FINANCIAL ANALYSIS OF WATER AND SEWER INFRASTRUCTURE ALTERNATIVES – ISLANDS OF DHIDHDHOO AND HINNAVARU, THE MALDIVES

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Annexes

ACRONYMS

EPA	Environmental Protection Agency, regulatory agency within the Maldives Ministry of Housing and Environment
GCC	Global Climate Change
GOM	Government of the Maldives
MEA	Maldives Energy Authority
MRf	Rufiyaa, currency of the Republic of Maldives
MVR	The International Organization for Standardization code for Maldivian rufiyaa
MWSC	Male' Water and Sewerage Company
NUL	Northern Utilities Limited
STELCO	State Electric Company
UNUL	Upper North Utilities Limited
USAID	United States Agency for International Development

SECTION 1
Background and Objectives

The Enhance Climate Resiliency and Water Security in the Maldives project, or Maldives Global Climate Change (GCC), is intended to demonstrate the process and outcomes needed to allow island communities to maximize their opportunity to overcome impacts from global climate change. The program is providing assistance to the Government of the Maldives (GOM); island councils; regional utilities; the private sector; and residents of two islands (Hinnavaru and Dhidhdhoo) in the northern part of the country designated to become "climate resilient islands" with USAID assistance. The project's focus is based on climate-related risk-reduction associated with the development, use, and conservation of water resources in ways that are responsive to the environmental, social, cultural, economic, and governance context of the atolls. Maldives GCC is providing assistance for provision of water supply, sewerage, and solid waste services, and associated infrastructure. The overall objective and intended outcome of the project is to develop the knowledge, skills, and attitudes that island residents need to become stewards of their island environment and to make rational and informed decisions related to climate change adaptation.

A climate vulnerability assessment was conducted and documented in a separate report entitled *Climate Vulnerability Assessment – Islands of Dhidhdhoo And Hinnavaru, The Maldives* (CH2M HILL, 2012) using available climate data to assess the vulnerability of key services (e.g., water, sanitation, solid waste management) to the impacts of climate change. A second report entitled *Utility Service Delivery and Institutional Capacity Assessment – Islands of Dhidhdhoo and Hinnavaru, The Maldives* (CH2M HILL, 2012) documented the Utility Service Delivery Assessments and the associated institutional assessments for the islands of Dhidhdhoo and Hinnavaru. The Utility Service Delivery Assessment offered recommendations and action plans for the islands of Dhidhdhoo and Hinnavaru, with some qualitative assessment of the long-term affordability and financial sustainability of the proposed infrastructure alternatives.

The objectives of this assignment were:

- To analyze the financial viability of operating and maintaining Maldives GCC project-financed water supply and sewerage system infrastructure development and rehabilitation activities on the islands of Hinnavaru and Dhidhdhoo.
- To compare desired improvements in water supply and sewerage with the financial capacity to operate them.

SECTION 2
Scope of Work

The following tasks were completed to determine the current tariff framework and policies:

1. Review the Utility Service Delivery Assessment prepared by the Maldives GCC project.

2. Review current legal requirements for water sector tariff setting in the Maldives and determination of the process for water sector tariff setting by utilities.

3. Review additional mechanisms whereby the capitalization and operations and maintenance costs of water production and delivery systems are financed, or other relevant cost-recovery mechanisms, e.g., subsidies, taxation, etc.

4. Determine the current status of water sector tariff setting for the NUL and UNUL, and other mechanisms, if any, for offsetting or recovering costs.

5. Based on information in the Utility Service Delivery Assessment, determine tariff rates sufficient to operate and maintain each (or each combination) of the alternative water supply and sewerage infrastructure activities proposed, including (a) 100 percent cost recovery, (b) 75 percent cost recovery, and (c) 50 percent cost recovery.

6. Make recommendations about the implementation and financial viability of different water infrastructure "packages" on each island, at 100 percent, 75 percent, and 50 percent cost recovery. These packages may be a blend of options suggested in the utility assessment.

Two related reports were prepared to summarize the findings:

- *Maldives Water and Sewer Tariffs: Current Framework and Policies* (Tasks 1 through 4).

- This report, *Financial Analysis of Water and Sewer Sector Infrastructure Alternatives – Islands of Dhidhdhoo and Hinnavaru, The Maldives* (Tasks 1, 5, and 6).

