Water Management Planning

Handbook for facilitators

USAID
FROM THE AMERICAN PEOPLE

Ministry of Environment and Energy

FEN FAHI

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FROM THE AMERICAN PEOPLE

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May 2016

This publication was produced for review by the United States Agency for International Development. It was prepared by Maldives GCC Project. The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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May 2016

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Introduction

This handbook has been developed to complement the work done as part of the USAID Enhance Climate Resiliency and Water Security in the Maldives (Maldives GCC) project on Lh. Hinnavaru. The book is designed to be used by community facilitators as a guide to train a core group of leaders from the community to identify and apply effective and achievable management actions in order to improve the safety and quality of water resources and to develop an integrated water resource management plan for the island. The factsheets provided in the manual are to be distributed at the trainings to participants.

It is anticipated that the plan developed using this program will serve as a foundation for water management planning in the Maldives for the next 5 years. The plan will be prepared to comply with respective laws and guidelines related to water management in the country.

STEPS TO WATER MANAGEMENT PLANNING

Step 1 – Discover the Water Supply

The starting point of the water management planning process is to have a good understanding of the water supply, to assess the sources of water available and to identify the existing gaps in knowledge.

Objectives

The objectives of this activity are for the participants to:

- Discuss the available water resources and provide background information on each resource
- Assess the current knowledge of water supply and identify knowledge gaps.

Time: 4 hours

What to do:

1. Ask the participants the availability of water resources on the island. What are the sources, and how do they use each source?
2. Divide participants into groups.
3. Assign different water resources to each group – groundwater, rainwater, desalinated water and imported water. Ask participants to list the constraints of their assigned resource. Ask participants the following questions about their assigned water resource and ask them to write down their answers to be presented and discussed. A card will be provided for the participants to write their answers on.

Name of the water source:	
Questions	Answers
1. Is the water resource readily available?	
2. Is the water resource affordable?	
3. Is the water resource as clean and safe as you need it to be for the way you use it?	
4. Is the use of the water resource sustainable? For example, will future generations still be able to continue using this resource?	
5. How much does it cost per litre for each resource?	
6. Is the water resource sustainable if current usage trend continues? How can the water resource be sustained?	
7. What impacts do the changing environment and climate change have on the water resource?	

4. Participants then present and discuss their work.
5. Participants will be provided with a map of the island with the water supplies marked.
6. Participants will identify the components of the water supply system.
7. Facilitator will then pose the following questions to the whole group:
   a. Do you have enough water on the island to survive?
   b. What does it mean when we talk about water security?
   c. Do we have water security on the island?

Ask each group to discuss amongst themselves and come up with a definition for water security. Write it on a card provided by the facilitator. Paste the cards on the wall.

8. Icebreaker: Play the game "toss the globe"

Toss the Globe

Arrange all participants in a circle. Facilitator stands in the middle and tosses a globe of the earth to the participants, one at a time. Each participant will throw back the globe (toss) to the facilitator. When each participant catches the globe, ask him or her to express one word about water, and tell the group where their right thumb had landed (land or ocean). The proportion of thumbs landing on ocean and land will be tallied up on the board by one of the participant.

	Land	Ocean
Total	XX	XXX
Percentage		

This random survey of the planet is sometimes a reasonably accurate estimation of the actual surface of the Earth covered by ocean and land (70% and 30%).

9. Open discussion – how much water is available in the world to use? **Show video in weather kit .**
10. Present the PPT's showing the water use summary from the surveys conducted by Maldives GCC. Compare with participants' responses.

Resources

- Map of the island with the water supply marked
- PPT – Demographics of the island and summary of water sources used - community profile survey and bottled water survey, Maldives GCC

References

Rasheed. M Bari (2005), Ground Water Protection and Conservation, Maldives Water and Sanitation Authority

STEP 2 – Identify Risks and hazards to the water supply

There are basic activities that must be carried out locally to maintain and manage the water supply. Step 2 in the water management planning process is to identify routine management activities that prevent hazards and reduce risks to water supply.

Time: 4 hours

Objectives:

The objectives of this activity are for the participants to:

- Identify risks and hazards to the water supply
- Describe ways to manage risks to the water supply
- Think critically about the idea of water security and what it means to them as individuals
- Think about the constraints associated with each of the water resources previously discussed and how these constraints impact the sustainability of their water supply.

What to do:

1. Provide the poster on "ground water lens" and ask the participants to familiarize themselves with the hydrological cycle. Water in the environment is constantly being used, de-contaminated and re-used in a never ending cycle. The hydrological cycle is the continuous cycle of water in the environment. In it, water evaporates from the surface system and eventually falls as rain. The complete hydrological cycle includes storm water and rainwater and the repeated cycling of these sources.

2. Present the posters and factsheets on water contamination and risks to water quality. Discuss how water gets contaminated and risks to water supply.

3. Discuss the factsheets, how ground water becomes saline, ground water replenishment, ground water pollution and ground water protection.

4. Participants should then present and discuss their findings with the entire group.

5. Provide the posters, factsheets and pages from the booklet to participants.

6. Identify the water contaminants and the nature of the contaminants – chemical or microbiological?

7. Discuss with the participants:

- What can individuals do to conserve the water resource?
- What can be done at the island level to conserve the resource?
- What can be done to minimize or reduce risks of pollution?
- Provide Maldives GCC factsheets on water pollution and water conservation.

8. Present the Emergency Response Plan for the Hinnavaru water supply system completed by the Maldives GCC project. Participants will identify the objectives for the plan, the key actors and the actions to be carried out during various types of emergencies.

Resources

1. Factsheet, 'how groundwater lens is formed', Maldives GCC
2. 'How ground water becomes saline' – Maldives GCC
3. Factsheet, 'Rainwater harvesting', Maldives GCC
4. Community Water, MEE, 2006, Factsheet, 'water going salty'
5. Factsheet, 'groundwater pollution', Maldives GCC
6. Factsheet, 'preventing water pollution', Maldives GCC
7. Factsheet, groundwater replenishment, Maldives GCC
8. Factsheet, 'water conservation', Maldives GCC
9. Emergency Action Plan for Hinnavaru Water supply system, Maldives GCC.

Step 3 – Water borne diseases and disinfection

Objectives:

The objectives of this activity are for the participants to:

- Familiarize themselves with different types of waterborne diseases, which can be acquired from contaminated water sources.
- Introduce commonly used water treatment techniques which they can adapt and use in their homes.

Time: 2 hours

What to do:

1. Ask participants the following questions:

What diseases can people acquire by consuming contaminated water? Are the diseases mainly from contaminated water or poor hygiene such as not washing hands properly?

2. Provide participants with the factsheet on waterborne diseases.

Discuss using the following prompts:

- What waterborne diseases are of concern to the community?
- What is the risk of actually contracting this disease in your community? (use data from the Health Center)
- What are the early symptoms of the disease?
- What can be done to prevent this disease, by each household and by the community?

3. Discuss the need for water quality monitoring. Explain what it involves; sampling, testing and analyzing. Each requires following a protocol of scientific precision to be accurate.

4. Water testing and sampling gives a "snap shot" of local water quality conditions. Discuss the relevance of a testing program to the local residents' understanding over time of the safety of their water supplies.

5. Discuss what they can do as individuals and as an island to ensure that the water consumed is safe and clean.

6. Draw the following (on the floor) or paste a string on one of the classroom walls to show a continuum with sterile pure water on one end and dirty or brackish water on the other end. Ask the participants to tell you where on this continuum to place each type of water use. Suggested water uses are listed below. You can add others as appropriate. Give cards to the groups to write the activities down.

- Toilet flushing
- Industrial processes such as for food production
- Drinking water
- Cleaning a fishing boat
- Cleaning a fish
- Cooking rice
- Cooking baby food
- Washing the floor
- Washing your hands
- Putting out a fire
- Watering the garden
- Irrigating food crops

7. Discuss the responses. What are the concerns/ issues with each use? What's wrong with using water further to the right on the scale for each use?

Resources

1. Community Water, MEE (2006) MWSA information Sheet
2. Factsheet, 'Water bourne diseases', Maldives GCC
3. Factsheet, 'Water quality testing', Maldives GCC

Step 4 – Roles and Responsibilities

It is important for the residents of the community to know who to contact about their water supply and under what circumstances. In most islands in the Maldives, the respective utility company will oversee the supply and may be responsible for reporting water supply management or monitoring compliance with the EPA in accordance with the legislative requirements set by them.

