ATKINS

IPART

Potential Leakage Requirements for Sydney Water

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Notice

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GLOSSARY OF TERMS

Term	*Meaning / Definition*
BOO	Build Own Operate
Burst	A burst, or main break, is defined as leakage from a water main that requires the water main to be isolated to allow repairs to be undertaken. Typically it involves the replacement of a section of pipe or a fitting such as a tee or bend (source SWC).
Completion time for repair	For leakage and water continuity related tasks that require water main isolation completion time is considered to be the time at which water supply is reinstated after a shutdown. For leakage jobs where no water main isolation is required, completion time is currently defined as job complete including restoration (source SWC).
ELL	Economic Level of Leakage: In the short run this minimum value is where the marginal cost of leakage control work equals the marginal cost of water saved.
ILI	Infrastructure Leakage Index
IPART	Independent Pricing and Regulatory Tribunal
Kl/km/day	Kilolitres (m^3) per kilometre of water main per day
l/prop/day	Litres per (connected) property per day
Leak	A leak is defined as leakage from a water main that can be rectified without requiring the water main to be isolated. i.e. repairs could be effected under pressure. Typically this involves the resealing of minor leaks from joints or the installation of an under pressure leak clamp (source SWC).
Ml/d	Megalitres per day
Ofwat	Office of Water Services (England and Wales)
Response Time	Response time is defined as the time taken from the initial notification to Sydney Water of a reported service fault to the time of arrival on site by a Sydney Water maintenance crew (source SWC).
SCA	Sydney Catchment Authority
Service Pipe	The section of private service pipe between the point of connection to the water main and the customer's meter, or to a point 1 metre within the property boundary in cases where there is either no water meter or the water meter is located some distance within the property. (source SWC) This differs from the definition in England where the service pipe is the length of main from the boundary of the property to the dwelling.
Water balance	Definition in Appendix B

1 Executive Summary

Background

The Independent Pricing Tribunal of New South Wales (IPART) is currently carrying out a review of the Operating Licence of Sydney Water Corporation. It is considering including a target level of leakage and, if appropriate, other leakage measures in the Licence and has engaged WS Atkins International Ltd to provide advice in this area.

This report sets out the findings of our review of whether a leakage target is appropriate for Sydney Water, the form that this could take, and other possible leakage measures that could be included in the Licence. We present the justification for the measures selected and the values to be achieved by Sydney Water over the Licence period.

The Need for a Leakage Target

There is a public perception that there should be no or minimal leaks in water distribution systems. The current low levels of storage in the reservoirs that supply Sydney, the demand management initiatives promoted by Sydney Water and the recently announced Metropolitan Water Plan have focussed attention on leakage management as a key issue in the need to reduce the quantity of water drawn from the city's reservoirs. A measure of leakage in the public domain is needed to inform stakeholders and allow them to obtain a clear view on the current position and historical trends in the level of leakage. The measure would also set clear leakage targets for Sydney Water to achieve over time.

The Form of Leakage Measure

The form of measure should be linked to the outputs of leakage detection work. We have examined possible alternative forms of a leakage measure to meet the overall requirements of clarity, ease of understanding by a non-technical readership, relevance to the purpose to enable comparisons to be made over time and with other agencies. The most appropriate measure is total volume in Megalitres per day (Ml/d). This can be expressed as litres per property per day (l/prop/day) and kilolitres per km of water main per day (kl/km/day). Expressing the measure in litres per property per day can be readily understood by a non-technical readership.

The Value of Leakage Target

Sydney Water should aim to minimise the total cost of leakage management by 2009. The target should be based on the economic level of leakage (ELL) where marginal cost of detection and repair equals the marginal cost of water saved. For the purposes of ELL modelling, we are of the view that the marginal cost of water should be the highest source cost; that of using the Shoalhaven supply. This represents a 'public' marginal cost of water although it is not necessarily that which Sydney Water has to pay. Environmental and social costs should be included in the ELL analysis to reflect the opportunity cost of environmental benefits within the analysis. As there is no definitive value of environmental cost available, Sydney Water has assumed a surrogate unit cost of water. This approach is appropriate

and applied in many current ELL models where environmental costs have not been quantified.

The leakage target should reduce over the four year period from 2006 to 2009 to recognise the time needed to secure sustainable reductions in leakage. We suggest that the target be to achieve 105 Ml/d by 2009, consistent with the funding proposed for this activity in the price submission. The value should be reviewed at the end of 2006 in the light of further information on marginal costs and leakage management costs.

Estimating and Reporting Leakage

Sydney Water has a methodology in place to assess total leakage using the integrated flow method for the water balance. Sydney Water needs to accelerate its programme of bulk meter installations from the current five year programme to a period of two to three years. This will allow reporting of water balance at each reservoir zone with greater confidence.

Activity Measures

We have identified three activity measures which directly measure progress on leakage detection, repairs and pressure management. These are pragmatic and are included within the activities we would expect for good-practice leakage management. The measures are defined as;

(i) A measure of *frequency of leak detection*. We suggest that, as a minimum, each reservoir zone should be inspected twice per year. The term inspection should be defined as the application of best practice leak detection methods to meet working-level zonal leakage targets. This measure is more effective and targeted to leak detection than a broader requirement for inspecting water mains every three years;

(ii) A measure of *repair effectiveness*. That 90% of all leaks found or reported should be repaired within three days.

(iii) A measure of progress on *pressure control*. The number and percentage of pressure control zones completed each year against the planned programme.

These measures will provide a clear statement of progress with leakage reduction activity which can be readily understood by a non-technical readership. The measures will present Sydney Water with challenging targets.

A Measure of Response Time

We reviewed Sydney Water's proposal for a 'response time' measure for bursts and found that it relates to the time an operative arrives on site and not when a main is repaired and back in use. The proportion of water lost through bursts generally forms a small proportion of total leakage as the duration of these losses is far shorter than undetected or un-repaired leaks. A measure of the time for the repair of bursts and the restoration of supply would therefore only address a small part of total leakage. The measure would also overlap with the current unplanned interruptions measure, where Sydney Water is incentivised to reduce the duration time of outages to customers. We found that there is little benefit in the inclusion of a response time measure.

