SAMOA WATER AUTHORITY

NON –REVENUE WATER (NRW) GUIDELINE

Statement for the PWWC theme:

- **Smart Island Water :**

As islanders we have come a long way in planning and implementing water system projects that exists today. Most of these utilities have aged and exceeded its usefulness and at least 40yrs old or more in some islands including Samoa. Now we are faced with a new kind of challenge of water loss and NRW rates that keeps increasing every year.

How can we be smart about it? What methods and technologies that exists today that can be used to counter this new problem in the island?

Content of the Guideline

1. Purpose of the Guideline

- Assist SWA in enhancing its activities to reduce and monitor NRW.
- Assist SWA to conduct effective and complete water audits
- Assist SWA in planning and design
- Assist SWA in Operations and Maintenance of old and new systems
- Assist SWA in sustaining an economical position as one of Samoa's SOEs.

2. Definition of NRW

- Volume of water that is distributed in the water supply network but does not yield returns.

NRW is the total production of treated water minus the total billed metered consumption.

…Malcolm Farley (NRW Handbook)

NRW = Production Volume – Billed Consumption

Assumption:

- System input has been corrected of any errors
- Billed metered consumption period for customers billing records are consistent with the system input volume period.

<table>
<tr><td rowspan="8">System Input Volume</td><td rowspan="3">Authorised Consumption</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="6">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Commercial Losses</td><td>Unauthorised Consumption</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Erros</td></tr>
<tr><td rowspan="3">Physical Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows from the Utilities Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the Customer Meter</td></tr>
</table>

3. System Assessments

- System assessments are carried out by various ways including Water balance exercises that are carried out periodically to access the volumes that are produced to match up with monthly consumptions per DMAs.
- SWA to conduct this exercise on a quarterly basis to evaluate and audit water that is lost through the network or from big transmission pipes.
- Billing accuracies and meter reading analysis to assess the accuracy of the information that will be used to calculate NRW
- Accurate systems mapping and DMA isolations to be corrected
- System information

SWA NRW HISTORICAL INFORMATION

	Unit	Average	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Average
		2016/17													2017/18
Malololelei	%	**49%**	67%	46%	48%	53%	59%	60%	62%	54%	63%	43%	68%	48%	**56%**
Alaoa	%	**56%**	64%	55%	50%	56%	49%	54%	46%	42%	51%	53%	55%	44%	**52%**
Fuluasou	%	**52%**	51%	41%	50%	52%	47%	49%	47%	43%	63%	55%	56%	44%	**50%**
Weighted average - all 3 service areas	%	**54%**	59%	48%	50%	54%	48%	52%	47%	43%	58%	53%	56%	44%	**51%**
Malololelei	L/conn/d	**1,873**	3,022	1,779	1,577	1,731	2,138	2,229	2,300	2,319	2,218	1,452	2,445	1,631	**2,070**
Alaoa	L/conn/d	**2,962**	3,736	3,151	2,840	3,139	2,360	2,624	2,131	1,975	2,548	2,514	2,643	2,149	**2,651**
Fuluasou	L/conn/d	**2,072**	1,799	1,525	1,814	1,852	1,611	1,624	1,635	1,624	2,602	2,216	2,050	1,455	**1,817**
FY 2017/18 Target	**L/conn/d**	**2,900**													**2,650**
Weighted average - all 3 service areas	L/conn/d	**2,496**	**2,865**	**2,349**	**2,324**	**2,500**	**1,995**	**2,139**	**1,904**	**1,822**	**2,560**	**2,310**	**2,342**	**1,799**	**2,242**

	Unit	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Average
														2017/18
Vailele WTP	%	40%	17%	47%	55%	41%	39%	43%	17%	32%	16%	32%	21%	**33%**
Fagalii WTP	%	78%	73%	40%	60%	64%	55%	57%	-3%	39%	30%	49%	27%	**48%**
Vailima WTP	%	56%	51%	15%	51%	24%	47%	41%	31%	51%	37%	54%	27%	**40%**
Vailele WTP	L/conn/d	1,075	388	1,527	2,606	1,455	1,230	1,199	440	711	364	717	444	**1,013**
Fagalii WTP	L/conn/d	5,047	4,487	1,716	1,689	1,947	1,413	1,314	-48	650	527	749	446	1,661
Vailima WTP	L/conn/d	3,168	2,916	762	2,776	967	2,317	1,956	1,504	2,382	1,646	2,370	1,169	1,994