In islands where they do not have an island wide water system, the day to day operation of the water supply is often carried out by the residents. The council may oversee and manage the communal water supply and they do not have a service provider to whom reporting of water management practices or compliance is required.

Objectives:

The objectives of this activity are for the participants to:

- Identify who is responsible for what and who should be contacted when there is a problem, a hazard or a risk to the water supply.

Time: 1 hour

What to do:

It is important for participants to understand the difference between a water quality (or health) issue and an infrastructure or water reliability issue because different responses will be required.

For this step you need to understand that there are two situations when a community may need to seek advice from authorities:

- When there is a risk to public health (water quality)
- When there is a water supply failure (water infrastructure)

Identify and discuss steps in the emergency plan.

Ice Breaker – Impromptu speech

- Assign a situation for each group. Each group will be given a certain demographic of the community, such as Island council/local, Ministry of Environment, utilities manager, health workers etc.
- Ask a participant from each group to give a speech of about 1 minute.
- Discuss about how the situations given could be handled.

IDENTIFY ENTITIES / PERSONS RESPONSIBLE

Fill in the tables below.

	WATER QUALITY	Entity	Department/ Person Responsible
1	Sampling and water quality monitoring	Water Q. Lab/	
2	Water Quality Regulation		
	WATER INFRASTRUCTURE		
1	Repairs, operations and works		
2	Coordinate service provision		
3	Assets and infrastructure (rules for water storage, and services		

* Add any related actions as necessary

Water Management - Implementation Tasks and Responsible Entities
Review with the Utility whether these tasks are allocated to personnel

	TASK	**ENTITY**	**Responsible Person**
1	Water Auditing	UTILITY	Operations and Maintenance Supervisors
2	Demand Auditing	UTILITY	Environmental Specialist
3	Water Conservation	UTILITY	Environmental Specialist
4	Groundwater monitoring	WATER TESTING LABORATORY	Operations Supervisor
5	Water recharge	UTILITY	Operations and Engineering Supervisors
6	Water shortage planning	UTILITY	Operations and General Manager
7	Financial preparedness for water shortages	UTILITY	Finance Manager

* Add any other tasks as necessary

STEP 5: Identify and discuss the components of a Water Management Plan for your Island

Objectives:

The objective of this activity is for the participants to:

- Identify the components of the water management plan for the Island

Time: 4 hours

What to do:

- Present samples of water management plans and discuss the components in them.
- Introduce the template that they could use to develop a water management plan. Discuss the different components in it. Get the participants' ideas as to what changes they may want to bring to it to make it more appropriate for their situation.
- Identify a leader to record the information for the group.

Appendix 1: Glossary of terms:

Water security: "the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks" (Grey, David; Sadoff, Claudia (2007), *Sink or Swim? Water security for growth and development, Water Policy, 9 number 6, IWA Publishing, p. 545-571)*

Water quality: refers to the chemical, physical and biological characteristics (parameters) of water. The standards used to set and define each of the characteristics (parameters) are determined by the intended use of the water. (Diersing, Nancy (2009). "Water Quality: Frequently Asked Questions." Florida Keys National Marine Sanctuary, Key West, FL and Johnson, D.L., S.H. Ambrose, T.J. Bassett, M.L. Bowen, D.E. Crummey, J.S. Isaacson, D.N. Johnson, P. Lamb, M. Saul, and A.E. Winter-Nelson (1997). "Meanings of environmental terms." Journal of Environmental Quality. 26: 581-589).

Water sustainability: A sustainable water resource is one which remains productive and safe for use over time. Overuse, improper use and contamination of a water resource results in the destruction of the water resource, thereby making it unsustainable for future use this in turn affects the water security of a community.

Constituents of Concern: Specific materials likely to be found in a specific water source that may, if enough of it is present, make the water unsuitable for its intended use.

- Example: Birds and other animals may nest in the rain gutter during the dry season, so that bacteria from animal feces is a constituent of concern in Maldivian rainwater.
- Example: High level of arsenic will make the water unsuitable for drinking. This is a concern in the Central Valley of California where arsenic naturally occurs in the soil, but it is highly unlikely that any arsenic will be found in Maldivian rainwater, so it is NOT a constituent of concern here.

ppm: Parts per million is a common way of measuring small amounts of constituents in the water supply. It is the same as milligrams per litre; think about 1ppm as one orange in a truckload of a million apples.

Appendix 2:
FACTSHEET 1 - Water resources

The Maldives is a unique island nation. Surrounded by the Indian Ocean, the Maldives has very limited freshwater resources. Traditionally Maldivians have relied on rainwater and groundwater as their sources for potable water. Recently, however, due to population growth and development, the groundwater has become polluted. As there is not enough rainwater stored to last through each year's dry season, Maldivians have started using other water resources such as desalinated water and imported water as their potable water sources.

This factsheet provides you with background information on all the water resources available to you on your island.

Groundwater

A portion of the rainwater that falls on the islands infiltrates into the sandy soils and accumulates underground as fresh groundwater. Saline seawater also infiltrates into the soil of the island from the sea. Fresh groundwater, being less dense than saline seawater, floats on top of the infiltrated saline seawater. Because of density differences, a freshwater lens develops. This tends to be deepest in the centre of the island, where groundwater levels are highest (compared to mean sea level).

Rainwater infiltrates into the porous and permeable soil by gravity. Trees and vegetation also draw the rainwater by its roots into the ground. This process of rainwater seeping back into the ground is referred to as "natural recharge". Some rainwater runs off back into the sea in areas where the soil is impermeable, including paved areas, roofs, compacted ground and areas where the ground is already saturated and can therefore not infiltrate into the ground.

The water passes between particles of soil, sand, gravel, or fissures in the rock to form an "aquifer". An aquifer is an area in the soil that is permanently saturated; it's what we call groundwater. This groundwater may be very near the ground's surface or it may be hundreds of feet below. Wells are simply holes dug into the aquifer to expose a free water surface.

Groundwater can vary in quality, depending upon the soluble minerals in the soil and contaminants present in the area either naturally occurring or as a result of human activity. A previously uncontaminated well can become polluted from sewage, industrial or agricultural activities, or because oil or other materials have been dumped or spilled on the ground. When pollutants leak, spill, or are dumped on the ground they can move through the soil to contaminate the groundwater. Over pumping of a groundwater aquifer will upset the balance of natural recharge to the aquifer, creating a negative pressure that can draw contaminants into a previously clean water source. Contaminated groundwater is generally difficult and expensive to clean up, but with diligent care, reduction of groundwater pumping and improved infiltration of higher quality water, the health of an aquifer can be restored.

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How groundwater becomes contaminated

The groundwater lens can become contaminated due to various reasons, including:

- **Sewage:** waste disposed in old and unmaintained septic tanks may leach through or spill over into the ground, thereby contaminating the surrounding soil. (Fact: The biodegradation of sewage produces sulfate, which is what gives the groundwater the sulphurous (rotten egg) smell.)
- **Spills:** Engine oil, fuel, agricultural chemicals and other materials spilled on the ground seep directly into the aquifer along with the rainwater. The sandy soils in the Maldives provide a particularly susceptible means for this kind of contamination.
- **Seepage:** Old batteries, electrical or electronic components and other manufactured goods may contain acids, mercury or other undesirable minerals that leach into the soil and groundwater when the casing rusts or breaks down.
- **Naturally occurring minerals:** Minerals such as phosphorous and copper can leach into the groundwater, making it undesirable if the mineral content in the groundwater is high.
- **Construction activity:** In order to construct a building, vegetation has to be cleared and the soil needs to be compacted, reducing the water retention and infiltration capacity of the area. But when you build a new building, you essentially cover that area with a completely impermeable surface (the roof). So if you have 100 sq meters of land and you build a 50 sq meter building on it, you have reduced the permeable surface by 50% where the house is, plus you have altered (reduced) the permeability of the rest of the site if you have removed the vegetation and compacted the soil. Can you calculate how much permeable land has been lost on your island by construction in the last 20 years? Unless the water that runs off the impermeable surface is captured and reintroduced to the aquifer through artificial recharge, you have a reduction in the sustainability of that aquifer.
- **Over-pumping:** As the population of the island increases and more well water is used, greater strain is put on the natural balance of the aquifer. If you take more water out of the aquifer than goes back in, the aquifer will shrink and potentially disappear. (Fact: Scientists can calculate the rate at which an aquifer is shrinking and how much "artificial" recharge is required to restore its natural balance.)
- **Salinity:** Rising sea levels result in a smaller land mass above sea level and a shallower depth of the freshwater lens, effectively reducing the quantity of freshwater available and an increase in the concentration of any impurities in the water.

