WORLD BANK GROUP

Mauritius Potable Water Sector Reform & PPP Advisory Services for Central Water Authority

Diagnostic Report – Final

July 2016

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Mauritius Potable Water Sector Reform – CWA Diagnostic Report - Final

1. Background

The Government of Mauritius (GoM) has requested the World Bank to provide Reimbursable Advisory Services (RAS) in the form of strategic advice and support for the design and implementation of a Public Private Partnership (PPP) for the Central Water Authority (CWA) and for potable water sector reform in GOM's territory. This shall include, amongst other deliverables, a study of the institutional framework and performance of the CWA, its operations and activities to date, an assessment of the risks associated with the most suitable PPP structure and a roadmap for the transaction and associated legal and institutional reforms, including terms of reference for transaction advisors.

The Bank's Advisory Services are not intended to be a full diagnostic of the water sector and PPP options in Mauritius but rather focused advice - largely based on looking at past reports and studies (such as a PPP feasibility study and due diligence of the IFC in 2003-4 (IFC 2004 Report)) as well as more recent work carried out by various consultants - to make strategic recommendations on the most feasible PPP option, key design features of the PPP schemes, and road map for the reform, taking into account most recent data available.

The World Bank appointed Jalakam Solutions Private Limited (hereinafter referred to as the 'Consultant') to undertake the diagnostic study focused on technical due-diligence for establishing the current performance status of CWA.

2. Objective

The objective of this study is to assist the project team in the analysis of the technical aspects of the proposed PPP reform, including (i) assessing CWA operational performance, (ii) reviewing and validating CWA's investment program, (iii) providing projections for revenues, opex and capex for the financial model, and (iv) providing inputs for the key design features of the PPP scheme.

The Consultant visited CWA during 14th -23rd March 2016 and 1st - 7th April 2016, and undertook technical and financial due-diligence and performance evaluation through a series of discussions with the senior management staff, review of existing study reports, as well as field visits and presents the findings hereunder.

CWA is responsible for managing the potable water to all the customers (domestic, non-domestic, commercial and industrial) in Mauritius as well as provision of non-treated surface and ground water for irrigation and business purposes. For the purpose of current study, the revenue data for both potable and non-treated water business is provided but the analysis is limited to the potable water business only.

3. Report Structure

The report presents the findings in three sections (i) Part 1 provides the background and summary of existing water supply services; (ii) Part 2 presents the summary on the CWA' operational performance and (iii) Part 3 provides the details of proposed service improvement plan with necessary proposals and costs including implementation timeline.

4. Review of existing water supply services

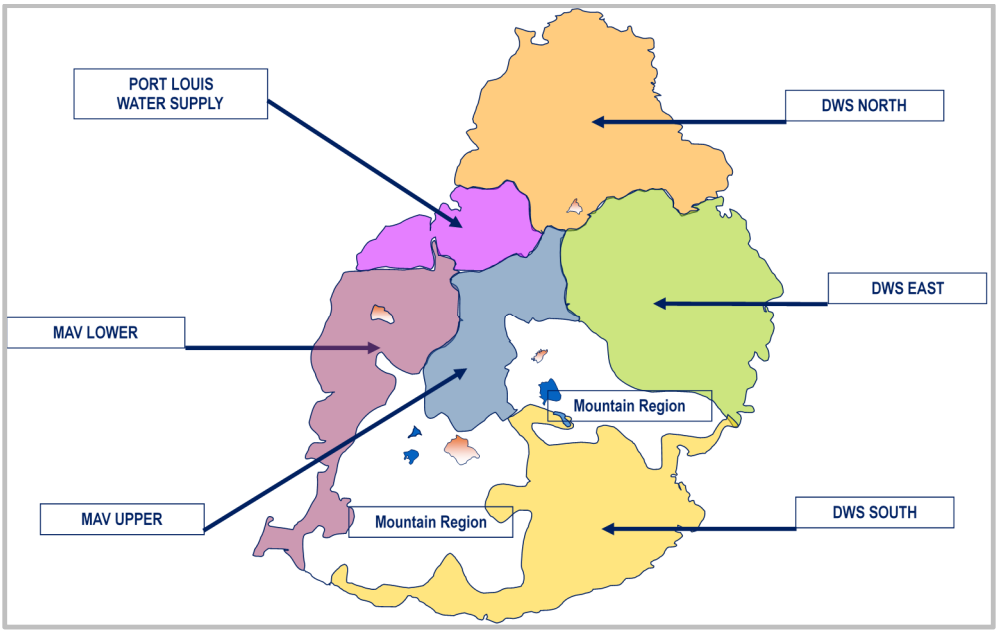
The Central Water Authority (CWA) historically had been providing a reasonable level of water services to the local population with over 99% coverage and meeting the growing needs of the developing economy. However, in the past decade, CWA had been witnessing lower than required performance in respect of managing water losses in the networks, resulting in operating inefficiency and increased rationing of available supplies to the customers. In turn this has led to hardship and increased risk to public health as well as rapid degeneration in the condition of infrastructure. This situation coupled with lack of demand management, low tariffs and inaccuracies in metering and billing is further affecting the service levels on a downward trajectory.

CWA had over the last couple of decades implemented a Non-Revenue Water reduction program by dividing the networks into District Metered Areas and undertaking periodical leak detection and repair. Despite the efforts, the level of Non-Revenue Water has generally remained at over 55%. During the period between 2004–6, CWA with funding from European Investment Bank hired Severn Trent Water on a short term technical service contract with limited improvement in performance. Recently CWA partnered with the consortium led by Singapore Cooperation Enterprise and implemented a focused NRW reduction program in MAV Upper zone. While appreciable improvements in data management and monitoring had been witnessed, as well as capacity building, this did not result in sustainable reduction in NRW and CWA continues with the intermittent water services in a substantial part of the service area. Works are ongoing for pipe replacement and so impact of the activity is not yet established.

4.1. Service Areas

CWA operations are divided into six geographically distinct operating zones as shown in the following figure[1].

Figure 1 – CWA Operating Zones



[1] Areas in white are mountain regions with protected forests and limited habitation

The summary of CWA infrastructure for potable water in each of the operating zones is shown in the following table.

Table 1 – CWA Infrastructure Details for Potable Water Business

	Code	Area	Population	Commuters	Consumers	Resources	Ground water	Surface water	Service reservoirs	Pipe Network
Operating Zone		Km2	Nos	Nos	Nos	m3/d	%	%	Nos	Km
Port Louis Water Supply	PLWS	36	130000	70000	49000	83000	40%	60%	14	450
District Water Supply- North	DWSN	340	230000	-	77000	106000	55%	45%	17	948
District Water Supply - East	DWSE	230	140000	-	44000	58000	70%	30%	12	586
District Water Supply- South	DWSS	235	190000	-	52000	70000	43%	57%	15	666
MARE AUX VACOAS Supply -Upper	MAVU	220	220000	-	69000	90000	17%	83%	21	818
MARE AUX VACOAS Supply -Lower	MAVL	200	200000	-	62000	98000	80%	20%	27	860
Total		1261	1110000	70000	353000	505000	51%	49%	106	4328

5. Water Resources

The water resources in Mauritius have their origin and are maintained by the rain. The long-term mean annual rainfall over the island is about 2,000 mm pa (1971 - 2000). The topographical features of Mauritius enhance the rainfall, and the annual rainfall over the island is about twice the amount experienced over the surrounding ocean.

In spite of the relatively small area of Mauritius, the variability in the spatial distribution of annual rainfall is very prominent and varies from about 1,300 mm on the east coast to more than 4,000 mm at the plateau and down to 600 - 800 mm on the west coast.

The variability in mean monthly rainfall over the year is rather uniform across the island. In average some two-thirds of the annual rainfall occurs in the summer period, i.e. from December to April, due to passage of low pressure troughs and occasional tropical cyclones. The dry season is between May to November. The water resource balance for the island is given below.

Table 2 – Water Resources Balance for Mauritius[2]

Water Balance for Mauritius		**Million-m^3**
Input	Rainfall	3737
	Surface run off to sea	1318
	Evaporation	1604
	Usable potential	815
Output	Potable water	244
	Irrigation	265
	Present use volume	509
Balance		306

Source for potable water data – Author's analysis for the year 2015

Against the above available resources, the water demand projection for CWA is shown in the table in the following page. The projected water demand for the year 2050 is estimated to be 738070cum/day which is equivalent to 270million m^3 per annum indicating an additional annual water resource requirement of about 36million m^3 over and above the current usage.

[2] Master Plan for Development of Water Resources in Mauritius Volume I, Table 5

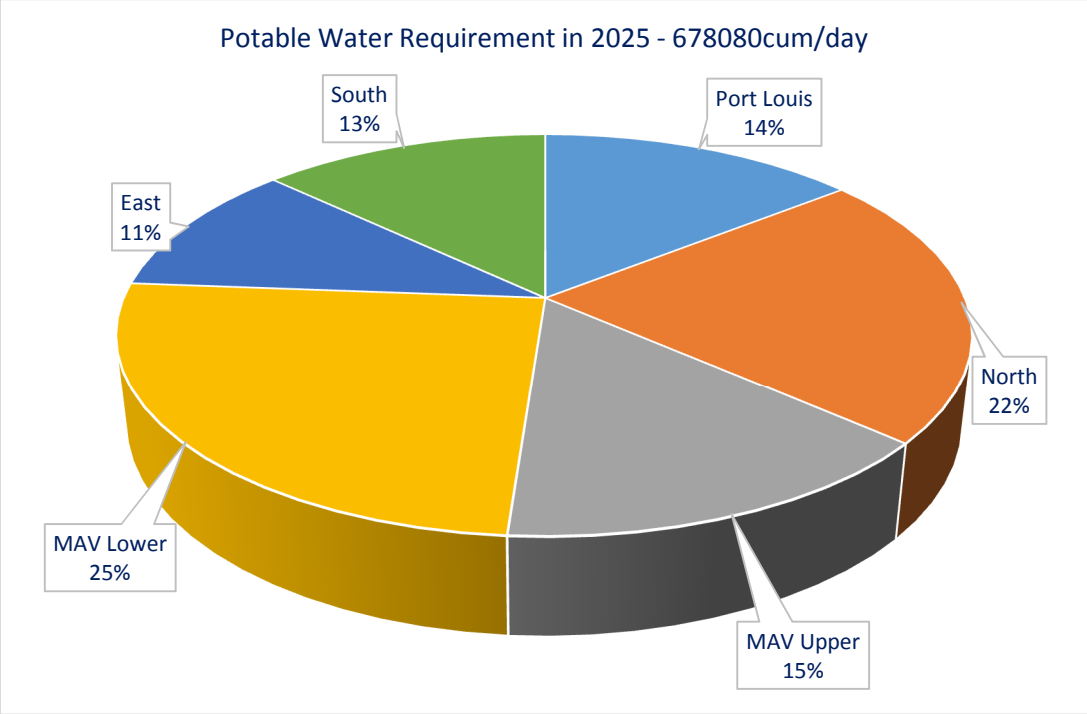
Table 3 – Water Resource Requirement Projection[3]

Category	Year	Water Supply Zone (m3/day)						Total
		Port Louis	North	MAV Upper	MAV Lower	South	East	
Potable Water								
Domestic	2009/10	68,890	95,560	88,890	82,220	68,890	57,780	4,62,230
	2025	60,000	85,000	80,000	75,000	61,670	53,330	4,15,000
	2050	62,670	90,670	77,330	81,330	61,330	54,670	4,28,000
Commercial	2009/10	14,440	7,780	8,890	8,890	4,450	4,450	48,900
	2025	13,330	6,670	8,330	75,000	3,670	3,830	1,10,830
	2050	12,000	6,670	8,000	72,000	3,470	3,860	1,06,000
Industrial	2009/10	14,000	4,440	3,110	2,220	2,440	440	26,650
	2025	14,170	37,830	3,170	2,330	2,500	500	60,500
	2050	18,670	32,670	4,130	2,930	3,330	670	62,400
Tourism	2009/10	1,020	11,470	110	5,930	3,380	7,640	29,550
	2025	2,000	14,000	1,000	10,000	15,000	12,000	54,000
	2050	1,600	11,200	800	8,000	12,000	9,600	43,200
Agriculture	2009/10	220	2,220	2,220	2,000	890	1,100	8,650
	2025	170	2,500	2,330	2,170	1,000	1,170	9,340
	2050	130	3,730	3,600	3,330	1,600	1,870	14,260
Institutional	2009/10	8,880	4,890	5,110	5,780	4,440	2,670	31,770
	2025	7,500	4,330	4,670	5,330	4,080	2,500	28,410
	2050	8,670	5,070	5,200	6,000	4,670	2,800	32,410
Sub-total Potable water	2009/10	1,07,450	1,26,360	1,08,330	1,07,040	84,490	74,080	6,07,750
	2025	97,170	1,50,330	99,500	1,69,830	87,920	73,330	6,78,080
	2050	1,03,740	1,50,010	99,060	1,73,590	86,400	73,470	6,86,270
Raw water								
Industrial boreholes	2009/10	1,700	4,700	4,500	2,500	400	500	14,300
	2025	2,300	6,300	6,000	3,400	500	700	19,200
	2050	3,700	10,300	9,900	5,500	800	1,100	31,300
Agriculture boreholes	2010/25/50	100	4,700	200	2,200	5,200	200	12,600
Agriculture surface water	2010/25/50	300	1,900	900	200	200	0	3,500
CTBV	2010/25/50	0	4,400	0	0	0	0	4,400
Sub-total raw water	2009/10	2,100	15,700	5,600	4,900	5,800	700	34,800
	2025	2,700	17,300	7,100	5,800	5,900	900	39,700
	2050	4,100	21,300	11,000	7,900	6,200	1,300	51,800
Total requirements	2009/10	1,09,550	1,42,060	1,13,930	1,11,940	90,290	74,780	6,42,550
	2025	99,870	1,67,630	1,06,600	1,75,630	93,820	74,230	7,17,780
	2050	1,07,840	1,71,310	1,10,060	1,81,490	92,600	74,770	7,38,070

[3] Master Plan for Development of Water Resources in Mauritius Volume I, Table 31

It can be seen in table 3 above, the potable water requirement in the year 2025 is projected to be 678080cum/day in the year 2025 and 686270cum/day in the year 2050. The zone wise distribution of resource requirement is shown in the following chart.

Figure 2 – Potable Water Resource requirement in the year 2025



6. Potable Water Production

CWA produces about 46% of treated water from surface water resources and about 54% of the treated water from boreholes.

6.1. Surface Water

CWA operates six water treatment plants as per the details below.

Table 4 – Water Treatment Plants in CWA

		Production capacity cum/day	
Location	Location Zone	Design	2015
Pailles WTW	Port Louis	80000	80000
La Marie -Old		60000	50000
La Marie – New	MAV Upper	72000	70000
La Nicoliere	DWSN	66000	67000
Piton du Milieu	DWSE	37000	30150
River du Poste	DWSS	15000	17160
Mont Blanc	DWSS	10000	9615
Total		340000	323925

CWA has had technical assistance from a JICA organized study of water treatment processes and planned implementing process improvement works in all the water treatment plants (WTPs) including capacity augmentation in Pailles and La Marie WTPs.

The WTP at Pailles has been rehabilitated and commissioned recently both to increase the effectiveness of treatment process as well as to increase the production capacity from 60,000 to 80,000cum/day.

In the case of La Marie WTP, CWA is implementing process improvement works to ensure more effective and efficient settlement of sludge during high turbidity events.

Similarly, CWA has planned implementing treatment process improvement works in all other WTP locations under the Build Mauritius Fund (BMF) and initiated procurement of consultants.

6.1.1. Proposed Augmentation from Bagatelle Dam

With a view to cope with seasonal deficits in water resources as a result of climate change, and to address the present unsatisfied and projected demand for potable water in the Port Louis and MAV Lower operating zones, CWA proposed to set up a new WTP and accompanying distribution pipelines from the Bagatelle Dam (25 Mm^3 dam annual storage capacity). The source augmentation project being implemented under a loan from the Government of Mauritius (GoM), comprises the construction of a 60,000m3/day capacity rapid gravity filter plant, associated storage reservoir and transmission facilities, is split into 4 contracts the status of which is as follows:

i. Construction of Bagatelle Water Treatment Plant (est. cost: Rs 1.25 billion) (status: Award delayed as case challenging award is still in court). If and when it is awarded, construction period expected to be 18 to 24 months

ii. Construction of Feeder Pipeline from Municipal Dyke to Pailles WTP (status: completed and pipeline in service) (project value: Rs 144.5M)
iii. Construction of Pipeline (8km) from Bagatelle WTP to Soreze (Est. cost: Rs 144.3M) (status: Award imminent)
iv. Construction of Pipeline (8km) from Bagatelle WTP to Belle Rose and Rose Hill (Est. cost: Rs 87.8M) (status: Award imminent)

With the completion of Bagatelle bulk water facilities and transmission system, the MAV Lower zone should get good relief from the chronic intermittent water supply. Also availability of 60000cum/day surface water with the proposed water transfer grid would ease the dry season shocks currently experienced by CWA and facilitate more sustained reduction of NRW with the availability of spare demand.

6.2. Ground Water

CWA as of 3rd March 2016, had installed 164 bore holes with a total pumping capacity of 6243kW. The spatial distribution of the boreholes in given below.

Table 5 – CWA Boreholes and Pump Capacity Installed updated up to 3rd March 2016

Operating Zone	Bore Holes	KW	%
PL	16	575	9%
DWSN	43	1597	26%
MAVU	13	444	7%
MAVL	50	1636	26%
DWSE	19	1102	18%
DWSS	23	889	14%
Total	164	6243	100%

The boreholes and the pumps are maintained by the CWA central mechanical and electrical (M&E) maintenance teams reporting to the Chief Engineer (Water Resources and Support Services). The ground water production trend is analysed in the next section.

6.3. Water Production

At the end of year 2015 CWA sourced about 54% (average 360mld) of the resources from some 164 boreholes located across the island and the balance 46% (average 310mld) from surface water from raw water reservoirs as well as direct abstraction from the local rivers.

The share of surface and ground water in each operating zone is shown below.

Table 6 – Share of surface and ground water on potable water production in CWA in 2015

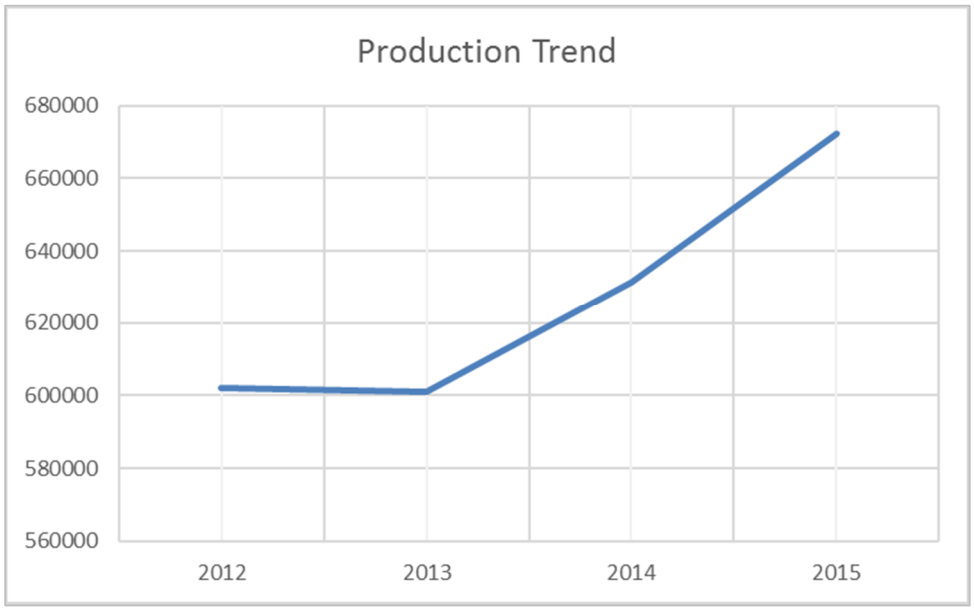
2015	Surface	Ground	Total	Surface	Ground
Zone	Cum/annum			%	%
PL	179,28,360	170,72,297	350,00,657	51%	49%
DWSN	261,12,047	247,72,434	508,84,481	51%	49%
MAVU	439,65,622	77,15,639	516,81,261	85%	15%
MAVL	0	325,39,549	325,39,549	0%	100%
DWSE	143,63,872	235,51,792	379,15,664	38%	62%
DWSS	107,07,317	255,65,135	362,72,452	30%	70%
Total	1130,77,218	1312,16,846	2442,94,064	46%	54%

6.4. Production Trend

The water production trend for the period 2012- 2015 is presented in Table 7 in the next page and the analysis is presented in the chart below.

The total water production trend is analysed below.

Figure 3 – CWA total water production trend



It can be seen above that there had been a slight dip (-0.2%) in production during the year 2013 and it increased by about 5% in year 2014 and by about 6% in year 2015. CWA informed that the year 2013 was a drought year and the utility had struggled to meet the demand due to shortage of resources and resorted to water cuts across the island.