Rural NRW Summary	Average 2016/17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Average 2017/18
Fuluasou EU WTP & Supplementary Boreholes	**46%**	49%	38%	41%	40%	55%	58%	72%	47%	58%	57%	56%	51%	**52%**
Lefaga	**55%**	57%	69%	67%	47%	48%	58%	40%	51%	64%	62%	50%	69%	**57%**
Tafitoala & Tiavi	**65%**	59%	47%	54%	74%	65%	58%	32%	40%	56%	53%	49%	41%	**52%**
Togotogiga TP	**46%**	58%	52%	64%	50%	54%	66%	54%	61%	66%	64%	68%	32%	**58%**
Vaovai BH, Piu & Matatufu BH	**54%**	63%	60%	63%	54%	53%	62%	46%	49%	61%	62%	64%	55%	**58%**
Lepa	**21%**	-5%	12%	-3%	-14%	8%	14%	-56%	1%	-25%	14%	-8%	13%	**-4%**
Lake Lano														
Lalomanu	**44%**	52%	43%	47%	55%	47%	49%	51%	36%	53%	31%	30%	44%	**45%**
Satitoa	**66%**	73%	70%	44%	56%	66%	71%	54%	70%	67%	73%	61%	62%	**64%**
Faleapuna	**59%**	53%	45%	46%	42%	47%	46%	31%	49%	64%	62%	47%	50%	**48%**
Overal Rural NRW	**51%**	**52%**	**46%**	**47%**	**46%**	**54%**	**58%**	**67%**	**47%**	**59%**	**58%**	**55%**	**53%**	**54%**

	Average 2016/17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Average 2017/18
Faleata (Palauli)		55%	52%	55%	53%	44%	60%	53%	48%	59%	65%	61%	49%	50%	**54%**
Iva		21%	58%	48%	41%	48%	68%	64%	47%	61%	73%	12%	7%	56%	**48%**
Lalomalava				4%	7%	44%	5%	36%	24%	55%	76%	44%	66%	81%	**40%**
Sapapalii		60%	60%	61%	43%	40%	45%	37%	42%	58%	39%	78%	81%	73%	**55%**
Logoipulotu		75%	84%	70%	68%	69%	76%	81%	60%	72%	82%	76%	75%	79%	**74%**
Faga 1		43%	52%	48%	24%	31%	43%	34%	14%	58%	62%	85%	88%	86%	**52%**
Lano & Puapua		39%	48%	51%	32%	31%	49%	35%	25%	38%	34%	41%	38%	8%	**36%**
Saleaula		34%	55%	47%	61%	51%	59%	56%	51%	36%	52%	12%	6%	21%	**42%**
Safotu		41%	50%	30%	26%	23%	29%	15%	9%	22%	26%	30%	27%	8%	**25%**
Matavai 1		29%	55%	59%	49%	47%	50%	49%	23%	35%	14%	15%	23%	38%	**38%**
Matavai 2		64%	72%	66%	62%	45%	68%	61%	48%	40%	33%	11%	15%	2%	**44%**
Letui		78%	70%	69%	66%	66%	64%	65%	65%	71%	86%	77%	74%	63%	**70%**
Asau		48%	51%	48%	48%	33%	68%	69%	77%	75%	71%	66%	48%	45%	**58%**
Auala		46%	22%	57%	58%	49%	59%	53%	56%	61%	50%	70%	72%	65%	**56%**
Sataua		67%	59%	76%	71%	68%	28%	69%	51%	49%	73%	56%	61%	42%	**59%**
Falealupo		33%	6%	12%	15%	23%	9%	28%	15%	19%	49%	29%	19%	38%	**22%**
Neiafu		50%	21%	33%	21%	10%	6%	34%	24%	50%	23%	43%	54%	50%	**31%**
Samata & Fogatuli		55%	43%	55%	46%	44%	57%	69%	57%	42%	63%	32%	55%	46%	**51%**
Fogasavaii & Sagone		44%	45%	47%	46%	43%	35%	40%	35%	34%	58%	25%	26%	21%	**38%**
Taga		61%	50%	50%	54%	51%	57%	58%	43%	48%	52%	48%	62%	50%	**52%**
Overall Savaii NRW	**58%**	53%	51%	54%	51%	44%	53%	53%	44%	53%	60%	54%	48%	45%	**51%**

4. NRW Target Setting

01

Target setting and preparation for SWA will be based on detailed analysis of all its independent systems.

02

Each systems are unique and has to be evaluated and assessed carefully due to its age and considered as new, fairly new, partially new, and old as in more that 30years.

