



Ministry of Environment,  
Climate Change & Technology  
Republic of Maldives

# **WATER AND SEWERAGE MASTER PLAN**

**REPUBLIC OF MALDIVES**

**2021-2035**

# Water and Sewerage Master Plan

## Republic of Maldives

### 2021 -2035

Ministry of Environment, Climate Change & Technology Republic of Maldives

Green Building

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The Republic of Maldives

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## List of Abbreviations and Acronyms

ADB	Asian Development Bank
CBO	Community Based Organization
CSO	Civil Society Organization
EC	Electrical conductivity (salinity indicator)
E.coli	Escherichia coli (indicator for microbial contamination)
ECWRS	Enhance Climate Resilience and Water Security project (see GCC)
EIA/ESIA	Environmental/and Social Impact Assessment
EMMP	Environmental Mitigation and Monitoring Plan
EPA	Environmental Protection Agency
FGL	Fresh Groundwater Lens
FENFAHI	National awareness campaign for water and sewerage
GAP	Gender Action Plan
GoM	Government of Maldives
GCC	Maldives Global Climate Change Project (USAID)
GCF	Green Climate Fund (Supporting Vulnerable Communities project)
HDC	Housing Development Corporation
HH	Household
HIES	Household Income and Expenditure Survey
HPA	Health Protection Agency
IUCN	International Union for Conservation of Nature
lpd	(water consumption of) liter per person per day
MEA	Maldives Energy Authority
MFDA	Maldives Food and Drugs Authority
MIS	Management Information System
MLSA	Maldives Land and Survey Authority
MMS	Maldives Meteorological Service
MNPHI	Ministry of National Planning, Housing and Infrastructure
MNU	Maldives National University
MoE	Ministry of Education
MoED	Ministry of Economic Development
MoEnCC&T	Ministry of Environment, Climate Change and Technology
MoGFSS	Ministry of Gender, Family and Social Services
MoFMRA	Minister of Fisheries, Marine Resources, and Agriculture
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs
MoFMRA	Ministry of Fisheries, Marine Resources and Agriculture
MoH	Ministry of Health
MoHE	Ministry of Higher Education
MoIF	Ministry of Islamic Affairs

MoT	Ministry of Tourism
MoYSCE	Ministry of Youth, Sports and Community Engagement
MURDP	Maldives Urban Development and Resilience Project
MWSC	Male' Water and Sewerage Company
M&E	Monitoring and Evaluation
NBS	National Bureau of Statistics
NCIT	National Centre for Information Technology
NDMA	National Disaster Management Authority
NGO	Non-Governmental Organization
NHL	National Health Laboratory
NRW	Non-Revenue Water
NWSP	National Water and Sewerage Policy
NWSSP	National Water and Sewerage Strategic Plan 2020-2025
O&M	Operation and Maintenance
PSIP	Public Sector Investment Program
SAP	Strategic Action Plan 2019-2023
SDG	Sustainable Development Goals
SLR	Sea Level Rise
STELCO	State Electricity Company
SuDS	Sustainable Drainage Systems
TVET	Technical, Vocational Education and Training (Authority)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
URA	Utility Regulatory Authority
USAID	United States Agency for International Development
V&A	Vulnerability and Adaptation
WASH	Water, Sanitation and Hygiene
WATSAN	Water and Sanitation
WATSAN Committee	Water and Sanitation Coordination Committee
WB	World Bank
WHO	World Health Organization
WSP	Water Safety Plan
W&SSP	Water and Sanitation Safety Plan

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## Chapter 1 Water and Sewerage Master Plan in Maldives 2021 -2035

### 1.1 Introduction

In the last 30 years, Maldives has developed rapidly. Education and health improvements have combined with economic and social progress. Maldives successfully promoted itself as a tourist destination. Where earlier it derived its income mainly from fishing, tourism has now become the main source of income for the government and increasingly for Maldivians engaged in this sector.

To ensure greater opportunities and wellbeing for all, the government has formulated the Strategic Action Plan (SAP). An important component of the SAP is provision of adequate water, sanitation and environmental services to the islands. Key components are water security, integrated water resources management, sewerage and wastewater management. Upgrading of water and sanitation services will reduce the multidimensional poverty in the islands and offer opportunity for greater participation in economically gainful activities such as offered through guesthouses and tourism related services.

In 2017, Ministry of Environment, Climate Change and Technology formulated a National Water and Sewerage Policy aimed at ensuring that all inhabitants of Maldives would benefit from access to safe water supply and adequate sewerage services. To enable this ambitious target, the policy states the priorities of the sector as

- < Adoption of cost-effective, environment friendly and appropriate technologies
- < Strengthening the legal framework
- < Encouraging private sector investments
- < Building Institutional capacity
- < Maintaining financial and environmental sustainability
- < Strengthening advocacy and awareness
- < Promotion of research and development
- < Protection and conservation of water resource

The National Water and Sewerage Policy was reflected in the Strategic Action Plan 2019-2023 (SAP) adopted by the Government. On 5<sup>th</sup> August 2020, the Water and Sewerage Act (8/2020) was ratified. On 5<sup>th</sup> November 2020, the Ministry published the National water and sewerage strategic Plan 2020-2025 (NWSSP).

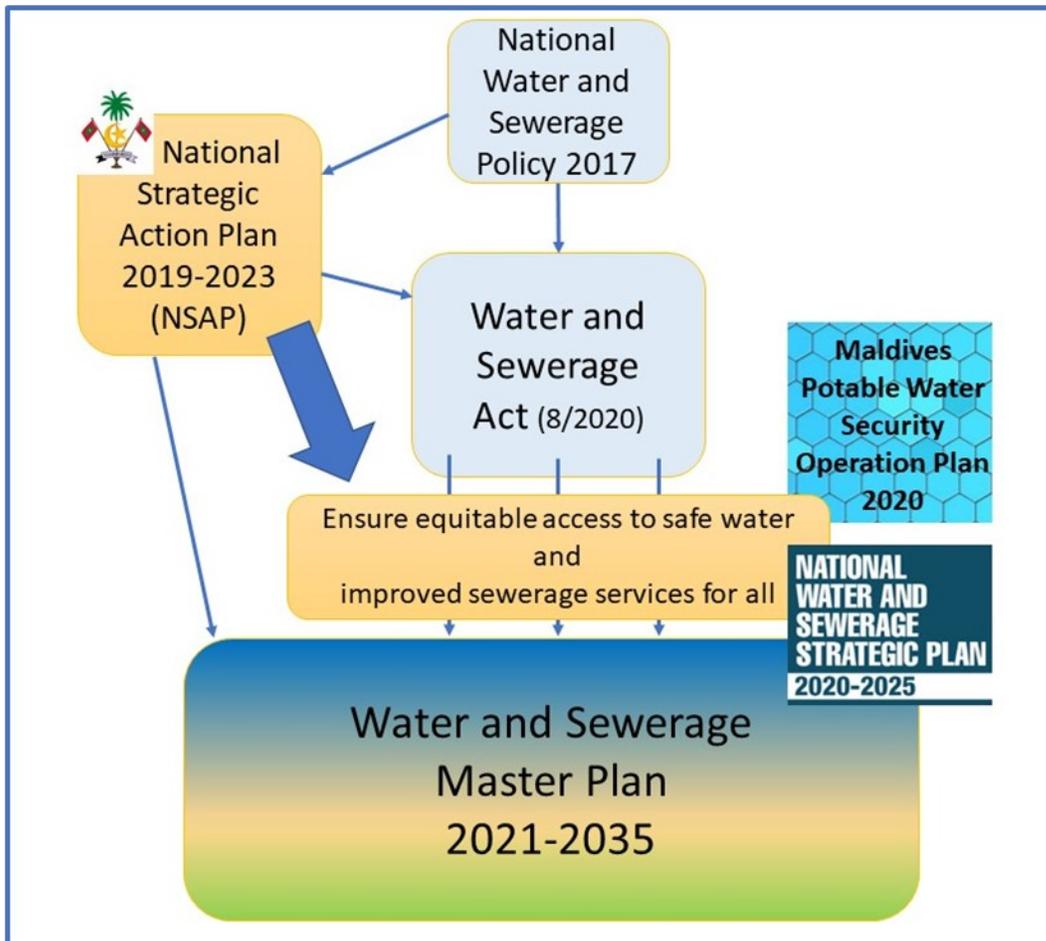


Figure 1 Timeline from Policy to unified Water and Sewerage Master Plan

## 1.2 Strategic Action Plan 2019-2023

The Strategic Action Plan 2019-2023 gives guidance and purpose to national development and outlines how the government aims to tackle *“an overly congested capital; stark regional disparities in socio-economic and infrastructural progress; environmental degradation; unequal opportunities to accessing basic goods and services; and difficulties accessing meaningful employment, quality education, and affordable housing, among a plethora of other issues”* (Government of Maldives, 2019). The implementation of the SAP aims to achieve a better sharing of the development dividend between Male’ and the Atolls, through decentralization while improving social outcomes.

The SAP describes five priority areas for the period 2019-2023

- < Blue Economy
- < Caring State
- < Dignified Families
- < Jazeera Dhiriulhin
- < Good Governance

The Strategic Action Plan (SAP) is the Government’s overarching reference point to steer its national development efforts. The Strategic Action Plan 2019-2023 has 5 sectors and 33 subsectors.

Sector	Subsector	Linkage with the water and sewerage sector
 <b>1. BLUE ECONOMY</b>	1.1 Fisheries & Marine Resources	1.1 Coral Reef Monitoring/ice production
	1.2 Agriculture	1.2 Promote agriculture for import substitution
	1.3 Tourism	1.3 Guesthouse facilities
	1.4 Small and Medium Enterprises	1.4 Green SME initiatives
 <b>2. CARING STATE</b>	2.1 Health	2.1 Primary Health Care focus
	2.2 /2.3 Education	2.2 /2.3
 <b>3. DIGNIFIED FAMILIES</b>	3.1 Family	3.1 inclusive to persons with disabilities/ elderly; accessibility
	3.2 Housing	3.2 social housing
	3.4 Community empowerment	3.4 community orientation and consultation/ CSO participation
	4.1 Decentralization	4.1 Functionality of councils and gender representation
 <b>4. JAZEERA DHIRIULHUN</b>	4.3 Environmental Protection &	4.3 Functioning env. protection, EPA ok!
	4.4 Clean Energy	4.4 Raise renewables substantially
	4.5 Waste as a Resource	4.5 Apply RRR
	4.6 Water & Sanitation	4.6 100% access, ++ trained staff, WSP/SSP, Increase renewables
	4.7 Resilient Communities	4.7 Risk based planning/emergency teams Water Security and Sanitation Safety Plans
	5.4 Accountable State	5.4
	5.6 Gender Equality	5.6
 <b>5. GOOD GOVERNANCE</b>		

Figure 2 Strategic Action Plan 2019-2023: in sectors and subsectors, and link to WASH

The linkages between the sectors and subsectors in relation to the water supply and sewerage concerns that are discussed in this document, are shown in figure 1. The column at right highlights the aspects that need to be taken care of when undertaking water and sanitation investments.

Each of the subsectors has goals indicated relevant to each area. For water supply and sanitation, these are described in the Jazeera Dhiriulhun sector.

Water and Sanitation plans are outlined in subsector 4.6 of the SAP. The subsector describes 5 policies, the targets set and the results to achieved. Several other subsectors in Jazeera Diriuulhun have a bearing on the outcomes in water and sanitation, such as clean energy, the state of the environment and climate change adaptation.

The following policies are pursued in the SAP in relation to water and sanitation:

- ◁ Ensure access to safe water supply and adequate sewerage services
- ◁ Adopt cost-effective and environment-friendly, water and sewerage infrastructure
- ◁ Build sector capacity in water resources, water supply and sewerage services
- ◁ Strengthen advocacy and awareness programmes in water resources, water supply and sewerage
- ◁ Protect and conserve natural water resources
- ◁ Promote Environmentally Sound Technologies and practices towards building sustainable climate resilient island communities

Building on the National Water and Sewerage Policy and following the guidance and targets of the SAP, the National Water and Sewerage Strategic Plan 2020-2025 (NWSSSP) describes strategies and specific actions to achieve and protect sustainable water supply and sanitation services for all.

### **1.3 Rights-based approach**

The Government of Maldives follows a human rights-based approach to development. Maldives is a signatory to 14 human rights instruments, such as the Convention on the Rights of the Child (CRC) and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), and the Convention on the Rights of Persons with Disabilities. ([indicators.ohchr.org/](http://indicators.ohchr.org/))

In July of 2010, the United Nations General Assembly “explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights” in Resolution A/RES/64/292. The human right to sanitation was explicitly recognized as a distinct right by the UN General Assembly in 2015 (Resolution A/RES/70/169).

The right to water entitles everyone to have access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use.

The right to sanitation entitles everyone to have physical and affordable access to sanitation, in all spheres of life, that is safe, hygienic, secure, and socially and culturally acceptable and that provides privacy and ensures dignity. (UNWATER, 2018)

General Comment 15 of the Economic, Social, and Cultural Rights Committee lists four critical points that are specifically connected to the accessibility of water and water facilities:

1. physical accessibility: water should be “within safe physical reach for all sections of the population”;
2. economic accessibility: “costs and charges associated with securing water must be affordable”;
3. non-discrimination: “the most vulnerable or marginalized sections of population should have access to water and water services”; and

4. information accessibility: an important requirement for the implementation of the right to water”

The Government of Maldives in its acts, policies and regulations endeavors to progressively implement and enable the attainment of these rights to water and sanitation for all residents of Maldives. In doing so, the Ministry of Environment, Climate Change and Technology will amongst others implement a Gender Action Plan (GAP). The GAP will ensure non-discrimination and inclusiveness by promoting that gender considerations and interventions are mainstreamed into all aspects of water supply and sewerage development, implementation, management and reporting. The GAP will highlight potential entry points to ensure that the water supply and sanitation and benefits reach women and men equally across all islands

#### **1.4 Climate Change resilience enhancement**

The effects of climate change form the greatest threats to Maldives. With islands that on average are 1.7 meter above sea level, a rise in sea level will increase the risk and frequency of waves and surges. Flooding with seawater will raise the salinity of the groundwater, endanger the lives of people and damage their assets. Rainfall will become more erratic and intense. These effects will affect the availability of water for drinking and cause flooding in parts of the islands, with more water running off to sea.

In Maldives Government is investing heavily on projects that increase resilience of the communities. Most of its public sector investments are on resilience programs. This includes investments in coastal protection, water, sanitation, flood mitigation, and improved accessibility. An integrated approach to these projects is applied for cost effectiveness, such as combining nature-based solutions with engineering solutions and traditional knowledge with modern technology.

For delivery of water supply and sewerage services in the islands, Maldives strives to apply integrated water resources management approaches that will raise water security, keep energy costs reasonable through increased use of renewable energy, improve environmental degradation through sewerage and solid waste management, improve the quality and quantity of the freshwater lens by increasing recharge of rainwater, and continue to collect and store rainwater at domestic and community level, so enhancing resilience at household level and for emergencies.

## Chapter 2 Socio-economic development of Maldives

### 2.1 Introduction

Maldives is situated in the Indian Ocean. The southern atolls are just across the equator while the country extends a further 870 kilometers north. It has 1,192 coral islands forming 26 atolls.

Inhabited islands are generally small, with an average size of 70 hectare and a median of 39.5 hectare. Around 100 islands have a population ranging from 300-900 inhabitants and a little over 60 islands have 1000-5000 inhabitants. Male', the capital, and its twin city Hulhumale' are by far the largest settlements with over 230'000 inhabitants. Small populations widely distributed across the archipelago are difficult and expensive to service with public services in water, sewage and electricity. In addition to Male' there are three more cities: Addu City, Fuvahmulah City, and Kulhudhuffushi City.

Land space is a necessary resource for development. Maldives has only less than 250 square kilometers (km<sup>2</sup>) of land. With its limited available land, allocation of space for specific land use is a challenge. Currently, the country has more vegetated land cover (shrubs, herbs, forest, and palm trees) than built-up areas (high density urban areas, road, airport, and low density urban areas). Most land is allocated for beaches (20.9 km<sup>2</sup>) and island resorts (16.8 km<sup>2</sup>). A small portion (6.7 km<sup>2</sup>) is for agriculture. Other spaces are classified as inland water and wetlands.

To compensate for limited land availability, and to enable infrastructure development for communication (harbors/airfields) and economic opportunities over 25% of inhabited islands have increased their size through land reclamation during the last decade.

### 2.2 National Development Plan

The Strategic Action Plan is the Government's overarching reference point to steer its national development efforts. The SAP aims to bring structure to national development, with a medium-term vision and indicating targets aimed at sharing economic and social development more evenly in the country.

A draft National Spatial Plan is being formulated as part of the SAP. It aims to transform Maldives to an equitable, prosperous, inclusive connected island nation. The draft Plan has identified 21 Regional Centers and developed a typology of two tiers of Urban Centers, Satellite Centers, and a Central Urban Center of the Greater Male' area. The 14 Urban Centers include 5 upper tier Urban Centers and 9 lower tier Urban Centers. As the 5 upper tier Urban Centers will be developed to support a larger population than the other regions, a higher order of services has been allocated for these centers. Kulhudhuffushi, Naifaru Gan, Thinadhoo, Addu City and Lhavandhoo are to be developed as regional centers, with a range of services in health, education, economic development, transport and essential goods storage. A further 9 sub-regional centers have been designated with a lesser portfolio of services. These include: Funadhoo, Manadhoo, Dhuvaafaru, Eydhafushi, Nilandhoo, Thimarafushi, Vilingili.

### 2.3 Demography

189 of the islands in Maldives are inhabited. The population is concentrated in a few of the larger islands. Around 60% of the total population live in the Greater Male' capital region (which includes Male', Hulhumale', Hulhule, Villamale', Gulhi Falhu, Thilafushi islands) and 32 inhabited islands in atolls of Kaafu, Alifu Alifu, Alifu Dhaalu and Vaavu, with some 73 tourist resorts, 14 city hotels, 177 guest houses, along with institutions and industry. In 2020 some 557,000 people resided in Maldives. Of these, 178,000 were foreigners, most working in the tourism industry. (National Bureau of Statistics, 2020b)

The 2019/20 Household Income and Expenditure Survey estimates the current population to be 451 thousand, with 214 thousand living in Male'. (National Bureau of Statistics, 2020c). This survey excludes the population of non-administrative islands and tourist resorts.

The most striking transformation expected over next decades is the shift in the population between Male' and the Atolls. Due to constant internal migration which takes place mostly to Male' and the low fertility rate, ever more Maldivians will live in Male'. In 2030 it is expected that 51% of the Maldivian population will live in Greater Male'. (National Bureau of Statistics, 2018).

The capital Male' for a long time had 100,000 inhabitants (2006), but in recent years due to the construction of high-rise apartment blocks and reclamation and growth of Hulhumale', the resident population has grown to 167,000 in 2014 and would have reached around 280,000 in 2020. In 2020 it was estimated that 67'000 foreigners would be living in Male'. The COVID crisis will have reduced this number very substantially and current numbers of foreign residents may be around 22,000, leaving a population of 236,000 in Male'. By 2030 it is estimated that Greater Male' will have 347,000 inhabitants and may even grow to 510,000 in 2050.

From 2020 the Maldivian population in the administrative atolls is expected to decline due to migration and low birthrate. The influx of foreign resident workers in the atolls will keep the overall atoll population stable until around 2035.

(National Bureau of Statistics, 2018)

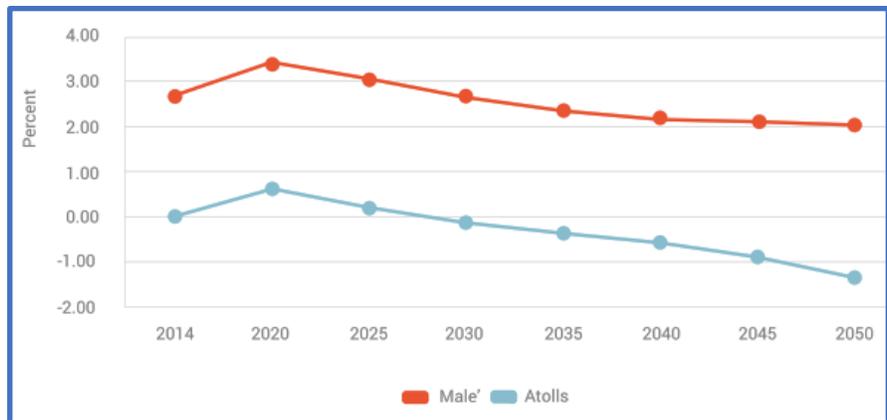


Figure 3 Population growth rate for Male' and Atolls, 2014-2050 (NBS 2018)

Apart from Male' and the administrative atolls where most people reside, there are non-administrative islands which include tourist resorts, industrial islands and islands used for other purposes such as agriculture and fisheries, for waste management or as port facilities.

