Performance Audit

Water Loss Control Management

by the

Water Services Corporation

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List of Acronyms

AMR	Automated Meter Reading
AWWA	American Water Works Association
CARL	Current Annual Real Losses
GIS	Geographic Information System
ILI	Infrastructure Leakage Index
IT	Information Technology
IWA	International Water Association
LNC	Legitimate Night Consumption
MRA	Malta Resources Authority
NAO	National Audit Office
NSO	National Statistics Office
OMR	Off-Site Meter Reading
RO	Reverse Osmosis
SIV	System Input Volume
UARL	Unavoidable Annual Real Losses
WAC	Water Accounting System
WIS	Water Information System
WSC	Water Services Corporation

Executive Summary, Conclusions and Recommendations

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Executive Summary

Background

The National Audit Office (NAO) carried out the performance audit: "Water Loss Control Management by the Water Services Corporation". Wherever possible, the report takes into consideration data available up to 2008. This report examines how the Water Services Corporation (WSC) carries out its responsibilities to minimise water losses.

In theory, the water available in the System Input Volume (SIV), that is the water available for distribution, should be wholly accountable through metered billing. The WSC's water production in Malta and Gozo amounts to nearly 31 million cubic metres. In practice, due to a number of factors, a discrepancy between the SIV and the amount of metered water materialises. Water losses can be categorised as real and apparent losses. As at end 2007, these losses amounted to over 41 per cent of the water available for distribution.

Real losses are physical water losses from the pressurised distribution system, up to the point of customer metering. The volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average durations of individual leaks. The WSC estimated that real losses amounted to over 18 per cent of the SIV (5.6 million cubic metres) in 2007. Real losses are valued at variable cost of water production and distribution incurred by the Corporation.

Apparent losses refer to the water that is consumed but is not properly measured, accounted or paid for. In 2007 the WSC estimated that apparent losses amounted to around 23 per cent (7.13 million cubic metres) of the SIV. Apparent losses are valued at retail billing rates. Consequently, such losses cost the WSC revenue and distort data on customer consumption patterns.

This audit focused on the WSC's management regarding real and apparent losses. In this respect, the main objectives of this exercise included the determination of:

- the adequacy of the WSC's initiatives to detect, monitor and record water losses; and
- the adequacy of the WSC's management of water loss control.

Real Losses

An Infrastructure Leakage Index (ILI) close to 1.0 demonstrates that all aspects of a successful leakage management policy are being implemented – such a ratio is, in practice, unattainable since it denotes that all of the losses incurred by a system are unavoidable losses. Economic values of the ILI depend on the system specific marginal cost of real losses, and typically lie in the range of 1.5 – 2.5 for most systems.[1] The WSC is aiming to attain an ILI of 2.0 by 2009. Since 2001, the ILI within the hydrologically encapsulated zones in Gozo remained stable at 1.5. For zones in Malta, the ILI decreased from an average of 5.0 in 2004 to 2.97 in 2008.

Trunk mains water balances are accurate to within five per cent, which is the potential error margin of meters. To date trunk mains and reservoir losses were not included in the WSC's estimation of real losses. These losses are instead being considered as a balancing item under apparent losses in order to reconcile the water account. At the time of writing this report, the WSC was in the process of centralising the responsibility to account for trunk mains and reservoir losses by allocating such responsibility to its Control Room.

Since the establishment of the Corporation in 1992, the WSC adopted a strategy to substantially reduce real losses. Such strategy involved the following major phases:

i. Efforts to quantify real losses;

[1] Thornton J. (2002). Water Loss Control Manual, McGraw-Hill: USA (p.48).

ii. A business re-engineering programme which divided the Maltese Islands into four Regions (the Northern, Central and Southern Regions in Malta, and Gozo) to optimise the efficiency and control of all the WSC's operations;

iii. Pilot studies and trials in order to develop strategies, test and monitor leakage control methodologies; and

iv. Implementation of the leakage control management methodology - currently in use by the WSC. This approach encompasses five interrelated components: pressure management, active leakage localisation, network rationalisation, dynamic leak repair, and the replacement of critically weak pipe-work.

The WSC was actively implementing the above methodology throughout the four regions. This claim is not only supported by the actual ILI results but by a number of good practices observed during the course of this audit, namely:

- the use of Information Technology (IT) to monitor water leakages enables the WSC to locate water leakage to within one of its three hundred encapsulated hydrological zones;

- the various pilot studies which were embarked upon;

- a provision in the WSC's quality service charter to repair reported leaks within 24 hours; and

- regular and formal management meetings to discuss issues related to water management within the four regions.

Despite the foregoing, this audit revealed that the opportunity exists for the WSC to further exploit the benefits of IT. In fact, in-house developed software - the Water Accounting System (WAC) - was hardly utilised by the Corporation since it was not supported with Automated Meter Reading (AMR) technology. Although the implementation of the latter technology is actively being pursued by the Corporation, the WAC is now considered as obsolete. The Corporation is in the process of commissioning a state of the art computerised system to comprehensively handle real and apparent losses. The new technology is also viewed by the WSC as complimentary to the AMR project.

In addition, substantial backlogs of postings relating to cost of repairs has only recently been cleared up. The lack of computerised records in this regard prohibited the WSC from having up to date management information to gauge the cost efficiency and effectiveness of repairs being undertaken. The Corporation remedied this situation through the introduction of electronic job sheets and costing systems.

Apparent Losses

The Corporation's strategic plan for 2005 – 2008 aimed to reduce apparent losses from the 23.2 per cent recorded at end 2007 to around 18.6 per cent of the SIV – a decrease of 20 per cent. Such a target, however, was considered as premature since it is only recently that work to compile an *ad hoc* strategy to deal with apparent losses has started.

As at end 2007, the WSC estimated apparent losses at around 23 per cent of the SIV. However, the WSC has not fully broken down this amount into the various components – such as, billing system errors and unauthorised consumption. Such a state of affairs prohibits the Corporation from compiling a more realistic strategy, where resources are allocated in accordance with priorities, to tackle apparent losses. The WSC contends that it will be in a stronger position to analyse apparent losses once the AMR is implemented.

One of the principal contributors to apparent losses is customer meter inaccuracies. Customer meter inaccuracies refer to the under-registration of consumption of water meters. This generally occurs due to the quality and inaccuracy of meters. In order to deal with meter inaccuracies, the WSC replaced most of the meters installed with Class D meters, which are considered more accurate than the previous Class. As at September 2008, 16,350 were Class C or older (pre 1994) whilst another 25,250 were Class D but did not have a pulse output to which an AMR module can be connected.

The weighted average meter inaccuracy, based on the findings of a WSC's internally commissioned study on the performance of domestic customer water meters, stands at nearly 16 per cent. This implies that the WSC is not billing 16 per cent of water consumption due to the inaccuracies of meters. The problem is mainly caused by meters which are aged 10 years and over. There are over 51 per cent of these meters installed. The combined estimated weighted average error of these meters results in the WSC not billing over 13 per cent of water consumption. During the period 2009 – 2011, the WSC is planning to replace 120,000 'old' meters. The Corporation contends that through this initiative the combined estimated weighted average error rate of meters would decrease to around 5.75 per cent.

Indirect plumbing systems, which are widespread in Malta and Gozo, are a significant contributor to meter under-registration. These plumbing systems are generally dependant on float-valve controlled water storage – such as roof water storage tanks. An internal study by the WSC in September 2008 concluded that with a roof storage tank

(indirect) system, no matter how efficient the low-flow and starting-flow characteristics of a new rotary piston mechanical meter are, there will always be a quantity of water that would be consumed without the billing meter registering it. On the assumption that average domestic consumption amounts to 318 litres of water daily, the WSC's study team contends that an indirect plumbing system will result in an under registration of the 'best' meter tested by 2.8 litres of water daily or 0.9 per cent of consumption.