03

Mapping is the key components to be established and ensure all system assets are consolidated and network pipes are in accurate locations

04

System meters for all DMAs should be updated and upgraded. All domestic meters replaced and within seven year replacement period

05

Calculate a target that is achievable within specified timeframes

5. Control of NRW

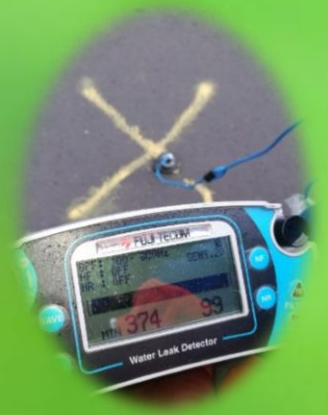
SWA will control NRW developing KPIs for each component of the system. Such components are:

1

Pressure management (1 – 4)bar pressure. By using control valves and appropriate pipe sizing

2

Accurate meter reading of target consumption and flow allowances



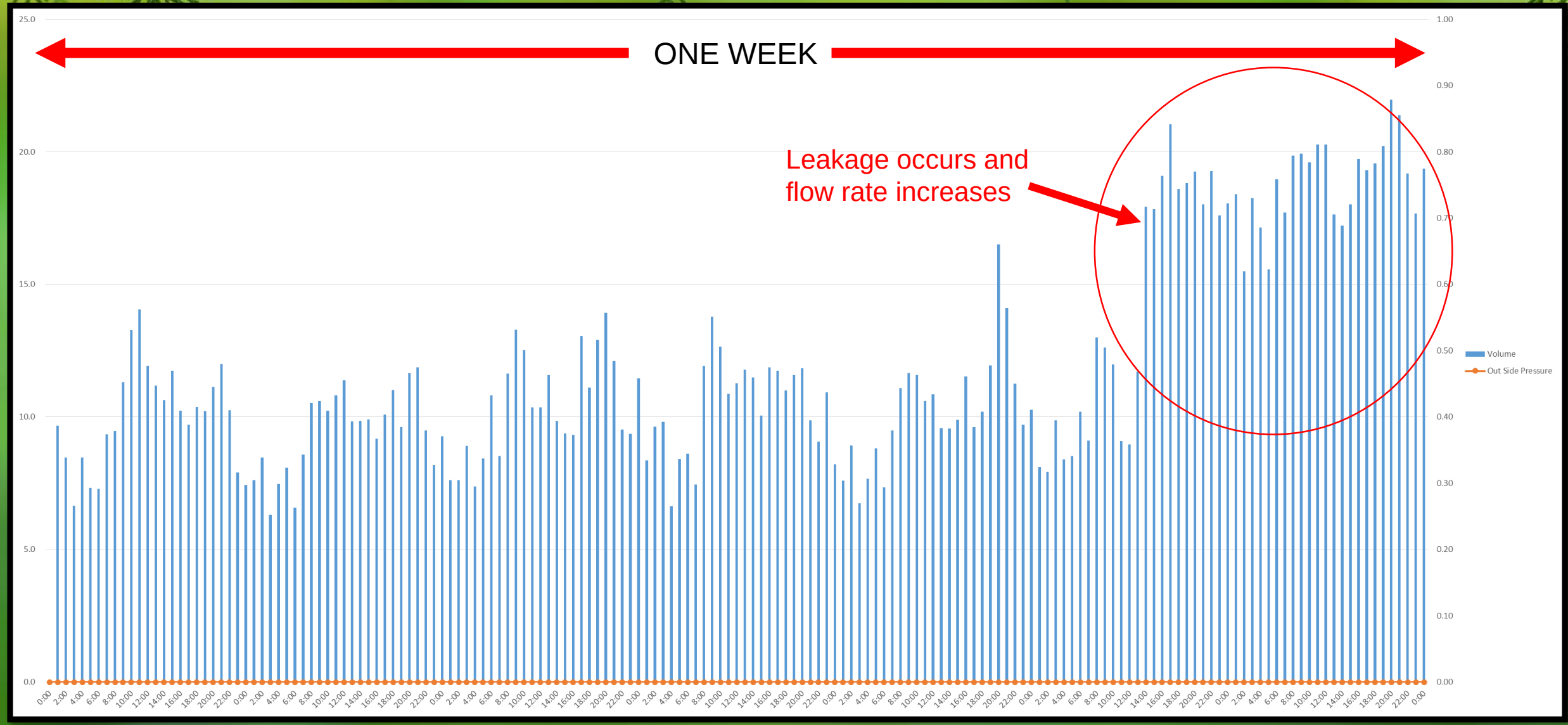
3

Ensure instrumentation and equipment calibrations for ultrasonic meters and leak detection devices