References throughout this report made to a year or fiscal year mean the calendar year beginning January 1 and ending December 31. Financial amounts that are reported in United States Dollars (USD or $) or Maldivian Rufiyaa (MVR or MRf) assume a currency exchange rate of 1.00USD to 15.35MVR.[1] Future amounts do not consider fluctuations in foreign exchange rates over time. Unless stated otherwise, capital and O&M expenses are reported in 2011 dollars. Findings are based on the best input information and assumptions available at the time of this report.

[1] http://www.google.com/finance?q=USDMVR#, accessed on May 7, 2012.

SECTION 3
Current Situation

Dhidhdhoo (Dhivehi: ދިއްދޫ) is the capital of Haa Alif Atoll administrative division in the Maldives. The island lies on the northwestern tip of Thiladhummathi Atoll. Originally, the island was 52 hectares, but after land reclamation in 2010, the island is now approximately 85 hectares. The estimated population of Dhidhdhoo is 3,740, the largest population in the Atoll[2]. The population of Dhidhdhoo has increased in recent years at a steady rate of approximately 2.0 percent per year.

Hinnavaru (Dhivehi: ހިންނަވަރު) is one of the inhabited islands of the Lhaviyani Atoll. Originally, the island was 22 hectares, and after land reclamation in 2010, the island is now 55 hectares. It has a population of approximately 4,500 with 715 registered households. Population data and growth rates available for the past decade through 2010 show a slow rate of increase with an annual average growth rate of about 0.6 percent.

The conventional water resources available on the islands are shallow groundwater aquifers and rainwater. Non-conventional water resources include desalinated water, bulk water imported by barge, and imported bottled water. The main source of drinking water across the Maldives remains rainwater, and desalinated water providing the primary drinking water sources in Male' (capital of Maldives) and on two of the larger more developed islands.

In Dhidhdhoo, the existing desalination plant and distribution system through public taps is in disrepair and inoperable. In Hinnavaru, piped desalinated water is supplied to four non-domestic accounts and approximately 42 domestic accounts on a 24-hour basis—this equals approximately six percent coverage of households with safe, secure water provision. The main potable source of water on both islands remains rainwater harvested on rooftops.

The vast majority of homes on both islands utilize and/or have access to central utility services for electricity, cable TV, internet and telephone, but have essentially no central water supply services, and limited wastewater services. The institutional structures related to the provision of water, wastewater, and electricity services are described in CH2M HILL's prior reports.

[2] Registered Statistical Yearbook 2010.

SECTION 4
Infrastructure Alternatives

Infrastructure alternatives were developed for each of the infrastructure areas (water, wastewater, and solid waste) as described in the Utility Service Delivery and Institutional Capacity Assessment. This financial analysis focuses on the water and wastewater alternatives only. After consultation with the stakeholders on the island, the alternatives were developed by the assessment team to meet the climate change resiliency and water security goals of the project. The infrastructure capital and O&M costs are summarized in Table 4-1 for Dhidhdhoo and Table 4-2 for Hinnavaru.

Table 4-1: Infrastructure Alternatives Cost Summary
Island of Dhidhdhoo

Alternatives	Estimated Cost	Number of Persons Affected	$ Per Person	Annual O&M
Water Alternatives				
W1 - Repair Existing 10 Ton SWRO	$ 65,250	667	$ 97.83	$ 33,000
W2 - Community Rainwater Storage Tanks	$ 386,250	4,500	$ 85.83	$ 8,400
W3 - New 30 Ton SWRO	$ 856,500	2,000	$ 372.75	$ 58,000
W4 - New 150 Ton SWRO	$ 1,230,000	4,500	$ 273.33	$ 122,000
W5 - 10 Ton Solar SWRO Pilot Plant	$ 225,000	667	$ 337.33	$ 18,000
W6 - Repair Existing Water Distribution Network	$ 30,000	667	$ 44.98	$ 10,000
W7 - Distribution Network for all Households	$ 405,000	4,500	$ 90.00	$ 20,000
W8 - Solar Array for SWRO Offset	$ 40k - 225K	-	$ -	$ 2.2k - 13.5k
W9 - Additional Household Rainwater Storage Capacity	$ 1,275	5	$ 255.00	NA
Wastewater Alternatives				
WW1 - Integrity Testing of Existing Sewer	$ 30,000	4,500	$ 6.67	$ -
WW2 - New Sewage Treatment Plant	$ 2,302,500	4,500	$ 511.67	$ 232,600