Meter reading inaccuracies contribute to apparent losses. The use of technology has drastically reduced the Corporation's billing system data errors. The WSC has already embarked on projects like the Off-Site Meter Reading (OMR) - a hand-held computer that has replaced the old manual (paper-based) record system. Its advantages include the transferring of metering activity information directly into the billing database on the same day[2] and the avoidance of a possible human inputting error. In fact, since the introduction of the OMR, data handling errors emanating from transcription or posting errors are considered as insignificant. The introduction of AMR will further facilitate water losses management since it would enable the Corporation to obtain customer meter readings at a single cut-off date.

The improvements registered by the WSC in the estimation procedures of unread meters resulted in a decrease of apparent losses. Legal Notice 331 / 2008 places the onus for ensuring that customers' meters are read and that the Corporation is duly informed by the WSC's clients. The WSC makes an estimate of consumption in situations where no actual readings are available and where the user has not forwarded the relative meter reading. WSC's estimation procedure entails establishing an average daily consumption rate as based on two historical actual readings, one of which has to be dated at most 540 days and the other at most 1,080 days back from the day when consumption is to be estimated. The NAO's verification exercise, based on 146 out of the 210,035 estimations of meter readings, revealed that in 56 per cent of the cases (82 cases) it was not possible for the WSC to derive an estimate since there were no previous readings available. In these cases, the bills were based on benchmarks.

According to the WSC's records, 11,517 accounts out of a total of 210,035 accounts[3] have not had any actual meter reading during the period reviewed: January 2003 – July 2006. A random sample of 372 of these 11,517 accounts revealed that in 203 cases – 55 per cent, the WSC had no access to consumers' premises. In another 108 of the sampled cases – 29 per cent, the customer indicated that the meter would no longer be used. The WSC's 'accessibility' problem can be contextualised against the National Statistics Office's (NSO) estimate that, as at end 2005, there were over 53,000 unoccupied dwellings in Malta and Gozo.

Following the verification of billing errors claims by consumers (claims variations), the Corporation duly refunds the over-charged amount to the claimant. Although the Corporation's accounting records are duly updated, the electronic system in place does not permit that the relative changes be made to the water account. This situation potentially leads to under registration of apparent losses since claims variations generally relate to over-estimated consumption.

The WSC is tackling water theft in a reactive manner as it limits its efforts to investigating reports from the public. Such reports are followed up by WSC inspectors. Generally, perpetrators prefer to avoid court proceedings and settle the issue immediately by paying the amounts due. Recent legislative amendments, incorporated in Legal Notice 331 / 2008, place the WSC in a position to take a stricter stance with regards to water theft. This Legal Notice stipulates that damages payable for water theft are not to be less than €1,500.

Conclusions

This audit established that generally the WSC's initiatives to detect, monitor and record water losses have led to significant reductions in water losses. The results attained by the WSC are also a positive indicator of the adequacy of the WSC's management of water loss control, particularly with regards minimising real losses. Despite the progress registered the opportunity exists for the WSC to decrease the level of water losses from the 41 per cent of the SIV (as at end 2007) to a level of losses which is closer to what is considered as unavoidable losses.

The WSC's efforts to curb real losses have proved successful although predetermined ILI targets in the 300 zones were marginally missed. Minimising real losses entailed a significant capital investment in Malta's water distribution infrastructure. Moreover, such a capital expenditure was complemented with the Corporation adapting the corresponding business, technical and management practices. It is also worth noting that, through its Customer Care Section, the WSC enabled consumers to contribute towards minimising water losses by reporting leakages. Despite the progress registered the Corporation has to continue with its efforts to further decrease real losses.

[2] WSC Annual Report 2002/3, Operations Review, p. 13.

[3] Throughout this report, the number of accounts quoted may vary. This is due to different cut off dates utilised for the various audit tests undertaken.

In contrast, the WSC is increasingly shifting its focus to tackle apparent losses. As a consequence, initiatives intended to reduce apparent losses have been mainly directed at reducing data handling errors and the replacement of older meters. Such an approach is understandable since errors of this type not only have an impact on any apparent losses estimation but also negatively affect the Corporation's clients through erroneous billing. Moreover, the WSC has completed studies on the impact of the indirect plumbing system and the under-registration of meters.

The Corporation is in the process of awarding the relative contracts relating to the implementation of the AMR. This will facilitate meter reading and consequently enable a more accurate calculation of apparent losses. In addition, the opportunity exists for the Corporation to further increase its efforts towards minimising water theft.

Recommendations

In view of the foregoing, the NAO proposes that the WSC considers the implementation of the following recommendations:

i. The calculation of the ILI be fine tuned to render such calculations more reliable. This entails that the WSC reconsiders its practice to utilise as a constant factor in the ILI calculation the legitimate night consumption throughout all zones. The legitimate night consumption could be based on additional criteria, such as industrial, commercial, agricultural, entertainment zones, etc., other than just residential areas;

ii. The introduction of an economic leak intervention model be considered. This will further aid the WSC in prioritising its schedule of infrastructural, maintenance and repairs;

iii. A strategy on how the WSC plans to minimise apparent losses be drawn up and communicated to all stakeholders involved;

iv. The relative adjustment to the water account be made following the verification of billing errors claims by consumers. Such an approach will ensure a more reliable estimate of water losses;

v. Recommendations proposed through the WSC's internal study 'A Research Projected at Improving the Water Metering Policy of The Water Services Corporation of Malta' be followed up. The potential benefits to be derived by following up this study's recommendations will not only reduce apparent losses but will also contribute towards ensuring that the Corporation recoups all revenue due related to consumption;

vi. Co-ordination between the various sections of the WSC be enhanced to enable the Corporation to take on a more pro-active role to tackle water theft. The opportunity exists for the WSC to tackle theft through a risk analysis approach. Such an approach would take into consideration clients' particular characteristics (namely, industrial, commercial, agricultural, entertainment and residential) and consumption trends. Moreover, this approach would be complemented with reports from the public as well as inspections by the WSC; and

vii. Strict application be made of penalties existing in current legislation.

Chapter 1

Introduction

Chapter 1 – Introduction

The National Audit Office (NAO) carried out the performance audit: "Water Loss Control Management by the Water Services Corporation". Wherever possible, the report takes into consideration data up to 2008.

The Water Services Corporation's[4] (WSC) responsibilities with respect to minimising water leakage are clearly spelled out in the Water Services Corporation Act. This Act stipulates that it is the duty of the Corporation to develop, maintain and promote a safe and efficient production and distribution system in order to satisfy, as economically as possible, all reasonable demands for water.[5] The Corporation's responsibilities regarding water leakage have also been incorporated in the WSC's mission statement.[6]

Water remains a scarce resource in the Maltese Islands and is under intense pressures from competing users, especially industrial, commercial, agricultural, entertainment and residential. While immediate supply constraints have been addressed, principally through significant investment in Reverse Osmosis (RO) plants, this has been achieved at a high cost in financial and environmental terms due to fossil fuel use and related emissions.[7] This situation was also confirmed in the report: Water Resources Review (2006), published by the Food and Agriculture Organisation of the United Nations.

The NAO report examines how the WSC carries out its responsibilities in minimising water losses. This part of the report primarily discusses:

- the extent, causes and cost of water loss;
- the WSC's approach to minimise water loss; and
- audit objectives and structure of this report.

1.1 The extent, causes and cost of water loss

The Water Services Corporation services over 224,000 households and business clients. As at end 2007, the System Input Volume (SIV), that is the water produced and is available for distribution, amounted to 30.97 million cubic metres of water (Table 1 refers), or around 3,534 cubic metres per hour. Most of this water is produced at RO plants. During the period 2004 – 2007, the SIV decreased by around 5.6 per cent. The WSC distributes water to its clients in Malta and Gozo through some 1,852 kilometre distribution network.