4

Line replacement planning and targets

DATA LOGGING



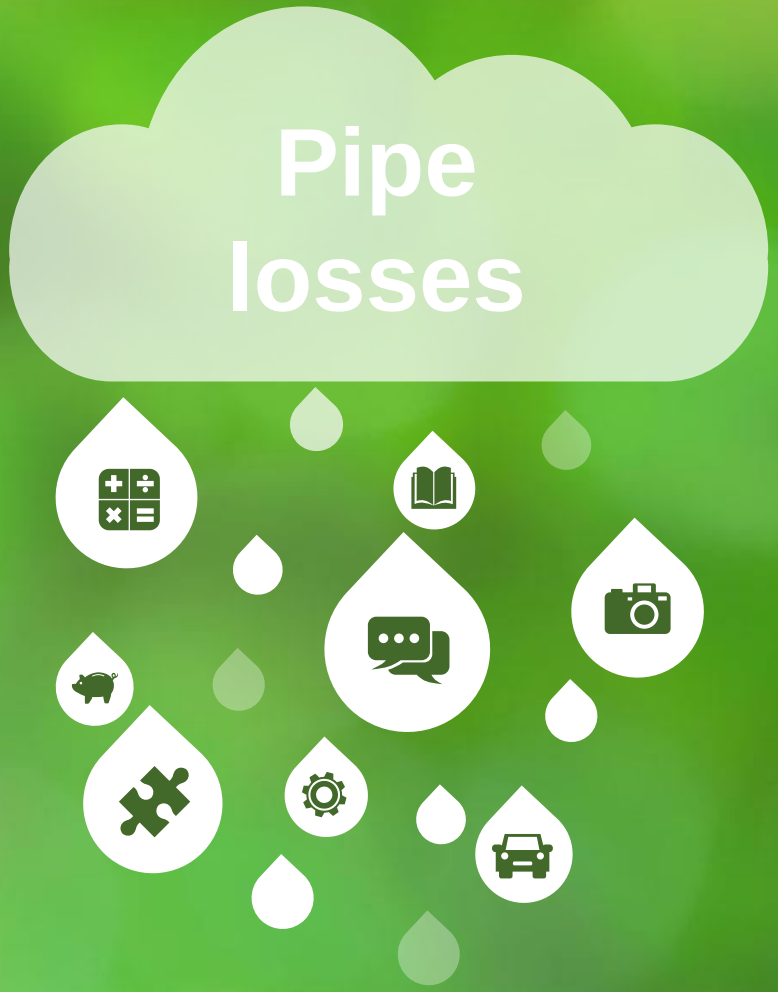
6. Water Loss and Leakage Detection

01 By utilizing the new SCADA system to record and collect accurate information

02 Utilizing smart meter technology

03 Using ultrasonic meters for water balance

04 Using leak detection equipment (ground mic, listening sticks, correlators, etc



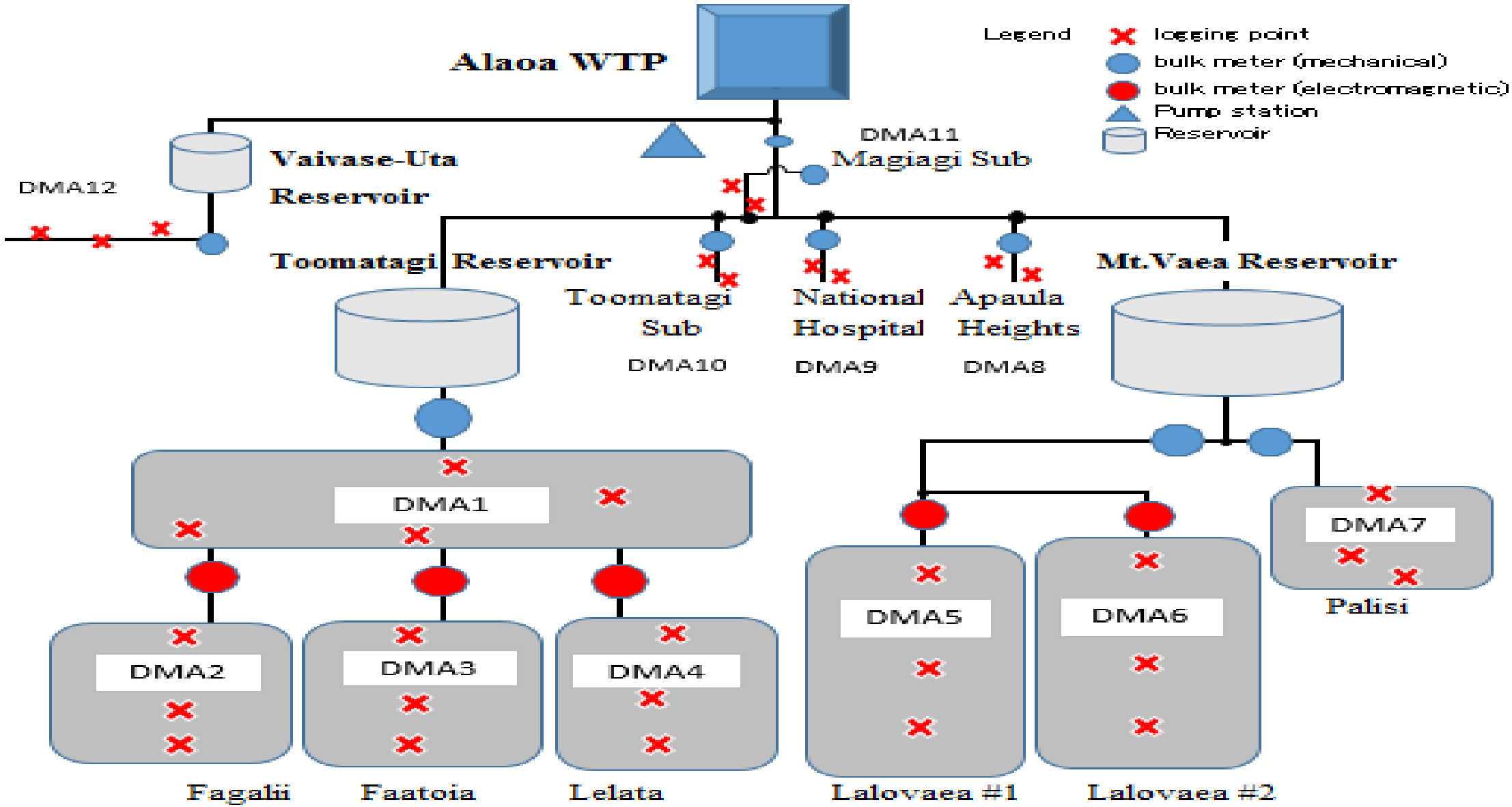