Recommendations

We recommend the following for inclusion in Sydney Water's Operating Licence:

1. *Leakage target*. We recommend that an annual leakage target is included in the Operating Licence for Sydney Water. This target shall follow the profile shown in the table below, reaching the economic level of leakage (ELL) in 2009. The measure is defined as the average annual value of leakage for the year ending June 30th for each year shown. The value of the leakage target should be reviewed at the end of 2006 when more cost information will be available.

	2006	2007	2008	2009
Leakage Target in Ml/d	**132**	**122**	**112**	**105**
Expressed as l/prop/day	78	72	66	62

2. *Bulk meter installation.* We recommend that the agency's current five year programme of bulk meter refurbishment and new meter installation be accelerated. We suggest that 90% of all these meters should be in place by June 2007. This will allow a more reliable estimate of leakage to be made at reservoir area level and improve the confidence in the agency's overall reported level of leakage.

3. *Network Inspection. We* recommend that as a minimum each reservoir zone should be inspected twice per year. The term inspection should be defined as the application of best practice leak detection methods to meet working-level zonal leakage targets.

4. *Leak Repairs.* We recommend that 90% of all leaks found or reported should be repaired within three days of a leak being detected or reported.

5. *Reporting.* We recommend that estimated total leakage is reported annually against the leakage target. The method of estimation should be agreed with Sydney Water.

6. *Pressure Reduction.* We recommend that the agency be required to report its progress in completing the proposed pressure reduction programme. The form of the report could be the number and percentage of pressure control zones completed each financial year. The total percentage achieved to date could also be reported each year.

2 Background

The New South Wales government has recently released a document outlining its strategy to ensure that Sydney has enough water to meet its current and future needs for the next 25 years. Entitled the "Metropolitan Water Plan 2004 Meeting the challenges – Securing Sydney's water future," one of its proposals is the reduction of leakage from Sydney Water's supply system.

The Plan outlines expected reductions in the volume of leakage from the trunk main and distribution system, and corresponding expenditure on mains renewal and leak detection and repair activity. Further, it states that;

"*In consultation with the Independent Pricing and Regulatory Tribunal, Sydney Water's Operating Licence will have additional conditions attached. These will require more rapid repairs of burst water mains. In addition, all mains will be inspected at least once every three years*."

The Independent Pricing and Regulatory Tribunal (IPART) is currently conducting its end of term review of Sydney Water's Operating Licence and is considering and consulting on the additional Licence conditions proposed by the Plan.

Sydney Water is currently required to identify strategies for reducing unaccounted for water losses and include these in its "Demand Management and Strategy Implementation Report" submitted annually to IPART. Under its 1995 Operating Licence, Sydney Water was required to reduce unaccounted for water losses to a maximum of 15 per cent by 2000. This target was achieved, through meter recalibration, quantification of unbilled authorised consumption (e.g. for fire-fighting) and limited leakage reduction works.

In its recent submission to IPART outlining its proposals for the next pricing period, Sydney Water has indicated that it intends to carry out a higher level of activity in relation to leakage reduction over the next four years. It has set itself a target level of leakage of 105Ml/d by 2009.

Such leakage targets, based on keeping leakage at an economic level, have been set in the United Kingdom by the Office of Water Services (Ofwat). Ofwat is the economic regulator for the water industry in England and Wales. We discuss the concept of an economic level of leakage further in sections 4.3 and 5.1. IPART has indicated that it may seek to include a requirement to meet a leakage target of some description as one of the "additional conditions".

In order to assist it with its Licence review, IPART has engaged WS Atkins International Ltd to advise it on;

- Whether a leakage target is appropriate for Sydney Water, and if so, the appropriate form of such target; and
- Any other obligations that should be imposed on Sydney Water, via its Operating Licence, in relation to leakage.

This report has been prepared in accordance with the Terms and Conditions set out in the contract between Atkins and IPART exchanged on December 3 2004.

3 The Need for a Leakage Measure

The extent of leakage of water from pipelines in a trunk or distribution system is related to the condition of the assets, the effect of ground conditions and loadings on these pipelines, and the operating pressures. Leakage occurs in all water networks although the amount depends on these factors and the actions taken by water utilities to find and repair leaks.

Water utilities have built up their pipeline assets over many decades. The condition of pipes and joints deteriorate over time as a result of the quality of the materials used and/or the workmanship of joints and laying techniques. This deterioration means that the likelihood and value of leakage increases over time. Leakage management theory proposes that there is a minimum value of leakage that can be achieved using current technology. This value will be different for each distribution system.

There is a public perception that there should be no or minimal leaks in water distribution systems. The current low levels of storage in the reservoirs that supply Sydney, the demand management initiatives promoted by Sydney Water and the recently announced Metropolitan Water Plan have focussed attention on leakage management as a key issue in the need to reduce the quantity of water drawn from the city's reservoirs.

IPART has asked for submissions from interested parties as part of its end of term review of Sydney Water's Operating Licence. A number of stakeholders have responded, and have expressed a view that there is a need for clear information in the public domain to show how leakage is being reduced over time, consistent with the long term view of reducing water demand. This need for transparency is one driver of the proposed leakage measure.

Water utilities should operate to minimise total costs. Achieving the theoretical minimum level of leakage may not be the most cost effective means of managing supply and demand. However, it is possible to calculate an economic level of leakage (ELL) where the cost of leak detection equals the marginal cost of water. If the current volume of leakage is above the economic level, there are efficiencies to be gained through reducing leakage. Achieving the economic level of leakage is therefore in the best interests of the water agency customers and stakeholders. IPART and the public should be informed as to the agency's progress towards its ELL to gain comfort that the agency has been operating in an efficient manner.

There is currently a requirement in Sydney Water's Operating Licence for it to reduce the number of properties affected by interruptions to supply from broken water mains. Sydney Water has to pay a penalty to customers if an interruption exceeds 5 hours. The requirement to make these payments forms an incentive for Sydney Water to minimise the duration of an interruption.

Experience from leakage management in England, and confirmed by Sydney Water's experience, shows that the volume of water lost through main breaks is relatively small compared with the total volume of water lost as leakage. Many leaks are not visible on the surface, particularly if they are of relatively low volume and the pipes are laid in soil that drains easily. Such leaks are only fixed when they are found by Sydney Water's detection team and could have been running for

a significantly longer duration than a water main burst, which only runs for a short period until a section of pipeline is isolated.

Regulating the interruptions to supply drives the agency to operate in a manner that provides a good level of service to its customers. However the water lost from mains bursts only accounts for a small part of total leakage. With the aim of monitoring leakage reduction, then different and more focussed measures are appropriate.