Table 7 – CWA Surface Water Production Trend

2012	Code	Surface	Ground	Import	Export	Sys Input	Avg/day
PL	S11	217,06,243	142,05,252	65,62,590	7,41,998	417,32,087	114335
DWSN	S12	259,02,121	223,09,601	9,20,464	59,88,052	431,44,134	118204
MAVU	S21	362,39,298	63,83,823	2,07,055	86,70,376	341,59,800	93589
MAVL	S22		306,32,916	80,73,581	6,47,595	380,58,902	104271
DWSE	S31	118,18,724	213,92,530	73,057	17,23,389	315,60,922	86469
DWSS	S32	107,73,062	183,87,952	19,34,665		310,95,679	85194
Total		1064,39,448	1133,12,074	177,71,412	177,71,410	2197,51,524	602059
2013	Code	Surface	Ground	Import	Export	Sys Input	
PL	S11	207,00,277	131,31,122	65,99,077	6,18,479	398,11,997	109074
DWSN	S12	264,14,256	214,80,499	7,81,928	59,70,000	427,06,683	117005
MAVU	S21	433,77,346	67,81,120	1,93,645	111,22,332	392,29,779	107479
MAVL	S22		312,49,056	103,44,955	6,76,527	409,17,484	112103
DWSE	S31	95,14,234	201,28,925	47,450	18,27,330	278,63,279	76338
DWSS	S32	98,56,462	167,77,261	22,27,552		288,61,275	79072
Total		1098,62,575	1095,47,983	201,94,607	202,14,668	2193,90,497	601070
2014	Code	Surface	Ground	Import	Export	Sys Input	
PL	S11	193,46,387	156,30,381	56,34,832	7,49,305	398,62,295	109212
DWSN	S12	269,54,646	223,12,155	12,24,752	52,16,208	452,75,345	124043
MAVU	S21	420,41,910	72,34,389	3,42,389	109,41,714	386,76,974	105965
MAVL	S22		321,21,497	101,55,466	5,24,832	417,52,131	114390
DWSE	S31	123,25,841	203,21,569	46,631	28,12,048	298,81,993	81869
DWSS	S32	105,82,822	216,20,020	28,39,977		350,42,819	96008
Total		1112,51,606	1192,40,011	202,44,047	202,44,107	2304,91,557	631484
2015	Code	Surface	Ground	Import	Export	Sys Input	
PL	S11	174,92,061	178,92,717	57,46,343	11,53,400	399,77,721	109529
DWSN	S12	261,12,046	247,72,435	13,12,543	52,95,485	469,01,539	128498
MAVU	S21	439,65,614	77,18,127	4,33,540	126,21,363	394,95,918	108208
MAVL	S22		332,67,091	119,06,009	6,36,341	445,36,759	122019
DWSE	S31	143,63,871	235,51,790	50,200	26,69,536	352,96,325	96703
DWSS	S32	107,07,322	255,65,133	29,27,491		391,99,946	107398
Total		1126,40,914	1327,67,293	223,76,126	223,76,125	2454,08,208	672352

The seasonable variations in surface and ground water production is presented in the following charts.

Figure 4 – CWA Surface Water Production Trend

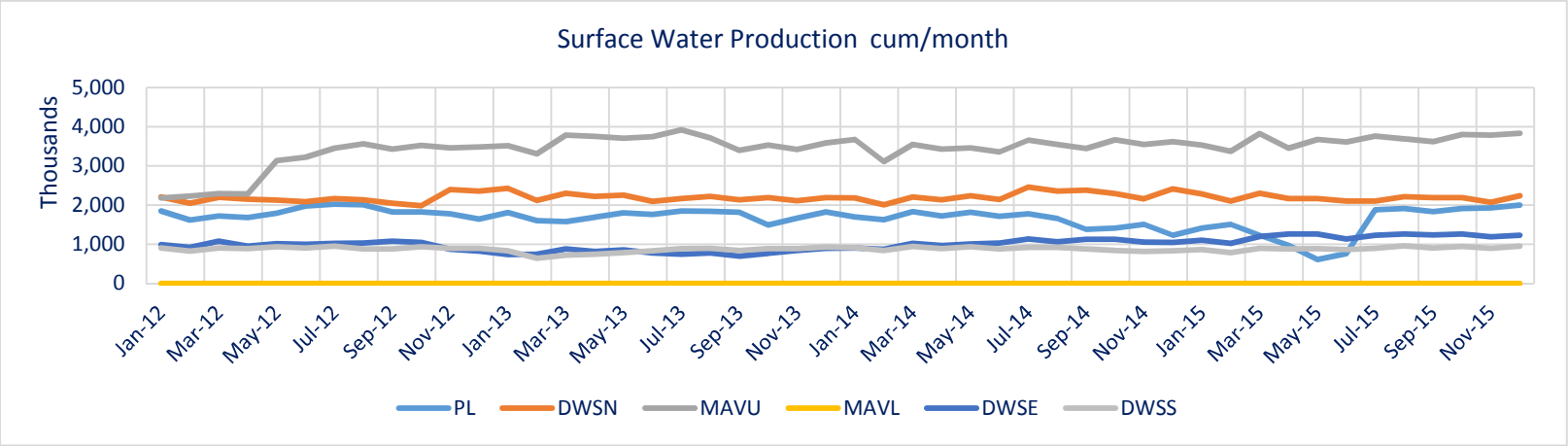


Figure 5 – CWA Ground Water Production Trend

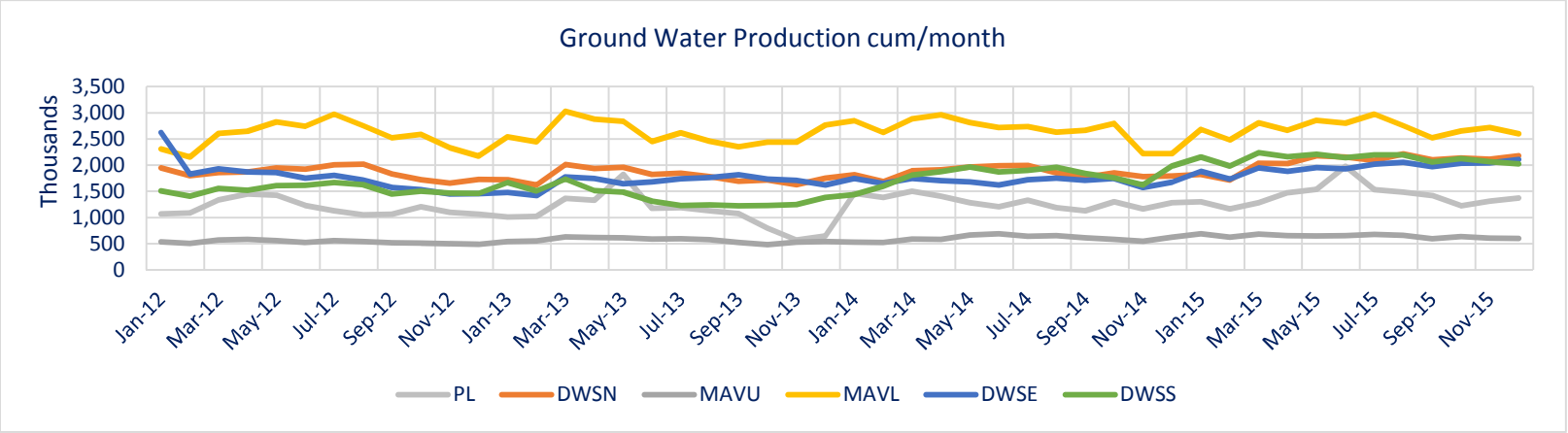


Figure 6 – CWA Total Production Trend

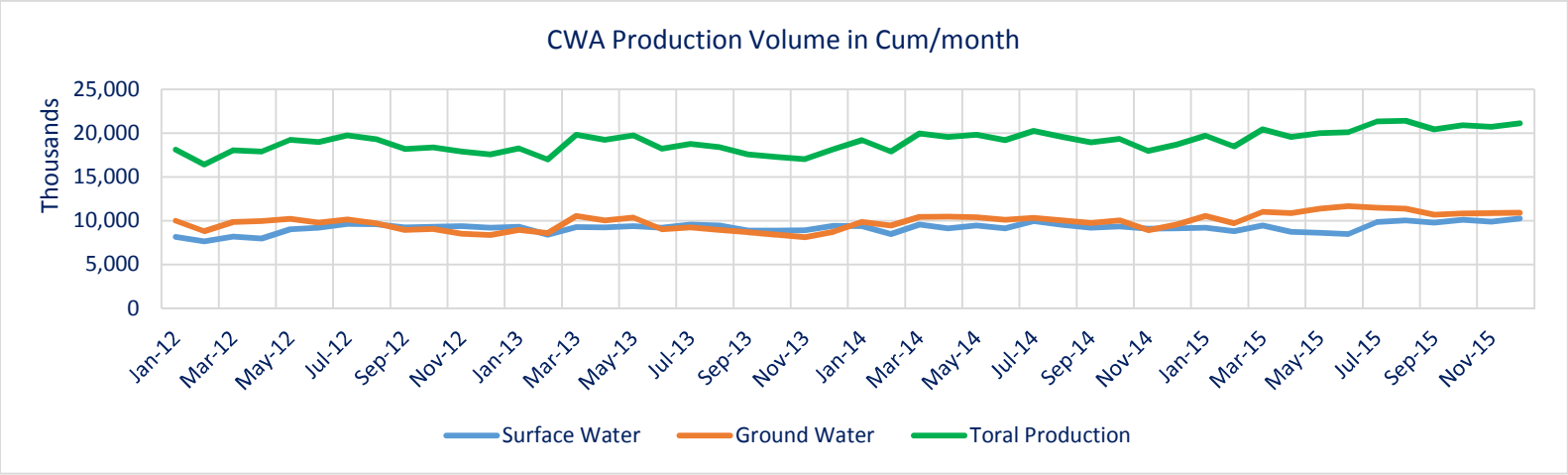
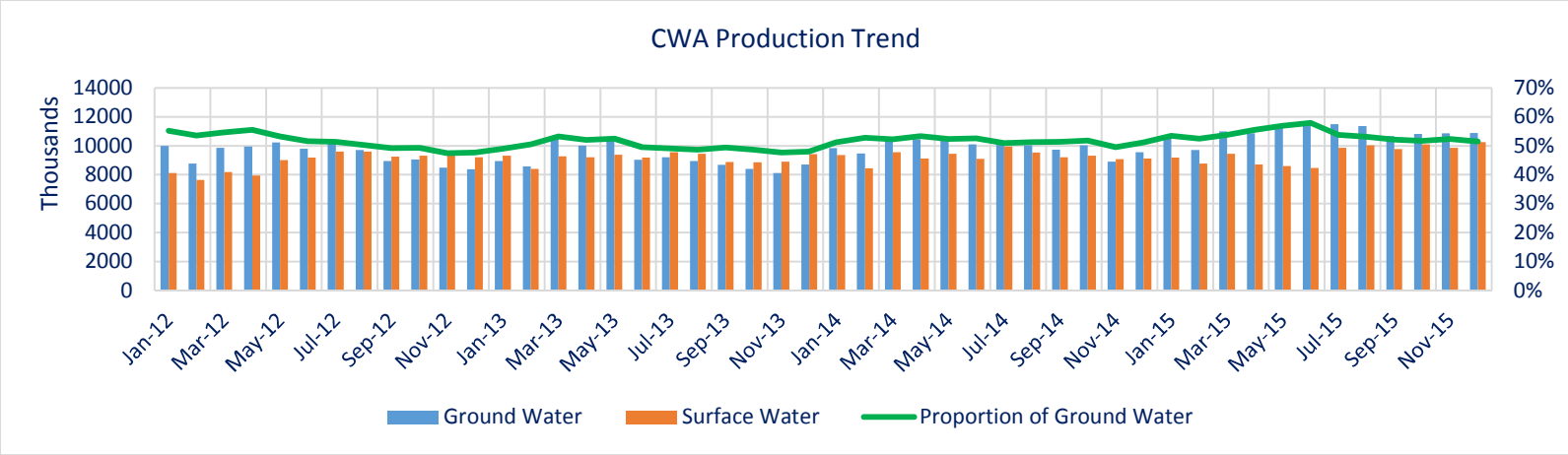


Figure 7 – CWA Production – Comparison between surface and ground water



Inferences:

i. Ground water production share was at 55% and later reduced to 48% in the drought year 2013 and stabilized at 52% in the recent times.
ii. During dry seasons in each year, CWA produced more ground water by operating more boreholes.
iii. MAV Lower is totally dependent on ground water at 100% followed by DWS South at 70%.
iv. Port Louis had been witnessing substantial variation between share of ground water and it is apparently due to quality problems in Clairefonds source and the problem is said to be solved with the commissioning of the rehabilitation of Pailles WTP.

6.5. Adequacy Check of Available Resources

An attempt is made to check the adequacy of the available water resources, by comparing the future demand to the current production levels both in the drought year of 2013 and the normal rainfall year of 2015.

CWA Master Plan projected future demand for potable water with the following assumptions.

i. Increase in per capita consumption to 175lpcd by the year 2025 and 180lpcd by the year 2050
ii. Reduction in Non-Revenue Water to 40% by the year 2025 and 25% by the year 2050.

An attempt is made to compare the projected demand with that of lowest production occurred in the drought year 2013 and also during the normal rainfall year of 2015 and is presented below.

Table 8 – Comparison of Projected Demand with Actual Production in the year 2013 in cum/day

		Comparison to drought year 2013			Comparison to normal year 2015		
Operating Zone	Demand at Tap in 2025	Production	Difference	Losses permissible	Production	Difference	Losses permissible
PL	57540	109075	51535	47%	109527	51987	47%
DWSN	90410	117005	26595	23%	128498	38088	30%
MAVU	59180	107479	48299	45%	108209	49029	45%
MAVL	101920	112103	10183	9%	122019	20099	16%
DWSE	44390	76338	31948	42%	96702	52312	54%
DWSS	52610	79072	26462	33%	107397	54787	51%
Total	406050	601072	195022	32%	672352	266302	40%

It can be seen above that except in MAV Lower the available production as achieved in the normal year of 2015 is reasonably sufficient to meet the demand needs in the year 2025 provided CWA institutes a focused and structured program of water loss control to reduce the average losses to 40% from the present level of 56%.

With the advent of Bagatellle with capacity of facilitating an additional resource of 40000cum/day for MAV Lower, the CWA would be comfortable with the available resources even during the risky drought years.

The adequacy check, against the production volume during the drought year 2013 shows that CWA requires additional efforts to contain the water losses so as to insulate the customers from water rationing or water cuts.

If the water loss reduction program is coupled with demand management measures like rationlisation of domestic tariff and robust customer meter maintenance program, the available resources during a normal rainfall year would be able to meet the demand needs even in the year 2050.

7. Water Networks

CWA in the six operating zones distributes both treated surface water and chlorinated ground water. The water distribution sectorisation was implemented over time with about 256 District Metered Areas (DMAs) established for non-revenue water control. The information management in regard to flow and pressure measurement and leak detection was practiced up to about 2005 but later the NRW unit was disbanded and limited to just record keeping. It is understood that the integrity of the DMAs has been neglected but could be revived with relatively small investment.

7.1. Composition of Networks

The details of water network infrastructure are abstracted below.

Table 9 - Water Networks in CWA4

Operating Zone	DMAs	PE	DI	AC	CI	St	GI	PVC	Total
PORT LOUIS	43	95246	81313	196182	23628	0	5828	11620	413817
DWS NORTH	31	281043	210992	272520	45051	28850	23716	4600	866772
MAV UPPER	47	227774	135002	178173	71164	40709	23148	107	676077
MAV LOWER	50	191803	211259	203701	72199	13939	35412	34956	763269
DWS EAST	36	180856	119833	190295	27064	14570	6981	0	539599
DWS SOUTH	49	199387	147895	132696	23800	16911	1941	0	522630
Total	256	1176109	906294	1173567	262906	114979	97026	51283	3,782,164

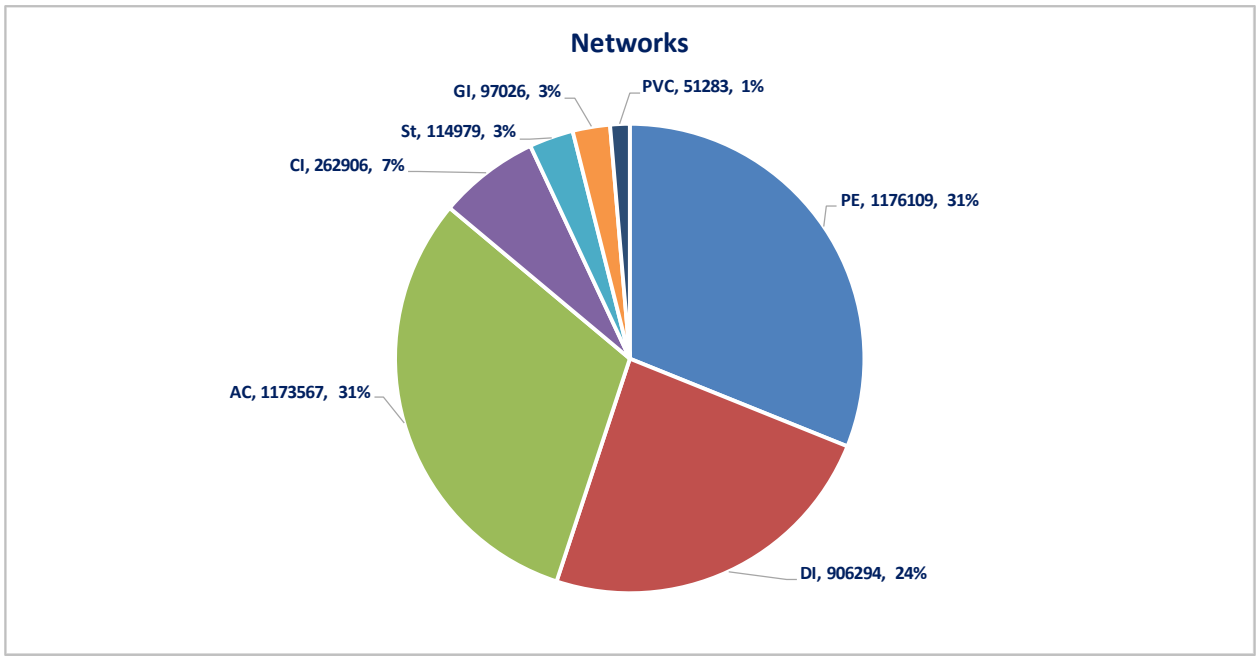
It can be seen above that details on about 3,782km of network are available in the drawing office. Under the recent NRW reduction project undertaken by CWA in MAV Upper the survey for establishing a GIS system has identified 815km of mains up to 20mm size showing a variance of 20%.

The drawing office has an established system of updating the asset data before a bill is paid for in the Planning & Development (P&D) division. However, in case of networks laid by private real estate developers *(Morcellemonts*), the power to issue no-objection certificates on the quality and performance of network works is with Operations Division and as such these privately developed networks are said to be not efficiently captured by the central database. In addition, the Operations Division also carries out pipe renewal programs of short lengths under maintenance, the details of which are not captured at all.

The size wise distribution of existing networks is provided in Annexure 1. Applying 20% variance, the total networks would be in the range of about 4,500km.

[4] Source: CWA Drawing Office

Figure 8 – Network Composition



It can be seen above that slightly more than half of the networks are Poly Ethylene (PE) and Ductile Iron (DI) pipes whereas Asbestos Cement (AC) pipes constitute about 31% and cast Iron (CI) pipes about 7%.

The age of the networks is shown in the following table.

Table 10 – Age distribution of networks[5]

Pipe Material	Period of usage		Average Age
	From	To	Years
Asbestos Cement	1860	1980	96
Cast Iron	1880	1979	87
Steel	1900	1960	86
Galvanised Iron	1950	1979	52
PVC	1973	1979	40
Ductile Iron	1980	2016	18
Poly Ethylene	1988	2016	14

Below is an estimate of pipe material distribution to understand the pipe renewal requirements in each operating zone.

