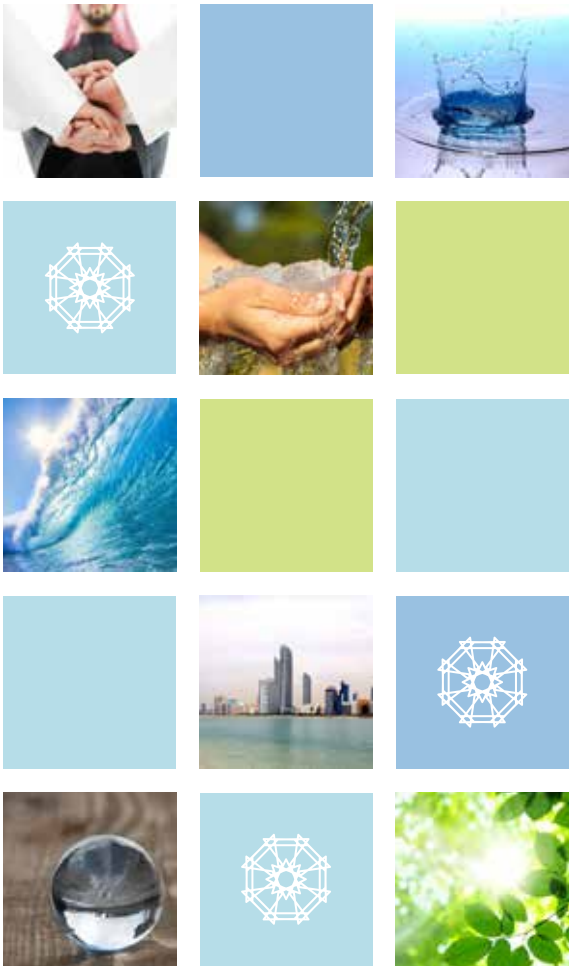
شركة أبوظبي للتوزيع

Abu Dhabi Distribution Co.



5-Year Planning Statement 2019-2023 (Potable Water)

Issued by:
Water Planning Department Asset Management Directorate, ADDC

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Introduction

5-Year Planning Statement 2019-2023

(Potable Water)

1 Introduction

1.1 Purpose of the Statement

1.1.1 Abu Dhabi Distribution Company (ADDC) is a part of Department of Energy (DOE). ADDC was established as a public joint stock company on 25th November 1998, following the unbundling of the vertically integrated water and electricity sector in the Emirate of Abu Dhabi. Registered and incorporated in the United Arab Emirates on 1st January 1999, ADDC is responsible for distributing potable water and electricity services to all customers in the Emirate of Abu Dhabi (excluding the Al Ain region). The Company was established under the provisions of Law No. 2 of 1998. ADDC has an exclusive license to distribute Potable Water, recycled Water and Electricity to consumers in its service area with the operations being governed by its license, issued by Regulation and Supervision Bureau (RSB – now DOE). As per the regulatory requirements, ADDC is required to submit its "Five Year Planning Statement" to DOE every year enumerating its system expansion and reinforcement plans, to meet the growing demand adhering to all security and supply standards per DOE.

The objective of this 5-year planning statement is to produce a medium term plan for the development of Abu Dhabi water distribution system. This plan includes identification of the future water demand of areas operated by ADDC. The extent of the details of the plan includes future water projects in line with ADDC strategy, budgeting, etc., which depends on the information of the existing system as well as the new developments in the region.

This document is also in line with the direction set in Asset Management Policy and objectives defined in the Asset Management Strategy.

1.2 Who We Are & What We Do

1.2.1 Prior to the formation of ADWEA (now it's been merged with DOE), the Department of Water & Electricity (WED) was responsible for all matters related to the sector, including power generation, water desalination, transmission, distribution and supply operations in Abu Dhabi Emirate. The organization was based on a conventional hierarchical system descending from top to bottom like any other Government Department composed of different interrelated sections.

In March 1998, ADWEA has been incorporated by virtue of law No. 2 issued by the Abu Dhabi Government to replace Water & Electricity Department. After establishment, as earlier mentioned, ADWEA dissolved and restructured the vertical & horizontal organizational system of the old WED and implemented a new structure for the water and electricity sector on the first of January 1999.

Now Department of Energy (DOE) supplies potable water, recycled water and electricity to a population of approximately 2.0 million in the Emirate of Abu Dhabi. The management and operation of water and electricity distribution networks within its service area also rest with DOE.

ADDC, a licensee:

- To plan, develop, operate and maintain water and electricity distribution systems to the three geographical regions viz., Central Region, Eastern Region and Al Dhafra (Western) Region excluding Al Ain Municipal Jurisdiction.
- To purchase of potable water & electricity from the Abu Dhabi Water & Electricity Company (ADWEC) through a water transmission system owned by Transmission and Dispatch Company (TRANSCO) and recycled water from Abu Dhabi Sewerage Services Company (ADSSC) and the resale of water (potable & recycled) and electricity to customers within the service area.
- To sell water and electricity to customers in Abu Dhabi Emirate with the exception of Al Ain,

The total service area of ADDC is approximately 47,700 sq. km. ADDC's core business is the planning, design, construction, and operation of the Abu Dhabi water (potable & recycled) and electricity distribution network.

1.3 Vision, Mission & Corporate Values

1.3.1 Vision

ADDC becomes a leading water and electricity distribution and supply company comparable with the top quartile performers worldwide by 2020.

1.3.2 Mission

Plan, develop, maintain, and operate a reliable, secure, safe, and cost effective distribution system in Abu Dhabi and deliver services that meet or exceed our customers' expectations.

1.3.3 Core Values

- Care
- Innovation
- Ownership
- Teamwork
- Transparency

1.4 Strategic Development Plan & Strategy

1.4.1 ADDC's Alignment to Abu Dhabi Plan 2020 Programmes

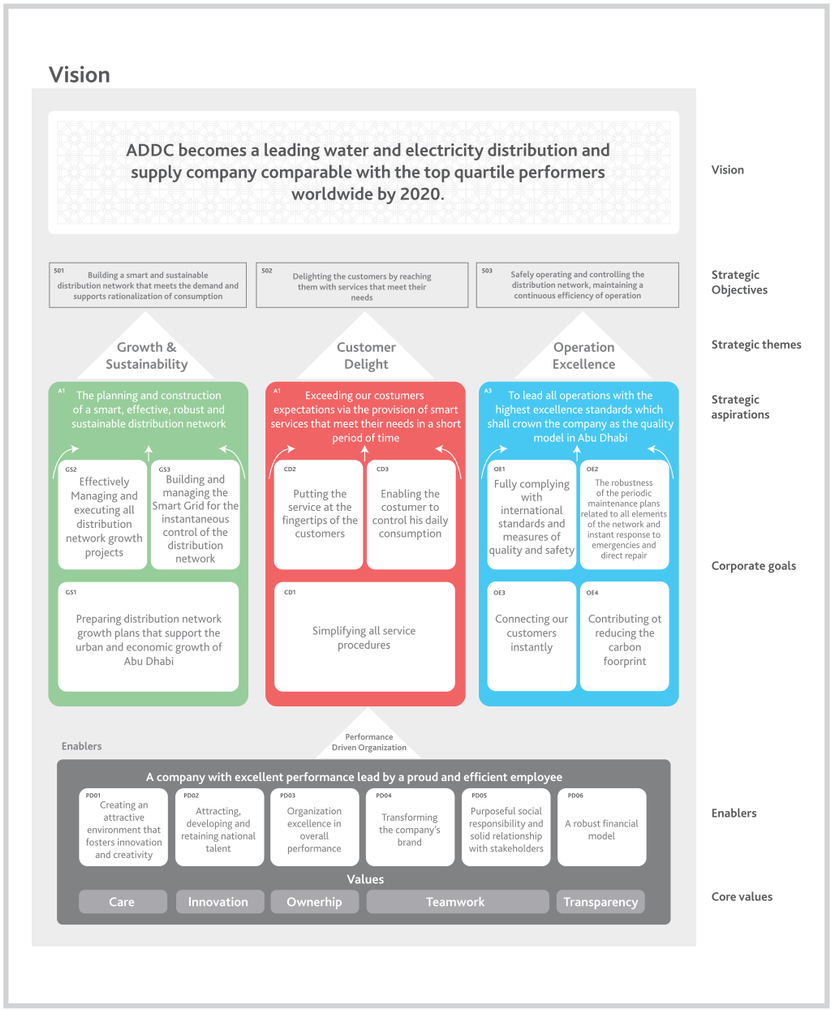
The programmes and goals outlined in Abu Dhabi 2020 Plan provide a blueprint for achieving the government's vision for the emirate. ADDC has aligned all of the company's capital and non-capital projects with the government programmes detailed in the plan, to actively contribute to the prosperity of Abu Dhabi. The process also requires alignment with stakeholders who have leading or supporting roles in the government programmes. The matrix of government responsibility ensures full cooperation between the different stakeholders, especially regarding the active programme management effort exerted by GSEC with other government entities.

1.4.2 Strategy Statement

Our strategic direction is to meet demand growth while enhancing efficiency, meeting or exceeding customer expectations, and building a performance driven organization to create a sustainable business.

ADDC strategy map captures our direction, what we aspire to be, strategic pillars, and approach. It also describes the broad areas that we need to focus on to achieve goals.

Strategic Plan Map 2016 - 2020



The Strategic Plan map is the high level summary of the five years strategic plan of the company, which by itself summarizes the strategic direction of the company in the next five years. It illustrates the logical cascade of goals across the different encompassing strategic themes and the logical link between them. The strategic plan map details the following:

Company's vision:

The vision is the final destination that the company aspires to reach after five years via successfully achieving all of its strategic objectives. Our vision is closely linked to the Abu Dhabi vision and the Abu Dhabi Plan goals 2020. Furthermore, the vision represents the inspirations of the long-term decisions taken by the company.

Strategic goals:

Strategic goals are the five years goals that were put by the company to translate it's vision, mission, government direction, stakeholders requirements especially employees and customers regardless of segmentation.

Strategic themes:

Strategic themes are the contextual frames that foster all of the company's aspirations and organizational goals that are deemed crucial to translate the strategic goals in to reality.

Strategic aspirations:

Strategic aspirations are the priorities that sprouted from our strategic goals, which detail in a practical and logical manner the strategic objectives of the organization.

Organizational goals:

Organizational goals are the primary goals set by the company that when accomplished, the strategic aspirations and strategic goals are achieved and hence the ultimate vision of the company is fulfilled.

These goals are achieved via strategic initiatives, which within them encompasses a number of specialized projects spread across the organization and collectively contribute to the progress of the initiatives. The achievement of these goals is measured by strategic KPIs.

All of the different directorates work collectively to achieve these strategic goals on daily basis via achieving the different elements of the strategic initiatives and enhancing the performance of the different KPIs.

Enablers:

Enablers are the elements that empower the company to achieve its strategic goals such as transforming the culture to an attractive culture that fosters innovation and creativity, attracting talented employees and retaining them, achieving performance excellence in all of the company's operations etc., in addition to any other aspect that will enable the company's directorates to successfully achieve the initiatives and improve the performance of the strategic and operational KPIs.

As per the ADDC Strategic Plan Map 2016-2020 the following 4 strategic pillars will be on our focus:

- Growth and Sustainability
- Customer Delight
- Operational Excellence
- Performance Driven Organization

Priorities listed under each theme represent the broad areas that we focus on to deliver our strategic intent.

The strategy plan map was created in alignment with ADWEA (now DOE) and the sector companies. Since then, various strategic initiatives have been completed while many are currently in place to address these priorities.

1.43 Summary of Strategic Direction (Business Plan – Business Drives)

- Achieving the strategic direction requires solid execution of the 5-year strategic plan, which will enable ADDC to move towards the long-term goal of being a leading utility company. This means that:
- Each business unit must adopt best practices to achieve excellence across all areas of the business.
- ADDC must engage in a productive manner with all stakeholders to support the sustainability of the business.

1.5 Key Statistical Data

1.5.1 The key statistical figures with related to the existing water distribution network as of 31st December 2017 are enumerated in the table below:

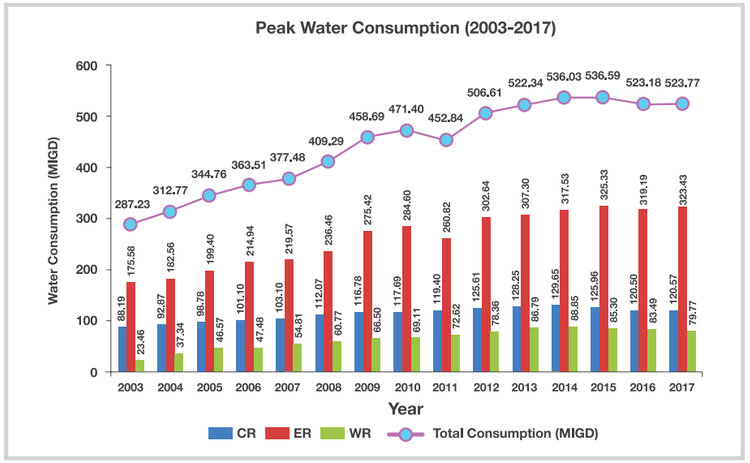
Geographic area served	**47,700 km2**	
Length of Total Pipeline	**8,901 km**	
Number of Customers (2017)	CR ER WR Total	169,175 113,711 15,850 **298,741**
Quantity Received during 2017	CR ER WR Total	39,841.97 MIG 106,533.86MIG 27,652,58 MIG **174,028.41 MIG**
Total ADDC Peak Supply 2017 (Peak supply is the average supply for the peak week in each region)	CR E WR Total	120.57 MIGD R323.43 MIGD 79.77 MIGD **523.77 MIGD**
CAGR Growth in Peak Demand between 2003 - 2017	CR ER WR Overall	2.26% 4.46% 9.14% **4.38%**
Number of Active Interface Points with TRANSCO	CR ER WR Total	32 nos. 103 nos. 32 nos. **167 nos.**
Number of Active Pumping Stations	CR ER W Total Capacity	3 nos. 7 nos. R25 nos. **35 nos.** **32 MIG**

1.52 Number of Customers and Water Demand

ADDC is currently supplying water to around 298,741 registered customers. It is anticipated that the accelerating rate of development, mainly industrial & commercial, within the Emirate will lead to a rapid increase in the number of customers over the next decade, which is in line with a forecast predicting that the population of the emirate will be substantially increasing in this period.

The following chart summarizes the growth in water demand experienced by ADDC over the last fifteen years. The peak water demand (average of peak week for each region) in 2017 was 523.77 MIGD, which indicates an average increase of 4.38% year on year.

Note: The growth rate is calculated based on the increase in water demand for last 15 years that indicates an average increase of 4.38% year on year as Compound Annual Growth Rate (CAGR), which is the mean annual growth rate over a specified period longer than one year.



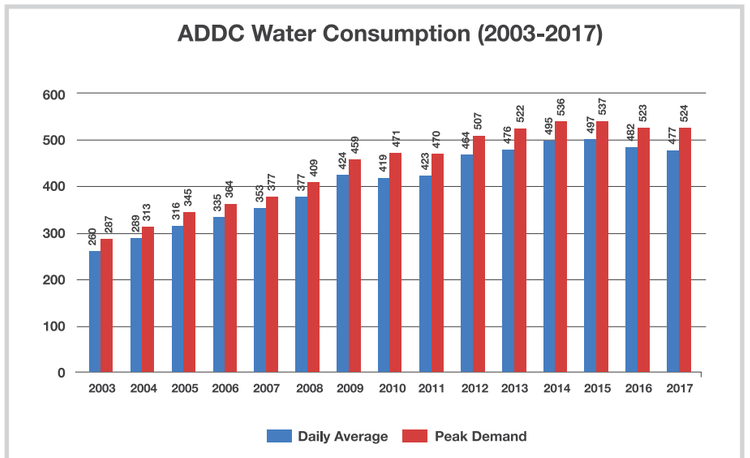
Historical Regional Peak Water Consumption

Peak supply is considered as the average daily water supply during the week of maximum consumption in the year.