7. Integrated Approach in NRW Management

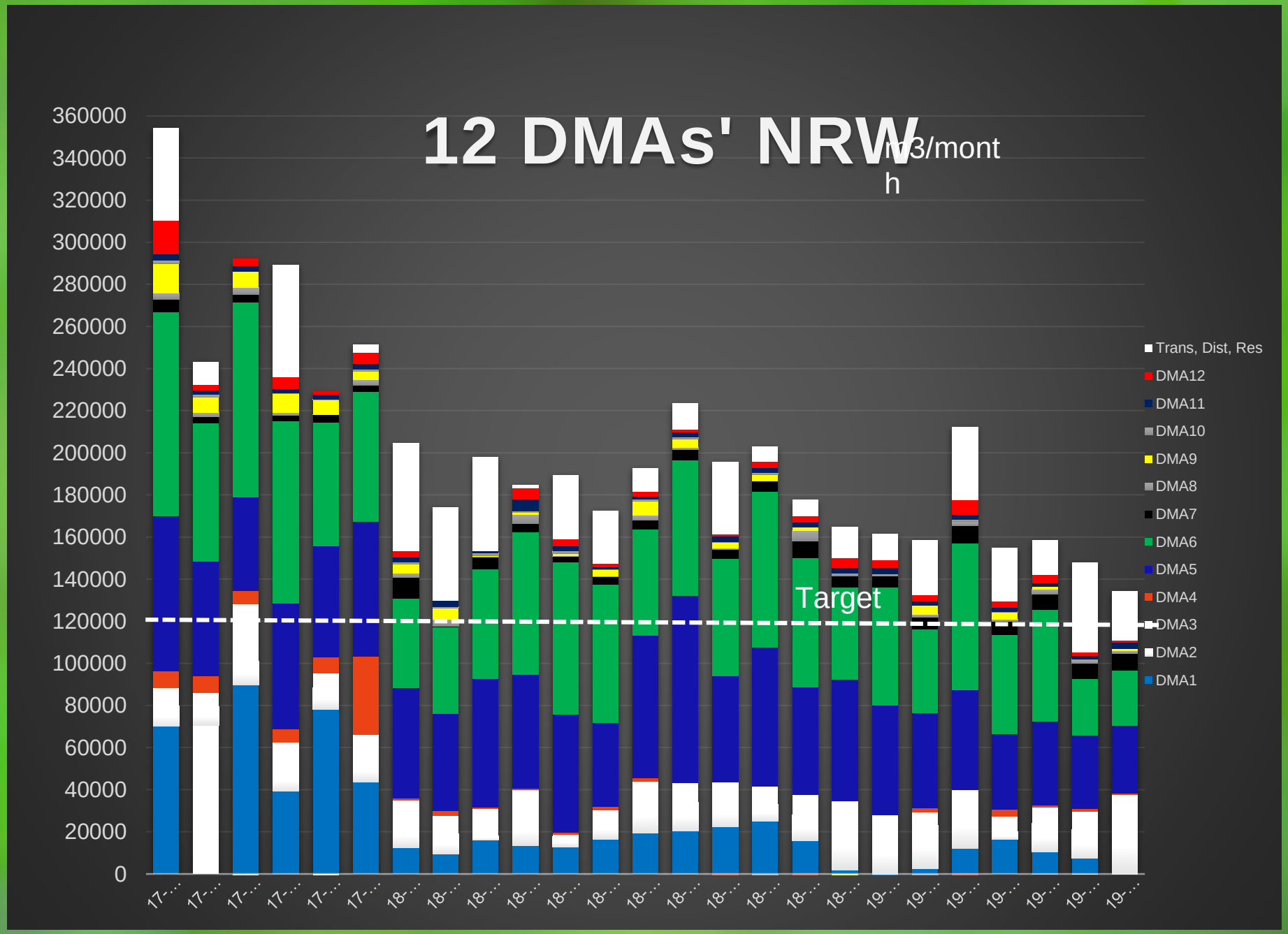
- Develop Strategic approach and action plans with other department. Includes, O&M Divisions, Billing Division, Technical Planning & Asset Management Division, Customer Service Division and I.CT Division. Also awareness programs with the customers.
- Ensure that everyone is aware of NWR % monthly targets
- Work towards the same targets and update all systems