[5] Source: Analysis of leaks and Repairs; NRW Unit, CWA

Figure 9 – Cast Iron Pipe Distribution

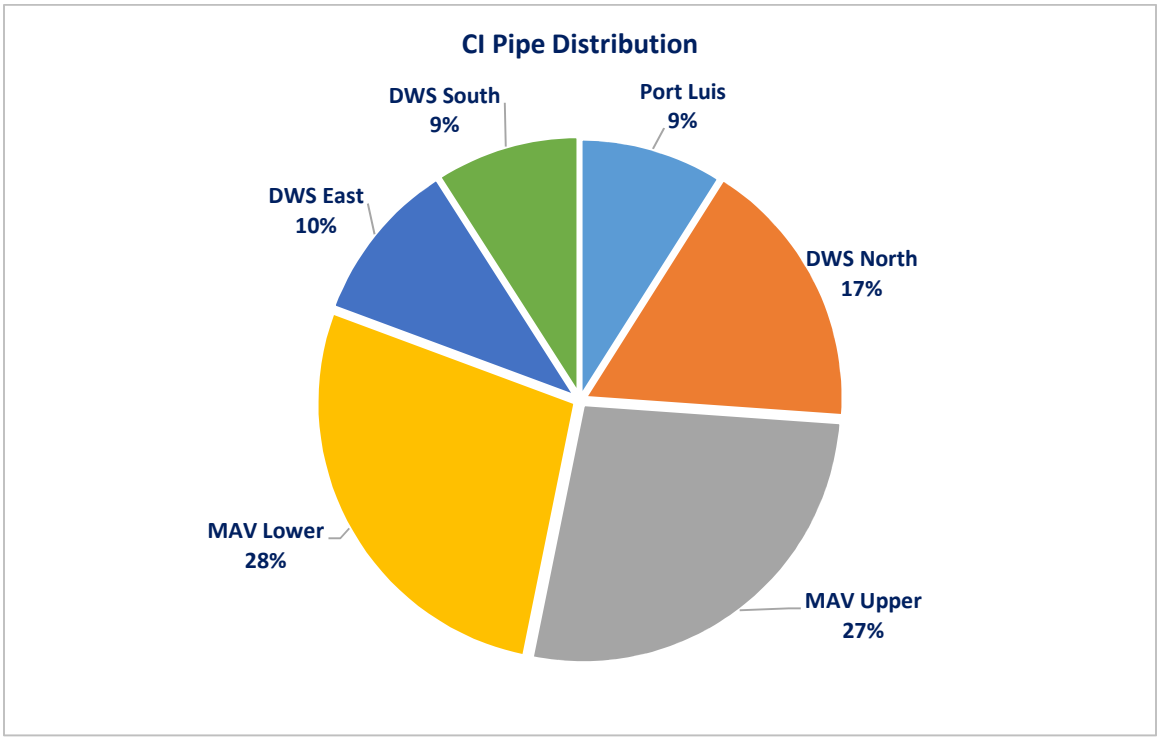
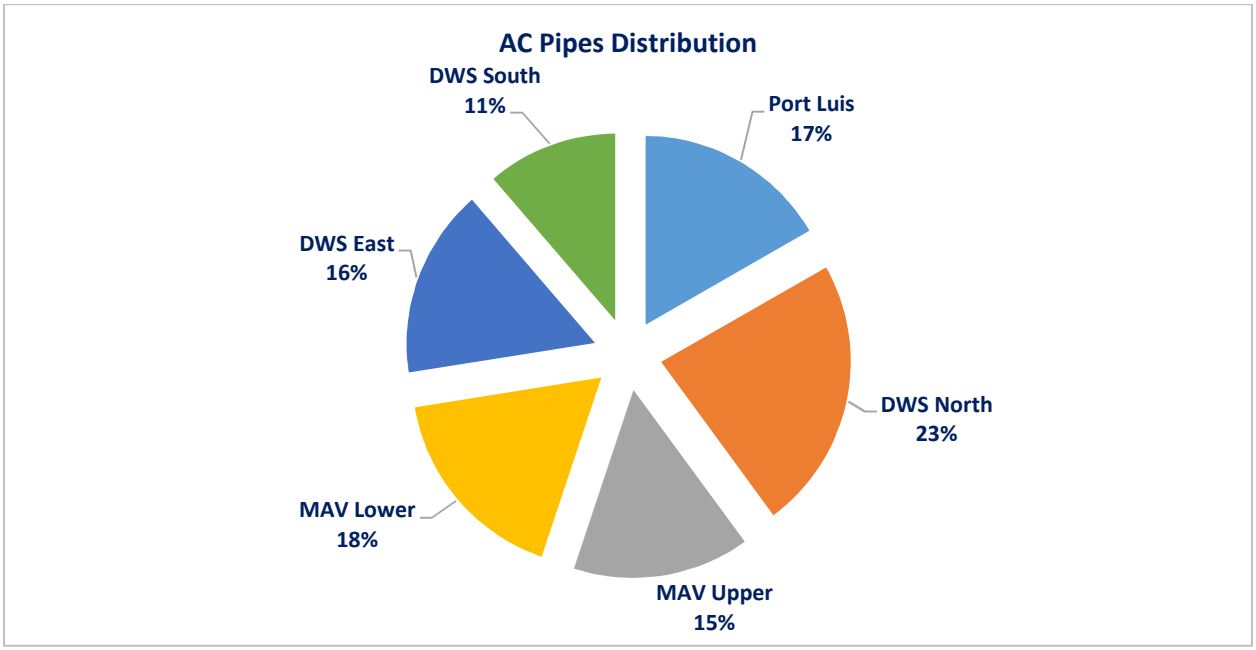


Figure 10 – AC Pipe Distribution



It can be seen above that MAV Upper and Lower constitute the maximum length of old cast iron pipes whereas about a third of AC pipes exists in these two operating zones.

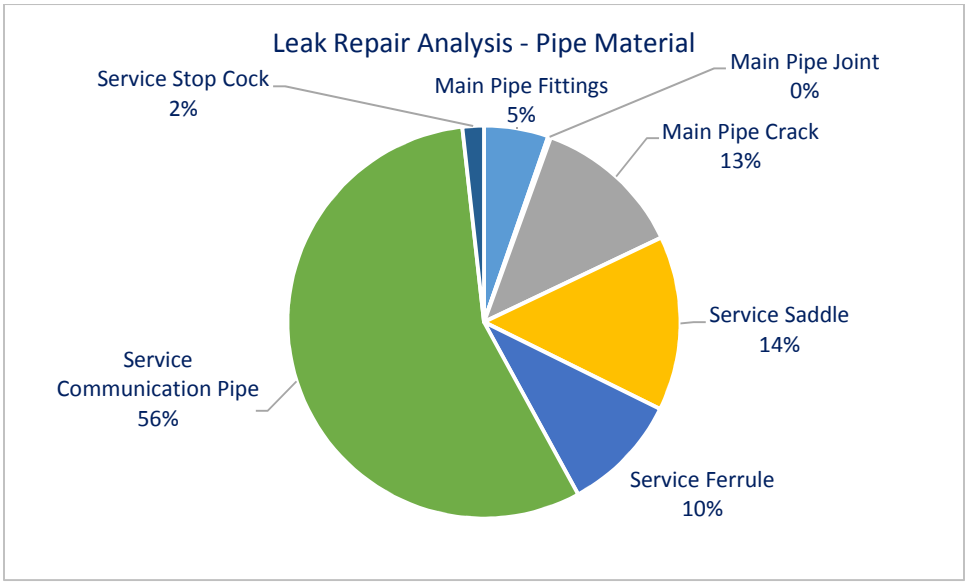
7.2. Leak Repair Analysis

The leak repair data is not very robust. The recent NRW project collected leak repair data for MAV Upper which is further analysed and shown below.

Table 11 – Leak Repair Analysis in MAV Upper Zone

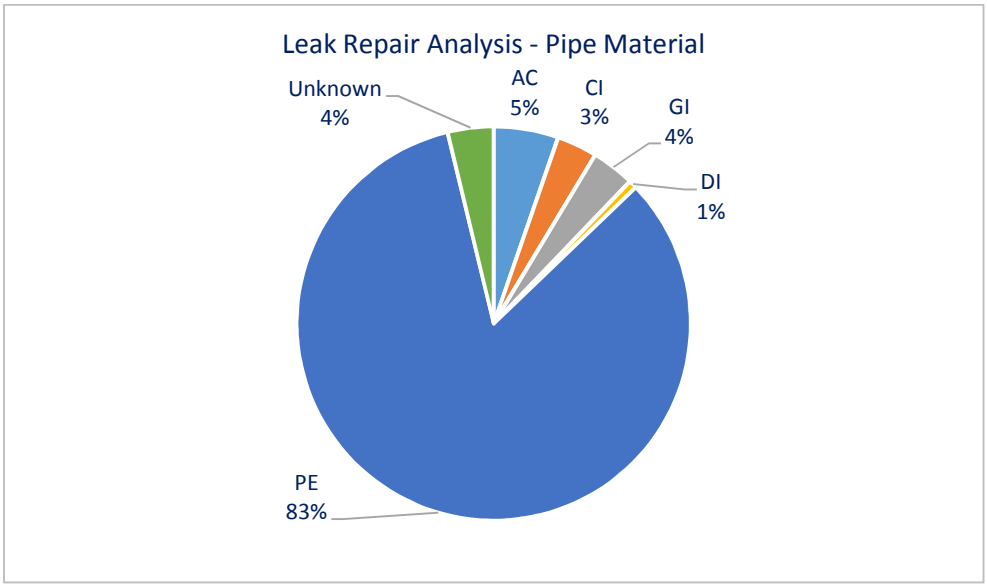
Category of Leak	AC	CI	GI	DI	PE	Unknown	Total
Main Pipe Fittings	2	1	1		18	2	24
Main Pipe Joint	1						1
Main Pipe Crack	3	3	4	1	44	1	56
Service Saddle	5	4	4		51	1	65
Service Ferrule	12	5	1	2	24		44
Service Communication Pipe	1	2	6		233	12	254
Service Stop Cock	0	0	0		7	1	8
Total	24	15	16	3	377	17	452

Figure 11 – Leak Repair Analysis – Category of Leak



It can be seen above that the Service Pipe repairs were about 56% followed by service saddle and ferrule together at 24% and the main pipe cracks are about 13%.

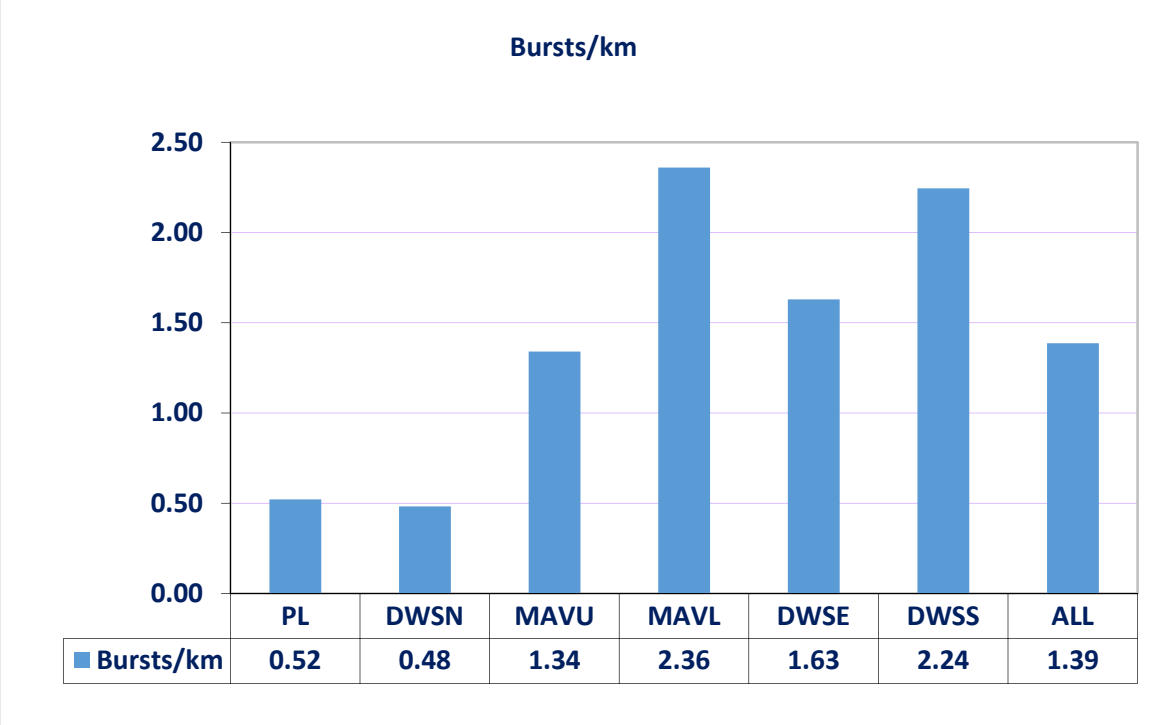
Figure 12 – Leak Repair Analysis – Pipe Material



This suggests that the vast majority of repairs were on the recently laid poly ethylene pipes. The team was informed that problems found related to poor workmanship or poor quality materials.

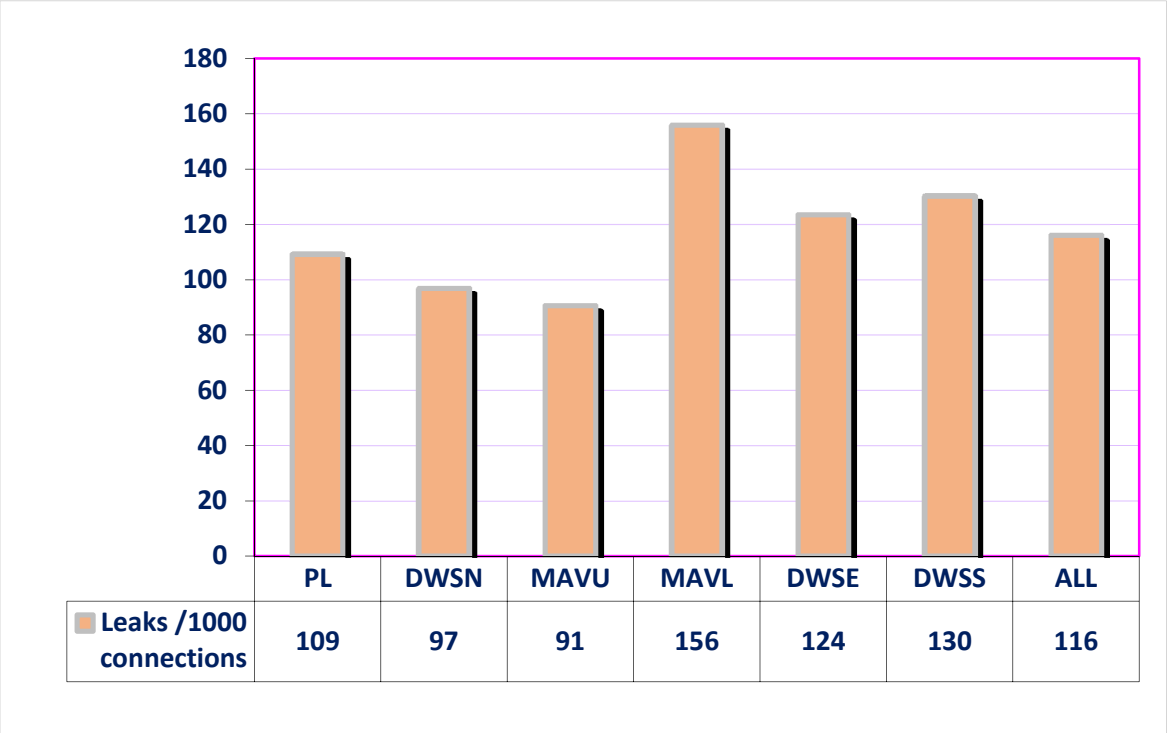
In the absence of latest data, the leaks and bursts analysis carried out by the author for year 2003 is shown below.

Figure 13 – Comparison of Bursts in year 2003



	PL	DWSN	MAVU	MAVL	DWSE	DWSS	ALL
Bursts/km	0.52	0.48	1.34	2.36	1.63	2.24	1.39

Figure 14 – Comparison of Leaks in Year 2003

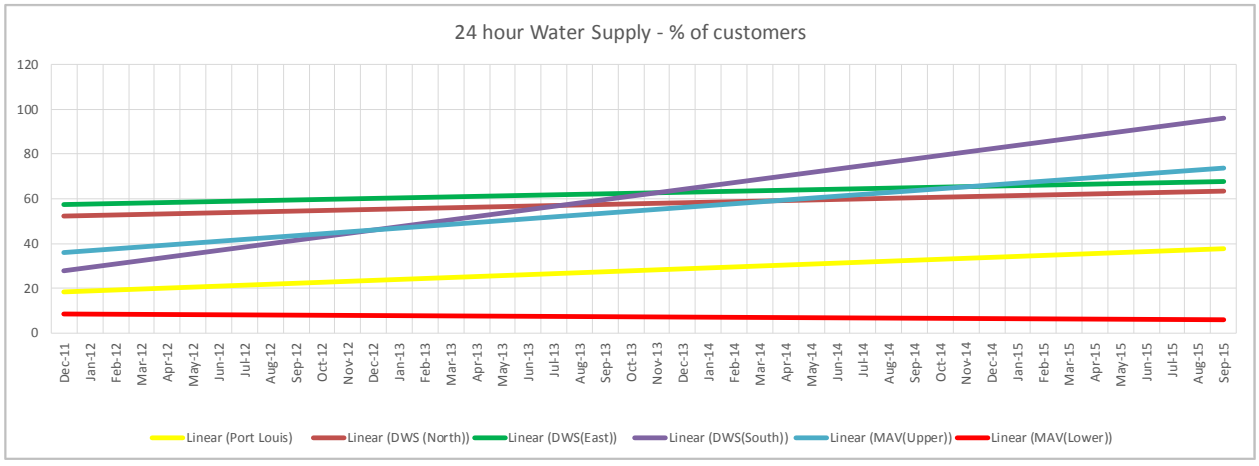


	PL	DWSN	MAVU	MAVL	DWSE	DWSS	ALL
Leaks /1000 connections	109	97	91	156	124	130	116

7.3. Continuity of Water Services

Due to increasing physical NRW resulting in absence of active leakage control, pipe deterioration and inadequate hydraulics of the distribution network (lack of pressure management), CWA resorts to rationing primarily to limit the physical losses, especially in the dry season. CWA has a quarterly monitoring system of supply hours in each sub-zone and the data pertaining to December 2011 and up to December 2015 has been analysed and shown in the figure below.

Figure 15 – Water Supply Hours Trend



It can be seen above that Port Louis and DWS South have been showing significant improvement in percentage of customers with 24hour water supply whereas MAV Lower had been in further decline.

However, this data is based on oral reports of operations staff and has no practical method of measurement.

8. Commercial Services

CWA has a customer services department with full electronic data processing although the systems are in desperate need of software (currently operating on Windows XP platform) and hardware upgrade. It is not however what one would expect from a true commercial department, more a billing department with little link with clients in practice as complaints relating to leaks and service are routed to the Operations division and customer services does not follow up on complaints and repairs.

The commercial division is responsible for (i) meter reading, (ii) billing, (iii) bill delivery and (iv) managing CWA hotline of customer complaint management, but once the complaint has been forwarded to the Operations division the commercial division has no further involvement or follow up role.

8.1. Customer Categories

CWA customers are divided into two global categories (i) Non-Treated Water and (ii) Potable water. The customers receiving non-treated water are further divided into some 10 sub-categories based on tariff charged such as irrigation, business, industry etc again depending upon surface or ground water.

The potable water customers are further divided into 10 sub-categories such as domestic, commercial, industrial, religious trusts, agricultural etc.

The number of customers at the end of year 2015 are shown in the following table.

Table 12 – Customer Accounts in CWA

	Number of customer accounts		
Service Zone	Non-Treated	Potable	Total
Port Louis	42	49,186	49,228
DWS North	122	76,694	76,816
MAV Upper	78	68,920	68,998
MAV Lower	61	62,176	62,237
DWS East	16	43,780	43,796
DWS South	56	52,172	52,228
Total	375	352,928	353,303

8.2. Customer Meters

CWA has in theory 100% metering of customers although about 60,000 meters are not working currently and the number keeps rising due to limitation in procurement of good quality meters. It is unknown how many meters are functioning but inaccurate.

Meter reading is done and recorded manually monthly by 106 meter readers who report to the commercial manager with very little accountability to the field operations teams. Monthly billing is done at central office where the manual readings are then manually entered into the database. Bills are physically distributed to all field offices for delivery to customers. Revenue collection is done through ?? number of field customer service centers.

8,000 new connections are sanctioned on an average per year.

Due to qualification criteria for meter readers and also trade union pressure, there is significant lack of professional skills in the commercial division and it is compounded with limitation of vehicular transport due to shortage of vehicles.

Despite these limitations the current revenue collection efficiency is reported by the commercial division to be around 99% with no significant customer debt problems.

8.3. Customer Complaints

CWA's hotline part of commercial services has been outsourced under a performance based ervice contract (with Mauritius Telecom??). CWA hotline received an average of about 141,000 complaints per annum in the period during 2012 -15 with an average 24,000 complaints per each operating zone. Analysis of complaints is shown below.

Table 13 – CWA Complaints Analysis

Category	2012	2013	2014	2015	Average
No Water	40%	38%	41%	36%	39%
Insufficient Hours of Supply	3%	4%	4%	4%	4%
Broken Mains	3%	3%	3%	2%	3%
Broken Communication Pipes	20%	19%	13%	13%	16%
Leakage	5%	4%	7%	12%	7%
Meter Connection Leakage	3%	3%	2%	3%	3%
Meter Reading	6%	7%	7%	6%	6%
Excessive Bills	3%	4%	5%	5%	4%
Others less than 2%	18%	18%	19%	20%	19%

Inferences:

i. Highest number of complaints about 39% were for 'no water'; in addition, the in-sufficient hours of supply account for 4%.

ii. About 29% pertain to physical leakage with 16% on broken communication pipes. This suggest both a high frequency of visible leaks (35,000 call per year or about a hundred per day) and that the population seems fairly involved

iii. Meter reading and excessive billing accounted for about 10% together

The majority of complaints related to service performance and would have been forwarded to the Operations division for resolution, with no follow up by the hotline.

9. Water Sales

For the purpose of analysing the water sales and performance efficiency, the production and sales data pertaining to potable water supplies is presented below.