Between 2003 and 2017 there was a substantial progress in providing continuous supplies to customers. ADDC has also had considerable success in connecting customers to the network. Both these steps have substantially reduced the risk of any contamination of the water supply to customers and improved security of supply.

The details of historical water supplied area wise is provided under Appendix I.

The following chart summarizes the difference between the daily average and peak supply over the last fifteen years.



Historical Average and Peak Water Supply Details

2

Current Distribution Network Characteristics & Operational Philosophy

5-Year Planning Statement 2019-2023

(Potable Water)

2. Current Distribution Network Characteristics & Operational Philosophy

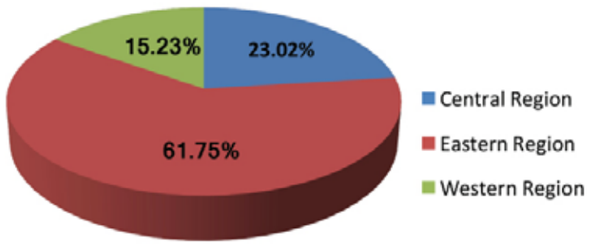
2.1 Network Characteristics

ADDC supplies water to customers on Abu Dhabi Island and allied locations and across the Eastern and Al Dhafra region of the Emirate, excluding Al Ain and its environs, which are under the responsibility of a separate company (Al Ain Distribution Company or "AADC").

ADDC also operates and maintains a few water production facilities operated and maintained by the Remote Areas Department, operating within the Water O&M Division, mainly located in the remote parts of the Emirate.

In year 2017, ADDC supplied around 524 Million Imperial Gallon of water per day (average of peak week) to around 298,741 registered customers in its jurisdiction. The distribution system consists of 8,901 km (approx.) of pipelines with diameter ranging from 80 mm to 1200 mm and 35 pumping stations.

The following graph illustrates the percentage of peak water supply to each region in year 2017:



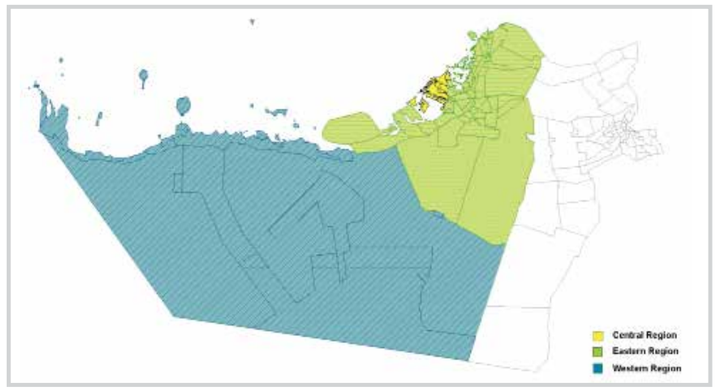
Regional Peak Water Consumption

The categories of pipes in the distribution system consists of mainly DI pipes (approx. 78%) followed by HDPE pipes (approx. 20%).

2.2 Network Configuration

2.2.1 Network Topology

ADDC's service area covers the entire Abu Dhabi Emirate, apart from those areas of the Eastern Region that are supplied by AADC. ADDC service area comprises of three regions i.e. Central, Eastern and Al Dhafra region. ADDC's service area is shown in the drawing below:



Available Detailed Connectivity schematics for Central, Eastern and Al Dhafra Region of ADDC Network provided in Appendix II.

2.2.2 Connection to the Transmission System

The water is produced at desalination plants located along the coastline and transmitted by M/s. Transmission and Dispatch Company (TRANSCO) up to the Interface Points with ADDC, which is distributed to the Customers. ADDC supplies water to customers on Abu Dhabi Island and allied locations and across the Eastern and Al Dhafra region of the Emirate, excluding Al Ain.

It should be noted that some locations or areas (TRANSCO Pressure Zones) are fed through number of interface points of different sizes and some interface points are feeding different areas either completely or partially. Currently, there are 167 active interface points; out of which 32 are in Central Region, 103 in Eastern Region and 32 in Al Dhafra Region. A detailed list is attached in Appendix III. It is to be noted that the areas, where the existing interface connection is fully utilised or the existing ADDC distribution system is not reachable to the new customers, ADDC may require new interfaces with TRANSCO in the future.

Most of the Interface Points with TRANSCO are in compliance with MDEC requirements (MDEC compliance in Q4-2017 is 93%). ADDC has initiated new Contract D-107098 for replacement of faulty Outstations and conversion of Radio modems to GSM modems which is under technical evaluation stage and will support to enhance the MDEC compliance for Water DMPs. ADDC customer service doing their best to enhance the MDEC compliance and reach to 100 % by end of 2018.

2.2.3 Configuration

The water distribution network is primarily arranged as a pressurised loop/grid system. It is mainly configured to provide two alternate sources to sectors and areas. Conventionally, the fire-fighting system in Abu Dhabi is an integral part of the water distribution system with the fire hydrants directly placed on the water pipelines. The water distribution network is generally sectorised dividing it into districts, area or zone making areas for the purpose of leakage control and Demand Management.

The hydraulic model project was aimed to build and calibrate the entire water distribution system under ADDC to improve the level of services of the system. The objectives led to divide the water distribution network to District Metering Area (DMA). Every DMA had a minimum of two supply sources and each source was required to have flow and pressure metering devices, which were used for hydraulic modelling and for leakage analysis. There are about 150 DMAs in Central Region, 125 DMAs in Eastern Region and 93 DMAs in Al Dhafra Region.

2.3 Security Standards, Planning Criteria & Risk Analysis

2.3.1 Security Standards

As per the DoE's approved standard, DISCOs are responsible to ensure security of water supply from the planning perspective under their Water and Electricity Distribution and Supply Licenses.

There are three aspects to network security:

- Network capacity planning;
- Network risk analysis;
- Operational contingency planning.

The objective of the security standard is to set down the best practice planning tools and procedures for DISCOs to adopt ensuring that their pipelines, pumping stations and reservoirs have sufficient capacity to meet all reasonable demand. They should have redundancy and operational flexibility to deal with contingent events.

Minimum Capacity = 1 x daily consumption + fire-fighting reserve to be held completely in the ground tank; and

Maximum Capacity = 2 x daily consumption + fire-fighting reserve to be held completely in the ground tank.

The outcome of the of hydraulic model project analysis provided clear picture of the Pressure Zone of ADDC water network. A sample Pressure Zone Map for Central, Eastern and Al Dhafra Regions are attached under Appendix IV.

Although, as per the design requirements, the minimum guaranteed pressure in the system is 1.25 bar, all the distribution systems components are being designed for a minimum pressure of 10 bar in line with the DOE Standards & Specifications. Since the new distribution systems are being designed considering the minimum pressure requirement at the farthest point in the network, most of the network carries higher pressure than 1.25 bar. ADDC, as an end user, receives water from TRANSCO and is geared up for receiving supply with improved pressure and flow in order to serve its customers in a better way.

2.3.2 Planning Criteria

The planning criteria and design guidelines (Standard Factors and Parameter Guidelines) have been revised by Water Distribution Code (WDC) review panel committee and accordingly incorporated as part of the WDC. The latest revision is attached in the Appendix V.

In addition to the Water Distribution Network Planning and Development Guidelines of the Water Distribution Planning Code the following shall be considered:

2.3.2.1 Whole-life Costs

In considering alternative investment options for network and storage planning, DISCOs are to demonstrate that their preferred options are the most economic through undertaking whole-life cost analyses. In particular, whole-life costs shall be used to:

- Determine planning horizons and the appropriate phasing of development, taking account of growth in demand and changing operating conditions.
- Size new transmission and distribution mains in conjunction with their associated pumping stations to determine the most economical sizes.
- DISCOs shall use the discount interest rate stipulated by the Bureau for whole-life costing.

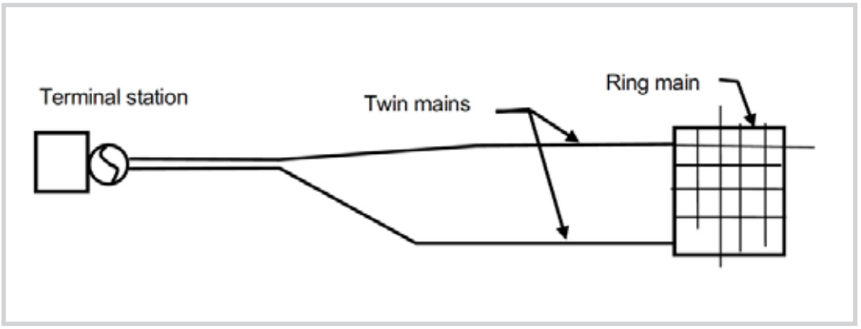
2.3.2.2 Storage Planning

Service reservoirs shall be designed to serve the following three purposes:

- To balance downstream diurnal variations in demand with relatively constant rates of inflow;
- To balance pumped inflows and pumped outflows at forwarding stations;
- To provide contingency storage in the event of a failure in transmission upstream.

2.3.2.3 The Terminal Station to Distribution System

For the design of new systems, at least two delivery mains shall be provided, each capable of conveying the average demand from the pumping station and connected at their extremities to form a ring main through the distribution area (see below). This allows supply to be maintained if one of the mains fails, it copes more effectively with peak rates of flow and it provides flexibility in case development and demand increases do not follow predictions.



2.3.2.4 Risk Management Policy

ADDC has taken into consideration the possible risks encountered in the distribution system in their hydraulic modelling project.

The calibrated models and design horizon models are being used (including extended period simulation) by ADDC to identify the following for all models; with the exception of item (ii) below, in which case the operational calibrated model only will be used:

i. Areas not satisfying the Minimum LOS (1.25 bar) and the 130% Security Standard as required by ADWEA for current operational model. Where DMAs are supplied by more than one flow meter, the simulations are to examine the effects of supplying the DMA via each meter alone.

ii. Areas at risk of single point failure where >10,000 customers will be affected in urban areas and >2,000 customers will be affected in rural areas.

iii. Assessment of surge for all pumps and pumping stations based on the following:

   a. Pump Start

   b. Pump Stop - emergency / power failure

   c. Control valve (Flow and Pressure)

d. Reservoir / Tank Inlet Control Valves

iv. Assessment of Fire Flow capacity.

v. Pump optimization / scheduling.

vi. Review of current pressure regimes and pump operation.

vii. Identification of potential additional DMA/DPA's based on the following criteria.

a. DMA Property counts >2000 and <5000

b. Mains length < 30Km

Justifications for variation from these criteria are to be included.

viii. Potential for leakage reduction based on DMA design or the installation of pressure management valves and the formation of DPAs.

2.4 Network Modelling

ADDC is currently operating and maintaining around 8,901 km of water distribution network of various pipe sizes and material. It had become utmost important to introduce Hydraulic Model to understand the system in a better way for its efficient performance and planning suitable measures for improvement. Foreseeing the future need, ADDC has completed a project, "D-101633: Consultancy Services for the Supply & Installation of Network Modelling Software including complete Hydraulic Models of Entire ADDC Distribution Network", related to the calibrated network model for the entire ADDC water distribution system. This model is for a variety of planning activities such as Sensitivity Analysis, Criticality Analysis, Water Age Analysis, Hydraulic Analysis for new connections and developments etc. ADDC is also planning to update the model area to cover the newly developed network in a stage wise approach.

The findings, based on the hydraulic modelling project have enabled ADDC to decide on bulk connection approvals, and also facilitated the in-house pipeline design works. Moreover, identification of the DMA boundary, SMP, control valves as well as system valves for current automation project in Central Region and coming phase for Eastern and Western Regions depend on the analysis based on the outcome of hydraulic modelling project.

As the hydraulic model is also very useful for operational strategies, planned shutdowns and routine operations to minimize disruption, ADDC is conducting users' training for operation and maintenance.

2.4.1 Assessment of network against the Security Standards

In line with the Water Distribution Code version 3.0 requirements, ADDC is adopting the assessment of Network Security Standard and has set up the statistical analysis for evaluating the probability of major component failures.

ADDC is initiating with pipe as the key component and accordingly planned to select least one significant pipe segment from each of the three regions (Abu Dhabi Mainland, Al Dhafrah and Eastern Region) depending upon the criticality agreed within ADDC. The portions of the network with dual feeds will be exempted and the priority of selection should be for single feed pipe(s) or peripheral Ring Main(s). However, if the downstream network is an isolated Island and the complete demand is shared by the two feeds, then the same would also be taken into consideration for the analysis.

Further, the following pipes are taken specifically into the analysis (soft copies of individual cases are attached):-

Abu Dhabi Mainland

Pressure Ring Main (PRM) on Abu Dhabi Island

Al Dhafrah Region

- DN400 pipeline in Liwa East from Mazeirah to Jabana/Qusahwirah
- DN500 pipeline from Jabal Dhannah to Sir Baniyas Island

Eastern Region

DN 600 pipeline on Graveyard Road.

ADDC is having the system such as Maximo for recording asset failures. The main pipe attributes such as diameter, material, length, location, failure type, frequency for the individual failure with respective dates from the time of installation (age) are extracted and analysed from the Maximo's burst history by the respective Department/Section of ADDC .

Once the major attributes are extracted for the chosen Pipe segment, the following are prepared as part of the Statistical analysis exercise agreed with the key Stakeholder:-

- Total interruption time is adopted based upon the Detection, Response and Repair Time allocating the total interruptions respectively to 5 % and 95%. Currently the response time is uniformly taken as 3 hours. The Repair time is taken proportionate to the pipe size in reasonable means.
- Burst interruption time Normal Distribution Curves are followed based upon the Mean and Standard Deviation of the interruption time.
- Burst rate B measured in Bursts/Year is calculated as per the formula B = Pi * Ps * Q * f (A) * f (D) along with the Diameter, Length, Age and Material. While ADDC has agreed to adopt the parameters mostly used by the UK Burst model statistical analysis, the respective parameters, if required will be revisited from the Abu Dhabi Emirate perspective and more details shall be included in the subsequent year submissions as and when available.
- Probability (Likelihood) of 3 hours, 6 hours, 12 hours, 15 hours, 18 hours, 24 hours Outage in one year are respectively calculated from the likelihood of 0 hour outage and the Normal Distribution Curve for the respective size range.
- Return Period in Number of Years without Customer Storage and with Customer Storage are respectively calculated as the inverse of respective Probabilities'. The particular 2 curves versus cumulative interruption duration are also plotted.

Meanwhile, The Target and Trigger Return periods are mainly chosen as follows:-

Target

i. An one hour interruption of 2 to 3 occurrences in a year

ii. A 6-hours interruption of no more than once in 4.7 years

iii. A 12-hours interruption of no more than once in 76 years.

Triggering values are respectively set as half the Target

iv. An one hour interruption for up to 5 occurrences per year

v. A 6-hours interruption of no more than once in 2.35 years

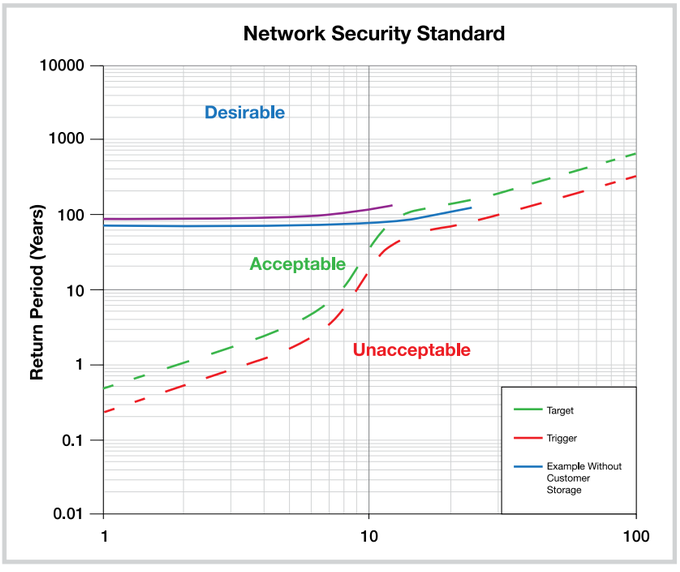
vi. A 12-hours interruption of no more than once in 38 years.