[4] An Organisation Chart of the WSC is attached at Appendix 1.
[5] Paragraph 3 (3a) of the Water Services Corporation Act, XXIII of 1991 as amended by Legal Notice 129 of 1992 and Acts XV of 1995, XVI of 1997 and XXV of 2000.
[6] Water Services Corporation, Annual Report, 2003, p.1.
[7] State of the Environment Report, Sub Report 7 – 'Waters', p.80.

Table 1: Total water production in Malta and Gozo

	2004		2005		2006		2007	
	(million) m^3	Percentage of total production	(million) m^3	Percentage of total production	(million) m^3	Percentage of total production	(million) m^3	Percentage of total production
Reverse osmosis	17.89	54.59	17.05	54.92	17.47	57.22	17.01	54.92
Pumping stations, boreholes and springs	14.89	45.41	13.99	45.08	13.06	42.78	13.96	45.08
Total production	**32.78**	**100**	**31.04**	**100**	**30.53**	**100**	**30.97**	**100**

Source: WSC

In theory, the water available in the SIV should be wholly accounted for through metering billing purposes. In practice, due to a number of factors which are summarised and shaded in Figure 1, a discrepancy between the SIV and the amount of metered water result materialises.

This discrepancy relates to the unbilled water volume, that is water losses. Water losses can be categorised as real and apparent losses.

Figure 1: The Water Balance – Authorised consumption and water losses

<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 (including water exported)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Un-metered 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 Un-metered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorised Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

Source: AWWA

Figure 1 implies that apparent losses relate to water that is consumed but is not properly measured, accounted for or paid. Apparent losses occur in the Corporation’s operations due to customer meter inaccuracies, billing system data errors and unauthorised consumption. These losses cost utilities revenue and distort data on customer consumption patterns.

Water losses materialising through real losses relate to the physical losses of water from the distribution system, including leakage and storage overflows. These losses inflate the water utility’s production costs and stress water resources since they represent water that is produced, extracted and treated, which however never reaches beneficial use.[8] Real losses cannot be completely eliminated. The lowest technically achievable annual volume of real losses for well-maintained and well-managed systems is known as Unavoidable Annual Real Losses (UARL).

[8] American Water Works Association.

Table 2 portrays the WSC's extent of real and apparent losses during the period 2004 – April 2008.

Table 2: Extent of real and apparent losses 2004 – April 2008

	2004	2005	2006	2007	Jan - Apr 2008
	m³	m³	m³	m³	m³
System input volume	32,791,152	31,033,802	30,474,178	30,799,534	9,803,950
Billed water	18,551,991	16,337,250	17,767,274	18,059,320	6,526,354
Real losses	8,513,501	7,131,938	5,970,235	5,589,572	1,889,589
Apparent losses	5,725,659	7,564,614	6,736,669	7,150,642	1,388,007
Total losses	*14,239,160*	*14,696,552*	*12,706,904*	*12,740,214*	*3,277,596*
Total billed as a % SIV	56.58	52.64	58.30	58.64	66.57
Total losses as a % SIV	43.42	47.36	41.70	41.36	33.43
Real losses as a % of SIV	25.96	22.98	19.59	18.15	19.27
Apparent losses as a % of SIV	17.46	24.38	22.11	23.22	14.16

Source: WSC

Table 2 shows that despite the increase in the proportion of water billed, as at end 2007, the total water losses amounted to over 41 per cent of the SIV. As at end 2007, water lost through real and apparent losses amounted to around 18 per cent and 23 per cent respectively.

Table 2 also depicts the decreasing and rising trends of real and apparent losses respectively. During the period 2004 – 2007, real losses decreased from 8.5 million cubic metres to 5.6 million cubic metres. On the other hand, during the same period, apparent losses rose from 5.7 million cubic metres to 7.2 million cubic metres.

It is to be noted that 2008 data presented in Table 2 is for information purposes only as it pertains to the period January – April 2008. Consequently, such data does not lend itself for meaningful comparisons with previous years.

1.1.1 Cost of water losses

Real losses are valued at the variable cost of water production and distribution, whereas apparent losses are valued at retail billing rates – Table 3 refers. This implies that apparent losses cost the utility more on a per unit basis and overall have a greater effect on its economic condition.

Table 3: Marginal cost of production

Water production source	Water production	Cost of water production per cubic metre		
		'Old' rates[9]		'New' rates[10]
	m³	Lm	€	€
Reverse osmosis plants	17,049,042	0.220	0.513	0.683
Pumping station	7,670,196	0.055	0.128	0.266
Boreholes	6,324,363	0.055	0.128	0.266
Weighted average marginal cost of water		**0.146**	**0.339**	**0.495**

Source: WSC

[9] The 'old' rates relate to the marginal costs as used by Water Services Corporation up to end September 2008.
[10] The 'new' rates relate to the marginal costs as used by the Water Services Corporation as from October 2008.

Throughout this report, the marginal cost of water is being considered to amount to €0.495. This rate will be utilised for costings associated with real losses.

The marginal cost of production refers to the additional costs incurred by the WSC to produce the next unit of water. In this case, such costs would relate to the variable costs of production. This would include the cost of electricity and chemicals used in the production of water. Consequently, this rate excludes direct costs, namely personnel salaries and other recurrent costs, depreciation of assets, etc.

The lowest water rate charged through billing, as from October 2008, was that of €1.40. This rate will be utilised for costing purposes regarding apparent losses throughout this report.

1.2 The WSC's approach to minimise water losses

The WSC had embarked on a programme to contain water losses since the establishment of the Corporation in 1992. In 1994, water leakage was estimated at 3,900 cubic metres per hour. As at end 2007, total water losses amounted to 1,454 cubic metres per hour.

The WSC's strategy and actual achievements in this regard, which are discussed in detail in Chapters 2 and 3 of this report, included a business re-engineering programme which divided the Maltese Islands into four regions as well as the zoning of the Maltese Islands into over 300 hydrologically encapsulated zones.

The WSC also adopted water leakage performance indicators. In this regard, the most reliable performance indicator for real losses is the Infrastructure Leakage Index (ILI). An ILI value of 1.0 can only be attained when the water distribution infrastructure is in a very good condition and the management of water leakage is of the highest standard. The WSC aims to achieve an ILI measurement of 2.0 by 2009. A detailed explanation of the calculation of the ILI is attached at Appendix 2. A discussion of the WSC's performance in relation to the ILI is presented in the next Chapter of this report.

1.3 Illegal abstraction of ground water

Although not within the scope of this audit, the NAO also enquired with the Malta Resources Authority (MRA) regarding its initiatives to reduce ground water theft. Ground water theft usually occurs through the drilling of illegal boreholes. On enquiry with the MRA, it resulted that on 7 October 2008 action to counter ground water theft has been reinforced through the issue of two legal notices.

Legal Notice 255 / 08 is intended to ensure that all unregistered boreholes be duly registered within a month of the issue of this Notice. Legal Notice 254 / 08 establishes a regulatory framework for the drilling of new boreholes. The drilling of boreholes henceforth necessitates the MRA's permission. This Legal Notice provides for the imposition of penalties ranging from €20,000 to €50,000, together with impounding of machinery used for this purpose. A one year moratorium is currently in place, during which time the MRA will compile a strategy to ensure the sustainable use of ground water.

1.4 Audit objectives

This audit focused on the WSC's management regarding real and apparent losses. In this respect, the main objectives of this exercise included the determination of:

- the adequacy of the WSC's initiatives to detect, monitor and record water losses; and

- the adequacy of the WSC's management of water loss control.