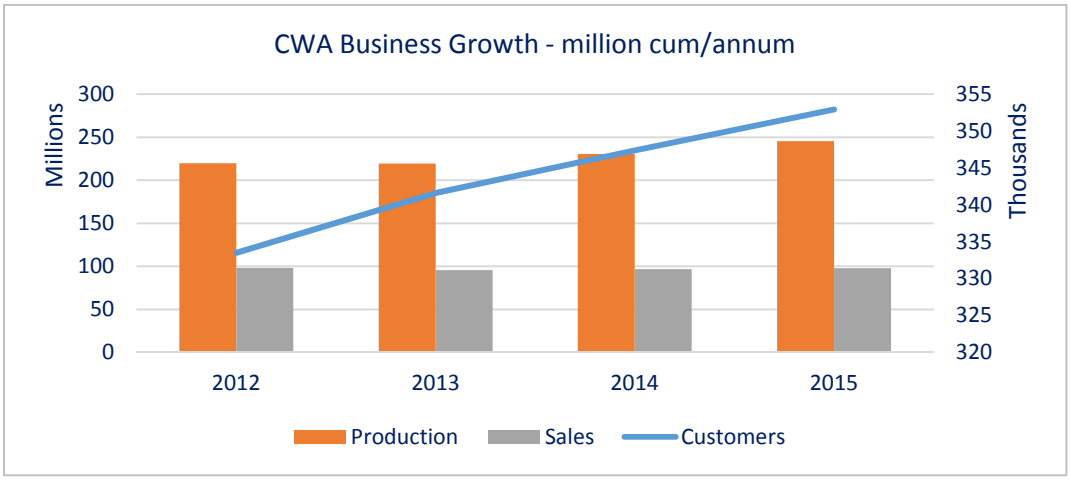
Table 14 – Water Sales Summary

CWA Potable Water Business Analysis								
2012	Code	Customers	Production	Sales	Difference	NRW %	L/Conn/ day	Cum/conn /month
PL	S11	47231	417,32,087	16931135	248,00,952	59%	1,435	29.9
DWSN	S12	71322	431,44,134	21732616	214,11,518	50%	820	25.4
MAVU	S21	65404	341,59,800	16473722	176,86,078	52%	739	21.0
MAVL	S22	59279	380,58,902	16387676	216,71,226	57%	999	23.0
DWSE	S31	41223	315,60,922	11817331	197,43,591	63%	1,309	23.9
DWSS	S32	49045	310,95,679	14839524	162,56,155	52%	906	25.2
Total		3,33,504	2197,51,524	98182004	121569520	55%	996	24.5
2013								
PL	S11	48123	398,11,997	16533666	232,78,331	58%	1,322	28.6
DWSN	S12	73435	427,06,683	20743333	219,63,350	51%	817	23.5
MAVU	S21	66762	392,29,779	16746246	224,83,533	57%	920	20.9
MAVL	S22	60647	409,17,484	16462956	244,54,528	60%	1,102	22.6
DWSE	S31	42157	278,63,279	11666958	161,96,321	58%	1,050	23.1
DWSS	S32	50491	288,61,275	13655352	152,05,923	53%	823	22.5
Total		3,41,615	2193,90,497	95808511	123581986	56%	988	23.4
2014								
PL	S11	48658	398,62,295	16379984	234,82,311	59%	1,319	28.1
DWSN	S12	75015	452,75,345	21222003	240,53,342	53%	876	23.6
MAVU	S21	67940	386,76,974	17193498	214,83,476	56%	864	21.1
MAVL	S22	61325	417,52,131	16312743	254,39,388	61%	1,133	22.2
DWSE	S31	42941	298,81,993	11885710	179,96,283	60%	1,145	23.1
DWSS	S32	51512	350,42,819	13753747	212,89,072	61%	1,129	22.3
Total		3,47,391	2304,91,557	96747685	133743872	58%	1,052	23.2
2015								
PL	S11	49186	399,77,721	16571385	234,06,336	59%	1,300	28.1
DWSN	S12	76694	469,01,539	21439294	254,62,245	54%	907	23.3
MAVU	S21	68920	394,95,918	17939918	215,56,000	55%	855	21.7
MAVL	S22	62176	445,36,759	16215926	283,20,833	64%	1,245	21.7
DWSE	S31	43780	352,96,325	11894024	234,02,301	66%	1,461	22.6
DWSS	S32	52172	391,99,946	13901669	252,98,277	65%	1,325	22.2
Total		3,52,928	2454,08,208	97962216	147445992	60%	1,141	23.1

9.1. Business growth trend

The four-year business growth trend is analysed and shown below.

Figure 16 – CWA Business Growth Tend



Note: Production is in cum/annum; Sales is cum/annum and Customers are number

It can be seen above that while customers are growing by about 1.5% to 2% per annum, the production increased over 5% and sales remained stagnant indicating an overall increase in Non-Revenue Water (NRW).

9.2. Comparison of production and sales trend

An attempt is made to compare the production and sales growth and is shown in the figures below.

Figure 17 – Production Trend

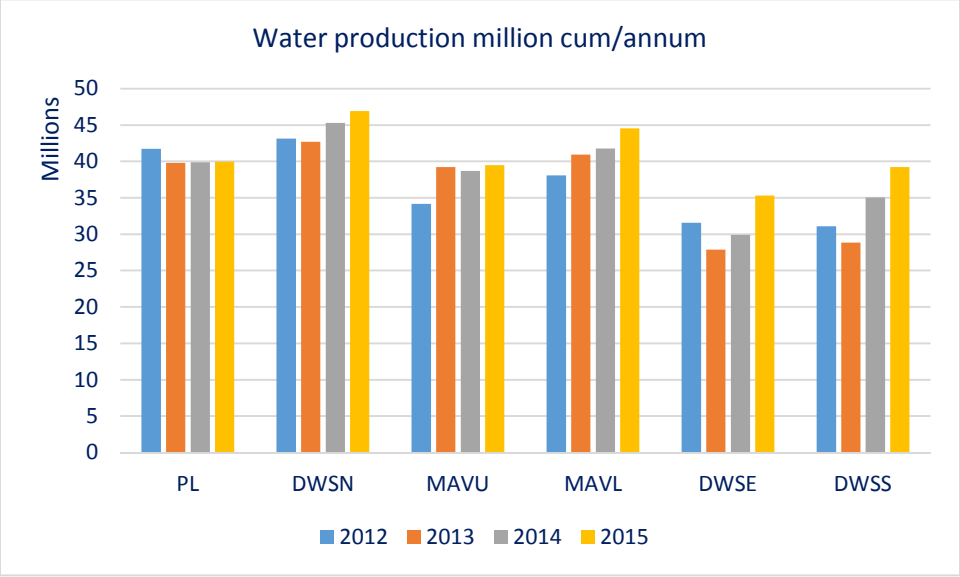
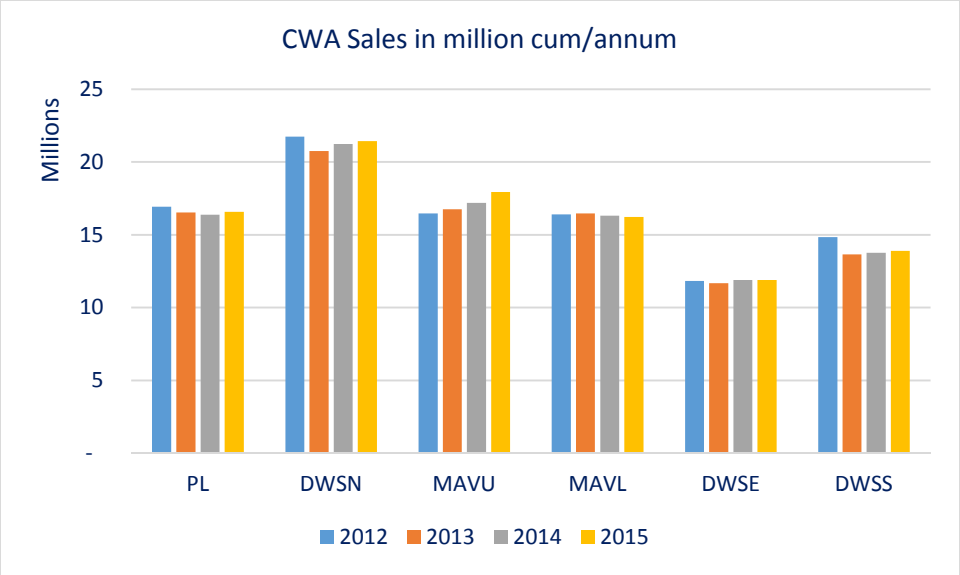


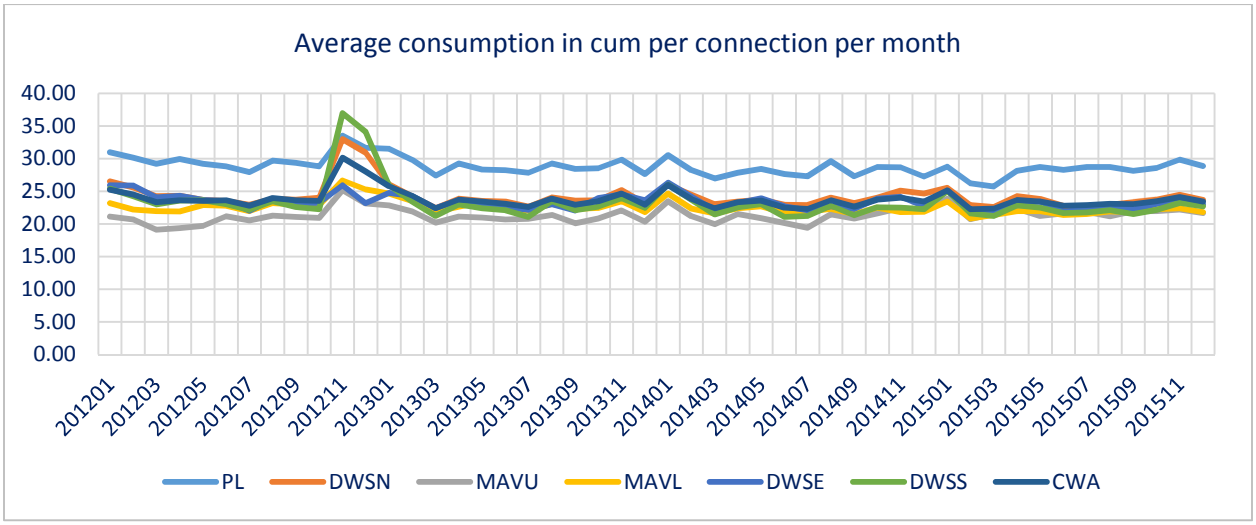
Figure 18 – Sales Trend



9.3. Consumption Analysis

The trend of consumption in different operating zones in presented below.

Figure 19 – Consumption Trend



Inferences:

i. Average consumption per connection per month is highest in Port Louis zone since the number of customers served per connection is highest in the urbanized capital city.

ii. The aberration of high consumption during November 2012 could be due to delay in billing resulting in a spike

iii. Despite the erratic intermittent water supply with least supply hours when compared to other zones, the consumption is not very different meaning the customers do get water they need and

possibly make coping arrangements through private storage. It may also possibly due to the effect of air in the pipelines, entrapped during rationing, resulting in over reading of meters.

iv. DWS South being relatively less populated and also less economically prosperous has slightly lower consumption level.

v. The stable consumption pattern indicates that the demand satisfaction level would be almost asymptotic with less possibility of any future increase in consumption.

vi. This analysis does not take into account the customer meter errors but considering the principle of averages it may not substantially affect the future consumption levels.

9.4. Customer Analysis in Different Consumption Range

Based on monthly consumption range, customer accounts are analysed and shown below.

Table 15 – Distribution of Customers as per monthly consumption range

Volume Range	PL	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	8550	14817	12122	11829	7617	8555	63490	18%
6.1 - 10	8591	12255	9542	12508	5640	7253	55789	16%
10.1 - 15	8978	14545	12647	11520	8044	8985	64719	18%
16.1 - 20	7457	11822	11598	9029	7152	8576	55634	16%
21.1 - 25	4218	6246	6554	4763	4149	4961	30891	9%
25.1 - 30	3464	5368	5477	3831	3721	4509	26370	7%
30.1 - 35	2112	3221	3356	2276	2221	2806	15992	5%
35.1 - 40	1340	2030	1951	1438	1367	1782	9908	3%
40.1 - 50	1355	2022	1903	1495	1390	1704	9869	3%
Above 50	3168	4549	3871	3566	2509	3126	20789	6%
Grand Total	49233	76875	69021	62255	43810	52257	353451	100%

The category wise analysis is shown below.

Table 16 – Distribution of customers - Domestic

Domestic								
Volume Range	Pl	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	7555	13209	10514	10776	6605	7595	56254	17%
6.1 - 10	8059	11733	9020	11986	5305	6849	52952	16%
10.1 - 15	8585	13954	12141	11050	7741	8588	62059	19%
16.1 - 20	7142	11398	11177	8710	6933	8194	53554	16%
21.1 - 25	4039	6029	6330	4592	4005	4745	29740	9%
25.1 - 30	3301	5140	5232	3651	3568	4311	25203	8%
30.1 - 35	1973	3049	3179	2142	2112	2640	15095	5%
35.1 - 40	1229	1916	1801	1328	1287	1680	9241	3%
40.1 - 50	1189	1835	1720	1353	1295	1561	8953	3%
Above 50	2096	3451	2989	2719	2057	2518	15830	5%
Grand Total	45168	71714	64103	58307	40908	48681	328881	100%

Table 17 – Distribution of Customers - Commercial

Commercial								
Volume Range	Pl	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	743	613	942	747	439	429	3913	28%
6.1 - 10	429	271	345	372	177	218	1812	13%
10.1 - 15	307	306	340	356	169	271	1749	13%
16.1 - 20	242	181	274	232	139	278	1346	10%
21.1 - 25	127	115	157	120	86	155	760	5%
25.1 - 30	117	105	164	123	97	139	745	5%
30.1 - 35	99	86	110	95	72	115	577	4%
35.1 - 40	64	43	83	67	42	62	361	3%
40.1 - 50	102	73	101	85	46	84	491	4%
Above 50	549	379	373	388	143	235	2067	15%
Grand Total	2779	2172	2889	2585	1410	1986	13821	100%

Table 18 – Distribution of Customers - Hotels, Casino, Service Stations

Hotels, Casino, Service Stations								
Volume Range	Pl	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	32	52	29	31	21	33	198	12%
6.1 - 10	10	20	8	15	14	20	87	5%
10.1 - 15	16	24	18	14	7	10	89	6%
16.1 - 20	14	14	12	11	8	6	65	4%
21.1 - 25	10	18	5	5	3	11	52	3%
25.1 - 30	8	22	11	7	7	8	63	4%
30.1 - 35	8	16	7	8	10	7	56	3%
35.1 - 40	12	17	5	4	4	7	49	3%
40.1 - 50	20	30	9	9	9	9	86	5%
Above 50	205	284	99	119	70	82	859	54%
Grand Total	335	497	203	223	153	193	1604	100%

Table 19 – Distribution of Customers - Government and Charity Institutions

Government, Charity and Stand pipes								
Volume Range	Pl	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	186	369	314	150	277	346	1642	36%
10.1 - 15	65	74	55	74	55	62	385	8%
16.1 - 20	53	57	40	35	32	58	275	6%
21.1 - 25	38	20	32	28	27	25	170	4%
25.1 - 30	35	27	19	27	15	27	150	3%
30.1 - 35	28	22	23	14	9	21	117	3%
35.1 - 40	32	14	25	22	12	13	118	3%
40.1 - 50	38	30	30	24	14	30	166	4%
6.1 - 10	88	125	77	82	77	116	565	12%
Above 50	243	162	172	194	94	130	995	22%
Grand Total	806	900	787	650	612	828	4583	100%

Table 20 – Distribution of Customers – Non-Potable

Others Non-Potable								
Volume Range	Pl	DWSN	MAVU	MAVL	DWSE	DWSS	Total	%
0 - 6	19	39	22	19		15	114	30%
6.1 - 10	1	3	2	1		1	8	2%
10.1 - 15	1	2					3	1%
16.1 - 20		1	2				3	1%
25.1 - 30	1	1	1	2			5	1%
30.1 - 35						1	1	0%
35.1 - 40		1		1			2	1%
40.1 - 50		1	1	1		1	4	1%

Above 50	22	71	50	37	16	41	237	63%
Grand Total	44	119	78	61	16	59	377	100%

9.5. Bulk Customer Unit

Out of the customers receiving potable water, some 2,500 customers are high revenue or high consumption customers accounting for a sales volume of about 29% contributing about 35% of revenue who are serviced through a dedicated Bulk Customer Unit (BCU) from the CWA central office.

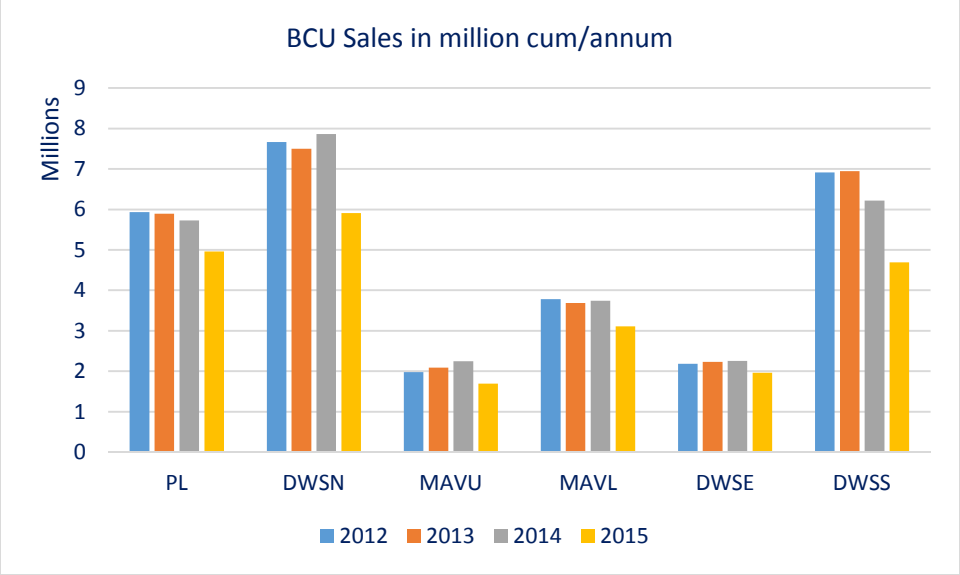
The tasks of meter reading, billing and customer complaints redressal is managed by the BCU. The customers and sales details of BCU are shown in below.

Table 21 – Customer and sales data for Bulk Customer Unit

2012	Connections	Volume	Water Charges
PL	582	5930382	107003453
DWSN	756	7666389	126856749
MAVU	395	1979316	36631353
MAVL	380	3779511	65179297
DWSE	169	2185763	59011505
DWSS	209	6913293	55268536
Total	**2491**	**28454654**	**449950893**
2013			
PL	584	58,91,425	1084,97,016
DWSN	737	74,96,537	1338,30,839
MAVU	403	20,85,030	404,07,752
MAVL	391	36,83,466	719,27,541
DWSE	172	22,31,192	592,91,156
DWSS	215	69,46,883	543,27,662
Total	**2502**	**28334533**	**468281966**
2014			
PL	579	5731029	108216390
DWSN	722	7863322	141222479
MAVU	412	2247137	42624805
MAVL	401	3743772	69376195
DWSE	172	2257540	58702973
DWSS	221	6220292	53448446
Total	**2507**	**28063092**	**473591288**
2015			
PL	543	4962407	106024459
DWSN	648	5910407	139110116
MAVU	391	1693063	35145312
MAVL	394	3105935	63908767
DWSE	161	1959572	58526059
DWSS	208	4688409	45431426
Total	**2345**	**22319793**	**448146139**

The sales trend of BCU unit is further analysed and shown in the following chart.

Figure 20 – BCU Sales Trend



It can be seen above that there had been significant reduction in BCU sales volume. Even in the drought year of 2013 the BCU sales remained constant but the drop had been significant from the year 2014 and even higher during 2015. CWA anti-fraud unit had been made active in the recent months and had been discovering large customers tampering the meters and is said to be proceeding with legal action.

An analysis of consumption and revenue realization is presented in the table below.