Note: - 12 hours Customer Storage is stipulated as per Regulations.

The above is principally adopted and the Target/Trigger Curves are also superimposed between Cumulative duration of interruption (in hours from 1 to 100 say) Versus Return Period (in Years) as per the following table:-

	Return Period	
Interruption	Standard	
Min Duration (hr)	Target	Trigger
1	0.5	0.2
6	4.7	2.3
12	76.1	38.1
24	152.2	76.1
48	304.4	152.2
96	608.8	304.4

The final representation of the Risk analysis is delivered by Return Period in Years and plotted as per the following sample Risk Criteria Figure:-

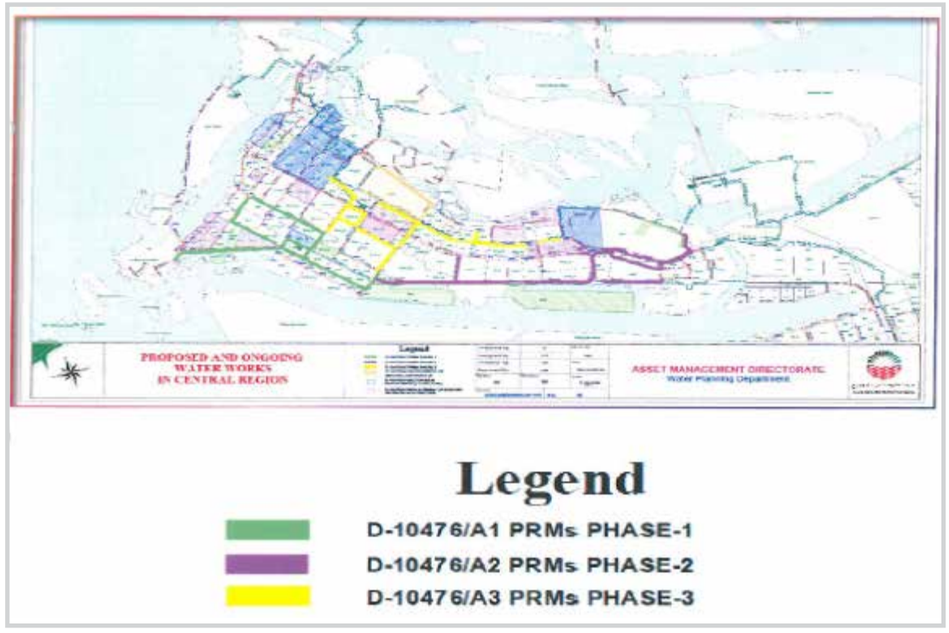


The outcome of the analysis will augment ADDC in predicting the actual requirement of additional investment such as new/alternate pipe laying, pipe replacement due to age, increasing the storage etc. ADDC also uses the criterion of Priority Action Number (PAN) considering the various service Performance Aspects such as Age, Frequency of Breaks, Pipeline condition, Location, Critical Customer impact, Pipe Depth, Hydraulic Performance concerns and the respective weighted value is determined in conjunction to complete the assessment (copy of the PAN Assessment criteria is attached in Appendix XXII). Necessary action further including the feasibility and Cost-Benefit analysis shall be made in order to mitigate/eliminate the risk if identified as unacceptable and bring to the acceptable/desirable range.

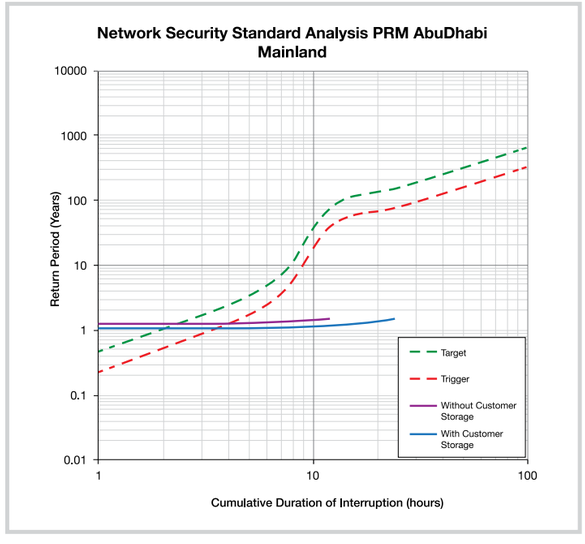
Abu Dhabi Mainland PRM

The existing Pressure Ring Main (PRM) in Abu Dhabi Island is installed more than 35 years ago and is approximately 55.0 km long. Many of the sections are corroded and requiring steady maintenance. Also, the pipeline is vulnerable to be operated at higher pressures after the completion of new transmission mains under construction by TRANSCO.

Location Map



The burst model risk analysis (Appendix XXIII) is carried out as explained above and the following is the final outcome of the analysis. Even though the PRM is ranging from DN 400 to DN 1200, the analysis is done with mid- range size of DN 1000 for the total 55.0km length. The outcome of the analysis will not be varying much. The necessary precise analysis (if required) for the entire range of different diameters will be carried out and presented in the future submissions.



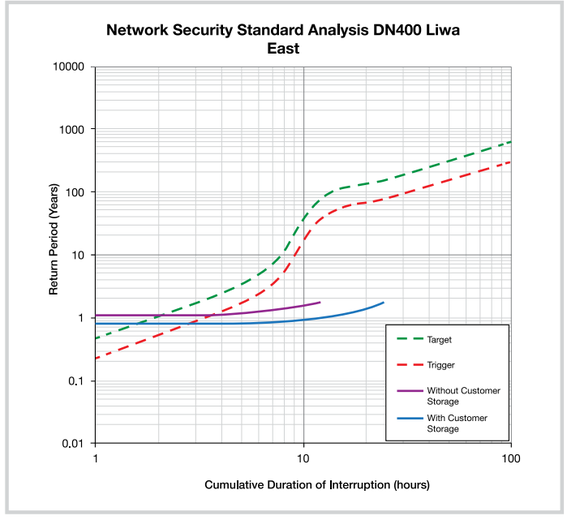
It is found from the analysis that the two respective curves of Return Period with and without Customer Storage are in the Unacceptable region, thus leading ADDC to the replace the subject PRM pipeline.

Al Dhafrah Region DN400 pipeline in Liwa East from Mazeirah to Hameem

The existing DN400 pipeline in Liwa East starting from TRANSCO Pumping Station at Maziraa extended up to Hameem area of Western Region is in very critical condition with repeated failures (approximately 2 bursts/year recorded) due to deteriorated condition of the pipe line. This pipeline is installed dated 1994-1995 and is the main feeding line to Liwa East including many VIP locations such as Qasarwa Palace, Al Qasr Resort etc. Also, the pipeline is supplying many industrial related Customers and local communities living in different Shabiyas along the route of the pipeline. As the line is serving a large area of Liwa East, any interruptions in this line affects significant amount of Customers.

Location map

The burst model risk analysis is carried out as explained above and the following is the final outcome of the analysis.



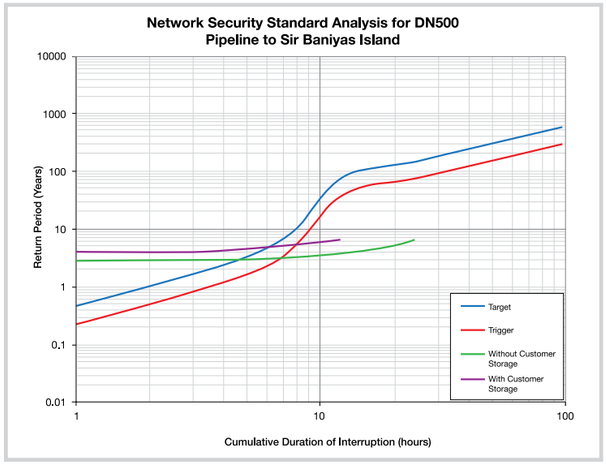
It is observed that the two respective curves of Return Period with and without Customer Storage are predominantly falling in the Unacceptable region, thus leading ADDC to initiate the process of replacing the subject DN 400 pipeline.

Al Dhafrah Region DN500 pipeline from Jabal Dhannah to Sir Baniyas Island

The existing DN500 DI pipeline is approximately 12.0km long and is installed in1979. The majority of the pipeline is submarine and the pressure in the pipeline is maintained low suspecting leakage and subsequent loss of water. The pipeline is currently supporting the water supply to the Sir Baniyas Island in addition to existing DN600 pipeline. By considering the importance of the Island, the security of supply has to be maintained by minimum two feeds to the Island.

Location Map

The network Security risk analysis is carried out as explained above and the following is the final outcome of the analysis.

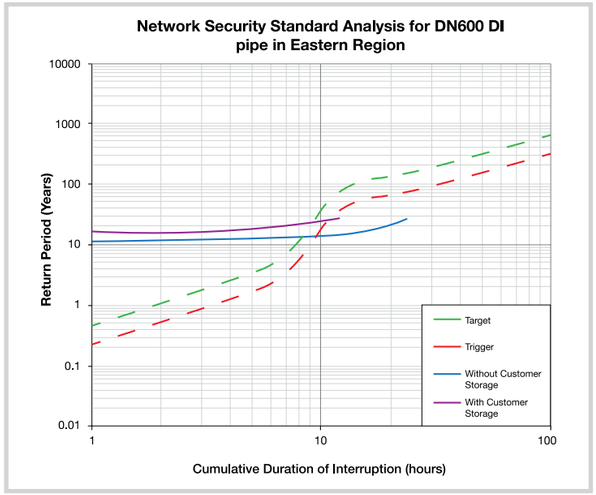


It is observed that the two respective curves of Return Period with and without Customer Storage have entered the unacceptable region. ADDC would initiate the process of rehabilitation of the subject DN 500 pipeline.

Eastern Region DN 600 pipeline on Graveyard Road

The existing pressure main of DN600 DI pipeline of approximately 10.0 km along Graveyard Road in Baniyas area. The pipeline is around 14 years old with the only limited history of breakages.

The network Security risk analysis is indicatively done and the following is the final outcome of the analysis.



It is observed that the two respective curves of Return Period with and without Customer Storage is not fully in the Desirable region. Moreover, there is a requirement for the relocation of the subject pipeline of Baniyas, since it is affected by the land filling carried out for the new developments in Shamkha. ADDC is in preparation to include the relocation of subject DN 600 pipeline in the long-term plans.

2.5 Key Asset Data

ADDC existing water assets are mainly comprised of distribution networks, including house connections, together with above ground assets such as storage reservoirs and pumping stations. ADDC Key Water Asset Data in AIS format is given in Appendix: VI.

2.5.1 Pipelines

The total length of distribution network as of December, 2017, is around 8,901 km. These include DI pipes (about 78%) of different diameters ranging from 80 mm to 1200 mm. Other types include HDPE, AC, GRP, uPVC and CS pipes of various sizes. It is to be noted that the total length of the distribution network has increased from 4,050 km (approx.) in 2001 to 8,901 km (approx.) in 2017, an increase of more than 100%.

Item Description	Pipe Dia. (mm)	Unit	Quantity
Asbestos Cement Pipelines	80 - 500	km	67.47
Carbon Steel Pipelines	150 - 600	km	29.90
Ductile Iron Pipelines	80 - 1600	km	6,946.85
GRP Pipelines	150 - 900	km	26.72
HDPE Pipelines	80 - 710	km	1,788.55
PVC Pipelines	100 - 200	km	3.57
uPVC Pipelines	50 - 300	km	42.46
Others	80 - 1200	km	0.01
TOTAL	**km**	**8,901**	

2.5.2 Pumping Stations

At the far end of the distribution network in some sectors including the customers in some islands, the pressure available is not enough to reach all customers. At such locations, ADDC has got dedicated pumping stations to boost the pressure. The number of Pumping Stations owned by ADDC at the end of December, 2017 is 35. The following table shows region wise distribution of Pumping Stations.

Water Pumping Stations	Nr
Central Region	4
Eastern Region	5
Western Region	26
Total	**35**

2.5.3 Storage Tanks:

As part of the network system, ADDC has 85 storage tanks; out of 4 are in Central Region, 15 are in Eastern Region and 66 in Al Dhafra Region. The total water storage capacity is approximately 40 MIG.

2.6 Assets Failure

In the pipeline distribution networks, the main asset failure is the pipe failure. Pipe failure occurs when the pipe cannot contain the fluid internally within the pipe; either the strength is too low (from wrong material selection, fatigue, stress corrosion, etc.) or the stress is too high (overloads, loss of wall thickness etc.) resulting in an interference zone between loads and strengths. Generally, pipe failures can be classified by type and by size.

Causes of failure: Generally the deterioration of pipes has been classified into two categories as structural deterioration and deterioration of the inner surface of the pipe. Pipe breakage, with exception of situations when it is caused by a third party interference, is likely to occur when the environmental and operational stresses act upon pipes whose structural integrity has been compromised by corrosion, degradation, inadequate installation or manufacturing defects. In another way, causes of failure can be classified as corrosion, excessive forces, Production flaws and human error.

Consequences of a failure: Losses associated with a pipe failure can be divided into three main categories in a similar manner:

1. Direct costs
   - Repair cost that depends on the parameters of the pipe and failure as well as the location of the failure;
   - Cost of lost water that depends on the severity of the failure, the isolation time, the size of the pipe and the production cost of water;
   - Cost of damage to the surrounding infrastructure and property (flooding, road collapse, structural damage, etc.) that depends on the severity and location of the failure as well as the time of isolation;
   - Liabilities (injury, accident, etc.) that depend on the severity and location of the failure.
2. Indirect costs
   - Costs of supply interruption (loss of business due to the water outage) that depend on the isolation time of the failure;
   - Cost of potentially increased deterioration rate of affected surrounding infrastructure and property;
   - Cost of a decreased fire-fighting capacity, both due to water outage and insufficient hydraulic capacity.
3. Social costs
   - Cost of water quality degradation due to contaminant intrusion caused by de-pressurising;
   - Cost of decrease in public trust and quality of water supply that depends on the location and isolation time of the failure;
   - Cost of disruption of the traffic and business that depends on the location and isolation time of the failure;
   - Cost of disruption of the water supply to special facilities (hospitals, schools, etc.) that depends on the location and isolation time of the failure.

The table below shows the Water Maintenance Key Performance Indicators in ADDC, based on the information extracted from Maximo Database, for year 2017. The same has also been benchmarked with International best practices, wherever applicable, to ascertain the position vis-à-vis the best practices.

