pilot activities through the Project period.

10.1.2 Implementation Stage

(1) Formulation of IAP and Self-evaluation

The Project introduced annual IAP and encouraged NRW Management Team and NRW Action team to self-evaluate their performance against their own Annual Action Plan. IAP is composed of targeted achievement, indicators for self-evaluation, etc. This introduction was able to contribute to inspiring their performance in order to evaluate them highly.

(2) NRW Action Team's Leadership in the Workshop and JCC

When outputs of the Pilot Projects were summarized from time to time, NRW Action Team released progress and achievement of the Pilot Project in the workshop and JCC. These events spread out importance of NRW to MMERE, other relevant organization as well as board members of SW. These activities by NRW Action Team contributed to building self-confidence.

(3) Cost-effectiveness through the NRW Reduction

The Project Team analyzed the estimated income based on revenue water to be increased and the actual expenses required for NRW reduction activities. Cost-effectiveness through the NRW reduction activities is remarkably high. Quantitative analysis of cost-effectiveness contributed to promotion of the motivation of SW staff.

(4) NRW Reduction Activity by Team

After primary NRW reduction activities in 15 Pilot areas were completed, the Project appointed six teams to conduct NRW reduction activities in DMAs. In other word, one team was responsible for one DMA. Each team leader was appointed among counterparts of the Project. It was likely that each team leader had tried to compete for the good output on NRW reduction.

(5) Weekly Meetings

Even though less staff attended weekly meeting, it took place every week. It was important for SW staff to be aware of the weekly meeting as routine work for NRW reduction activities. The weekly meeting almost took place throughout the Project. Consequently, SW staff made it a rule positively to participate in the weekly meeting and report the progress of NRW reduction activities.

(6) Mini-award Ceremony

As part of Capacity Assessment at individual level, the JET gave NRW Action Team a take-home exam. and practical test on hydraulic analysis and NRW reduction activities. As procedure to keep motivation of SW staff, the Project Team commended those who gained high score on the exam and test in the weekly meeting that NRW Management Team attended. Actually, it was observed that particular staff gained high score in exam. of outside field after the staff was commended.

10.2 Lessons Learned

(1) Procurement of Equipment

Water supply facilities are composed of pipes, valves, air valves, flowmeters and their fittings. Most of the equipment has been procured from Australia and or New Zealand directly. In this case, SW spent much time for procurement of equipment after order to delivery. Items in wrong specification sometimes are delivered because of lack of communication and confirmation between suppliers and SW. SW needs enough time to order equipment from abroad with close-communication.

(2) Successor of Staff

The Project Team was forced properly to control the Pilot Project including DMA-based-Project so that it was not delayed extremely. However, if key staff like Sub-Team Leaders is on day-off, it was risky that the Project might be suspended or went on slowly. Therefore, assistants for the work must be involved in the training session frequently as a successor.

(3) Financial Factor for PDM

Balance of current account is influenced by water tariff. When indicators and or goal related to financial status are set out, a tendency of external factors in future like water tariff must be learned and carefully considered for setting out goal and indicators in the PDM.

(4) Arrear

Water tariff of SW is higher than that of neighboring countries. Domestic water tariff makes up more 15% of monthly income. From this aspect, SW has been facing customers with arrears for long time, while customers have reasons why they have arrear. In addition, some school was suffering from insufficient budget of utilities. It is anticipated that SW considers not only disconnection for users with arrear but also the grace period, exemption, amnesty, loan for pay-back etc. Otherwise, users

disconnected by SW will connect the lines illegally from necessity.

(5) Time Schedule considering the Status-quo of the existing Pipelines

At the beginning of the Project, database of the existing pipelines were not developed well, so location of distribution & service pipelines and functional condition of the existing valves were not clear. Consequently, it took much time for NRW Action Team to isolate the pilot areas. The time schedule of the NRW reduction activities must be prepared considering the status-quo of the existing pipelines in database, and maintenance condition of the existing valves.

CHAPTER 11 FINAL CAPACITY ASSESSMENTS AND CAPACITY DEVELOPMENT

11.1 Objective of Capacity Assessment on NRW Reduction

With the purpose to setup goals of achievement for SW's capacity, JET initially assessed its capacity by the individual and organizational level respectively and accordingly drew up plans of capacity development (see the Capacity Assessment and Development Plan, Supporting Report S11.1-1.

11.2 Final Assessment at Organizational Level

Following the baseline in March 2013, respective interim assessment in March 2014 and 2015, JET made a final assessment of SW at the organizational level through individual interviews, collection of annual data of water supply service, and monitoring SW's activities from April 2015 to December 2015.

(1) Methodology of Assessment

The final assessment were conducted based on the Performance Index (hereinafter 'PI') list and the Detailed Checklist for Water Supply Entity as shown in Handbook for Capacity Assessment on Urban Water Supply Sector and Water Supply Entity in Developing Country (published by JICA).

(2) Fundamental Information for Assessment

PI was coordinated based on the technical and financial data for 2015. Concerning the current status of water supply services related to NRW, JET had an interview with the Project Manager, NRW Taskforce Leader and an in-house consultant of SW according to the detailed check list.

(3) Assessment Items

1) Performance Index (PI)

JET assessed PI of 20 items.

2) The Detailed Check Items for Water Supply Entity

JET assessed 23 items in the following six categories.

- NRW Reduction
- Financial Performance
- Management/Human Resources
- Communication
- Training
- Customer Relation

(4) Final Assessment

1) Performance Index (PI)

Table 11.2-1 presents the Performance Index (PI) for the whole of Honiara City from 2011 to the end of 2015.

NRW ratio in Honiara City in 2015 was 66.3%, an increase by 3.5 points from 62.8% NRW in 2014. This negative trend in the improvement of NRW is mostly related to the increase in water production in 2014. It was also noticed that as more water was feed into the system, the system became pressurized resulting in increasing losses due to leakage. In addition to that the rate of disconnection of customers with high outstanding bills has also increased with an average rate of 230 disconnections per month in 2015 compared to 80 disconnections per month in 2014 in Honiara. Not all services that were disconnected were being reconnected again immediately. It may take weeks or months before reconnection takes place. In other instances, the services were never reinstated. The rate of reconnection is not measured. However, it is a common belief that due to the need for water, the customer who remained disconnected either resorted to look for alternative water sources like rainwater, water tankers or streams or worst illegally using SW water through illegal tapping.

As more and more customers are disconnected each month, more and more disconnected users are feared to be using water illegally which would also contribute to the rise in NRW. This is an important issue that SW needs to address. At the moment, SW does not have a solid awareness or knowledge on the approximate number if illegal users that are out there. Illegal users are only recorded if reported by the public or the meter readers. In order for SW to develop an effective plan to tackle the issue, it needs to understand the actual magnitude and extend of this problem and that's where data collection becomes important. A good starting point for this is to record all the daily disconnections and reconnection of customers.