How groundwater can be recharged

The balance between the freshwater layer and the saline seawater layer in the groundwater lens exists in a delicate equilibrium. Overuse of the freshwater layer by over pumping or other withdrawals results in the decrease of the quantity of freshwater in the lens. In order to ensure that the lens is maintained in equilibrium, the rate of use has been counterbalanced by the rate of recharge of the lens. The lens can be recharged in a variety of ways most commonly by natural means. That is, allowing rainwater and other relatively clean water that falls on the ground to soak into the soil, or by vegetation trapping water at the surface and drawing it into the soil by its roots.

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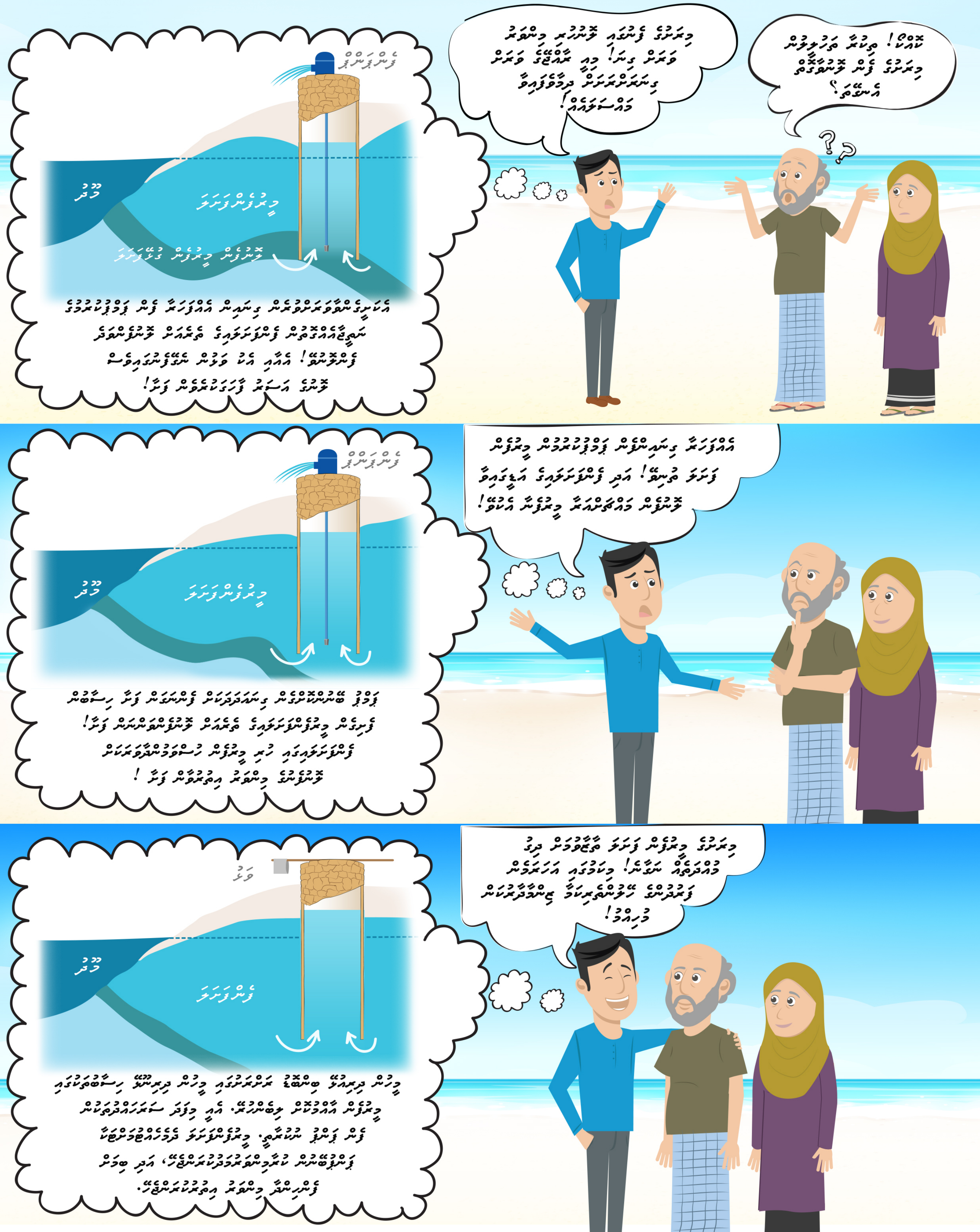
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ޕަމްޕު ބޭނުންކޮށްގެން ގިނައަދަދަކަށް ފެންނަގަން ފަށާ ހިސާބުން ފެށިގެން މީރުފެންފަށަލައިގެ ތެރެއަށް ލޮނުފެން ވަދެން ފަށާ! ފެންފަށަލައިގައި ހުރި މީރުފެން ހުސްވަމުންދާވަރަކަށް ލޮނުގެ މިންވަރު އިތުރުވާން ފަށާ !
މިތަނުގެ މީރުފެން ފަށަލަ ރައްކާތެރިކުރުން ދިރު މުއްދަތަކަށް ނުހާސް! މިކަމުގައި އަހަރެމެން ފަރުދުންގެ ހޭލުންތެރިކަމާ ޝާމިލުވުން މުހިއްމު!
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މީހުން ދިރިއުޅޭ ބިންބިމުގެ ރަށްރަށުގައި މީހުން ދިރިއުޅޭ ހިސާބުތަކުގައި މީރުފެން އާއްމުކޮށް ލިބެނީ ވާރޭން. އެއީ މީރުފެނުގެ ސަރަހައްދުތަކުން ފެން ޕަމްޕު ނުކުރާނީ. މީރުފެންފަށަލަ ދެމެހެއްޓުމަށް ޕަމްޕުކުރުން ކުޑަކުރުމަކީ ވަރަށް މުހިއްމު ކަމެއް، އަދި ބިމަށް ފެންހިނގާ މިންވަރު އިތުރުކުރަންޖެހޭ.


ބިމުގެ ފެންގަނޑަށް ތަޣައްޔަރުވުމުން ދިމާވާ ސަލަބީ އަސަރު!
ބޭނުންނުކޮށް ދޫކޮށްލާފައި
ހުންނަ ފެންވަޅުތަކުގެ ތެރެއަށް
ކުނި އެޅުމުން ފެންގަނޑަށް ނުސާފުވޭ!
ސެޕްޓިކް ޓޭންކު ހަރާބުވެއްޖެނަމަ ނަޖިސް
ލީކުވެގެން ފެންގަނޑަށް ތަޣައްޔަރުވޭ!
ގަސްކާނާ އަދި ބޭރުގެ ޒަހަރު
ގަދަށް ޖަހަން ބޭނުންކުރާ ކުނިކަތިގެ
ސަބަބުން ބިމުގެ ފެން ނުސާފުވުމަށް މަގުފަހިވޭ!
އުކާލާ ވިހަ ބޯސް، ބެޓަރީ އަދި ނުރައްކާތެރި
މަޢްދަނާއި ކެމިކަލުން ބިމުގެ ފެންގަނޑަށް ތަޣައްޔަރުވޭ!
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ބިމުގެ ފެންފަހަރަށް ތަޣައްޔަރުވުމުން ދުރުކޮށް ކަށަވަރުކޮށްލަމާ!
ބޯނުނުކުޅުނު ހުންނަ ފެންތާނގައި މަތިއަޑިއާފަރާ ބޯހިތުމުން ފެންފަހަރަ ތަޣައްޔަރުވުން ހުރެކުރޭ!
ސެޕްޓިކްޓޭންކް މަރާމާތުކޮށް ބެލެހެއްޓުމަށް ސަމާލުކަން ދޭނަމަ، އެއިން ނަޖިސްބޭރުވުމުން ފެންފަހަރަށް ނަޖިހުގެ އަސަރުކުރުމުގެ ފުރުސަތު ހުނަމާ!
ކުނިކޮށި
ބަދިގެކުނި
ފަތްކުނި
ޕްލާސްޓިކް
ޕްލާސްޓިކް
ގަސްގަހާ އާއި ގަހަނޑުފައިބާގެ ބަރުވުގައި އާދައިގެ ހިނގޮސް ތަޣައްޔަރުކޮށްފައިވާ ކާނި ބޭނުންކުރުމުން ދިރުފެންފަހަރަ ތަޣައްޔަރުވުމުން ސަލާމަތްކުރާ!
ސާރު
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ކުނިކޮށިތަކުގައި ހުރި މަކާތި ކުރޫއަށް ބިމުގެ ފެންފަހަރަ ތަޣައްޔަރުވުމުން ސަލާމަތް ކުރޭ!