SN.	Water Network System Performance KPIs	Descriptions	2017	Benchmark - International Best Practice
1	Water Network Pipeline Failure Rate	**Main line failures/100 km/year** DI Pipe: DN 600 - 1.88 DN 1000 – 0.55 DN 900 – 0.55	2.98	High ≥ 10 failures/100 km/year Medium = 5-9 failures/100 km/year Low = 1-4 failures/100 km/year
		Sector line failures/100 km/year DI Pipe DN100 – 0.30 DN150 – 2.03 DN200 – 0.32 DN250 – 0.18 DN300 – 0.31 HDPE Pipe OD225 mm – 0.68 OD160 mm – 1.05 OD200 mm – 0.10	5.00	
		Customer Service line failure/100 connections ½" – 1.78 ¾" – 1.43 1" – 0.61 1½" – 0.52	4.34	Only Comparison for Customer Service line failures because no any accepted BM
2	Preventive Maintenance Effectiveness (e.g. Planned Vs Achieved and PM Vs CM)	Planned Vs Completed WO	99.6%	> 95%
		PM Vs CM	9	> 6
3	Water Network Assets: Pumps, Valves and Fire Hydrants Failure.	Pumping Station Asset Failure/Year	123	No any accepted BM, only comparison
		Valves Failure/Year	167	
		Fire Hydrants Failure/Year	38	

Based on the above Maximo Data Base analysis, the following observations, analysis & recommendations have been concluded:

Observation & Analysis:

- As per average Main Pipe Line KPI, Failure rate is Low Likelihood = 2.98 < 4-1 failures/100 km/year. This is in line with the service level Indicator of International Best Practice.
- As per average Sector Pipe Line KPI, Failure rate is Medium Likelihood = 5.00 which is within 9-5 failures/100 km/year. This is in line with the service level Indicator of International Best Practice.
- It is also noted that the main line and sector line failures are comparatively less. The planned replacement of existing aged pipes, based on the result of condition assessment report will further enhance system performance.
- Referring to the average Service Pipe Line KPI, Failure rate is = 4.34 per 100 Nos. of Service Line connections. The focus area is to reduce the existing failure rate of service line connections. The replacement of LDPE with MDPE, which is in progress, shall improve service line performance as move forward.
- For service pipeline, there is no benchmark available as per our understanding; however, ADDC follows the best international practices to operate and maintain the distribution network as a whole.
- Asset Tagging is in in the planning stage and after completing this tagging, Asset Grade (based on Condition & Criticality) to be populated in the Maximo because this is mandatory for the full implementation of Reliability Centered Maintenance (RCM).

Recommendations:

To improve the Quality of the Performance Evaluation Process, it is recommended to correct the usage of Location/Tag Nos. pertaining to the focused asset. This shall be extended down to the Asset level tags and also select/check the correct and designated Failure Class per the actual failure before closing the PM & CM work orders.

2.7 Level of Service

ADDC is currently supplying water to around 298,741 registered customers. It is anticipated that the accelerating rate of development within the Emirate will lead to a rapid increase in the number of customers over the next decade, which is in line with a forecast predicting that the population of the emirate will substantially increase in this period.

The primary purpose of the asset performance management team is to monitor and analyze the current levels of service performance to customer in an economically efficient manner that meets and exceeds the needs of Customers, Regulator and the Business. The levels of service performance targets are measured based on the following criteria:

- Reliability of Supply in routine operation
- Restoration of Supply during planned or unplanned interruption/s.
- Complying water quality parameters
- Water system pressure performance
- Water sampling frequency
- Deviation from maintenance plan
- Planned maintenance Vs. total maintenance
- Assets failure

In addition to the monitoring and analyzing of the asset performance, the performance team recommends the business to take further action to improve the outlined deficiency either via capital expenditure or via optimization to ensure improvements. The business has agreed with DOE to deliver specific target levels of service performance, which is based on a balance of past practice, cost, customer satisfaction, recognized international best practice, and safety considerations.

ADDC has initiated many projects to improve the flow and pressure measurements down to the sector level.

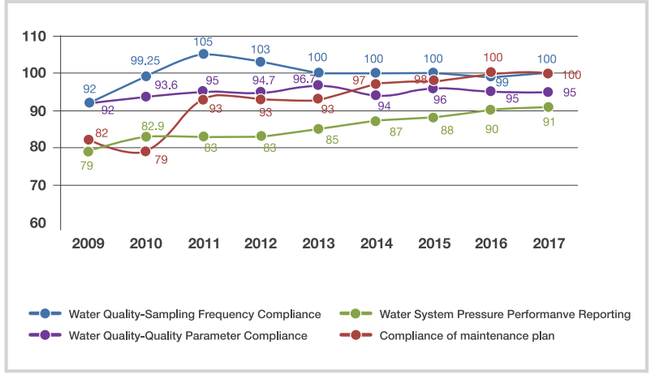
ADDC considers that the current security, variability and reliability of the network can be improved. Therefore, it is decided to introduce realistic key performance indicator targets. The KPI for pressure monitoring was 91% for year 2017, while the compliance to network maintenance exceeded the set target. Attached Appendix VII includes the month wise compliances values verses the Targets set for water sampling frequency compliance, water quality compliance, pressure performance monitoring, customer & service interruptions and other relevant system performance statistics.

#		1	2	3	4	5	6
KPI(s)		Water Quality-Sampling Frequency Compliance in %	Water System Pressure Performance Reporting in %	Water Quality-Quality Parameter Compliance in %	Compliance of maintenance plan in %	Distribution Interruptions* (Water) in Nos.	Mean time to repair in Hrs.
2009	Actual	101	79	92	82	65	5.7
2010	Target	92	68	92	80	72	6
2011	Actual	99.3	82.9	93.6	79	54	5.52
2012	Target	92	82	93	84	60	6
2013	Actual	105	83	95	93	41	4.41
2014	Target	100	82	94	88	60	6
2015	Actual	100	83	94.7	93	36	4.32
2016	Target	100	83	95	93	50	5
2017	Actual	100	85	96.7	93	39	4.17
	Target	100	85	95	93	40	4.75
	Actual	100	87	94	97	39	4.35
	Target	100	87	95	94	40	4.75
	Actual	100	88	96	98	41	4.52
	Target	100	87	95	95	40	4.75
	Actual	100	90	95	100	41	4.63
	Target	100	90	95	100	40	4.75
	Actual	100	91	95	100	36	4.63
	Target	100	90	95	100	35	4.75

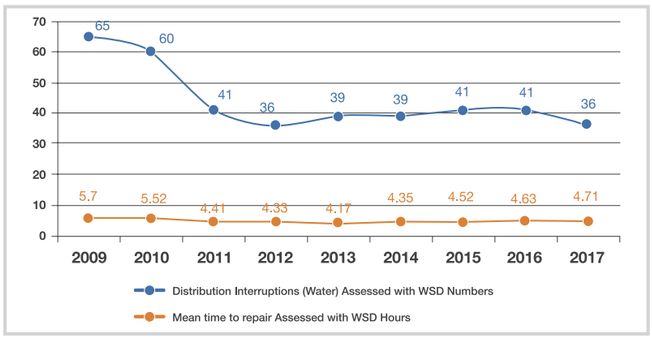
*Distribution Interruptions: Distribution interruption is unplanned shutdowns, which affect the distribution of water for more than 6 hours or more. It is calculated as the number of events occurred. If a Distribution Interruption affects the customers and can be identified under the categories of reportable incidents mentioned in Incident Reporting Regulation, it is called as Service Interruption. {Ref. The Incident Reporting Regulation (Second Edition) 2015, page 28 of 33}.

The below charts provide the graphical representation of the KPIs comparing the milestones achieved in the above stated areas:

The KPIs following upward trend



The KPIs following downward trend



2.8 Challenges & Solutions

A number of Developments planned by third party Developers are either on hold, cancelled or behind their planned original schedule. For many of the Developments which are either partially or fully completed, the occupancy is much less than the projected one. This scenario results in the underutilization of the assets already in place leading to stagnation and water quality issues, which further needs frequent flushing of the system resulting in wastage of water.

In order to overcome this issue ADDC has suggested DPM (Department of Urban Planning & Municipalities) to allocate the plots in the developments sector wise so that the water supply system also can be operated sector wise. For future Mega Developments, ADDC has recommended to implement the Developments in phases based on a realistic occupancy plan. The Plan Abu Dhabi 2030 Update has forecasted a much lower population figure for the future, which will lead to more realistic assumptions. It has also been suggested to develop the area where the infrastructure is already available instead of developing a remote land.

With the control on the allocation of plots and realistic occupancy forecast, ADDC will be in a much better position to have a reasonable demand forecast.

Moreover, DPM has been assigned to develop the procedure, taking into consideration all the utility providers' viewpoints, on constructing the infrastructure by the third party developers and asset transfer. The proposal has been coordinated with DOE/ADDC and agreed principally and currently in approval process.

DPM/Abu Dhabi Municipality is initiating several TRIP projects based on the urgent requirement for more Emirati Housing Schemes in different sectors. As ADDC is not aware of the prospective planned infrastructure projects proposed to be included in the future Development Plans of DPM, such projects could not be considered beforehand by ADDC in its 5 Year Investment Plan. In order to mitigate this issue, continuous coordination with DPM is happening. In this regard, please note that DPM is not in practice of publishing any 5 YPS.

Now, ADDC and DPM/Al Dhafra Region Municipality (DRM) have agreed and currently have a principle agreement by which DPM/DRM will be responsible for the design and implementation of all the TRIP projects including the water infrastructure in coordination with ADDC. ADDC has implemented the same practice with Third Party Developers also.

Another challenge ADDC has is to have the continuous improvement to the current distribution system in terms of Level of Service to its customers, maintaining the water quality throughout in its distribution network as well as system security. In order to achieve these tasks, the following projects have been undertaken/completed:

- ADDC has completed the Hydraulic Modelling project and the projects for automation, and intermittent chlorination systems are at the tendering stage.

Objective for **Hydraulic Model** is as follows:

1. To improve the level of service.
2. To enhance and reinforce Water distribution network
3. To identify UFW at the level of DMA.
4. To provide recommendation for 50 worst-case scenarios.

- Objective of **Intermittent Chlorination Project** is as follows:

The main objective of the project is to ensure wholesome potable water supply to the customers by maintaining the desired residual chlorine levels in the distribution network as per DOE Guidelines and to have proper sampling systems installed within the distribution network to aid ADDC operators in taking water samples for laboratory testing.

- Objective of **Automation Project** is as follows:

To improve and upgrade the water network automation system by the implementation of a central SCADA system with communication option to ADDC pump stations, metering points and elevated tanks with the following:

1. Energy efficiency
2. Reduce operational response time and increase performance
3. Provide system security and supply management
4. Preventive actions and Leakage management
5. Real time hydraulic analysis

The approved Network Automation Strategy is attached in Appendix VIII.

3

System Capacity

5-Year Planning Statement 2019-2023

(Potable Water)

3. System Capacity

3.1 Locations / Descriptions

ADDC's service area covers the entire Abu Dhabi Emirate, apart from those areas of the Eastern Region that are supplied by AADC. It comprises three regions i.e. Central, Eastern and Al Dhafra region. In order to facilitate the distribution and supply business of water effectively ADDC's jurisdictional area is divided into 3 Regions namely Eastern, Central and Al Dhafra Field Operational Regions. Central region has been considered one area, Eastern region has been divided to two sub region coastal and inland and the Al Dhafra region the same coastal and inland in the purpose of hydraulic modeling with the proper connectivity to TRANSCO system.

3.2 Mode of Supply & Supply Limitations

3.2.1 Sources of Water

ADDC distribution system is mainly sourced from TRANSCO transmission system being supplied from the desalination plants located at Umm Al Nar, Taweelah, Mirfa and Shuweihat. A very few remote areas / islands are being supplied by producing water by ADDC from RO plants dedicated for these areas.

TRANSCO transmission system from different production plants is boosted by intermediate pumping stations to supply ADDC with the required pressure. According to TRANSCO planning strategy, to serve ADDC network, the Transmission Network was divided into three Supply Zones defining the areas mainly served by the particular Desalination Plants and Pumping Stations as follows:

- Supply Zone 1: Abu Dhabi Island and Adjacent Islands from the Umm Al Nar Desalination Plant, Unit 3 PS and Mussafah PS.
- Supply Zone 2: All areas extending from Taweelah to Unit 3 and Ajban Pumping Station and Areas towards Abu Dhabi - Dubai Border from the Taweelah Desalination Plant.
- Supply Zone 3: All Areas from Sila to Mussafah; and Unit 4 and Shobaishi Pumping Station from the Shuweihat, Mirfa and Taweelah Desalination Plant.

TRANSCO has created the above supply zones to study and clearly define the surplus or shortfall in water supply within each zone as well as to determine the most economical import-export route between the zones.

3.2.2 Supply & Demand Management

ADDC is committed to plan, develop, maintain and operate a reliable, secure, safe and cost effective distribution system across our licensed area within the Emirate of Abu Dhabi, and deliver services that meet or exceed our customers' expectations. The obligation will be met by assessing the demand across ADDC's distribution systems & supply regions, liaising with internal & external stakeholders and executing suitable expansion plans on a timeline to cater to the demand.

ADDC is aiming to achieve this target by:

- Developing a fairly accurate Demand Forecast for short (One Year) to medium term (5-Years), utilizing the historical data, ensuring plans are aligned with the planning horizons of the Emirate.
- Developing system expansion, reinforcement and refurbishment on a time-line required to meet the forecasted demand.
- Defining planning criteria and design philosophy in line with DOE standards & specifications and also in compliance with all regulatory and statuary requirements.
- Developing Capital Expenditure (CAPEX) for expansion, reinforcement, refurbishment proposals and securing funding, required regulatory approvals.
- Planning and preparing detailed proposals for programs.
- Close co-ordination with other stakeholders to ensure upstream facilities are provided in a timely manner.
- Continual improvement of planning and forecasting of demand through application of improvement processes, best utility practice and benchmarking.

This will help ADDC in the development of the distribution infrastructure in timely manner to meet customer requirements.

3.2.3 By-Passing of Unit I & Unit II

TRANSCO, as per their strategic requirement to reduce the operational cost, has requested ADDC to assess its distribution system downstream of Unit I & II in case of by-passing Unit I & II pumping stations. During the trial operation, ADDC faced major breakdown in its system and hence decided to replace the critical assets (Pressure Ring Mains) before proceeding further on this subject. During 2017, Water O&M was very keen in maintaining the network pressure to the lowest of the optimum pressure range, which is enough to deliver the required quantity of water to the customer end. The philosophy has helped ADDC to minimize the risk of pipeline bursts in the critical locations of distribution network.

ADDC has undertaken a project to replace the critical pipeline assets and as per the current plan the consultancy award date is Q3-2018, construction award date is Q3-2019. The construction duration of the project is for 36 months and is expected to be completed by Q3-2022. The trial operation for by-passing of Unit I & II can only be possible once the project is completed and ADDC is ensured that its customers won't be affected again due to such trials.

3.3 Capacity Utilization / Flow Analysis

The water network is being designed for the ultimate peak demand of the respective area along with the fire flow. Hence, the total capacity of the system will be higher than the rate of average supply of water. The utilized capacity of the system is generally lower than the capacity of the system. In several cases the projected rate of occupancy is not achieved leaving the system capacity much higher than the rate of supply.

The following table shows some of the areas, as part of third party Mega Developments, where water infrastructure have been developed and are underutilized due to low occupancy rates. These indicate the areas with available connection opportunities which can be prioritized for future development.

Sr. No.	Name of Development	Installed Capacity (MIGD)	Current Supply (MIGD)	Utilized Capacity (%)	Spare Capacity (%)
1	Al Raha Beach Development: Eastern Precinct	12.83	4.10	32%	68%
2	Yas Island, (including Emirati Housing, Zone K, Zone JA, North Yas)	12.70	3.15	25%	75%
3	Al Reem Island	22.28	4.00	18%	82%

4	Al Mariyah Island (Phase 1)	2.72	0.79	29%	71%
5	South Shamkha	14.70	0.00	0%	100%

The following table shows the region wise capacity at Interface level and the peak quantity supplied during 2017:

Region	System Capacity MIGD	Peak Supply MIGD
Central Region	151.15	120.57
Eastern Region	650.89	323.43
Western Region	156.31	79.77

3.3.1 Asset Utilization

In the water distribution network, Sensitivity Analysis, one of the modules in ADDC hydraulic modelling software, represents the Asset utilization. It is an advanced analysis to recognize the capacity of the system to supply more demands with the same mode of supply. Each discrete metered area (DMA) was analyzed to confirm the spare capacity using the calibrated hydraulic models analysis results. This was done as detailed below:

Using WaterGEMS software, pressure analysis has been conducted for all models to identify which DMAs are having low level of services. DMAs with pressure lower than 1.25 bar have been negatively adjusted and DMAs with adequate pressures have been positively adjusted. Each DMA water demand has been identified using the demand control center of the software. By trial and error, the adjustment percentages have been conducted by multiplying factors for each DMA water demand in the calculation option of the new scenario created for the sensitivity analysis. The same process has been used for all the Regions.