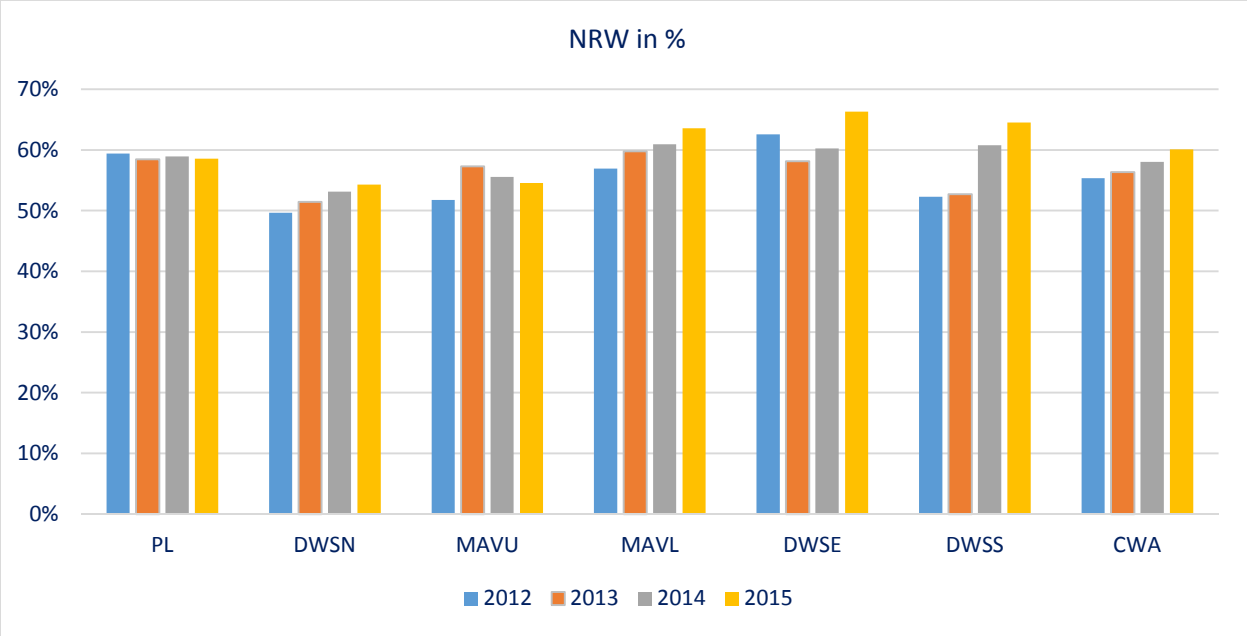
Table 22 – Consumption and revenue realization analysis

	Consumption/Conn/month			Revenue/conn/month			Average realisation/cum		
Zone	Including BCU	Excluding BCU	Only BCU	Including BCU	Excluding BCU	Only BCU	Including BCU	Excluding BCU	Only BCU
2012									
PL	29.87	19.65	849	419	234	15321	14.04	11.89	18.04
DWSN	25.39	16.61	845	342	196	13983	13.48	11.81	16.55
MAVU	20.99	18.58	418	242	197	7728	11.54	10.59	18.51
MAVL	23.04	17.84	829	298	208	14294	12.94	11.64	17.25
DWSE	23.89	19.55	1,078	328	210	29098	13.73	10.72	27
DWSS	25.21	13.53	2,756	297	204	22037	11.79	15.1	7.99
CWA	24.53	17.55	952	317	206	15053	12.94	11.76	15.81
2013									
PL	28.63	18.58	841	408	222	15482	14.27	11.97	18.42
DWSN	23.54	15.07	848	334	183	15132	14.21	12.14	17.85
MAVU	20.9	18.36	431	249	199	8356	11.89	10.82	19.38
MAVL	22.62	18.32	785	307	217	15330	13.55	11.83	19.53
DWSE	23.06	18.65	1,081	318	200	28726	13.77	10.74	26.57
DWSS	22.54	11.20	2,693	286	199	21057	12.69	17.74	7.82
CWA	23.37	16.46	944	314	200	15597	13.43	12.13	16.53
2014									
PL	28.05	18.32	825	402	218	15575	14.34	11.89	18.88
DWSN	23.58	15.35	908	338	187	16300	14.33	12.19	17.96
MAVU	21.09	18.33	455	253	200	8622	11.99	10.94	18.97
MAVL	22.17	17.08	778	295	201	14417	13.32	11.77	18.53
DWSE	23.07	18.92	1,094	316	204	28441	13.68	10.8	26
DWSS	22.25	12.34	2,346	281	198	20154	12.65	16	8.59
CWA	23.21	16.49	933	312	198	15742	13.43	12.02	16.88
2015									
PL	28.08	19.67	762	404	224	16271	14.39	11.4	21.37
DWSN	23.3	16.87	760	332	181	17890	14.27	10.75	23.54
MAVU	21.69	19.64	361	258	215	7490	11.88	10.96	20.76
MAVL	21.73	17.57	657	286	200	13517	13.16	11.4	20.58
DWSE	22.64	18.91	1,014	312	200	30293	13.77	10.59	29.87
DWSS	22.2	14.72	1,878	280	208	18202	12.62	14.11	9.69
CWA	23.13	17.86	793	309	204	15926	13.37	11.4	20.08

10. Non-Revenue Water

An analysis of NRW in each operating zone is shown below.

Figure 21 – NRW Trend in CWA



It can be seen above that despite several attempts to contain NRW, it had been increasing year on year in percentage terms in the entire CWA operation area. In the case of Port Louis zone the NRW had been stable attributable to the concentrated urban area with higher density of customers per unit length of network. At the same time, the NRW level in percentage terms has been on a downward trend in case of MAV Upper (the pilot PUB zone) since the year 2012 but still remains high.

The overall NRW increasing trend when correlated with the increasing trend in number of customers with 24x7 water services (See Figure 7) also indicates that it is the physical loss or leakage in the system which is contributing to the NRW.

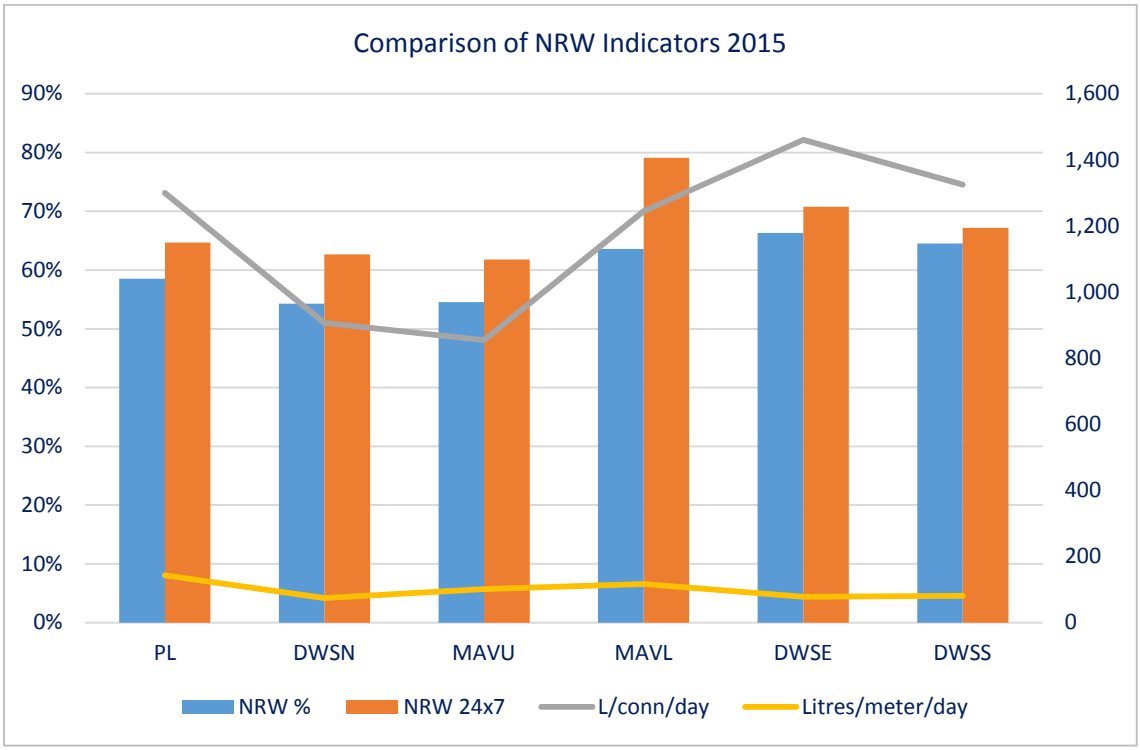
As the general percentage NRW level would not be sufficient to benchmark each operating zone, an attempt is made to project the same on a continuous pressurized supply (24x7) scenario as well as to compare in different performance indicators as shown below.

Table 23 – NRW Performance Indicators

Operating zone	NRW %	NRW 24x7	L/conn/day	L/meter/day
PL	59%	65%	1,300	143
DWSN	54%	63%	907	74
MAVU	55%	62%	855	101
MAVL	64%	79%	1,245	117
DWSE	66%	71%	1,461	78
DWSS	65%	67%	1,325	81
Total	60%	69%	1,141	93

Notes: NRW % - NRW level in percentage terms; NRW 24x7 – Projected NRW if the network is charged for 24hour supply; L/conn/day – Litres per connection per day; L/meters/day is the NRW in litres per meter length of network per day

Figure 22 – NRW Indicators



Inferences:

i. MAV Lower is the zone requiring immediate attention and relatively high investments in pipe renewal as the prevailing intermittent water supply is rapidly degenerating the networks. The current production is totally dependent on ground water meaning several smaller network zones. CWA has proposed to augment the resources from Bagatelle dam on its completion. Moving from disaggregated networks to more centralized supply system would tend to increase the physical losses further until checked and repaired on a rapid response regime.

ii. MAV upper is the most favourable zone for quick conversion into 24x7 services

iii. The high level of losses in litres/connection/day in Port Louis is also related to very old existing networks and also CWA's limit in timely repairs in the capital city high traffic operating environment. It could also be due to high commercial losses from meter errors as the general consumption per connection is higher due to higher number of customers per connection.

iv. DWS East has highest losses in litres/connection/day and lowest in terms of litres/meter network length per day. This contradiction indicates that the commercial losses in the zone may be relatively high and also leakage on services pipes could also be high when compared to other zones.

v. The projected losses in 24x7 service is lowest in MAV Upper indicating the continuous trend of reduction in losses in the zone including the recent intense efforts of NRW project implemented on partnership with PUB, Singapore, albeit that the improvements are modest compared to the resources spent during the partnership.

11. Review of NRW Project

CWA established about 256 DMAs with flow and pressure management instrumentation commencing in MAU Upper the in the year 1995 as a pilot and then expanded in the entire island in 2001.

There had been earlier (Year 2003-4) attempts with Severn Trent Water International funded by European Investment Bank to develop a strategy and action plan. After receiving strategic recommendations, CWA in the year 2005, decided to disband its internal NRW control unit by limiting the unit's activities to information management.

Under this background Government of Mauritius invited the Singapore Government to provide the services of Singapore Cooperation Enterprise (SCE) for reducing NRW in CWA.

MAV Upper zone was chosen and the project was implemented from July 2013 and up to June 2015 and further continued by CWA through internal resources. The project has undertaken following activities.

Objective 1: Reduce NRW and improve water network efficiency through active leakage control and effective asset renewal

i. Establish baseline, targets and leakage reduction strategy
ii. Identify mains and communication pipes with the high failure rates and develop a justified asset renewal program optimised in line with the budget.
iii. Manage implementation of pipe infrastructure renewal / modification works with contractors appointed by the Mauritius Government
iv. Mobilise and manage field investigation contractors to carry out active leakage control & Leak Detection and Repair
v. Implement pressure management schemes if supply conditions allow
vi. Customer Meter Replacement Program

Objective 2: Improve water network management / monitoring of the system

i. Calibrate / replace bulk meters
ii. Re-establish the existing DMAs in the Upper MAV System

iii. Establish effective and intelligent monitoring and management of the water distribution system - data logging at key locations in the system
iv. Establish good DMA and defects data management
v. Establish a working GIS system
vi. Establish a hydraulic network model

Objective 3: To affect knowledge transfer to CWA to enable sustainable water network management

i. Carry out required on-the-job NRW Management training of the CWA staff
ii. Develop best practice procedures to support NRW Management including data analysis, GIS/modelling, active leakage control, material /equipment selection, engineering and contract documents, procurement and construction management.

The project scope comprises of following.

Table 24 – NRW Project Scope

Scope	Unit	Value (US$)
Number of DMAs	Number	48
Network length	Km	815
Number of DMAs with pipe renewal	Number	17
Network replacement length	Km	80
Connections	Number	69069
Customer meters replaced	Number	15828

The project financials are as follows.

Table 25- NRW Project Financials as on 29th February 2016

NRW Project Expenditure	Budgeted	Expenditure	Budgeted	Expenditure
	MRU	MRU	US$	US$
Staff Cost		38191129		1091175
Consultancy Services	108188752	75218107	3091107	2149089
Other Supply & Works Contracts		6448236		184235
Tools & Equipment & IT Software		30178542		862244
Subtotal for DMA rehabilitation		150036014		4286743
Major Pipe laying Contracts	542361101	249083235	15496031	7116664

Some of the key lessons learnt were:

i. Problems of workmanship with HDPE mains.

ii. HDPE to replace LDPE for house connections pipes
iii. Pipe replacements program to be maintained and prioritized for the coming 3-4 years with a view to reduce NRW
iv. New strategy for systematic replacement of ageing meters to be implemented
v. Close liaison between NRW & Operations essential to maintain integrity of DMA's
vi. Written down procedures to develop and maintain best practices

Key observations on the physical achievements reported are as follows.

a. 59% initial estimation of NRW was later reduced to 56% as the CWA existing bulk flow meters (mostly Voltman type mechanical) were apparently showing more flows with positive error and hence the production volume was to be readjusted by the NRW team

b. Existing 47 DMAs were rehabilitated into 48 DMAs but NRW activities were implemented in 17 DMAs only due to shortage of resources and limitations of procurement restrictions

c. Out of 815km pipe network, about 80km were replaced with 25m per day output per one construction management team including night working.

d. NRW project accounts 69,069 connections up to end of February 2016 as against the 68,920 as per commercial services billing record at the end of December 2015 indicating that there had been limited effort to identify un-authorised connections.

e. 15,828 dysfunctional customer meters amounting to 23% were replaced. On replacement it was observed that there was about 18% increase in sales volume for the meters that were changed. However, this cannot necessarily be fully attributed to higher accuracy of new meters as the analysis is also affected by generally increased water consumption during dry season. Further CWA has a practice of average billing (to be checked on number of months) and assuming two months average prior to meter's dysfunction the consumption would surely be about 15% less as the meter stops after running slow over at least a year.

f. Pressure Reducing Valves (PRVs) have been procured to be installed in one sub-zone to reduce leakage (author has noted that CWA had already installed 2 PRVs which were dysfunctional due to lack of maintenance).

g. 1,507 leaks were repaired during the CSE tenure followed by 670 leaks repaired by CWA internal team

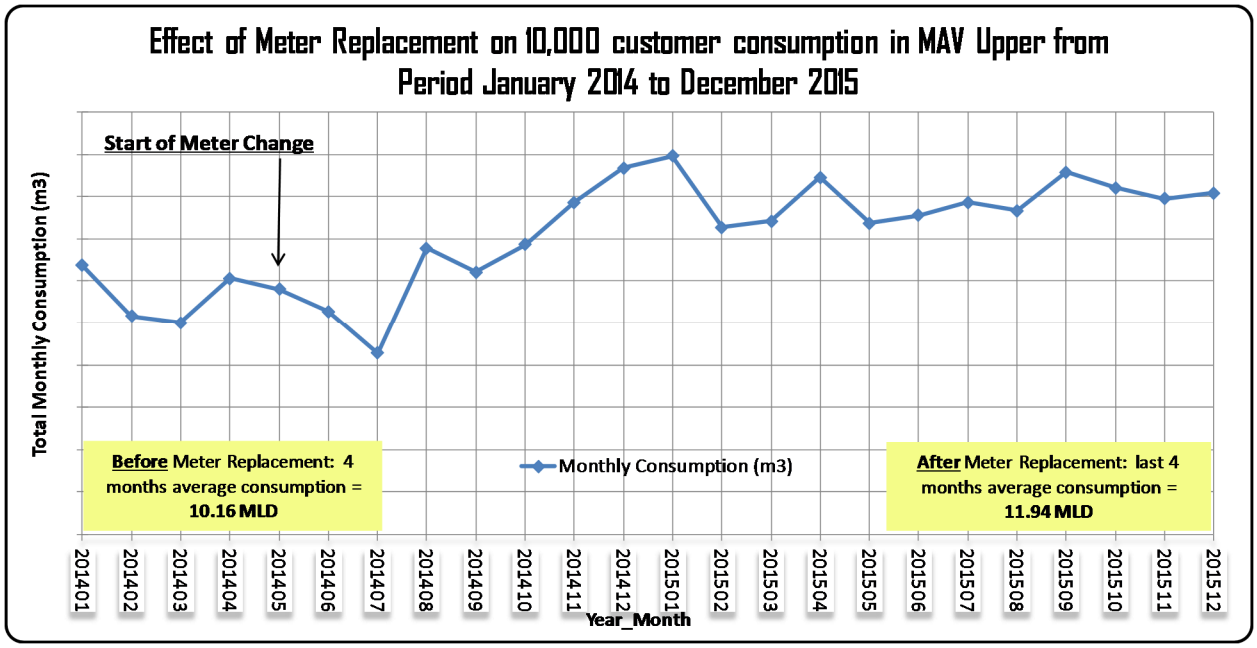
h. 13l/s minimum night flow (MNF) was observed when induced with 24x7 services which is generally in high range

i. The project proponents have initially targeted to reduce the level of NRW from 59% to about 44% during the project tenure and to be further reduced to 25%. On commencing the project

j. At the end of year 2015 the NRW level was 55% as against the adjusted baseline of 56% resulting in slightly more than 1% reduction.

k. The team has analysed the effect of replacement of about 10,000 customer meters which has shown 18% increase in consumption when compared to the month of March and August (Please see figure 16 below).

Figure 23 – Analysis of consumption from 10000 connections with replaced meters



l. Normally a dysfunctional meter is billed based on average consumption the six billing months immediately preceding the month to be billed.

m. However, this fact requires further analysis as in all the zones in the past four years the consumption keeps increasing during dry season which starts from April and goes up to October (please see Figure 8 – Consumption analysis)

n. Another key lesson is the decision to switch over from HDPE pipes to DI pipes based on the pipe replacement position paper[6].

   i. The position paper relies on the concern of bad workmanship on HDPE pipe laying and jointing and recommended usage of DI pipes also attributable to the fact that PUB has very low usage of PE pipes due to very high pressures and larger size connections.

   ii. In the same paper the authors quote UKWIR and AWWA recommendations on PE pipes having lowest leakage levels when compared to other pipes (pl see Figure 12 below)

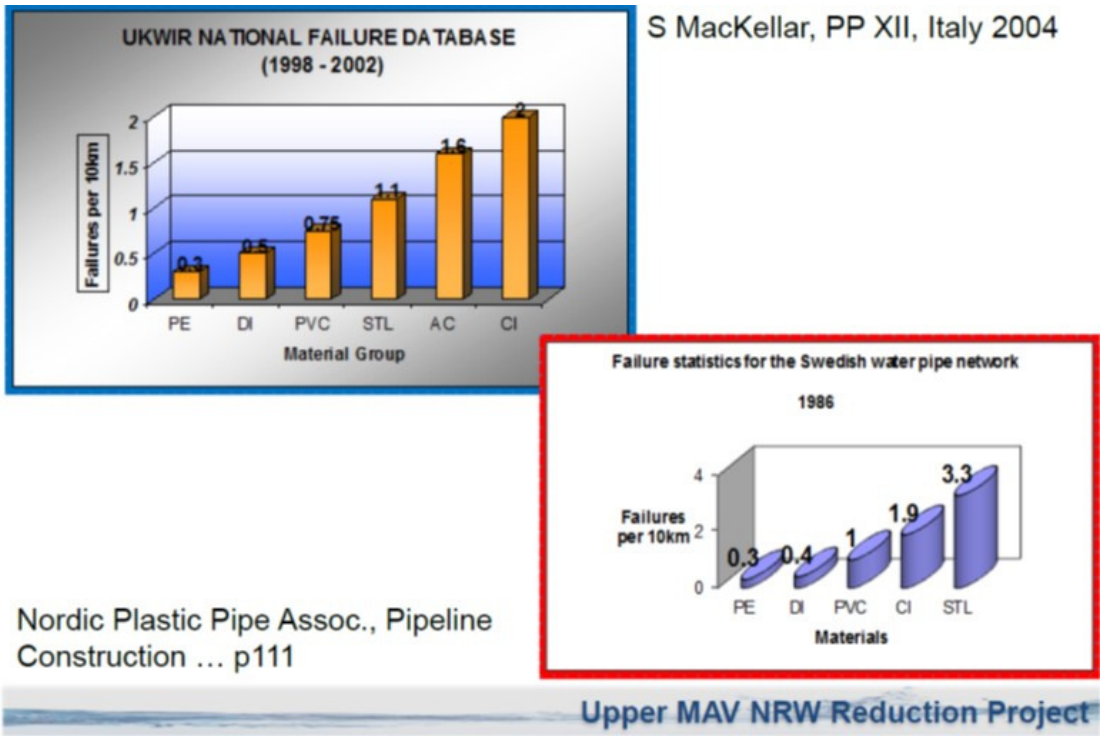
   iii. The migration to DI pipes is also due to apparently the same cost of both PE and DI in the island. Surprising the PE pipe is locally made and DI is imported but PE fittings are to be imported into the island nullifying the advantage of locally made pipes.

   iv. Considering the small island economy and creation of jobs, it might be necessary to review this decision as the pipe material cannot be blamed for deficient quality control and supervision by the concerned staff.

[6] Upper MAV NRW reduction project – Position Paper for Pipe Replacement

o. One significant weakness of the project implementation is the institutional arrangement that the NRW unit was to directly report to the General Manager instead of head of operations. This has led to typical hands-off approach from the operations managers, compromising the accountability. NRW control has to be a continuous focused program of the operations team of a water utility for internalizing and sustaining the improvement achieved.

Figure 24 – Extract from NRW Report on Pipe Failure



12. Review of Planning and Development Activities

12.1. Planning and Development (P&D) Division

P&D Division is a weak division within CWA. It spends about MRU 400m investments per year with no strategic plan. Although it had a Master Plan prepared (Arcus GIBB), the result was of questionable quality.

The Chief Engineer is retiring in a year and the Principal Engineers have an average of 15 years experience and the Executive Engineers are almost fresh graduates with very little training. There is therefore a significant need to strengthen capacity in this area.

Project implementation is painstakingly slow despite outsourcing most of design and construction supervision activities. The average duration time for a procurement of pipe network is about 9 months. The average cost of outsourcing to local engineering consulting firms is about 6% with about half split between design and supervision charges.