In order to attain the above objectives, the NAO reviewed WSC documentation, namely water losses policies and plans. Various interviews with key WSC personnel were held. In addition, the WSC's databases relating to water leakage management, customer service and billing systems were reviewed to evaluate the WSC's performance regarding its initiatives to control water losses.

1.4.1 Structure of the report

Chapter 2 of this report discusses the WSC's initiatives regarding the management of real losses and comments on the results of the WSC's initiatives to reduce real losses. The discussion mainly centres on issues relating to the detection and monitoring of real losses, the WSC's performance in relation to the ILI benchmark, the upgrading of the distribution network, the WSC's reaction time to deal with water losses, and the WSC's economic leakage intervention model.

Chapter 3 of this report focuses on the WSC's efforts to deal with apparent losses. The main discussion of this report focuses on the Corporation's efforts to minimise data handling errors, unauthorized consumption and meter inaccuracies. The overall conclusions and recommendations emanating from this study are included in the Report's Executive Summary.

Chapter 2

Real Losses

Chapter 2 – Real Losses

2.1 Introduction

Real losses are physical water losses from the pressurized distribution system, up to the point of customer metering. The volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average durations of individual leaks.

In 2007, the real losses incurred by the WSC were estimated at around 5.6 million cubic metres or over 18 per cent of the water available for distribution. This part of the report primarily focuses on:

- benchmarking the WSC's efforts to reduce real losses against the ILI and the Current Annual Real Losses; and
- management Information available at the Corporation.

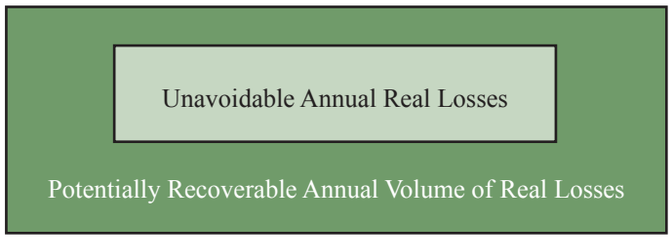
2.2 The WSC is striving to attain its ILI targets within the hydrologically encapsulated zones by 2009

The ILI is a measure of how well the water system is being managed for the control of real losses at the current operating pressure. It is the ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). Figure 2 refers.

UARL are calculated through a methodology which takes into account the average operating pressure, length of mains, the number of services provided, and the location of customer meters relative to the kerb stop-cock. In 2008, the WSC estimated that in Malta's case the unavoidable real losses should amount to 187.88 cubic metres per hour or 1,645,829 cubic metres annually. Based on the latest WSC's marginal cost of water production (€0.495 per cubic metre)[11], these unavoidable losses cost the WSC €814,685 annually.

Figure 2: The Infrastructure Leakage Index

This diagram depicts the ILI. The large square represents the potentially recoverable annual volume of real losses. The smaller square represents the annual unavoidable real losses – that is, the lowest technically achievable value for real losses under current operating pressure.



Source: Thornton J. (2002). Water Loss Control Manual, McGraw-Hill: USA (p.48).

[11] Refer to Table 3 – Marginal cost of production.

An ILI close to 1.0 demonstrates that all aspects of a successful leakage management policy are being implemented – such a ratio is, in practice, unattainable as it denotes that all of the losses incurred by a system are unavoidable losses. Economic values of the ILI depend on the system specific marginal cost of real losses, and typically lie in the range of 1.5 – 2.5 for most systems.[12] The WSC is aiming to attain an ILI of 2.0 by 2009.

2.2.1 Losses from trunk mains and reservoirs are maintained within predetermined parameters

The WSC adopts an internationally recognised methodology to determine real losses. In the past, this methodology has been audited by International Water Association (IWA) experts. This methodology entails the estimation of the ILI for all the 300 hydrologically encapsulated zones and to adopt a zero-leakage stance for trunk mains and reservoirs.

The approach adopted by the Corporation to monitor trunk mains is to sustain a balance between inputs and outputs, which is monitored via the respective input and output flow meters. Trunk mains balances are accurate to within five per cent, that is the potential error margin of meters. However, as stated in the preceding paragraph, a zero-leakage stance on trunk mains and reservoirs is adopted by WSC.

It must be said that trunk mains leakages are in the main immediately and easily identified due to:

a) instant manifestations of water flows; and/or

b) significant pressure/flow drops on the network causing supply problems.

The NAO confirmed that the WSC periodically tests reservoirs for potential leakages by performing drop tests. Although such tests are not carried out in accordance with any predetermined time-frames, results indicate that relative losses are insignificant.

To date, trunk mains and reservoir losses were not included in the WSC's estimation of real losses. These losses are instead being considered as a balancing item under apparent losses in order to reconcile the water account.

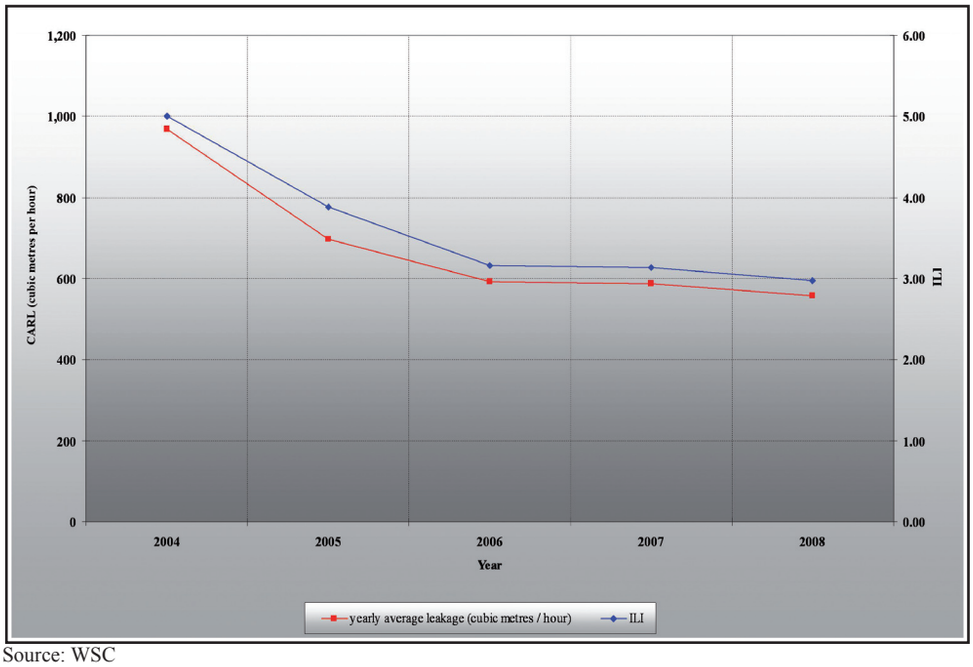
At the time of writing this report, the WSC was in the process of centralising the responsibility to account for trunk mains and reservoir losses by allocating such responsibility to its Control Room.

2.2.2 The WSC aims to attain an ILI of 2.0 by 2009 within zones

The WSC plans to reduce the ILI to 2.0 by 2009 within the zones. With the UARL estimated in 2008 at 187.88 cubic metres per hour, in 2009 the CARL will decrease to around 376 cubic metres per hour from 557 cubic metres per hour – the level recorded in 2008.

The ILI for zones in Gozo remained stable at around 1.5 for the last five years, while that of Malta decreased from an average of 5.0 in 2004 to 2.97 in 2008. Chart 1 shows the yearly ILI and CARL values from 2004 to 2008 for the zones within Malta.

Chart 1: ILI and CARL for zones in Malta (2004 – 2008)



Source: WSC

[12] Thornton J. (2002). Water Loss Control Manual, McGraw-Hill: USA (p.48).