Table 4-2: Infrastructure Alternatives Cost Summary
Island of Hinnavaru

Alternatives	Estimated Cost	Number of Persons Affected	$ Per Person	Annual O&M
Water Alternatives				
W1 - Community Rainwater Storage Tanks	$ 386,00	4,500	$ 85.83	$ 8,000
W2 - New 30 Ton SWRO	$ 756,000	4,500	$ 167.92	$ 58,000
W3 - New 150 Ton SWRO	$ 1,169,000	4,500	$ 259.83	$ 122,000

Table 4-2: Infrastructure Alternatives Cost Summary
Island of Hinnavaru

Alternatives	Estimated Cost	Number of Persons Affected	$ Per Person	Annual O&M
W4 - 10 Ton Solar SWRO Pilot Plant	$ 225,000	667	$ 337.33	$ 18,000
W5 - Distribution Network for all Households	$ 540,000	4,500	$ 120.00	$ 16,000
W6 - Solar Array for SWRO Offset	$ 120k – 225k	-	$ -	$ 8k – 14k
W7 - Additional Household Rainwater Storage Capacity	$ 1,275	5	$ 255.00	NA
Wastewater Alternatives				
WW1 - Energy Audit and Optimization of STP	$ 45,000	-	$ -	$ -
WW2 - Solar Power to Offset STP Energy Usage	$ 375,000	-	$ -	$ 15,000

k = thousands

These infrastructure alternatives form the basis for the financial analysis of water and sewerage infrastructure alternatives provided in this report. It should be noted that the expected level of accuracy for the cost estimates associated with each alternative is Class 4, as classified by the Association for the Advancement of Cost Engineering International. The expected accuracy range of a Class 4 estimate is within 50 percent over the estimate to 30 percent under the estimate. In order to reduce the risk of the impact of underestimation, for capital costs, a contingency of 50 percent is applied to the developed estimates. The final cost of the projects will depend on actual labor and materials costs, actual site conditions, productivity, competitive market conditions, bid dates, seasonal fluctuations, final project scope, final project schedule, and other variables. As such, the financial analysis and preliminary tariff estimates presented in this report will also have a similar range of uncertainty. Despite the level of uncertainty, the financial analysis has validity for the comparison of alternatives.

4.1 HINNAVARU WATER CONSUMPTION PROFILE

CH2M HILL obtained the most recent water billing data from the NUL on Hinnavaru to determine the consumption patterns in the community. Figure 4-1 illustrates the monthly residential billed water consumption on Hinnavaru.