The Ministry of Tourism reported that as of January 2021 143 resorts and marinas are in operation out of 164 resorts that are registered. The number of resort islands continues to grow and by the end of 2020 the number could have risen to 177, if all planned resorts were indeed completed.

## **2.4 Health**

Maldives have made significant progress in its health status and development indicators over the past decades with sustained high investments in health and ensuring universal health coverage for its population. In recent years Maldives achieved several public health milestones such as elimination of Malaria, Filariasis, and Measles to add to elimination of Polio and Maternal and Neonatal Tetanus.

Still, several challenges remain. Dengue and chikungunya are prevalent. Dengue appears all over the country, while Chikungunya is more prevalent in the Northern atolls.

These vector-borne diseases are prevalent where solid waste management is poor and in shrublands respectively. Breeding places for Aedes mosquitoes should be eliminated by clearing standing fresh water near the home.

The social and economic development of Maldives has reduced the importance of communicable diseases, and now non-communicable diseases are becoming more important.

Each inhabited island has a primary health care post with community health workers. Primary health care will be strengthened through the promotion of healthy lifestyle and health education. (SAP Health: action 3.2a) The SAP also aims to establish a mechanism for community health workers to regularly visit homes for health check-up and awareness. (SAP Health: action 3.2b)

Medical health-care waste management system in health facilities is still to be improved. Major shortcomings include: (i) infectious waste including pharmaceutical waste are disposed of without appropriate treatment; (ii) chemical liquid waste is drained and routed to the sea; and (iii) inadequate technical capacity of the persons involved in healthcare waste management.

## **2.5 Economy**

The Strategic Action Plan states that the economy and well-being of Maldives is tied to the health and wealth of the natural environment, primarily the ocean. The largest contributors to the economy, tourism and fisheries sectors are highly dependent on the wellbeing of the ocean, coral reefs, beaches and marine life. The SAP therefore calls for a Blue Economy, consisting of tourism, fisheries, agriculture and other productive activities.

## **Tourism**

Maldives is renowned for its beautiful islands, with nice beaches and beautiful marine life. Tourism is the main industry in Maldives, contributing 26% to the country's Gross Domestic Product (GDP) directly. In 2019 Maldives received some 1.7 million visitors resulting in 3.2 billion US dollar travel receipts.

Maldives is an upper middle-income country that has shown remarkable economic development in the last several years due to continued growth in tourism. Social and human development have similarly grown. As the Maldivian population is relatively too small to support economic developments and tourism in Male' and the island resorts, the number of expatriates residing in Maldives has grown substantially.

The Greater Male' capital region and the 32 inhabited islands in central atolls of Kaafu, Alifu Alifu, Alifu Dhaalu and Vaavu is home to 73 tourist resorts, 14 city hotels and 177 guest houses.

## **Fisheries, agriculture and other industries**

From time immemorial, fishing has provided food and income to Maldivian families. Fishing is usually with pole-and-line and is thus, sustainable. Since 2012 Maldives fisheries sector is certified with the Marine Stewardship Council (MSC) which allows export of Maldivian tuna fish products such as canned tuna to carry the eco-label. This gives the products access to the European market.

While the sector currently only contributes some 4% to GDP, the fisheries sector provides a huge contribution to the economy from exports and employment. Some 10% of employment is generated by the sector.

Agriculture has so far had limited scope in Maldives due to land constraints.

Some islands, such a Thoddoo, are agriculture oriented and produce papaya, watermelon, chilies, brinjal and leafy vegetables. Government intends to increase agricultural production to attain 50 percent food security.

## **2.6 Disparities and equity: Multidimensional Poverty Index (MPI)**

Equitable and affordable access to water and sanitation for all is an important goal of the SAP. One of the objectives is to reduce the differences in service delivery and ensure that safe and adequate water and sanitation will be available to all people residing in Maldives.

Monetary income in the islands is clearly lower than in Male'. Male' would offer more opportunity to earn money, while generation of a regular income is less reliable in the islands.

Poverty is however broader than income and includes various other aspects of development and well-being. To understand poverty better the Government of Maldives adopted the

Multidimensional Poverty Index (MPI) in February 2020. For Maldives the MPI includes health aspects (underweight, obesity and access to health care), education and information (years of schooling and access to internet) and living standard (use safe drinking water, a household toilet connected to a sewerage system, and overcrowding). A person is considered multidimensionally poor when (s)he is poor in at least three indicators.

The Maldives Statistics Bureau (MSB) assessed MPI in Male' as nearly 10% but noted that the population in the atolls was 40% multidimensionally poor. In Maldives, more people were living in multidimensional poverty (28%) than monetary poverty (8% were living below the poverty line of MVR 74). 87% of the people who are multidimensionally poor were living in the Atolls, but only 13% in Male'.(Riyaza, 2020)

The MPI study considers a household deprived for safe drinking water when it consumes water that is not safe to drink. It considers rainwater that is not treated as unsafe. Similarly, a household that is not connected to a sewer line is considered deprived. Water supply and sewerage service provision achieved by 2023 would have a very important impact on the MPI. It is an intervention that can be undertaken relatively easily, though at substantial cost. To sustain the MPI reduction, HRD and good institutional arrangements are required.

## 2.7 Environmental conditions and climate change

### Fresh water resources

The islands in Maldives are small and depend fully on seasonal rainfall and the rainwater the islands can retain in the fresh groundwater lens (FGL). The diagram in figure 4 gives a schematic overview of this situation (Ministry of Environment, 2021).

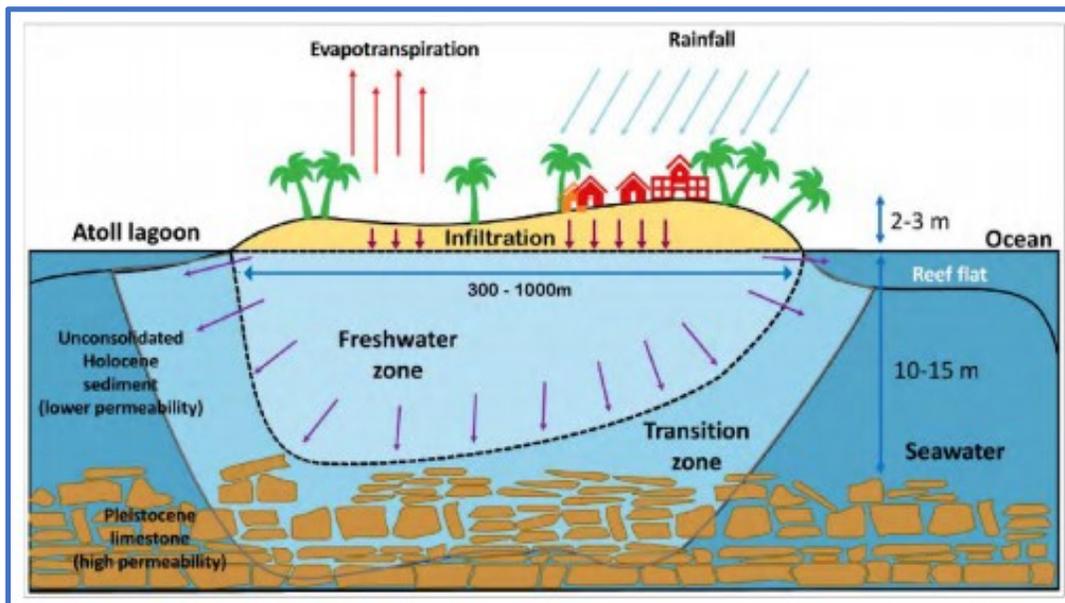


Figure 4 Typical hydrology and island geology determining the water balance (Ministry of Environment, Climate Change and Technology, 2021)

The water balance of the islands is fragile, with high levels of evapotranspiration, depending on the type of vegetation, with outflow to the sea and salinity increasing with depth in the freshwater zone. Traditionally households collect rainwater for drinking and food preparation, while water for other purposes is drawn from the fresh groundwater lens. Over abstraction will lead to saline upconing.

### **Climate Change & Ecosystems**

Climate change is affecting life and prospects in Maldives. Rainfall patterns will change over time. Climate change predictions indicate that rainfall will become more intense during the monsoon, with up to 5-10% increase of annual precipitation in 2050 and 2100 respectively. The dry season will become drier, however.

The Multihazard Risk Atlas of Maldives highlights two of the climate change scenarios and assesses the longer-term effects. Northern Maldives will gradually receive more rainfall. The wettest months will still be June/July/August. During this period, rainfall will mostly be distributed in the north. During December/January/February the Southern part of the archipelago will receive more rain. The beaches are threatened by coastal erosion and low-lying islands are prone to inundation due to sea-level rise and degradation of reefs and mangroves. (ADB, 2020)

Ecosystem-based adaptation to climate change is vital to Maldives. Conserving terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems is vital to the overall goals of the National Climate Change Adaption Plan for Maldives.

Most studies address the future of atoll islands focusing on ocean-climate drivers of risk, especially sea-level rise, and disregard the role of local human disturbances. In natural, undisturbed islands, coral reefs act as first line of defense against wave action and storm surges and reduce coastal erosion. Shallow lagoon and sea grass beds in between the reef and beach act as second line of defense. The coastal vegetation (Heylhi) with salt tolerant plants acts as third line of defense. Mangroves play a vital role in protecting the atoll islands from coastal erosion by the waves, stop erosion and protect the islands.

Recognizing that sound coastal resource management is critical to sustainable development and climate adaptation, the Government of Maldives is implementing policies to protect coral reefs and support marine management. (Ministry of Environment and Energy, 2017)

Of critical concern is that Maldives' vulnerability to natural hazards and climate variability increasingly impacts basic infrastructure and livelihoods, pointing to the need to ensure that resilience is incorporated in the development efforts of both Greater Male' and outer atolls.

Management actions include those that limit or restrict human activities so as to reduce the sensitivity of coral reefs to disturbance events, such as coral bleaching. MPA – Marine

Protected Area: areas of seas and oceans protected to conserve biodiversity, natural or cultural resources; they typically limit (but not necessarily prohibit) human activity and are often managed for multiple use – and MSP – Marine Spatial Planning; a process for allocating human activities and use in marine areas to achieve ecological, economic, and social objectives are essential instruments in reef protection. (UNEP, 2020)

### **Environmental Impact Assessment**

For water supply and sewerage development projects environmental impact assessments (EIA) are usually required. The EIA Regulation outlines a step-by-step approach and describes all major requirements to be included in an EIA report. The EIA regulation came into force in 2012 and has since been amended several times. Currently the EIA with fifth addendum is in force (2018).

The primary objective of the EIA study is to safeguard the environment during planning, design, construction and operation of the proposed project activities and associated facilities by mitigating environmental impacts envisaged during various phases of the project.

Specific objectives of the EIA study are to:

- ◁ Determine the baseline environmental conditions of the project area;
- ◁ Identify, predict and assess environmental impacts that might arise during the construction and operation of the proposed project and activities associated with it;
- ◁ Suggest environmental impact mitigation measures to suit local conditions in order to eliminate or reduce the negative impact on the environment;
- ◁ Enable the project proponent to comply with environmental rules and regulations and train operating personnel in order to protect the environment.

The EIA reports are available in the public domain on the website of the Environmental Protection Agency (EPA).

## Chapter 3 Current status of the Water and Sewerage sector

### 3.1 Introduction

Traditionally the people of Maldives used rainwater groundwater for their daily water demands. Groundwater wells tapped water for various domestic purposes from the freshwater lens and rainwater was collected and stored for drinking. Before 1980's open defecation caused regular diarrhea outbreaks and even occasional cholera. Government intervention has since promoted latrines, and later toilets with septic tanks. Gradually through promotion of primary health care and hygiene education, water supply and sanitation has improved. The capital, Male', has been served with piped water since the late 1980's. RO-based piped water supply has increasingly been introduced in the islands and is now the main technology of the government plan to achieve universal coverage in water supply.

The increasing population density in the islands caused the freshwater aquifer to become contaminated due to poorly constructed and functioning septic tanks and waste discharges from workshops as well as due to excess abstraction from the fresh groundwater lens. Treatment of sewage flushed with saline water is complex and often too expensive for island communities, leading to untreated discharge off the reef into the sea.

#### 3.1.1 Alignment with SAP and SDG

The sustainable development goals are reflected in the Strategic Action Plan 2019-2023. In brief the water and sanitation strategies contained in the SAP and their links to the SDGs have been indicated here:

#### SAP Subsector 4.6 Water and Sanitation

Policy 1: Ensure access to safe water supply and adequate sewerage services  
(SDG 6.1 & 6.2, regulatory guidance on SDG 6.3)

Target: Target 1.1: By 2020, Utility Regulatory Authority (URA) for integrated utility services is functional

Target 1.2: By 2023, all water and sewerage utility providers have an operating license

Strategy 1.1: Improve policy, legal and regulatory framework to ensure the provision of safe water supply and sewerage services to all inhabited islands

Strategy 1.2: Provide Water and Sewerage services through an integrated utility service provision model and decentralize the utilities to ensure cost effectiveness

Strategy 1.3: Improve research and evidence on water and sewerage sector to support policy making

Strategy 1.4: Strengthen operation, maintenance and management of water supply and sewerage systems through compliance monitoring and safety planning

Policy 2: Adopt cost-effective and environment-friendly, water and sewerage infrastructure (SDG 6.4, contributing to SDG7, 11 and 13)

Target: Target 2.1: By 2023, all inhabited islands will have access to safe water supply and sewerage facilities

Target 2.2: By 2023, 30% of energy consumption for water and sewerage facilities across Maldives will be met with renewable energy

Target 2.3: By 2020, a standard mechanism to foster private sector investment in the water and sanitation sector will be in effect

Strategy 2.1: Ensure climate resilient and cost-effective water supply and sewerage systems

Strategy 2.2: Promote and commercialize low cost water production and efficiency in water use

Policy 3: Build sector capacity in water resources, water supply and sewerage services (SDG 6.4, 6.b, contributing to SDG 4, 11, 13 and 15)

Target: Target 3.1: By 2023, at least 60% of technical staff in utility service providers are licensed

Target 3.2: By 2023, at least 40 engineers will be trained in water and sanitation related field

Strategy 3.1: Build human resource capacity required for water and sewerage system operations, maintenance and management

Policy 4: Strengthen advocacy and awareness programmes in water resources, water supply and sewerage (SDG 6.a)

Target: Target 4.1: By 2022, public perceptions on safe water and sanitation practices improved

by 33% compared to 2018 levels

Target 4.2: By 2023, at least 40% of households phased out bottled water use

Strategy 4.1: Promote awareness on water resources management, water supply, and sewerage service operations and maintenance

Policy 5: Protect and conserve natural water resources

(SDG 6.4 and 6.5)

Target: Target 5.1: By 2023, water resource conservation and management plans are implemented in all islands

Strategy 5.1: Reduce vulnerability of the island freshwater resources

Strategy 5.2: Improve fresh water quality testing and monitoring

#### **SAP Subsector 4.7 Resilient Communities**

Policy 2: Promote environmentally sound technologies and practices towards building sustainable climate resilient island communities  
(SDG 6.a, 11 and 13)

Target: Target 2.1: By 2023, Water Security Plans and Sanitation Safety Plans are implemented for all inhabited islands

Strategy 2.2: Scale up integrated water resource management practices to improve water security across the nation

The Sustainable Development Goals are well reflected in the Government's Strategic Action Plan, except for the reduction of treated wastewater. This component will require some more thought to ensure better management of sewerage systems, their treatment and the benefits of safe reuse and discharge.

For strategies and actions in the water and sanitation segment the focus is on enacting the Water and Sewerage Act (8/2020) ratified on 5th August 2020.

### 3.1.2 Status of water and sanitation services

Maldives has developed its water supply and sanitation services rapidly since 2000. Surely there was a setback following the Tsunami in 2004, but with the assistance of the international community, the Government of Maldives has been able to improve service levels in Male' and most islands. That is not to say that there are no serious challenges with respect to water security, groundwater protection, water quality, wastewater treatment, solid waste management, etc. Management capacity, indigenous engineering capacity, and public understanding of sustainability issues are to be further increased to strengthen resilience.

### 3.1.3 SDG 6.1 drinking water and 6.2 sanitation and hygiene

The sustainable development goals for water and sanitation aim to achieve safely managed water supply and sanitation by 2030. Safely managed water supply is defined as drinking water from an improved source, which is located on premises, available when needed and free from fecal and chemical contamination. Safely managed sanitation means use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site.

Figure 5 shows the coverage as assessed based on the HIES 2019/20 data provided by NBS.

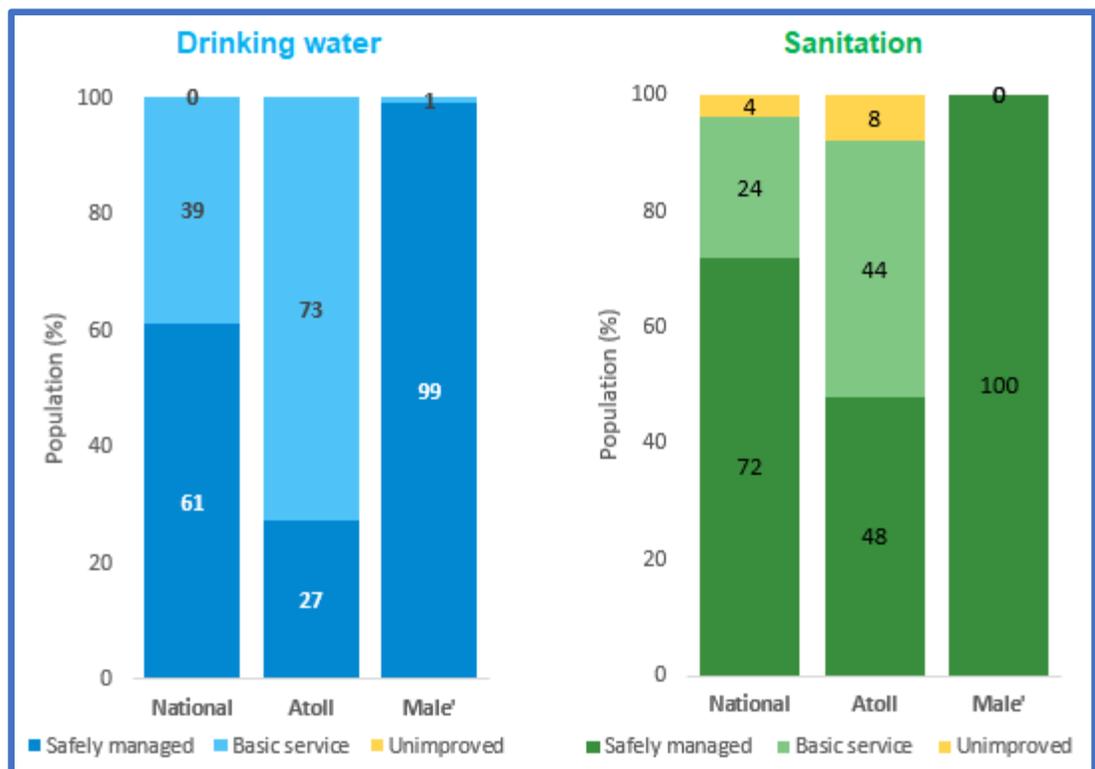


Figure 5 Current coverage figures as assessed in NBS 2020 SDG update

### 3.1.4 Water and Sewerage in Male' and the Atolls

The Male' Water and Sewerage Company (MWSC) provides water and sewerage services to Male', Villimale', Hulhumale', Maafushi, Kulhudhuffushi and Dhuvaafaru. It provides only water supply in Hulhule (airport island), Thilafushi (waste management island), Gulhifalhu. In Dhuvaafaru it also provides electricity services and solid waste management services.

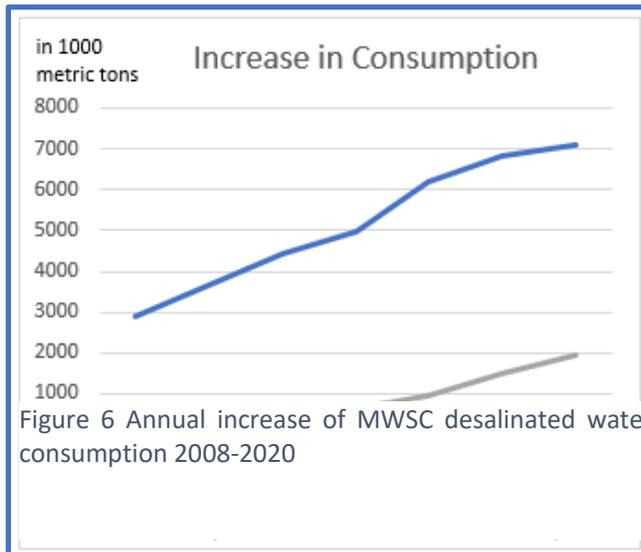


Figure 6 Annual increase of MWSC desalinated water consumption 2008-2020

With a growing population Male' has seen water consumption double in the last 10 years. In 2020 consumption appears to have been levelling off a little. This increase compares well with the population increase between 2014 and 2020.

New housing and other economic developments in the newly reclaimed island Hulhumale' have led to more than a doubling of water consumption in the last 5 years.