Pailles WTP rehabilitation undertaken by a local contractor group has been badly delayed with the concrete walls leaking and sweating and ended up in litigation. CWA blames the consultant (GIBB) for poor construction supervision and delays.

The proposed new WTW at Bagatelle dam is subject to a legal challenge of procurement decision in local courts with no clear date for resolution.

Qualification criteria for procurement seems to be set to support local suppliers with a high level of mis-procurement and legal challenges.

Quality assurance is almost absent resulting in low quality products and workmanship. In one pipes and fittings contract, the fittings did not fit due to quality control issues but the P&D had stipulated in the tender that that pipes and fittings should be of same brand and manufactured in the same factory. Most pipe manufacturers in the world do not make fittings and either supply them as bought out items or outsource them from fittings manufacturers under their brand, so making this stipulation hard to meet.

This stipulation has created a near monopoly situation, with one local trading agency supplying a single brand pipes and fittings.

In the recent NRW project, this stipulation was not followed by the SCE Project Manager and the team accepted pipes and fittings from manufacturers which are not permitted by P&D Division and the NRW team could complete the pipe replacement in much shorter time frame.

12.2. CWA Capital Projects Implemented between 2006 – 15

Table 26 – Capital Projects Implemented during 2006 - 15

Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
	Capital Cost in MRU										
WTW expansion	0	0	0	31	0	0	0	0	0	0	31
WTW Rehabilitation	0	0	0	0	0	0	0	0	0	735	735
Expansion of storage	0	0	0	24	117	0	0	0	0	0	141
Inter zonal transfer	0	125	0	0	22.1	75	0	0	0	71.9	294
Network expansion	158.32	165.2	242.8	140	101.1	126.4	539	0	188.9	107.1	1768.82
Network pipe renewal[7]	0	0	0	0	0	0	110	281.3	48.8	179.3	619.4
Office buildings	0	0	0	143	0	0	0	0	0	0	143
Total Cost in MRU	158.32	290.2	242.8	338	240.2	201.4	649	281.3	237.7	1093.3	3732.22
Total Cost in US$	4.52	8.29	6.94	9.66	6.86	5.75	18.5	8.04	6.79	31.24	106.63

12.3. CWA Ongoing Improvements

[7] Network Pipe Renewal details during the years 2006 – 11 is not known and possibly included in network expansion costs.

As at the end of March 2016, CWA is implementing the following capital projects for service improvements.

Table 27 – CWA ongoing capital projects

Sl.No	Contract No.	Funded by	Contract Name	Contract Value (in Million)	
				MRU	US$
1	CWA/C2013/104	100% CWA	Replacement of Pipeline from Cap Malheureux to Saint Francois	45	1.29
2	CWA/C2012/72	100% CWA	Water Supply to SSRN Hospital and associated works	27.7	0.79
3	CWA/C2013/88	100% BMF	Renewal of Pumping Main from Alma to Alma Hill Reservoir	33	0.94
4	CWA/C2013/27	GOM loan	Upgrading of Pailles Water Treatment Plant	631	18.03
5	CWA/C2012/15	GOM loan	Construction of Pipeline from Bagatelle Water Treatment Plant of Soreze	228	6.51
6	CWA/C2013/04	100% CWA	Water Supply of South Western Coast - Phase I; Trois Mamelles to Bon Asile and Cae Noyale to Coteau Raffin	66	1.89
7	CWA/C2014/17, 20,30,32	50% BMF 50% CWA	Non-Revenue Water Project in Upper Mare aux Vacoas System	1,000	28.57
8	CWA/C2013/101	100% CWA	Rehabilitation of Sedimentation Tank at La Marie Treatment Plant	42.4	1.21
9	CWA/C2014/84	100% CWA	Renewal of Service Main at Ferney and Morcelement Ferney	75	2.14
10	CWA/C2013/47	100% CWA	New Pipeline from Melrose Reservoir to Montagne Blanche (Le Chaillet)	38	1.09
11	CWA/C2013/11	100% CWA	Pipeline from Poste de Flacq to Poste Le Fayette	28.2	0.81
			Total	2214.3	63.27

In addition to the above, CWA through the Wastewater Management Authority (WMA) was also mandated to undertake pipe renewal programs in areas where sewerage projects are being implemented. This decision was apparently to avoid repeated road restoration requirements and also based on requirement of shifting of existing CWA water networks.

WMA had been implementing some four contracts (Plaines Wilhems Sewerage Project) on behalf of CWA, mostly located in MAV Lower Operating Zone for replacing 110km of CWA existing networks.

Table 28 – WMA Contracts for Replacement of CWA Networks

Sl.No	Contract No.	Location	Network Length in Km
1	Lot 1A – WW80F	West Rose Hill, South West and Central Quatre Bornes	50
2	Lot 1B – WW99F	Rose Hill, Beau Bassin, Roches Brunes, Plaisance and Mont Roches	10
3.	Lot 2 – WW81F	Quatre Bornes, Sodnac, Belle Rose	50
	Total		110

The above contracts have estimated and provided for110 km replacement but during implementation, CWA identified that a total of 150km needed to be replaced and the contract variations are still in preparation.

The above contracts were entrusted to WMA in the years 2007-9 and are yet to be completed. While WMA completed most of the pipe laying, moving connections linked to the new networks is still in progress due to poor coordination between the local CWA operations units and WMA. Now that some of pipes laid are already 8-years old with no commissioning in sight it would lead to risk of poor performance of the assets even before handover to CWA.

The above issue is one of the reasons for the MAV Lower Zone which is very densely populated continues to struggle with erratic intermittent water supply.

In all the above ongoing works of pipe replacement with shifting of connections, CWA does not replace the customer meter. Even though it is stated that as long as the customer meter is functioning at the time of shifting of connections there is no need of replacement but the actual reason could be that the meter replacement is the responsibility of commercial division while shifting of connections is the responsibility of operation division.

12.4. CWA Proposed Investments

GoM, recognizing the decline in water supply service levels both due to CWA's organizational performance and lack of required investment in asset management has launched an ambitious program funded under the "Build Mauritius Fund" (BMF) with the source of revenue from a cess on fuel.

Under the 'Build Mauritius Fund', GoM has in Budget 2015, earmarked an outlay of MRU.3.6billion ($103million) for implementation of some priority water sector projects. These include replacement of old and inefficient pipelines in strategic locations (blackspot areas) including shifting of connections, increasing storage capacity by construction of new service reservoirs and construction of new and upgrading of existing water treatment plants. The basis for prioritization and selection of these projects is not clear with different perspectives provided by different divisions of CWA. The timeframe proposed by CWA for implementation of Phase 1 projects with an outlay of MRU 5.5billion ($157million which includes MRU 3.6billion already budgeted in FY 2015) is 2016-2018. In the second phase ie 2018-20 it is proposed to implement pipe renewal works at an outlay of MRU5.3billion ($151million). The proposed projects are listed in Annexure 2A and 2B.

No resource plan has been identified and no project implementation for these projects has been developed. The P&D division had been struggling to appoint consultants for about a year.

The capacity of current CWA staff (P&D) is is said to be about MRU400million (per year and the SCE Project Manager could deliver MRU600million ($17million) in two years under the NRW project. It indicates that an outsourced capital works manager can deliver about MRU300million ($8.5million) per year and hence the proposed program would require at least five additional project managers. Another significant limitation is the capacity of local contractors which require substantial improvement through partnership with overseas contracting firms specialized in water supply pipe line works especially with trench-less technologies to meet the requirements of the Road Development Authority. CWA had tried to recruit three project managers from the local market but could not find suitable candidates.

13. CWA Financials

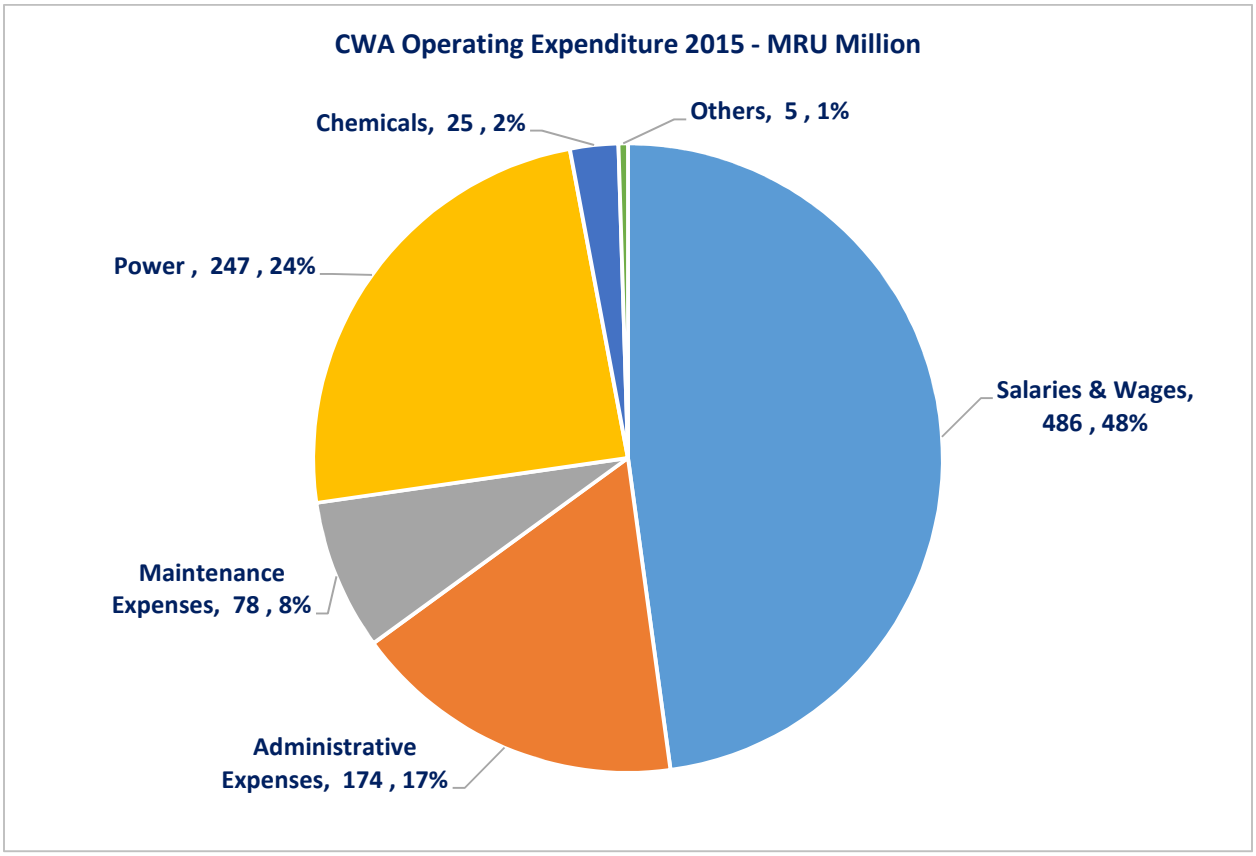
CWA operating expenditure is abstracted below.

Table 29 – CWA Operating Expenditure

Year/Category	Admin	Commercial	Operating Zones	WRSS Services	Total
2012					
Salaries & Wages	398.77	-	-	-	399
Administrative Expenses	81.74	0	25	3	110
Maintenance Expenses	86.83	1	44	12	144
Power	125.35	-	79	0	205
Chemicals	11.72	0	0	13	26
Others	2.36	-	0	0	3
Total	706.77	2	149	29	887
2013	-	-	-	-	-
Salaries & Wages	541.72	-	-	-	542
Administrative Expenses	75.60	1	57	13	147
Maintenance Expenses	17.55	4	123	45	190
Power	4.10	0	190	1	196
Chemicals	0.24	0	2	25	27
Others	2.40	0	3	-	5
Total	641.61	5	375	85	1,106
2014	-	-	-	-	-
Salaries & Wages	543.71	-	-	-	544
Administrative Expenses	287.48	1	88	34	411
Maintenance Expenses	8.16	4	107	20	139
Power	3.47	0	218	2	223
Chemicals	0.59	0	7	19	26
Others	2.17	-	1	-7	-4
Total	845.57	5	421	68	1,339
2015	-	-	-	-	-
Salaries & Wages	486.06	-	-	-	486
Administrative Expenses	29.59	2	107	35	174
Maintenance Expenses	12.63	5	43	17	78
Power	2.48	0	240	5	247
Chemicals	2.88	0	6	16	25
Others	1.32	-	4	0	5
Total	534.96	8	400	73	1,016

The breakup of category of Opex for the year 2015 is shown below.

Figure 25 – CWA Operating Expenditure 2015



Observations:

i. Salaries & Wages do not include Planning & Development Division which are capitalized.

ii. With power costs at 24% there is a potential for savings of up to 10% from non-revenue water management. For instance, the local operations staff under pressure due to intermittent water supply often resort to pumping from stand by pumps and stand by bore-holes assuming additional discharge. The amount of additional discharge of water (ie physical losses) from such parallel pumping would be about 20% due to increase in friction losses in the system and pumps operating at a far lower than the designed operating point.

iii. Chemicals at 2% also has some potential for savings as in most of the water treatment plants the chemical dosing is very adhoc and not based on recommendation of scientific services resulting in excessive chemical dosing or wrong choice of chemicals. However, due to the dependence on imports this may have cost variations depending upon the global economic situation and maritime regulations

13.1. CWA Tariffs and Income

13.2. CWA has increasing block structure tariff regime

CWA charges volumetric tariff on increasing block structure tariff regime where the higher the consumption, the higher the unit rate per cubic meter. The current applicable tariff is provided in Appendix 1 as part of Data Volume A. GOM had in the year 2015 declared free water up to 6kl and later amended the same to apply only to consumers consuming a total up to that level, and not applying to consumers who consume more than that.

The free water has only been made available since [March] 2016. As per analysis of the billing data (Table 16, Page 21) there were about 56254 customer accounts billed for a consumption range between 0 – 6kl. CWA is to be made whole by GoM for any shortfall as a result of the free water but CWA will need to monitor consumption carefully to ensure that consumers are not incorrectly being counted as below the 6kl threshold.

14. CWA Organisation

CWA Organisation chart is provided at Annexure 3. The management structure is shown below.

Figure 26 – CWA Management Structure

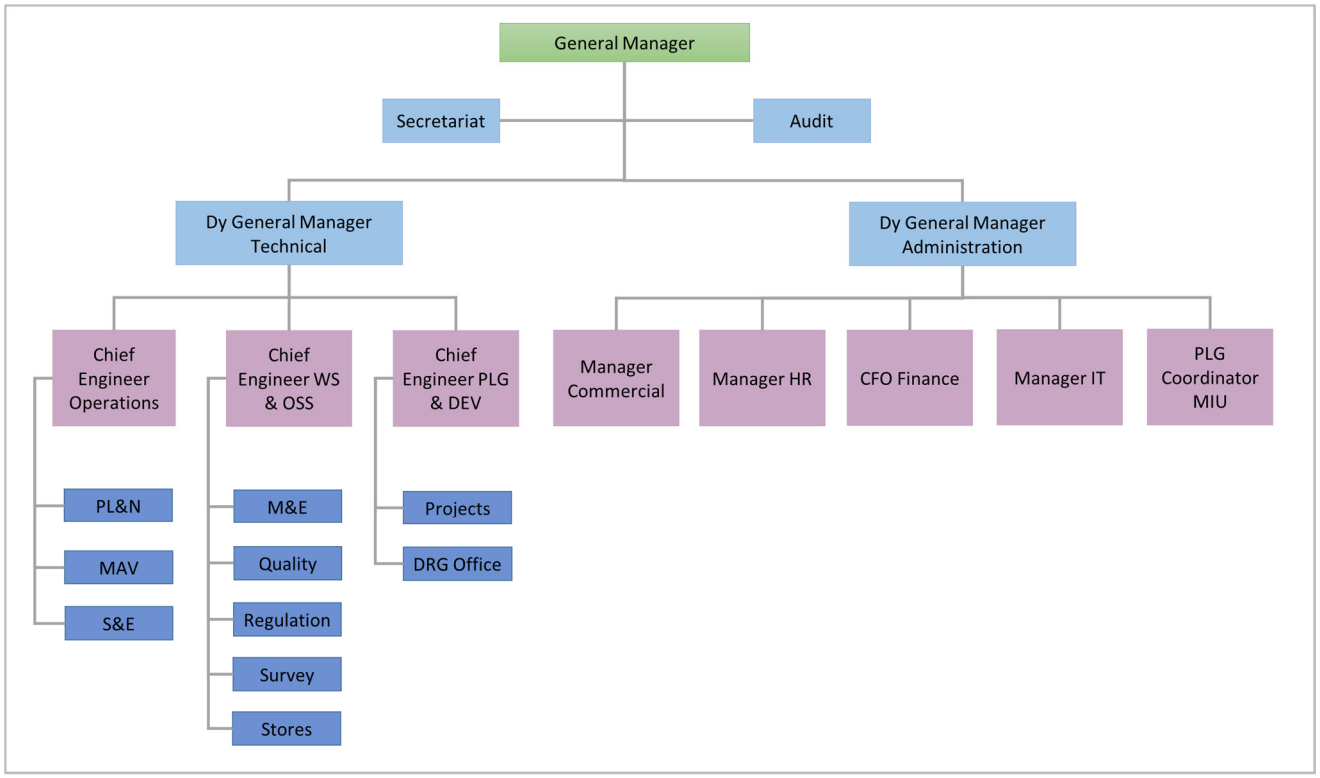


Table 30 - Retirements up to Year 2020

Detail	Number
Approved posts as at 2016	1357
Employees Working	1007
Vacancies	350
Retirements	
2016	17

2017	11
2018	25
2019	23
2020	47

It can be seen in the table above, that CWA's staff strength was 1007 for about 353000 connections at the time of study and it translates to 2.85 staff per 1000 connections. While this staff ratio is healthy for a well-functioning water utility but the CWA is currently on a downward spiral with deteriorating service levels and is in desperate need of rapid investments to put back into a reform path.

Considering the short term (at least for next five years of investment timeframe) requirement of skills in project management, contract management, commercial services, water loss reduction and quality assurance, it is necessary to ramp up the skills and staffing numbers with at least another 300 skilled staff leading to a staff ratio of 4 per 1000 connections. Deploying such critical skills would not be feasible in the current public sector recruitment process and hence need to be mobilized by the delegated private sector. This would also boost the local employment opportunities and can attract return of Mauritian skilled manpower to the island provided the remuneration and benefits match with international labor market standards.

14.1. Organisational Analysis of CWA

The organizational performance is summarized below.

i. Good coverage of customer connections
ii. More than sufficient water resources
iii. Service level in between emerging economies and developed world bureaucracy
iv. Ageing assets
v. Ageing staff
vi. High and increasing water losses

The critical issues in terms of organization performance are summarized below.

Table 31 – CWA Organizational Performance Review

S.No	Cause	Effect	Strategy
1.	Monopolies in • Functional responsibilities • Suppliers • Consultants	• No accountability • Blame game • Distress decision making	Break Monopolies • Introduce competition • Water account translates to team performance with safety net for historical asset conditions • Pilot area – learn and improve • Vendor development • Global bidding •

2.	Bureaucratic organization mindset • Strategic planning stops at corporate level • Middle managers engaged in paper work • No guidance to line staff • Allowances promoting inefficiency	• Internal problems left for interventions by Consultants • Wastage of time and resources • New staff leave after couple of years	Professionalize the staff • Appropriate, simple information systems • Rationalise allowances regime • Develop/hire analytical skills • Introduce Enterprise Resource Planning (ERP) • Train the younger staff
3.	Poor Contract Management • No recognition of employer powers and responsibilities • More time and more money • No individual targets • Over dependence on consultants	• Cost over runs • Mismatched implementation • Arbitration • No experience to new staff •	Improve Contract Management • Performance based contracting • Introduce individual targets • Electronic procurement • Develop local professional contracting expertise • Support joint ventures between local and global contracting agencies • Rationalise contract conditions •
4.	Compromise on quality and workmanship • 30000 leaks repaired and added • Low or no supervision and inspectors busy with paper work • No verification of consultants work • No cross check with specs • Engineers lost touch with sites	• Intermittent supplies • Deterioration of assets • Poor public image •	Improvement QMS • Institute a Quality team 2 International + 1External local • Review specs and reinforce with latest practices • Incorporate minimum supervision standards • Develop simple job charts and site drawings for use of line staff • Stipulate key and critical equipment • Prescribe post qualifications for specialised works • QMS certification
5.	Poor internal and external communications	• No periodical customer interactions	Improve Communications • Fortnightly management meetings

	• Chinese walls between functional heads • Formal paper communications • Low utilisation of intranet • Archaic paper trail	• Gap between Ops face and customer •	• Reduce file movement steps • De-bottleneck the intranet and train staff • Quarterly get-together • Half yearly meetings with resident associations • Customer message leaflets • Disclosure of Half Yearly Performance Reports

15. Service Improvement Planning

CWA over the past fifteen years, had made several attempts to improve the water services but did not meet with desired level of success. These attempts are summarized below.

15.1. NRW Reduction Consultancy Contract

CWA hired the services of Severn Trent Water International to undertake the study and development of a strategy for NRW reduction. The consultant had completed base line studies and prepared a strategy for reduction but it was totally peripheral advice and CWA could not implement as it lacked internalized organizational improvement by the operations and commercial staff.