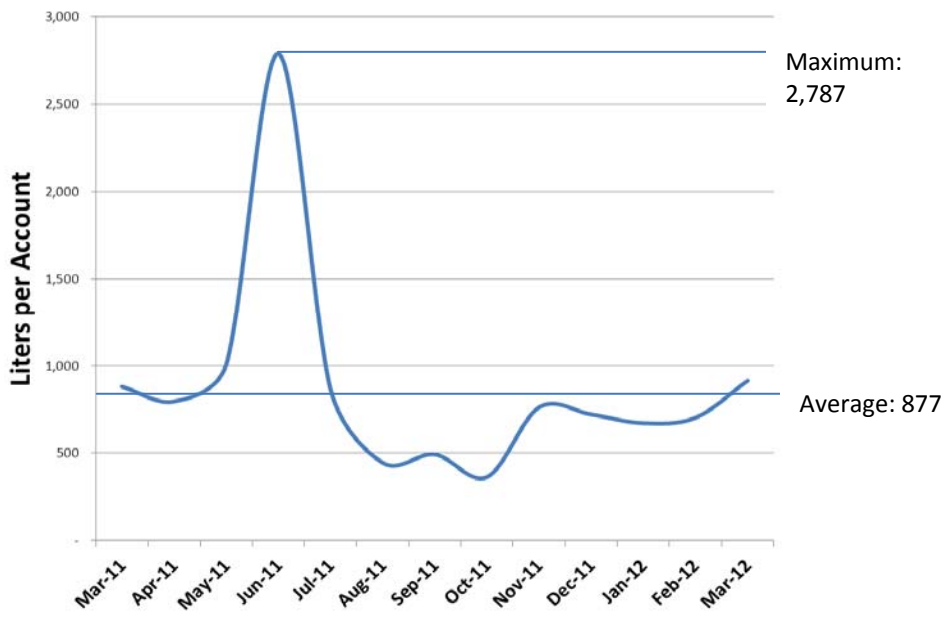

Figure 4-1: Monthly Residential Billed Water Consumption, Hinnavaru

As shown in Figure 4-1, the maximum billed monthly volume of 2,787 liters per account occurred in June 2011. Note that this reflects the data in the NUL billing system so there is likely a lag of one month or more following the actual peak consumption period, which therefore would have occurred at the height of the dry season in May 2011. Regardless of the precise timing, consumption per account in the peak month (2,787 liters) is nearly 3.2 times the average monthly consumption (877 liters). Using the Hinnavaru billing data, a number of important statistics can be derived; these are listed in Table 4-3. Because of the similarities in demographics on both islands, the Hinnavaru statistics serve as good proxy for the likely customer behavior on Dhidhdhoo if they were using a centralized desalination production and distribution system.

Table 4-3: NUL Water Service Statistics, Hinnavaru

Description	Average	Maximum
Domestic Consumption (liters/account/month)	877	2,787
Domestic Consumption (liters/account/day)	28.9	91.7
Domestic Per Capita Consumption (liters/person/day)	4.6	14.6
All Classes Per Capita Consumption (liters/person/day)*	7.1	16.2

* All classes include domestic and non-domestic customers (business, government and private schools).

As shown in Table 4-3, maximum per capita consumption is more than three times average consumption rates. A central water supply system designed to meet peak month demands will have a limited base load water demand in the remainder of the year to generate revenue and recover the cost of operations unless people on the islands can be

convinced of the quality of the desalinated water and the advisability of supporting the desalination system that is so critical to supporting their needs.

Note that when non-domestic classes (business, government, and private schools) are included in the consumption metrics, the NUL billing data indicates that the maximum per capita consumption was 16.2 liters per capita per day in Hinnavaru. This is comparable to the Maldivian EPA guidance of a minimum 20 liters per capita per day for the design of island water supply systems in the atolls. The complete billing data and water service financial statistics are provided in Annex A.

4.2 AFFORDABILITY OF WATER AND WASTEWATER

Water affordability as an international issue emerged in the 1992 Dublin Statement on Water and Sustainable Development: "it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price." In March 2000, the Ministerial Declaration of The Hague on Water Security in the 21st Century (Second World Water Forum) included the common goal that "every person has access to enough safe water at an affordable cost to lead a healthy and productive life." Water was also referred to in the Millennium Declaration but is not mentioned in most references to the Millennium Development Goals.

Assuming that drinking water prices should be affordable, then the most commonly used measure has become an affordability index comparing the household water and sanitation bill to median household income (total pre-tax income). One benefit of this approach is that typically the data are readily available and easy to understand; one disadvantage is that the wider the distribution in household income levels, the larger the proportion of the population unable to afford the tariffs - even if tariffs are considered affordable on an aggregate basis. While the affordability index has its detractors and shortcomings, it serves as a good initial screening measure on an aggregate basis.

A commonly-referenced affordability index in both developed and developing countries is 5.0 percent (i.e., the five-percent rule). This index is similar to indices and approaches used in various countries and provides an objective basis for quantifying the concept of water affordability. For the purposes of this report, an affordability index of 2.5 percent for water and wastewater each (5.0 percent, total) was assumed.

In the Maldives in 2009-2010, monthly median household income was estimated to be MVR 18,000 in Male' and MVR 8,466 in the atolls as shown in Figure 4-2.

