



ENVIRONMENT AGENCY

LEAKAGE METHODOLOGY REVIEW:

**ALTERNATIVE APPROACHES TO LEAKAGE TARGET
SETTING**

FINAL REPORT

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SUMMARY

BACKGROUND AND OBJECTIVES

The UK Water Industry has applied the concept of deriving an 'Economic Level of Leakage' (or ELL), which balances the costs and benefits associated with leakage management, since the mid 1990's. It set out the framework calculating the ELL in reports published in 1994⁽¹⁾, 1996⁽²⁾ and 2002⁽³⁾. The latest of these reports, published by DEFRA, the Environment Agency and Ofwat (collectively known as the 'Tripartite Group'), recommended a best practice approach for companies to follow in calculating an economic level of leakage (ELL). Water companies routinely prepare ELL assessments based around the framework methodology provided by these reports and submit them to Ofwat as part of the leakage target setting process.

It is over four years since the Tripartite Group report was published and the ELL approach has been tested through a complete price setting process. There have also been several recent independent reviews of water demand management in the UK which have commented on the leakage target setting process, and suggested alternative approaches.

A group representing the main stakeholders, comprising the original The Tripartite Group plus the Consumer Council for Water and Water UK, has agreed that it is a good time to:

- review the work done in 2002;
- consider additional alternatives to the ELL and compare these to the current ELL approach;
- recommend a preferred option or set of alternatives to the ELL that provides genuine benefits and is workable within the constraints of existing regulatory regimes.

In recent statements, the Minister for Climate Change and the Environment has set out a clear steer that any leakage target setting methodology should be based in an economic framework.

PROJECT APPROACH

This project has reviewed the Tripartite⁽³⁾ and Leakage Target Setting⁽⁴⁾ reports. A wide range of alternatives to the ELL were selected for further analysis through contact with other sectors, the UK water industry, water companies outside the UK and by literature review. These alternatives have been compared against the current ELL process using a Multi Criteria Decision Analysis technique, allowing alternative options to be evaluated in a structured and open manner. The methods that compared favourably with the ELL were analysed further. The preferred options were then subjected to a partial impact assessment.

CONCLUSIONS AND RECOMMENDATIONS

A wide ranging review of alternative leakage target setting options has been carried out. From this process, 24 potential alternative options have been identified and described.

The 24 options have been evaluated using a MCDA technique, the most appropriate options were discussed with the project steering group and compared against the current ELL process. Four preferred alternatives have been identified which provide benefits which are workable within the constraints of the existing regulatory regime. The four alternative options are:

- Option A: Modified ELL – inclusion of full environmental and social impacts.
- Option B: Modified ELL – inclusion of volumetric abstraction charges.
- Option C: Modified ELL – inclusion of limits on abstraction levels.
- Option D: Frontier based targets (relative leakage efficiency targets).

These four options have been subject to a partial impact assessment. All of the options could lead to lower leakage targets in the short and long term, particularly in those areas where the value of abstracting less water from the environment is higher. Where leakage targets are lower there may be additional costs to be borne by either the company or the customer.

The four options identified above should be subject to a full regulatory impact assessment, once other parallel projects have been completed and reported. The full regulatory impact should investigate the impact on leakage levels, the cost (monetary or carbon) impact to companies and customers, and quantify the value (monetary or carbon) of the resulting levels of leakage.

The options for alternative leakage target setting identified above should be consulted on more widely in the industry.

Following the completion of the full RIA and consultation one of the preferred options should be put in place as the new approach to setting leakage targets. The Tripartite Report should then be updated to provide guidance on the new approach.

Regardless of the option taken forward it is recommend that as part of the EBSD process, network renewal, network growth and network condition should be built into the modelling to ensure that improvements in technologies and practices are factored into the long term leakage glide-path.