In the recent NRW consultancy contract with the Singapore Cooperation Enterprise (SCE) although reasonably good efforts were made by the external consultants it was limited to information management through GIS, hydraulic modelling, some pipe renewal and capacity building of the NRW team in CWA. Due to very nature of structure of the NRW team not being part of operational or commercial divisions, with no oversight or input in respect of meter reading, meter readers or meter replacement or pipe laying, the results from the efforts were just about 1% reduction in NRW over 2 years.

15.2. In-sourcing of external professionals

CWA with the objective of inducting professional management had attempted and continues to hire professionals from the market for the key positions of General Manager, Deputy General Manager, NRW Manager, Commercial Manager etc. While these attempts have resulted in some islands of excellence,t due to short term nature of such contracts, by the time the professional has understood the weaknesses of CWA, the contract term is almost ended and such arrangements further diluted the accountability of permanent internal staff towards the external professionals.

15.3. Hiring of Consultants

CWA hires local and international consultants for most of project planning, detailed engineering design and construction supervision tasks. However due to the lack of performance based contracting, these consulting contracts mostly result in high cost overruns and poor quality and workmanship of the resultant infrastructure improvements.

For example, CWA had to face substantial leakage through over ground assets like Pailles WTP built recently and CWA ended blaming the supervision consultants and the contractors.

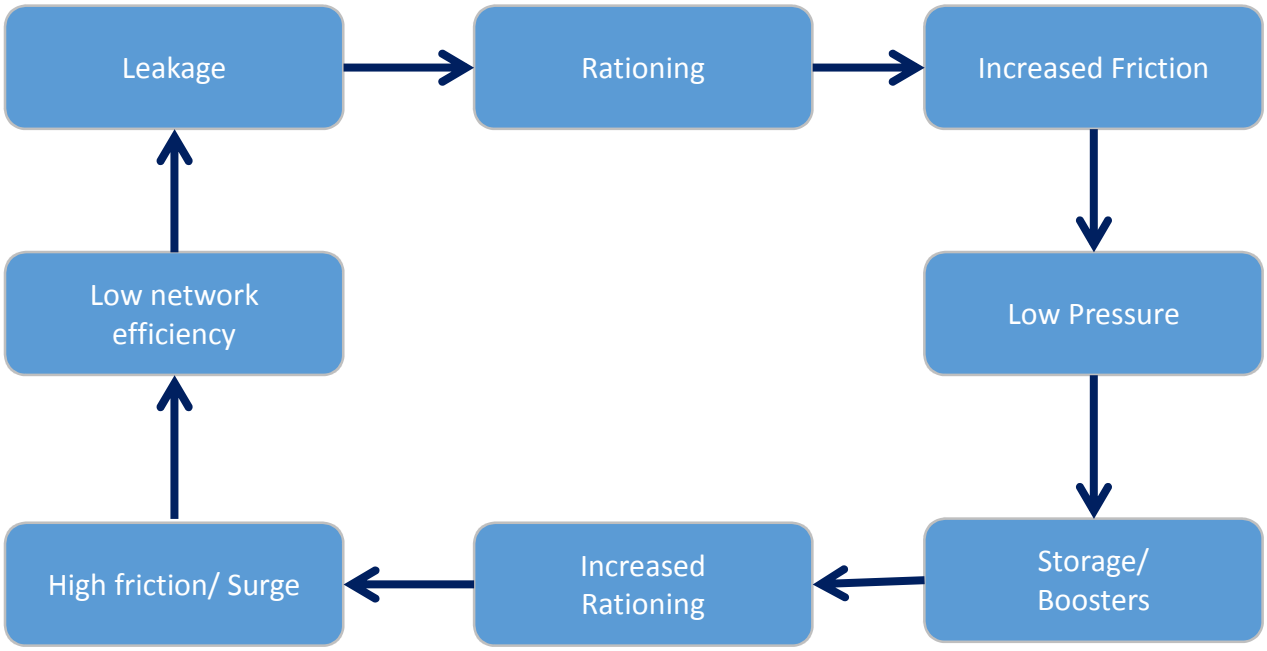
As noted above, limited capacity and dubious selection requirements have led to contractors being selected who have delivered poor workmanship and materials for PE pipe replacement.

In the above background, it is imperative to understand the core reasons for CWA's deteriorating performance and failure of the attempts discussed above.

15.4. Intermittent Water Supply

CWA's key problem is the prevailing practice of intermittent water supply which makes all the efforts to reduce non-revenue water futile.

Figure 27 – Vicious cycle of intermittent water supply



With each dry season and aggravated with high leakage and bursts, CWA resorts to increased rationing affecting the network strength and reducing the asset life.

The rationing would seriously inhibit operational feasibility of active leakage control (ALC) resulting in ever increasing losses.

To break this downward spiral, CWA requires a carefully planned and dry season insulated strategy of expanding the service areas with continuous (24x7) water supply and going after the resultant increased losses with high vigilance and trained human resources supported by sufficient and timely availability of financial resources.

Implementation of above strategy requires the following key ingredients:

i. Change Management: Major surgery of change management especially in the functioning of operations, commercial, planning and development and procurement divisions and practices. CWA itself should be subject to performance requirements which are then reflected in management and division performance targets. Procurement bottlenecks and processes need to be addressed, so that improvements can be achieved over a reasonable timeframe
ii. Improving Quality and Workmanship: A total change of mindset is absolutely necessary to ensure that CWA procures and implements the best quality, sustainable workmanship.
iii. Water Resources: Additional water resources to meet the increased losses that will result from the introduction of continuous supply (see 15.5 below)
iv. Structured and focused NRW control program to reduce NRW to about 44% through a holistic and phased approach.

v. Financial Resources: It is essential to ensure continuous and timely availability of financial resources for pipe renewal plus working capital to meet the incremental opex necessary for additional production and intensive leak repair in the short term and for investment and asset planning in the longer term. As CWA does not recover its capex needs through revenue it cannot rely on investment levels and so is unable to plan medium or long-term. The most sustainable way to ensure that CWA has consistent funding available and is financially self-sufficient would be through improving CWA's operational and financial performance so that it can raise funding through tariffs and can eventually raise commercial finance.

While the components (i) and (ii) above would be dealt in detail by the project team separately, an attempt is made to assess the resources required to address the components (iii) and (iv) hereunder.

15.5. Requirement of additional water resources

The rationing resorted by CWA during the year 2015 is shown below.

Table 32 – Percentage customers with different supply hours

Zone	24 hours	16 - 20hrs	12-15hrs	< 12 hours
PL	69	0	22	9
DWSN	47	28	5	20
MAVU	54	7	36	3
MAVL	9	5	8	78
DWSE	68	8	21	3
DWSS	83	6	8	3

In moving to 24x7 water supply typically more water is required as NRW increases in a pressurized system and there is a general increase in uptake by consumers. Based on the average hours of supply in each operating zone and the NRW levels seen during the year 2015, an attempt is made here to project the NRW volume in simulated 24x7 supply and the resultant production capacity required which is shown below.

Table 33 – Projected NRW and Production Volumes

	Projected volumes in 24hour supply						
Zone	NRW					Production	%NRW
PL	16150372	0	9154478	5055769	30360618	46932003	65%
DWSN	11967255	9505905	2263311	12221878	35958348	57397642	63%
MAVU	11640240	2011893	13795840	1552032	29000005	46939923	62%
MAVL	2548875	1888056	4027852	53016599	61481382	77697308	79%
DWSE	15913565	2496245	8736859	1684966	28831635	40725659	71%
DWSS	20997570	2023862	3597977	1821476	28440885	42342554	67%
Total	79217877	17925961	41576317	75352719	214072874	312035090	69%
Daily production required in 24x7 supply scenario in million litres per day						855	

The total production required to move to 24x7 service in the entire service area would be approximately 312million cubic meters of production which is equivalent to 855mld of daily production. During year 2015, CWA produced an average of 673mld and hence additional resources of (855-673=) 182mld would be required.

However, it is not prudent to switch over to 24x7 service in the entire service area simultaneously if NRW is to be managed and it has to be planned efficiently from upstream to downstream DMAs in a phased campaign. Assuming a time line of five years of implementation to switch over to 24x7 to achieve say a 44% resultant NRW level, the requirement of production capacity would be 710mld necessitating additional water production of 37mld.

CWA had already initiated augmentation of water resources by 60mld (60000cum/day) capacity water treatment works at Bagatelle Dam at a cost of MRU1.25billion. Although the associated water transmission works are in completion stage, the dam and treatment works procurement are held up in local courts due to a procurement award controversy. Assuming CWA resolves the procurement issue, the availability of additional 60mld should be achieved in about three years that is by 2019.

15.6. Focused NRW Control

Although considerable efforts have been made by the recent NRW consultancy implemented by SCE, the resultant reduction in NRW was not encouraging (although as some of the planned works are still in implementation the overall impact of the pilot is not yet established). Taking into account the lessons that are being drawn from the consultancy, the following strategy would need to be systematically implemented:

i. DMAs isolation integrity can be achieved with relatively limited investment as the DMA structure is still in tact
ii. Information management, analysis and monitoring requires modern tools like GIS and ERP systems for improving efficiency of operations and commercial services. There needs to be greater coordination between the operations and commercial divisions
iii. High amount of losses in communication pipes and about a third of dysfunctional meters and another third of slow moving meters indicate that the network rehabilitation should focus on house service connections and a scientific meter replacement policy
iv. About 4,000 bulk customers consume about 30% of the potable water supply and contribute about 35% of CWA revenue. Assuming 10% meter-error in this category would account to almost 3% of losses and 10% loss of revenue. As such it would be ideal to install high accuracy electronic customer meters (ultrasonic and automatically and remotely read) for these customers.
v. High pipe breaks in MAVL due to greater proportion of AC pipes indicate that pipe renewal should focus on early replacement of AC, PVC, Steel, GI and CI pipes which are more than 40years of age. CWA desperately requires a scientific and robust asset replacement policy and protocol to sustain the improvements made.
vi. Customers are treated as sources of revenue and complaints rather than as assets which are the center of CWA's business. Change management and an overhaul of the commercial division is required to transform it into a modern customer facing and orientated business.

Currently GoM has proposed to support CWA with investment funding of MRU 8 billion under BMF and the investment proposals drawn up by CWA to utilize these funds are shown in Annexure 2A and 2B.

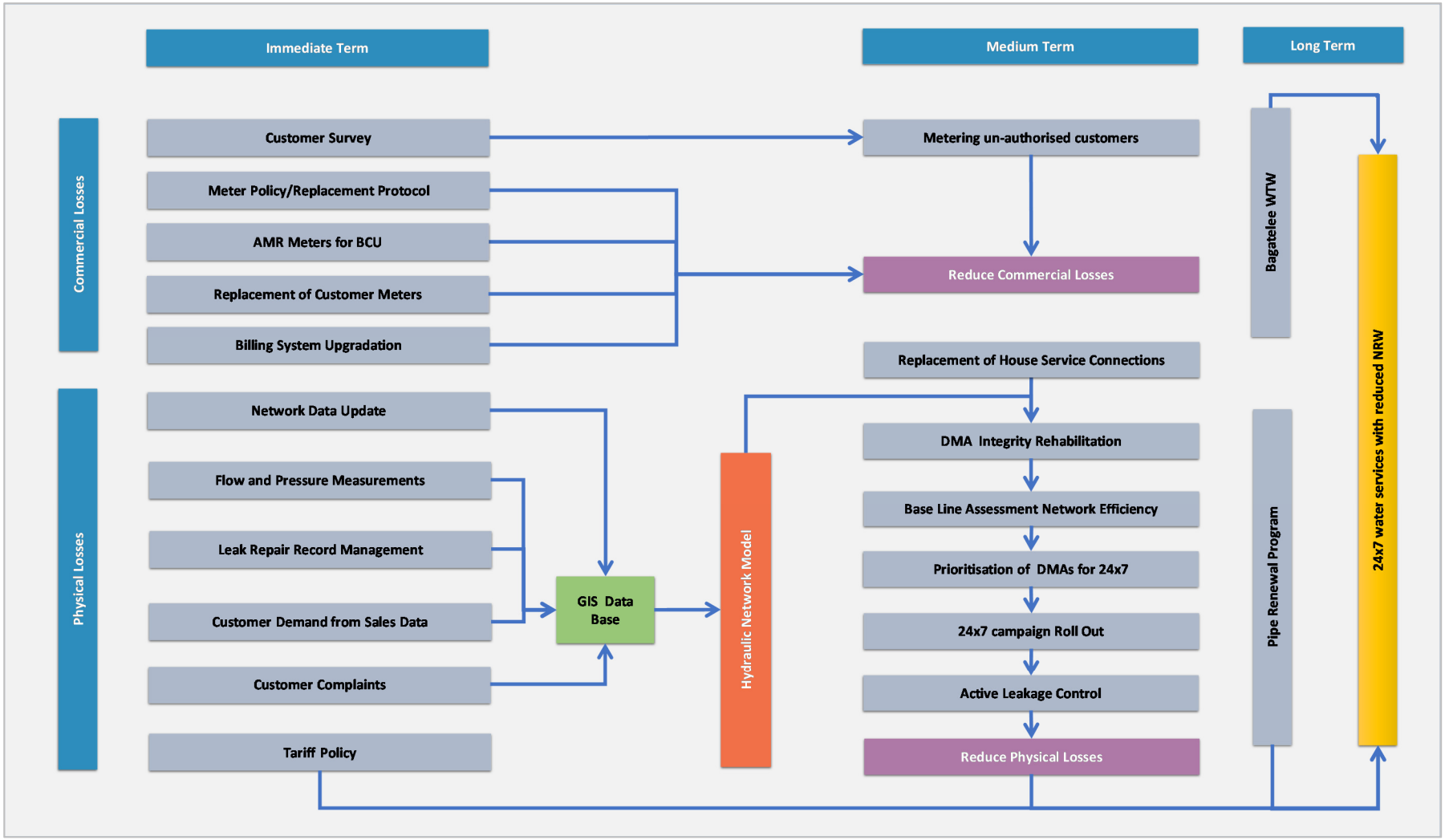
However, these proposals are adhoc and are not based on a structured strategy of NRW control and achieving continuous water supply.

In light of above, an effort is made to develop an outline structured investment and asset management strategy, founded on the following principles.

a. Water resource adequacy to be achieved with Bagatelle water treatment and transmission system to be completed by year 2019
b. Debottlenecking the existing water extraction arrangements to facilitate inter-zonal transfer to DWS North and MAV Lower zones
c. Upgradation of water treatment process to meet the increasing turbidity in raw water resulting from climate change and deforestation
d. Focused and structured water loss reduction program comprising of following components.
    i. Renewal of DMAs to ensure functional measurement and monitoring instrumentation and integrity of isolation of zone
    ii. Replacement of service connections and customer meters to reduce leakage and commercial losses
    iii. Prioritised pipe renewal program to minimum dependence of Asbestos Cement pipes and old cast iron pipes
    iv. Replacement of identified mains with high leakage and repair history
    v. Pipe-renewal cum remodeling of primary distribution mains to improve water supply and pressure in the network

The above strategy is pictorially shown in the process flow diagram provided in the following page.

Figure 28 – Strategy for Service Improvement



16. Costing of Service Improvements

16.1. Capex Requirements

Considering the local operating environment and the absence of detailed asset management plans and asset condition assessment, any attempt to estimate the capex requirements is based on set of assumptions made as per prudent industry practice. Unless the system is operated on site and the network activity is captured and the asset data updated on continuous basis, it is not practical to determine exact capex requirements. In addition, the level of capex is also influenced by future growth and especially any demand management measures CWA undertakes in lieu of reaching the limit of locally available water resources. As CWA progresses towards cost recovery to reduce dependence upon the government subsidy by improving the operating efficiency and rationalizing user fees, the demand at tap would tend to reduce facilitating deferment of any further resource augmentation. Taking these issues into consideration the scoping of capex and costing is undertaken and an indicative capex profile is determined. This profile is to assess the impact on level of capex subsidy required and also user fees to be charged for improved operating efficiency. The profile is subject to continuous update based on availability of funds and ground truthing of actual investments required during the first five years of operations.

16.2. Basis for Scoping

Asset rehabilitation and replacement assumptions are made duly taking into account the historical capex investments made by CWA since year 2006 including the recent NRW project by itself as well as the network rehabilitation being implemented by the Central Wastewater Authority.

16.3. Basis for Costing

The unit costs for planning service improvements are derived from analyzing the recent NRW consultancy project as well as the proposed investments by CWA under BMF Phase I as shown in the following table.

Table 34 – Unit Costs considered for capex planning

US Dollar Conversion rate in MRU			35			
Item of work	Source	Unit	Quantity	Amount	Unit Cost	
				MRU	MRU	US$
GIS and IT	NRWU	Number	48	30178542	628800	17970
DMA civil works	NRWU	Number	48	2737675	57100	1640
Dataloggers	NRWU	Number	55	2994466	54500	1560
Bulk flow meters	NRWU	Number	26	716095	27600	790
DMA Integrity Rehabilitation	NRWU	Number	48	19181088	399700	11420
Customer Survey	AKJ	Connection	400000		40	1.2
ERP System	AKJ	Job	1		30000000	857150
Vehicles	AKJ	Each	1		1000000	28580
Customer meters	AKJ	Each	1		1200	40
AMR Meters	AKJ	Each	1		10000	290
DMA Integrity Rehabilitation	NRWU	DMA	1		399700	11420
Network rehabilitation	AKJ	Running Meter	1		2500	80

Network Expansion	AKJ	Running Meter	1		2500	80

In addition to water loss reduction program, the rehabilitation of existing production works to meet the water quality requirements and also resource augmentation planned by CWA are as follows.

Table 35 – Proposed renovation and augmentation of production capacity

Water Treatment Plants Rehab	Cum	Capex MRU Million	Implementation period
La Nicoliere	66000	715	2018-21
River du Poste intake works	15000	88	2021-21
Mont Blanc	10000	187	2019-21
Piton du Milieu	30000	173	2017-19
Water Treatment Plants New			
Bagatelle	60000	1250	2017-18
Riv des Auguilles	40000	1600	2025-27

The scoping assumptions are shown in Annexure 4. The capex profile and the projected capital costs are shown in the tables provided below.

Table 36 – Abstract of Capex Investments

Capex in millions without inflation	MRU	US$
Capex up to Year 2020	7803	223
Capex from Year 2021-25	5340	153
Capex from Year 2026 -30	3655	104
Total	16798	480

All numbers are without inflation.

Table 37 – CWA Capex Projections

	Capex up to 2022		Capex 2022-30		Total Capex	
Capex Item of Work	MRU Million	US$ million	MRU Million	US$ million	MRU Million	US$ million
Soft costs for billing and IT systems	268.64	7.68	97.28	2.78	365.92	10.46
Water Treatment Rehabilitation	1163	33.23	0	0	1163	33.23
Water Treatment Plant new	1250	35.71	1600	45.71	2850	81.42
Service storage and buildings	155	4.43	215	6.14	373	10.57
DMA Related	608.29	17.38	550.48	15.73	1158.77	33.11
Network Replaced	4551.83	130.05	1021.16	29.18	5572.99	159.23
Annual network rehabilitation	1597.75	45.65	2130.33	60.87	3728.07	106.52
Network Expansion	680.94	19.46	907.92	25.94	1588.86	45.4
Total capex	10275.45	293.59	6522.17	186.35	16797.61	479.94