ADDC has further carried out the analysis considering the following criteria and considerations:

a. Maximum water adjustment for each node is +100% or two times of the current demand. Minimum adjustment is -50%, mostly on DMA with low level of services.

b. The minimum residual (level of service) pressure at any nodes in a DMA is 1.25 bar at any point of time during the analysis.

c. Fire-fighting flows are not considered in the analysis.

d. The velocity along the pipes during the analysis shall not exceed the maximum allowed velocity.

e. Minimal adjustment of existing network valve settings.

f. All sources (TRANSCO interface points) are adjusted to one (1) bar assuming future requirements.

Each DMAs water demand are calculated and categorized into following categories; underutilized, balanced and over-utilized DMA. Underutilized DMAs are having high pressure which can take positive adjustment of demand up to maximum 100%. Balanced DMAs have sufficient pressure just above LOS which will not require or minimal (10%) water demand adjustments. Over utilized DMAs are having less than 1.25 bars of pressure hence negative adjustments shall be considered. Sensitivity Analysis has been carried out for the complete DMAs in all the regions; Central, Eastern, and AL Dhafra and the approach analysis is accepted by DOE. The report of this analysis is included as Appendix IX.

4

Demand Forecast & Allocation

5-Year Planning Statement 2019-2023

(Potable Water)

4. Demand Forecast & Allocation

4.1 Water Demand Forecast

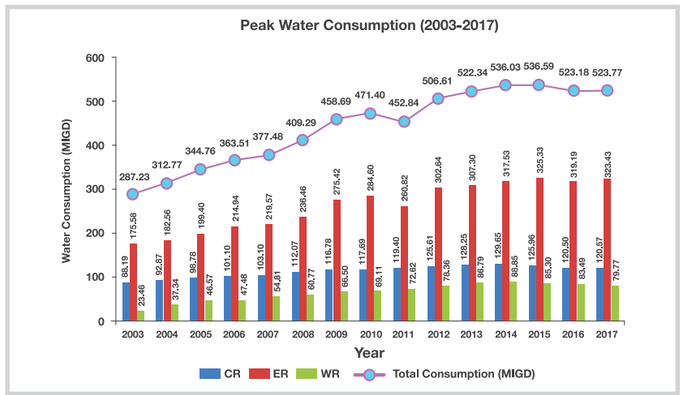
Water demand forecasting is a fundamental requirement of the development for a secure, reliable and economic water distribution network system. Forecast refers to projected requirements determined using a systematic process of defining future demand in sufficient quantitative detail to permit important system expansion decisions to be made. The demand forecast is used as a basis for the distribution system enhancement, reinstatement, development and expansion.

Even with the best available information, forecasting is basically an inexact science. It is open to the occurrences of various unpredictable events that may vary the consumption pattern. Prediction of future demand may call for revising the estimate at regular intervals to take care of new policies and changes in socio-economic trends.

4.2 Analysis of Historical Data, Population Projections & Forecast Methodology

1.1.1 Historical Data – Consumption Patterns

The peak water supply (average of peak week in each region) for the years from 2003 to 2017 in different regions; is shown in Figure below:



Historical Peak Water Consumption

The peak water consumption in different regions for year 2017 is provided in Appendix X.

1.12 DPM (UPC) Plan Abu Dhabi 2030 Update

DPM commissioned the update of the Plan Abu Dhabi 2030 (as previously published in 2007), to guide planning and development in the Capital Region. The update to Plan Abu Dhabi 2030 was created in partnership with Government Departments and Agencies and under the direction of the Leadership of Abu Dhabi.

This update has been done considering mainly the following factors:

- Changes in the world economic climate and consequent impact on the rate of growth in the Emirate, with many Development projects delayed or postponed;
- Infrastructure-led development has resulted in advance provision of assets, some of which are currently underutilised;
- Some oversupply of residential and office space, in part due to dislocation between land use allocations and policy recommendations;
- Unbalanced residential supply (oversupply of luxury housing units, undersupply of lower income housing units);
- A growing population has generated additional demand for community facilities (parks, schools, clinics, etc.);
- Introduction of Estidama and other environmental policies, which now require protection measures for sensitive areas.

In the Plan Abu Dhabi 2030 Update, UPC is forecasting a lower population from the previous plan.

1.1.3 Population Projections

ADDC future planning is based on the system capacity projection based on historical water supplied to normal growth and the requirement by the Developers for their future development projects, which are in turn approved by UPC for the type of Development and for population.

ADWEC's future planning for their production capacity is based on the population figures based on DPM's Plan Abu Dhabi 2030 Update. Based on the population forecast by ADWEC, which is available in ADWEA GIS portal, the population growth forecast for each region is as follows:

Region	2018	2019	2020	2021	2022	2023
CR	614,327	633,571	654,940	659,079	672,204	686,149
ER	1,074,841	1,135,782	1,198,138	1,264,971	1,321,585	1,375,015
WR	339,371	351,103	365.980	378,077	390,603	404,956
Total	2,028,539	2,120,456	1,853,444	2,302,127	2,384,392	2,466,120

Source: ADWEC Population Forecast 2018 (https://gisweb.adwea.ae/ADWECForecast/Maps/PopulationMap)

4.3 ADWEC Winter Demand Forecast

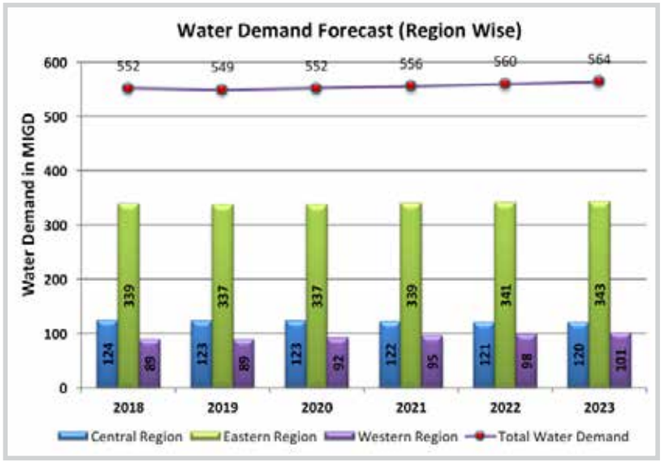
4.3.1 ADWEC Winter Demand Forecast

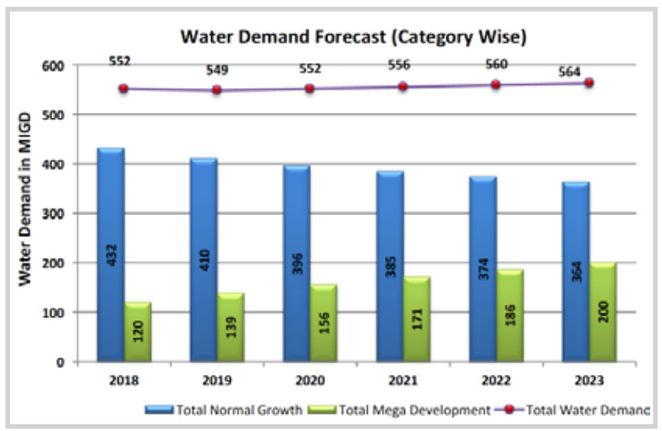
Abu Dhabi Water & Electricity Company (ADWEC) winter Demand Forecasts are required under the terms of the Electricity and Water Transmission Codes. ADWEC is submitting the forecast to DISCOs and TRANSCO on 7th week of every year.

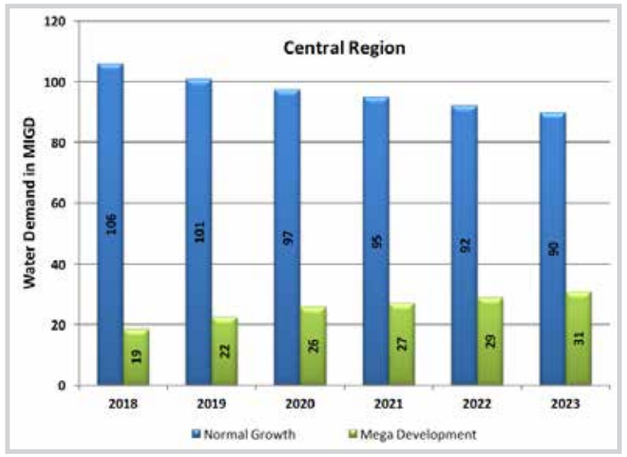
ADDC had projected its capacity built-up forecast for distribution system expansion plans based on the updated

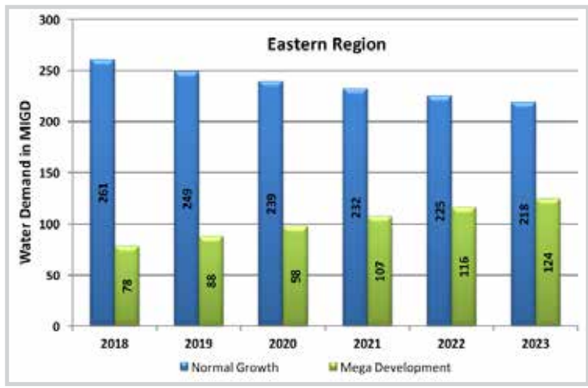
information received from various stakeholders. ADWEC has prepared the final Demand Forecast for TRANSCO and DISCOs to facilitate expansion of their networks based on the DISCOs data provided to TRANSCO on 48th week of 2017 and submitted to ADWEC by TRANSCO. Subsequently, ADWEC has prepared the ADDC Most Likely Water Demand Forecast, which is included as part of Appendix XI.

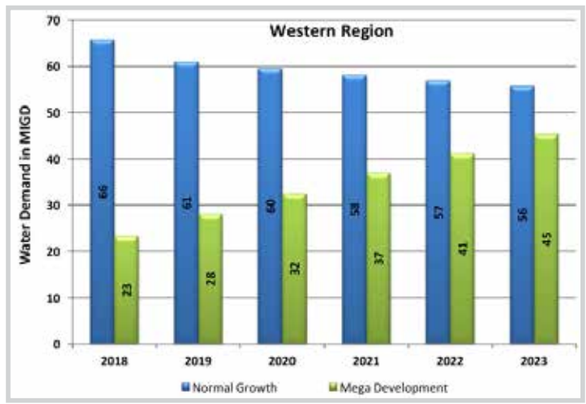
The below charts indicate the graphical representation of ADWEC's Demand Forecast with necessary breakdown for ADDC jurisdiction.











4.4 Water Balance Analysis

Water Balancing and Accounting is the first essential step in the assessment of volumes of Non-revenue water and the management of water losses in potable water distribution systems. A global water balancing for ADDC network can be done considering the total quantity of water invoiced by ADWEC & TRANSCO against the total quantity of water metered at the customer end. Water Balancing and accounting is the first essential step in the assessment of volumes of Non-revenue water and the management of water losses in potable water distribution systems. Upon installation of interface meters, district / area meters and sector meters, ADDC will carry out water balancing effectively for Major Feeder lines, Pressure Ring Mains and most of the distribution systems.

4.4.1 Methodology

In this year, ADDC concentrated to optimize different types of customer's data and reflect them in the appropriate cells of IWA format as indicated below.

IWA Water Balance 2017

<table>
<tr><td rowspan="6">System Input Volume (S.I.)</td><td rowspan="3">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td>Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="4">Non-Revenue Water</td></tr>
<tr><td rowspan="3">Water Losses</td><td></td><td>Unbilled Unmetered Consumption</td></tr>
<tr><td>Commercial Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td></td><td>Customer Metering Inaccuracies & Data Handling Errors</td></tr>
<tr><td colspan="2">Physical Losses</td></tr>
</table>

Based on the data collected from different resources like CC&B, Operational Data, HANA, and as per the revised definitions, Water Balancing has been carried out. As per the water balancing result, the total NRW is 9.96% of the input volume.

A detailed analysis has been carried out for each components identifying status, concerns, remedial actions and expected improvements with the proposed remedial actions.

Note: Water Balance Assessment is attached in Appendix XII. Following which, ADDC has undertaken several projects to achieve water balance equilibrium. The details of the relevant projects are attached in Appendix XIII.

4.5 Demand Side Management

ADDC has formulated various steps to campaign on Demand Side Management to reduce the water consumption. These campaigns are part of water conservation strategies initiated by ADDC and will enable to inculcate a sense of awareness and responsibility on the target groups. ADDC is regularly campaigning in schools to spread the message of water conservation and its significance. Through public media also, campaigns are being conducted to increase the awareness of water conservation.

ADDC has an ongoing consultancy project for the Demand Side Management. High level objectives of this Demand Side Management Program include the following:

- Raise awareness of the need for more sustainable use of resources;
- Provide the necessary incentives to all sectors of society to increase efficient use of resources;
- Achieve significant reductions in per capita consumption of electricity and water within Abu Dhabi;
- Reduce the gap between peak (summer daytime) electricity load and average load in order to make more efficient use of our generation and distribution assets.

A variety of initiatives are being planned or delivered under this programme including:

- Development and launch of the "Tarsheed" website providing routinely updated messages and information on how to more efficiently use water and electricity;
- Assistance to Government Entities in their efforts to reduce consumption in compliance with GSEC Circular No. 3;
- Launch of the Kafa'ati Initiative to reduce consumption in buildings for cooling and lighting;
- Launch of the Mosque Water Reduction Initiative to reduce water used for ablution purposes;
- Launch of an Early Leak Detection Initiative to enable leaks in residences to be identified and repaired more quickly;
- Launch of a pilot program to optimize water used for irrigation of gardens.

Following the initial pilot project for the "Masjidi" initiative in 2017, almost 400 mosques were retrofitted during Q2&3 2018. The excluded mosques are pending with AWQAF for various reasons such as renovations or demolition scheduled in the near future. The M&V to measure the savings achieved for these mosques is expected to be completed by the end of this year. Another key water DSM initiative is the VIP Palaces Irrigation pilots. A tender to develop business cases and run pilot projects in 8 palaces was awarded in July 2018 and is expected to be completed by Q3 2019. The "Kafa'ati" ESCO initiative, while primarily focused on energy savings through building retrofits, is also intended to target water savings. The first EPC tender under Kafa'ati, for six ADDC buildings was launched in September 2018.

4.6 System Capacity Forecast

System Capacity Built-Up is based on a Peak Factor on new development ultimate demands (Average Daily Demand) which should be checked against the WSR sizing criteria. For previous years, ADDC was using trend analysis technique1 to carry out System Capacity Forecast in which the future trend of the development of the demand was mainly dependent on the information available on the past development as well as the new expected project developments.

[1] The general practice of considering the available historical data for the same or more number of years for which the demand is projected and arrived at a reliable forecast.

4.6.1 System Capacity Built-up in line with Demand Forecast

ADWEC water demand forecast serves as the basic input for System Capacity Built-up projection. Following ADWEC demand forecast, the Distribution Companies enhance their system capacities applying area wise peaking factors in line with Water Distribution Code & prevailing guidelines. Based on the Demand Study and Consumption data analysis that provide consumption patterns for different categories carried out under hydraulic modelling project, the current peak factors have been validated.

4.6.2 ADDC System Capacity Built-up Approach

ADDC is currently using Trend Analysis, a widely accepted method, as a tool for forecasting works following historical data, extrapolating past consumption patterns into future with appropriate corrections necessitated due to the current global slowdown trend. Trending techniques involve fitting trend curves to basic historical data adjusted to reflect the growth trend itself. ADDC considers ADWEC approved Global Water Demand Forecast as a basis to enhance its regional distribution system by applying appropriate peaking factors using Water Distribution Code as per DOE guidelines, which in turn, augments the system capacity over the supplied quantity in aggregate.