Since the establishment of the corporation in 1992, the WSC adopted a strategy to substantially reduce real losses. In this regard, the WSC's strategy entailed the following major phases:

i. Initial efforts were directed towards quantifying leakage. This exercise included the zoning of the Maltese Islands into over 300 hydrologically encapsulated zones, and the further sub-division of high leakage zones into segmented areas to enable step-testing.[13] Computations of leakage can thus be made through the continuous data logging of all zone inlets and metering of all services connections.

ii. A business re-engineering programme divided the Maltese Islands into four Regions (the Northern, Central and Southern Regions in Malta, and Gozo). Such restructuring was intended to optimise the efficiency and control of all the WSC's operations, including leakage control management.

iii. The WSC carried out a number of pilot studies and trials in order to develop strategies, test and monitor leakage control methodologies that the WSC intended to implement nation wide. Most of these studies were carried out in Gozo.

iv. The leakage control management methodology currently in use by the WSC encompasses five interrelated components: pressure management, active leakage localisation, network rationalisation, dynamic leak repair, and the replacement of critically weak pipe-work. Figure 3 refers.

As depicted in Figure 3, the effective implementation of this methodology entails that all components of the model must be managed simultaneously. The WSC was found to be actively implementing the above methodology throughout the four regions. This claim is not only supported by the actual ILI results but also by a number of good practices observed during the course of this audit, namely:

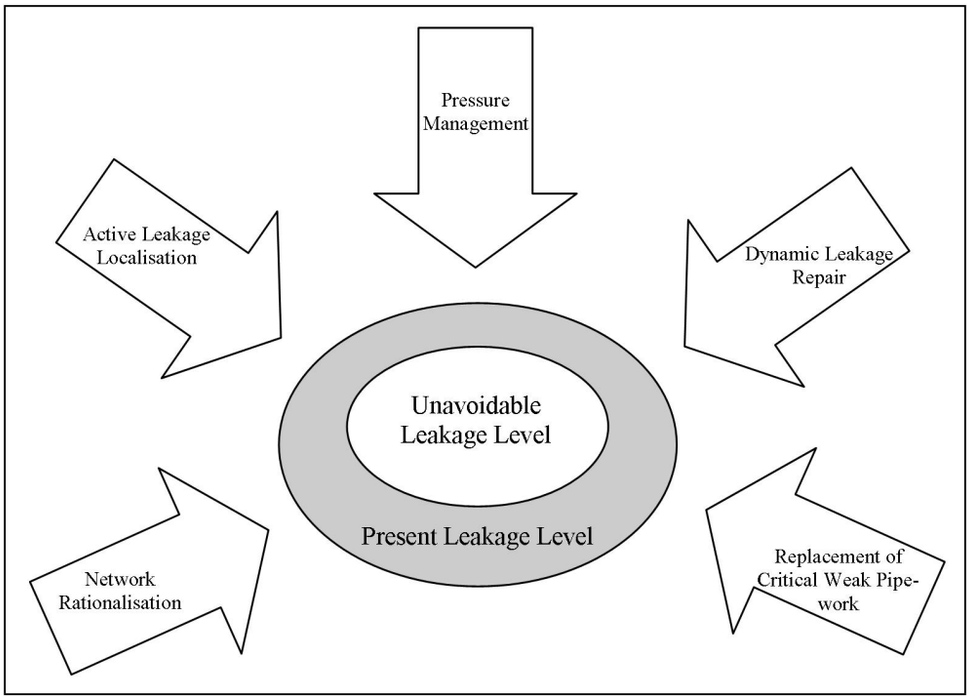
- the use of IT to monitor water leakages enables the WSC to locate water leakage to within one of its 300 encapsulated hydrological zones. However, the opportunity to further exploit the benefits of IT to enhance the overall management of water leakage exists – Section 2.4 refers;

- a number of pilot studies were embarked upon, such as those related to the OMR, AMR, zoning of Malta and Gozo into 300 hydrologically encapsulated zones, efficiency of meters, etc.;

- a provision in the WSC's quality service charter to repair reported leaks within 24 hours; and

- regular and formal management meetings to discuss issues related to water management within the four regions.

Figure 3: The five force national leakage control methodology



Source: WSC

[13] Step testing is a flow based method of localising water loss within a zoned distribution system.

2.3 The ILI of some zones is artificially high

Certain hydrologically encapsulated zones would be expected to be more problematic to manage than others for a number of reasons. Table 4 lists the zones which, as at end April 2008, had an ILI higher than 10.

It transpired that the zones listed in Table 4 are artificially inflated due to the conservative assumptions made by the WSC when determining the ILI of particular zones.

The WSC considers the Legitimate Night Consumption (LNC) of all zones in Malta as a constant based on residential areas. The WSC has carried no specific studies to measure the LNC of non-residential zones, such as industrial estates, entertainment areas, etc. In fact, the zones listed in Table 4 are mainly industrial and entertainment locations. The WSC is aware of this limitation but does not consider it to be impinging on its operations.

Another factor leading to an artificially high ILI relates to the number of consumers per service (account). The WSC's ILI calculation assumes that the number of consumers per service, and consequently water consumption, is similar to that of a typical household. However, when an account services a large number of people or a production line (for example, a factory), the WSC's determination of the ILI would be distorted since such a calculation would result in artificially inflating the ILI.

All of the zones listed in Table 4 are considered to be typical situations where the ILI is artificially inflated since:

- seven of the zones listed are either industrial estates or entertainment areas;
- the G'Mangia Hill St. Luke's zone, which used to accommodate St. Luke's hospital, can be considered to have similar characteristics to the situations depicted within this section of this report;
- the Wied il-Għasel / Burmarrad zone also accommodates some manufacturing plants; and
- the Floriana, Belt is-Sebħ zone, has a high number of users to the number of accounts ratio.

The foregoing shows that the practices adopted by the WSC to determine the ILI of particular zones, in some cases, result in artificially inflating this index. Nevertheless, it must be stressed that the above mentioned practices have a minimal effect on the WSC's global ILI estimation since their effect is grossly reduced through averaging. The rectification of such practices would only serve to have more accurate readings rather than better management of real losses.

2.4 Some computerised systems are not being updated regularly

Information Technology (IT) is extensively utilised by the WSC in its water management. The main electronic systems in use were the Water Accounting System (WAC), Water Balance Tool Spreadsheet, and the Geographic Information System (GIS).

The WAC is a custom made software, created in-house by the WSC. This software calculates the difference between customer meter reading and master meter recordings, as well as information about the proportion of real and apparent losses. It is to be noted that the WAC makes use

Table 4: Zones with an ILI of 10 or more as at end April 2008

Region	Zone reference	Zone name	ILI
Central	4133	G'Mangia Hill, St. Lukes	73.79[14]
Central	3255	St Georges	43.18
Central	3278	Wistin	29.72
Central	4113	Mrieħel Ind. Est.	24.19
South	6659	Ħal-Far Ind. Est.	22.81
North	1123	Wied il-Għasel / Burmarrad	17.05
South	6500	Bulebel Ind. Est	15.00
Central	4131	Belt is-Sebħ, Floriana	14.06
Central	3421	Balluta	12.84
South	6353	Xrobb l-Għagin	10.41

Source: WSC – Balance Tool Spreadsheet.

[14] Apart from the reasons explained, the ILI for G'Mangia Hill, St. Lukes is high due to a significant leakage within that zone found at the time when figures were compiled. The usual ILI region for this zone is around 45.

of various databases within the WSC – including the billing database. The billing system will be discussed further in the next Chapter (Apparent Losses).