After a fortnight or a month, a picture will image as to which of the disconnected customers have not reconnected their services. Questions can then be asked as to where they are taking water from and leading on to that, teams can be sent to the premises to check the status of the connection to determine if the users are illegal or they resort to taking water from alternative water sources like rains, streams and so on.

Another contributing reason for the high NRW is that much of the organized NRW reduction activities are concentrated on the water service areas and not the transmission pipelines. Therefore improvements and saving of water in the water service areas are lost in the transmission pipelines.

At this stage the breakdown of the total NRW into its various NRW components such as leakage, meter inaccuracies and so on is not yet possible. SW still cannot quantify these parameters due to the absence of IWA water balance analysis data for the whole Honiara City. It is vital that SW should work toward quantifying all components of NRW in the near future to help with decision making. Currently IWA were produced only for DMAs that have been worked on.

In the technical aspect, the billed quantity of water in Honiara City in 2015 has only slightly increased from 2014 by about 2%. It is also noticeable that the billed amount in Honiara in 2015 has increased from 2014.

The operational cost per billed water for whole of SW has decreased from SBD20/m3 in 2014 to SBD18/m3 in 2015. Since the Honiara Scheme contributes more than 60% to the costs and usage, this can be seen as a progress for Honiara Water Supply. The PI also revealed that the revenue per billed water in SW in 2014 is SBD14.2/m3 and has increased to SBD19/m3 in 2015. But it was the first time since 2011 that the revenue per billed water is higher than the operational cost per billed water. This sounds a positive financial standing for the company in terms of water sales.

There are 20 staff for every 1,000 connections in Honiara as opposed to 19 in 2014. The World Bank's recommended ratio is about 4 to 5 staff per 1,000 connections for public water works in the developing countries. However for our case, the number of staff is consistently the same, but it is the number of active connections that is decreasing due to disconnections which gives rise to the increasing ratio staff to connections. The total number of training days for staff working in Honiara on water supply in a year have decreased from 2.23 days/annual/staff in 2014 to 2.19 days/annual/staff in 2015.

In the non-technical aspect, there are no data for the "Number of customer complaints responded to within 10 days" throughout the past five years. Response to customers' queries were not properly recorded due to the absence of a suitable channel to communicate feedback from the various department's teams to customer care, the entry point of all customer complaints. This system was newly established in 2016. Being an important performance indicator on customer care service for SW as well, there must be an established mechanism to record all incoming customer complaints, which also enables customer care to easily track the status of complaints immediately when required. With this in place, customers can be informed on a timely basis on the status of their complaints appropriately which should bring about customer satisfaction.

Table 11.2-1 Performance Index (PI) of SW's Water Supply Service

Relevant Output in PDM	Category 1	Category 2	Index		Baseline Data for Entire Honiara City					Remarks
					2011	2012	2013	2014	2015	
1,2,3	Technical Aspects	Measures of NRW	NRW ratio (%)	[1]= ([2]-[3])/[2]	52.5%	57.9%	57.1%	62.8%	66.3%	
			Unbilled metered consumption (%)			N/A	N/A	N/A	N/A	
			Unbilled unmetered consumption (%)			N/A	N/A	N/A	N/A	
			Unauthorised consumption (%)			N/A	N/A	N/A	N/A	
			Metering in accuracies and data handling errors (%)			N/A	N/A	N/A	N/A	
			Leakage on pipes (%)			N/A	N/A	N/A	N/A	
			Leakage & overflow at storage (%)			N/A	N/A	N/A	N/A	
2			Water production (m3/day)	[2]	22,142	23,973	23,836	30,203	34,173	Derived from Network operation (for Honiara Only)
3			Billed water (m3/day)	[3]	10,178	10,088.85	10,215.08	11,233.76	11,511.69	Obtained from billing
3			Ratio of water meter installation (%)	[4]	60.5	70.0	75.0	80.0	88.0	Obtained from meter reading Department
2			Number of the water pipe breaks responded to within 24 hours (%)	[5]		<50%	78%	59%	53%	For 4 months average only (Jan to April 2015)
2			Quantity of NRW (m3/km/day)	[6] = ([2]-[3]) / pipe length	63.0	69.78	68.10	73.73	77.06	
2			Quantity of NRW (m3/connection/day)	[7] = ([2]-[3]) / connection	2.5	1.72	1.92	2.33	3.55	
3	Non-technical aspects	Financial Performance	Water tariff collection ratio (%)	[8]	83.0	82.0	86.0	80%	N/A	Include Province
3			Billing amount (SBD x 1000)	[9]	24,837	33,520.50	46,368.28	58,241.46	61,067.05	For Honiara Water sales Only
2,3			Operational cost per billed water (SBD/m3)	[10] = O&M cost / ([3] x365)	11.2	12.97	18.70	20.43	17.93	For whole SW
2,3			Revenue per billed water (SBD/m3)	[11] = Revenue / ([3} x 365)	7.4	9.10	12.44	14.20	18.65	For whole SW
2,3		Staff Efficiency	Number of staff working (Number/1000 connections)	[12]	9	18	17	19	20	Obtained from HRD
2		Training	Total number of training days in the year on water supply sector (days/annual/staff)	[13]	1.1	2.3	4.17	2.23	2.19	Obtained from HRD
3		Customer Relations	Number of customer complaints responded to within 10 days (%)	[14]		N/A	N/A	N/A	N/A	No proper records kept

Source: Project Team

2) Detailed Checklist for Water Supply Entity

Result of the final assessment on 23 items at organizational level is shown in Supporting Report S11.1-1. Current achievement is quantitatively scored in four categories such as '81-100%: 3 in rating score', '61-80%: 2', '31-60%: 1' and 'Less than 30%: 0'.

a. Non-Revenue Water

NRW Management Team and NRW Action Team mainly learned the processes, data coordination of measurements such as MNF and leakage ratio, etc. through the Pilot Project. SW was able to achieve the following capacity:

- NRW Management Team and NRW Action Team partly prepare an annual action plan.
- SW's Project members understand the main causes of NRW well through IWA water balance analysis.
- SW's Project members understand necessity of calibration of water meter and are able to check accuracy of water meters by using a test meter.
- Water meter readers contribute to report of malfunctioning water meters.
- SW's Project members are able to detect underground leakage by using leak detector, etc.

Meanwhile, there still remain issues as follows:

- There are no test meters to calibrate bulk flow meters.
- Water meters are not replaced with new ones regularly because of no regulation.
- Not all the malfunctioning water meters have been identified in the whole of Honiara.

[Recommendation]

SW will establish regulation for replacing water meters regularly.

b. Financial Performance

It is important that water meter readers appropriately fulfill their roles which are composed of meter reading, revelation of illegal connection, surface leakage, etc. so as to increase revenue. In Phase 2, SW prepared water meter's work manual or SOP in cooperation with the JET. SW has fully not follow SOP.