8. NRW Case Study – "ALAOA WATER SUPPLY SYSTEM"

- Alaoa Water supply system supplies the Apia township in the urban central of Upolu Island, Samoa
- It caters for about
- Can produce at an average 200,000-400,000cm per month at and average flow of 150l/s
- Alaoa Supply is divided into 12 DMAs all logged and data loggers
- Most leakages occur in the central Apia area,
- Study period from 2013 – 2019
- NRW% in 2013 = 74% (due to heavy leakages in the network)
- NRW% in 2019 = 36% (reduction due to Target setting, strategic planning, meter replacement, pipeline replacements, leak detection and technology improvement with integrated efforts)

Alaoa Water Supply Scheme Logging Points




12 DMAs' NRW
m3/month
360000
340000
320000
300000
280000
260000
240000
220000
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
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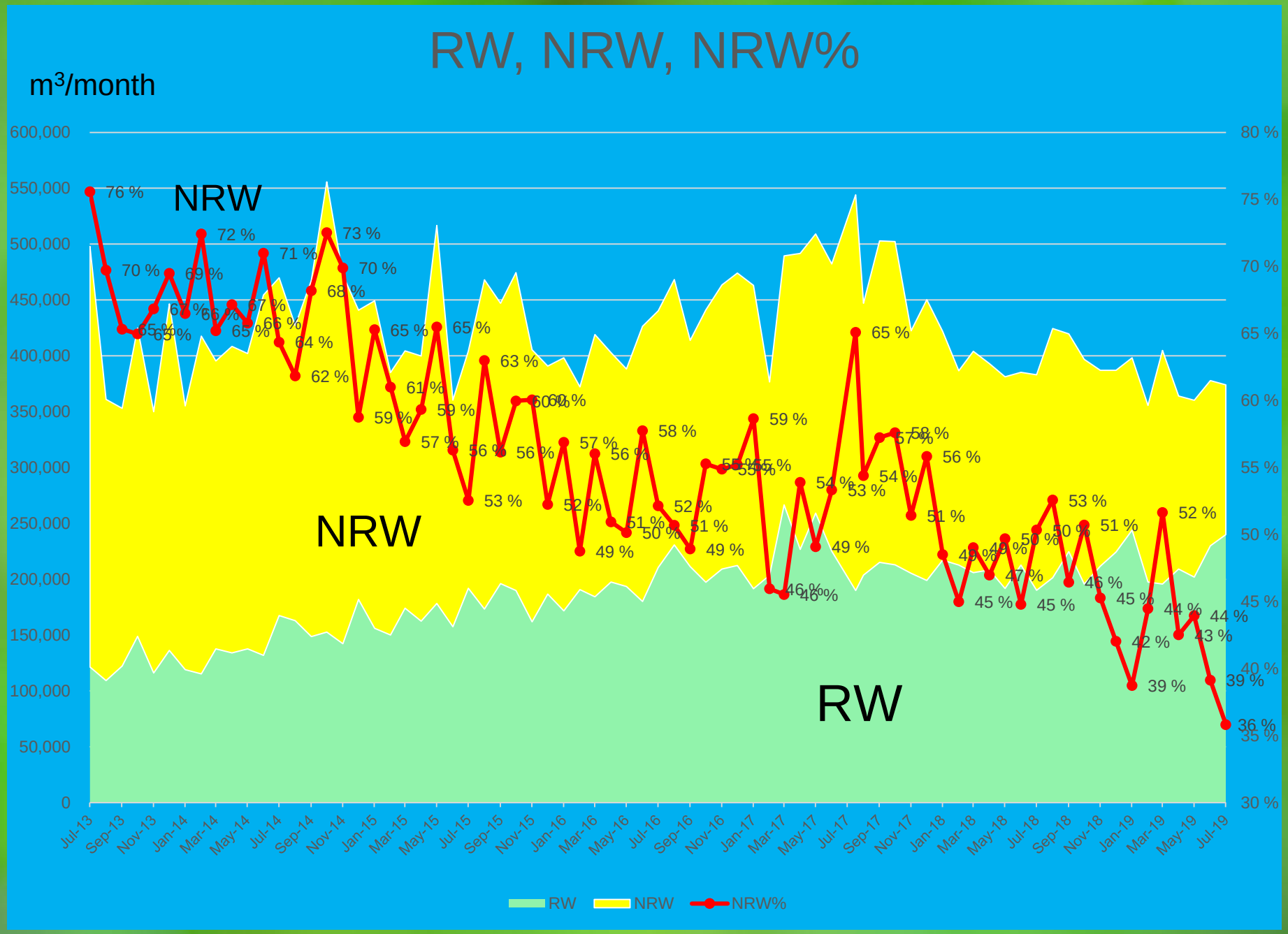
Target
Trans, Dist, Res
DMA12
DMA11
DMA10
DMA9
DMA8
DMA7
DMA6
DMA5
DMA4
DMA3
DMA2
DMA1
17-...
18-...
19-...