Another means of increasing recharge is through artificial means. This means that human intervention by directing excess water (from gutters, storage tank overflow pipes, etc.) directly into the soil to accelerate the natural recharge. This can be as simple as piping excess water into a nearby well, or more complicated by construction of infiltration galleries. Infiltration galleries are structures, which can be used increase the transfer or discharge of rainwater back into the groundwater lens thereby recharging the lens.

Rainwater

Rainwater provides the main drinking water supply for 90% of all households in the Maldives outside of Male'. Rainfall data for the Maldives shows that the annual average is 2124mm—which is really quite a lot.

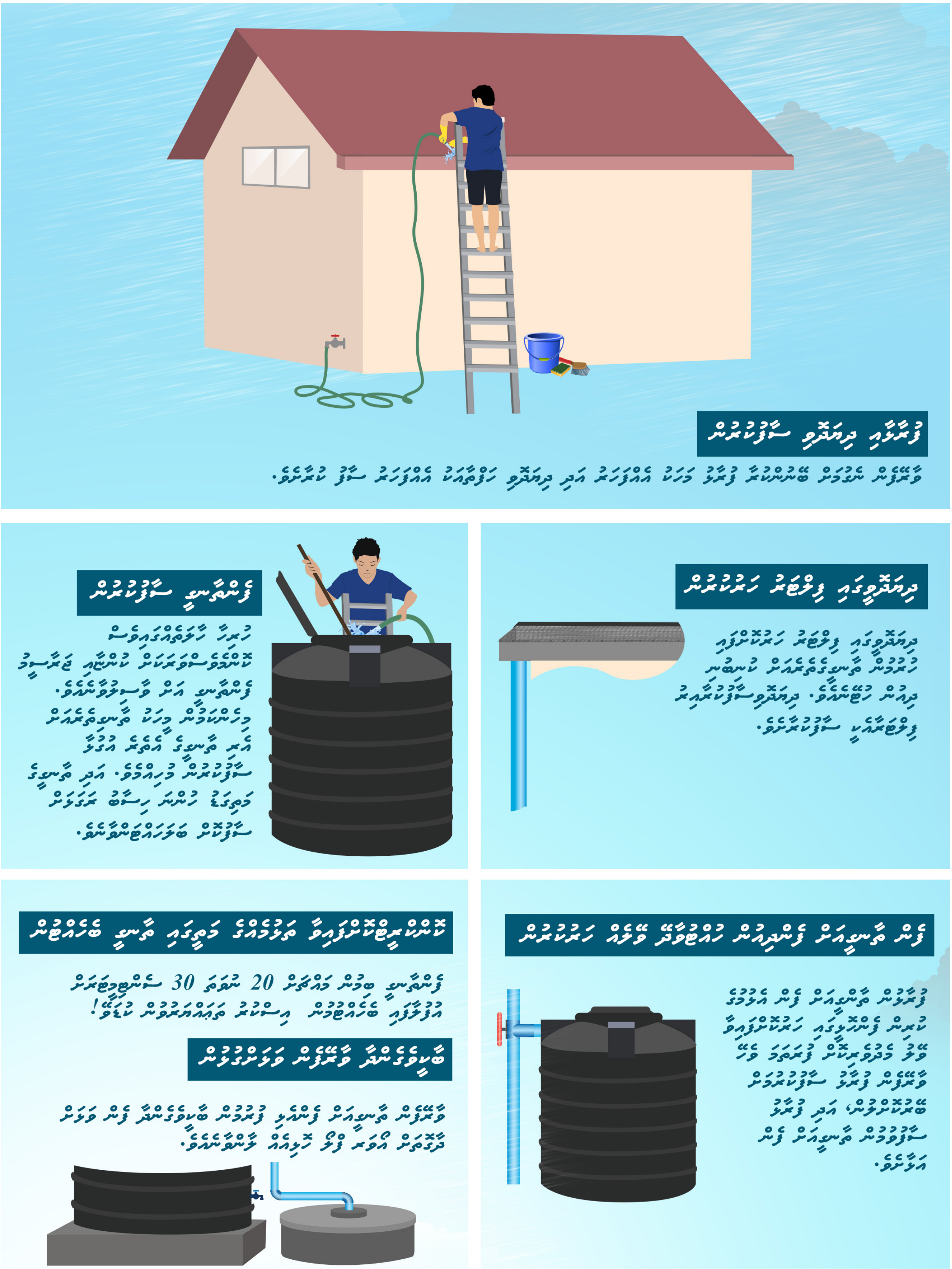
Although variable, enough rain falls on Lh. Hinnavaru for each household would have enough water to sustain their needs throughout the year if only we could more efficiently utilize this free, sustainable water source. However, 70% of all households report their water tanks becoming empty in the dry season. Part of the reason for this is inadequate storage capacity for enough water to last through the dry season and part is due to inadequate maintenance and operation of the existing rainwater systems.

Almost every household in Hinnavaru has a rainwater collection tank; therefore, each household has the potential to collect and store water to sustain their needs. More can be done to collect and store more water for a sustainable yield.

There are a variety of issues that affect how well we are able to access this very affordable water source:

- Rainfall varies, and collection needs to be timed with rainfall. This is sometimes inconvenient to households.
- There are common misconceptions that collecting the rainwater from the asbestos or corrugated galvanized iron (CGI) roofs may contaminate water. However, this is not the case, as asbestos particles can only cause damage if inhaled, and rust from iron roofs can be easily removed by an effective first flush system. Most particulate matter will settle out if you let the water sit undisturbed overnight. Fine particulate matter will drop out when boiled.
- There are common misconceptions about how long a "first flush" needs to be. In general, 5-10 minutes of a good rain is plenty to wash the roof of anything that will be harmful or undesirable. Anything that remains after that probably is going to stay there.
- Rainwater tanks fill up and more cannot be collected. An overflow pipe can be used to redirect rainwater to wells, to recharge groundwater resource. Additional storage tanks, if space can be found will provide additional household water.
- Most first flush systems are manual and require to be turned on and off in time with the rain, which is inconvenient to the household.
- Roof catchment areas, guttering and rainwater tanks are not properly maintained or cleaned (clogged with dead leaves or animal feces); therefore not all the rainwater collected and what is collected is sometimes unsuitable for use. Clean off your roof and gutters each year, ideally just before the first major rainfall.

ސާފު ވާރޭފެން ރައްކާކުރަމާ!



ފުރާޅާއި ދިޔަދޮޅި ސާފުކުރުން

ވާރޭފެން ނެގުމަށް ބޭނުންކުރާ ފުރާޅު މަހަކު އެއްފަހަރު އަދި ދިޔަދޮޅި ހަފްތާއަކު އެއްފަހަރު ސާފު ކުރާށެވެ.

ދިޔަދޮޅިގައި ފިލްޓަރު ހަރުކުރުން

ދިޔަދޮޅިގައި ފިލްޓަރު ހަރުކޮށްފައި ހުރުމުން ވާރޭގެ ފެނާއެކު ކުނިބިލި ދިޔުން ހުއްޓުވޭނެއެވެ. ދިޔަދޮޅި ސާފުކުރާއިރު ފިލްޓަރާއި ސާފުކުރާށެވެ.