In addition, the bill collection section works in collaboration with the accounting section, so that they cross-check each other and accurately compile data of billed and collected amounts.

[Recommendation]

A SOP for meter reading, billing, etc. should be improved in future if necessary.

c. Management/Human Resource

Adequate number of vehicles was purchased by the fund of DFAT under the Two-Year Plan. However, vehicles were not sufficiently provided to water meter readers and billing team.

NRW reduction team members are aware of the importance of Performance Index (PI) and they understand the key data to some extent.

NRW team members routinely prepared IAP of 2013 and 2014 during the Project and evaluated their one-year performance. The results of the performances were provided to the Human Resource & Corporate Governance Manager for their evaluation. This method could contribute to raise the personal motivation of staff.

[Recommendation]

PI enables not only SW to be aware of issues in its current water supply service, but also allows customers to understand the actual situation of the water supply service through disclosure of PI to customers.

Self-evaluation on the IAP will give SW's staff motivation through acknowledgement of their performance. In addition, it is timely that SW will introduce promotion system with some criteria and awarding the staffs achievements.

d. Communication

NRW reduction team has continuously had the weekly meeting which the Strategic Planning Manager (Project Manager) and the Planning & Operation (former: Operation & Technical) Manager attends therefore they are well versed with the problems on water supply service and the progress of the NRW reduction activities.

On the other hand, meetings between SW and MMERE do not take place periodically. Therefore, it is unknown if MMERE clearly understands the current status of SW's water supply service.

[Recommendation]

It is ideal that the PI and the cost effectiveness on NRW reduction, etc. should be presented on a monthly or a quarterly meeting with MMERE, and other stakeholders to enable them to understand the current status of water supply service. This kind of meetings will truly give SW the cooperation of MMERE to examine the penalty regulations for illegal connections.

e. Training

SW does not own a training center. However, SW has international training programs some times a year.

Meanwhile, some of the NRW Team members are candidates as trainers for future trainings on NRW reduction supported by the JET.

[Recommendation]

Key members who have learned on NRW reduction activities through the Project must train other staff to develop their capacity on NRW reduction activities as much as possible.

f. Customer Relation

SW has Public Relations (hereinafter "PR") activities through newsletter, radio and newspaper. Newsletter has not been published since Phase 2. PR activities in newspaper and radio mainly focus on water conservation, illegal connections and revelation of water leakage. It is anticipated that an impact can be made and effective only through aggressive PR activities.

In addition to the above PR routine activities, SW has also conducted school program on water supply service, water conservation, illegal connections and leakage, and has carried out public awareness meetings in some Pilot Project areas. However, SW conducted the program and awareness meeting irregularly.

For cases of illegal connections SW has either legalized or disconnected them. However, there are still in existence of a lot of illegal connections in Honiara as a result of massive ongoing disconnections by SW due to arrears. Those that cannot afford to pay up their arrears and relevant fees tend to connect illegally.

[Recommendation]

In order for water users to understand water supply service well, it is important to increase the publication of newsletters and promote PR activities by sufficient PR staff members. In addition, PR through mediums such as radio and newspaper require some budgeting which could be approved by SW's board and MMERE. Meanwhile, in cases of inadequate budget for PR activities, it is still possible to sustain PR activities such as public awareness meeting, delivery of hand-made catalogue, and school education materials. Activities of water meter readers can be utilized to deliver leaflets that contain information on water conservation, bill arrear, illegal connection and water registration, etc.

In addition to strengthen PR activities, SW is forced to enforce regulation including penalty and to reform water tariff. Since current water tariff of SW is remarkably high for domestic users, households with arrears are increasing year by year.

11.3 Final Assessment at Individual Level

Based on the Capacity Assessment and Development Plan (see Supporting Report S11.1-1), the JET examined the effects of the Project and improvement in capacity of counterparts at individual level through some examinations and observation of their involvement in the project activities. The examinations itself and prior intensive lectures contributed to acceleration of their understandings as brush-up and developing self-confidence.

(1) The Final Examinations

The JET conducted several examinations in respective area, which consist of some question groups including practical exercise to comprehend accurately the degree of understanding of each key counterpart (see Table 11.3-1).

Table 11.3-1 Target and Contents of Examination

	Subject	Main Target	Question Group
1	NRW General	NRW Management Team, NRW Action Team	1. Water audit (IWA water balance analysis) and terminology 2. RW and NRW in Honiara 3. Flow of Pilot Project implementation 4. DMA and LCZ, DMA Management 5. What is benefit and effect through NRW reduction?
2	NRW Technical (MNF & Step Test)	Technical Sub-Team, Leakage Detection Sub-Team	1. What are NRW and MNF? 2. Leak Detection Technique 3. Equipment of Leak Detection 4. Maintenance of Equipment 5. Estimation of Lekage Volume 6. Procedure of NRW Activities in DMA
3	GIS	GIS Sub-Team	1. GIS operation 2. Advantage of GIS 3. Workflow of database 4. GPS features
4	Meter Reading, Billing and Customer Care	Customer Services Sub-Team	1. Knowledge on Concepts of Water Supply Service 2. Calculation of leakage volume 3. Measure of illegal connection inspection and internal leakage 4. Understanding on task of meter reading, billing, PR, etc.
5	Hydraulic Analysis	Some of NRW Action Team	1. Definition of hydraulic factors 2. Hydraulic calculation

Source: JET

The purposes and contents of each examination are as follows;

1) NRW General

The examinations confirmed the following items developed in the project period as well as see if they have the initiative and the capability in expansion of NRW reduction, monitoring and maintenance.

- Understanding of key counterparts on NRW
- Its actual condition in Honiara
- IWA water balance analysis
- Methodology of NRW reduction
- Definition of DMAs
- Project implementation flow and interaction between activities

2) NRW Technical (MNF & Step Test)

The examinations confirmed the following items developed in the project period as well as see if they have the initiative and the capability in continuing to implement field activities.

- Understanding of key counterparts on technical procedures of NRW reduction
- Process of leakage detection
- Analysis of measurements and manipulation of equipment
- Equipment management
- Estimation of leakage volume and plan of leakage detection

3) GIS

The examinations confirmed the following items developed in the project period as well as see if they have the initiative and the capability in continuing to build up the database and workflow.

- Understanding of key counterparts on GIS basic operation
- Update of mapping & attributes
- Check of GPS devices prior to field survey
- Improvement of workflow of database

4) Meter Reading, Billing and Customer Care

The examinations confirmed the following items developed in the project period as well as see if they have the initiative and the capability in strengthening activities and updating SOP.

- Understanding of key counterparts on water supply services in general
- Customer service, billing and meter reading method

5) Hydraulic Analysis

The examinations confirmed the following items developed in the project period as well as see if they have the initiative and the capability.