In its submission, Sydney Water advised us that it supports measures of leakage performance in its Operating Licence.

3.1 Conclusion

Leakage measures will allow stakeholders to make an informed judgement on the current position and historical trends in the level of leakage. This will facilitate discussions on leakage policy. It would also set clear targets for Sydney Water over time.

We conclude that there is a need for a leakage measure in Sydney Water's Operating Licence.

4 The Form of Leakage Measure

4.1 Criteria

We have considered alternative forms of a leakage measure to meet the overall requirements of clarity, ease of understanding by a non-technical readership, relevance to the purpose and to enable comparisons to be made over time and with other agencies. The measure should also present challenging but achievable targets for Sydney Water to meet over the next Licence period.

In defining a measure, care should be taken not to establish an instrument that relates to other factors and could therefore limit the flexibility of the agency's management processes and create perverse incentives. In addition, measures should not be related to factors not within the direct control of an agency.

Measures can be either a direct output of or input to the leakage management process. We discuss each in turn below.

4.2 Current Practice

We have carried out a desktop review of leakage measures to supplement our detailed understanding of current practice. We have compared practice across utilities in Australia, New Zealand, England and the United States. Our results are summarised in the table below.

Table 1 Worldwide Leakage Indicators

Country or State	Basis of leakage measure
Victoria	Infrastructure Leakage Index (ILI)
Australia (WSAA)	The WSAA methodology uses the Infrastructure Leakage Index (ILI)
England	Total leakage in Ml/d as derived from the economic level of leakage.
New Zealand	The Auckland Water Industry members report cubic metres per kilometres of watermain.
United States Singapore	Based on a percentage of water delivered

4.3 Output Measures

Our review of leakage output measures currently in use has identified three alternatives;

(i) A percentage measure;

(ii) Use of the infrastructure leakage index (ILI); and

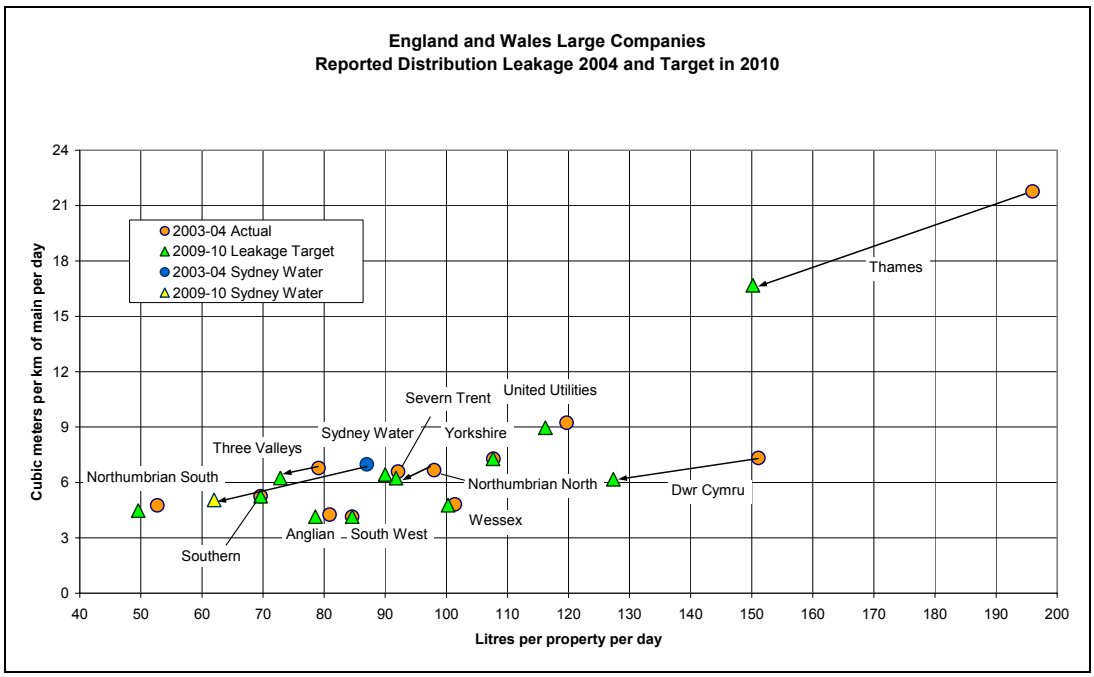
(iii) A volumetric measure.

The percentage measure is derived from a volumetric measure divided by total water delivered. The water delivered denominator is in itself variable across a range of water use patterns dependent on climate and customer preferences. For example, an increase in water use during a dry summer would reduce percentage leakage when no effective leakage reduction may have taken place. Conversely, the impact of other demand measures would reduce demand and hence increase leakage. While the measure is understood by non-technical readers it is not relevant as the denominator is variable and therefore comparisons are not valid. We suggest that this is not an appropriate form of measure.

The Infrastructure Leakage Index (ILI) is a factor that compares the current level of leakage in a water utility with the minimum achievable. The advantages are that it can be consistently applied across a range of utilities and that it is measure of what can be achieved given the condition of infrastructure. It is an appropriate technical measure. Its key disadvantage is that it is not easily understood by non technical readers. The measure does not take into account the relative costs of leakage management and other marginal costs, such as environmental costs, and it is not able to define what level of reduction is economically feasible. We therefore suggest that this is not an appropriate form of measure.

The third option, an absolute measure of leakage in Ml per day, provides greater visibility. Comparisons with other utilities can be made with confidence, calculated using loss per property (l/prop/day) and loss per length of main (kl/km/day). Both denominators are dependent on drivers of potential leakage; properties can be used as a surrogate for the number of mains tappings and pipe length is related to the number of joints. In England and Wales, comparisons of leakage are reported each year using both measures. Comparisons with English companies should be made with care as reported leakage includes customer's own leakage which forms about 30% of the total. Figure 1 below shows a good way to compare leakage using both indicators.

Figure 1 England and Wales Large Companies – Distribution Leakage 2003-04 to 2009-10



Source: Tables 6 and 13c Security of supply, leakage and the efficient use of water 2003-2004 report, Ofwat, adjusted to report only distribution losses.