The quality of the tap water in Male' meets national standards and is safe to drink. However, most people like to consume bottled water. There are few bottled water producers in Maldives using RO for their production.

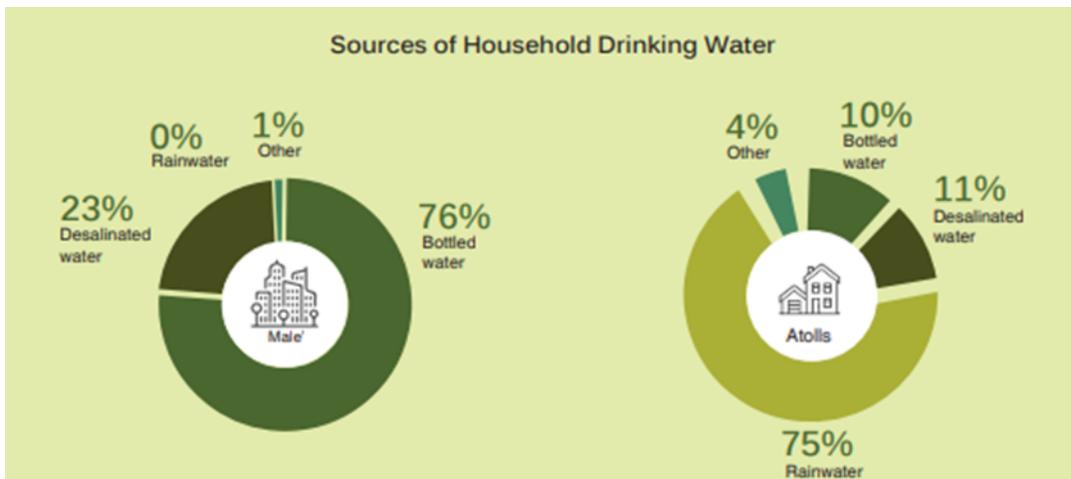


Figure 7 Types of drinking water use in Male' and the Atolls (NBS 2020)

Water supply and sanitation services in the islands are provided by Fenaka, STELCO and MWSC. These companies are state-owned. In only a few islands other private sector companies and an

island council provide the service. The resort islands are self-managed in water and sanitation services, with RO plants for water supply and sewerage systems.

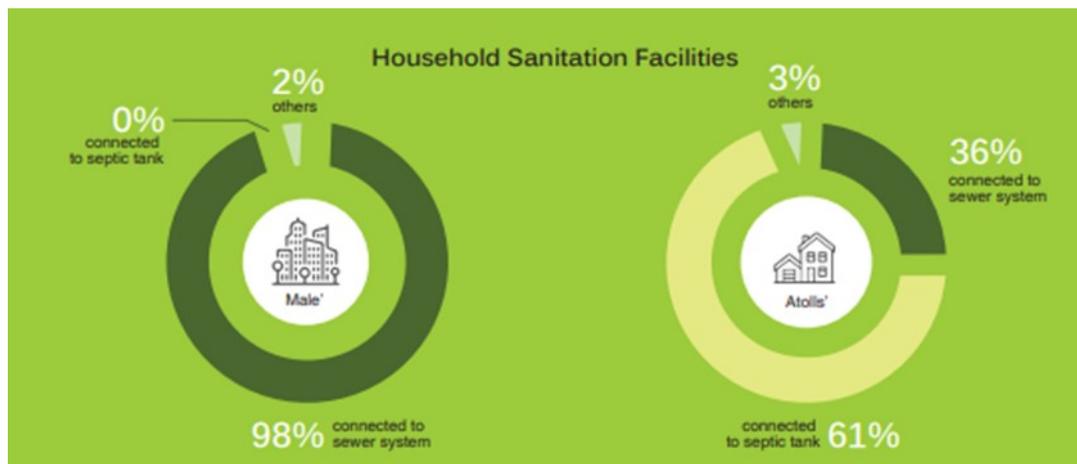


Figure 10 Status of household sanitation in Male' and the Atolls (NBS 2020)

The Government of Maldives aims to provide full coverage in water supply and sewerage of all inhabited islands by 2023. The status of coverage by water supply and sewerage networks in the outer islands in January 2021 is shown in table 1.

Table 1 Status of Water Supply and Sanitation in the outer Islands

Status of water supply and sanitation in the outer islands of Maldives (January 2021)			
Water Supply Network	Islands	Sewerage	Islands
Completed	44	Completed	72
On-going	78	On-going	77
Planned	63	Planned	37

Financing for these projects mainly comes from the Public Sector Investment Program (PSIP) and through loans and grants from different donor agencies.

### 3.2 : Water Quantity and Quality

#### Water Quantity

In the islands, to improve water security and contain production costs a combination of rainwater and desalinated water is used to provide water for consumption and food preparation. Over 140 islands still rely on rainwater only. Their drinking-water supply runs out when the rains are delayed. Then, emergency supplies need to be provided. Well water is used for other domestic purposes, such as flushing of the toilet, laundry and bathing.

Islands with reverse osmosis drinking water plants do not run out of water unless there is a power failure. The RO plants take feedwater from boreholes drilled in the ground to 30 meters or deeper determined according to Environmental Protection Agency's (EPA) regulations. The

feedwater then passes through multiple prefiltration systems before passing through the RO membranes. The product water is then either chlorinated or passed through UV light for sterilization. To ensure that the water produced complies with URA standards for potable use, the RO product water and feedwater is tested regularly.

The minimum design quantity of treated water for drinking and food preparation is 20 l per person per day according to URA guidelines. This quantity agrees with WHO which assumes 10-15 l per person per day (lpd) in emergency conditions. (Howard et al., 2020) Emergency supply should be able to provide this quantity for the resident population for at least 5 days.

The design quantity assumed by URA is 150 lpd. In greater Male' less is likely used by most households as desalinated water is expensive. In the islands may be only 20 lpd will be used as households have alternative sources in stored rainwater and groundwater from their wells. The uncertainty in actual consumption makes it difficult to plan the investment for RO production.

### **Water Quality**

Water quality is tested against a set of parameters prescribed by the Utility Regulatory Authority. For water supply services, it distinguishes between tests to be taken daily, monthly, every six months or annually.

At present water quality is tested by the MWSC laboratory which is certified under ISO 17025. The National Health Laboratory (NHL) also provides water quality testing services..

Service providers such as Fenaka are also setting up water quality testing capacity in their islands. These will not require to measure all the parameters listed by URA, but rather focus on basic parameters.

### **3.3 Service areas in water supply and sanitation**

#### **Male' and Greater**

The Male' Water and Sewerage Company provides RO water supply and sewerage services in Male', Hulhumale', Villimale', Maafushi, Kulhuduffushi, Dhuvaaafaru, and RO supply only in Gulhifalhu and Thilafushi. Operations are of high quality and water quality is good.

Sewage is disposed of from Male' in five locations off the island reef (N 1, W 2, S 2) using a discharge pipe of some 100m at a depth of 43 m. In Hulhumale' 2 such outfalls are in use. Sewage treatment would be necessary eventually and options for treatment are being considered/explored.

With growing population and high-rise buildings in Male' sewerage and drainage systems need planning for replacements and upgrading.

#### **Administrative atoll islands**

For delivery of water supply and sewerage services in the islands, Maldives strives to apply integrated water resources management approaches that will raise water security, keep energy costs reasonable through increased use of renewable energy, reduce environmental

degradation through sewerage and solid waste management, improve the quality and quantity of the freshwater lens by increasing recharge of rainwater, and continue to collect and store rainwater at domestic and community level, so enhancing resilience at household level and for emergencies. Water and sanitation are presently available in all islands, but of uncertain quality. Water quality testing is done only occasionally while in many islands sewerage systems are not constructed yet to replace the poor-quality septic tanks that contaminate the fresh aquifer.

### **Non-administrative atoll islands**

In the industrial or agricultural islands, provision of water supply is the responsibility of the owners/lessees of those islands.

In the case of fish factories, to meet export quality, fish is processed and packed to the most hygienic standards (using HACCP standards). This will require availability of high-quality treated water. Factories have drinking water treatment plants that meet URA and MFDA standards.

As there are few people residing in the industrial islands, sanitation is a lesser concern. Islands with large factories have sewerage networks, while other islands can manage using septic tanks.

### **Tourist Resort Islands**

The tourist resorts take care of their own water supply, sanitation, waste management and environmental protection. The systems include desalination equipment and various wastewater treatment systems that require skilled labor and technical back-up, preferably through dealerships based in Greater Male'.

## **3.4 Service quality**

There are several areas that the government, the island communities and the service providers need to work on. In general, it can be stated that domestic water supply services are quite acceptable. However, many islands face water shortages for some weeks in a year at the end of the dry season. Projects are on-going or planned to overcome this shortfall. The quality of water is good in MWSC serviced areas and the areas operated by Fenaka and STELCO that operate RO plants.

Sewerage may be functional in a growing number of islands. The wastewater is collected in a central place, which may or may not have a functioning sewage treatment, from where it is discharged on an EIA approved location on or beyond the reef. That situation is undesirable as it may degrade the reef and the marine environment in turn reducing its capacity to protect the island against the sea. Availability of financing and an adequate revenue stream will determine how quickly services will be upgraded and how sustainable these will prove.

### 3.5 Climate change concerns

In 2020 ADB published a Multihazard Risk Atlas of Maldives. The Multihazard Risk present the various components of disaster risk in the country. Hazards include climate, extreme weather, earthquakes, tsunamis, typhoons, surges, sea level rise, and others. The conditions of elements such as the presence of land reclamation, sand mining activities, and coastal erosion characterize the vulnerability of the exposed islands to storm surges, sea level rise, inundation, and tsunamis. Other factors, such as the human development index, power source, health, education, and transportation, define the vulnerability of the exposed population to various hazards. Having coastal protection and monitoring capacity indicates adaptation capacity, which lowers vulnerability.

As the islands are likely to experience more frequent inundation due to sea level rise, water supply and sanitation plants will need to be constructed well above the expected flood levels. This will increase the costs but will be required to ensure continuous supply of water during an emergency. Many islands already have elevated public water storage. Every few years an assessment is necessary by the island council to determine the storage required for some 5 days of drinking water supply. Further trials and research are also necessary to test emergency scenarios that will secure people's safety, continued access to safe water, food and communications, and a level of resilience in design of adaptation measures that will allow for quick restoration of daily life once the emergency passes.

Climate change is affecting all aspects of the Maldivian society. Water supply is undoubtedly an important aspect, but so are many other ecosystem related aspects that impact on safety and security, economy and livelihood. Island communities must play the key role in determining how holistically they can protect their island in the face of the climate challenge. Government must assist with technical advice and support for adaptation measures. However, the initiative lies with the people and the island council.

The situation in Greater Male' is no different, except that greater economic risk is combined with more options for a variety of adaptation solutions, and so the outcome of the adaptation process will be different, if only because the funds are available to invest in high-rise buildings and other solutions that reduce the effect of sea-level rise., Challenges and opportunities

The challenges and opportunities to water supply and sanitation services can be categorized in a few areas:

Domestic water quality:

- < groundwater is saline and not safe to drink; treatment is mostly beyond the capacity of the household.
- < domestic rainwater can be collected and stored..
- < piped water supply will require RO treatment at considerable cost per liter. Water rates are usually not adequate to recover costs and will thus require some form of government subsidy.

#### Cost saving:

- ⟨ RO treatment and pumping (for water supply and sewerage) is energy intensive. Greater and smart use of solar panels is recommended to make the production costs manageable.
- ⟨ At the same time, promote responsible use of RO produced water through demand management.
- ⟨ Collect rainwater from public institutions or the futsal pitch to increase cheap fresh water supply.

#### Wastewater treatment

- ⟨ Energy efficient, technical solutions to be identified for treatment of small quantities of wastewater (1000-5000 i.e.), that preferably allow for extraction of water and nutrients.
- ⟨ Sewage will be saline as flushing will happen with well water. Maldives may study Chinese experience (e.g. on SANI® ) for optimizing treatment process.(Liu et al., 2016)

#### Marine Environment

- ⟨ Discharge of brine from RO plant and (untreated) wastewater needs suitable locations offering good dispersion.
- ⟨ As much as possible cost-effective wastewater treatment systems should be put in place to avoid deterioration of the marine environment by discharge of waste and nutrients.

#### Management and Human Resources Development

- ⟨ Service providers cannot make a reasonable profit as water rates are too low to cover costs, and fees for sewerage are non-existent. Private sector lacks interest, except for State-owned Enterprises, that can be subsidized by government.
- ⟨ Human resources are problematic at all levels. More engineers and more operators are needed for development and extension of services, and to replace retiring staff. More women should be trained and encouraged to engage with the water and sewerage sector.
- ⟨ Island level staff capacity needs to remain in place for operation and maintenance.
- ⟨ Extra efforts in staff training and retention, as well as in smart monitoring are needed to ensure efficient operations.
- ⟨ The island council will need to be able to oversee operations and assess functionality and future upgrading. Adequate communication and occasional (regional) training activities need to ensure the required capacity.
- ⟨ Cost-effective operations to enable affordable fees will require annual consultation between island council and the service provider.

## Chapter 4 Acts, policies and institutional mandates

### 4.1 Water and Sewerage related acts and policies

The Constitution of the Republic of Maldives provides the umbrella under which the water and sewerage sector must function and that describes context and responsibilities. Environmental protection and social rights are the most important in respect of the formulation of the water and sewerage masterplan.

These rights are reflected in the **National Water and Sewerage Policy (2017)** and the **National Water and Sewerage Strategic Plan (NWSSP 2020-2025) (November 4, 2020)**, and elaborated in the **Water and Sewerage Act (Act No. 8/2020)**. The water and sewerage strategies and targets included in this NWSSP 2020-2025 are taken from the overarching National Strategic Action Plan 2019-2023. The NWSSP states the sectoral vision of Maldives to

#### **Ensure equitable access to safe water and improved sewerage services for all**

The accompanying Mission focuses on the

- Provision of efficient, effective and reliable water supply and sewerage services.
- Promotion of conservation and management of the water resources.
- Development of sector capacity for sustainable management of resources and services.

#### **Decentralization Act**

The Act on Decentralization of the Administrative Divisions of Maldives (2010) allows island communities to make their own decisions to improve living standards and to empower island councils to manage their own utilities. The Act gives atoll and island councils wide powers, including:

- ◁ Provision of water, electricity, and sewerage
- ◁ Collection of fees for services provided
- ◁ Supervision of the services provided by Divisions of Government Ministries
- ◁ Power to take on loans and issue securities
- ◁ Power to enter into service contracts for services to be provided under their authority

The 8<sup>th</sup> amendment of the Decentralization Act (2019) has further expanded these powers and responsibilities. The latter give island councils more flexibility in resolving issues faced by the island community.

#### **Disaster Management Act**

The Disaster Management Act (2015) refers to the responsibility of the State to protect its people, their health and well-being, their property, and the natural and built-up environment they live in from natural and man-made disasters, and hazards. W&S facilities should be above flood level and protected from tidal surges.

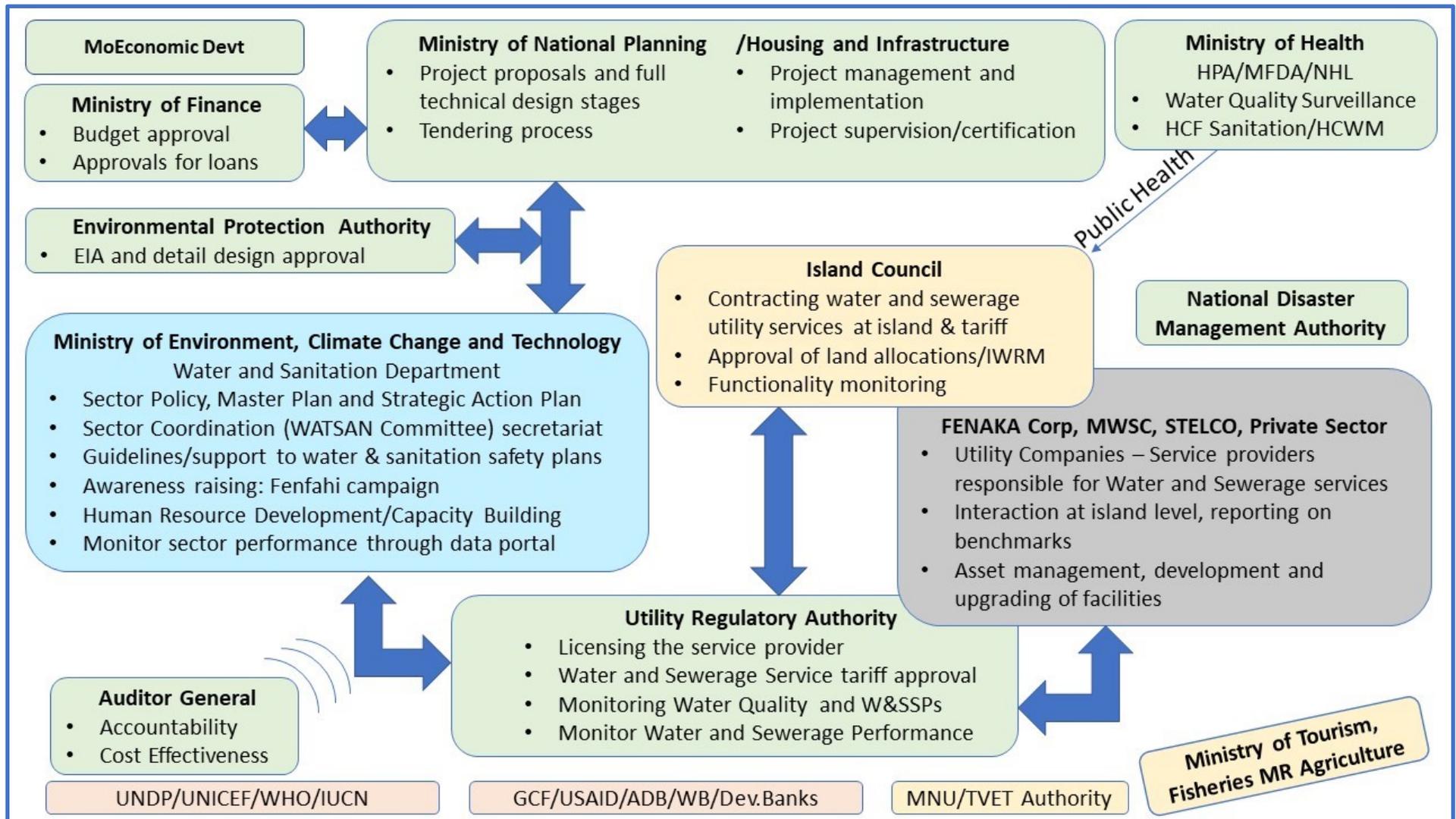


Figure 9 Overview of WATSAN sector agencies, mandates and interactions

## 4.2 Institutional aspects and mandates

The Ministry of Environment, Climate Change and Technology is the key sector institutions and leads policy development and quality control in several important national development and protection areas. It has departments on environment, climate change, energy, waste management and pollution control, and water and sanitation.

### **Mandate of the Ministry of Environment, Climate Change and Technology as per the Water and Sewerage Act**

- < Develop national policies for water supply and sewerage to develop and implement all the required regulations under the Water and Sewerage Act
- < Develop a Water and Sewerage Master plan within one year from the ratification of Act. The Master Plan needs to be reviewed every 10 years
- < Ensure that the water and sewerage systems are developed, and services are provided in a sustain-able manner to all islands and areas of tourism and industrial sector
- < Establish water and sewer systems in all the inhabited islands within a 5-year period from the ratification of the Act
- < Plan and conduct awareness programs on water and sewerage
- < Monitor the Utility Regulatory Authority
- < Monitor the Councils with regard to water and sewerage services
- < Provide guidance to government institutions regarding water and sewerage
- < Maintain and publish statistics on water and sewerage services of all islands
- < Develop water quality testing laboratories
- < Conduct research for further development
- < Promote private sector participation

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- < Provide guidance to government institutions regarding water and sewerage
- < Maintain and publish statistics on water and sewerage services of all islands
- < Develop water quality testing laboratories
- < Conduct research for further development
- < Promote private sector participation

To improve and sustain water security and ecosystem quality, the Ministry runs the FENFAHI public awareness campaign in support of the National Water and Sewerage Policy. (Ministry of Environment, Climate Change and Technology and Energy, 2017a).

GoM through the FENFAHI campaign (2017 - 2021) aims to increase knowledge on WATSAN in the public, and will specifically target youth, school children, educators, businesses, industry, community groups, and NGOs. The goal and objectives of the strategy have been developed to instigate behavior change at individual and community levels to promote best practical actions to protect and manage water resources, water supply and sewerage systems.

### **Water and Sanitation Department**

The Water and Sanitation Department is charged to fulfill the Ministry's mandatory function to provide safe water and sewerage systems. The department is tasked with developing policies and regulations, facilitating and coordinating the mobilization and use of resources for water and sewage systems. The department provides advice to both the government and the private sector in the planning and implementation of water and sanitation programmes and in the provision and usage of such services.