- Examination process of hydraulic analysis
- Water demand Projection
- Network system flow
- Demand allocation
- Development of network model

(2) Date of the Final Examination and Number of Examinee

35 examinees participated in the final examinations.

Table 11.3-2 Date of the Final Examination and Number of Examinee

Subject	Date	No. of Examinee	Key Counterparts	Other Staffs
NRW General	2 April 2015	12	12	0
NRW Technical	16 March 2015	3	3	0
GIS	30 April 2015	6	2	4
Meter Reading, Billing and Customer Care	6 May 2015	9	8	1

Subject	Date	No. of Examinee	Key Counterparts	Other Staffs
Hydraulic Analysis	4 May 2015	5	4	1
Total (Cumulative)		**35**	**29**	**6**

Source: JET

(3) Examination Results

Most of the examinees earned higher scores in the examination compared with the past examination, except for hydraulic analysis which the Project started its training in Phase 3 according to modification of PDM.

Examination results are summarized in Table 11.3-3;

Table 11.3-3 Summaries of the Final Examination Results

Data	NRW General	NRW Technical	GIS	MR, B & CC	Hydraulic Analysis
No. of Examinee	12	3	6	9	5
Average	92.6	87.3	93.7	93.9	49.0
Median	92.0	91.0	95.5	95.0	47.0
Maximum	98.0	96.0	98.0	97.0	88.0
Minimum	89.0	75.0	86.0	89.0	17.0

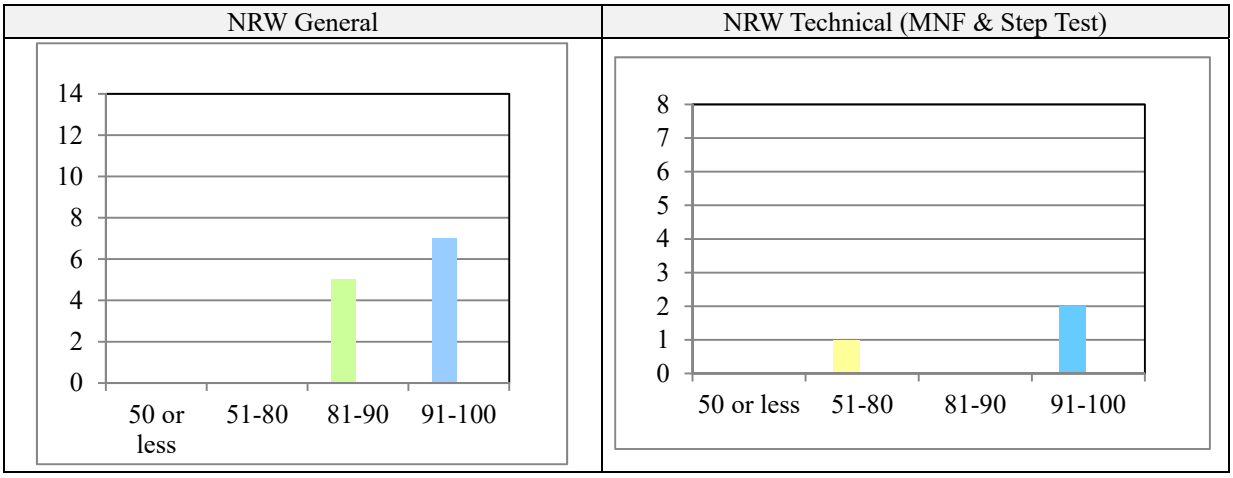
Source: JET

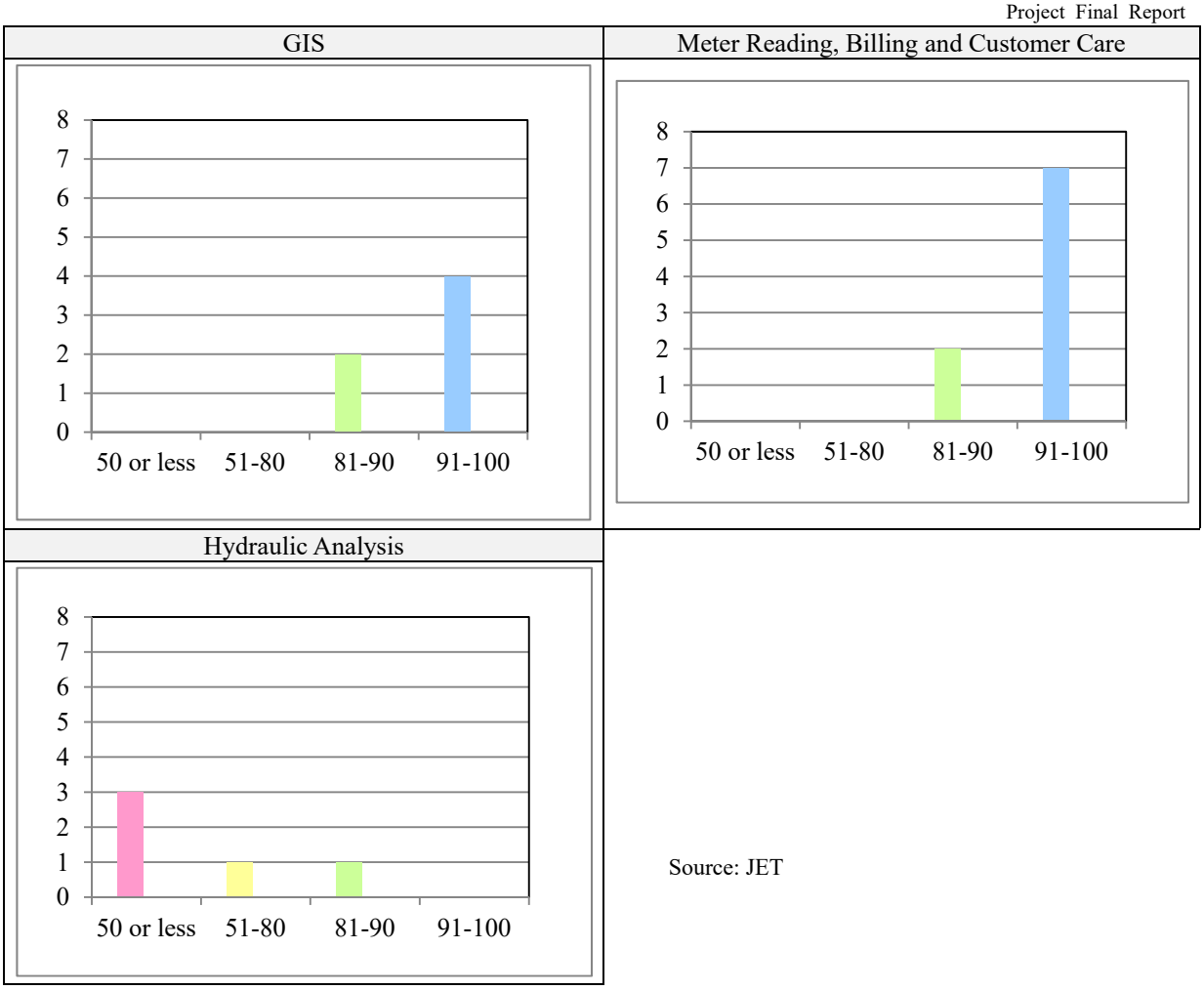
Table 11.3-4 and Figure 11.3-1 show frequency distribution of examination results.