All numbers are without inflation

Annexure 1 - Existing Pipe Networks in CWA

	Poly Ethylene														
Zone	**25**	**32**	**37**	**40**	**50**	**63**	**75**	**90**	**100**	**110**	**160**	**200**	**250**	**300**	**Subtotal**
PL	562	749	0	2287	5371	8136	0	23102	0	33728	20282	0	0	1029	95246
DWSN	0	3490	0	920	11383	19420	0	77328	0	102649	57403	8450	0	0	281043
MAVU	0	1547	526	3011	25046	34307	5845	80930	0	46653	28487	1422	0	0	227774
MAVL	0	0	0	0	20441	27579	2404	32770	215	75333	28520	1230	3311	0	191803
DWSE	0	0	0	0	2935	9595	453	57092	0	65758	44443	0	580	0	180856
DWSS	0	0	0	0	11310	19690	0	53542	0	49955	54195	0	10695	0	199387
Subtotal	562	5786	526	6218	76486	118727	8702	324764	215	374076	233330	11102	14586	1029	1176109
	Ductile Iron (DI)														
Zone	**50**	**75**	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**800**		4225
PL	0	769	7266	23940	23079	4898	10461	2933	1909	5251	807	0	0		81313
DWSN	0	0	15967	83349	46275	37416	13483	1920	12582	0	0	0	0		210992
MAVU	0	3260	6975	22176	28651	21094	15869	7607	14029	2424	0	2374	10543		135002
MAVL	0	14290	8789	70850	33341	16762	59209	7312	0	706	0	0	0		211259
DWSE	0	5421	4354	26814	35747	19186	11004	6933	4861	5513	0	0	0		119833
DWSS	0	2825	7460	39740	25745	20875	37295	5300	5655	1250	0	1750	0		147895
Subtotal	0	26565	50811	266869	192838	120231	147321	32005	39036	15144	807	4124	10543	0	906294
	Asbestos Cement (AC)														
Zone	50	75	100	125	150	175	200	225	250	300	375	400	525	600	3550
PL	84635	53955	3420	32883	9845	3749	5499	0	989	135	1072	0	0	0	196182
DWSN	0	66263	100383	7562	59817	21183	9146	0	3361	4805	0	0	0	0	272520
MAVU	0	55306	83124	4999	13337	0	4478	2972	0	13042	0	915	0	0	178173
MAVL	8161	76369	42978	11129	35894	615	15296	1100	2644	5046	4309	0	160	0	203701
DWSE	0	34694	59457	3060	36824	5989	20279	0	9766	10626	3200	0	0	6400	190295
DWSS	0	30406	48025	25218	11788	0	7531	0	4100	5628	0	0	0	0	132696
Subtotal	92846	317068	337487	84976	167655	31711	62429	4297	21110	39582	8956	1315	685	7000	1177117
	Cast Iron (CI)														
Zone	50	75	100	125	150	175	200	225	250	300	350	400	450	475	3325
PL	0	5635	4074	716	446	803	3784	311	3604	0	1066	0	456	2733	23628
DWSN	0	20883	776	18010	5382	0	0	0	0	0	0	0	0	0	45051
MAVU	0	17191	4680	15094	776	4135	12200	2473	4331	610	8566	1108	0	0	71164
MAVL	1808	21391	20184	4132	6136	2916	2494	2389	6721	4028	0	0	0	0	72199
DWSE	0	4526	13924	2895	1508	2731	0	0	0	1100	380	0	0	0	27064
DWSS	0	0	4500	3850	15450	0	0	0	0	0	0	0	0	0	23800
Subtotal	1858	69701	48238	44822	29848	10760	18678	5398	14906	6038	10362	1508	906	3208	266231
	Steel														
Zone	75	100	150	200	225	250	300	350	400	450	525				3025
PL	0	0	0	0	0	0	0	0	0	0	0				0
DWSN	2375	26475	0	0	0	0	0	0	0	0	0				28850
MAVU	0	1118	9037	0	686	0	5601	0	11486	7000	5781				40709
MAVL	0	0	0	105	3588	542	9704	0	0	0	0				13939
DWSE	0	2593	420	1760	0	1765	0	1673	0	6359	0				14570
DWSS	1625	0	1875	0	0	260	2200	0	10951	0	0				16911
Subtotal	4075	30286	11482	2065	4499	2817	17805	2023	22837	13809	6306				118004
	Galvanised Iron (GI)														
Zone	32	37	50	75	100	125	150								569
PL	0	0	1209	3644	975	0	0								5828
DWSN	0	0	11650	6927	5014	125	0								23716
MAVU	133	2863	16534	3618	0	0	0								23148
MAVL	0	0	23379	10114	1334	0	585								35412
DWSE	0	0	3200	985	2796	0	0								6981
DWSS	0	0	1941	0	0	0	0								1941
Subtotal	165	2900	57963	25363	10219	250	735								97595
	Poly Venyle Chloride (PVC)														
Zone	50	63	75	90	100	110	160	200							848
PL	4964	4716	0	0	0	816	0	1124							11620
DWSN	0	0	4000	0	0	600	0	0							4600
MAVU	0	0	0	107	0	0	0	0							107
MAVL	20821	2572	2046	1250	5147	463	2657	0							34956
DWSE	0	0	0	0	0	0	0	0							0
DWSS	0	0	0	0	0	0	0	0							0
Subtotal	25835	7351	6121	1447	5247	1989	2817	1324							52131
Grand tot	**125341**	**459657**	**512628**	**431760**	**486792**	**286485**	**258487**	**369811**	**98104**	**448649**	**259761**	**18049**	**26720**	**11237**	**3793481**

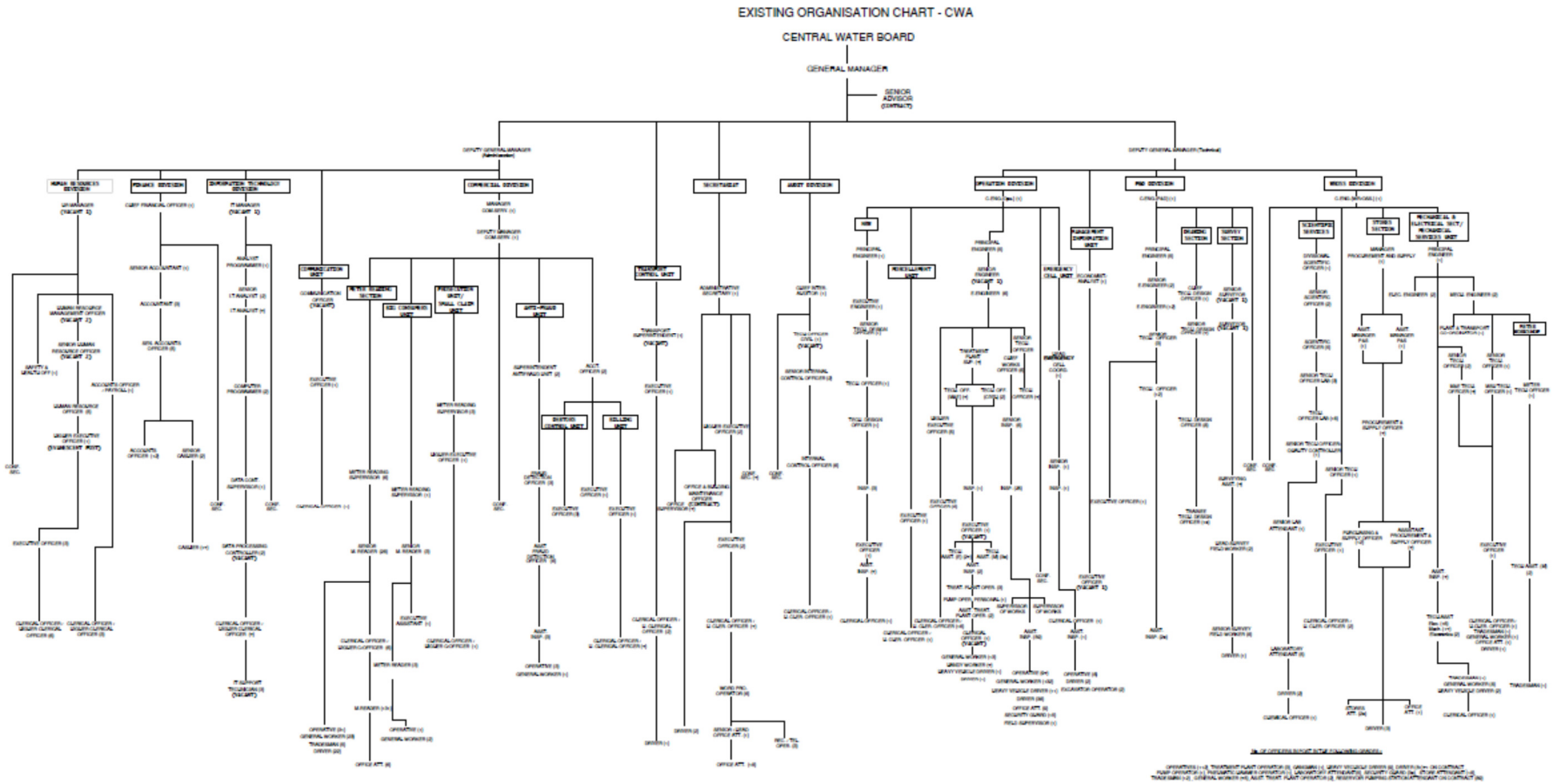
Annexure 2 A - Capital Projects Proposed under BMF Program Phase 1

S/N	Project	Zone	Scope	Estimated Value	Funding
	PIPE REPLACEMENT		Km	MRU Million	
1	Beau bassin and Rose Hill (ML)	MAVL	35	500	100% BMF
2	Pierrefonds (PL)	PL	12.5	300	100% BMF
3	Montagne Fayence-Ecroignard €	DWSE	4	100	100% BMF
4	Roche Boise-Plaine Verte (PL)	PL	20	100	100% BMF
5	Cite Roche Bois (PL)	PL	15	100	100% BMF
6	Alma-Malinga (MU)	MAVU	9	100	100% BMF
7	Alma-Alma Hill (MU)	MAVU	2	33	100% BMF
8	Riv du Rempart-Roche Noire (N)	DWSN	20	220	100% BMF
9	Salazie-Les Mariannes (N)	DWSN	4	60	100% BMF
10	Lallmatie-Brisee Verdiere-Laventure (E)	DWSE	12	200	100% BMF
11	Piton du milieu-Q Militaire (E)	DWSE	7	100	100% BMF
12	Moka	MAVU	10	75	100% BMF
13	Rose Belle-Plaine Magnien-Beau Vallon (S)	DWSS	10	250	100% BMF
14	Grand Bel Air-Ville Noire (S)	DWSS	12	120	100% BMF
15	Surinam	DWSS	4	25	100% BMF
16	South West Coast	MAVL	10.3	75	100% BMF
	SERVICE RESERVIOIRS		Cum	125	50% BMF
1	Cluny (S)	DWSS	200		
2	Rich en Eau (S)	DWSS	200		
3	Balisson (S)	DWSS	200		
4	Riviere Dragon (S)	DWSS	200		
5	Alma (MU)	MAVU	200		
	WATER TREATMENT PLANTS				
	Upgrading/Extension of Existing Treatment Plants				
1	La Nicoliere	DWSN		715	50% BMF
2	Riv du Poste	DWSS		88	100% BMF
3	Mont Blanc	DWSS		187	100% BMF
	New Treatment Plants and Associated Works				
1	Riv des Auguilles	DWSS	40000	1600	50% BMF
2	Pont Lardier (Deep River Beau Champs)	DWSE	15000	425	50% BMF
	Total Cost			5498	

Annexure 2 B - Capital Projects Proposed under BMF Program Phase 2
Pipe Replacement Projects to be implemented during 2018-2020, budget provision is yet to be made

S.No	Project	Zone	Unit	Estimated Value
1	Pipe Replacement at More Gubies Palles	PL	4	70
2	Offsite works at Les Salines and Mains Renewal at Les Salines		2.2	85
	Subtotal		6.2	155
1	Replacement of Pipeline from triolet to trou aux Biches and Trou aux Biches Coastal RD	DWSN	4	60
2	Nicoliere D`Epinay Pepeline 300 dia) and to Terre Rouge		10	51
3	Renewal of Pipeline from poudre D`Or Hamlet to Cottage		3	30
4	Replacement of Pipeline in Pereybere and Morc. Swan		2.5	25
5	Replacement of Pipeline in Morc. Raffray-Pte aux Cannoniers		2.5	25
6	Replacement of Pipeline at llot Branch Rd and Bois Pignolet		7.5	80
	Subtotal		29.5	271
1	Supply and Replacement of Mains in DWS East DMA(4 contract Packages) -under NRW project	DWSE	50	600
2	Supply and Replacement of Mains in DWS East DMA(another 4 Contract packages) -under NRW project		50	800
	Subtotal		100	1400
1	Mangalkhan DMA	MAVU	10.4	200
2	La Marie to Diolle		2.4	200
3	Eau Couiee DMA		13.1	200
4	Couvent St, Malherbes, Bigara, & Les Casernes DMAs		10	200
5	La Marie to La Brasserie		3.6	350
6	St Paul-Phoenix, Highlands, & Sadally Vacoas DMA		5	200
7	Other MAV(Upper) DMA Projects (4 contracts)		50	600
	Subtotal		94.5	1950
1	Contracts for pipe replacement in MAV(Lower) which includes regions such as Rose Hill, Moka, Bambous and Riv Noice, Also includes Pipe renewal from Beau Songes to Palmyre reservoir	MAVL	50	600
	Subtotal		50	600
1	Pipelaying works in upper part of Bambous Virieux	DWSS	5	25
2	Pipelaying works from Choisy to baie du Cap		2	30
3	Replacement of Pipeline from Cluny to St Hubert		4	40
4	Supply and Replacement of Mains in DWS South (4 contract packages) - under NRW Project		50	800
	Subtotal		61	895
	Grand Total	CWA	341.2	5271

Annexure 3 - CWA Organisation Chart



Annexure 4 A- CWA Capex Assumptions

Assumption	Unit	Quantity	2017	2018	2019	2020	2021	2022
Soft costs								
Customer Survey	Connection	400000	50%	50%	1%	1%	1%	1%
Setting up GIS	Zone	209	105	105	2	2	2	2
ERP system	Lump sum	1	100%					
Vehicles	Number		30	10	10	10	10	10
Water Treatment Plants Rehab	Cum	MRU Million						
La Nicoliere	66000	715		20%	40%	40%		
Riv du Poste intake works	15000	88				50%	50%	
Mont Blanc	10000	187			20%	40%	40%	
Piton du Milieu	30000	173	20%	40%	40%			
Water Treatment Plants New								
Bagatelle	60000	1250	50%	50%				
Riv des Auguilles	40000	1600						
Pont Lardier (Deep River Beau Champs)	15000	425						
Service Reservoirs	200	25	100%	100%	100%	100%	100%	100%
Cluny (S)	200							
Rich en Eau (S)	200							
Balisson (S)	200							
Riviere Dragon (S)	200							
Alma (MU)	200							
Ops office and customer service centres		5				100%		
Asset Replacement								
Port Louis								
Customer meters	Number	49228	20%	20%	20%	20%	20%	15%

Assumption	Unit	Quantity	2017	2018	2019	2020	2021	2022
AMR Meters	Number	578	100%	1%	1%	1%	1%	1%
Service Connections	Number	49186	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	43	20%	20%	20%	20%	20%	5%
Network Replacement								
100	Meters	161673	5%	5%	5%	5%	5%	5%
150	Meters	41093	5%	5%	5%	5%	5%	5%
200	Meters	9594	10%	10%	10%	10%	10%	
400	Meters	0	10%	10%	10%	10%	10%	
Network Expansion	Meters	496580	1%	1%	1%	1%	1%	1%
Network Rehabilitation	Meters	284220	1%	1%	1%	1%	1%	1%
Subtotal Port Louis								
DWSN								
Customer meters	Number	76816	20%	20%	20%	20%	20%	15%
AMR Meters	Number	559	100%					
Service Connections	Number	76694	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	31	20%	20%	20%	20%	20%	5%
Network Replacement								
100	Meters	115462	8%	8%	8%	8%	8%	5%
150	Meters	155581	8%	8%	8%	8%	8%	5%
200	Meters	9146	10%	10%	10%	10%	10%	10%
400	Meters	0	10%	10%	10%	10%	10%	10%
Network Expansion	Meters	1040126	1%	1%	1%	1%	1%	1%
Subtotal DWSN		759937	1%	1%	1%	1%	1%	1%
MAVU								
Customer meters	Number	68998	20%	20%	20%	20%	20%	15%
AMR Meters	Number	535	100%					
Service Connections	Number	68920	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	47	5%	5%	5%	5%	5%	5%
Network Replacement								

Assumption	Unit	Quantity	2017	2018	2019	2020	2021	2022
100	Meters	92756	5%	5%	5%	5%	5%	
150	Meters	118052	5%	5%	5%	5%	5%	
200	Meters	28410		5%	5%	5%	10%	
400	Meters	24267			5%	10%	10%	
Network Expansion	Meters	811292	1%	1%	1%	1%	1%	1%
Subtotal MAVU		547807	1%	1%	1%	1%	1%	1%
MAVL								
Customer meters	Number	62237	20%	20%	20%	20%	20%	15%
AMR Meters	Number	522	100%					
Service Connections	Number	62176	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	50	20%	20%	20%	20%	20%	5%
Network Replacement								
100	Meters	178097	8%	8%	8%	8%	8%	8%
150	Meters	78423	8%	8%	8%	8%	8%	8%
200	Meters	35218	10%	10%	10%	10%	10%	
400	Meters	0	10%	10%	10%	10%	10%	
Network Expansion	Meters	915923	1%	1%	1%	1%	1%	1%
Subtotal MAVL		624185	1%	1%	1%	1%	1%	1%
DWSE								
Customer meters	Number	43796	20%	20%	20%	20%	20%	15%
AMR Meters	Number	204	100%					
Service Connections	Number	43780	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	36	20%	20%	20%	20%	20%	5%
Network Replacement								
100	Meters	46201	5%	5%	5%	5%	5%	5%
150	Meters	82349	5%	5%	5%	5%	5%	5%
200	Meters	23804		10%	10%	10%	10%	
400	Meters	6359		10%	10%	10%	10%	
Network Expansion	Meters	647519	1%	1%	1%	1%	1%	1%

Assumption	Unit	Quantity	2017	2018	2019	2020	2021	2022
Subtotal DWSE		488806	1%	1%	1%	1%	1%	1%
DWSS								
Customer meters	Number	52228	20%	20%	20%	20%	20%	15%
AMR Meters	Number	286	100%					
Service Connections	Number	52172	20%	20%	20%	20%	20%	1.5%
DMA Integrity Rehabilitation	DMA	49	20%	20%	20%	20%	20%	5%
Network Replacement								
100	Meters	32347	5%	5%	5%	5%	5%	5%
150	Meters	85093	5%	5%	5%	5%	5%	5%
200	Meters	9991		10%	10%	10%	10%	
400	Meters	10951		10%	10%	10%	10%	
Network Expansion	Meters	627156	1%	1%	1%	1%	1%	1%
Subtotal DWSS		488774	1%	1%	1%	1%	1%	1%
Customer Meters			366897	374092	381430	388915	396550	404337
Customer meters	Number	353303	70661	70661	70661	70661	70661	6538
AMR Meters	Number	2684	2684	6	6	6	6	6
DMA Integrity Rehabilitation	DMA	256	44	44	44	44	44	13
Network Replacement								
100	Meters	626536	40134	40134	40134	40134	40134	32032
150	Meters	560591	35050	35050	35050	35050	35050	24480
200	Meters	116163	5396	10196	10196	10196	11616	915
400	Meters	41577	0	1731	2944	4158	4158	0
Subtotal Network Replacement	Meters	1344867	80580	87111	88324	89538	90958	57427
Network Expansion	Meters	4538597	45386	45386	45386	45386	45386	45386
Network Rehabilitation	Meters	3193730	31937	31937	31937	31937	31937	31937
Cumulative Scope								
Customer Meters	Number	353303	70661	141322	211983	282644	353305	359843

Assumption	Unit	Quantity	2017	2018	2019	2020	2021	2022
DMA Integrity Rehabilitation	Number	256	91	135	179	223	267	280
Existing Network Replacement	Meters	1344867	312937	400048	488372	577910	668868	726295
Network Expansion	Meters		45386	90772	136158	181544	226930	272316
Network Rehabilitation	Meters		31937	63874	95811	127748	159685	191622

Annexure 4B – CWA Capex Profile up to the year 2022

Capex Category		2017	2018	2019	2020	2021	2022
Soft costs							
Customer Survey		8000	8000	160	160	160	160
Setting up GIS		67000	67000	2000	2000	2000	2000
ERP system		30000	0	0	0	0	0
Vehicles		30000	10000	10000	10000	10000	10000
Subtotal Soft Costs		**135000**	**85000**	**12160**	**12160**	**12160**	**12160**
Water Treatment Plants Rehab							
La Nicoliere		0	143000	286000	286000	0	0
Riv du Poste intake works		0	0	0	44000	44000	0
Mont Blanc		0	0	37400	74800	74800	0
Piton du Milieu		34600	69200	69200	0	0	0
Subtotal Water Treatment Rehab		**34600**	**212200**	**392600**	**404800**	**118800**	**0**
Water Treatment Plants New							
Bagatelle		625000	625000	0	0	0	0
Riv des Auguilles		0	0	0	0	0	0
Pont Lardier (Deep River Beau Champs)		0	0	0	0	0	0
Subtotal Water Treatment Works		**625000**	**625000**	**0**	**0**	**0**	**0**
Service Reservoirs							
Different new service reservoirs		25000	25000	25000	25000	25000	25000
Ops office and customer service centres		0	0	0	5000	0	0
Subtotal - bulk supply improvements		**25000**	**25000**	**25000**	**30000**	**25000**	**25000**
Asset Replacement							
CWA							
DMA Related							
Customer meters		84820	84820	84820	84820	84820	63630
AMR Meters		26840	60	60	60	60	60
DMA Integrity Rehabilitation		17660	17660	17660	17660	17660	5120

Capex Category		2017	2018	2019	2020	2021	2022
Subtotal DMA Related		**129320**	**102540**	**102540**	**102540**	**102540**	**68810**
Subtotal Network Replacement		**700730**	**799620**	**834120**	**868610**	**883300**	**465450**
Network Rehabilitation		**266291**	**266291**	**266291**	**266291**	**266291**	**266291**
Network Expansion		**113490**	**113490**	**113490**	**113490**	**113490**	**113490**
CWA subtotal for networks		**1080511**	**1179401**	**1213901**	**1248391**	**1263081**	**845231**
CWA Grand total capex		**2029431**	**2229141**	**1746201**	**1797891**	**1521581**	**951201**
Capex in millions without inflation		MRU	US$				
Capex up to Year 20202 (Six years)		10275	294				
Capex from Year 2022-30		4922	141				
Total		15197	435				
Capex by category in millions		2017	2018	2019	2020	2021	2022
Soft Costs		135	85	12.16	12.16	12.16	12.16
Water Treatment Rahab		34.6	212.2	392.6	404.8	118.8	0
Water Treatment Works - New		625	625	0	0	0	0
Bulk Supply Improvements		25	25	25	30	25	25
DMA Related		129.32	102.54	102.54	102.54	102.54	68.81
Network Replacement		700.73	799.62	834.12	868.61	883.3	465.45
Network Expansion		113.49	113.49	113.49	113.49	113.49	113.49
Network rehabilitation		266.29	266.29	266.29	266.29	266.29	266.29
Grand Total CWA		**2029**	**2229**	**1746**	**1798**	**1522**	**951**