As such it is the main driver for the development of the Sector Policy, Master Plan and Strategic Action Plan. It acts as the WATSAN Sector Coordination secretariat.

### **Environmental Protection Agency**

The Environmental Protection Agency (EPA) is a regulatory entity, affiliated to the Ministry of Environment, Climate Change and Technology. It is responsible for regulatory activities for protection, conservation and management of environment and biodiversity, as well as waste management and pollution prevention under the Environment Protection and Preservation Act (4/93).

Environment Impact Assessment (EIA) studies are required to assess the possible detrimental impacts to the environment both terrestrial and marine by the infrastructure projects proposed for implementation in the islands of Maldives. At the same time, the design of the proposed water supply and sewerage infrastructure projects should identify the best options of development of the network and outfall setup. The EIA will review the social, cultural and health aspects and the potential impacts of the proposed project, as an integral part of the assessment. Approval of the EIA is required for piped water supply and wastewater management systems.

### **Utility Regulatory Authority**

The Utility Regulatory Authority (URA) was established on December 14, 2020. The authority is established following the ratification of the Utility Regulatory Authority Act (Law No. 26/2020). The objectives of the Act include providing high quality utility services to all those residing in Maldives in a more affordable, sustainable and trustworthy manner which is efficient and

environment friendly. Utility services that fall under the purview of the URA include the supply of electricity, provision of drinking water and sewerage services, and waste management.

Regulation of water supply and sewerage sector is part of the mandate of the URA. The Utility Regulatory Authority is tasked with licensing of utility companies as their registrar, as well as the enforcement body to investigate and penalize companies that violate laws related to water and sewerage.

Final detailed designs for water supply and sewerage schemes are approved by URA.

Among other services, URA publishes guidelines and standards for environmentally safe procedures for waste management, permits for construction dewatering, and research into the available sources of potable water in Maldives. URA also manages reporting and monitoring on these matters. Water and wastewater quality testing results are monitored as well.

The authority is mandated to formulate a structure to subsidize water and sewerage services in a decentralized manner and to empower island councils in assigning water rates for services provided by the council (directly or through a service provider).

Additional information on the role of sector institutions can be found in the Background Document to the Water and Sewerage Masterplan.

### **Water and Sanitation Coordination Committee**

The Ministry of Environment, Climate Change and Technology convenes the National Water and Sanitation coordination (WATSAN) committee. It is chaired by the Ministry. The Department of Water and Sanitation acts as the Secretariat.

The following government organizations are represented in the WATSAN committee:

- < Ministry of Environment, Climate Change and Technology
- < Ministry of National Planning, Housing & Infrastructure)
- < Ministry of Health
- < Ministry of Fisheries Marine Resources and Agriculture
- < Ministry of Tourism
- < Ministry of Economic Development
- < Ministry of Higher Education
- < Ministry of Education
- < Ministry of Islamic Affairs
- < Environmental Protection Agency
- < Health Protection Agency
- < Local Government Authority
- < National Disaster Management Authority

The World Health Organization, the United Nations Development Programme and the United Nations Children's Fund are also invited as members.

The WATSAN committee representing all stakeholders will be a suitable instrument for regular review of progress. As there are many development and climate change challenges, coordination and consultation among WATSAN stakeholders will create greater opportunities for collaboration and successful and environmentally sound services and operations.

Holistic and sector wide monitoring and evaluation of sector interventions will be helpful for learning and timely adjustments. Joint sector reviews at two-yearly intervals are useful to record progress, recalibrate policies and projects, and generate the energy and capacity for sustained and determined efforts.

### **International relations**

Maldives will continue to pursue good working relations with UN agencies, bilateral donors, development banks and relevant projects. Expertise and financing infrastructure development is a critical component that can be assured through international partnerships.

The UN system has been a longstanding partner in the development and application of good practices in water, sanitation and health. Agencies such as UNDP, UNICEF, WHO, FAO, UNEP, WMO and several other UN entities, provide finance and technical support. They also provide an essential link to regional and global expertise at low cost. Development Banks such as the ADB and the World Bank offer technical assistance of national relevance, which may lead to sector investments, often in an urban setting, e.g. waste management or urban drainage.

Maldives has benefited from investment projects funded by GEF/GCF, USAID, OFID, AFD, etc. and continues to receive support from Finance Institutions based in India, China and Gulf states. It benefits in particular from various climate related funds.

International relations in research and information management are critical for identification of best practices and innovations. Maldives National University, national professional associations and Educational Institutes can promote contacts with regional and international expertise and research opportunities.

Maldives has been an initiator and active participant of the Small Island Developing States (SIDS) group. The initiative has assisted Maldives to influence action on climate change effects experienced by small islands states.

The International Water Association is a global membership organization bringing together professionals in water supply, sanitation and sewerage. It offers an open, yet ordered platform in which both innovators and adopters of new technologies and approaches can generate creative friction. It is a place for diffusion, benchmarking and evidence. IWA has several thematic working groups on aspects that are relevant to Maldives, such water utility management, water governance and regulation, treatment technologies, water and health, etc. IWA would be a useful resource for Maldives to be associated with.

## Chapter 5 Criteria for a comprehensive water and sewerage masterplan

### 5.1 Development status

From a development perspective, the water and sewerage service sector in Maldives can be grouped in four categories:

**Malé & Hulhumale', Vilingili:** urban and becoming more of a city scape. Customers live in high-density apartment blocks and expect full, high quality services. They can afford to pay for the RO water service. Alternative water resources are scarce, rainwater is mostly considered stormwater.

Sewerage is not (yet) treated and discharged off the reef. Potential for slow degradation of surrounding waters. No charges for domestic wastewater discharge

Expansion and upgrading of RO production is a continuing process. Some rainwater harvesting is contemplated and may become of use in the near future. This will require large water storage capacity, which is also needed for produced water. Similarly controlled use could be explored from ground water resources. Growing population and economic activities require regular expansion of all utility services. Wastewater treatment (preferably with resource recovery) is urgent.

#### **New island cities**

In the next decade there may be some more islands that will have features similar to the Greater Male' area. Three islands have been declared as cities: Addu City, Fuvahmulah City, and Kulhudhuffushi City each with over 10'000 residents. These islands that will change into cities with all facilities. The speed with which these developments will take place depend on the National Spatial Plan and the implementation of the Government's Strategic Action Plan. Even then, there is good potential for improved planning and including water security and resilience measures for the water supply and sewerage infrastructure in these new cities, integrating rainwater harvesting and retention into the water resources protection framework.

**Atoll islands and non-administrative islands** all have very unique features in size, population and population density, inundation risk, vegetation cover, economic opportunities beyond fishing, and linkage to Male' or atoll headquarters' services. Many islands have a few hundred inhabitants, living close together. Still, households have access to their own well and rainwater harvesting system. 65% use a septic tank to store and treat human waste. Density determines the degree of degradation of groundwater. Sewerage is introduced or already in place to reduce the level of contamination of the aquifer. Unfortunately, sewerage treatment is often not in place or functional. A sea outfall discharges the untreated sewage off the reef.

In these islands there is still a way to go to achieve sustainable piped water supply and environmentally sound sewerage systems. Household incomes are usually low and alternative water resources are available. The business model for service providers is fragile while

management capacity and oversight from the Island Council needs strengthening. Good monitoring and occasional support from Regional and Central Government will be required. Occasional water shortages during droughts may be a problem in some islands.

Administrative islands have a few thousand inhabitants. However, most are small with a median number of inhabitants of 838 (NBS, 2020). Not all residents are in the island year-round. They may have moved for work or studies to other islands or mostly to Male'. That also means that up to 20% of homes may not be occupied at any given time.

As islands are unique, tailor made solutions are necessary for water supply and sewerage. This requires extensive consultation with the residents and the Island Council. Unless the Island Council is strongly involved and takes on the responsibility for the (in)direct management of water and sewerage, systems will quickly break down and the benefits of the expensive services will not accrue. Such failures will be costly as the loans and interest for the systems will still need to be paid for by the Central Government.

Non-administrative islands may have been leased for agricultural purposes or for a fish processing plant. Only a few people live there. Water is usually needed for the business and will supply the few residents as well. RO systems are often in place, otherwise rainwater harvesting will provide safe drinking water. Sanitation is required for only a few people. Septic tanks will be in use and where there is a factory, a sea outfall may be in place. While non-administrative islands in principle must follow the same regulations as inhabited islands health and environmental risks are small. Risk may however be introduced by agriculture (excess fertilizer use) or factory waste. An EIA is usually required when leasing an island for an industrial purpose.

**Tourist resorts** are investments geared towards providing well-paying guests a luxury holiday at the beach, with opportunity for snorkeling on the reef, and a relaxing time on the resort island. RO water supply and a sewerage system is in place. Wastewater treatment before discharge is in place in some resorts and resorts promote their green and climate resilience credentials by extensively using solar panels and other renewable energy sources, growing vegetables in on-island plots, etc. The tourist resorts cannot afford to underperform in water supply and sanitation. For reasons of cost-saving and resource recovery the resorts usually look for operational improvements, e.g. through use of renewable energy or use of rainwater for toilet flushing at staff quarters or for kitchen garden irrigation.

It would be advisable that tourist resorts would follow the Global Reporting Initiative (GRI) Standards. These standards are stricter than URA standards and can be applied to four-star resorts and above that belong to international hospitality chains.

## 5.2 Service quality

With respect to the quality of service, there are different perspectives to consider:

1. Consumer perspective when the service is provided by a contracted service provider (MWSC, Fenaka, STELCO and private sector) and considering a degree of self-supply through well-water and rainwater.
2. User perspective in hospitality industry (resort island) or industrial island. The guesthouse, hotel or industry is responsible for full functionality of the service and should provide a service equal or better than under 1.
3. Island Council perspective: the services should protect and improve upon the water ecosystem in the island using an IWRM approach and create greater water security and resilience.
4. Regulatory perspective: aspects of Health (HPA), Environment (EPA), Tariffs and Value for Money, performance standards (URA), Disaster Prevention (NDMA) need to be secured according to prevailing standards and regulations, and should be monitored.
5. Policy perspective aimed at ensuring perspectives 1-4 above AND enhancing climate change resilience and reduction of recurrent costs of operation and maintenance of the services through renewable energy, reduction of wastage and non-revenue water, demand management, treatment and reuse of wastewater, etc.

### 5.2.1 Consumer perspective

At home, water supply and sewerage services should provide a service that is sufficient for all domestic chores and of acceptable quality. The service should be reliable, affordable and without interruption.

In Greater Male', in institutional settings such as hospitals and government offices, and for special situations (high-rise buildings where alternative sources of water are not available) this means that provision of RO-water meets all services according to the required standard, from that source.

In the islands it means that the aggregation of sources at the home provides a service that is affordable, safe for drinking and food preparation (treated rainwater or RO-water), and adequate for all other domestic requirements.

The toilet facilities should in all instances be suitable for the household or the institution in terms of availability, adequacy and convenience (including facilities for persons with a variety of disabilities). Removal of waste will be effected by functional sewerage systems (or in the interim, by functional septic tanks systems).

### 5.2.2 User perspective in hospitality industry or industrial island

In the hospitality industry the quality of service is equal or better than referred in the previous section. The difference is that the host, the hotel or guesthouse, is responsible to assure the service. While consumption of water for food preparation is borne by the host, larger volumes

of water are used by guests for shower and bath, while laundry use is often higher as well. Water quality needs to meet national standards. So, the RO water produced at the resort will have to attain this quality.

For guesthouses and restaurants, the responsibility for maintaining water quality lies with the service provider, with the guesthouse operator arranging to secure an uninterrupted safe water supply for its guests.

In an industrial setting, or for an island set aside for agriculture, the users will usually be workers at the plant who are staying on the island overnight. Ensuring adequate water supply and sanitation will be the responsibility of the owner or lessor of the island. Often one of the workers will be assigned to look after the water and sanitation services.

### **5.2.3 Island Council perspective**

In the islands the island council takes a direct responsibility for managing the water supply and sewerage scheme. Under the decentralization act, it can delegate the task of operational management by contract to a dedicated service provider. The service provider will provide the service by supplying RO-water through a distribution network and collect the sewage through a sewerage system. Proper discharge of brine and treated sewage is the responsibility of the contractor. Monitoring of the service is the responsibility of the island council.

Beyond the provision of services, the island council is responsible for sound environmental management in the island and protection of the quality and quantity of the groundwater aquifer. In consultation with other stakeholders and the population, bylaws, community awareness programmes and monitoring schedules may be drawn up to strengthen environmental protection.

Overall, an IWRM approach and application of a water and sanitation safety plan approach will create greater water security and resilience. The water and sanitation safety plan will be reviewed annually and corrective action taken up to reduce risks from newly identified hazards.

Application of IWRM and smart infiltration of rainwater, in combination with sensible abstraction of groundwater, within the limitations of the island water balance, will gradually improve the water quality of the fresh groundwater lens.

### **5.2.4 Regulatory perspective**

The regulatory framework in Maldives aims to ensure that during development, establishment, operation and maintenance of the water supply and sewerage systems the processes are in compliance with the national standards and rules. The guidance provided by EPA and URA in design and establishment should lead to functional systems that meet primary health care associated requirements and simultaneously safeguard and protect the island and marine environment. Environmental Impact Assessments will confirm the suitability of the project. HPA will assist through sanitary inspections by island-based public health personnel and testing of

water samples for bacteriological contamination. Water quality surveillance and functional water safety plans will gradually be integrated in health protection framework.

The Utility Regulatory Authority will develop further regulations as may be required under the Water and Sewerage Act. It will control the quality of service through issuing of design criteria and licensing. URA will review tariffs set for services and ensure equitable services to all in a service area. Monitoring performance and compliance with water quality standards (from the service provider perspective) will be an important task. This will need a substantial effort in setting up a comprehensive sector-wide data collection system fit-for-purpose for decision-makers and for policy review.

Up-to-date sector data will also be useful to predict shortfalls in supply. In addition, the National Disaster Management Authority can identify other reportable aspects related to water security and disaster preparedness.

The establishment of a water sector data portal that is available for sector stakeholders and has a section that is open to the public, would be a boon to strengthening sector management, resulting in better and more climate resilient services.

### **5.2.5 Policy perspective**

The policy perspective aims to ensure implementation of the guidance given in 1-4 above AND simultaneously enhancing climate change resilience and reduction of recurrent costs of operation and maintenance of the services through renewable energy, reduction of wastage and non-revenue water, demand management, treatment and reuse of wastewater, etc. The Strategic Action Plan and the Water Supply and Sewerage Policy cover these additional policy aspects. Regular monitoring and evaluation of the measures in place will be necessary to ensure intended outcomes. The data-management capacity envisaged in the water sector data portal mentioned in the previous section, will be an essential and convenient tool into which some policy related indicators can be incorporated.

From time to time, based on review of data and data trends, the overarching policy perspective may be refined to strengthen implementation or to adjust to changing conditions.

## **5.3 Public health and hygiene**

### **5.3.1 Water Quality**

For health reasons, water that is used for human consumption should meet the URA standards. This generally means that drinking water needs to meet the URA guidelines.

When dealing with small children or vulnerable people, or in the health centre or hospital this quality of water should be used always. In resort islands the desalinated water with this standard is mandatory for water used by all guests and staff. (MoT Resort Handbook)

In the islands several water sources are available and in use. 75% of households in the islands collect rainwater and use as drinking water. Rainwater needs to be treated though boiling or using a household treatment option to be safe to drink. Where a service provider supplies RO water in the island, this will usually be used for drinking and cooking.

The presence of fecal coliforms would indicate the potential presence of disease carrying organisms. Elevated levels would indicate contamination of water with human waste. This parameter is usually expressed as E.coli coliform units. It is the only critical health parameter in the set of minimum standards. The other parameters are of operational nature (free chlorine, turbidity) or esthetical (taste, visual).

### **5.3.2 Water Quantity**

Design standards as published by URA provide approach and data for calculation of required RO (or combined RWH+RO) production capacity and delivery at consumer level. The Design Criteria for water supply assume that 20 liters is used per person per day for drinking and cooking. In addition, 130 liters per person per day is assumed for other daily chores, or a total consumption of 150 lpd.

In Greater Male' and the tourist resorts these volumes of water are available through the supply of RO water. As the water is costly, effective and responsible use is a greater concern. Especially in municipal areas where no alternative sources of water are available, and in the resorts where tourists use large volumes of water, demand management and nudging consumers to use water well is in the interest of society.

In the islands 10-15 lpd will be used for drinking and cooking and supplied by the piped supply network. Domestic rainwater and water from the well will supply the additional requirements.

High-end tourist resorts – as in Maldives - tend to have higher levels of water consumption per guest night due to their higher quality standards, and the services and facilities offered. It may range from 600-800 liters per guest night. Reduction of water consumption, especially when most of it is derived from reverse osmosis will save a lot in energy costs. Resorts are undoubtedly experimenting with these cost-saving measures, but the Ministry of Tourism and the Ministry of Environment, Climate Change and Technology will promote this further by inviting trade representatives to hold seminars and exchange visits.

In the islands water use is often substantial with an assessed average usage from the fresh groundwater lens at the end of the dry season of 223 lpd. Drinking water is taken from the rainwater tank. While the groundwater is often a bit smelly, because of the general contamination due to poor septic tanks, the quality is accepted for laundry, bathing, toilet flushing and cleaning. Towards the end of the dry season, the absence of a RO water facility in the island will start to show. Until a central water system is in place or water support can be provided from nearby islands, this situation will continue to exist. (Ministry of Environment, 2020)

## 5.4 Evaluation, research and assessment

Developing and sustaining the water and sewerage sector in a competent and effective way, will require investing in a capacity to evaluate and assess suitable WATSAN approaches and techniques. An important objective will be to encourage continuing improvement of service levels and the resilience of the existing systems. To make this happen, a catalogue of climate resilient options needs to be identified for initial implementation or retrofitting.

Evaluation of installed wastewater treatment systems in Maldives will provide an insight in the type of technology that will work and is cost effective. Sharing the evaluation and the underlying data with ‘critical friends’ and senior scientists in regional universities and professional associations will help to identify solutions to overcome existing problems.

Similarly, collaborating with regional universities and laboratories on water treatment and wastewater treatment that can work in Maldives, is an excellent way of enhancing the skills and experience of national professionals.

Borrowing the results obtained by competent national WATSAN organizations in the region on water-saving appliances and household water treatment, for instance, will speed up validation and acceptance by regulatory authorities.

A knowledge hub established would focus on current knowledge, experience and research on water supply, sanitation and IWRM. Simultaneously, in consultation with MoEnCC&T and other sector partners, it can develop a research portfolio relevant to the WATSAN challenges in Maldives. The trends that become apparent from monitoring the operational data collected by the WATSAN database will offer further suggestions for research. Research can include technology, benchmarking, footprint assessments, etc.

Setting up the knowledge hub will require investment. To implement research activities, a research and development fund on WATSAN will be needed. Such a fund will come from Government, donor projects, collaborative frameworks with other universities that allow accessing research funds, and from service providers and the private sector for validation services rendered.

## 5.5 Water and Sanitation Safety Planning

### Water Safety Plans

Water Safety Plans (WSP) have been put forward by the World Health Organization as a tool to ensure good water supply in which health risks are properly managed. Water Safety Plans were developed as a participatory approach to identify risks to the water supply from catchment to consumer and set out ways to mitigate, minimise and manage those risks. The WHO/IWA *Water Safety Plan Manual: Step by Step Risk Management for Drinking-Water Suppliers* (Bartram et al., 2009) , provides a practical guide to developing WSPs for organized water supplies managed by a larger water utility or similar entity. This would fit the situation in Greater Male’. Adequate guidance is available from WHO and IWA.

The special situation, hazards and risks encountered in coral islands have not been developed yet in a water safety plan. Climate change concerns have been reflected in a recent WHO WSP manual (World Health Organization, 2017a). The document advises that a simple approach to incorporate climate change in the risk assessment is to assess, based on climate change scenarios, the likely change in the risk over time. It is worth considering the level of risk that is deemed acceptable and identifying control measures that will reduce risks under all potential future climate change scenarios.

The water safety plan approach has also been applied to sanitation. The sanitation safety plan that is envisaged by WHO focuses on safe management of human waste and. The WHO guidance assists users to systematically identify and manage health risk along the sanitation chain; and guide investment based on actual risks, to promote health benefits and minimize adverse health impacts. (WHO, 2015) It certainly has several aspects that are of importance to safe management and functioning of sewerage systems that Maldives has built/is building in the islands. In the small islands, often densely populated, poor functioning of the sewerage system will have a direct effect on water quality of the freshwater lens and, potentially, on water security.

Small, low-lying islands in the open sea, face the risk of storm surges and swells which may cause damage and disruption to water and sewerage infrastructure. Disaster events may also disrupt power, generating secondary risks to water security.