Table 11.3-4 Frequency Distribution of the Final Examination Results

Score	NRW General	NRW Technical	GIS	MR, B & CC	Hydraulic Analysis
No. of Examinee	12	3	6	9	5
Less than 50	0	0	0	0	3
51-80	0	1	0	0	1
81-90	5	0	2	2	1
91-100	7	2	4	7	0

Source: JET





Source: JET

Figure 11.3-1 Graphs of Frequency Distribution of the Final Examination Results

Examination results in each area are summarized as below;

1) NRW General

Not only key counterparts but also NRW Action Sub-team in Customer Service Sub-Team, who have been involved routinely in the whole activities of the Project, earned high score of more than 80 points. The scores of non-technical counterparts in questions of effect and benefit on NRW reduction are a bit lower than other questions such as IWA analysis and definition of DMA and LCZ.

2) NRW Technical (MNF & Step Test)

Two of three Leakage Detection Sub-Team members earned scores of more than 90 points, which means their capacity has been developed. Remaining one scored less than these two. This member was absent from the Project for long periods to attend technical training in Samoa. However, the two members can train the one.

3) GIS

Not only GIS Sub-Team but also other key counterparts participated in the examination. All examinees

earned higher scores of more than 80. GIS Sub-Team members scored more than 90 points, which means their capacity has been developed, but other lost points in practical questions such as advantage of GIS and establishment of database through workflow.

4) Meter Reading, Billing and Customer Care

All examinees earned higher scores of more than 80, and most of them scored more than 90 points, which means their capacity has been developed.

5) Hydraulic Analysis

Regarding hydraulic analysis, capacity on replacement of pipelines was enhanced through OJT, take-home exam and lecture. However, since training period is shorter than other field, capacity is still developing.

(4) Conclusion of Capacity Assessment and Development at Individual Level

Compared to the previous capacity of members assessed at the beginning of the Project and the end of Phase-2 as an interim, capacity of key counterparts has been well developed to the almost targeted capacity level through the Project.

For details, see the results of capacity assessments of each member and examination papers shown in Supporting Report S11.1-1.

11.4 Assessment on Social and Institutional Aspects

Capacity development at social and institutional aspects is restrictive because of external factors. Specifically, experts which are funded by DFAT has affected institutional aspects of SW significantly, and the Project cannot control such external factors.

CHAPTER 12 TERMINAL EVALUATIONS OF THE PROJECT

12.1 Objectives

The Terminal Evaluation was carried out in August 2015. Its objectives are as follows:

- To review the progress of the Project and evaluate the achievement by the five evaluation criteria and PDM;
- To identify obstacles and/ or facilitating factors that affected the implementation process;
- To make recommendations on the project regarding the measures to be taken for the remaining period and the post-project period; and
- To draw lessons learned from the Project implementation.

12.2 Members and Schedule of the Terminal Evaluation

The members of the Team are as follows:

Table 12.1-1 Members of the Terminal Evaluation

Name	Field	Affiliation
Solomon Islands Side		
Mr. Michael MAEHAKA	Senior Hydrogeologist	Ministry of Mines, Energy and Rural Electrification (MMERE)
Japanese Side		
Ms. Eriko TAMURA	Team Leader	Director, Water Resources Team 1, Global Environment Department, JICA
Mr. Yoshiki OMURA	Urban Water Supply	Senior Advisor (Water Supply Development), JICA
Ms. Momoko OTSUKSA	Cooperation Planning	Assistant Director, Water Resources Team 1, Global Environment Department, JICA
Dr. Makoto TANAKA	Evaluation and Analysis	Senior Consultant, ICONS Inc.

Source: Terminal Evaluation Mission

The evaluation was performed from 11 to 28 August 2015 as shown in Table 12.1-2.

Table 12.1-2 Schedule of the Terminal Evaluation

No.	Date	Team Leader: Ms. TAMURA	Urban Water Supply: Mr. OMURA Cooperative Planning: Ms. OTSUKA	Evaluation Analysis: Dr. TANAKA
1	Tue., 11 Aug.			Departure from Japan
2	Wed., 12 Aug.			Arrival at Honiara Meeting with JICA Solomon Office and the JET
3	Thu., 13 Aug.			Individual Interview to NRW Management Team, Mr. Ray ANDRESEN, Operation& Technical

No.	Date	Team Leader: Ms. TAMURA	Urban Water Supply: Mr. OMURA Cooperative Planning: Ms. OTSUKA	Evaluation Analysis: Dr. TANAKA
				Manager, SW Individual Interview to NRW Management Team, Ms. Tima KOFANA, Human Resources Manager, SW Meeting with, Mr. Isaac LEKELALU, MMERE
4	Fri., 14 Aug.			Individual Interview to NRW Management Team, Ms. Debbie JOHNSEN, Finance& Administration Manager Individual Interview to DFAT, Ms. Alexandra & Mr. Edward
5	Sat., 15 Aug.			Documentation (revision of the draft evaluation report)
6	Sun., 16 Aug.			Documentation (revision of the draft evaluation report)
7	Mon., 17 Aug.			Group Interview to NRW Action Team (Output 2,3)
8	Tue., 18 Aug.			Individual Interview to NRW Management Team, Mr. Ray ANDRESEN, Operation & Technical Manager, SW Group Interview to NRW Action Team (Output 4)
9	Wed., 19 Aug.		Departure from Japan	Documentation (revision of the draft evaluation report)
10	Thu., 20 Aug.		Arrival at Honiara Meeting at JICA Solomon Office	Observational attendance in NRW Action Team Weekly Meeting Meeting at JICA Solomon Office
11	Fri., 21 Aug.		Courtesy visit to Mr. Ian GOODEN, General Manager, SW Meeting with main CP to discuss the draft evaluation report	
12	Sat., 22 Aug.	Departure from Japan	Site visit Documentation (revision of the draft evaluation report)	Documentation (revision of the draft evaluation report)
13	Sun., 23 Aug.	Arrival at Honiara Documentation (revision of the draft evaluation report)	Documentation (revision of the draft evaluation report)	
14	Mon., 24 Aug.	Meeting with main CP to discuss the draft evaluation report		
15	Tue., 25 Aug.	Meeting with main CP to discuss the draft evaluation report		
16	Wed., 26 Aug.	Holding JCC and Signing to the M/M		
17	Thu., 27 Aug.	Meeting at JICA Solomon Office to report the Mission Results Meeting at Japanese Embassy to report the Mission Results		

No.	Date	Team Leader: Ms. TAMURA	Urban Water Supply: Mr. OMURA Cooperative Planning: Ms. OTSUKA	Evaluation Analysis: Dr. TANAKA
		Departure from Honiara		
18	Fri., 28 Aug.	Arrival at Japan		

Source: Terminal Evaluation Mission

12.3 Result

(1) Result of the Terminal Evaluation

The Minutes of Meetings (hereinafter "M/M") and the results of the terminal evaluation are shown in Attachment-10. The results are summarized as follows:

- The Relevance of the Project is evaluated as 'High'.
- The Effectiveness of the Project is evaluated as 'High'.
- The Efficiency of the Project is evaluated as 'Moderate'.
- The Impact of the Project is evaluated as 'Moderate'.
- The Sustainability of the Project is evaluated as 'Relatively Low' but expected to be improved, provided that SW makes efforts with assistance of JICA and DFAT.