The WAC system was piloted only in two localities in Gozo (Kerċem and Żebbuġ) and in one locality in Malta (Tal-Fjuri, Xemxija). The implementation of this system encountered a number of problems, namely financial and the complexities of water management as well as teething troubles – mainly due to the WSC's inexperience – with this type of electronic system. It is to be noted that the full benefits offered by this system were never fully exploited by the WSC as the Corporation had not implemented telemetry technology.[15] Telemetry technology enables the WSC to determine losses more accurately since it would be possible to make such calculations by using real time readings of water supply volumes and consumption.

The Corporation considers the WAC software as obsolete and is in the process of commissioning a state of the art computerised system to comprehensively handle the WSC's operations. The new technology is also viewed by the WSC as complimentary to the AMR project. This project would facilitate the calculation of real and apparent losses since the AMR would enable meter readings to be undertaken at a single cut-off date. The current practice of staggered meter readings could provide misleading or distorted estimations of the water account. The AMR system is a fully automated meter reader system – the installation of radio-based meter modules transmit meter reading data upon request. A pilot project concerning the implementation of such a system was undertaken and the Corporation has recently awarded the relative contracts for the implementation of the AMR system. In this regard the WSC aims to jointly implement AMR technology with Enemalta Corporation.

The Water Balance Tool Spreadsheet, in use to monitor water input and output volumes in all zones, was found to be updated. This Spreadsheet enables the WSC to localise abnormalities, such as leakages or changes in consumption patterns in specific zones. Such information is utilised to carry out more work (namely through leak detectors) to home in on problems within specific zones.

One of the initial tasks that must be undertaken when considering tackling real losses is to ensure that the maps and plans of the system, as well as its components, are accurate and up to date. The GIS provides such a facility to the Corporation as this system is, *inter alia*, able to provide a graphical interface with the system plans. This system is regularly updated with repairs and technical details of the water distribution system. However, the dates of repairs have only recently started being posted. Information on whether an area is considered to be problematic (such as prone to bursts, leakages, theft, etc.) is not posted on the GIS. This situation is considered to deprive the WSC of an efficient and effective way to generate the relative management reports (for example, on the age of particular components – such as pipes and fittings, frequency of repairs on particular zones, incidence of water theft, etc.).

There existed a substantial backlog within all regions of postings related to the cost of repairs undertaken by the WSC. The lack of computerised records in this regard prohibits the WSC from having up to date management information to gauge the cost efficiency and effectiveness of repairs being undertaken. Recently, the Corporation embarked on remedying this situation through the introduction of electronic job sheets and costing systems. The WSC contends that the backlog of pending postings has now been cleared.

2.5 Concluding remarks

Through various initiatives over the years, the WSC has made significant progress to reduce real losses. The Corporation is striving to attain an ILI of 2.0 in the hydrologically encapsulated zones in Malta by 2009. Action has also been recently initiated to control leakages emanating from the trunk mains. Despite such efforts, in 2007, real losses still amounted to around 18.15 per cent of the total water available for distribution.

A further reduction in real losses necessitates significant investment in the water distribution infrastructure and the relative technology to facilitate meter reading. Although the WSC has available the relative management information, this may need some refining – for instance, more accurate water accounting and up to date computer systems – in order to enable the Corporation to prioritise investment in this regard.

[15] Telemetry typically refers to wireless communications (i.e. using a radio system to implement the data link), but can also refer to data transfer over other media, such as a telephone or computer network or via an optical link.

Chapter 3

Apparent Losses

Chapter 3 – Apparent Losses

3.1 Introduction

Apparent losses refer to the water that is consumed but is not properly measured, accounted or paid for. In 2007, apparent losses incurred by the WSC were estimated at around 23 per cent of the SIV (7.13 million cubic metres). These losses cost utilities revenue and distort data on customer consumption patterns. This part of the Report discusses the ensuing action undertaken by the WSC to minimise apparent losses. It deals with the following main issues:

- The management of apparent losses;
- Customer meter inaccuracies;
- Billing system data errors; and
- Unauthorised consumption.

3.2 The WSC focuses more initiatives to deal with apparent losses

In 2007 the WSC estimated apparent losses at 23.2 per cent of the SIV (that is, the water available for distribution to consumers). However, the WSC has not broken down this amount into the various components – namely, billing system errors and unauthorised consumption – which by and large constitute apparent losses.[16] Such a state of affairs prohibits the Corporation from adopting a more realistic and effective strategy, where resources are allocated in accordance with priorities, to tackle apparent losses. The Corporation contends that, in view of the various assumptions that would have to be made, any attempt at such estimation would produce unreliable results.

The Corporation's strategic plan for 2005 – 2008 aimed to reduce apparent losses from the 23.2 per cent to around 18.6 per cent of the SIV, a decrease of 20 per cent. Such a target is considered as premature since it is only recently that the WSC is increasingly focusing on the apparent losses issue – especially since matters related to real losses are considered to have improved substantially. In this regard, work to compile an *ad hoc* strategy to deal with apparent losses has started. As a matter of policy, it was decided that the Corporation would reap higher benefits if more priority was given to tackle the problem of real losses rather than that of apparent losses.

In addition, the WSC has no software enabling estimations of apparent losses, and reliable estimation methods are still in their development stage. During 2000, the WSC developed the Water Information System (WIS) software, to enable reconciliation of consumption as registered by consumers' meters with master meters flows. This software is used to compare the amount of water registered by the zone master meters together with the consumers' meters and then quantify and qualify the difference between the two sources.

However, this is not being utilised by the WSC because certain key components are missing, including real-time information with the billing system. Computerised estimations of apparent losses can only be carried out on the introduction of the AMR and when the strategy of managing apparent loss is tackled further. It is to be noted that the WSC, together with the Enemalta Corporation, are in the process of awarding a contract for the implementation of AMR technology.

The opportunity exists for increased co-ordination between a number of Sections within the WSC, namely the Theft, Billing and Meter Sections, which have a direct influence on apparent losses.

[16] An important component of apparent losses, customer meter inaccuracies, has recently been the subject of an internal study carried out by the Corporation. Section 3.3 refers.

3.3 Customer meter inaccuracies contribute towards apparent losses

One of the principal contributors to apparent losses is customer meter inaccuracies. Water flows must be accurately measured if they are to be accounted for from the source to the consumer. Customer meters measure flow at the point of use. Consequently, metered water data forms the basis for the establishment of the water audit or water balance.

Customer meter inaccuracies may arise as a consequence of the under-registration of consumption of water meters, which generally may be due to the poor quality and inaccuracy of meters. Consequently, the Corporation's policy with regards to its meter replacement policy should include references related to the average age of meters.

The WSC commissioned an internal study on the performance of domestic billing water meters, with recommendations to augment the metering policy of WSC.[17] The report, dated September 2008, *inter alia*, concludes that all meters of the mechanical type invariably suffer from a reduction in performance with time and local conditions. Moreover, the report states that indirect plumbing systems are causing the WSC to lose revenue from meter under-registration.

This document should spur the WSC to review its working practices relating to customer meter replacing. The WSC is aiming to replace meters after approximately ten years from installation. However, the study referred to in the preceding paragraph revealed that over 51 per cent of meters installed are aged 10 years and over (Table 5 refers).

As at September 2008, the WSC had over 230,000 active water accounts[18] in the Maltese Islands. All these meters are of the mechanical type and, out of which, just under 1,000 are installed for heavy consumers. A total of 16,350 are still Class 'C' or older (pre 1994) and another 25,250 are Class 'D' but do not have a pulse output to which an AMR module can be connected.[19]

Table 5 shows how the meter error rate increases by age, as determined by the WSC's study, and the number of meters of a particular age which are installed in domestic households.