ފެންޓާންކި ސާފުކުރުން

ހުރިހާ ހާލަތްތަކެއްގައިވެސް ޓޭންކުވެސް ތަރަކާ ކުނޑާއި ދޫރާސިމު ފެންޓާންކި އަށް ވާސިލުވާނެއެވެ. މިގޮތުން މިހަކު ޓާންކީގެ އަޑީގައި ކުނި އެޅޭ ޓާންކީގެ އެތެރެ ސާފުކުރުން މުހިއްމެވެ. އަދި ޓާންކީގެ މަތީގައި ހުންނަ ހިސާބު ބަހަގަން ސާފުކޮށް ބަހައްޓަންވާނެވެ.

ފެން ޓާންކީއަށް ފެންދިއުން ހުއްޓުވާލާ ވޭވެއް ހަރުކުރުން

ފުރާޅުން ޓާންކީއަށް ފެން އެޅުމުގެ ކުރިން ފެންދޮޅިގައި ހަރުކޮށްފައިވާ ވާލް މަދުވެރިކޮށް ފުރަތަމަ ވާރޭ ވާރޭފެން ފުރާޅު ސާފުކުރުމަށް ބޭނުންކުރުން، އަދި ފުރާޅު ސާފުވުމުން ޓާންކީއަށް ފެން އަޅާށެވެ.

ކޮންކްރީޓްޓާންކީއާ ތަފާތުގައި މަތީގައި ޓާންކީ ބަހައްޓުން

ފެންޓާންކީ ބިމުން މައްޗަށް 20 ނުވަތަ 30 ސެންޓިމީޓަރަށް އުފުލާފައި ބަހައްޓައިފިނަމަ އިސްކުރު ތަޣައްޔަރުވުން ކުޑަވާނެ!

ބޯފެނަށް ވާރޭފެން ބަޔަށްކުރުން

ވާރޭފެން ޓާންކީއަށް ފެންއެޅި ފުރުމުން ބޯފެނަށް ފެން ވަކިން ބަހައްޓައި ފެންބޯށެވެ.

What can be done to improve rainwater collection?

- Proper and regular maintenance and cleaning of roof, guttering and rainwater tank.
- An effective first flush system does not require hours of rainfall for rainwater to be collected. Using an efficient first flush system will enable the maximum collection of rainfall.
- Larger tanks or differently shaped tanks (not just circular ones, oblong shaped tanks can be used when space is an issue and they can also be stacked if conditions permit) can be used to collect rainwater.
- Where separate households share a common roof, households can cooperate and share collected rainwater. Households can also share the task of maintaining the tanks.
- A household pressure tank will supply sufficient pressure to household plumbing fixtures.

Air pollution levels in the Maldives are very low; therefore, rainwater in the Maldives is very clean. There are methods which can be used to further ensure that the rainwater collected in the tanks does not become contaminated. Some of these methods include:

- Using a simple first flush system removes debris and sediments.
- Using a sand filter. Sand filtration is useful water purification technique and work because as the water flows through the sand the particles and pathogens in the water come into contact and are trapped by surface of the sand grain.
- Clean tanks annually with mild soap and water. Rinse the tank thoroughly and without getting inside the tank, rinse with a mild chlorine solution. The chorine in bleach kills bacteria and algae that can grow in the tank. However, it is a strong oxidizer and can be very harmful to eyes and skin and can kill you if you breathe the fumes, so do not put your head inside the tank with the chlorine. Wear rubber or latex gloves and goggles, long sleeves and long pants and good shoes; avoid contact with eyes and skin and DO NOT breathe chlorine fumes. And please keep children away when working with chlorine.
- Keep a lid secured on the tank to prevent mosquitos, dust, debris or vermin from entering the tank.

Desalinated Water

Since water is so critical to life and in short supply in the Maldives, we have turned to desalination of sea water for use as drinking water in high population areas like Male'. Imagine all the things in the sea: fish and plants, salt and other minerals, diesel and oil from boats and even dead fish and garbage and sewage is discharged into the sea. Sure, there is a LOT of sea, and for many years, a popular expression was "Dilution is the solution to pollution." But as people have come to realize that our world is not infinitely large, our resources are limited and precious, and the sea is becoming a source of water supply in several countries, it has become more important that we take care of what we put in the sea. If we are to turn sea water into drinking water, we need to take all that pollution out of it. It is not just salt.

The type of desalination process most commonly used in the Maldives is Reverse Osmosis. This uses high pressure and complex membrane systems to reduce the salinity in the water. These membrane systems are expensive and foul easily, so it's important to treat them well. We do that by cleaning the water as best as we can before forcing it through the membrane. This "Pre-treatment" attempts to remove dissolved and suspended solids from the water to minimize how much muck ends up on the membrane during the desalination process. There are number of ways to do this, which you probably aren't that interested in, but you should know that there is a highly

technical process required to get all this other "stuff" out of the water before trying to remove the salt and that the aim of this pre-treatment process is to get the most clean water for the money spent.

The first step in Sea Water Reverse Osmosis (SWRO) is pre-treatment. A large amount of energy is required to force the salt water through the desalination unit. If you start with a lot of salt in the water (and there is a lot of salt in sea water) and want very little salt in the finished water product (as you do if you want to drink it), then you may have to repeat the reverse osmosis process a few times, each time extracting more salt. The final step is a post-treatment process which includes disinfection of the finished water as well as adjustment for pH and mineral balance.

Desalination is expensive because there are several highly technical processes, lots of expensive parts that are sensitive and damage easily, requires a lot of energy and a skilled technical workforce to operate. Because of all these things, you cannot just turn on and off a desalination plant, or leave it unused for a while, then expect it to work when you want more desalinated water. Furthermore, disposal of the waste product (brine) is highly hazardous to marine life, So it is mandatory for utilities to follow EPA's guidelines and make proper, safer arrangements to discharge waste product into the sea.

As an effective process to produce high quality drinking water from abundant sea water, there are many advantages and disadvantages to using reverse-osmosis desalination. Below is a table showing many of the advantages and disadvantages of desalinated water in the context of the Maldives.

Advantages	**Disadvantages**
Continuous/ dependable supply	Requires substantial pre-treatment
Suitable for seawater	High capital and operational costs
Can produce a very high quality of water	Hard to replace filters in Maldives, as filters are not supplied in the country and are very costly
Can construct plant of any production size and can expand production capacity by adding more units as capital investment comes available	Varies in quality, the better the quality the more expensive it will be to produce it as the filtration process needs to be repeated
	Requires a huge amount of energy (electricity) to run the plant
	Is an expensive service to provide and therefore will need to be paid for by the consumer.
	Requires trained personnel to run and maintain plant

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ފުރަތަމަ ވާހަކަ ދައްކަންޖެހޭ
ކަންތައް ދެރައްވާ!

ތަކެތި ދަށްކުރުން
ހުއްޓުވާ!

ލެބޯޓަރީ ޓެސްޓް
ތަކެތި ކުރާ!

ފައިސާ ދައްކާ ދުވަހު
ދެރައްވާ!

ENHANCE CLIMATE RESILIENCY
AND WATER SECURITY IN THE MALDIVES
(MALDIVES GCC)

Imported Water

Due to increasing constraints being put on the water resources available to communities of the islands, as a result of development and increase in population size, certain islands in Maldives (including Hinnavaru) have taken to importing water to fulfil their needs. There are two primary sources of imported water in the islands:

1. Bottled Water: This can be purchased at premium rates at most shops on the islands. This water is either bottled at a desalination plant or other commercial water treatment plant. Sometimes extra minerals are added to the water at the bottling plant because the desalination process may have reduced the amount of natural minerals in the water so much that the water will taste "flat" to most people. Studies have shown that bottled water is not always perfectly clean or reliable, yet people pay extremely high prices for some bottled water because they perceive that the water tastes good or is healthy for them. In Hinnavaru, desalinated water is sold for 15 Laari/litre, but a litre of bottled water costs about 6 Rf. (That's 40 times the price for essentially the same thing.) In addition, the disposal of the plastic bottles creates a huge solid waste disposal issue.