The growth in demand is basically attributed to two main factors:

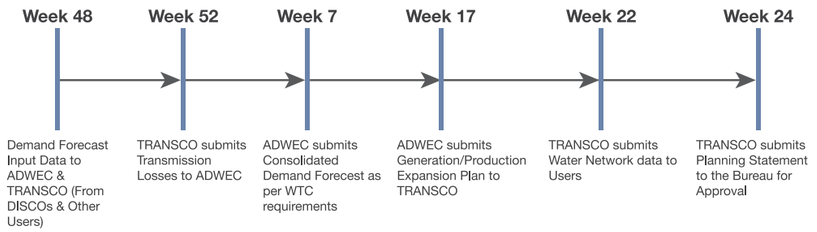
- New demands additions for major or special developments;
- Growing demand of the existing consumers; classified as Normal Growth.

The ultimate water demand detailed calculations submitted by various Developers are verified by ADDC in accordance with the projected population figures and the different categories of customers identified such as residential, commercial, hotel, etc. The per capita water demand for various categories is checked so as to be in line with the "Guide to Water Supply Regulations – Issue 3 (2017)" produced by DOE. Special cases (e.g. landmark developments) demands are evaluated based on detailed calculations submitted by the Developer/Developer Consultant.

ADDC has adopted the trending techniques to forecast the required system capacity to accommodate the demand of existing consumers. The total demand forecast for a short term will be the summation of the confirmed water supply requests in hand and the capacity forecasted by the trend method using the available data for the peak water consumption quantities for the last 14 years (2003 through 2017). This method is applied to individual areas to calculate the required capacity of distribution system. The total forecast up to year 2023 (the horizon year) is based on the rational extrapolation of the historical supply figures. The Flow chart for Demand Forecast confirmation, in line with WTC requirements, is as follows:

Chapter 3 Planning Code

Figure 2: The Timeline of the Data Exchange Arrangement



4.6.3 System Capacity Forecast to Area Level

The system capacity forecast shows the capacity to be built by ADDC needed to fulfill their customer requirements in future. In development of the network, ADDC has done the ultimate system capacity forecast up to area level under each of the different regions in order to provide the basis for verifying the need to develop future capital schemes.

ADDC demand forecast follows TRANSCO's defined pressure zones. ADDC groups the water demands of the identified developments under pressure zones and further cascades them down into various areas. Based on the area demand forecast, ADDC plans for the projects.

4.6.4 System Capacity of Mega Developments

The water demand estimates for Mega Developments have been provided by the Developers, after, in most cases, discussions with ADDC and ADWEA affiliates concerning realistic demand figures which are based on the guideline provided as part of the "Guide to Water Supply Regulations – Issue 3 (2017)" published by DOE. They are however, based on full occupancy of the Developments by residents. This is taking into consideration that the distribution system is designed for the ultimate demand. ADDC plans its system expansion based on ADWEC Demand Forecast.

Asset Management

5-Year Planning Statement 2019-2023

(Potable Water)

5. Asset Management

5.1 Asset Management Strategy

This Strategy provides a roadmap for the decomposition delivery of the "line of sight", initiated by Asset Management Policy to achieve the Vision of ADDC as detailed in the Strategic Plan. The scope of the Strategy comprises all assets related to the supply and distribution of Electricity and Water within the licensed area of ADDC.

The principal objective of the asset management is to guide the acquisition, use and dispose of distribution system assets to provide the level of service required by customers in a cost-effective manner, encompassing the strategic planning, utilisation, operations and maintenance, and disposal of all physical assets throughout its lifecycle.

Objectives of Asset Management Strategy:-

- Asset Management Strategy shall be consistent with the Asset Management Policy and the organization's strategic plan and other organization policies and strategies
- Asset creation based on Supply and Demand Policy shall be governed by 5 year planning statement. Investment prioritization and optimization of CAPEX expenditure shall be ensured during any Asset creation. A business case, which clearly explains optioneering based on cost-benefit analysis, risks and constraints, reliability and sustainability shall be authorized by competent authorities for initiation of any new projects.
- The 5 year planning statements shall be closely aligned with long-term plans of Abu Dhabi, set out in Abu Dhabi - 2030 Economic Vision. Also, a close coordination between upstream companies and other stakeholders shall be done to formulate a robust plan for a medium term horizon (5 years).
- Efficient and cost effective Operation and Maintenance of all key assets shall be accomplished by adopting Reliability Centred Maintenance (RCM) practices. The RCM module in Maximo shall be enabled and implemented to achieve this objective.
- Asset Lifecycle Costing and Asset Condition Assessment based on RCM program and criticality of assets shall be the decision-making factors for maintenance planning, refurbishment, replacement and disposal of assets. Strict implementation of the Asset Maintenance, Asset Replacement Procedure and Asset Disposal Strategies in decision-making process shall be ensured.
- Simple and effective monitoring of Asset performance by establishing appropriate KPIs and other performance indicators to assess performance. Projected targets of KPIs and other performance indicators shall be carefully monitored and achieved to match the regulatory requirements and the benchmarked best international practices.

5.2 Asset Management Plan

Asset Management Plan involves the following sub-contexts:

5.2.1 Asset Creation Plan

The assets are being created to meet the increasing demand where the existing capacity is limited. The demand projection is done in each year with respect to the historical consumption for normal growth and the requirement of mega developments. ADDC is required to meet with the projected demand. The new network or extension / rehabilitation of the existing network will be planned for implementation in each year through the approved CAPEX for such projects.

Following is the framework to achieve this plan:

- Developing planning statements aligned with the planning horizon of the Emirate of Abu Dhabi and complying with regulatory and other statutory requirements.
- Developing yearly Capital Expenditure (CAPEX) Plans for planned infrastructure and securing necessary funding, approvals and authorization.
- Adhering to clear and robust governance for project delivery that ensures the requirements and milestones are achievable.
- Ensuring full compliance with ADWEA standards & specifications, regulatory requirements and to meet end user requirements.
- Ensuring strict adherence to Health, Safety, Environment and Quality procedures to avoid any untoward incidents and to monitor the quality of service at various stages of the project by scheduled and unscheduled audits.
- Maintaining effective processes for the cost control of projects as they progress through the stages to avoid change in scope.
- Ensuring project quality by review of the construction methodology, quality control inspections, audits and performance assessments.
- Analysing the project delivery stages and obtain feedback from end-users for lessons learned to inform the delivery process.

5.2.2 Asset Operation Plan

The water operation plan is to operate the assets efficiently and effectively to utilise and optimise the life cycle of an asset. It is mainly done by supplying the capacity required under ADDC jurisdiction. The capacity required to be delivered is based on the forecasted quantity of water every year. ADDC is responsible to meet with the increased demand it goes through every year. The forecasted demand forecast can be planned by considering last year's actual weekly consumption for every sector along with checking how much the overall consumption has increased for each sector between January and December. The main objectives of the Operation Plan are to continue to:-

- Improve the operational performance and its efficiencies.
- Improve return on assets.
- Decrease costs and risk related to operating those assets
- Decrease Network Losses.
- Ensure the availability of information to improve decision making

5.2.3 Asset Maintenance Plan

The water asset maintenance plan is decided by adoption of the water maintenance manual that is developed by Water Asset Performance and Water Operation and Maintenance. The Water Maintenance Manual is a detailed description of schedules and tasks of different types of corrective and preventive maintenances to be performed on water ADDC assets during the required timeline while taking into consideration the RCM (Reliability Centred Maintenance). RCM is a process used to ensure that an asset's condition continues to operate as it is required. The objective of this Water Maintenance Manual is to define tasks and frequencies of maintenance that will be undertaken to:

- Protect the assets, in order to optimise and complete their designated life cycle.
- Implement a maintenance regime by ensuring optimised inspection, condition monitoring and preventive maintenance activities

- Guarantee security of supply.
- Ensuring maintenance of assets are recorded consistently.
- Protect water quality at all times.
- Reduce physical water losses.

5.2.4 Data and Information Plan

ADDC is committed to identify and analyse asset data through the asset life cycle to enable decision making for creation, operation & maintenance, and disposal by creating and maintaining asset data and information in the enterprise systems with adequate reporting capabilities to meet all business requirements and support decision making.

The plan is achieved through creating and maintaining asset data in enterprise systems as per the set of standard defined in the Asset Data Hierarchy. Asset data quality shall be maintained in enterprise systems based on the quality standards established and the data security shall be managed by user level data access/permission matrix in accordance with the DOE data management policy and standards.

5.2.5 Asset Disposal Plan

- During the appliance for PAS55 certificate, disposal has become one of the focal points of Asset Management. It is done to achieve the following objectives:-
- Maximize asset utilization and financial returns and minimize operational costs by disposing/recovering of assets at the right time in a transparent, efficient, effective and economical way.
- Systematically identify and deal with assets, which are in the disposal stage when they are surplus, fully depreciated, damaged materials or non-moving store items.
- Identify the procedure of dealing with every case an asset can go through in the disposal stage.
- Carry out asset disposals that are in compliance with ADDC policy.
- Update the condition assessment criteria to keep it in line with best international practices.

In order to achieve those objectives, a new plan was set for the current years, which are as follows:

- Clearly define and document a practical and effective disposal procedure.
- Define and apply the condition assessment.
- Differentiate between end of life and recovery stages.
- Clearly categorize the options available for end of service and recovery stages.
- Recovering Assets to a secure location for non-operational assets.
- Link the disposal strategy and process to other interrelated strategies and processes available.

5.2.6 Risk Management Plan

(i) Risk Management Policy:

ADDC is committed to plan, develop, maintain and operate a reliable, secure, safe and cost effective distribution system across our licensed area within the Emirate of Abu Dhabi, and deliver services that meet or exceed customers' expectations.

Through this policy, ADDC aims to increase awareness of the need of risk management and provide a common risk management framework to manage all business risks across the enterprise.

This policy forms part of ADDC's internal control and corporate governance structure and is an integral part of good practice asset management.

The policy aims to:

- Ensure that risks are identified, analysed and prioritised so that appropriate proactive response planning is developed and implemented.
- Manage risk in a proportionate and timely manner in compliance with all legal, regulatory, statutory and business obligations.
- Identify and reporting major emerging or escalating risks that may be outside the business's control to permit timely development of appropriate response strategies.
- Make informed and risk- based decisions to create, operate, maintain and dispose assets across the business.
- Maintain a sound system of internal control and escalation by considering all risks to safeguard shareholder investment, customer service and the company's assets.

(ii) Risk Management Strategy:

Risk management strategy is required to facilitate a consistent trade-off between performance, cost and risks by following best international practices and standards and to obtain credible results that can be relied upon by ADDC management to make robust business decisions.

The plan is to implement risk management system is to minimize uncertainties and informed risk-based decisions, the main risk process include:

- Identifying, recording and assessing risks;
- Qualifying those risks in terms of the effects they have on the company objectives;
- Assigning a risk owner with the appropriate span of control to each risk;
- Ensuring that an appropriate risk response plan is in place;
- Monitoring and controlling identified risks in terms of risk treatment and changing circumstances.
- Ensuring there is continuous improvement of the risk management system to the benefit of ADDC.

The ADDC risk management framework is shown in the diagram below. It shows how each level of management, including the Board receives appropriate and regular assurance about the management of risk within their span of control. This framework ensures that the appropriate management teams are provided with sufficient information to allow them to plan actions with respect to risks where:

- The risk is not acceptable;
- There is assurance about risks which are considered to be acceptable or under control;
- Important risks/ issues develop suddenly or emerge and need to be escalated.

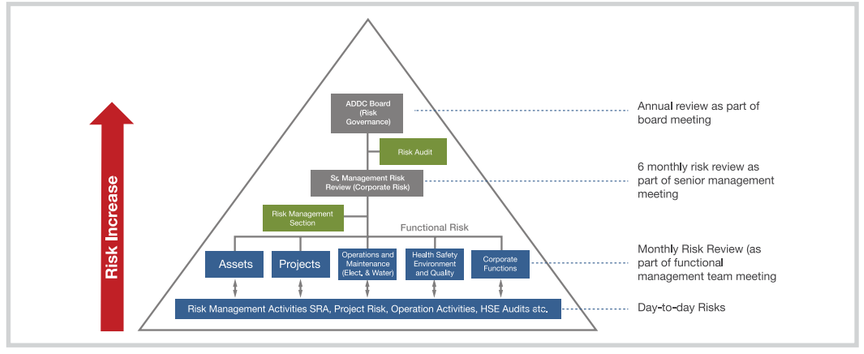


Figure 1 - ADDC Risk Management Framework

5.2.7 Asset Lifecycle Cost Plan

Asset Lifecycle cost plan is to implement the asset life costing procedure that was recently adopted. The main reason for adopting Asset life costing procedure is to compare maintaining a desired level of service at the lowest life cycle cost with the most appropriate cost for replacing an asset. It helps in making decisions in a timely matter, which would result in delayed investments.

The process for computation of Life Cycle Cost is as follows:

Step 1: Determine useful life cycle of an asset based on estimated length of time during which the asset is able to deliver a given level of service.

Step 2: Estimate value of each cost element that will be incurred in every year.

Step 3: Calculate Net Present Value of each element, for every year (over its time period)

Step 4: Summation of Present Values (PV)

Step 5: Analysis

Asset Life cost analysis can be completed to help determine whether the asset should be maintained or replaced, taking into account specific energy and asset efficiency.

5.3 Condition Assessment & Risk Criteria

Water Asset Condition Assessment reflects the physical state of the asset, which may or may not affect its performance. The performance of the asset is the ability to provide the required level of service to customers. Generally, this can be measured in terms of reliability, availability, capacity, and meeting customer demands and needs. All of this is critical for determining the remaining useful life of an asset and more importantly the timing for possible intervention steps to bring levels of service, provided by the asset, back to a desired standard. The current criteria of the condition of water assets are determined by the following procedures:

5.3.1 Water Asset Replacement Procedure

The major portion of existing water distribution network in Abu Dhabi has been constructed between 10-35 years. For many pipelines, technical specifications have changed after this period. The Operation and Maintenance Division indicated that the condition of older portions of the existing water network is deteriorating and pipelines need rehabilitation and/or replacement.
ADDC requires evaluating the condition of the existing water distribution network and preparing a plan for the implementation of an effective program for the rehabilitation and/or replacement of the waterlines in Abu Dhabi based on a set of pre-defined criteria.

The main reason of replacement is the failure of assets in which they reach a point where no reasonable amount of maintenance will improve safety, reliability, and maintainability of the equipment. Despite performing maintenance according to developed plans, distribution assets do ultimately fail and reach a point where no reasonable amount of maintenance will improve safety, reliability, and maintainability of the equipment. To ensure that ADDC Water assets are replaced in time before the assets become unsafe or incapable of delivering the reliable service, Asset Replacement plan is developed to do so.

Major Factors, which rule replacement strategy:

(i) Asset Criticality:

Asset Criticality defines the importance of the equipment to the business and associated Consequence of Failure. There are six factors that are considered for defining the criticality of the equipment:-

- Population served
- Type of Customer
- Spare availability
- Cost of Replacement
- Mean Time To Repair
- Special Network Criticality

(ii) Asset Condition:

Asset condition has been classified for each asset class. Essentially, the Asset condition is a criteria of combining information (such as Age, Serviceability, Ambient Condition, Operational Safety, Performance Issues, test results, inspection result etc.)

(iii) Risk Analysis:

The risk analysis involves an estimation of the level of concern with the potential failure of components within each asset class. This involves an assessment of the probability of a failure reflected by asset condition and estimating the severity of the consequences in the event of such a failure (Asset Criticality). Components in poor condition and with severe consequences upon failure would be targeted for replacement first.

Asset Risk Number = Asset Conditions X Asset Criticality

Accordingly, an Asset Risk Number is computed based on which replacement plan shall be prioritized:

Asset Risk Number (ARN)	0- 15	15-40	40-60	60 - 80	80-100
Replacement Plan	No replacement plan in 5 years. Lower Maintenance priority	No replacement Plan in 5 years, Regular maintenance	Include in the 5 year plan with lower priority. Higher maintenance priority	Include in next year CAPEX. High replacement priority	Urgent Execution Required for replacement

The asset risk number finds out an estimation of when the replacement needs to take place if required and adopt it to the replacement plan.