This table shows that the weighted average meter inaccuracy, based on the findings of the WSC's study team, stands at nearly 16 per cent. This implies that the WSC is not billing 16 per cent of water consumption due to meters' inaccuracies. The problem is mainly caused by meters which are aged 10 years and over. There are over 51 per cent of these meters installed. The combined estimated weighted average error of these meters results in the WSC not billing over 13 per cent of water consumption.

The WSC contends that when the customer meters aged ten years and over are replaced the combined estimated weighted average error rate of meters would decrease to around 5.75 per cent. In this regard, during the period 2009 – 2011, the WSC is planning to replace 120,000 'old' meters.

All meters purchased by WSC are certified according to the related international standards and EU Directive 2004/22/EC. In fact, every single meter purchased by the WSC is tested and certified at the manufacturer's facilities by independent third-party regulators. WSC has in the past occasionally requested such certificates for individual meters.

Table 5: Meter error rates by age as at November 2008

Age of meter (years)	Number of meters	Percentage of meters	Estimated percentage error rate[20]	Contributory weighted average meter percentage error rate
0 < 5	73,320	31.8	3.0	0.95
5 < 10	39,002	16.9	9.5	1.61
10 < 15	76,594	33.2	21.0	6.97
15 >	41,703	18.1	35.0	6.34
Total	**230,619**	**100**		**15.87**

[17] Water Services Corporation, A Research Project Aimed At Improving The Water Metering Policy of The Water Services Corporation of Malta (2008).
[18] Throughout this report, the number of accounts quoted may vary. This is due to different cut off dates utilised for the various audit tests undertaken.
[19] Water Services Corporation, A Research Project Aimed at Improving the Water Metering Policy of The Water Services Corporation of Malta (2008) p. 71.
[20] Ibid, pp. 72-73.

The only 'installed' meters being tested for their accuracy by the Corporation relate to those based on consumer complaints. However, the provision of this service is not intended to contribute towards minimising apparent losses since customer complaints tend to be about meter over-registration.

3.3.1 Indirect plumbing systems are a significant contributor to meter under-registration

Indirect plumbing systems are widespread throughout Malta and Gozo. These plumbing systems are generally dependant on float-valve controlled water storage – such as roof water storage tanks. Indirect plumbing systems, however, encourage meter under-registration. Normal domestic use is conducive to situations where the float-valves allow very low flow rates of water to refill the roof top tanks.

The WSC's internal study 'A Research Project Aimed at Improving the Water Metering Policy of the Water Services Corporation of Malta' contends that:

- at flows less than 7.5 litres per hour, the meter metrological accuracy level of a Class 'D' 15mm meter can considerably exceed the five per cent acceptable limit; and

- at flows less than four litres per hour, the meter might simply not register any flow at all.

The main conclusion reached by the project team conducting this study is that with a roof storage tank (indirect) system, no matter how good the low-flow and starting-flow characteristics of a new rotary piston mechanical meter are, there will always be a quantity of water that would be consumed without the billing meter registering it.

The project team also sought to estimate the losses incurred by the Corporation through indirect plumbing systems on the basis of the trials undertaken. The project team assumes an average consumption rate of 318 litres per day per household. From the logged data, in a 13 day period, there were 50 instances where the flow from the new meter under test (brand noted) subsided from four litres per hour towards zero, and remained at zero for at least two hours. In accordance with the study findings, there would have been 50 instances where the meter did not register 0.72 litres – which equates to 36 litres per household over the thirteen day period. This amounts to around 2.8 litres daily. Whilst stating their assumptions and testing limitations, the project team estimated that the total under-registration for the 'best' meter against the true volume is 0.9 per cent per day.

The project team asserted that the above refers only to a new meter under the particular test conditions. The project team states that the findings in the preceding paragraph do not relate to the high level of under-registration obtained in their study with old mechanical meters. For example, if an older meter does not read anything below four litres per hour, then the quantity of water that goes unregistered in one tank fill-up would be 1.8 litres and not 0.72 litres.

3.3.2 The use of technology has drastically reduced billing system data errors

Errors in the billing system inevitably leads to distortions in apparent losses since, potentially, water available for distribution in the SIV would remain unbilled or over billed. Data handling errors, which contribute significantly towards apparent losses, include:

- errors in meter readings;

- transcription errors which may occur during meter reading posting in the relevant client accounts; and

- erroneous consumption estimations.

The WSC has already embarked on projects like the OMR – a hand-held computer that has replaced the old manual (paper-based) record system. Its advantages include the transferring of metering activity information directly into the billing database on the same day[21] and the avoidance of a possible human inputting error. In fact, since the introduction of the OMR, data handling errors emanating from transcription or posting errors are considered as insignificant.[22] Moreover, the introduction of AMR technology will further facilitate water losses management as it would enable the Corporation to obtain customer readings at a single-cut off date. Section 3.2 of this report refers.

3.3.3 Improvements in the estimation procedures of unread meters decreased apparent losses

Article 40 of Legal Notice 331 / 2008 seeks to encourage clients to submit their meter readings. The Legal Notice stipulates that preferential rates shall only apply where a bill is issued upon an actual reading taken either by the Corporation or by the consumer and submitted to the Corporation. In this respect, this Article places the onus for ensuring that the customers' meters are read, and that the Corporation is duly informed of the readings, with the WSC's clients. The WSC, however, facilitates this process by assigning meter readers to note readings, and accepts readings provided by customers over the phone or through on-line services provided.

[21] WSC Annual Report 2002/3, Operations Review, p. 13.
[22] The WSC does not keep the relevant statistics in order to be able to back up this statement with quantitative data.

The WSC estimates consumption in situations where no actual readings are available and where the user has not forwarded the relative meter reading. The NAO tested the WSC's compliance to its own estimation procedures.

The estimation procedure entails establishing an average daily consumption rate as based on two historical actual readings, one of which has to be dated at most 540 days and the other at most 1,080 days back from the day when consumption is to be estimated.

The NAO reviewed a sample of 146 estimations. The population for this exercise was assumed to be all the estimated meter readings since 27 January 2006 - the date when bill estimations were introduced. The population totalled 210,035. Table 6 shows the results of these counterchecks.

Table 6: Outcome of verification of water bill estimations

Outcome of verification of bill estimations	Frequency	Percentage
Unsuitable historical readings	82	56.16
Negligible discrepancies	8	5.48
No discrepancies noted	56	38.36
Total	**146**	**100.00**

Table 6 indicates that:

- in 56.16 per cent of the cases (82 cases), it was not possible for the WSC to derive an estimate as there were no previous readings available. For these cases, bills were based on benchmarks; and

- in 5.48 per cent of the cases (8 cases), the estimation was counterchecked but did not match that produced by the WSC by a negligible margin.

3.3.4 Over three per cent of accounts have not been read for over 3.5 years

According to the WSC's records, 11,517 accounts out of a total of 210,035 accounts have not had any actual meter reading during the period under test: January 2003 – July 2006. A random sample of 372 of these 11,517 accounts was forwarded to the WSC for further explanations. The WSC explanations are summarized in Table 7.

Table 7: Meters which have not been read for over 3.5 years

Reason for not reading the meter	Frequency	Percentage of unread meters	Extrapolation to whole population	Percentage of total accounts
No access	203	54.57	6,285	2.99
Not used	108	29.03	3,344	1.59
Reading provided by customers	29	7.80	898	0.43
Other	32	8.60	990	0.47
Total	**372**	**100.00**	**11,517**	**5.48**

Table 7 shows the following:

- The most occurring reason for an unread meter is 'no access to the premises' – generally due to unoccupied dwellings. During the test period, the extrapolated results of the NAO exercise indicate that, in 6,285 cases (about 3 per cent of total clients accounts), the WSC could not gain access to premises for customer meter reading purposes. The WSC's 'accessibility' problem can be contextualised against the NSO's estimate that, as at end 2005, there were over 53,000 unoccupied dwellings in Malta and Gozo;

- In 108 cases (29 per cent) the customer indicated that the meter was no longer in use;

- In another 29 cases (about eight per cent) meter readings were supplied by customers;

- Other reasons which inhibited meter readings included stopped meters, removed meters, closed accounts and illegible meters; and

- Out of the 203 accounts, the meters of which could not be read during the test period, three related to heavy consumers.