2. Bulk Water: The National Disaster Management Centre (NDMC) in the Maldives is mandated to provide communities with imported water in an event of an emergency, thereby providing the community with the much-needed water to sustain life and their livelihood. This is a short-term solution in an event of an emergency such as a Tsunami. NDMC however also provides communities that fail to collect enough rainwater during the wet season with emergency imported water. The water is transported in tankers and pumped into community storage units and is distributed to households. This practice results in a huge cost to the government which is unsustainable and de-incentivizes communities to effectively plan and manage their water collection and storage systems sustainably.

Appendix 3:
FACTSHEET 2 - Defining the parameters

Physical Attributes: All water has color, taste and odor, but most people are very particular that water should taste, smell and look like whatever it is that they are used to. Granted, some water, like the groundwater in some islands, has a very strong odor, whereas on other islands, the odor is barely perceptible. The point is, though, that physical attributes that you perceive as strong or bad are not necessarily bad for you. When the groundwater smells like rotten eggs, it is because it is off-gassing sulfides. Here in the Maldives, that is an indication that there is probably sewage seeping into the groundwater and it would not be safe to drink it. Yet there are places on this earth where sulfurous water is considered very desirable and thought to aid in healing a variety of ailments.

A tiny amount of chlorine (2ppm) is slightly detectable by taste and odor if you are not used to it, but it is what most industrial nations maintain in their urban water supplies to prevent bacterial growth in their water system and people who drink it don't notice it. They are used to it.

There are a lot of physical attributes that are important to what we consider to be high quality water. These include:

- **Color:** caused by a wide variety of chemical reactions or something dissolved in the water. The water can still be clear, but colored. It is not an indication that the water is not good to use unless it is caused by a constituent of concern at a high concentration.
- **Odor:** Nobody likes water that stinks. Nevertheless, some stinky water can be used for some things. The problem is that the odor lingers with us, so we generally want to avoid using it if we can.
- **Taste:** Taste is important in drinking water and water used for food preparation and people are VERY particular about it. But tastes are acquired. You may have learned to like the taste of something that is not particularly good for you and it may be worthwhile to learn to also like the taste of water that has been treated, filtered or disinfected.
- **Dissolved/Suspended Solids:** Water high in dissolved or suspended solids are usually so because very fine particles have gotten in the water. Most dissolved/suspended solids in the water are harmless but other, less benign matter can attach to these particles. So the concern is not the solids, but the effect that a solid content may have on our ability to remove undesirable constituents from water with a high solid level. The suspended solids are too tiny to settle out easily and dissolved solids are often salts, contributing to conductivity (see below) and color. Both dissolved and suspended solids contribute to turbidity.
- **Turbidity:** Turbidity is a measure of the overall cloudiness of the water and the problem is that very cloudy water may form large particulate matter by molecular attraction between benign particles and undesirable matter like pathogens. This has the effect of the making the undesirable matter harder to find and making it more complicated to treat or clean the water.
- **pH:** This is a measure of the balance between acid and base (similar to alkalinity). This is very sensitive and liquids that are strongly alkaline or strong acids are dangerous. Small changes in pH make a big difference in how the water reacts with other things.

- **Conductivity:** This is a measure of how easily electrical current can be transmitted through the water. Pure water is a good insulator and does not conduct electricity well. Add salt and the conductivity jumps tremendously. Several minerals (not just sodium) are considered to be salts by scientists because of their ability to dissolve in water and conduct electricity. So electrical conductivity is one way of determining if the water is salty. (It also explains why you want to get out of the sea if there is a lightning storm around you!)

Biological Constituents:

Biological constituents are all the things in the water that are or were living…and that is a LOT of stuff. Modern science has discovered a HUGE world of microorganisms. It includes bacteria, many of which are very useful as bacteria can break down very specific larger or harmful bacteria into smaller benign components, help our digestive system work, provide the leavening in bread, penicillin and host of other beneficial things.

- **Pathogens:** While most biological constituents are harmless to humans, there are a few things that we want to watch out for in our water systems. These are called pathogens, which comprise a broad category of biological microorganism such as bacteria, viruses and cysts which can cause disease in a human or animal. Since there are so many kinds of pathogens out there, we cannot test or monitor water for them all. Fortunately, there is one type of bacteria, coliform, that is very prevalent and almost always found wherever there are other pathogens present. So we can test for coliforms as an indication of any pathogen in the water. Coliforms are very common bacteria all over the world and are found in rivers and lakes, in the soil and on vegetation. A specific type of coliform, fecal coliform is found in large quantities in the feces of warm-blooded animals. Therefore, **fecal coliforms** are a good indicator species for identifying water and food that has been contaminated by feces. While most coliforms themselves present no significant health risk, their presence may coincide with a concern for the potential for numerous water borne diseases such as gastroenteritis and dysentery. The presence of fecal coliform in food may indicate that water used in the preparation of the food is contaminated, or that the food was contaminated by coming into contact with feces in some way—the cook may have dropped the food on the floor or may not have washed his/her hands after using the toilet.

Chemical Constituents:

The last category of constituents is chemical constituents. These are everything simple minerals naturally in the soils to complex manmade chemical compounds, and include: hydrocarbons, grease and oil, pesticides, pharmaceuticals, salts and minerals, detergents and chemical by-products of biochemical reactions in the environment. Here in the Maldives, our relatively clean environment presents a minimal set of chemical constituents of concern. However, there are a few that we'll take a closer look at so you can understand what you should be concerned about and when.

- **Total Nitrogen:** Nitrogen is an extremely common element in our environment and one of the building blocks of life. It's an important plant nutrient. It is a common product of more complex compounds breaking down. In certain forms and at high concentrations, it can prevent other important chemical reactions from occurring. When we find high levels of nitrogen in a water source, it is often indicative that the water has been contaminated with organic material that has biologically degraded into simpler components. This can be plant material or sewage. Mostly what we are looking for in Nitrogen levels is that the

form called Nitrate is not too high in drinking water supplies. If it is, it can interfere with the oxygen levels in your blood. This is not a serious concern here in the Maldives, since it is unlikely that our drinking water supply (usually rainwater or desalinated water) will have a lot of organic matter in it.

- **Phosphates:** While phosphates can occur naturally in some soils, that is not a problem in the Maldives where the soils are mostly coral and limestone. However, the major reason we find phosphates in water in modern times is because of the high level of phosphates in detergents. So when we see high levels of phosphates, we should start looking upstream for soapy water.
- **Sulfides:** Sulfides are another by-product of biochemical degradation of organic matter—especially sewage. Since sulfides are very volatile (as the sewage breaks down, the sulfur splits off as sulfide in a gaseous form and mixes with the air), you can easily smell sulfides. That is the rotten egg smell often found in contaminated ground water. Concentrated sulfide gas in an enclosed space is very dangerous, but it is not a serious health problem to drink, mainly because the bad taste will prevent you from drinking very much of it.
- **Arsenic:** In many places in the world, (Bangladesh, for example), naturally occurring arsenic, which is soluble and highly toxic, is an important constituent of concern. Arsenic is not found in the Maldives; therefore it is not a constituent of concern for us. The reason it is listed here and why we have tested for it in Hinnavaru water source because USAID requires that all water sources developed with US government funding should be tested for arsenic.
- **Free Chlorine:** Chlorine is a very important chemical in the discussion of drinking water supplies because it is the cheapest, easiest, most dependable way to disinfect a community water supply. Many countries require all public water systems to be dosed with chlorine. Chlorine will kill almost all pathogens on contact although the amount in the water is so small that it is harmless to humans, plants and animals. Chlorine is highly volatile, so it will turn into a gas and escape to the atmosphere, (even though you think of the water system as an enclosed space). That means that the amount of chlorine left in the water decreases over time. So the measurement of chlorine in the water is dependent upon time and distance, and the amount of chlorine that is left in the water is called the residual or free chlorine. In a water distribution system, we like to have at least 2ppm free chlorine at the location farthest from the disinfection point. (Fact: The widespread use of chlorine to disinfect public water supplies in the United States in the early 20th century reduced the incidence of typhoid from epidemic levels to become a rarely seen disease in the space of a few years nationwide.)
- **Hydrocarbons:** Fuels and oils are the most significant of the large category of hydrocarbons which threaten to contaminate water supplies. In the Maldives, fuels, oils and chemical cleaners can spill on the ground. They make their way into the soil and aquifer and are referred to as "persistent" contaminants because they often remain in the water without degrading for a long time. Hydrocarbons taste and smell bad, leave an oily slick on the surface of water and containers and you are therefore unlikely to drink very much of it. However, at higher concentrations, water contaminated with hydrocarbons can affect your central nervous system.