For accomplishing the above objective, ADDC has undertaken/planned to undertake Condition Assessment studies and Central Region, Eastern Region and Western Region.

The following Condition Assessment projects have so far been undertaken by ADDC (Asset Investment & Performance Department).

a) Contract No. D – 9641: Condition Assessment and Energy Management Survey of ADDC Pumping Stations.

The main objective of this project was to develop a methodology to provide consistent information to ADDC – AMD/ AIPD on the condition of Pumping Stations and its connected accessories, Hypo Chlorination Plants & Water Tanks etc. to extend the life of company asset through prioritized maintenance planning. Based on the output of this survey, action plan was prepared to implement projects in line with the recommendations of the study.

Projects taken up as per the Action Plan prepared following the Recommendations of the Study:

1. Rehabilitation of the Pumping System for Sea Palace Pumping Station of Central Region
2. Refurbishment of existing Pump Stations located in Sea Palace, Jubail Island, Al Hail Island, Samha East and Samha West area of Central and Eastern Region of ADDC and Refurbishment of existing RCC Water Reservoirs in the Central, Eastern, Western region Pumping Stations.

b) Contract No. D – 9838.1: Condition Assessment of Water Distribution Network in the Central Region of Abu Dhabi Island

A large extent of the existing water distribution network in Abu Dhabi Island has been constructed over the last 30-35 years. Operation and maintenance reports indicate that the condition of the older portions of the existing network is deteriorating and pipelines may need to be rehabilitated or replaced.

To address the above need, ADDC commissioned MWH, in May 2010, to undertake a Condition Assessment of the water distribution network on Abu Dhabi Island. The overall objective of the project is to quantify the condition of the network in 52 sectors and identify pipes that need to be rehabilitated / replaced in the most cost effective manner. These sectors are spread throughout the Central Region of Abu Dhabi Island.

Conclusions of the Condition Assessment Study in Central Region

The Condition Assessment study report presents an assessment for the optimized replacement and rehabilitation plan for the 52 study sectors. The plan highlights where and when proactive intervention is required in an optimized priority list of assets. Further, the assessment has also grouped assets which have very low consequence of failure to allow these to run to failure.

The optimized plan is produced by assigning weighted scores against consequence and probability to produce a risk score. From the analysis of additional data obtained from trial pits and CCTV surveys, assets of a high consequence were given a suitably high priority. The filters also removed assets with a low consequence and placed them in the priority group allowing run to failure or re-assess. The assets are divided into the following priority groups:

- Priority 1 – schedule replacement within the next 3 years
- Priority 2 – schedule replacement within the next 4 to 10 years
- Priority 3 – schedule replacement after 10 years or undertake reassessment
- Priority 4 – no pro-active intervention or undertake reassessment (if consequence increases)

Based on the recommendations of the study, AMD/Water O&M Division finalized an action plan and prioritized replacement projects in various sectors of Central Region. Accordingly, Replacement Projects to be taken up for implementation in different years have been included in the 5 Year Investment Plan of ADDC, as part of 5 Year Planning Statement prepared annually.

The existing asset rehabilitation/replacement criteria for DI pipes is attached in Appendix XIV. Updating of this criteria, developing new criteria for high density polyethylene (HDPE) pipe along with developing the risk-based criteria for selecting pipes for condition assessment are included under the contract D-103291 - Condition Assessment of Water Distribution Network in the Western Region of Abu Dhabi.

c) Condition Assessment of Water Distribution Network in the Western Region of Abu Dhabi – Contract D-103291

The entire existing water distribution network in the Western Regions of Abu Dhabi has been constructed over the last 25 years. Operation and maintenance reports indicate that the condition of the older portions of the existing network is deteriorating and pipelines may need to be rehabilitated or replaced. The need has been growing for the Abu Dhabi Distribution Company (ADDC) to develop a renewal plan due to more stringent service levels enforced by the regulator (Regulation and Supervision Bureau), namely, more stringent water quality requirements, increases water demand due to new developments, and increased accountability towards the public.

To address the above need, ADDC commissioned MWH, in March 2014, to undertake a Condition Assessment of the Water Distribution Network in the Western Region of Abu Dhabi. The overall objective of the project is to quantify the condition of the network in the Western Region of Abu Dhabi and identify pipes that need to be rehabilitated / replaced in the most cost effective manner. The project scope covers the condition assessment of the assets in the Abu Dhabi Western Region.

In stage 1 of the project, a risk-based inspection strategy was developed to select a set of candidate pipelines from above areas. The selected pipelines were then prioritized for condition assessment based on their perceived level of risk. The perceived risk associated with each candidate pipeline was based on indicators for likelihood and consequence of pipeline failure. Stage 2 of the project included an inventory assessment.

Stage 3 of the project used a range of techniques to assess the internal and external condition of the pipe lines that were prioritized in stage 1. Internal condition assessment was carried out along the pipelines that were identified in Phase 1. The CCTV surveys were conducted using a novel in-pipe CCTV camera technique where the camera is inserted into the live water pipelines through existing fire hydrants. External condition assessment was based on data recorded from trial pits, soil analysis and ultrasonic pipe wall thickness measurements. Locations for trial pits were chosen to target those areas of a pipeline where external surface corrosion was considered likely or where highlighted by the internal CCTV survey.

Stage 4,included Developing risk based criteria for prioritizing rehabilitation and/or replacement and few updates were added to the PAN criteria used in stage 1, in order to increase the accuracy of the results and in terms reduce the overall cost. The proposed criterion for condition assessment has been developed based on the followings:

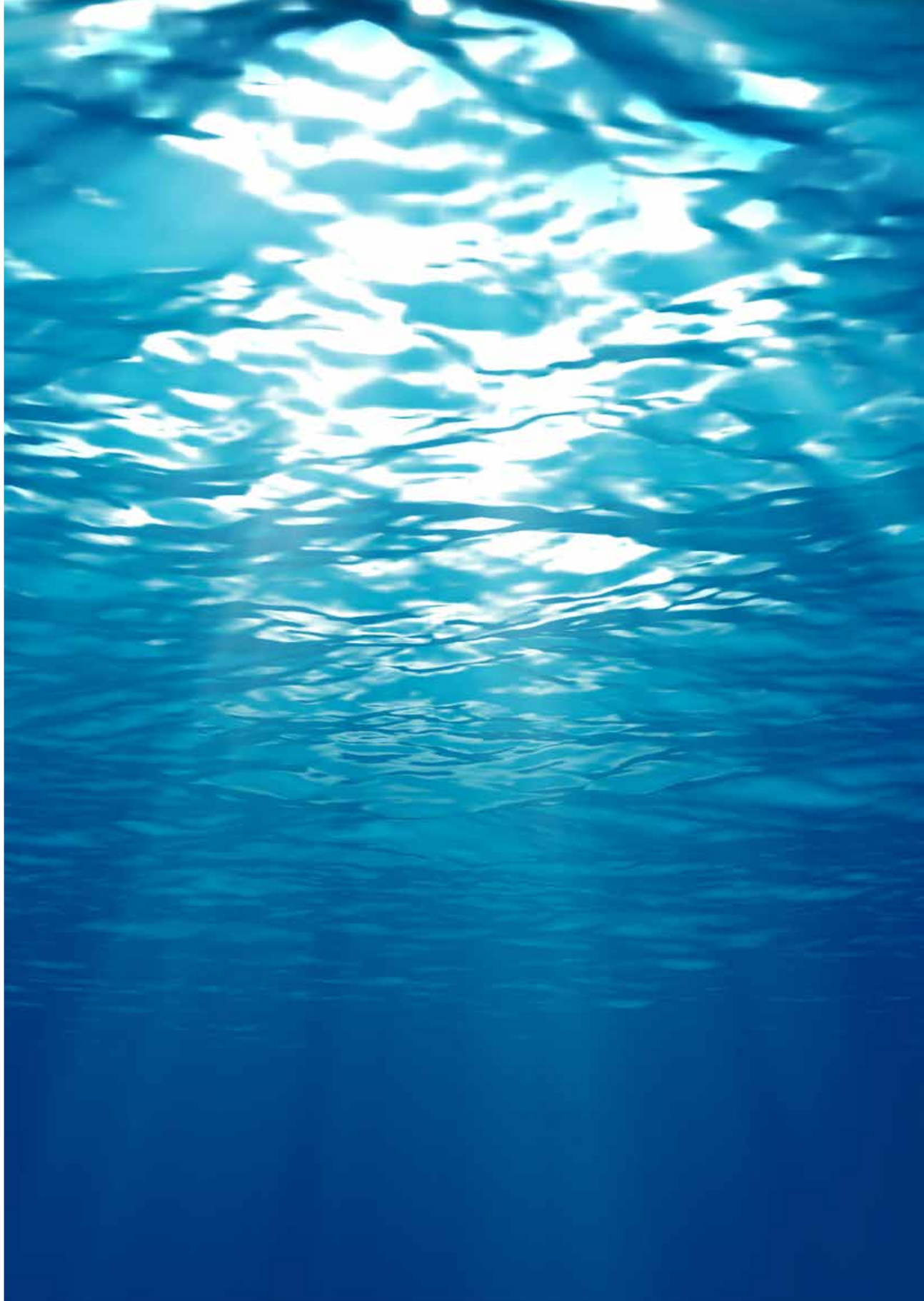
- International best practices and standards
- International water company practices
- MWH varied experience in the field of condition assessment and asset management in UAE and around the world
- MWH best engineering knowledge and experience
- Related references as it has been listed in the report
- Considering ADDC Asset Replacement Procedures

- Risk Method has been also developed in alignment with ADDC Assets Risk Management Procedure
- Each particular test has been linked with the relevant standard and reference

The optimised replacement plan has been produced by assigning weighted scores against each input to the overall PAN. As well as the asset specific data, a set of trial pits and CCTV surveys were undertaken to gather additional data to assist in this assessment. The assets were assessed based on stage 4 PAN score. Certain PAN criterion was chosen to have high accuracy in prioritizing the pipes. The assets are divided into the following priority groups:

- Pipelines in priority 1 shall be included in the short-term plans of network replacement program (within the next two years).
- Pipelines in priority 2 shall be included in the medium-term plans of network replacement program (within the next 2 to 5 years).
- Pipelines in priority 3 shall be included in the medium-term plans of network improvement program (within the next 5 to 10 years).
- Pipelines in priority 4 shall be included in the long-term plans for system improvement.

The analysis of trial pit data showed how important the quality of protective layer was. A well-installed, undamaged, sleeve seemed to provide protection against most of the soil corrosivity indicators measured and analysed. As a result, an increased level of quality control and site supervision may result in reduced levels of corrosion in all but the most corrosive soils. For new ductile iron pipelines ANSI/AWWA (American National Standard for Polyethylene Encasement for Ductile Iron Pipe Systems) soil assessment should be carried out, this will assess the soil corrosivity and determine the required protection system.



6

Connection Opportunities

5-Year Planning Statement 2019-2023

(Potable Water)

6. Connection Opportunities

6.1 Existing & Future Developments

One of the core objectives of ADDC is "To support the rapid development of Abu Dhabi Emirate as the utility service provider of choice". ADDC is committed to supply potable water to the customers under its jurisdiction following the license regulations and in compliance with its commitments in terms of the readiness to handle the new requests for water supply whenever encountered.

The drawings included in Appendix XV illustrate the existing water distribution network spread over Abu Dhabi Emirate. ADDC distribution network has adequate capacity to accommodate a reasonable potential water demand of Central Region. Eastern Region is experiencing rapid growth in terms of the Developments and ADDC has taken up adequate measures in order to expand its distribution network to meet the growing water demand. On the other hand, Al Dhafra Region, which contributes a major part of economy of the UAE, anticipates water supply for new Master Plan for major cities in accordance with Al Gharbia Plan and for Oil and Gas fields as well as Irrigation purpose requested by Al Dhafra Region Municipality. ADDC has taken its maximum efforts to supply the existing customers and trying its best to upgrade and augment its distribution system to cater to the identified prospective demand.

The drawings showing the projects included under CAPEX 2018 is attached in Appendix XVI. The future developments are shown in the Investment plan 2019-2023 in the Appendix XVII.

6.2 Mega Developments

Mega Developments, both Government and private funded spread all over the Abu Dhabi Emirate in line with the Plan Abu Dhabi 2030. Once the source of water for the mega development is approved by ADDC, the water distribution infrastructure works for Mega Development Projects were normally executed by the Developer by appointing his Consultant/Contractor. ADDC is overviewing the design and execution of the project to ensure that they are being constructed to DOE/ADDC Standards and Specifications. The assets are generally transferred to ADDC later in accordance with the standard handing-over procedure No. PR.AMD.10. The summary list of Mega Developments and drawings are provided under Appendix XVIII.

ADDC has so far taken over the below mentioned Mega Development projects following the approved procedure for Handing-over of Distribution Network Assets (Electricity and Water) - Appendix XIX:

1. Al Falah Community Village
2. Al Reem Island (Package 01)
3. ADNEC Phase IV - Capital Centre
4. Yas Island
5. Emirati Housing on Yas Island
6. 48 Villas in MBZ City
7. Al Maryah Island Phase 1
8. Rawdat Abu Dhabi
9. Motor World (Phase 1)

6.3 System Constraints

ADDC is committed to provide safe potable piped water to all the customers. The aim is to supply piped water on a 24-hour basis to all customers with adequate pressure/ head in accordance with water quality parameters. In case of new water distribution networks designed the requirement is to provide water with a minimum of 1.25 bar head at the end service main to which the customer is connected. However, in some locations in the ADDC water distribution network following system constraints are experienced:

6.3.1 Madinat Zayed – Liwa Water Distribution Network:

This distribution network in the Western region is presently dependent on two transmission pipelines originating from Mirfa and supplying through the pumping stations at IPS1, IPS2, Madinat Zayed and Mezeirah (Liwa). There were two transmission pipelines DI.900 and 800 CS supplying water up to Madinat Zayed. Recently laid DN 1200 pipeline to recharge the aquifers at Liwa has enhanced the transmission supply to Madinat Zayed and summit tank. However, there is still transmission capacity constraints between the summit tank and Mezeirah.

Action Plan:

TRANSCO has completed the Lot 1 upgrading of the transmission system from Mirfa to Madinat Zayed which includes construction of CS 800 pipeline from Mirfa to Madinat Zayed. The Lot 2 works includes extension of transmission pipeline from summit tank to New Mezeirah Pumping Station and from Jabana (Liwa East) to Quesahwira Palace, which is currently under awarding stage (N-12192). Moreover, in line with TRANSCO project, ADDC has a planned project to serve Liwa with continuous water supply. The project is estimated to be completed by 2022.

6.3.2 Western Region – Coastal Areas:

Along the coastal area in Western Region, especially in areas like Radeem & Haramiya, there are some developments whose status is temporary as per the categorization of DMA. As ADDC does not provide permanent water network for temporary developments, at present these customers are supplied by water tankers.

Action Plan:

ADDC has initiated a project for the water supply to Radeem & Haramiya, which is currently under Consultancy tendering stage and the project is likely to be completed by 2021. Moreover, there is a new project planned to supply remaining coastal areas in Al Dhafra Region under CAPEX 2018.