Figure 1 shows that several companies are expected to achieve a significant movement between the reported leakage values in 2004 to the targets in 2010. This indicates that continuing leakage reductions are expected over this period to achieve an economic level of leakage. For other companies, showing no movement between 2004 and 2010, the economic level of leakage has been achieved. We have included Sydney Water's position at 2004 and the proposed target for 2009, which we discuss in section 5.

The value of ELL for each company depends on its own explanatory factors and the short and long run marginal cost of water. The figures shows a trend that companies with greater resource issues, such as Southern Water and Anglian Water, have lower ELL's than other areas with fewer resource constraints such as United Utilities and Yorkshire Water. Sydney Water is in the former category and the proposed leakage target is comparable with English companies with significant water resource issues.

Each agency's target is based on an evaluation of the economic level of leakage. A robust ELL would include assumed environmental and social costs. Incorporating environmental and social costs into a measure recognises the concerns expressed by some stakeholders; one future debate could focus on the value of these costs in the analysis. This ELL approach assumes a 'policy minimum' level of leakage, which is the minimum level of leakage that can be obtained by current detection techniques.

One disadvantage may be the understanding of an absolute measure in Ml/d. This could be overcome by converting the value to litres per property per day (l/prop/day) to be more easily understood by the non-technical readership. Another alternative is to compare leakage levels with a percentage of total

reservoir storage, although this measure is unlikely to be sensitive to annual changes in total leakage.

4.4 Input Measures

It is possible to measure performance of inputs to, or processes for, the leakage management programme.

Sydney Water's submission suggests that the

"…*measures focus on defining the right processes and performance indicators to help ensure that Sydney Water appropriately invests in leakage reduction and that more transparent information on Sydney Water's performance in responding to and repairing mains breaks is available* …"

Sydney Water suggested a requirement that it develops and manages its leakage reduction programme based on the annual calculation of its economic level of leakage using best practice methodology.

We agree that the ELL modelling is fundamental to the leakage management programme but believe that it should form part of its normal operating procedures and is not necessary an appropriate Licence requirement. It does not address the need to set stretching targets for the agency.

The agency further proposed several leakage performance indicators;

(i) Frequency and duration of interruptions;

(ii) Repeat interruptions,

(iii) Losses in the water system,

(iv) Frequency of main breaks,

(v) Response times to breaks

We discussed Sydney Water's proposals with the agency and found that some of the processes were not directly related to the broad thrust of leakage control work.

As discussed in Section 3 the proportion of water lost through bursts ((i) and (ii) above) generally forms a small proportion of total leakage as the duration of these losses is far shorter than for leaks. A measure of the time for repair of bursts and the restoration of supply would therefore only address a small part of total leakage. It would also overlap with the current unplanned interruptions measure, where Sydney Water is incentivised to reduce the duration time of outages to customers. We suggest that these are micro-issues and areas where decisions should remain with Sydney Water's management and detailed measures avoided.

Loss in the water system (iii) is important as an actual annual output measure to monitor progress against a Licence target. It can be wrapped into the monitoring process.

The frequency of mains breaks (iv) provides a measure of the infrastructure performance over time and the influence of the mains replacement programme.

However, as bursts do not contribute significantly to total leakage the factor, although informative, is not a good measure of leakage.

We discussed with Sydney Water it's proposal (v) for a 'response time' measure for bursts and found that it relates to the time an operative arrives on site and not when a main is repaired and back in use. This is not an appropriate measure.

If there is a public interest need to obtain greater assurance with progress of leakage control activities in addition to an output measure, appropriate input measures could relate to monitoring, detection, location and repair. Appropriate examples are detection frequency and duration of leak repairs. We discuss these issues further in Section 7.

4.5 Conclusions

We conclude that the form of measure should be linked to outputs. The most appropriate measure is total volume in Ml/d and this can be expressed as litres per property per day (l/prop/day) or kilolitres per km per day (kl/km/day). Expressing the measure in l/prop/day can be readily understood by a non-technical readership.

5 Assessing the Value of a Leakage Target

5.1 The Approach

Having selected an appropriate output measure, in this case in a Ml/d form, the next stage is to consider the appropriate value of the leakage measure or target to be achieved over time. Key drivers are economic, social and political factors. The clearest way of setting an appropriate target is to first consider the economic level of leakage, and to then assess whether outperformance of this is appropriate for social or political reasons. Sensitivity tests and incorporating social costs into the analysis can inform this decision.

From an economic point of view, given that there are no externalities impacting on the leakage value, the target should be based on the minimum total cost to Sydney Water plus environmental and social costs.

In the short run this minimum value should be where the marginal cost of leakage control work equals the marginal cost of water saved. This is termed the economic level of leakage. The long run analysis should consider the benefits of further leakage reduction against the deferment of the next resource development.

If there is public interest in achieving a level of leakage below the ELL, then the additional costs incurred by Sydney Water in achieving this level need to be recognised. At this time, we are not aware of any requirements for a target lower than the ELL.

ELL modelling uses a standard approach with methods and assumptions defined in Future Approaches to Leakage Target Setting (Ofwat 2002). This approach represents current best practice in deriving leakage targets on an economic basis. The modelling uses values of the marginal cost of water, marginal environmental and social costs, and the cost of leakage detection.

A further factor is the time needed to achieve this economic level of leakage. This can be assessed in relation to the current level of leakage, the resources available for detection and repair of leaks to achieve further sustainable savings, and the infrastructure to measure flows within the distribution system. The robustness of the modelling is also important.

The ELL should present challenging but achievable targets for Sydney Water to meet over the next Licence period.

5.2 Economic Level of Leakage Modelling

Sydney Water has carried out an ELL assessment consistent with current best practice set out in Future Approaches to Leakage Target Setting (Ofwat 2002). It produced a discussion paper in September 2004 which set out its approach and initial results. A short run approach has been taken, based on marginal costs. The analysis is carried out for the whole network. Several assumptions are made relating to the policy minimum level of leakage, natural rate of leakage rise,

marginal cost of water and environment and social costs. We discuss these assumptions below.

Policy Minimum

The policy minimum level of leakage is defined as the minimum level of leakage that can be achieved using current technology and for the system operating conditions. To date, there is insufficient data available to Sydney Water to verify a policy minimum level. Two alternative values of 49.5Ml/d and 64.4Ml/d have been derived based on an initial assessment. These figures are equivalent to 29l/prop per day and 38 l/prop/day respectively.