- **Pesticides:** There are literally thousands of kinds of pesticides but in general, they are designed and intended to be toxic to living things and it is not a good idea to drink them, even in small amounts. But you knew that. The point here, however is that there is a potential for pesticides to get into your water supply if ANY pesticides are used on your island. They can get into groundwater, or into standing water if they are sprayed around an open water tank. The main message is that many factors such as what kind of pesticide and the concentration will affect what effect it has on your health. Like all poisons, be very careful how you use it and what is exposed to it. Because there are such a variety of pesticides, there is no simple test as an indicator that pesticides may be in your water. So we do not generally test for it. But you should be aware that if you use them, be careful with them and keep them away from water sources.
- **Pharmaceuticals:** These days the world is full of pharmaceuticals…and perhaps you never wondered what happens to them. Let's explore this. You take a pill every day for a week; it concentrates in your body until you excrete what your body does not use. That goes to wherever your sewage goes…groundwater, sea, etc. You have left over pills that you don't need, so you throw them away or flush them in the toilet. Where does that end up? The pharmacy cannot sell expired medicine, so what do they do with them? Same thing you do with them, mostly. So at the end of the day, a lot of pharmaceuticals end up in the sewer or in the ground water. This has become such a prevalent problem worldwide that they say polar bears in the North Pole show signs of having ingested pharmaceuticals that have gotten into the worlds water. There is no test for pharmaceuticals in drinking water and it is tricky to even know they are there or what, if any affect they may have on our health. But you should knowit is a concern that scientists have not found a solution for yet

Appendix 4:
FACTSHEET 3 – Waterborne diseases

Waterborne diseases are infections, which are a direct result of contact or consumption of an infected water source. The term waterborne derives from the fact that the infectious agent (microorganism) is transmitted via water. Therefore malaria and dengue fever are not considered waterborne diseases as the infection is not directly transmitted via a water source but by the mosquitos which breed in stagnant water, therefore an issue of poor sanitation as opposed to contaminated water resources. The real disease burden (risk of contraction) of waterborne diseases in the Maldives is comparatively low (compared to sub-Saharan Africa or India), as water availability and water quality are relatively good in the Maldives. The number of recorded cases of diarrhea in Lh. Hinnavaru for 2011 was 60, which is considered to be low for a population of roughly 4,000-5,000 people. However what this data does not indicate is how many of the cases were a direct result of an infected or contaminated water resource as opposed to other ways these diseases can be contracted, such as poor hygiene. Therefore the actual number of waterborne diseases in the respective islands might be much lower. Nevertheless it is important to understand the different types of waterborne diseases know how to prevent them.

Waterborne diseases, such as cholera, dysentery, and typhoid, are caused by specific microorganisms that can be contracted by drinking water contaminated with these microorganisms or passed between people through inadequate hygiene. In general, these diseases show symptoms in the form of gastro-intestinal distress: diarrhea, stomach cramps, fever, and vomiting. They can quickly cause dehydration in a patient and can be exacerbated by rehydrating with more contaminated water. Prevention and containment of these diseases is achieved through strict hygiene practices and water disinfection.

Hygiene: The best way to avoid getting sick is to wash your hands frequently with soap. This is especially important after using the toilet, cleaning up after children or the elderly, and before handling food. Proper laundering is also important, as germs can be passed from dirty sheets and towels to another person. If someone in your household or for whom you are caring is sick, wash them, your hands and their linens with hot water and soap frequently. Addition of a small amount of chlorine bleach to the wash water will kill the pathogens and disinfect the linens prior to next use. The most common way to contract a disease is from another infected person.

Water disinfection: If there are pathogens in your water supply, there are several ways you can treat the water to make is safe to drink. You can boil it, filter it, chemically treat it or irradiate it. Pathogens are most commonly found in groundwater. However, any water source that is not properly maintained can become contaminated, including municipal piped water systems, even in large cities. Contamination can occur when a pipeline breaks or when a disinfection system fails or for many other reasons. Rainwater systems that are properly constructed and managed with a first flush discharge and tanks that are periodically cleaned should be safe to drink. If you are unsure, there are some things you can do to assure that your water is safe to drink.

- **Boiling water** will kill just about all harmful pathogens (schistosomiasis being the notable exception). Most microorganisms will die if exposed to high temperatures for just a few

minutes, so you do not need to boil the water any longer than that. In fact, a lot of other constituents will be removed from the water by boiling, too, because the heat adds energy to the water and promotes intermolecular attraction that allows many suspended solids to clump together and get heavy enough to settle out. This is why you sometimes get some grainy deposit in the bottom of a kettle of boiled water. Boiling your drinking water is the simplest way to assure your water is safe to drink.

- **Filtered water.** There are lots of water filters on the market. Most of them use some sort of carbon filter to remove odors but will not remove pathogens from your water supply. However, there are 2 types of filters that do a pretty good job. Ceramic filters will remove most pathogens because the pore size in the ceramic is so small that they cannot get through the filter. Another type of filter with layers of different size sand works pretty well, too by trapping and consuming pathogens in a biological film that forms between the layers of sand. The ceramic filters are manufactured to precise specifications and are available commercially at an affordable price for home use. The bio-sand filter can be made at home for family use. In truth, if you keep your rainwater tank clean and covered, you probably do not need a home filter. But if you get your water from another source, it may be a good idea to invest in one. We will discuss them in more detail in another section.
- **Chemical treatment** is a reliable way to destroy pathogens in the water. A small dose of a chemical like chlorine or iodine will damage the cell walls of the tiny microorganisms that cause disease, but at such low doses will not harm humans or animals. Chlorine is the preferred disinfection chemical because it is cheap, available (you can use household bleach), reliable and palatable. Generally we aim for 2 ppm chlorine remaining in the water after dosing. The amount you put in to achieve this gets complicated, but if you add ½ cup of household bleach to a full 2500 liter tank of water, you should be fine. There are other chemicals that can be used for disinfection such as iodine and ozone, but chlorine is the most common and easiest to use.
- **Irradiation** is achieved with light. Ultraviolet light is a component of sunlight which has the ability to irradiate and kill microorganisms. For this reason, Ultraviolet disinfection units have been developed to disinfect water. It is a very clean way to disinfect water because there are no by-products left in the water. But, if the water is turbid, it does not work well because the light does not reach all the pathogenic material in the water. It can take a significant amount of energy to fully disinfect the water and exactly because there are no residual chemicals in the water, the water will not stay disinfected for very long and by the time it reaches your mouth, it may have become contaminated again. By the way, setting clear bottles of water out in the sun is not a good method of disinfecting water because the sunlight (rather than just the UV portion of the spectrum) will promote algae growth.

A word about Toxoplasmosis

Although not a waterborne disease, Toxoplasmosis has been a major concern among Maldivians and is one of the reasons Maldivians say they do not like to consume rainwater as it might contain Toxoplasmosis infectious agents. Toxoplasmosis is an infection cause by the protozoa, Toxoplasma gondii. The main sources of infection to humans are through the contact of infected raw meat, infection via hand to mouth contact with cat feces during gardening or cleaning litter, and mother to fetus transmission. Toxoplasmosis is NOT found in cat urine and because cats normally defecate in sand or dirt rather than on roofs, it is highly unlikely that Toxoplasma gondii will be found in rainwater supplies. In order to be infected with Toxoplasmosis via rainwater one would actually need to consume the cat feces on which the protozoan cysts are embedded. Therefore an effective first flush or even using a mesh to filter particulate debris from the rainwater is sufficient and effective in preventing the transmission of Toxoplasmosis from cat feces, which may rarely be found on the roof.

Appendix 5:
FACTSHEET 4 – Simple Water Treatment Methods

As we have already discussed, there are certain parameters which we use to measure whether water can be considered suitable for drinking. Groundwater must be treated to remove undesirable constituents from the water. Other water sources, such as rainwater, may require some treatment as well, to achieve the desired drinking water standard to prevent adverse effects to the consumers. A variety of purifications methods can be used to make rainwater and groundwater safe for drinking. Some of these processes will be discussed below.