WHO recommends to include the following three aspects while developing policy and regulatory guidance for small systems. (World Health Organization, 2021). These aspects are

<b>CONSIDER SUSTAINABILITY</b>	Effective and sustainable drinking-water service requires a whole-of-system approach that considers effective institutions, policies, planning, proactive system management, financing, monitoring, and regulatory oversight.
<b>TAKE A RISK-BASED APPROACH</b>	Ensuring that limited resources are applied most effectively requires a risk-based approach that includes promotion of proactive risk management by water suppliers and prioritization of surveillance activity on the basis of relative risk.
<b>CUSTOMIZE</b>	Small water supply system types, management models and capacities often vary considerably, and effective regulations and programmes should reflect due consideration of diverse circumstances to ensure feasibility.

the foundation of the W&S safety plans to be drafted.

### **A composite safety plan for Maldives islands**

In view of the unique situation on Maldives atoll islands, a conceptual approach can be developed (combining the various aspects already reflected in the National Water and Sewerage Strategic Plan) with the requirements to create a multicriteria safety plan for water and sewerage focused on water quality, water security, environmental protection and improvement of the freshwater lens and ecosystem, while keeping an eye on cost-efficiency, climate change adaptation and disaster risk reduction.

The W&SSPs for Maldives islands are proposed to be built up from simple to more complex

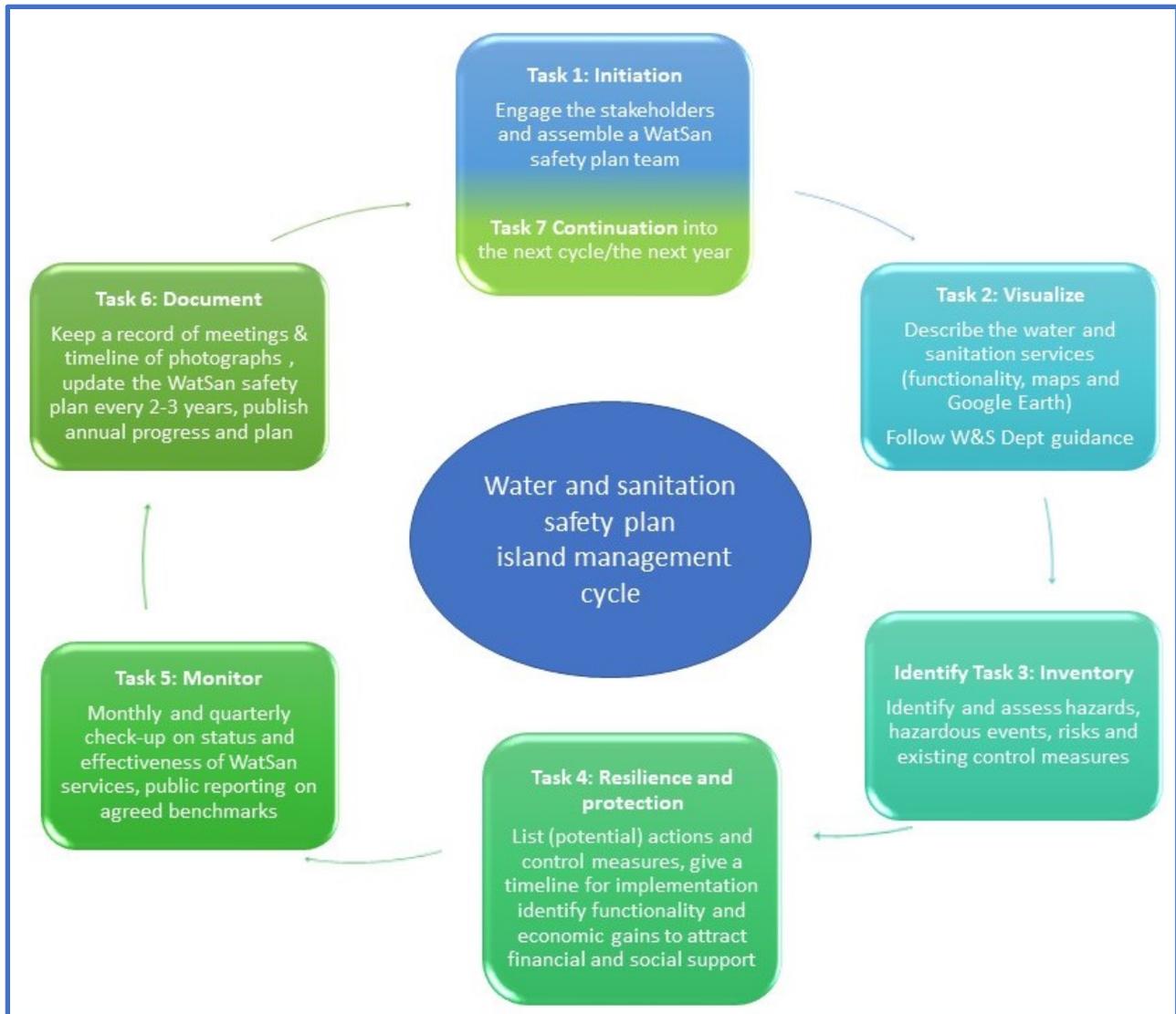


Figure 11 Approach for setting-up a Water and Sewerage Safety Plan for Maldives islands

situations. The National Water Supply and Sewerage Strategic Plan has already incorporated most of the elements of the comprehensive W&S safety plan.

The identification, implementation and monitoring of control measures to manage water quality is a critical component of water safety planning.

Where water availability and reliability are identified as significant risks, control measures are required to reduce levels of risk. In terms of managing scarcity and reliability risks, options can be classified as demand-side or supply-side options. Demand-side options aim to manage consumption and increase efficiency, thereby reducing the demand placed on the resource.

Increasing efficiency in water supply systems also brings the co-benefit of reducing energy consumption, lowering the costs of treating and pumping water and reducing greenhouse gas emissions. In addition, demand-side control measures will deliver these benefits under all future climate scenarios, whereas development of new water sources may be undermined by future changes in climate, which may reduce source yields compared to anticipated levels. The selection of a portfolio of demand- and supply-side options that is robust across a diverse range of potential future scenarios is a useful strategy to manage future uncertainty. (World Health Organization, 2017a)

. Water infrastructure often has a long lifespan and will be used in climate and societal conditions that could be very different to the present day. Infrastructure that can be upsized or adjusted with minimum cost and disruption is better placed to cope with future uncertainty. This might include designing water treatment works that can easily be upsized in the future if demand increases more than is expected.

Standardizing RO equipment would allow exchange of functional equipment among islands. An inventory of (refurbished) equipment available in Maldives would be advantageous to assist with replacement or upsizing of desalination equipment.

Control measures that reduce risks under all future scenarios of climate and development can be considered “no regret” or “low regret”. This means they deliver benefits under a wide range of possible futures.

## **5.6 Water Quality Surveillance**

Water quality is based on a set of biological, physical and chemical variables, which are closely linked to the intended use of water. Drinking water is expected to be free from harmful pathogens and toxic chemicals. The relevant standards as published by URA have been discussed in section 5.3.1. Independent water quality surveillance is usually done by public health or food safety authorities.

For water quality surveillance in the islands and tourist resorts, an E.coli test and free chlorine test in a few locations in the network would be sufficient to establish immediate health related compliance with standards. .

For operational reasons, as discussed in section 5.3.1, the service provider will perform water quality tests for free chlorine, turbidity, EC, TDS and E.coli, etc. The data should be properly

recorded, in a water quality register and preferably on a web-based portal. The data so generated will further contribute to building confidence in the surveillance instrument.

Service providers in the islands will usually test a parameter with a field test kit. These are these days reliable enough for operational purposes. In the next few years it is expected that easy-to-use, cost-effective testing methods will become available for several parameters that can be used with a smartphone. Water quality monitoring using optical readings will become the standard technique in the near future, such as the smartphone-based turbidity reader (Ceylan Koydemir et al., 2019).

## **5.7 Integrated Water Resources Management**

Integrated water resources management (IWRM) is expressed government policy. In the situation of Maldives, IWRM means a broad combination of protection and conservation of the fresh ground water lens, good use of available rainfall for domestic consumption and aquifer recharge, inclusion of rainwater in the public supply, demand management through use of efficient water fixtures and consumer practices, and leakage control in the system and at consumer level. In case water or drinking water shortages are expected through the year in the island or the atolls, reverse osmosis of saline water drawn from below the freshwater lens can be applied.

In addition, water security requires storage and water treatment capacity to avoid service disruption due to flooding and drought. Storage for at least 5 days, at least for drinking and cooking at 10-20/l per head per day would need to be reserved (W&S Act, article 24).

Achieving IWRM requires understanding and collaboration of the island communities and their guests. Adequate consumer education and communication is required to achieve this. The value of water – safe and wholesome water- needs to be emphasized regularly and any cultural practices that enhance the appreciation and protection of safe water, should be encouraged. Island councils and the island utility providers, need to continue to emphasize the importance of integrated water resources management to the consumers and stress the (moral) responsibility of households and institutions. Service provision in the islands is fragile and will only be secure when all contribute to its functionality and safety. IWRM serve to make best use of the water resources in terms of management, protection and effective use. In that way it supports raising water security in the islands. Effective use of rainwater through collection and contribution to the public water supply will reduce the costs and the carbon footprint of the production of drinking water.

## **5.8 Waste and wastewater management**

In Greater Male' off-site sanitation through sewerage is in place. Sewage treatment is not in place and wastewater is discharged through several outfalls. A wastewater treatment plant is in the process of being tendered for Hulhumale' Phase 1.

Overall, with the density of population growing and the need to protect the marine environment, discharge of untreated sewage is not acceptable. Solutions for wastewater treatment in Greater Male' will urgently be formulated and implemented. Maldives Urban Development and Resilience Project (MURDP) will run till 2026 and will also support a stormwater drainage masterplan and the upgrading of the primary drainage network in selected wards to be connected to underground storage tanks. Captured rainwater will be stored in the underground storage tanks to reduce flooding and to feed existing fire hydrants, irrigating landscapes and greening of neighborhoods. (Ministry of Finance, General Procurement Notice, 6 January 2020)

MURDP will contribute to a strategic plan with respect to wastewater management and treatment that includes upgrading and repair of the existing sewerage system in Male', Hulhule' and Vilingili, with updates integrated in a geographic information system, with full data management capacity.

In the islands it is government policy to provide sewerage systems and remove the existing septic tanks. The costs of installing sewerage, and maintaining the system is substantial. Sewerage systems collect wastewater that should be treated before discharge. This is again costly and complex requiring trained staff.

## 5.9 Regulatory framework

The regulatory framework for water supply and sanitation will lead to service delivery in water supply and sanitation that meets the policies, standards and guidelines of Maldives.

The regulations relate to design and construction standards and guidelines, and to operational aspects. The regulations will cover **health protection** (water quality, water, disaster preparedness, integrity of the water distribution and the sewage collection network), the **quality of service and their costs** (reliability, NRW, staffing levels, use of renewable energy), **equity** (responsible use, licensed abstraction), **environmental protection** (IWRM, groundwater protection, wastewater treatment and sea-outfall).

Performance monitoring will be required of important parameters that would provide information on compliance and improving efficiency. Such monitoring would apply to the service provider with respect to the operations of the water and sewerage system, while the island council, as the owner and representing the community, would also need to report on aspects that demonstrate social and environmental resilience. Some of these parameters and the method of reporting will still need to be formulated through a multi-stakeholder review of existing indicators and monitoring capacity.

### **Service monitoring and reporting (app-based)**

Within the decentralized national statistical system, the National Bureau of Statistics (NBS) is mandated as the core body with data collection, analysis and compilation at the national level,

while sectoral agencies are mandated for the data collection, analysis and compilation of the relevant sectoral data.

Under decentralization and to comply with the water and sewerage act, a robust mechanism is needed to collect data that are relevant to the sector. Agreement needs to be reached on the type of data to be collected by Island Councils, utility companies and associated government institutions and their frequency of reporting. A portal with a public forum and a member section should be managed by the Ministry of Environment, Climate Change and Technology in close partnership with the National Bureau of Statistics. (Ahmed, 2018)

The objective of the monitoring and reporting would be to gradually develop a common database that allows monitoring of individual island performance, but would also allow more general statistical analysis that is useful to report on SDGs or on water security, resilience, etc. Data collected from various stakeholders will strengthen the common understanding on current water and sewerage performance and trends in improvement in IWRM, fresh groundwater lens quality and water security. Island councils can compare performance among islands which may encourage further improvement and action.

### **Applying the internet of things (IoT)**

The development of communication with equipment for monitoring and adjustment using remote connections through the Internet of Things is growing rapidly. Software and apps are available that allow interaction with processes in remote locations, including visual reports and face-to-face discussion with staff on location.

Maldives will benefit from increased use of remote monitoring and management of systems, using ICT, wireless sensors and data loggers as appropriate. Feedback with digital photographs or video will make factual statements and remote assessments easier. Visual communications between colleagues using WhatsApp can quickly resolve a technical problem on another island. Smartphones will allow installation of all kinds of apps that would make reporting easier and secure.

In the same way, water and sanitation installations in islands can increasingly be monitored directly by linking the operations of equipment to the Internet of Things (IoT). It will save staff time and allow central, real time monitoring for 24hrs alert. (UNESCO, 2019)

### **5.10 Financing, revenue collection and subsidy**

Financing of water supply and sewerage is through a mix of Public Sector Investment Program (PSIP), loans from Development Banks and other foreign banks and loans and grants from various donor agencies.

To complete the government programme of universal piped water supply and sewerage in all islands, by 2023, the budgets for the coming three years will remain substantial. Together with

budget head 'Developing Transport Infrastructure' water and sewerage is the largest component of the PSIP at around 13%.

From 2023 onwards, a gradual shift from investment towards operation of water supply and sewerage will be seen. For the national budget this means that fund requirement under PSIP will fall. Components of asset management such as an extra storage reservoir or the upgrading or expansion of a system may still be included if these cannot be financed in another way.

The cost of operations will be met between the service provider and the consumers through tariffs. Where tariffs fall short or subsidies are put in place, the island council may have to contribute.

### **Development project funding**

Maldives receives loans and grants from a wide variety of agencies. Environmental concerns, climate change resilience and infrastructure development dominate the requests for assistance.

In water supply and sewerage, grants have been received from Saudi Fund, IDA/WB, GCF/UNDP, India and ADB. The loans portfolio is more extensive with loans outstanding from Saudi Fund, Kuwait Fund, Islamic Development Bank, Indian Exim Bank, Chin Exim Bank, OPEC Fund for International Development, IDA/WB and ADB. Loans are negotiated by the Ministry of Finance.

In addition to specific funding for water supply, there are several large renewable energy projects that will help Maldives to make the transition from diesel to solar power. This will be beneficial to the WATSAN sector, as it will reduce operational costs.

### **Self-supply and Household Investments**

Traditionally households in Maldives have taken care of water supply through the construction of private wells in their property and rainwater harvesting. As public resources are increasingly being used for piped water supply based on distribution networks with house connections, the importance of self-supply is likely to decline. Still, in 2021 it remains a very important supply component, with all households in the atoll islands managing their own water source.

Upkeep and improvements represent a substantial private household investment. Fitting the existing well with a small on-demand electric pump to supply the bathroom provides a very good quality service. Overall, the contribution given by households to securing improved water supply and sanitation services is quite substantial. (Danert & Hutton, 2020) Mostly this component of household investments is disregarded even though it represents a substantial part of sector investment and contributes substantially to the local business in sanitary improvements.

### **Tariffs**

The Water and Sewerage Act entrusts each island council to set tariffs on water and sewerage services. Rates cannot be set higher than the ceiling tariff set by the URA.

These are based on policy objectives such as economic efficiency, water resource management, asset management and inclusion and equity. Tariffs need to strike a balance between revenues needed by utilities to sustain coverage and improve service quality and providing affordable services to poor households.

For poor families the Island Council may have to (request National Social Protection Agency – NSPA to) support with a subsidy for the first 100 liters per day. As each family will have a well and rainwater as alternative sources, that should be sufficient in most instances.

Even then, it needs discussion and agreement at the island council. Based on the contractual agreement between the island council and the service provider the tariff and the system for tariff adjustments must be set. A business plan for the water supply and sanitation operation will usually be needed that reflects efforts to reduce the costs of production and energy by using renewables, encourage greater connected usage (i.e. sales of water) and reduce costs of human resources and system management through local solutions and IoT.

## Chapter 6 Consumer education and demand management

The importance of consumer education for environmental awareness and good practices is well understood in Maldives. The on-going FENFAHI campaign was designed to assist communities to take ownership of their water resources and their water and sewerage systems. That capacity will be further tested as Island Councils assume greater responsibility for ensuring service provision under the decentralization act.

The FENFAHI campaign also aims to foster a sense of responsibility for individuals and households with respect to the water and sewerage system in the island. The thematic areas of the campaign include the value and cost of water, water security, water safety and threats to water quality. It also aims to generate a greater appreciation for the cost of establishing and managing the water and sewerage systems. The campaign addresses consumers, decision makers, operators, island councils, youths and women groups.

The FENFAHI campaign will be continued and refreshed, with inputs from Island Council members and local influencers (in social media), women and youths.

The objectives of the FENFAHI campaign should be generating willingness in the islands to connect to the water and sewerage networks, use all water in the household responsibly, reusing as needed to reduce demand on the RO system, and through appreciation of the service and considering affordability find ways to raise the tariffs to at least the recovery of the costs of operation and maintenance.

In the city areas, demand management will be critical. Producing desalinated water is expensive, often more expensive than the tariff charged for consumption. It is the responsibility of every consumer to use the water well, for the right purpose and not waste this valuable resource. Creative and interesting ways will be used in the FENFAHI campaign to nudge people and support responsible behavior, so that water is used efficiently.

## Chapter 7 Island Council WATSAN management

In the islands, the role of the island council has been further enhanced by the 8th amendment of the Decentralization Act (2019) as it gives the councils more freedom to manage their own affairs.

The Act gives atoll and island councils wide powers, including those related to the provision of water and sewerage, and the collection of fees for the services provided.

Provision of water and sewerage services is complex and requires balancing health, convenience and reliability of services with asset management and operational costs that are affordable. Plans are needed to ensure that services are durable and can continue to be upgraded to meet consumer requirement and increasingly become disaster proof.

Technical and financial assistance needs to be provided to the Island Councils to be able to exercise these responsibilities. The Local Government Authority (LGA) is the government agency that supports the Island Councils in various ways, such as assisting councils to attain the SDGs, empowering Women Development Committees, conduct capacity building programmes and enhance local governance. LGA also monitors that the work and activities of councils are in accordance with the Constitution, the Decentralization Act and other Laws, and supports efforts to make island councils accountable and responsive.

To enable the local councils to operate the water and sewerage systems, or delegate these by contract, training and regular capacity building seminars are necessary. Some of the council members, appointed to look after the utility services on behalf of the council, should receive training that would enable them to negotiate, operate or manage the W&S systems.

Depending on the operational or management roles the Council intends to play with respect to the water and sewerage utility, specific training programmes need to be completed by council members. It is important that the Island Council has a fair capacity to interact with the management of the utility services.

Whether it should operate the service under its own management will depend on local conditions.

## Chapter 8 Human Resources Development and Management

To enable Maldives to manage the water and sewerage sector, substantial staff recruitment and development will be required in the next 10-15 years.

In the islands, within the systems operated by Island Councils or service providers, technical staff that can operate, maintain and troubleshoot simple errors in the systems are necessary. At atoll level, engineering (at times with B.Sc.) will be needed for redesign, asset management and upgrading. Some, with experience may enter the management levels of the utility companies.

In Male' at central level, the Water and Sewerage Department of the Ministry of Environment, Climate Change and Technology will require engineers and project managers that can grow into the various functions required in monitoring, regulation and policy development of the sector. In addition, engineers, sociologists and environmental scientists, including hydrogeologists, will be needed in other Government Departments and Ministries, and in the private sector. Some of the professionals may need to go to regional universities for further studies (specialized M.Sc. courses).

At island level, as indicated in chapter 6, local councilors and other interested citizens should have the opportunity to be trained in environmental sciences and the operational aspects of water and sewerage. The MNU, Maldives Villa College and Maldives Polytechnic provide technical and vocational education at certificate level through on-line modules. Government will encourage Island Councils to sponsor such human resourced development courses.

## Chapter 9 Water and sewerage masterplan 2021-2025

### 9.1 Introduction

The Government of Maldives has outlined its plans in the National Strategic Action Plan 2019-2023. The SAP aims to raise resilience and sustainability, provide better economic and social development opportunities for all Maldivians to allow greater participation in the various sectors of society. The effects of climate change bring additional urgency to actions that will help reduce the risks associated with sea-level rise.

With continued investment in education, there should be more capability and interest for decentralized governance, in which citizens are more able and willing to take on responsibilities in island councils and the decentralized services of government and the private sector. Greater participation will enhance good governance of decentralized structures and allow for people-driven economic and social development of the atolls and islands. Greater Male' will remain the economic hub of Maldives, with a variety of services.