The policy minimum level of leakage can be reduced by pressure reduction. Future improvements in technology and the impact of the proposed mains renewal programme may also reduce the policy minimum level of leakage in the longer term.

Natural Rate of Rise

The natural rate of rise is the increase in leakage from an area over time when no detection work is carried out. This figure is likely to vary across supply areas depending on the condition of the assets, pressure and ground conditions. Sydney Water has assumed a value of 38l/prop/day per year, which is similar to values currently used in England.

Marginal Cost of Water

The marginal cost of water is an important input to the analysis. Sydney Water has assumed that the marginal cost of water is the bulk supply cost from the Sydney Catchment Authority (SCA) with a full volume charge and no standing charge. Treatment costs from the Build Own Operate (BOO) plant are added.

The current tariff structural arrangements require the SCA to charge a fixed volumetric tariff. The marginal cost of water therefore equals the average cost of supply. The marginal cost of pumping from the adjacent Shoalhaven catchment, which is greater than average cost, is currently absorbed by the SCA.

For the purposes of ELL modelling, we suggest that the marginal cost of water should be the highest source cost, that of using the Shoalhaven supply. This represents a ‘public’ marginal cost of water although it is not necessarily that which Sydney Water has to pay.

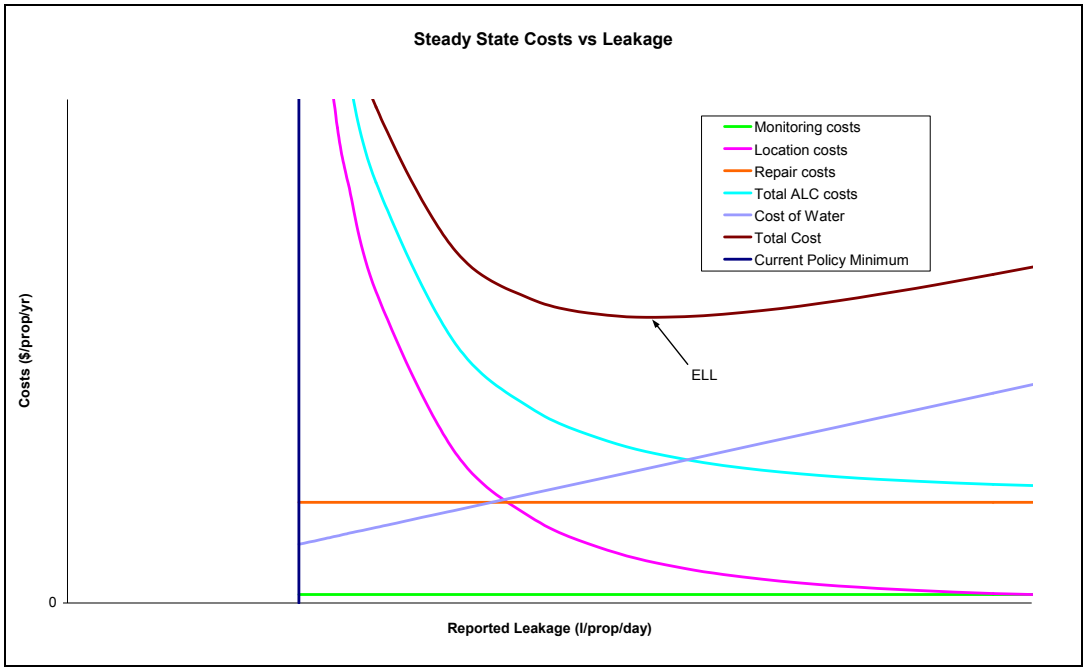
Environmental and Social Costs

The Metropolitan Water Plan identifies the need for environmental flow releases into the Nepean River and schemes are proposed to enhance current low flows. For example, a kilolitre of water lost to leakage could have been released into the river to provide environmental benefits. The ELL is able to reflect the opportunity cost of these environmental benefits within the analysis. As there is no definitive value of environmental cost available, Sydney Water has assumed a surrogate unit cost of water. This approach is appropriate and applied in many current ELL models where environmental costs have not been quantified.

The Cost of Leakage Detection

The cost of reducing leakage to pre-determined values and of sustaining these levels increases significantly as leakage is reduced. Current detection costs are available from Sydney Water's cost base. The ELL analysis requires leakage management costs for a range of leakage output values and the agency has made assumptions on cost increases consistent with a typical cost/ leakage curve. Such typical cost curves are shown in the figure below which is the result of a typical ELL analysis.

Figure 2 Typical Economic Level of Leakage Analysis



source: WS Atkins

5.3 Current Progress with Leakage Control

Leakage reduction achieved by Sydney Water over the last five years is summarised in the table below.

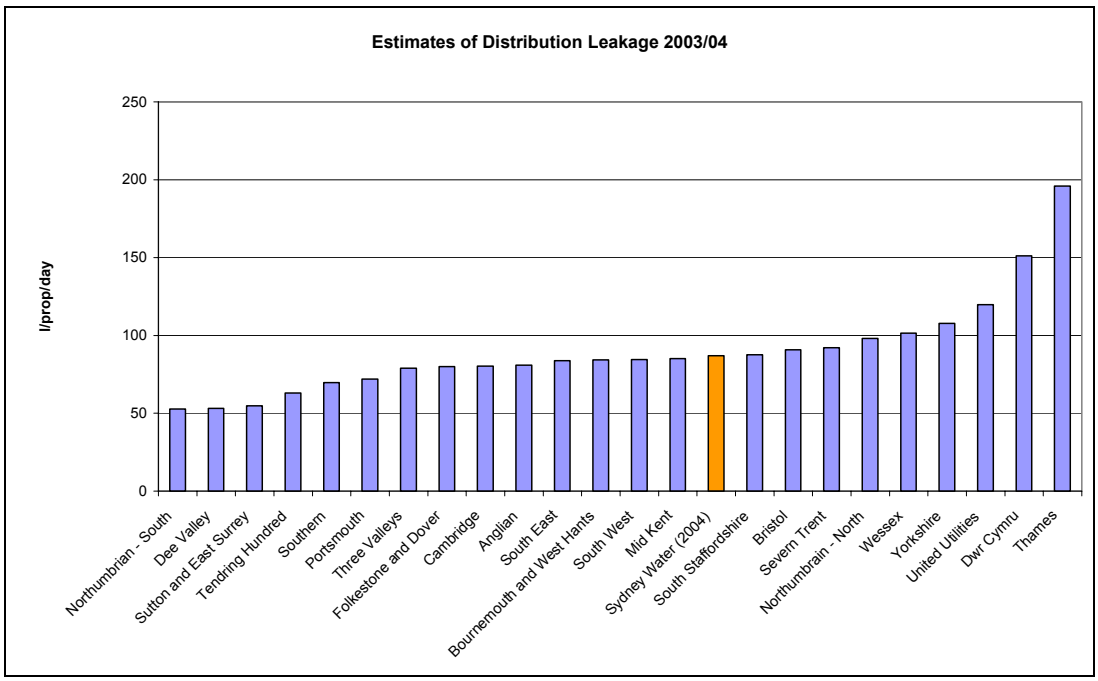
Table 2 Current Progress with Leakage Control