RW, NRW, NRW%
m3/month
NRW
NRW
RW
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
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50,000
0
80 %
75 %
70 %
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60 %
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Jul-19
RW
NRW
NRW%

Alaoa WTP Water Balance

m^3/month

Water Balance Item		Sep-2014	Average Jul thr Nov-2017	Jun-2019						
Authorized Consumption	1. Billed Authorized Consumption	RW **148,734**	RW **206,205**	1.1 Billed Metered Consumption (Including water exported)						RW **229,978**
			(726)	1.2 Billed Unmetered Consumption (Flat Rate)					(0)	
	2. Unbilled Authorized Consumption		(0)	2.1 Unbilled Metered Consumption					(0)	
			(77)	2.2 Unbilled Unmetered Consumption					(77)	
Water Losses	3. Apparent Losses		(1,237)	3.1 Unauthorized Consumption (Illegal Connection, etc.)					(0)	
			(19,400)	3.2 Metering Inaccuracies					(4,600)	
	4. Real Losses	NRW **318,754**	27,089	4.1 Leakage on Transmission and Distribution Mains up to DMA bulk meters except for DMA2, 3, and 4					35,322	NRW **147,910**
			7,256	4.2 Leakage and Overflows at Utility' storage Tanks					7,256	
			243,190 [NRW] **[277,535]**	4.3 Leakage on Distribution in DMA and Service Connections up to point of Customer meter Item 1,2, 2.1, 2.2, 3.1, 3.2	DMA1	7,244	DMA7	7,524	105,332	
					DMA2	13,919	DMA8	1,725		
					DMA3	8,475	DMA9	-10		
					DMA4	1,056	DMA10	232		
					DMA5	34,916	DMA11	1,781		
					DMA6	26,816	DMA12	1,654		
Water Distrubuted		**467,488**	**483,740**	**377,888**						