However, with an educated population, improved communication and use of information technology, and the intent of Government to decentralize further based on a National Spatial Plan, more capacity can be regionalized. With further improvement of utility services and internet connectivity, professional employment can be taken up in the islands and local hospitality services can thrive.

Water and sewerage masterplan aims to describe the required actions to be undertaken in this important subsector in physical infrastructure, strengthening of management and business models, island council and community responsibilities, financing and supportive functions in regulation, monitoring and research, training and higher education. The content of the Masterplan 2021-2025 is given in this chapter, while the subsequent decade of the Masterplan is described in the next chapter.

### 9.2 Enabling Island Council

With decentralization, the assets of the water supply system are owned by the Island Council. Thus, the complexity and risk regarding the management of the system will fall on the Island Council as well. The regulator, URA, and the Ministry of Environment, Climate Change and Technology should see to it that at least 2 of the sitting members of the Island Council have completed an orientation course on the management of water and sewerage services in Maldives.

Splitting the water supply service (in which households have an interest, at times) and the sewerage service (for which no tariff is charged and in which people have no real interest) is not an attractive business prospect.

By 2025 a solid business model needs to be developed that provides a good service to the island, offers sufficient control to the island council, gives a fair return to the service provider and ensure adequate financing for asset management.

### 9.3 Strategic Action Plan 2019-2023 and Water and Sewerage

The fourth priority of the SAP is *Jazeera Dhiriulhun*. It aims to put the islands on a road towards well-functioning, fairly self-sufficient communities with utilities and services that provide opportunities to all to live a dignified life. Availability of adequate water supply for the household, sanitation and personal hygiene, and sewerage systems that protect the environment, are essential and give the consumer peace of mind.

Other services such as electricity and waste management are just as much needed. Providing the services require technical infrastructure, good operation and management and above all appreciation by the community and agreement by individual households to contribute to the upkeep of the services. At times, infrastructure is needed that is too expensive for the island community to finance. In such instances, government subsidy or projects are needed to ensure timely realization. Through regulation, monitoring and research the quality of services needs to be maintained and improved. Island- level disaster preparedness planning and W&S safety plans should keep assess hazards and risks, especially those that relate to climate change or human interventions.

Figure 1 depicts the timeline from the development of a water and sewerage policy in 2017 to the ratification of the water and sewerage act in 2020, with a strong supportive push from the SAP to the formulation of a water and sewerage masterplan that will unify the vision, objectives and actions of the WATSAN sector and its partners.

The National Water and Sewerage Strategic Plan 2020-2025 provides current information about activities already scheduled for the period concerned.

#### **Strategic Pillars**

The Water and Sewerage Masterplan is built on a foundation of

1. Guidance provided by NSAP
2. Institutional Environment of the Sector
3. Acts, policies, guidelines and regulations
4. Sector financing

These allow infrastructure, regulatory controls and monitoring, and several other essential supportive components to be included in the Master Plan, as follows:

5. Establishment of cost-effective, climate resilient water supply, sewerage and treatment facilities in all islands, integrating IWRM in concept and design and in consultation with the Island Council

6. Retrofitting IWRM components into existing systems and further efforts for restoration of the Fresh Groundwater Lens through Sustainable Drainage Systems (SuDS) or Managed Aquifer Recharge (MAR) (geohydrological capacity?)
7. Develop water and sewerage safety plans for each island, that focuses on water security and reliability of service.
8. Provide supportive capacity for water quality surveillance at regional level, and occasionally at atoll or island level.
9. Performance improvement through monitoring of agreed benchmarks of service providers and resort islands (CO<sub>2</sub> reduction, renewable energy use)
10. Consumer education and demand management
11. Human resource development (Technical and Vocational Education and Training, University degrees in engineering, environmental sciences, Data management and analysis, IT, management and accounting, etc.)
12. Monitoring, sector information and data management portal
13. Research and development related to sector development.

The principles of the Master Plan also apply in a broad sense to the situation Greater Male', however its density, high-rise apartments and relative affluence creates a very different socio-economic situation compared with the atoll islands.

### **Service delivery requirements**

The criteria for comprehensive water and sewerage systems have been discussed in Chapter 5. These will be reflected when listing the activities to be included in the Master Plan.

### **Water quantity**

The URA Design Criteria and Technical Specifications - Design and Construction of Water Treatment and Supply System, provide details on the design approach and minimum standards. The specifications also require a minimum of 5 days of water demand to cover for disruptions or emergencies as water storage in the island.

At design, at least 25% of the water resource should be drawn from rainwater. Over time this component may fall in percentage due to population growth and economic activities, but the island council should continue efforts to keep the rainwater component as high as reasonably possible. The mix of production of RO water and collected rainwater should be stored in strategic locations such that the water in the storage facility will be adequately available in case of fire.

### **Water quality**

Drinking water quality needs to meet URA standards. In practical terms, in islands without water quality laboratories, on a daily basis turbidity and chlorine residual should be tested at the production outlet, and for every 100 connections, at least chlorine residual should be checked at random points in the distribution system. At the connection inlet of the school and of the health Centre residual chlorine should be tested always. Monthly a water sample will be tested for microbial contamination (E.coli) at the school and the health centre, and in at least

three other locations in the network, including at least two samples from a household tap used for drinking water. The E.coli tests would preferably be sampled and incubated at the health Centre as part of public health monitoring. Results are to be reported to the island council, the service provider, the Island Medical Officer-in-Charge, and uploaded at the national data portal.

This water quality monitoring procedure should also be practiced at tourist resorts. Critical points should be monitored daily, e.g. outlet of production facility, water bottle filling station, if any, the restaurant and the staff quarters. E-coli tests should be performed at least monthly or more frequently, as stipulated by Maldives Food and Drugs Administration, in the above locations and in addition in three or four hotel rooms towards the end of the distribution network.

Results are to be reported to the resort management, the resort medical officer, and uploaded at the national data portal.

### **Sewerage and wastewater management**

Regular monitoring of the sewer lines, collection chambers and pumps that are part of the sewerage network will ensure functionality and integrity of the system. In most islands a monthly walkabout at the time of meter reading will be adequate for this purpose. In addition, the mobile phone number of the sewerage service should be made known to the public so that a phone call or WhatsApp message can inform of any mishap.

It is assumed that in the island a maximum of 80 lcd (excluding greywater from showers that should be used for flushing or watering the garden) will be discharged by a household through the sewer. Guesthouses (400 l/guest night), restaurants (800 -1000 l, depending on number of seats) and other larger water users should be assessed on location, in consultation with the island council and other planners (incl. MNPHI).

## **9.4 Unique island solutions**

The various studies and reports on the islands in Maldives clearly demonstrate that all islands are unique in their water quality, population density, community understanding, economic opportunities, vegetation and marine environment. Whereas principles of integrated water resources management would apply to all islands, the way forward to affordable water supply and increasingly water secure island will vary from place to place. Many islands have also changed with reclamation of at times substantial acreage. This will have an effect of rainwater collection potential and on the extent and the quality of the fresh groundwater lens.

In the tourist resorts, RO plants can resolve the water supply concerns as sufficient funds are available. However, the growing interest of resort guests in 'green' and CO<sub>2</sub> reducing footprints, means that also in these usually smaller islands, rainwater harvesting and renewable energy are rapidly gaining ground. The resorts notice that these green retrofits are actually more cost-effective in their lifespan and can be used in promoting the resort's responsible climate behavior to its clients.

Several recent studies on groundwater resource management and aquifer protection provide further insights in essential aspects of assessment before outlining options, such as measurement of the fresh groundwater lens, the water balance, climate change related hazards and adaptation options. (Deng & Bailey, 2019), (Zheng et al., 2019)(ADB, 2020)(Ministry of Environment, 2020) (Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, 2019)

The sewerage systems collect the wastewater in a central location. Here the waste is supposed to be treated before discharge off the reef. So far sewage treatment plants are not in place everywhere, because of costs of construction, the complexity of design and operation, and the costs associated with the running of the plant. Alternative solutions need to be found so that SBR treatment plants are not constructed everywhere. For small islands with less than 200 population DEWATS have also proven to be cost-effective in construction and operation. Earlier research on sewage treatment in artificial wetlands may also need to be revisited. MNU can open a position in the civil engineering department for a researcher to develop a portfolio of options that would be suitable for the conditions in Maldives. As part of the Master Plan, more work can be done on identifying suitable technologies.

Clearly, each island situation needs to be assessed carefully. Some options can be proposed and discussed with the island Council. Ultimately a unique solution will be developed that will suit the island, that people understand and which their behavior and practice can protect, for the service of which they are willing to pay and that with their support can grow into a sustainable solution.

## **9.5 Water and Sewerage Masterplan 2021-2025**

For the period 2021-2025, the Water and Sewerage Act and the National Water and Sewerage Strategic Plan 2020-2025 will be the framework for the Master Plan. These are based on the criteria of Chapter 12 and augmented with additional observations as made in earlier chapters of this document. The institutional environment is shown in the diagram below and is further described in Chapter 5. The main mandates of each agency and their interactions are shown.

In the following pages the main components of the Master Plan are listed as several tables.

The Plan aims to ensure equitable access to safe water and improved sewerage services for all. In doing so, it focuses on the

- Provision of efficient, effective and reliable water supply and sewerage services.
- Promotion of conservation and management of the water resources.
- Development of sector capacity for sustainable management of resources and services.

Legend: Development phase; inaugurated/functional; continued implementation



Table 2 Activities and costing of WATSAN masterplan 2020-2025 (8 tables)

**Component 1: Regulatory Framework**

Description	Regulatory Framework	Actor	2020	2021	2022	2023	2024	2025	Estimated Costing
Improve policy, legal and regulatory framework to ensure the provision of safe water supply and sewerage services to all inhabited, commercial/industrial and tourist resort islands (W&S SAP Strategy 1.1)									In MVR
a) Water and Sewerage Act ratified (8/2020) (Action 1.1a)									
b) Promulgation and promotion of the Water and Sewerage Act		MoEnCC&T URA							GoM
c) Develop, introduce and enforce water and sewerage regulations, policies, standards, specifications and guidelines required under Water and Sewerage Act (Action 1.1b)		MoEnCC&T EPA URA MoH							GoM donors
d) Develop national drinking water quality standards (Action 1.1c)		MoEnCC&T/URA							620,000
e) Develop and enforce national quality standards for sewage and wastewater disposal (Action 1.1d)		MoEnCC&T							775,000
f) For infrastructure development and in land use- develop and enforce a regulation to include groundwater recharge mechanisms and (rain)water storage. (Action 1.1e)		MoEnCC&T LGA Councils							232,500
g) Utility Regulatory Authority (URA) for integrated utility services established (Action 1.1g)		MoEnCC&T/PO							GoM
h) Technical committee develops benchmarks for utility performance (technical, water quality, financial) (to be revised every 5 years) (Action 1.4c&d)		MoEnCC&T URA							GoM 310,000
i) Enhance sector-wide collaboration and establish a Water and Sanitation (WATSAN) Sector coordination committee (Action 1.1f)		MoEnCC&T							GoM
j) Organize Joint Sector Review in two-to-three-year intervals to review progress and refresh		MoEnCC&T							465,000

targets										
								Subtotal	MVR	2,402,500

### Component 2 Implementation and upgrading of water supply and sewerage infrastructure

Description Establishing WS&S Infrastructure	Actors	2020	2021	2022	2023	2024	2025	Estimated Costing
Establishment of cost-effective, climate resilient water supply, sewerage and treatment facilities in all inhabited islands, integrating IWRM in concept and design and in consultation with the Island Council								In MVR
a) Design and implement water supply and sewerage infrastructure in all inhabited islands (Action 2.1a)	MNPHI							4.7 billion
b) Assess the status of the FGL in all islands and identify locations for managed aquifer recharge (MAR), sustainable drainage (SuDS) (Action 5.1a&c)	MoEnCC&T							GoM
c) Develop and implement water resource conservation and management plan in all the islands (Action 5.1.b)	MoEnCC&T Island Councils							GoM 15,500,000
d) Review existing water supply and sewerage system design specifications and assess current operations (Action 2.1c)	MoEnCC&T URA							GoM
e) Upgrade and retrofit existing water supply systems, including IWRM, rainwater harvesting and groundwater aquifer recharge with improved technology, and renewable energy. (Action 2.1 b, 2.1c & 2.1d)	MoEnCC&T URA EPA							GoM 10,230,000
f) Evaluate existing sewerage treatment plants and identify environmentally friendly sewerage treatment options of low operational, maintenance and management cost (Action 2.1e)	MoEnCC&T EPA URA							GoM 310,000
g) Develop a suitable technical solution for managing sludge at sewage treatment facilities (Action 2.1f)	MoEnCC&T							GoM 775,000
h) Ensure water and sewerage systems	MoT							GoM

established in commercial/ Industrial islands and tourist resorts are in compliance with Water and Sewerage Act (8/2020) (Action 2.1h)	MoEnCC&T MoFMRA								
						Subtotal	MVR	4,726,815,000.00	

### Component 3 Creating resilience and water security through water and sanitation safety plans and water quality testing

Description	Water and Sanitation Safety Plans	Actors	2020	2021	2022	2023	2024	2025	Estimated Costing
Develop water and sanitation safety plans for each island, that focuses on water security and reliability of service.									In MVR
a)	Develop island-wide water and sewerage safety plan (W&SSP) and national water resource management plan (Action 1.4a & 1.4b)	MoEnCC&T URA Councils							232,500
b)	Organize Master Trainers programme for W&SSP for sector staff, service providers and Island Council representatives	MoEnCC&T							1,240,000
c)	Develop regional water quality testing and surveillance capacity through establishment of laboratories or collaboration with certified local laboratories, in RUCs in line with National Spatial Plan (Action 1.4e)	MoEnCC&T URA councils							7,750,000
d)	Conduct national data collection and monitoring of the quality of freshwater resources (Action 5.2a)	MoEnCC&T Island Councils							2,325,000
e)	Develop and standardize parameters for groundwater quality in all monitoring activities. (Action 5.2b)	MoEnCC&T							232,500
f)	Accurately map and identify flood prone areas in islands and Develop design criteria and technical specifications for disaster proofing of critical water supply and sewerage infrastructure (Action 6.1a & 6.1b)	MNPHI							232,500

g) Develop and implement National Potable Water Security Plan (Action 1.4f)	MoEnCC&T								310,000
h) Ensure delivery of safe drinking water to vulnerable islands during droughts and emergencies. (Action 1.4g)	MoEnCC&T								GoM
i) Incorporate flood mitigation and minimization measures in public infrastructure such as roads, reclamation projects, harbors, coastal protections, high rise buildings etc. (Action 6.1c)	MoEnCC&T								GoM
							Subtotal	MVR	12,322,500.00

#### Component 4 Benchmarking for improved performance

Description	Promoting cost-effective operations	Actors	2020	2021	2022	2023	2024	2025	Estimated Costing
Provide Water and Sewerage services through a comprehensive utility service provision model and decentralize the utilities to improve cost-effectiveness (W&S SAP Strategy 1.2)									In MVR
a) Develop benchmarked mechanism for operation & maintenance, and asset management of water supply and sewerage systems (Action 1.2c)		MoEnCC&T URA							310,000
b) Throughout the year, conduct random regulatory, financial and technical audit of at least 20% of utility operations in the islands and report to regulatory authority (Action 1.2a)		MoEnCC&T URA							GoM 465,000
c) Develop and enforce a tariff model for water and sewerage services, considering affordability at island level (Action 1.2b)		MoEnCC&T URA MoF							GoM
d) Develop and introduce a private sector investment framework for development of water and sewerage facilities (Action 2.2a)		MoEnCC&T							GoM
e) Develop mechanisms to verify and provide an efficiency rating schemes for water saving devices and appliances (Action 2.2b)		MoEnCC&T							GoM
							Subtotal	MVR	775,000.00

**Component 5 Strengthen advocacy and awareness programs on water resources, water supply and sewerage**

Description	Advocacy and awareness	Actors	2020	2021	2022	2023	2024	2025	Estimated Costing
Promote public awareness on water resources management, water supply and sewerage services, and O&M costs									In MVR
a)	Refresh and roll out FENFAHI (national awareness) campaign (Action 4.1a)	MoEnCC&T							1,627,500
b)	Leverage mainstream media for promoting water resource protection and safe water and sanitation practices, with a focus on youths (Action 4.1b)	MoEnCC&T MoCST HPA							GoM
c)	Conduct a nationwide campaign on promoting [consumption of] piped water and household treated water to phase out single use plastic bottles (Action 4.1c)	MoEnCC&T Service Providers							1,395,000
d)	Carry out orientation programs on WASH awareness to Island Council members, women groups and CBOs. Provide training to suitable NGO partners to assist and intensify local actions (coordinate with W&S safety plans) (Action 4.1d)	MoEnCC&T Island Council							1,860,000
e)	Provide orientation and training on WASH to management of local hotels and guesthouses, to enhance responsible use of water resources.	MoT MoEnCC&T Island Councils							620,000
							Subtotal	MVR	5,502,500.00

**Component 6 Raising Human Resource Development for a vibrant WATSAN Sector**

Description	Human Resource Development	Actors	2020	2021	2022	2023	2024	2025	Estimated Costing
Build human resource capacity required for water and sewerage system operations, maintenance and management (Strategy 3.1)									In MVR
a)	Undertake a needs assessment for the water and sanitation sector (Action 3.1a)	MoEnCC&T MoHE							465,000
b)	Develop water and sewerage engineering courses at national level (Action 3.1b)	MoHE MNU							15,500,000
c)	Prioritize trainings required to meet the water and sanitation sector needs in national scholarships and	MoHE							GoM



**Component 8 Develop and strengthen research and evidence on water supply and sewerage**

Description	Evaluation and Research	Actor	2020	2021	2022	2023	2024	2025	Estimated Costing
Strategy 1.3: Improve research and evidence on water and sewerage sector to support policy making									In MVR
a) Integrate and update data on the water and sewerage, and publish the data through a web-based public platform (Action 1.3a)		MoEnCC&T							1,440,000
b) Develop collaborative partnership arrangements with international educational institutes for capacity building in water and sewerage sector services (Action 3.2a)		MoEnCC&T							378,500
c) Develop and introduce incentive mechanism to adopt climate resilient and environment friendly technologies to water and sewerage sector (Action 2.1g)		MoEnCC&T							387,500
d) Develop and Implement an E-Library for dissemination of publications and studies done on water and sewerage in Maldives in collaboration with NDC (Action 1.3b)		MoEnCC&T							310,000
e) Conduct climate modelling under different emission scenarios for natural water resources (Action 5.2c)		MoEnCC&T							
							Subtotal	MVR	2,516,000.00

## 9.6 Investment plan

An indicative estimated costing for the period 2020-2025 is given in below table, based on the activities provided above (8 components). The investments are reasonable estimates for costing of the activities planned.

Note that above table refers to GoM when it is assumed that activities are part and parcel of regular government activities that can be financed from government budget allocations. Funds are indicated for consultancy services, development of training programmes, costs of research and studies and ICT services. Infrastructure investment is by far the largest component.

Table 3 Indicative costing for investment in the period 2020-2025

Component 1: Regulatory Framework	2,402,500.00
Component 2: Implementation and upgrading of water supply and sewerage infrastructure	4,726,815,000.00
Component 3 Creating resilience and water security through water and sanitation safety plans and water quality testing	12,322,500.00
Component 4: Benchmarking for improved performance	775,000.00
Component 5: Strengthen advocacy and awareness programs on water resources, water supply and sewerage	5,502,500.00
Component 6: Raising Human Resource Development for a vibrant WATSAN Sector	19,685,000.00
Component 7: Monitoring, sector information and data management portal	775,000.00
Component 8: Develop and strengthen research and evidence on water supply and sewerage	2,516,000.00
<b>Grand Total in MVR</b>	<b>4,770,793,500.00</b>

## Chapter 10 Water and sewerage masterplan 2026-2035

### 10.1 Moving from service development to upgrading and sustainable, cost effective services

The water and sewerage masterplan is a continuous, rolling plan that does not distinguish really between 5 or 10-year plans. The current split between a five-year bloc and a ten-year subsequent period reflects the fact that a Water and Sewerage Act was ratified in 2020 and received its first implementation plan through the National Water and Sewerage Strategic Plan (NWSSP 2020-2025). It was then decided to have the next component of the Master Plan to last for a ten-year period. This would allow for a review and evaluation of achievements by 2030, coinciding with the reporting on the Sustainable development Goals, and the start of the preparation of a fresh ten-year Master Plan up to 2045, dovetailing neatly on the previous masterplan that would conclude by 2035.

The Master Plan has as objective to anticipate and implement water and sewerage developments based on government policy (rights-based, equity, gender and environment friendly) and conditions forced upon us by climate, sea level rise, the social and economic situation. The water and sewerage Master Plan also provides a financial framework for planning.