	2002	2003	2004
Leakage Volume in Ml/d	182	169	145

Source: SWC AIR submission to IPART 2004

Leakage in 2004 is equivalent to 88 l/prop/day or 6.9kl/km/day. For comparative purposes we include below a chart of leakage per property of the water companies in England and Wales for the year ending March 2004. The corresponding value for Sydney Water is shown. Supply pipe leakage has been excluded from the figures presented below. Many of the larger water companies have yet to achieve their economic level of leakage.

Figure 3 UK Water Companies and Sydney Water Leakage per Property in 2003-04



Source: 2003/04 figures from Table 13c, Security of supply, leakage and the efficient use of water 2003-04 report, Ofwat.

5.4 Leakage Target

Our view of an appropriate leakage target is based on an appraisal of Sydney Water's ELL analysis and supporting information, and our detailed understanding of the agency's leakage management process and practices. We are also informed by the expenditure activities and outputs proposed in the agency's pricing submission. We have not carried out any independent modelling.

In it's price review submission Sydney Water proposes to reduce leakage to 105Ml/d (62 l/prop/day) by 2009. This is based on its ELL modelling using a range of assumptions for the marginal cost of water and policy minimum leakage.

In its submission, Sydney Water states that

"*Sydney Water considers it feasible to reduce leakage from the current 143Ml/d in 2003/04 to the identified midpoint value for the economic level of leakage range (based on a marginal cost of 38c/kl) of approximately 105 Ml/d by expanding its current range of activities*…."

Proposals for funding for increased leakage activity and extensive pressure reduction schemes are included within its price submission. The impact of pressure control on the reduction of the policy minimum leakage value is likely to be material.

Our review suggests that the marginal cost assumption of 38c/kl is likely to be low when the marginal pumping and environmental costs are taken into account. We also consider that the long run marginal cost of future water resource development could be understated.

The agency recognises that there are uncertainties in the assessment of ELL and that the estimates can be improved over time. Notwithstanding this, we note that there will always be uncertainties due to the nature of the task, as evidenced by more advanced ELL assessments that we have seen elsewhere.

Sydney Water also comments in its price submission that:

"*Sydney Water considers that a quantitative volumetric target such as reducing leakage to 105 Ml/d would not be the most appropriate form of leakage target at this stage given the uncertainties in many areas of leakage cost benefit analysis*…"

We have commented on the form of target in earlier sections. While there are uncertainties affecting this initial value of ELL, these can increase or decrease this figure. We suggest that the leakage target should be to achieve 105 Ml/d by 2009, consistent with the funding proposed for this activity in the price submission.

Sydney Water's leakage reduction forecast in the price review is shown in the table below. The agency suggests an accelerating trend in reduction over time. This is not consistent with our experience elsewhere which suggests that there is increasing difficulty in achieving further reductions over time. Conversely we recognise that the necessary monitoring systems and improvements will be implemented over time and as such gains will not be immediate. Our proposed phased target is shown in the table below.

Table 3 Proposed Leakage Levels

Leakage Volume in Ml/d	2005	2006	2007	2008	2009
Sydney Water Proposals	140	136	128	118	105
Atkins proposals	140	132	122	112	105

Source: Sydney Water SIR and Atkins

By 2009, Sydney water's leakage will have reduced to 62 l/prop/day or 5kl/km/day, consistent with well performing utilities with similar infrastructure.

5.5 Conclusion

We conclude that the value of a leakage target for Sydney Water should be based on an economic level of leakage (ELL) analysis. This target should reduce over the four year period from 2006 to 2009 to recognise the time needed to secure sustainable reductions in leakage. We suggest that the target be to achieve 105 Ml/d by 2009, consistent with the funding proposed for this activity in the price submission.

6 Assessing and Reporting Leakage

6.1 Leakage Assessments

The ability of Sydney Water to assess leakage volumes with confidence is fundamental to reporting against the targets which may be set in the Licence. We discuss methodologies for leakage assessment, progress made by Sydney Water and the requirements it could be expected to be able to report with confidence.

Total leakage cannot be measured; it is estimated using established water balance or night flow assessments. These estimates are in turn derived from several components such as water delivered to customers, meter under-registration and unmeasured but small components such as use for fire fighting. There are two conventional approaches to leakage assessment.

The first is a water balance, or integrated flow approach that assumes that:

> Leakage = distribution input – consumption

In this approach leakage is the residual or balancing item in an annual water balance. Each component of water use is either measured (such as metered supply) or estimated where it is not possible to measure; for example meter under-registration. This method is applied across the Australian water industry using a methodology prepared by WSAA and consistent with the IWA approach. As nearly all customers are metered this approach is appropriate subject to a statistical assessment of the variance of each component. The drawback is that leakage is a small number derived from differences in large numbers. Therefore any small variance in the larger components could have a significant impact on leakage

A second approach is derived from monitoring minimum night flows in supply areas. Using this approach:

> Leakage = (minimum night flow – legitimate use)*pressure adjustment factor

This method assumes that there is minimum normal water use over a small time window during the night. The estimated leakage component is aggregated with other water use components and compared with distribution input. Errors are distributed across all components on a statistical basis.

The appropriate application of one or both approaches depends on the confidence in the water delivered components and the ability to measure night flows and assess legitimate use. Nearly all customers in Sydney are metered therefore there

is greater confidence in water delivered components compared with England and Wales where most properties are not metered.

6.2 Application in Sydney Water

Sydney Water undertakes water balance calculations to derive estimates of leakage for the agency as a whole. It also estimates water saved from the leak detection programme through an estimation of water loss by type of leak.