6.3.3 Abu Dhabi – Al Ain Highway Area:

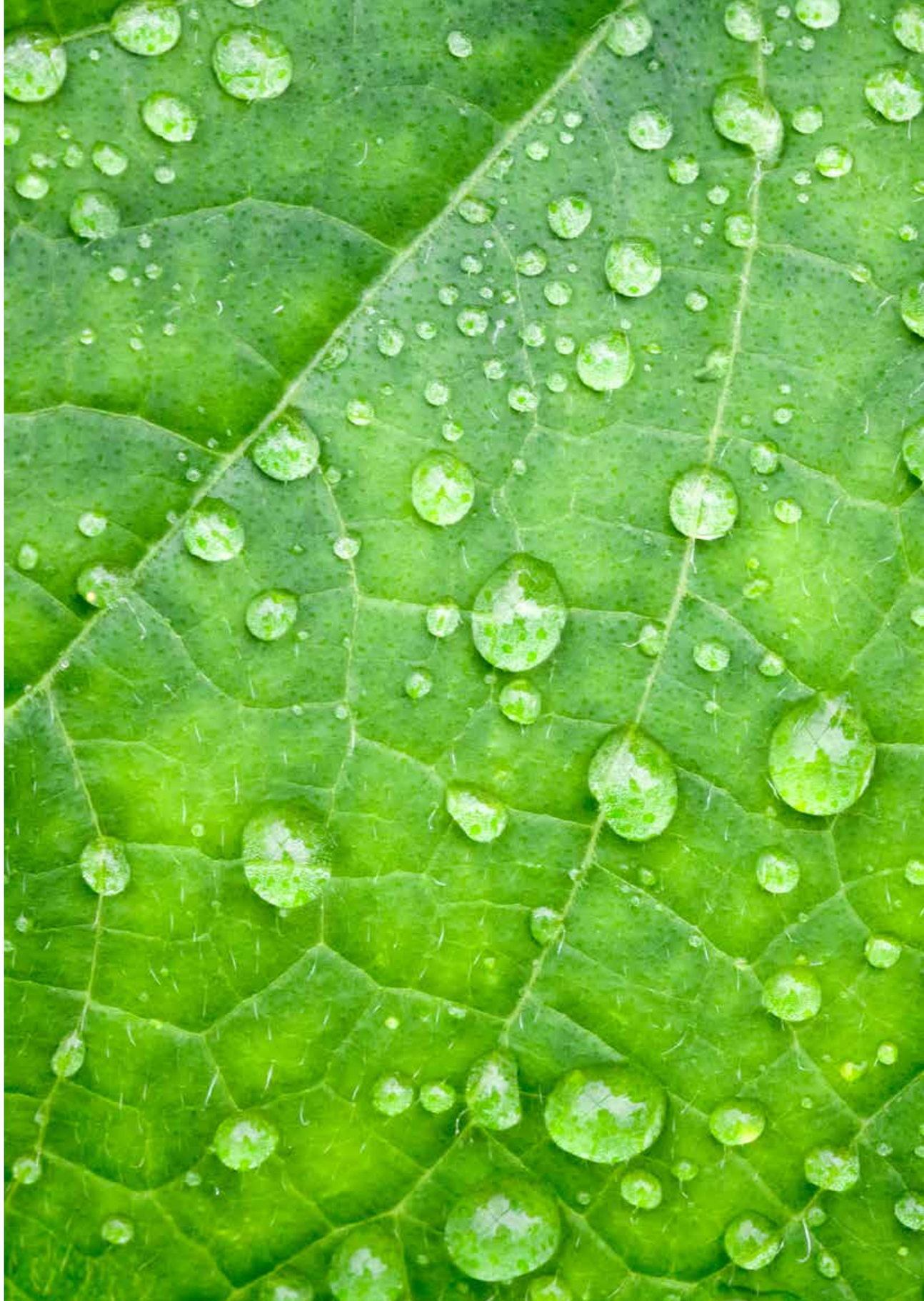
The distribution system for this area excluding Al Wathba Palace area is presently dependent on the DN 1000 transmission main originating from Unit IV pumping towards Al Ain. Out of the total capacity of 19 MIGD for this transmission scheme the majority of the quantity is transmitted to AADC distribution and only 2.6 MIGD is available for ADDC distribution. Presently, there are requests for special water demands for various large privately owned farms. However, due to the unavailability of required quantity of water ADDC is unable to supply water, at present. The list of identified special water demands is shown in Table below:

System Constraints – Abu Dhabi-Al Ain Highway Area

S. No.	Area	Demand (MIGD)	Remarks
1.	Al Khatim	2.50	Current restricted supply = 1.00 MIGD (2.46 MIGD)
2.	Buteeb Endurance Village	2.00	Current restricted supply = 0.30 MIGD (0.53 MIGD)
3.	Ghuweiliat	0.50	Nil
4.	Al Wafia Farms	1.00	Current restricted supply = 0.40 MIGD (Nil)
5.	Zahrat Al Teeb Farms	2.00	Current restricted supply = 0.70 MIGD (Nil)
6.	Buteeb Stables	1.00	Current restricted supply = 0.40 MIGD (0.53 MIGD)
7.	Buteeb Forest	0.50	Nil
8.	Majola Forest	0.30	NIl
9.	Al Qaima Farms	0.50	Nil
10.	Abu Touq Forest	0.50	Nil
11.	Al Faya Farms	1.00	Nil
12.	Al Faya Crown Tank	0.50	Nil
13.	Nahda Al Jadeedah Farms	1.00	Nil
14.	Al Nahda Askaria Farms	0.50	Nil
15.	Al Wathba Farms	1.50	Nil
16.	Endurance (Qudra) Village	1.00	Nil
17.	Razeem Prison	0.20	Nil
18	Razeem Farms	0.50	Nil
19	Ud Al Hawaa	2.50	Nil
TOTAL	**19.50**		

ADDC has recently awarded a Consultancy Contract (D-107038: Consultancy Services for Design, Review, Tendering, HOS and Site Supervision for the Construction of Recycled Water Mains in Abu Dhabi – Al Ain Road) to supply the farms with Recycled Water. Upon completion of the project by 2022, most of the irrigation demand will be supplied from this project. The project has a capacity to meet farm demands along Al Ain Road (between Al Wathba Palace & Al Khatim: 79,243 m3/day = 17.43 MIGD) & Downstream of Al Khatim PS: 170,757 m3/day = 37.56 MIGD). As a part of this project, the potable water saving for ADDC would be around 5.5 MIGD to Al Wathba Palace tank.

Additionally, upon establishing transmission source to supply AADC demand from Al Ain Reception by TRANSCO, existing DN 1000 Shubaishi pipeline will be available for ADDC to cater its demands along Al Ain Road. This will add on approx. 16 MIGD transmission capacity. Accordingly, ADDC can plan for supplying new Development demands at Al Riyadh, Al Faya and Razeen area based on the availability of water.



7

Capital Expenditure

5-Year Planning Statement 2019-2023

(Potable Water)

7. Capital Expenditure

Asset Management Directorate (AMD) on behalf of ADDC undertakes the Capital Investment Planning (CIP) on an annual basis. In AMD, Asset Programme Management Department (APMD) is responsible for the preparation of Annual CAPEX by coordinating with other Directorates/ Departments within ADDC including Finance Department. The concerned Directorates/Departments will provide the project proposals for Annual CAPEX in the prescribed template to APMD after identifying projects in line with the ADDC's approved strategic goals and initiatives. The list of projects are selected based on the outcome of evaluation of projects through necessary business case preparation involving appraisal of technical feasibility and financial viability.

Projects are classified mainly under four strategic pillars of ADDC namely, Growth and Sustainability (GS), Operational Excellence (OE), Customer Delight (CD) and Performance Driven Organization (PDO), which are further cascaded down to appropriate objectives, goals and ultimately to initiatives of the corresponding strategic pillars.

In line with ADDC 7-Year Water Demand Forecast, which is prepared during 48th week of every year, and also based on customer requests received from time to time during the year, Load Related/ Growth Oriented projects will be identified for developing new network/enhancement of existing network. The proposals will be finalized after proper technical scrutiny and financial analysis. Asset Replacement projects are identified based on the outcome of the Condition Assessment Studies and in line with ADDC approved Rehabilitation/ Replacement Criteria and consistent with ADDC's approved initiatives evolved from the Strategic Pillar of Operational Excellence included in the approved ADDC Strategic Plan 2016-2020. System Improvement projects are also proposed based on the requirements received from Operation & Maintenance wing of ADDC.

The processing of CAPEX proposals for the forthcoming year starts as early during May/June of the current year. As per the rule, the budget for the projects, which are not awarded in the current year, will not be allowed to be carried over to next year. Hence, it is a common practice to include those projects also under the next year CAPEX assuming that these projects will not be awarded in current year. Consequently, an overlap of the budget is occurred in each year due to the rolling over of the projects.

Upon CAPEX approval, the identified projects will be initiated in the respective quarter of the year in which that have been planned.

7.1 Quantification of the Capital Expenditure

Total planned cash flows of CAPEX 2017 projects under three categories viz. Normal Growth, Replacement and System Improvement are given in the following table. Also, the total net cash flows before and after the rolled over/cancellation of projects are segregated and presented in the table below against each category to have more clarity.

7.1.1 Load Related Projects for Normal Growth

Under this category, there are 16 projects having a total estimated budget of AED 1,269.50 Million with year-wise cash flow (in Million AED) as given in the Table below. Out of the 16 projects, one project (Water Supply to Bida Mutawa from Ghayathi Pumping Station in Western Region) was rolled over to 2018 and another project (Water Supply to new areas in Liwa in Western Region) was cancelled. The breakdown of the cash flow showing the cash flow of the rolled over project and the cancelled project and the resulting net total cash flow are also given in the Table below:

Year	2017	2018	2019	2020	2021	Total
Total Cash flow of all the projects						
Amount (in m AED)	121.40	529.08	470.06	128.85	20.13	**1,269.50**
Total Cash flow of the rolled over projects						
Amount (in m AED)	3.18	25.40	20.96	10.80	3.18	**63.50**
Total Cash flow of the cancelled project						
Amount (in m AED)	3.75	10.00	10.00	1.25	0.00	**25.00**
Net cash flow deducting rolled over and cancelled projects						
Amount (in m AED)	114.47	493.68	439.10	116.80	16.95	**1,181.00**

7.1.2 Non-Load Related Projects

(i) Replacement/Refurbishment/Reinforcement Projects

The number of projects under this category is two with an estimated cost of AED 10.00 Million. The year wise total cash flow (in Million AED) is given in the following table:

Year	2017	2018	2019	2020	2021	Total
Total cash flow of all projects						
Amount in m AED	1.50	2.50	2.50	2.20	1.30	**10.00**

(ii) System Improvement Projects

There are seven projects identified under this category with a total estimated budget of AED 649.86 million. The year wise total cash flow of System Improvement projects are given in the Table below:

Year	2017	2018	2019	2020	2021	**Total**
Total cash flow of all projects						
Amount in m AED	50.22	238.20	239.34	103.49	18.60	**649.86**

(iii) Customer Services Directorate (CSD) Projects

Customer Services Directorate (CSD) has initiated two projects under CAPEX 2017 and total cash flow of the projects is given in the following table:

Year	2017	2018	2019	2020	2021	Total
Total cash flow of CSD projects						
Amount in m AED	15.00	35.00	17.50	12.50	-	**80.00**

7.2 CAPEX 2018 Projects

Under CAPEX 2018, Water Planning Department (WPD) has planned 15 projects, Asset Performance Department (APD) planned 4 projects and Customer Services Directorate (CSD), 2 projects. Of the 21 projects included in 2018 CAPEX plan, 10 are under the category of Normal Growth, 5 under the category of Replacement Projects and 5 under the category of System Improvement Projects. In addition to the above, CSD has planned two projects. CAPEX 2018 projects planned by Water Planning Department, linking to their principle drivers is attached under Appendix XVI.

7.2.1 Load Related Projects

There are 10 Load Related projects included in CAPEX 2018, linked to the Organisational Strategy of Growth and Sustainability. The year-wise cash flow for the projects under this category is given in the Table below:

Year	2018	2019	2020	2021	2022	Total
Amount m AED	160.67	356.63	473.08	52.13	0.00	**1,042.50**

7.2.2 Non-load Related Projects

Under the category of Non-load Related projects, aligning with the Strategy of Operational Excellence, 6 projects come under Asset Replacement and 5 under System Improvement classifications. The year-wise cash flow for the two categories of projects are given in the Table below:

Year	2018	2019	2020	2021	2022	Total
Non-Load Related Projects: Replacement Projects						
Amount m AED	38.00	63.50	39.50	24.01	7.40	**172.41**
Non-Load Related Projects: System Improvement Projects						
Amount m AED	81.19	171.76	222.06	25.00	-	**500.00**

Customer Services Directorate (CSD) Projects

Customer Services Directorate (CSD) has planned two projects under CAPEX 2018 and total cash flow of the projects are given in the following table:

Year	2018	2019	2020	2021	2022	Total
Total cash flow of all projects						
Amount in m AED	60.00	60.00	35.00	-	-	155.00

7.3.2 Awarded Projects

During 2017-2018, ADDC has awarded 2 projects as listed below:

No.	Name of Project
1	New Construction of Tanker Filling Stations at Mirfa & Sila
2	Relocation/Upgrading of Mina Pumping Station at Sila

7.3 Five Year Investment Plan for 2019-2023

The identification of projects for 5 Year Investment Plan (2019-2023) has been aligned with ADDC 2016-2020 ADDC Strategic Plan.

7.31. Load Related Projects

The main strategies envisaged under Growth & Sustainability based on which Load Related projects have been identified are shown below:

1. Preparing distribution network growth plans that support the urban and economic growth of Abu Dhabi.
2. Building a smart and sustainable distribution network that meets the demand and supports rationalization of consumption.
3. Planning and construction of a smart, effective, robust and sustainable distribution network.
4. Building and managing the Smart Grid for the instantaneous control of the distribution network
5. Effectively managing and executing all distribution network growth projects

7.3.2 Non- Load Related Projects

The main strategies linked to the identification of Non-Related Projects are given below:

1. Safely operating and controlling the distribution network, maintaining a continuous efficiency of operation
2. To lead all operations with the highest excellence standards which shall crown the company as the quality model in Abu Dhabi
3. Fully complying with international standards and measures of quality and safety
4. The robustness of the periodic maintenance plans related to all elements of the network and instant response to emergencies and direct repair

7.4 Economic Analysis of Major Schemes / Business Case Documents

ADDC has planned new network expansion projects based on the latest water demand; identified and allocated by ADWEC. At the time of individual CAPEX project initiation, ADDC notifies the management with Scope of Works, Business Needs/ Justifications, Benefits, Risks etc. as a Business Case while submitting Budget Approval Forms for all the Projects. Subsequently, when the project advances to design stage further optioneering of the proposal is taken up and accepted on due scrutiny.

ADDC has the Enterprise Projects & Portfolio Management (EPPM) System and the business cases for all the new projects are being prepared and approved online through the system.

7.4.1 Regulatory Price Control (RC1)

The Regulatory Price Control (RC1) period is defined for 4 years; starting from 2018 until 2021. To address the deficiencies in the previous ex-post approach (project review after CAPEX approval) and to help companies improve capital efficiency in a timely manner, DOE/RSB proposed to have a more forward-looking approach whereby, DOE undertakes regular ex-ante CAPEX (Capital Needs) reviews and approve planned CAPEX projects and associated budgets.

To support DOE's new initiative, ADDC has modified the scope for appointment of Technical Assessor's (TA), in coordination and alignment with the DOE, to include CAPEX processes including CAPEX needs for 2019 – 2021 and CAPEX efficiency for 2016 / 2017 and 2018 / 2019. ADDC will submit the CAPEX forecast for 2018 – 2023 as part of the planning statement and will include both new and running development projects. In addition, ADDC will submit the network length data as requested by the DOE. Separately, ADDC will submit the CAPEX needs for 2019 – 2021 to the TA, which will include development projects, non-development projects, connection LTRAs and material requirements. ADDC will submit business cases for all new projects. The TA will evaluate the business cases and make a recommendation to a panel composed of representatives from ADDC / DOE / Engagement Partner. Outcome of the recommendation will then determine CAPEX allowances for 2019 – 2021.

7.5 Explanation of the difference between the Capital Expenditure in the reporting year in comparison with the one reported in the previous year

The list of all running water projects as per CAPEX 2017, showing the material difference between the actual expenditure undertaken in 2017 compared with the capital expenditure envisaged for 2017 and reasons for the variance is given in the stipulated template provided by DOE and attached as Appendix XX.