It is anticipated that most islands will soon benefit from piped water supply and sewerage systems and continue on expanding and strengthening the IWRM approach in the islands by augmenting the rainwater component of the public water supply, enhancing managed aquifer recharge to enlarge and protect the fresh groundwater lens, and controlling the water balance in the island by responsible domestic use of treated water and abstractions from the freshwater lens, restrictions on larger abstractions for economic activities (guesthouses, agriculture, etc.). Wastewater treatment systems may not have been built everywhere in 2025 and research into smart solutions for treating sewage, recovering water for infiltration and reducing discharge off the reef will be required.

The period 2021-2025 will have set in motion a lot of support activities for sustainable and resilient water supply and sewerage. Most activities will need to be sustained to upgrade aging infrastructure, improve the business model through increasing use of renewable energy and counter climate change related hazards,

The challenge for the period 2025-2030 will be complete the restructuring of the WATSAN sector and ensure SDG proof services in water supply and sewerage for all. That is certainly doable but will require smart financing and fair payment for services. It will also require the realization of business models that are suitable for the island and service provider, and that reduce the dependence of the Island Council for subsidy to keep the water and sewerage services in good stead.

The services model will move from an emphasis on construction and establishment to one that operates the services and maintains the hardware in the services area and the treatment plant. Thus, overall costing for the water supply and sanitation sector will fall substantially in the period 2025-2035. Emphasis will be on providing cost-effective services, further raise cost effectiveness through smart measures, increased use of ICT, promotion of water saving appliances and consumer relations that highlight the importance of responsible use.

It is expected that the Island Council and the service provider will be able to hire and retain well-qualified operators and plumbers to maintain the systems. Water security will be raised by application of water safety plans that are forward looking with respect to functionality and risk, and that consider the social and economic needs of the island community and their guests.

## 10.2 National Spatial Plan

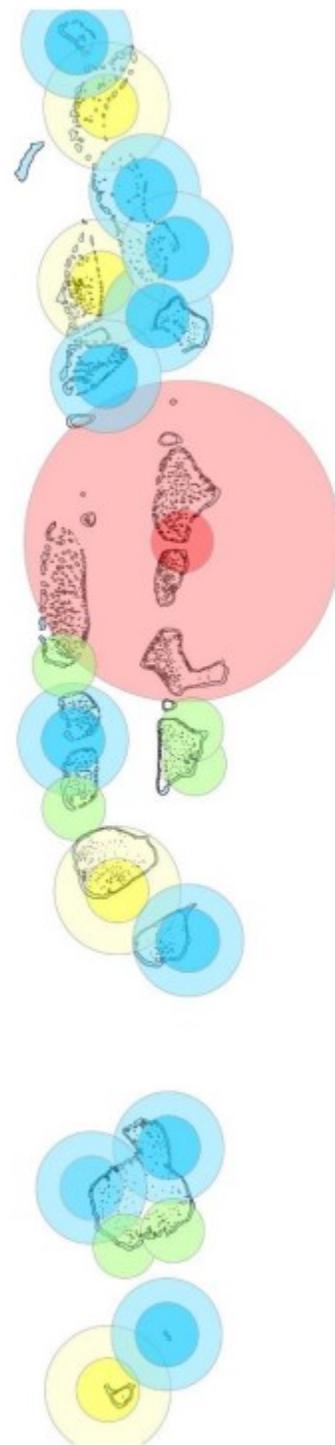
In November 2018 Government has developed and launched its Strategic Action Plan. This 5-year Plan includes inputs and commitments from different sectors which also includes means to identify how actions are aligned with the SDGs, the government’s Manifesto, and presidential pledges. Its objective is to “Transform[ing] Maldives to an Equitable, Prosperous, Inclusive, Connected Island Nation”.

### Strategic Spatial Development

A spatial development model to reduce socio-economic disparities across the archipelago of Maldives

Following the launch of the Strategic Action Plan, the 8th National Development Plan is being drafted. This Plan includes broader policies for development. SDGs are reflected and embedded into the Plan, which will act as a long-term strategy document that the country utilizes to address development priorities, ensuring the country’s commitment to successfully achieving the SDGs by 2030.

While the National Development Plan acts as a guiding document for the central government and local island councils and give priority to include the SDGs in its development plans at sectoral, regional and local levels, The Government of Maldives is also preparing to endorse a National Spatial Plan (NSP) which covers a timeframe of 20 years



from 2020-2040 integrating, the broad principles and goals of SDGs and lays out a roadmap for infrastructure and socio economic developments with the theme of “integrating People, Islands and Development”. (see also section 2.2)

The National Spatial Plan is expected to facilitate the timely realization of SDG goals as well as other national and international commitments of Maldives. The Spatial Plan also focuses on regional development and access to services and facilities through connectivity, helping to reduce the disparities in the quality of life between the capital city and the rest of the country.

It is a people centric Plan, which is very much focused on ensuring that no island, no person is left behind in the development and is ambitious in its target to break away from the current centralized development approach.

Maldives intends to achieve sustainable, decentralized, climate resilient and inclusive, regional and national development through developing hierarchies of well-connected development hubs across the country which will bring higher order services (such as tertiary healthcare and education) closer to all peoples of the country. It will improve competitiveness, resilience and livability of all areas.

### **10.3 Demographic and economic developments**

Through a variety of policy instruments and declarations, the Government works towards an “Equitable, Prosperous, Inclusive, Connected Island Nation”. The National Spatial Plan is an important instrument that defines the settlement hierarchy, the communication linkages and the services required at strategic locations to bring about equitable and inclusive development.

#### **Cities**

Male’, the regional urban centers and the sub-regional centers will require extra consideration with respect to water, sewerage and wastewater treatment, as these centers will host additional government and commercial establishments, and may also require additional accommodation and hospitality facilities for temporary stay by locals and for foreign guests and expatriate staff.

Table 4 lists the cities that are part of the spatial decentralization and their known connections to electricity, water and sewerage. Further investments are needed to bring several of the new cities up to acceptable level of service. Some projects are already underway. In the ‘water’ column, “yes, RO”, means that services are probably by tap bay, rather than piped into the house through a network. Where services are available, water and sewerage are lagging in connections with respect to electricity in several locations. This will need attention in the period 2025-2035.

Table 4 Current utility services in (sub) regional cities

	Island	Population	No of connections of utility services		
			2020 est	electricity	water
HA	Ihavandhoo	3,051	631	122	344
HDh	Kulhudhuffushi	10,001	2,508	1,675	MWSC
Sh	Funadhoo	2,493		yes, RO	498
N	Manadhoo	1,650	466	yes, RO	309
R	Dhuvaafaru	1,696		560	MWSC
B	Eydhafushi	2,894	910	yes, RO	670
Lh	Naifaru	4,715	1,471	870	
V	Thinadhoo	296	91 Stelco		
F	Nilandhoo	2,042	460		370
Th	Thimarafushi	1,342	379	yes, RO	420
Gn	Fuvahmulah	9,873	2,895	yes, RO	2,201
S	Addu City	25,043	9,856	yes, RO	723

Generally, for all the islands that are to function as decentralized urban service centers, the capacity and quality of the water and sewerage services need to be reviewed carefully, considering planned developments. Government may have to allocate additional funds to facilitate improvements in water supply and sewerage over and above the requirement of the current population. To enhance sustainability of services, full and effective connections to water supply and sewerage are desirable, together with affordable rates that reflect at least cost recovery of operations. Island councils and service providers should find ways to ensure this essential aspect of community service provision.

Depending on the island economic and social situation, the population normally resident in the island will change. The Island Council needs to assess the increase or decrease of the population in the next decade based on economic prospects. On the basis of that assessment, it should adjust the water supply and sanitation facilities. Also should focus not to overdesign services as this will increase investment and operational costs, and thus water rates.

### Islands

Under the decentralization act, upon completion of the water supply and/or sewerage system and its handover to the Island Council, the council will contract a service provider manage the operations. Annually the financial status of the operation will be reported to the council, and a workplan and budget for the coming year will be submitted for discussion.

In the islands status and development potential needs to be considered by the Island Council and the service provider to assess the upgrading and expansion requirements in water supply and sewerage. In most islands sewage treatment plants may still need to be constructed as well beyond 2025.

Most important will be the management and upkeep of the existing systems. This will require suitable tariffs and efficient staffing. Nationally funds also need to be set aside as a Trust Fund for major (unforeseen) repairs and improvements from which islands can borrow at reasonable conditions.

The guesthouse sector has emerged in recent years on the islands. The number of guesthouses has grown rapidly since the Government's policy change, and currently totals nearly 240 facilities with around 3,600 rooms. Moreover, the sector is projected to double in the next three years as global travel trends shift from luxury toward mid-level travel services with growing use of self-catering accommodations instead of traditional large hotels. As internal travel in Maldives is further improving, the number of Maldivian guests from Greater Male' will increase for short breaks.

There also appears to be a greater interest in agriculture and growing of vegetables. Where these developments are likely to demand the use of fresh water, this needs to be included in the water balance assessment.

All these aspects can be incorporated in the water and sanitation safety plans and need to be considered from the perspective of raising water security and climate resilience.

### **Tourist resorts**

Tourism-led growth in Maldives has followed an enclave model, reliant on imported goods, labor and finance, and providing luxury services at high rates. The luxury tourism sector yields a substantial income to the national treasury through rental of islands and tourist tax. Though most staff employed in the resorts are regional expatriates, it is expected that more Maldivians will be hired in this lucrative sector in the coming years. The tourist resorts further require a good supply of vegetables and fish which can be purchased from reliable local businesses.

The quality of the holiday experience is vital to the island resorts. Thus, water supply and sewerage are to be of impeccable quality. Abstraction of water for the Reverse Osmosis plants and discharge of brine and treated wastewater should be such that it does not cause degradation of the marine environment. So far, monitoring of the resorts has been occasionally done by the Ministry of Tourism. The Water and Sewerage Act (8/2020) requires that tourist resorts are in compliance with current regulations and this will be instituted by 2023.

URA will also maintain a full set of licensing data (including EIA) and an overview of the water supply and sewerage systems: the water sewage treatment technology and equipment used, their date of installation and substantial replacements. Water quality and wastewater quality data will be monitored on site and reported at least once a month. Upgrading and changes in technical components will normally be subject to an environmental impact assessment.

Tourist resorts will also be required to meet the benchmarks indicated by URA and report on these to the national WATSAN portal.

Rather, the resorts will want to move further on responsible water use, treatment of wastewater and some reuse of treated water for kitchen gardens and vegetation, installation of solar panels and other relevant measures that are part of promoting sustainable, responsible tourism.

From a public health perspective, and as Maldives is the ultimate host of the tourists arriving for a holiday, water quality testing and other measures that fall under the MFDA with respect to food safety of food stuffs and kitchen operations, will be monitored and reported as needed.

### **Industrial islands**

Water and sewerage systems in use in industrial islands or commercial settings will be subject to compliance with Water and Sewerage Act (8/2020). URA will license and monitor the quality of services according to the description given for tourist resorts. The National Spatial Plan appears to be making space for additional agricultural and industrial activities. These activities need to be guided and managed well by EPA for EIA and by URA during operation of the plants to ensure that negative consequences do not occur for the island and surrounding marine environment.

### **10.4 Climate change resilience, incl. protecting (waste) water treatment plants**

Climate change will have growing effects on living in Maldives. Changes in the rainwater pattern and the growing sea level rise, with increasing risks of flooding and inundations of the islands, means that water security needs to be ensured by a mix of greater storage capacity of drinking water in the island, raising the level of the RO plant above flooding level, and increased power supply generated by solar energy.

Collection and storage of domestic rainwater will remain important to ensure sufficient freshwater at home. Stocking up on RO water in domestic rainwater tanks in the latter part of the dry season, when solar power is amply available and water rates may be reduced as a relief measure, is likely to be efficient. Even better if the rainwater tanks are safely above flooding level.

Monitoring the effects of climate change and keeping tab on its consequences will require regular assessment of the climate change risks to water supply and sewerage systems and treatment plants. Studies such as the Multihazard Risk Atlas of Maldives provide useful guidance for medium and longer-term planning and risk assessments with respect to rainfall and the effects of sea level rise. (ADB, 2020)

### **Changes in rainfall and rainfall pattern**

The Multihazard Risk Atlas of Maldives Volume II presents the climate and geophysical hazards to be expected from now till 2050. Several charts also present the rainfall pattern across the nation based on two scenarios: RCP 4.5: moderate greenhouse gas emissions) and RCP 8.5: higher greenhouse emissions. For details refer to the Atlas.

<https://www.environment.gov.mv/v2/en/download/10458>

The conclusion of the two scenarios is fairly similar. The North will become wetter, while in the RCP 8.5 scenario the southern atolls will also receive a little more rainfall. Seasonal changes are also not substantial, although the risk of longer droughts in the North may need to be considered. By 2030 Hulhule may experience an average of 2010 mm/y, and Gan 2400 mm/y.

The southwest monsoon runs from mid-May to November. In this season Maldives experiences torrential rain. In future rain is likely to fall in less days with greater intensity. (Ministry of Environment and Energy, 2016) This will cause greater run-off to the sea unless there are better collection methods and greater managed aquifer recharge capacity. Islands need to experiment with engineering measures that optimize retention of rainwater on the island even during downpours.

Maldives Meteorological Survey should be consulted to obtain better planning data for annual rainfall and for seasonal projections. The latter could help to (1) determine the extra RO capacity required or -if extra capacity is not considered- (2) get consumers to accept a slight reduction in service during prolonged drought.

### **Sea level rise**

Sea level rise is going to affect Maldives in the period 2030-2050. Since establishment of tide monitoring stations in Male' and Gan in 1989 and 1992 respectively, a rise in sea level of 3.753 and 2.933 mm per year in Male' and Gan respectively have been measured (Ministry of Environment and Energy, 2016)

The combined impact of both rainfall and SLR shows a decrease in lens thickness by 2050, ranging from 0.11 m (600 m islands in Region 1) to 0.58 m (200 m islands in Region 3). For larger islands the impact is substantially smaller than for islands with a width smaller than 400 m. (Deng & Bailey, 2017)

The substantial effect on the FGL in smaller islands may be too costly to overcome and will at least require a substantial subsidy for RO water. It may lead to people ultimately abandoning the island.

## **10.5 Water and Sanitation Safety Plans and Regulation**

The composite water and sanitation safety plan has been described in annex 1. During the period 2025-2035 the application of the W&SSP will prove its mettle in maintaining water quality, raising water security and developing a medium-term climate proofing programme of all components of the water and sewerage systems. A well-developed plan will empower the community to contribute to upkeep and functionality of the systems and mobilize resources to ensure water security through robust, no-regret climate resilience measures and practices.

Developing workable local water and sanitation safety plans need good leadership from the Island Council. It requires time to engage the island community and to formulate and agree on actions and good practice with respect to ensuring sustained functionality. Measuring changes

in the community, taking photographs of undesirable conditions, listening and acting upon complaints or concerns, whether from the young or the old, from the powerful or the infirm, all needs to be included in the spirit of the SAP 2019-2023 and the realization of *Jazeera Dhiriulhin*.

URA will monitor and provide advise on W&S Safety Planning.

### **Water quality surveillance**

Water quality surveillance and sanitary inspection of the water supply conditions at the home will continue to be part of the public health role in protecting the people’s health. Between 2025 and 2035 improvements in water quality testing will enhance the role of the island hospital and its public health staff to perform regular water quality surveillance at critical points. As operational water quality tests by the service provider will be part of weekly reporting to the WATSAN database, algorithms can be developed to detect trends that indicate a deterioration of water quality.

### **Integrated Water Resources Management**

Restoration and protection of the fresh groundwater lens is an essential part of IWRM in the islands. Hydrogeological mapping is necessary where possible to map, model and quantify the stored volume and average annual replenishment of groundwater, while determining its chemical quality in the context of WHO parameters and guidelines..

## **10.6 Consumer education and demand management**

It takes an effort to change the behavior of the people. Therefore, the activities described in chapter 6 as part of FENFAHI remain valid and necessary. Depending on changes in society and environmental necessities, the campaign may need to address demand management, responsible use of water and continued emphasis on integrated water resources management in different creative ways. Youngsters will have been exposed to these concepts in their schooling and so more advanced, multi-pronged messaging may be required.

An important objective of the FENFAHI campaign will be sustaining the willingness in the islands to connect to the water and sewerage networks and use the service to the extent that the services can continue to function without the need to request subsidy from the central government.

Good consumer relations should be fostered between the service provider and its customers to ensure that a worthwhile business model for the service delivery can exist.

## **10.7 Water Supply Emergency Services**

There are many disasters that can hit the islands in Maldives. These range from rain-induced flooding; tsunamis; big waves or *udha*; and combined wave, rain, and wind hazards. In addition, there is the slow-onset drought that can cause general shortage of fresh water in the island.

On the islands disaster preparedness is an ongoing process of infrastructure development and regular review of anticipated disaster scenarios. Water supply is part of the critical preparedness for survival and recovery. The National Disaster Management Authority recommends water and sewerage plants to have elevated floors. During a disaster, the island population will be themselves the first responders. Outside assistance will take time to arrive. Safe drinking water for the population and for the hospital will be critical. A reserve elevated storage, safe from the disaster or disruption, should be placed at strategic points in the island. NDMA and MMA will usually be able to advise days or hours before about impending hydrometeorological hazards. An emergency protocol needs to be in place for the service provider to ensure that sufficient drinking water is stored and that the water treatment plant is secured. To ensure quick recovery good operational status of the water supply and sewerage system is essential. The emergency protocol needs to be trained and tested a few times during the year. Adjustments need to be made to overcome shortfalls.

Each year several islands fall short of drinking water at the end of the dry season. When all islands have a reliable piped RO water supply system, then these periods of water shortage may not occur regularly. The Ministry of Environment, Climate Change and Technology has put in place a Potable Water Supply Security Operation Plan that aims to create greater control and advance warning in case of drought or natural disasters. In addition to a decentralized water supply system that can supply bulk or bottled water it suggests portable RO plant that are able to produce water onsite. “Do no Harm” or better! approach to island and marine ecosystem protection

The Water and Sewerage Masterplan will benefit from integration and collaboration with other policies and plans that the Government of Maldives is implementing to raise climate change resilience. The Water and Sewerage Masterplan 2021-2035 is following the National Strategic Action Plan. The NSAP has a strong focus on making the island less dependent on central government.

The 8<sup>th</sup> Development Plan and the National Spatial plan aim to generate additional strength and capacity in the outlying islands. Functioning, reliable utilities in each of the islands as critical to sustainable development.

There will always be tension between the need to protect the island through IWRM and keep the surrounding marine ecosystem in good shape for fish development and to offer tourist sightseeing opportunities. The Island Council needs to balance the demands of all parties, whether these can speak for themselves or not. Managing waste and wastewater, treating it before discharge at suitable outfall into the nearby sea is going to be a critical concern for the island council. It will cost money, but when done consistently it will save the future.

As mid-level tourism is becoming more important, the heritage of the Maldivians looking after the health of their islands and keeping their surroundings pristine, will become critical to

attracting responsible tourists. Tourism offers opportunities to improve coral growth, teach about the marine wealth and engage tourists in ‘blue water’ protection. Showing tourists how the island is holding itself against the threat of climate change may also be of interest and offer guidance on how to “Do no harm” while enjoying the activities and interaction the island has to offer.

### 10.8 Financing and budget allocations

In the following pages the main components of the Master Plan are listed in several tables.

The Plan aims to Ensure equitable access to safe water and improved sewerage services for all. In doing so, it focuses on the

- Provision of efficient, effective and reliable water supply and sewerage services.
- Promotion of conservation and management of the water resources.
- Development of sector capacity for sustainable management of resources and services.