The water balance methodology is established within the agency and subject to audit. It provides the only rigorous assessment at this stage and produces good comparative data for the agency. We identified the need for a review of the statistical methodology to ensure that the likely variance of the several components is fully addressed.

Sydney Water's key constraint is that it is not able to undertake this water balance assessment at the level of individual supply areas. Sydney Water has 14 supply areas and about 170 reservoir distribution zones. These are discreet areas with boundary valves to ensure water is not 'lost' to other areas.

To complete the water balance methodology at reservoir zone area Sydney Water needs to provide reliable inflow monitoring, which we would normally expect to see at the reservoirs serving each zone. Sydney Water has a programme for the refurbishment of these bulk meters and for the provision of more meters to achieve substantial coverage of the distribution system. The current programme for the installation of these meters is of five years duration. During our discussions with Sydney Water it indicated that it would be possible to accelerate this programme into install these meters within two to three years. We suggest that this is a more appropriate time frame.

With these meters in place it would be possible to complete a water balance for each reservoir area. The reservoir zones are generally much larger than used for leakage control in current best practice utilities. Nevertheless, with new acoustic detection technologies it is possible leakage control work in these larger zones could be as effective as we have seen elsewhere.

Sydney Water has carried out some studies for monitoring night flows in pilot areas. With the provision of input meters to all reservoir zones it would be possible to monitor night flows across the distribution system.

The current relatively large zones would make operational monitoring more difficult. Operational monitoring refers to the monitoring of and response to changes in night flows where leaks are suspected. Nevertheless, this monitoring would provide the basis for better assessing a leakage component within the water balance. Further development of this methodology by Sydney Water would be appropriate so as not to rely on the integrated flow method in the medium term.

Full coverage of reservoir areas by bulk flowmeters is not necessarily a prerequisite to a successful analysis. Provided that a substantial coverage is in place, a statistical approach could be used to derive a total estimate. The chosen statistical approach needs to be agreed with and the uncertainties recognised by an independent auditor to ensure that it is suitably robust.

Assessment of flows from leakage detection and repair teams provides a useful operational measure in assessing progress and outputs, but is limited as an overall

and reportable measure. This is because these gains need to be offset by the natural rate of rise in other areas.

6.3 Conclusion

We conclude that Sydney Water has a methodology in place to assess total leakage using the integrated flow method for the water balance. Sydney Water needs to accelerate its programme of bulk meter installations from the current five year programme to a period of two to three years. This will allow reporting of water balance at each reservoir zone. Night flow monitoring within these zones would allow an alternative estimate of the leakage component to be made and compared with the integrated approach.

7 The Role of Activity Measures

In this section we explore the potential of activity measures as useful indicators of progress with leakage control work. Activity measures are inputs to the leakage control work.

We have already recommended an output measure as a leakage target for inclusion in Sydney Water's Operating Licence. If there is a need to obtain greater assurance in relation to the progress of leakage control activities an appropriate measure could relate to leakage monitoring, detection, location or repair.

In section 4.4 we have discussed possible input activity measures proposed by Sydney Water and explained why we believe that these are not appropriate.

To provide this additional level of comfort, we instead suggest three measures which are direct inputs to the leakage control work. These are;

(i) Detection. The frequency of leakage detection in defined zones;

(ii) Repair. The repair time for identified leakage; and/or

(iii) Progress with implementation of pressure control zones.

Where there is no intervention, leakage in water supply zones will increase at a 'natural rate of rise' as the condition of assets deteriorate. After one pass of leakage detection activity, these leaks will be found and repaired and total leakage reduced. Leakage will then again increase at the natural rate of rise until the next detection intervention. The duration of a leak would on average be the mean time between detection interventions. This duration forms a significant component of total leakage.

We suggest that a measure of the frequency of leak detection carried out by Sydney Water is therefore appropriate. The Metropolitan Water Plan recommends that the Operating Licence requires Sydney Water to inspect all mains at least once every three years. We suggest that, as a minimum, each reservoir zone should be inspected twice per year. The term inspection here is defined as the application of best practice leak detection methods and an appropriate level of detection input to maintain a 'working level leakage target' for each reservoir area. For example, some reservoir areas with night flows significantly greater than the working target would need a greater frequency and level of detection input compared with other areas.

Inspecting every length of water main could create perverse incentives. Greater efficiencies could be achieved by deploying detection effort in areas where the greatest benefits would result. The proposed reservoir area level detection frequency requirement does not create such a perverse incentive and should still provide Sydney Water with the management flexibility that it needs.

The time between leak detection and repair should be minimised to limit water loss. A measure of leak repair time would present an incentive for Sydney Water to ensure an effective response and provide visibility on performance. The Metropolitan Water Plan advises that a target response time to mains breaks will

be included in the agency's Licence. We instead suggest a measure to the effect that 90% of all leaks found or reported should be repaired within three days. The selection of the 90th percentile allows for a small proportion of work where it may be difficult to gain access to carry out the repair or other factors beyond the control of the agency. The three days period is the current internal standard and is similar to internal targets set in similar agencies elsewhere.

The pressure control zones are a fundamental component to leakage reduction and impact on the policy minimum leakage. Funding has been included for this work within the price submission. We suggest that it is in the public interest to report on progress of this programme as with other major projects. A measure could be the number and percentage of pressure control zones completed each year. The total percentage complete would also be illustrative.

7.1 Conclusion

If there is a public interest need to obtain greater assurance in relation to the progress of leakage control activities in addition to an output measure appropriate measures can be applied.

We have identified three activity measures which directly measure progress on leakage detection, repairs and pressure management. We have recognised the need to define measures directly related to progress with the leakage control programme. These are pragmatic and are included within the activities we would expect for good-practice leakage management. The measures can be defined as

(i) A measure of frequency of leak detection. We suggest that, as a minimum, each reservoir zone should be inspected twice per year. The term inspection should be defined as the application of best practice detection methods and appropriate level of input to maintain a 'working level leakage target' for each reservoir area;

(ii) A measure of repair effectiveness. That 90% of all leaks found or reported should be repaired within three days.

(iii) A measure of pressure control. The number and percentage of pressure control zones completed each year.