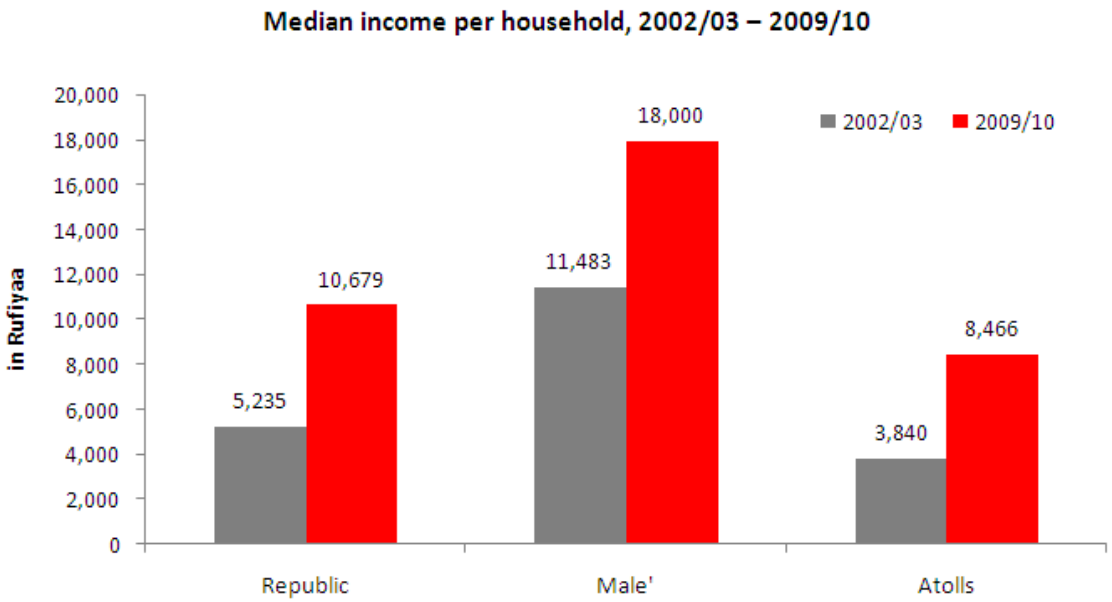

Figure 4-2: Monthly Median Income per Household, 2002/03 – 2009/10

For the purposes of this assignment, CH2M HILL examined the affordability of water service on the island of Hinnavaru. The average residential consumption level of 877 liters per month results in a monthly bill of MVR 162, which corresponds to 1.9 percent of median household income in the atolls.

These findings are quite interesting in that households in Hinnavaru appear to be self-limiting their water consumption to around 2.0 percent of median household income by using desalinated water sparingly when other water sources are available. When customers on Hinnavaru utilize their peak consumption of 2,787 liters in May, their monthly bill jumps to MVR 488 – or 5.3 percent of their median household income. The median household income calculation by month for Hinnavaru is provided in Annex A.

These findings suggest that the tariffs in Hinnavaru (MVR 150 per cubic meter) are under the assumed affordability index of 2.5 percent for the atolls. Using the same 2.5 percent index for wastewater, it can be assumed that a wastewater surcharge in this range (a flat rate MVR 212 per month) would represent an affordable tariff for wastewater service. The two services combined would therefore result in a monthly bill in the range of MVR 375, or approximately 4.4 percent of median household income.

4.3 INFRASTRUCTURE COST RECOVERY EVALUATION

The cost recovery of each infrastructure alternative was evaluated and tariffs were estimated at varying levels of cost recovery (50, 75, and 100 percent). The new 150 tonne desalination plants (both islands) were eliminated due to their capital investment cost above the project's level of available funding, and their high O&M costs and resultant unaffordable tariffs.

For the purposes of this assessment, a uniform volumetric tariff was assumed for water infrastructure cost recovery and a flat tariff per household was assumed for wastewater infrastructure cost recovery. Further, the fixed component of the tariff (MVR 30 per account per month) was assumed to recover the cost of management and administration functions, such as billing and collection, which were not included in the infrastructure O&M costs. Fixed charges vary widely, but normally fall within the range of 20 to 30 percent of the average water bill to cover fixed costs related to utility management and administration. In Male' and across the Maldives, the fixed charge component of the residential water bill is MVR 30 per month.

Initial capital investment costs were assumed to be paid by the project and therefore capital cost recovery was not evaluated or included in the affordability calculations. The estimated tariffs to achieve each level of O&M cost recovery are provided in Tables 4-4 and 4-5.