Legend: Development phase; inaugurated/functional; continued implementation



Table 1 Activities and costing of WATSAN masterplan 2025-2035 (8 tables)

**Component 1: Regulatory Framework**

Description	Regulatory Framework	Actor	2026	2028	2030	2032	2034	2035	Estimated Costing
Monitor effectiveness and safe water supply and sewerage services to all inhabited, commercial/industrial and tourist resort islands									In MVR
a) Review water and sewerage Act, regulations, standards and Guidelines		MoEnCC&T URA							GoM
b) Technical committee reviews benchmarks for utility performance (technical, water quality, financial) and formulates future application		MoEnCC&T URA							GoM 500,000
c) Organize Joint Sector Review in three-year intervals to review progress and refresh targets		MoEnCC&T							465,000
							Subtotal	MVR	965,000.00

**Component 2 Sustainability, Upgrading and Repair of water supply and sewerage infrastructure**

Description Sustainability, Upgrading and Repair	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Focus on functionality and asset management, retrofitting and upgrading to ensure cost-effective, climate resilient water supply, sewerage and treatment facilities in all inhabited islands								In MVR
a) Retrofitting, upgrading and repair promoting cost-effective treatment, new technologies, reducing NRW and achieving >80% renewable energy	MoEnCC&T							GoM
b) Assess the status of the FGL in all islands and identify locations for managed aquifer recharge (MAR), sustainable drainage (SuDS)	MoEnCC&T							GoM
c) Development of decentralized water hubs for emergency water supply	MoEnCC&T							GoM
d) Environmental friendly, low capital and operational cost sewerage treatment plants are operational in all inhabited islands and in industries	MoEnCC&T							GoM
e) Procure 4 containerized, solar powered emergency water supply units	MoEnCC&T							4,428,000
					Subtotal		MVR	4,428,000.00

**Component 3 Creating resilience and water security through water and sanitation safety plans and water quality testing**

Description	Water and Sanitation Safety Plans	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Water and sanitation safety plans established for each island, with focus on water security and reliability of service.									In MVR
a)	Develop an awarding scheme for green labelling of environment friendly water and sewerage infrastructure and services	MoEnCC&T							GoM 465,000
b)	Expand regional water quality testing and surveillance capacity through establishment of laboratories or collaboration with certified local laboratories, in RUCs and subcentres	MoEnCC&T HPA							15,500,000
c)	Monitor selected ground water quality parameters in all islands and include in WATSAN database.	MoEnCC&T							232,500
d)	Implement National Potable Water Security Plan	MoEnCC&T							7,750,000
							Subtotal	MVR	23,947,500.00

**Component 4 Benchmarking for improved performance**

Description	Promoting cost-effective operations	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Provide Water and Sewerage services through a comprehensive utility service provision model and decentralize the utilities to improve cost-effectiveness									In MVR
a)	Develop a business model for service provision	MoEnCC&T/URA							620,000
b)	Sustain and monitor benchmarked mechanism for operation & maintenance, and asset management of water supply and sewerage systems	MoEnCC&T/URA							310,000
c)	Throughout the year, conduct random regulatory, financial and technical audit of utility operations in the islands and report to regulatory authority (Action 1.2a)	MoEnCC&T/URA							7,750,000
						Subtotal	MVR	8,680,000.00	

**Component 5 Strengthen advocacy and awareness programs on water resources, water supply and sewerage**

Description	Advocacy and awareness	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Promote public awareness on water resources management, water supply and sewerage services, and O&M costs									In MVR
a)	Evaluate impact of FENFAHI campaign and update messaging and media								465,000
b)	Roll out FENFAHI (national awareness) campaign	MoEnCC&T							3,100,000
c)	Leverage mainstream media for promoting water resource protection and safe water and sanitation practices, with a focus on youths and social media	MoEnCC&T							GoM
d)	Carry out orientation programs on WASH awareness to Island Council members, women groups and CBOs. Provide training to suitable NGO partners to assist and intensify local actions	MoEnCC&T Island Council							3,100,000
							Subtotal	MVR	6,665,000.00

Note: The national awareness campaign will need to result in a change of behavior with respect to hygiene and environment on the islands, responsible use of water and reduction of waste, demand management. This can only be achieved through a sustained campaign further strengthened by regular policy statements (from various corners and influencers), inclusion of relevant aspects in the school curricula, and public events that generate positive pressure to change habits. Availability of technical solutions such as water saving devices and simple ways for growing hydroponic vegetables, etc. should complement the package and facilitate the changes. Annual island-level competitions for environment-friendly applications to homes and guesthouses may be organized by the island council with the assistance of local NGOs or women’s groups.

**Component 6 Continued Human Resource Development for WATSAN**

Description	Human Resource Development	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Build human resource capacity for the water and sewerage sector									In MVR
a)	Offer water and sewerage engineering courses at national level (10 BSc engineers a year)	MoHE MNU							6,720,000
b)	Facilitate MSc. Scholarships overseas in Engineering or Environmental Science to graduates	MoHE donors							GoM
c)	Prioritize water and sanitation sector needs in national scholarships and student loan schemes	MoHE							GoM
d)	Continue to strengthen quality of training and career development through certification and licensing for technical staff working in water and sewerage	MoEnCC&T URA							GoM
e)	Train and license all technical staff operating and maintaining the water and sewerage facilities to at least TVET certificate level 3 qualification and provide continuing training opportunities	MoEnCC&T Service Providers							GoM
f)	Conduct trainings specific to Island Councils through online learning system for overall utility operational services, governance and best practices	MoEnCC&T							GoM 3,100,000
g)	Sustain collaborative partnership arrangements with local educational institutes for capacity building of water and sewerage sector programmes and services	MoHE MoEnCC&T							GoM 310,000
h)	Sustain collaborative partnership with local NGOs, CBO's and institutions to support water and sewerage sector programmes and services	MoEnCC&T							465,000
i)	Assess gender balance in the WATSAN sector and evaluate effectiveness of the Gender Action Plan	MoEnCC&T							465,000
j)	Update Gender Action Plan and foster its implementation at all levels of the sector	MoEnCC&T							GoM 310,000
							Subtotal	MVR	11,370,000.00

**Component 7 Monitoring, sector information and data management portal**

Description	Monitoring and data management	Actors	2026	2028	2030	2032	2034	2035	Estimated Costing
Develop monitoring capacity and interactive data management portal									In MVR
a)	Operate and maintain functional, interactive WATSAN database management portal for water, sewerage and integrated water resources management	MoEnCC&T							1,550,000
b)	Monitor water and sewerage services in the islands	MoEnCC&T URA							GoM
c)	Promote remote monitoring and management of systems, using ICT, and wireless sensors and data loggers as appropriate.	MoEnCC&T MNU							GoM
d)	Apply smart solutions to information collection and data management, using smart phones and drones for visual reports and remote sensing	MoEnCC&T							3,100,000
						Subtotal	MVR	4,650,000.00	

**Component 8 Develop and strengthen research and evidence on water supply and sewerage**

Description	Evaluation and Research	Actor	2026	2028	2030	2032	2034	2035	Estimated Costing
Improve research and evidence on water and sewerage sector to support policy making									In MVR
a)	Support a knowledge hub at the MNU Engineering, Science and Technology faculty on current knowledge, experience and research on water supply, sanitation and IWRM	MoEnCC&T MNU							1,440,000
b)	Provide a research and development fund on WATSAN, in particular to test and finetune solutions for Maldivian conditions. Collaborate with regional universities to improve the quality of research. Research can include climate resilient and environment friendly technologies, benchmarking, footprint assessments, etc.	MoEnCC&T							7,750,000
c)	Maintain collaborative partnership arrangements with international educational institutes for capacity building in water and sewerage sector services	MoEnCC&T							GoM
							Subtotal	MVR	9,190,000.00

## 10.9 Investment plan

An indicative estimated costing for the period 2025-2035 is given in above table, based on the details provided above (8 components). The investments are reasonable estimates for costing of the activities planned.

Note that above table refers to GoM when it is assumed that activities are part and parcel of regular government activities that can be financed from government budget allocations. Funds are indicated for consultancy services, development of training programmes, costs of research and studies and ICT services.

Table 6 Indicative costing for investment in the period 2026-2035

Component 1: Regulatory Framework	965,000.00
Component 2: Implementation and upgrading of water supply and sewerage infrastructure	4,428,000.00
Component 3 Creating resilience and water security through water and sanitation safety plans and water quality testing	23,947,500.00
Component 4: Benchmarking for improved performance	8,680,000.00
Component 5: Strengthen advocacy and awareness programs on water resources, water supply and sewerage	6,665,000.00
Component 6: Raising Human Resource Development for a vibrant WATSAN Sector	11,370,000.00
Component 7: Monitoring, sector information and data management portal	4,650,000.00
Component 8: Develop and strengthen research and evidence on water supply and sewerage	9,190,000.00
<b>Grand Total in MVR</b>	<b>69,895,500.00</b>

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## Annex 1 Water and Sanitation Safety Plans

Water Safety Plans (WSP) have been put forward by the World Health Organization as a tool to ensure good water supply in which health risks are properly managed. The WSP concept was developed as an application of the guidance on health-based targets contained in the World Health Organization's *Guidelines for Drinking-water Quality* (World Health Organization, 2017b). Until 2000 the WHO guidelines were mainly followed by urban schemes or rural water supply programmes that could organize water quality testing and surveillance. Small community water supplies around the world would have access to water but have no notion of the quality. Public health officers would occasionally be able to make use of sanitary inspection forms and advise on improvements. Lack of community level understanding and limited capacity among rural water providers meant that water supply was often not quite safe.

Water quality testing and surveillance of rural water supply systems used to be relatively cumbersome and costly. Gradually, with further research and development, easier and better field level testing equipment is available. Knowing whether water is safe is important. However, when a water test fails, it will be necessary to ascertain why that was the case and what can be done to remove the cause.

Water Safety Plans were developed as a participatory approach to identify risks to the water supply from catchment to consumer and set out ways to mitigate, minimise and manage those risks. The WHO/IWA *Water Safety Plan Manual: Step by Step Risk Management for Drinking-Water Suppliers* (Bartram et al., 2009) , provides a practical guide to developing WSPs for organized water supplies managed by a larger water utility or similar entity. This would fit the situation in Greater Male'. Adequate guidance is available from WHO and IWA.

WHO published a WSP guideline for Small Community Water Supplies in 2012 to introduce the concept in settings that have less resources. This approach fits the islands and resort islands better. (World Health Organization, 2012)

In Maldives the authority charged with institutionalizing (the capacity to develop and monitor) water safety plans is HPA. Within HPA the Food and Drug Authority is placed. The Public Health Laboratory functions under FDA. So far, no water safety plans have been developed, although the sector policies and strategies make reference to the necessity to develop these. Consultancy support for the formulation of water safety plan approach for Maldives has been requested from WHO.

### Further development of water safety plans

Over the years water safety plans have been developed for a wide variety of situations. Basically, the water safety plan must be tailored to the situation and so each WSP is unique. The WSP manual acts as a guideline on how to start the process, identify hazards and risks, develop corrective measures to dealing with the hazards, and monitor the process together.

The special situation, hazards and risks encountered in coral islands have not been developed yet in a water safety plan. Climate change concerns have been reflected in a recent WHO WSP manual (World Health Organization, 2017a). The document advises that a simple approach to incorporate climate change in the risk assessment is to assess, based on climate change scenarios, the likely change in the risk over time. It is worth considering the level of risk that is deemed acceptable and identifying control measures that will reduce risks under all potential future climate change scenarios. Recently the Ministry of Environment, Climate Change and Technology has co-published a Maldives regional climate vulnerability assessment outlining the effects of climate change and other drivers on water resources and associated risks by atoll. (ADB, 2020)

The water safety plan approach has also been applied to sanitation. The sanitation safety plan that is envisaged by the WHO publication focuses on safe management of human waste. It assists users to systematically identify and manage health risk along the sanitation chain; and guide investment based on actual risks, to promote health benefits and minimize adverse health impacts.(WHO, 2015) It certainly has several aspects that are of importance to safe management and functioning of sewerage systems that Maldives has built/is building in the islands. In the small islands, often densely populated, poor functioning of the sewerage system will have a direct effect on water quality of the freshwater lens and, potentially, on water security.

Small, low-lying islands in the open sea, face the risk of storm surges and swells which may cause damage and disruption to water and sewerage infrastructure. Disaster events may also disrupt power, generating secondary risks to water security.

### **A composite safety plan for Maldives islands**

In view of the unique situation on Maldives atoll islands, a conceptual approach can be developed (combining the various aspects already reflected in the National Water and Sewerage Strategic Plan) with the requirements to create a multicriteria safety plan for water and sewerage focused on water quality, water security, environmental protection and improvement of the freshwater lens and ecosystem, while keeping an eye on cost-efficiency, climate change adaptation and disaster risk reduction.

The final draft of the Guidelines for Small Drinking-Water Supplies: Policy Guidance and Supporting Tools, urges to consider sustainability, to take a risk-based approach and to customize while developing policy and regulatory guidance for small systems. (World Health Organization, 2021). These aspects are the foundation of the W&S safety plans to be drafted.

The W&SSPs for Maldives islands are proposed to be built up from simple to more complex situations.

A small island with 400 inhabitants, a school, a mosque, a health centre, a government building and a small port has a different complexity than an atoll capital with 2500 inhabitants, institutions and commercial buildings, and guesthouses.

In all cases, the disaster reduction plan of the island needs to be consulted when preparing the W&SSP. When there is no disaster reduction plan, an extra effort needs to be done to incorporate hazards introduced due to weather or climate change into the deliberations and preparation of the plan.

The National Water Supply and Sewerage Strategic Plan has already incorporated most of the elements of the comprehensive W&S safety plan. See tables below for logical details of the elements to be considered when developing the water and sanitation safety plan.

The Water and Sanitation Department will support the W&SSP discussion at island level by preparing a guideline on the W&S safety plan to guide the discussion at island level. This guide should also list specific features and hazards common to all islands, and a catalogue of potential solutions and practices, with their advantages/disadvantages and effort/funds required.

Criteria to be considered when developing a water and sanitation safety plan

### Criteria to be met by the island water supply and sewerage utility system

- **Sufficient** for domestic chores and of acceptable quality (smell, perception) [groundwater]
- **Safe** water for drinking, cooking and food preparation [rainwater or RO-water or hybrid]
- Sewerage system **operating as intended**, with treatment before discharge of re-use of effluent
- **Available at all times** in adequate measure: (1) for all households and guesthouses ;  
(2) Available to commercial establishments ; (3) Available to agriculture and industry (fisheries)
- **Sources:** groundwater, rainwater, RO water → IWRM
- Technical aspects: for production (adequate back-up and storage), process waste removal (brine to sea-outfall), distribution (piped scheme or bottled during emergencies)
- Affordable service (transition to renewable energy, IWRM-based supply)
- Waste water treatment to be installed: treats waste water according to national WWT standards before discharge: issues: flushing water for sewerage rather saline, treatment to be cost-effective/low cost to ensure sustainable use, potential for retention of water for artificial recharge or for re-use in agriculture-depending on salinity.
- Existing septic tanks to be emptied, filled up and sealed.
- Responsible and informed consumers: **direct:** responsible usage, [managing demand] and **indirect:** supporting protection/improvement of the fresh water lens, solid waste and waste water management, other good ecosystem practices, understanding island living as striking a balance between responsible use of island resources and conservation and protection, inclusive of the marine environment.

**Task 2: Describe the water and sanitation services.** The general WHO WSP documents provide adequate information to develop a set of forms that can comfortably be used to describe the

Conditionalitys, risks and threats to consider in climate resilient W&S safety plan

### Conditionalitys and threats associated with island water supply and sewerage utility systems

<p><b>Conditionalitys</b></p> <ul style="list-style-type: none"> <li>• Good and timely management of utility</li> <li>• Good operation and regular maintenance</li> <li>• Funds available through revenue and subsidy, or through project funding</li> <li>• Active human resource development and educational opportunities (nationally) available</li> <li>• Water quality testing and surveillance in place</li> <li>• Availability of up-to-date disaster risk reduction and management plan that includes water and sewerage</li> </ul> <p><b>Weaknesses/risks</b></p> <ul style="list-style-type: none"> <li>• Lack of space for utility facilities incl. additional storage and treatment</li> <li>• Lack of space or conditions for artificial recharge of rainwater</li> <li>• Island council/national government approving local plans that may hinder W&amp;S operations</li> </ul>	<p><b>External threats</b></p> <ul style="list-style-type: none"> <li>• Increase in frequency and extent of flooding events by sea water</li> <li>• Deterioration of reef quality (annual severe bleaching/ASB) and sea-grass presence, reduction in natural protection offered by mangroves, and similar</li> <li>• Increase in frequency flooding events by intense rainfall (and reduced infiltration capacity in the island)</li> </ul> <p><b>Climate change effects</b></p> <ul style="list-style-type: none"> <li>• Changes in rainfall pattern over time (as assessed by relevant CC scenarios) in terms of annual precipitation in mm, its regularity, intensity and occurrence (when assessed in relation to drought conditions)</li> </ul>
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water supply and sewerage systems. For recently completed schemes digitized information may facilitate the collation of these data. However, as built information and important deviations may need to be included while mapping the systems. It is important to link the water supply and sewerage distribution network data topologically to understand where potential risks of cross-contamination may occur. A representative group of stakeholders should undertake the task, under the instruction of the island council and with support from the Water and Sewerage Department and URA and EPA as appropriate.

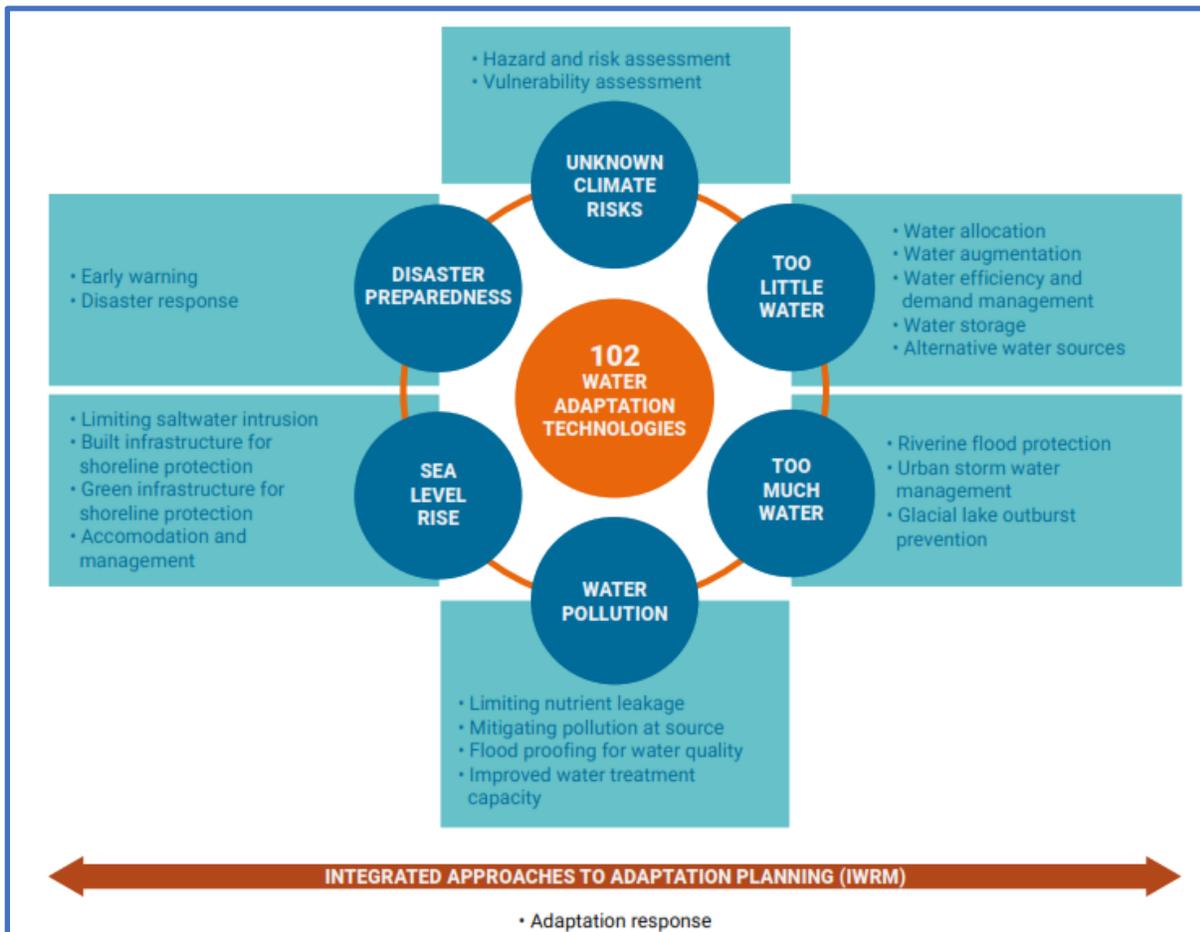
**Task 3: Identify and assess hazards, hazardous events, risks and existing control measures.** Based on the description of task 2 the W&S safety team can work with the island community and its representatives to review potential hazards and events that threaten the short, medium and long-term functionality and quality of the water and sewerage services. The impact of water uses for various purposes, the interaction between economic, social and marine aspects on sustainability and the island ecosystem, and expected climate change effects should be mapped and debated.

**Task 4: List (potential) actions and control measures, give a timeline, identify functionality and economic gains to attract financial and social support.** Weighing the various components of Task 3 based on good to reasonable data and evidence, and public agreement on action and

practice will help to document a sensible W&S Safety Plan, that reflects importance, urgency and regularity of control measures. Measures would need to meet criteria of efficiency, effectiveness, equity, affordability, practicality, legitimacy, synergy and coherence. Where climate change aspects are concerned, flexibility: is the option flexible and will it allow for adjustments in time, is important. As climate change impacts are occurring over time, are time-differentiated impacts adequately dealt with?

The W&S safety plan will be founded on the integrated water resources management concept securing water sources for effective current and future use, and protecting the island and marine ecosystem from contamination and degradation through a robust sewerage and wastewater treatment system. The diagram in the figure below presents elements of the concept, focusing on water.

UNEP published a document that addressed broader water concerns, including those that would be relevant to Maldives. (Bertule et al., 2017)



IWRM & Climate Change Adaptation for water

**Sensitivity check**

Before shortlisting a prioritized pool of adaptation technologies, a final check should be made on their sensitivity to changes under key assumptions. For example, in a multi criteria assessment, it is important to check prioritized technologies' robustness against other chosen criteria or their weights.