(2) Recommendation

1) Recommendation during the Project Period

a. Measures to be taken for ensuring sustainability

The following activities are recommended to ensure the organizational and technical sustainability.

i) Organizational sustainability

The organizational reform to establish "Task Force", which has the whole responsibility in managing NRW, has been delayed for more than a year by the resignation of the General Manager. As lessons learned from the other JICA's projects shows, the establishment of responsible post is crucially important to continue the management of NRW. Both SW and the Team agreed that the establishment of "Task Force" will be implemented by the end of November. Otherwise, the JET cannot be dispatched to assist the technical sustainability.

It is noted from SW that after establishment of "Task Force", job description should be developed for "Task Force" members with the assistance of Human Resources Manager. Since this position is currently vacant as of August 2015, the Team strongly recommend SW to solve the issue as soon as possible.

ii) Technical sustainability

Some CPs and the JET showed concerns in SW's capacity in monitoring and maintenance of DMAs, where already primary NRW reduction measures are taken. In the Project, SW and the JET are tackling reducing NRW ratio in DMAs without systematic monitoring and maintenance. From a view point of preventive maintenances, the Team recognizes the importance of capacity development in monitoring and maintenance. However, currently, SW has no post that is in charge of this duty. Thus, the establishment of "Task Force", which includes monitoring and maintenance post, is the condition to additional assistance in the area.

b. Revision of PDM

The present two indicators for Overall Goal "SW's service levels are improved and SW's revenue is increased." are not expected to be achieved within 3 years after the Project completion due to several changes in circumstance. Moreover, Indicator 1 is not technically feasible and Indicator 2 does not reflect its achievement due to external conditions. Thus, the Team proposes that Indicator 1 is revised as "NRW reduction activities are continued by SW's departments in charge." and Indicator 2 is deleted.

c. Appointment of the proper management staff and follow up of tasks to be carried out

The Project experienced frequent changes of the CP members, especially at the management level, which caused delay in decision-making and implementation of some activities. SW is recommended to prevent such resignation, and, in case it occurs, SW should take immediate actions to cover the vacant position for ensuring the task continues.

d. Close communication among SW

Closer communication among the managers and field staff is necessary to promote the Project activities and to accelerate the accomplishment of the Two-Year Plan. In addition, smooth communication should be ensured among Planning & Operations, Finance & Administration and Human Resources & Corporate Governance division to efficiently reduce NRW ratio.

2) Recommendation after the Project Period

a. Continuous utilization and modification of the Strategic plan

The Strategic plan should be continuously utilized and modified in accordance with the NRW reduction activities in the field and other changes in circumstances.

b. Maintaining motivation of CP staff members

The Project has had some positive impacts on staffs' motivation. According to some interviews, activities, such as communication between CPs, information sharing in the weekly meetings, awareness raising, bonding among staff members, has raised staffs' motivation. In addition to staffs' motivation, strong commitment by those in management is crucial.

c. Enhancement of awareness raising activities

The project increased the number of awareness raising activities for customers, and this will contribute to customers' understanding, which will contribute to improvement in bill collection and financial status of SW. Increase in budget and manpower is highly recommended to enhance awareness raising activities.

d. Utilization of GIS

Technical assistance for utilization of GIS was provided by the Project and CP staff members recognized the effectiveness of GIS for NRW management. However, assistance for GIS is an aspect of NRW reduction, and the Project cannot fully support the capacity development for utilizing GIS. Thus, SW is recommended to seek assistance and training opportunities for utilization of GIS.

e. Modification of tariff table

Current tariff table is unaffordable to some vulnerable groups, and it causes illegal connection and arrear customers. SW is planning to revise the tariff table with assistance from DFAT, so the Team strongly recommends modifying the tariff table with consideration to the social and economic conditions of Solomon Islands.

CHAPTER 13 MEETING AND WORKSHOP

13.1 Joint Coordinating Committee (JCC) Meeting

The 1st, 2nd, 3rd, 4th and 5th JCC Meetings were held until completion of the Project as shown in Table 13.1-1. The MMs are attached in Attachement-5 to Attachement-11.

Table 13.1-1 Summary of JCC Meetings and Discussions

Meeting	Date	Topics
1st JCC	24 Apr. 2013	- Presentation by the JET on the Project Progress and Annual Action Plan - Presentation by SW on the Solomon Water Development Plan 2013-2015 (the Two-Year Plan) - Suggestion for revision of the PDM and PO, including determination of indicator for the project purpose and changes in the project activities due to introduction of the Two-Year Plan. * See the M/M, Attachment-5 and Supporting Report S13.1-1
-	15 Aug. 2013	SW, JICA Solomon Islands Office and the JET discussed the suggested changes in the PDM and PO * See the Amendment of M/M on the 1stJCC, Attachment-6.
2nd JCC	27 Nov. 2013	- Confirmation and acceptance of PR2 -Agreement of the Amendment of M/M on the 1st JCC for revision of PDM_1, and acceptance of PDM_2 -Presentation by NRW Action Team members on creation of DMAs and acceptance of the creation of DMAs - Other than the above topics, participants made some comments and responded on the recently-opened Customer Care Center, Risk Management Plan of SW, and financial benefit of NRW reduction and so on. * See the M/M on 2nd JCC, Attachment-7 and Supporting Report S13.1-2.
3rd JCC	19 Mar. 2015	-Agreement of revision of PDM_2, and acceptance of PDM_3 - Presentation by NRW Action Team members on project progress of the completed the 15 pilot projects and ongoing DMAs - Participants made some comments and contributions to issues and challenges on procurement, illegal connections and DMA Management * See the M/M on 3rd JCC, Attachment-8 and Supporting Report S13.1-3.
-	30 Mar. 2015	-Commitment of procurement and its schedule by SW (see Attachment-9).
4th JCC	26 Aug. 2015	- Agreement of revision of PDM_3 - Report by Terminal Evaluation Team on result of joint terminal evaluation - Presentation by NRW Action Team on Project Briefing and Project Progress * See the M/M on 4th JCC, Attachment-10 and Supporting Report S13.1-4.
5th JCC	June 2016	- Approval of draft final project report - Report by SW on a summary of draft final project report * See the M/M on 5th JCC, Attachment-11.