Boiling:

A simple and highly effective method of treating water is to boil it. Raising the temperature of water to the boiling point and cooling it before consumption has been proven to be an effective way of destroying pathogens, which cannot survive the extreme temperatures. A potential disadvantage is the cost of fuel required for boiling water and the time required to boil and cool the water, but when weighed against the cost of getting sick, boiling is often a good investment.

Filtration:

A highly effective method of treating water is by filtering it. The simple sand filter which is a slow biofilm-sand filter, is one such filtration device, which is a cheap yet highly effective method of removing both particulate matter and pathogens from water. This device, adapted from a UNICEF sand filtration example, uses different gradations of sand layers that will (in about 2 weeks) develop a biological film between the different layers. The complete unit, although simple to construct and maintain, is actually a very complex treatment unit that physically removes particles from the water and biologically removes pathogens. Quite literally, the harmless bacteria in the biofilm layer eat the harmful bacteria.

Contaminated water is poured into a barrel filled with layers of stones at the bottom, gravel and sand. Water flows from the top filters through the sand layer where pathogens and debris become trapped between the sand grains, the water flows at different speeds through the different size (or grades) of sand and a film of bacteria that prefers different conditions grows between the layers. This is a beneficial colony of bacteria that consumes the pathogens in the water as it passes through the film. A tap near the top of the barrel is connected to a hose or pipe near the bottom of the barrel in the rock layer will assure the water you draw from the filter has been processed through the entire system.

Chemical treatment:

Use of iodine or chlorine is a common means to treat water that is suspected or known to contain pathogens. The oxidizing properties of iodine and chlorine results in the effective destruction of any pathogens present in the water. Flushing or swabbing pipes, valves or other components of the water supply system will disinfect them and it is a good idea to do so if you have been repairing them or otherwise handling these components. Unless water is continually flowing in the pipes, there is a good possibility that bacteria will grow in them. For this reason, most municipal water systems aim to maintain a small amount of chlorine (generally 2 to 5 ppm) in the water at all times. This is called "residual" or "free" chlorine because it is the amount of chlorine still available in the water that has not been used yet. Maintaining a residual chlorine level can be challenging because chlorine is highly volatile and is easily used up by impurities in the system, so over time and under most working conditions, the amount of chlorine in any water source is depleted. Therefore, if you are using chlorine to "batch" treat water, such as chlorinating your rainwater tank, you will need to periodically add more chlorine to the tank. How often and how much chlorine you add will depend on the conditions, including the quality of the water to start with how much flow there is in the tank and the temperature of the water. Therefore, a little experimentation is required to determine the appropriate dosing for your water.

Chlorine also is a common treatment for sulfides found in water sources, such as is common in Maldivian groundwater. Most groundwater in the island carries an unpleasant odor and taste of hydrogen sulfide (H_2S) which is a gas formed by the degradation of organic matter (including sewage that has leached into the groundwater). Hydrogen sulfide easily dissolves in water and has a detectable odor at very low levels. It is not harmful but is quite unpleasant. Chlorine can not only disinfect the water, but it can also remove this "rotten egg" smell from the water.

Irradiation treatment:

Ultraviolet light is a component of sunlight which has the ability to irradiate and kill microorganisms. For this reason, commercial ultraviolet disinfection units (commonly called UV disinfection units) have been developed to disinfect water. It is a very clean way to disinfect water because there are no by-products left in the water. But, if the water is turbid, it does not work well because the light does not reach all the pathogenic material in the water. It can take a significant amount of energy to fully disinfect the water and exactly because there are no residual chemicals in the water, the water will not stay disinfected for very long and by the time it reaches your mouth, it may have become contaminated again. UV disinfection units are commonly available in the Maldives, but before purchasing one, consider the conditions and specific application, weighing the pros and cons of each option available to you to decide if this is the best solution.

Appendix 6:
FACTSHEET 5 – Demographic Information
Population

Current Projected area population

	2010	2015	2020	2025
Resident Population				

Infrastructure

(description of the water supply system)

Water system demand

Customer water delivery in 2015

Water use category	# of units
Single family residential (2 people)	
Multi-family (3-4 people)	
Multi-family (5-10 people)	
Multi-family (11+ people)	
Guest house	
Institutional	
Café/ restaurant	
Other	

Projected Customer Water demand 2015 – 2030

Water use	2015 # of units
Total water provision / population	

Appendix 7:
FACTSHEET 6 – Average temperature and rainfall records

Year	Month (mm)												Total Annual Precipitation (mm)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
2006	112.6	17.4	48.9	4.1	287.2	257.7	77.4	191.8	303.3	199	190.1	59.6	1,749.10
2007	1.9	0	23.9	101.1	247.6	353.2	324.2	123.2	253.6	187.6	61.5	171.9	1,849.70
2008	9.4	145.7	169.3	109.3	239.6	161.1	389.1	152.2	28.9	302.9	82.1	142.4	1,932.00
2009	2.6	7.6	31.5	55.5	145.4	156.6	218.7	234.8	177.3	83.9	234.4	286.9	1,635.20
2010	8	6.9	2.8	107.7	201.7	511.7	378.4	205.3	234.9	163.1	194.1	161.9	2,176.50
Average	26.9	35.5	55.3	75.5	224.3	288.1	277.6	181.5	199.6	187.3	152.4	164.5	1,868.5
Maximum	112.6	145.7	169.3	109.3	287.2	511.7	389.1	234.8	303.3	302.9	234.4	286.9	2,176.5
Minimum	1.9	0	2.8	4.1	145.4	156.6	77.4	123.2	28.9	83.9	61.5	59.6	1,635.2

Appendix 8:
Information required to formulate the Water Management Plan:

Atoll / Name of island :			
Population:		Number of households:	
Registered population:		Registered number:	
Number of people living on the island:		Habited / in use:	
Community buildings:			

1. What is the status of the water resource and its availability on the island? (State sources of water available on the island and how it is utilized, quality of the island's ground water, changes that have occurred in the manner water is utilized or changes to sources of water due to various reasons, and problems related to water on the island.).

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2. (a) Describe the main causes of the problems identified in question 1.

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2. (b) State actions that could be implemented at island-level to solve the problems identified in question 1.

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3. State details of activities carried out at the community -level to store water on the island. : (State if water tanks are placed in communal areas and, if yes, how many tanks and its capacity. State Whether it is easily accessible for the community and who utilizes it. If this water is not utilized, state the reason for it. Additionally, state whether if water tanks were received for this purpose and if the island has a water plant (desalination plant.).

4. If water tanks are set up for community use, how are theyis it cleaned and maintained? (State how this is carried out, which party undertakes the responsibility, how it is cleaned and procedures in place to take and store water.).

5. Number of water storage tanks on the island:

5- (a) At households: (State how many households have water storage tanks and how many households do not have it.).

5- (b) In the communal areas: (If tanks are in more than one area, then state the areas.).

Number of tanks	Litres	Condition of the tank (damaged, usable, good condition but not in use)
Area 1 – (name)		

Area 2 – (name)		

Area 3 – (name)		

6- Duration of hot season :
Number of months _____ (from _____ to _____)

7- Areas of the island where water storage can be increased.: (State the areas where water is currently stored for communal use on the island, and rank them in order of their convenience to the community.).

Note: Please include photographs of the identified areas.

#	Name of building / area	Size of the area / building (square feet)	Distance to the nearest electrical supply board (feet)	Distance to the generator house or sewerage plant (feet)	Is it placed on a floor? If yes, diameter of the foundation	Is it sheltered? If yes, size and condition of the roof	Is it sheltered? If yes, size and condition of the roof	Depth of water
Area 1								
Area 2								
Area 3								

8- Information about the roofs near the area or building stated in response to question 6:

Note: Please include photographs of the areas.

#	Name of building with the roof from which water is collected	Area of the building (square feet)	Area of the roof used for collecting water (square feet)	Height of the building (from ground to water gutter) (feet)	Distance to location identified for water storage (feet)	Condition of the roof
Area 1						
Area 2						
Area 3						

9- Additional information about the areas stated above: (For example, if the area is currently utilized for any other purpose or , if any water tanks are kept there. If there are tanks, describe the condition of those tanks, whether the area has a foundation and roof for water collection and if distribution taps are installed.).

Information provided by: _____

Designation: _____

Signature: _____ Date: _____