8 Conclusions

We conclude that:

1. There is a need for a leakage measure in the Licence;

2. The form of measure should be linked to outputs. The most appropriate measure is total volume in Ml/d and this can be expressed as litres per property per day (l/prop/day) or kilolitres per km per day (kl/km/day). Expressing the measure in l/prop/day can be readily understood by a non-technical readership;

3. The value of a leakage target should be based on the economic level of leakage (ELL) analysis. This target should reduce over the four year period from 2006 to 2009 to recognise the time needed to secure sustainable reductions in leakage. We suggest that the target be to achieve 105 Ml/d by 2009, consistent with the funding proposed for this activity in the price submission;

4. Sydney Water has a methodology in place to assess total leakage using the integrated flow method for the water balance. It needs to accelerate its programme of bulk meter installations from the current five year programme to a period of two to three years. This will allow reporting of the water balance at the level of each reservoir zone. Night flow monitoring within these zones would allow an estimate of the leakage component to be made and compared with the integrated approach.

If there is a public interest need to obtain greater assurance with progress of leakage control activities in addition to an output measure appropriate measures can be applied.

We have identified three activity measures which directly measure progress on leakage detection, repairs and pressure management. We have recognised the need to define measures directly related to progress with the leakage control programme. These are pragmatic and are included within the activities we would expect for good-practice leakage management. They can be defined as:

(i) A measure of frequency of leak detection. We suggest that, as a minimum, each reservoir zone should be inspected twice per year. The term inspection should be defined as the application of best practice detection methods and appropriate level of input;

(ii) A measure of repair effectiveness. That 90% of all leaks found or reported should be repaired within three days.

(iii) A measure of pressure control. The number and percentage of pressure control zones completed each year.

9 Recommendations

We recommend the following for inclusion in Sydney Water's Operating Licence:

1. *Leakage target*. We recommend that an annual leakage target is included in the Operating Licence for Sydney Water. This target shall follow the profile shown in the table below, reaching the economic level of leakage (ELL) in 2009. The measure is defined as the average annual value of leakage for the year ending June 30th for each year shown. The value of the leakage target should be reviewed at the end of 2006 when more cost information will be available.

	2006	2007	2008	2009
Leakage Target in Ml/d	**132**	**122**	**112**	**105**
Expressed as l/prop/day	78	72	66	62

2. *Bulk meter installation.* We recommend that the agency's current five year programme of bulk meter refurbishment and new meter installation be accelerated. We suggest that 90% of all these meters should be in place by June 2007. This will allow a more reliable estimate of leakage to be made at reservoir area level and improve the confidence in the agency's overall reported level of leakage.

3. *Network Inspection.* We recommend that as a minimum each reservoir zone should be inspected twice per year. The term inspection should be defined as the application of best practice leak detection methods to meet working-level zonal leakage targets.

4. *Leak Repairs.* We recommend that 90% of all leaks found or reported should be repaired within three days of a leak being detected or reported.

5. *Reporting.* We recommend that estimated total leakage is reported annually against the leakage target. The method of estimation should be agreed with Sydney Water.

6. *Pressure Reduction.* We recommend that the agency be required to report its progress in completing the proposed pressure reduction programme. The form of the report could be the number and percentage of pressure control zones completed each financial year. The total percentage achieved to date could also be reported each year.

10 References

1. *Community Views on Sustainable Water Supplies*, Sydney Water Corporation, December 2003.

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3. *End Term Review of Operating Licence of Sydney Water Corporation - Water Demand and Supply Balance* – Submission by Total Environment Centre to IPART, November 2004.

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5. *Future Approach to Leakage Target Setting for water companies in England and Wales*, an investigation by WRc with Stone and Webster Consultants for the Tripartite Group of the Department for Environment, Food and Rural Affairs, the Environment Agency and Ofwat, 2002.

6. Letter from DIPNR to IPART re End Term Review of Operating Licence.

7. Letter from Sydney Water Corporate Customer Council to IPART re End Term Review of Operating Licence.

8. *Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures* International Water Association October 2000.

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10. *Metropolitan Water Plan 2004 Meeting the challenges – Securing Sydney's water future*, NSW Department of Infrastructure, Planning and Natural resources, November 2004.

11. *Mid Term Review of Sydney Water's Operating Licence*, IPART, September 2002.

12. *Mid Term Review of Sydney Water's Operating Licence*, Montgomery Watson Harza, September 2002.

13. *Practical Experience in using the Infrastructure Leakage Index*, A. O. Lambert and Dr R. D. McKensie, http://www.liemberger.cc/downloads/publicationsfiles/Lambert%204.pdf

14. *Security of supply, leakage and the efficient use of water 2003-2004 report*, Ofwat, 2004.

15. *Sydney Water Submission to the Independent Pricing and Regulatory Tribunal Review of Metropolitan Water Agency Prices*, Sydney Water Corporation, November 2004.

16. *Water Conservation and Recycling Implementation Report*, Sydney Water Corporation, 2003 and 2004.

11 Appendices

Appendix A: PEOPLE MET

1st December 2004

Name	Role	Organisation
Felicity Hall	Program Manager	IPART
Stephanie Biesaga	Senior Analyst	IPART
Matt Edgerton	Analyst	IPART

3 December 2004

Name	Role	Organisation
Paul Freeman	General Manager, Asset Management	SWC
Colin Nicholson	Process Leader, Water Operations	SWC
Gavin Morrison	Manager, Regulatory Strategy and Pricing	SWC
Gary Hurley	Acting Network Manager	SWC
John Werda	Manager Civil Maintenance	SWC
Lucinda Maunsell	Senior Advisor, Regulatory Affairs	SWC

Appendix B: CALCULATION OF SYDNEY WATER'S WATER BALANCE

Water Balance Table

<table>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><td rowspan="8">System input volume</td><td>Water exported</td><td rowspan="4">Authorised Consumption</td><td rowspan="3">Billed Authorised Consumption</td><td rowspan="3">Revenue Water</td><td>Billed Water Exported</td></tr>
<tr><td rowspan="7">Water Supplied</td><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Unmetered consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td rowspan="6">Non Revenue Water</td><td>Unbilled Metered Consumption</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorised Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Real Losses</td><td>Real Losses (ie Leakage)</td></tr>
</table>

The water balance is a simple accounting of each component of water use. Each component is deducted from the total volume supplied with the remainder defined to be losses or leakage. This is commonly referred to as the "top-down" approach to quantifying leakage.

Source: Sydney Water Corporation

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