Table 4-4: Infrastructure Alternatives Tariff Summary
Island of Dhidhdhoo

Alternatives	Annual O&M	Tariff at 2.5% MHI	100% Cost Recovery Tariff	75% Cost Recovery Tariff	50% Cost Recovery Tariff
Water Alternatives	USD	MVR per m3	MVR per m^3	MVR per m^3	MVR per m^3
W1 - Repair Existing 10 Ton SWRO	$ 33,000	207	173	130	87
W2 - Community Rainwater Storage Tanks	$ 8,400	207	13	10	7
W3 - New 30 Ton SWRO	$ 58,000	207	163	122	81
W4 - New 150 Ton SWRO	$ 122,000	207	Not Evaluated	Not Evaluated	Not Evaluated
W5 - 10 Ton Solar SWRO Pilot Plant	$ 18,000	207	95	71	47
W6 - Repair Existing Water Distribution Network	$ 10,000	207	16	12	8
W7 - Distribution Network for all Households	$ 20,000	207	31	25	16
W8 - Solar Array for SWRO Offset	$ 7,850	207	12	9	6
W9 - Additional Household Rainwater Storage Capacity	NA	207	-	-	-
Wastewater Alternatives		MVR per Residence per Month	MVR per Residence per Month	MVR per Residence per Month	MVR per Residence per Month
WW1 - Integrity Testing of Existing Sewer	$ -	-	-	-	-
WW2 - New Sewage Treatment Plant	$ 232,600	212	365	274	183

Table 4-5: Infrastructure Alternatives Cost Summary
Island of Hinnavaru

Alternatives	Annual O&M	Tariff at 2.5% MHI	100% Cost Recovery Tariff	75% Cost Recovery Tariff	50% Cost Recovery Tariff
Water Alternatives	USD	MVR per m3	MVR per m^3	MVR per m^3	MVR per m^3
W1 - Community Rainwater Storage Tanks	$ 8,000	207	16	12	8
W2 - New 30 Ton SWRO	$ 58,000	207	185	139	93
W3 - New 150 Ton SWRO	$ 122,000	207	Not Evaluated	Not Evaluated	Not Evaluated
W4 - 10 Ton Solar SWRO Pilot Plant	$ 18,000	207	108	81	54
W5 - Distribution Network for all Households	$ 16,000	207	33	25	17
W6 - Solar Array for SWRO Offset	$ 7,850	207	22	17	11
W7 - Additional Household Rainwater Storage Capacity	NA	207	-	-	-
Wastewater Alternatives		MVR per Residence per Month			
WW1 - Energy Audit and Optimization of STP	$ -	-	-	-	-
WW2 - Solar Power to Offset STP Energy Usage	$ 15,000	212	31	23	16

The tariff estimates indicate that the O&M costs of supplying desalinated water on either island will be more than the current volumetric tariff in Hinnavaru of MVR 150 per cubic meter, but potentially less than the tariff at the affordability index of 2.5 percent of median household income (MVR 207). These tariff levels are substantially below the reported MVR 800 per cubic meter that is paid on Dhidhdhoo for the short-term importation of bulk water by barge in the dry season.

Additional O&M costs related to water distribution networks, storage facilities, or other ancillary facilities would add to the volumetric tariff. It should be noted that the electricity is currently heavily subsidized on the islands. An increase in electricity prices will significantly increase the O&M cost of desalinated water.

Interestingly, the O&M cost recovery level for wastewater service in Dhidhdhoo is well above that for water service – in the range of MVR 365 per month per account. Assuming that operational costs on both islands would be similar, this would seem to indicate that the previously-constructed wastewater treatment system on Hinnavaru is not affordable or sustainable over the long term without some form of subsidy.

4.4 WILLINGNESS TO PAY

When discussing the affordability of water service, it is important to distinguish between two concepts: the ability to pay and the willingness to pay. Ability to pay applies to lower-income households and is concerned with whether the household has enough income to pay a higher water bill without forcing serious tradeoffs in other essential goods and services. Willingness to pay can apply to any water customer and is concerned with whether the customer believes that there is a sufficient benefit from the water service to justify a higher water bill. The focus of the affordability analysis is on ability to pay, though water systems must be equally concerned with their customers' willingness to support a higher level of water tariffs.[3]

The users on Hinnavaru appear to exhibit selective consumption behavior by significantly reducing water purchases dur ing the rainy season and relying instead on lower cost supplies - primarily rainwater and groundwater. Thus they appear to be self-selecting within an overall level of affordability based on a willingness (or unwillingness) to pay. The island residents' willingness to pay depends on seeing and experiencing obvious improvements in water quality and accessibility on the island. Developing water quality testing programs to gather evidence about how the three sources of water differ and including this knowledge in a public awareness program could increase the willingness to pay on the island.