Source: Terminal Evaluation Mission and JET

13.2 Project Team Meeting

Since April 2013, weekly meetings have taken place in order for NRW Management Team & NRW Action Team members to update and share progress and achievements of the Pilot Project and to confirm activities for the week ahead. The following contents have been reported and discussed during the weekly meeting:

- Weekly actual activities

- Weekly achievements
- Following week's activities
- Designation of staff member for each activity
- Issues encountered through the Pilot Project and their solutions

The memorandums of the meetings between April 2013 and March 2016 are attached in Attachment-12

13.3 Core Lectures, Workshops, Trainings and Sessions

The Project has conducted a series of core lectures, workshops, trainings and sessions. Table 13.3-1 shows a list of them, excluding OJTs, individual meetings and discussions. Materials of lecture, workshop, etc. are attached in Supporting Report S13.3-1 to S13.3-35.

Table 13.3-1 List of Core Lectures, Workshops, Trainings and Sessions

Date	Theme	No of CP attended	Details in Supporting Report
14 Dec. 2012	Draft Result of the Capacity Assessment and Capacity Needs	5*	S13.3-1
31 May 2013	Debriefing Session of the 1st CP Training in Japan	10	S13.3-2
27 Jun. 2013	Review on Analysis of IWA Water Balance	11	S13.3-3
28 Jun. 2013	Mini Workshop on Progress and Achievement of Pilot Projects	12	S13.3-4
28 Jun. 2013	Role-play in the Work of Meter Reading	11	-
16 Aug 2013	Purpose of the GIS Database	16	S13.3-5
26 Aug. 2013	Brainstorming	15	S13.3-6
30 Aug. 2013	Brainstorming	11	S13.3-6
29 Aug. 2013	Training for the NRW Reduction (Leakage Detection)	15	S13.3-7
8 Nov. 2013	Debriefing Session of the 2nd CP Training in Japan	14	S13.3-8
22 Nov. 2013	Intensive Lecture on NRW Technical (MNF survey & Step Test)	11	S13.3-9
29 Nov. 2013	2nd Role-play in the Work of Meter Reading	20	S13.3-10
24 Jan. 2014	Refresher training on NRW reduction activities and methods	15	S13.3-11
4 Feb. 2014	Intensive Lecture on NRW Technical (MNF survey & Step Test)	15	S13.3-12
10 Feb. 2014	Intensive Lecture on GIS	7	S13.3-13
17 Feb. 2014	Intensive Lecture on NRW General	18	S13.3-14
7 Feb. 2014	Workflows of GIS Database	14	S13.3-15
18 Feb. 2014	Intensive Lecture on NRW General	18	S13.3-14
18 Feb. 2014	Intensive Lecture on Meter Reading, Billing and Customer Care	15	S13.3-16
20 Feb. 2014	Follow-up Lecture for Review on Meter Reading, Billing and Customer Care	14	S13.3-16
24 Feb. 2014	Follow-up Lecture for Review on GIS	6	S13.3-15
25 Feb. 2014	Follow-up Lecture for Review on NRW Technical	11	S13.3-17
27 Feb. 2014	Follow-up Lecture for Review on NRW General	11	S13.3-14
1 Jul. 2014	Debriefing Session of the 3rd CP Training in Japan	26	S13.3-18
1 Jul. 2014	Progress and Issues of the Project	26	S13.3-19
1 Jul. 2014	GIS database Current / On-going Activities	26	S13.3-20
1 Jul. 2014	DMA-based NRW Reduction and Monitoring	26	S13.3-21
28 Aug. 2014	Mini-Workshop (Fact Finding on Social Aspects under JICA Internship Program)	15	S13.3-22
8 Oct. 2014	Training for Meter Readers to find out Illegal Connections & Internal Leakage	16	S13.3-23
5 Nov. 2014	Workshop (Hydraulic Analysis of DMAs in Honiara)	11	S13.3-24
13 Mar. 2015	Follow-up Lecture on the Leakage Detection Method in DMAs	3	S13.3-25

Date	Theme	No of CP attended	Details in Supporting Report
31 Mar. 2015	Mini-Workshop (Presentation on Agenda of 3rd JCC and NRW Strategic Implementation Plan	15	S13.3-26
29 Apr. 2015	Lecture on GIS Review (Outline of GIS & GPS)	2	S13.3-27
1 May. 2015	Lecture for Examination on Basic Planning of Water Supply and Hydraulic Analysis for Activity 1-3, 3-1, 3-2, 3-4 and 3-8	6**	S13.3-28
5 May. 2015	Lecture on Meter readers, Billing, Team and Customer Service	9	S13.3-29
26 Jun. 2015	Lecture on leak detection	12	S13.3-30
3 Jul. 2015	Lecture on leak detection	3	S13.3-31
20 Jul. 2015	Workshop (Presentation on Analysis of IWA Water Balance, Data processing and Leak detection, etc.)	11	-
4 Aug. 2015	Workshop (Presentation on Project Progress, Issues and Challenges)	19	S13.3-32
20 Aug. 2015	Lecture for Take-Home Examination on Basic Planning of Water Supply and Hydraulic Analysis for Activity 1-3, 3-1, 3-2, 3-4 and 3-8	6	S13.3-33
24 Sep. 2015	Lecture on GIS Review (Outline of GIS & GPS)	2	S13.3-34
7 Oct. 2015	Workshop of GIS on NRW Project	15	S13.3-35

Source: JET

* Attended CPs were General Manager, three Managers and Task Force Leader

** An Expert dispatched by DFAT to direct hydraulic analysis software operation is included.

13.4 Coordination with other Donors

JICA assisted SW in improvement of water supply service together with DFAT of Australian Government. The main support field by DFAT is financial assistance toward the overall operation and maintenance of SW. DFAT made a budget arrangement for implementation of Two-Year Plan.