Water losses become under-estimated when the relative adjustments to the water account following billing errors claims are not effected.

Following the verification of billing errors claims by consumers (claims variations), the Corporation duly refunds the over-charged amount to the claimant. Although the Corporation's accounting records are duly updated, the electronic system in place does not permit that the relative changes be made to the water account. This situation potentially leads to under estimation of apparent losses since claims variations generally relate to over-estimated consumption. The WSC envisages that the billing system which it intends to implement in the near future will cater for the circumstances discussed in this paragraph.

3.4 More could be done to tackle water theft

Unauthorised consumption falls under the responsibility of the Theft Section. Currently, the Theft Section has only one team composed of two people who perform regular theft inspections.

The WSC is tackling water theft in a reactive manner. The Corporation limits its efforts to investigating reports from the public. Incoming calls are always anonymous and are received by the Customer Care Section. Theft inspectors from the Theft Section follow up these reports with inspections. Upon confirmation of water theft, the police are called in to inspect the case and, when deemed appropriate, a court expert is requested to attend. Perpetrators are liable to criminal offence and may be taken to court. However, generally, people prefer to avoid court proceedings and settle the issue immediately by paying the amounts due.

To date, the Corporation has not carried out studies to determine the extent of water theft. Moreover, the WSC has not compiled a database or information system that groups together theft data. This limitation is considered as a significant hindrance for the WSC to establish an effective water theft strategy.

Through Legal Notice 331 / 2008, which was published in December 2008, the WSC is in a position to take a stricter stance against water theft. Article 39 of the Legal Notice states that whenever it is found that any tampering with or damage to the communication has been made the Corporation shall request the consumer to pay damages to it in an amount of not less than €1,500.

The NAO considers that the opportunity exists for the WSC to further encourage the public to report suspected water theft cases and to publicise the penalties involved in cases of proven wrongdoings.

3.5 Concluding remarks

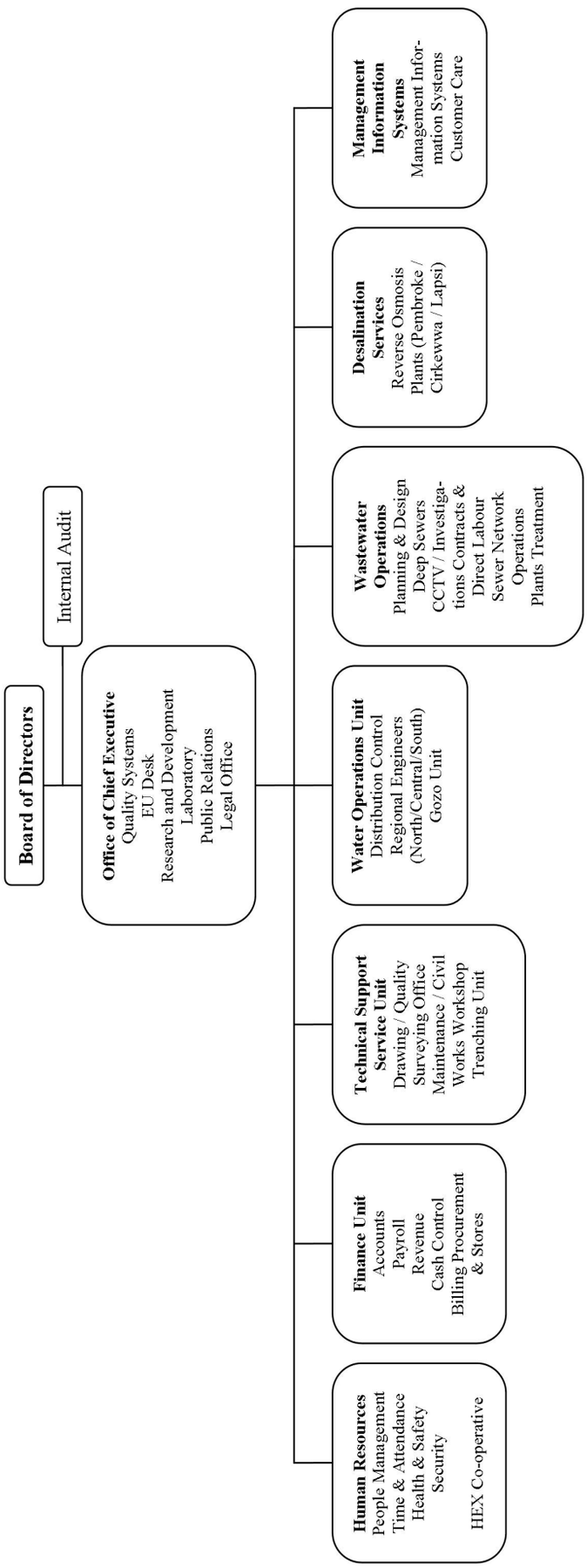
The WSC has been increasingly shifting its focus on apparent losses. This is evident by the number of initiatives, in the form of studies, pilot projects and technological investments undertaken in recent years, together with those that are in the pipe-line. Despite such initiatives, substantial progress is required to ensure that the situation regarding apparent losses reaches acceptable limits.

This Chapter has shown that apparent losses amounted to around 23 per cent of the SIV in 2007. The WSC is yet to establish the amount of such losses which are unavoidable. There are also a number of factors which may be distorting the water accounting, such as the fact that trunk mains leakages, unauthorised consumption and the lack of relative adjustments regarding claims variations are being used as balancing items in water accounting.

Moreover, the widely adopted indirect plumbing system in Malta is also contributing significantly towards apparent losses. These may be considered as unavoidable losses but nonetheless, are a source of unbilled water consumption.

Appendices

Appendix 1 – Organisational Chart



Appendix 2 – The Infrastructure Leakage Index (ILI)

The **Infrastructure Leakage Index (ILI)** is the internationally recommended benchmark for measuring water leakage. This is a dimensionless ratio of the **Current Annual Real Losses (CARL)** to the **Unavoidable Annual Real Losses (UARL)**. Specifically, the ILI is defined as:

$$ILI = \frac{CARL}{UARL}$$

The **Current Annual Real Losses (CARL)** is a technical indicator for real losses and is an indication of the current amount of leakage in the network. Its calculation depends on the length of mains, the number of connections, the density of connections, the location of the metering point on the service connection, the average operating pressure and the ground conditions. It is calculated as follows:

$$CARL = (MNF - NC \times Nc) \times DF$$

where:

	MNF	=	Minimum Night Flow
	NC	=	Night Consumption
	Nc	=	Number of connections
	DF	=	Day Factor

The **Unavoidable Annual Real Losses (UARL)** is the minimum amount of real losses which can be reached in a network. Leakage management practitioners are well aware that real losses cannot be totally eliminated. This arises from minor leaks on fittings, pipes, bends, etc, which are not easy to detect. The volume of unavoidable annual real losses is the lowest technically achievable annual real losses for a well-maintained and well-managed system. Its calculation depends on the number of connections, the length of mains, the density of connections, and the average zone pressure. Hence, all local key influences are taken into account. It is calculated as follows:

$$UARL = (1.8 \times Lm + 0.8 \times Nc) \times P$$

where:

	Lm	=	Length of mains
	Nc	=	Number of connections
	P	=	Average pressure