Furthermore, it is reported that the NUL only receives revenue for 20 to 40 percent of the water produced at the existing SWRO plant due to various schemes by the community to avoid paying for usage. This would seem to indicate that at least a portion of the community does not have the willingness or ability to pay for desalinated water service. Overall willingness to pay is low because of the other readily available sources of supply from groundwater and rainwater harvesting.

In debates about how to extend water services to the poor and/or unconnected, "willingness to pay" is often brought up as an issue, and often refers to an unwillingness to pay what the water actually costs to treat, deliver and sustain long term operations. The central issue is cost recovery. If the same water tariff is charged across an island, it should either be high enough to support a centralized system or alternative sources of funding must be identified.

4.5 OPTIONS FOR COST RECOVERY THROUGH TARIFFS

The current structure of the NUL and UNUL authorizes these utilities to provide multiple services, including water and wastewater services. Water tariffs are currently collected by the NUL on Hinnavaru using a separate billing and collection system. Depending on the selected infrastructure alternatives, consideration should be given to the integrated utility model that allows for billing, collection, and cross-subsidization of electricity, water, wastewater, and solid waste services.

[3] Affordability of Water Service, Scott J. Rubin, National Rural Water Association. May 24, 2001.

Because electricity is the only public utility widely provided and paid for by the government, this seems to be the only option other than a separate water and wastewater utility for tariff collection. It also would allow for capturing a broad base of wastewater customers who may not be water customers. Payment rates are usually intentionally high in such systems, because it is easy to administer centrally and fee collection cost is reduced given that it requires only one bill and one bank transaction.

Regardless of the fee collection system, the revenues from the fees should serve to sustain aggregate operations and should be the primary revenue stream of the providers of the various utility services.

SECTION 6
Conclusions and Recommendations

This financial analysis examined the financial viability of operating and maintaining Maldives GCC project-financed water supply and sewerage system infrastructure development and rehabilitation activities on the islands of Hinnavaru and Dhidhdhoo and compared the desired improvements in water supply and sewerage with the financial capacity to operate them.

Water Supply

Maximum per capita water consumption on Hinnavaru Island is more than three times average consumption values. A central water supply system designed to meet peak month demands will have a very limited base load water demand in the remainder of the year to generate revenue and recover the cost of operations unless people on the islands can be convinced of the quality of the desalinated water and the advisability of supporting the desalination system that is so critical to supporting their needs.

The tariff estimates indicate that supplying desalinated water on either island will cost more than the current volumetric tariff in Hinnavaru of MVR 150 per cubic meter, but potentially less than a tariff derived from an affordability index level of 2.5 percent of median household income (MVR 207). These tariffs would be among the highest levels in the Maldives and they exclude capital cost recovery and potential additional O&M costs beyond the scope of infrastructure alternatives evaluated in this report[4]. While the 2.5 percent affordability index level is reasonable based on global data, it is not clear that Hinnavaru residents are willing to pay tariffs in this range. However, even these high tariff levels are well below the reported MVR 800 per cubic meter that is paid on Dhidhdhoo for short-term importation of bulk water by barge in the dry season.

Affordable water supply service potentially could be achieved through the combination of limited desalination capacity to meet dry season water shortfalls from other sources, increased rainwater harvesting capacity, solar power to offset energy costs associated with desalination, increased storage capacity and increased distribution networks for all domestic and non-domestic customers island-wide. Efficient distribution of centrally stored water could be achieved through mechanisms other than household connections, including transport by truck in standardized containers, e.g., 20 liters.

[4] We exclude capital investment from the analysis because capital costs would presumably be paid using Maldives GCC funds. Also, the "potential O&M costs" are utility management and administrative costs that are typically excluded from the engineering estimate. Engineering estimates typically capture electricity, chemicals, labor, filter replacements, etc. that are required to operate the infrastructure. Engineering estimates generally do not consider the management and administrative costs associated with running a utility, such as meter reading, billing and collection, customer service, accounting, legal and similar functions. This analysis therefore makes a broad assumption that the fixed component of the tariff (MVR 30 per month, or about 20% of the average bill) was dedicated for these administrative costs. This is a very high-level estimate at this point in the study and is very much scale-dependent (administrative unit costs decrease with increasing utility size).