DFAT sent four advisors of hydraulic analysis & water pressure control, operation and maintenance of water supply facility and Hydraulic analysis software to SW since May 2014 as follows:

Table 13.4-1 Advisors dispatched by DFAT

Name	Role	Period
a. Ms. Christina Misiosi (UK)	Operation advice of hydraulic analysis & water pressure control	May 2014 to August 2014
b. Mr. Peter Clark (AUS)	Operation advice of water supply facilities	September 2014 to June 2015
c. Mr. Liam Eaton (UK)	Maintenance advice of water supply facilities	December 2014 to May 2016
d. Mr. Joshua May (AUS)	Operation advice of Hydraulic analysis software	April 2015 to May 2015

Source: Project Team

a. Operation advisor of hydraulic analysis examined the location where PRVs have to be installed and prepared draft creation of DMAs. The Project checked the equipment proposed by operation advisor and assisted SW in their procurement.

b. Operation advisor of water supply facilities assisted SW in not only regular operation of water supply facilities but also the procurement of PRVs and bulk flow meters purchased by the fund of DFAT. These pieces of equipment were utilized for NRW reduction activities of DMAs as well as

monitoring of DMAs.

c. Maintenance advisor focuses on disposition of the inventory of equipment such as spare parts. The stocked parts were sorted out as shown in Figure 13.4-1. Inventory management contributed to an efficient maintenance including NRW reduction activities.

d. Operation advisor instructed a general methodology for two weeks to develop network model in Honiara using WaterGEM. The advisor attended Lecture on Examination on Basic Planning of Water Supply and Hydraulic Analysis for Activity 1-3, 3-1, 3-2, 3-4 and 3-8 shown in Table 13.3-1, as an observer (see Figure 13.4-2).

Figure 13.4-1 Stock of Fittings

Figure 13.4-2 Attended Lecture of the Project on NRW Reduction

CHAPTER 14 ISSUES AND RECOMMENDATIONS

As mentioned in the Chapter 3 and the Chapter 12, the Project Purpose and outputs have been achieved. In addition, SW is continuously taking activities for the remaining DMAs and steps toward the overall goal. In order for SW to further improve water supply service and steadily to reduce NRW, the following must be challenged.

14.1 Organization Level

14.1.1 Ensuring Staff Motivation through Performance Award and Regular Acknowledgement

Compared with motivation of SW's staff before commencement of the Project, their motivation have extremely raised because most of the staff have been aware of their own contribution to NRW reduction activities. SW staff well-understood meanings of the quantitative values such as NRW ratio, cost-effectiveness, etc. Continuously, it is significant that SW's staff analyzes the output of their NRW reduction activities and releases the result of analysis.

Moreover, as procedure to ensure motivation of SW' staff, it is desirable that SW management selects the monthly most valuable staff based on their outputs and results and commends those who take positive actions on their task in the monthly meeting.

14.1.2 Capacity Development

Based on the result of final capacity assessment, some approaches were suggested by JET. Approaches such as establishment of regulation on water meter replacement, improvement of Standard Operating Procedure (SOP) on water meter reading, billing process, continuation of Performance Index preparation, regular report to MMER, etc., training for SW staff by persons trained through the Project and enhancement of PR activities are suggested in Chapter 11.

14.1.3 Revising Strategic Implementation Plan, etc. flexibly and taking NRW Reduction Activities

The strategic implementation plan and annual action plan should be revised flexibly based on any policies to be suggested by Management Team, and NRW reduction activities should be taken based on the strategic implementation plan so as to maintain NRW ratio at low level.

14.1.4 Planning Procurement Schedule of Equipment and its Budget

SW borne the capital required for NRW reduction activities through the Two-year Plan during the Project phases. In order for SW to continue the NRW reduction activities, SW must guarantee a budget for equipment. The fiscal year of the Government of Solomon Islands is January to December. It is recommended, therefore, that SW should prepare concrete activity plans and incur cost estimation by every around September at least for the next fiscal year, so that equipment can be procured smoothly and on time.

14.1.5 Reviewing Water Tariff System

Water tariff defaulters are categorized into two; households who intentionally not pay, and households

who have no ability to pay water tariff because of poverty. It is suggested that SW should enforce the former households to repay by installments within a particular period to recover the outstanding payments and consider not only a relevant amnesty arrangement but also a social security system for the later households based on their financial status.

On average the current water tariff makes up more than 15% of income of normal households, which is very high compared with the World Bank index (4 to 5%) for developing countries. Therefore, it is suggested that SW should drastically review water tariff system based on household survey to be conducted in future. Also should a social security system is introduced, SW needs to consider a governmental subsidy to cover for any deficiency in its budget, so that arrears and illegal connections may be reduced.

14.1.6 Eliminating Illegal Connections

Water loss due to illegal connection makes up about 10% of the whole NRW in Honiara. There are two types of illegal households; one is intentional illegal user and other one is low income households. It is suggested that SW will examine the following measures:

- Current tariff system is reviewed.
- Penal regulation for illegal connections is enforced.
- Social security system is introduced.
- PR activities including school program and awareness meeting are consistently being followed through with.

14.1.7 Develop a database system that captured important data for decision making.

It is vital that a central database system is developed to capture important data that can be analyzed and help to make important decisions going forward for SW. Also the database can be utilized to measure the performances of the different activities within SW. For example, to measure the customer base of SW, it is important to have a daily recording system that logs daily disconnections and reconnection data. With this data available, decisions can be derived to improve revenue collection methods.

14.1.8 Securing Transportation required for Water Meter Reading

Currently, meters readers are being dropped-off and picked-up from the various sites in Honiara using an allocated vehicle. The suburbs of Honiara sprawled from low lying areas up to high elevation. The terrain can be steep in some areas and road access difficult in some. Walking along these environments itself can be overwhelming for meter readers while trying to collect meter reading data and meeting deadlines. It is suggested that to ensure meter reading is done effectively and efficiently, SW must have a transport policy that would adequately cater for the different field roles of the company including meter reading. For example, water meter readers may use motor bikes, bicycles, cars and the readers who are on foot are distinguished by location and geographical feature.

14.2 Individual Level

14.2.1 Improving the database for Daily Meter Reading

During the Project, it was observed that some customers were not billed monthly in times when they were passed by water meter readers. This kind of meter readers' performance may cause arrears. Therefore, it is very important that customer's information must meet mutually between drawings and customer lists so that water meter readers do not pass particular customers. It is suggested that staff in charge of registration of customers in Finance & Administration Division must feed-back customer's data to GIS staff to update database properly and promptly.

14.2.2 Raising Knowledge of Water Meter Readers

Water meter readers have the most opportunity to meet with customers compared to other SW' staff members. In other words, the meter readers have better opportunities to receive complaints and inquiries. Therefore, water meter readers should adequately be equipped to immediately answer general inquiries such as water tariff system, rationing time, other water supply services to ensure customers satisfaction and to develop confident and trust toward SW. It is suggested that workshop for water meter readers will take place in the frequency of at least twice a year.

14.2.3 Compiling Data to be measured and Customer's Data Accurately and Efficiently

It was observed that there is discrepancy between data. It is essential that data to be measured and customer's data are compiled accurately in order to analyze IWA water balance. It is suggested that not only data is compiled in the standard template but also relevant persons must have close-communication with each other to share information on daily problems.

14.2.4 Ensuring Accurate Field Report

NRW reduction activities have been carried out systematically. However, it was observed that data measured and recorded in the field were not clear. It is very important to ensure the accuracy of field reports so as to examine subsequent activities precisely. Repeatedly, field staff should be trained by field officers and other staff.