Alaoa WTP Water Balance

Percentage %

Water Balance Item		Sep-2014	Average Jul thr Nov-2017	Jun-2019						
Authorized Consumption	1. Billed Authorized Consumption	RW **31.8%**	RW **42.6%**	1.1 Billed Metered Consumption (Including water exported)						RW **60.9%**
			(0.2%)	1.2 Billed Unmetered Consumption (Flat Rate)					(0.0%)	
	2. Unbilled Authorized Consumption		(0.0%)	2.1 Unbilled Metered Consumption					(0.0%)	
			(0.0%)	2.2 Unbilled Unmetered Consumption					(0.0%)	
Water Losses	3. Apparent Losses		(0.3%)	3.1 Unauthorized Consumption (Illegal Connection, etc.)					(0.0%)	
			(4.0%)	3.2 Metering Inaccuracies					(1.2%)	
	4. Real Losses	NRW **68.2%**	5.6%	4.1 Leakage on Transmission and Distribution Mains up to DMA bulk meters except for DMA2, 3, and 4					9.3%	NRW **39.1%**
			1.5%	4.2 Leakage and Overflows at Utility' storage Tanks					1.9%	
			50.3% [NRW] **[57.4%]**	4.3 Leakage on Distribution in DMA and Service Connections up to point of Customer meter Item 1,2, 2.1, 2.2, 3.1, 3.2	DMA1	1.9%	DMA7	2.0%	27.9%	
					DMA2	3.7%	DMA8	0.5%		
					DMA3	2.2%	DMA9	0.0%		
					DMA4	0.3%	DMA10	0.1%		
					DMA5	9.2%	DMA11	0.5%		
					DMA6	7.1%	DMA12	0.4%		
Water Distrubuted		**100.0%**	**100.0%**	**100.0%**						

Summary 1: DMA loss (l/s)

	Number of Pipelines	Length	Leakage	Fixed or Replaced	Remaining Leakage
Transmission	3	5,850 m	17.0 L/s	12.0 L/s	5.0 L/s
DMA1	16	6,440 m	4.1 L/s		4.1 L/s
DMA2	15	7,315 m	7.1 L/s	3.0 L/s **2.2 L/s**	4.2 L/s **2.0 L/s**
DMA3	10	5,586 m	3.9 L/s	 **2.2 L/s**	3.9 L/s **1.8 L/s**
DMA4	6	2,632 m	2.1 L/s		2.1 L/s
DMA5	31	9,600 m	33.2 L/s	12.6 L/s	20.6 L/s
DMA6	20	11,095 m	28.2 L/s	4.0 L/s	24.2 L/s
DMA7	7	2,362 m	4.2 L/s		4.2 L/s
DMA8	6	1,361 m	0.8 L/s		0.8 L/s
DMA9	5	1,467 m	1.8 L/s		1.8 L/s
DMA10	1	750 m	0.4 L/s		0.4 L/s
DMA11	1	1,185 m	0.9 L/s		0.9 L/s
DMA12	29	9,271 m	1.4 L/s		1.4 L/s
Total	150	64,914 m	105.2 L/s	31.6 L/s **35.9 L/s**	73.6 L/s **69.3 L/s**

Summary 2: Priority Works

DMA#	Section	Pipe Material	Diameter (mm)	Length (m)	Leakage (L/s)	Yearly Leakage (m3/Year)	Leakage Cost in one year (Tala)	Replacement Cost (Tala)	Payback Period (Year)	Priority
							only indicative			
DMA4	Submain Maagao	PVC	50	530	1.02	32,167	5,854	130,380	22.3	11
DMA5	Matautu St.-Submain 1	PVC	100	100	0.78	24,598	4,477	37,300	8.3	2
	Matautu St.-Submain 2	PVC	100	100	0.92	29,013	5,280	37,300	7.1	1
	Beach Rd. (Clock Tower - Ifiifi St.)	PVC	150	240	2.40	75,686	13,775	131,040	9.5	4
	Beach Rd. (Apia EFKS Church-After Bridge Intersection)	PVC	150	330	1.26	39,735	7,232	180,180	24.9	13
	Vaialavini Rd	PVC	100	500	1.39	43,835	7,978	186,500	23.4	12
DMA6	Fugalei St. (1/3)	PVC	150	400	2.00	63,072	11,479	218,400	19.0	10
	Fugalei St. (2/3)	PVC	150	400	2.50	78,840	14,349	218,400	15.2	9
	Fugalei St. (3/3)	PVC	150	400	1.50	47,304	8,609	218,400	25.4	14
	Saleufi St. (2/2)	PVC	150	313	3.00	94,608	17,219	170,898	9.9	5
	Mulinuu St. (1/2)	PVC	150	450	3.96	124,883	22,729	245,700	10.8	6
	Mulinuu St. (2/2)	PVC	150	450	1.55	48,881	8,896	245,700	27.6	15
	Savalalo Rd. (Saleufi St.-Fugalei St.)	PVC	100	228	1.70	53,611	9,757	85,044	8.7	3
DMA7	Valve C to Valve D	PVC	100	300	1.52	47,935	8,724	111,900	12.8	8
	Valve B to Main	PVC	50	366	1.23	38,789	7,060	90,036	12.8	7

9. Sustainable Monitoring

- Continuous reporting
- Updated SOPs
- Handover documents
- Improved technology (SCADA, Mapping, Smart metering, leak detection, GPS and data logging)
- Climate resilient design and planning

THANK YOU FROM SWA!