Sewerage

Wastewater tariffs to recover wastewater treatment O&M costs exceed levels considered affordable by more than 70 percent. Tariffs for full cost recovery of the existing wastewater collection systems on Dhidhdhoo and Hinnavaru would likely exceed both the ability and willingness to pay. Therefore, operating these systems likely is not sustainable in the long term without subsidies.

Water Storage

The dry-season peak water demands indicate that water storage is critically important to sustain affordable year-round operations, whether via a central rainwater harvesting system or via a desalination system. In addition, water distribution to the largest number of customers will reduce relative tariff levels as a result of economies of scale.

Regardless of the infrastructure alternatives selected, developing water quality testing programs to gather evidence about how the quality of water from the three sources differs and including this knowledge in a public awareness program will be required to increase the willingness to pay on the islands.

Annex A: Water Consumption, Expeditures and Financial Statistics for the Island of Hinnavaru

Description	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	AVERAGE
Quantity (Liters)														
Business	4,643	3,509	21,154	6,702	10,354	23,068	19,994	4,236	12,540	7,526	5,796	8,523	7,965	10,462
Domestic	35,220	30,221	41,351	103,125	36,282	24,860	17,719	20,264	28,198	25,234	20,132	34,411	41,172	35,245
Government	2,610	1,588	5,942	1,978	3,184	2,332	2,332	2,623	4,021	1,800	1,874	2,121	2,837	2,711
Private School	-	-	-	1,850	-	1,774	1,774	-	-	33,898	-	23,338	3,227	5,066
Additional Bills	5,503	8,729	6,991	1,426	-	-	-	-	-	-	-	-	-	1,742
Cancelled Bills (not included)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Quantity	47,976	44,047	75,438	115,081	49,820	52,034	41,819	27,123	44,759	68,458	27,802	68,393	55,201	55,227
Volumetric Rate (MVR/Liter)														
Business	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Domestic	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Government	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Private School	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Accounts														
Business	2	1	2	2	3	5	4	2	2	2	1	3	2	2
Domestic	40	38	41	37	42	56	36	56	37	35	30	49	45	42
Government	2	1	2	2	2	2	2	2	2	2	2	2	2	2
Private School	-	-	-	1	-	1	1	-	-	1	-	2	1	1
Total Accounts	44	40	45	42	47	64	43	60	41	40	33	56	50	47
Financial Performance Indicators														
Domestic Consumption (liters/account/month)	881	795	1,009	2,787	864	444	492	362	762	721	671	702	915	877
Domestic Consumption (liters/account/day)	29	26	33	92	28	15	16	12	25	24	22	23	30	28.9
Domestic Per Capita Consumption (liters/person/day)	4.6	4.2	5.3	14.6	4.5	2.3	2.6	1.9	4.0	3.8	3.5	3.7	4.8	4.6
All Classes Per Capita Consumption (liters/capital/day)	6.3	6.1	9.6	16.2	6.2	4.9	6.1	2.5	6.3	10.2	4.8	7.3	6.4	7.1
Average Volume Charge per Account	MVR 132	MVR 119	MVR 151	MVR 418	MVR 130	MVR 67	MVR 74	MVR 54	MVR 114	MVR 108	MVR 101	MVR 105	MVR 137	MVR 132
Average Fixed Charge per Account	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30	MVR 30
Average Monthly Bill per Account	MVR 162	MVR 149	MVR 181	MVR 448	MVR 160	MVR 97	MVR 104	MVR 84	MVR 144	MVR 138	MVR 131	MVR 135	MVR 167	MVR 162
Median Household Income[1]	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466	MVR 8,466
Average Bill as a Percent of MHI	1.9%	1.8%	2.1%	5.3%	1.9%	1.1%	1.2%	1.0%	1.7%	1.6%	1.5%	1.6%	2.0%	1.9%

Notes:
1. Median Household Income in the Atolls, HOUSEHOLD INCOME AND EXPENDITURE SURVEY, 2009 - 2010, Department of National Planning, Ministry of Finance and Treasury, Republic of Maldives.