1. INTRODUCTION

1.1 Background

The UK Water Industry has applied the concept of deriving an 'Economic Level of Leakage' (or ELL), which balances the costs and benefits associated with leakage management, since the mid 1990's. It set out the framework calculating the ELL in reports published in 1994⁽¹⁾, 1996⁽²⁾ and 2002⁽³⁾. The latest of these reports, published by DEFRA, the Environment Agency and Ofwat (collectively known as the 'Tripartite Group'), recommended a best practice approach for companies to follow in calculating an economic level of leakage (ELL). Water companies routinely prepare ELL assessments based around the framework methodology provided by these reports and submit these to Ofwat as part of the leakage target setting process.

The 'Tripartite Report'⁽³⁾ also considered alternative methods to leakage target setting based on the ELL. More recently the Environment Agency revisited these options and commissioned the report 'Leakage Target Setting review of target setting options'⁽⁴⁾ which looked at the alternatives to the ELL in more detail.

It is over four years since the Tripartite Group report was published and the ELL approach has been tested through a complete price setting process. There have also been several recent independent reviews of water demand management in the UK which have commented on the leakage target setting process, and suggested alternative approaches.

The review by the House of Lords Science and Technology Committee into Water Management⁽⁵⁾ made a recommendation that a "sustainable level of leakage" target would be more appropriate than the ELL target. The report argues that the sustainable level of leakage should encompass economic impacts and should factor in the environmental considerations, which would result in more stringent leakage targets.

The National Audit Office report "Ofwat – Meeting the demand for water"⁽¹³⁾ also recommended that Ofwat should build on its current approach and press for a long term and sustainable approach to leakage management. The report suggested that the ELL target setting process should require companies to improve the way in which environmental and social impacts are included in the ELL and consider the impact of public perceptions of leakage.

There is also greater awareness of leakage issues by water consumers. The CC Water report "Using water wisely"⁽⁸⁾ identified that 62% of consumers supported a leakage strategy based on achieving an economic level of leakage. However the same report also identified that consumers expected water companies to be more proactive at conserving water during periods of water stress.

A group representing the main stakeholders, comprising the original The Tripartite Group plus the Consumer Council for Water and Water UK, has therefore agreed that it is a good time to: review the work done in 2002, consider additional alternatives to the ELL and compare the alternatives to the current ELL methodology. In recent statements, the Minister for Climate Change and the Environment has set out a clear steer that any leakage target setting methodology should be based in an economic framework. The Group wishes to consider how far any alternatives meet this objective.

This report explores a range of alternative leakage target setting approaches in addition to variants of the current ELL approach. There are three additional projects which are running parallel to this work. The first is looking in more depth at the Environmental and Social impacts of leakage management. The second is looking at variations in per capita consumption estimates, which have an impact on the assessment of leakage levels. The third is examining the feasibility of setting water efficiency based targets (see Section 1.5).

1.2 Project Objectives

This report – “Alternative approaches to leakage target setting” has the following set of objectives:

- Review the work done in 2002 (Tripartite Report);
- Identify new alternatives to the ELL that were not mentioned in the tripartite report. These may be drawn from experiences with water or other utilities in the UK or abroad;
- Compare these new alternatives with the ELL by reviewing their economic, social and environmental effectiveness;
- Recommend a preferred option or set of alternatives to the ELL that provides genuine benefits and is workable within the constraints of existing regulatory regimes;
- Where options are constrained by existing regulatory structures identify the barriers and how they can be overcome;
- Where appropriate, include relevant findings from the two other reports being undertaken in parallel, as well as other relevant literature.

1.3 Approach to the project

In completing the project to meet the objectives the following approach has been used:

- a) Review the Tripartite⁽³⁾ and Leakage Target Setting⁽⁴⁾ reports. This establishes whether there are any improvements or variations to the ELL process which should be taken into account when comparing new alternative options against the ELL. It also provides a starting point for considering additional alternative options;
- b) Select a wide range of alternatives to the ELL for further analysis. Through contact with other sectors, the UK water industry, water companies outside the UK and literature review a list of alternative options or variants to the current ELL has been drawn for further consideration;
- c) Compare the alternatives against the current ELL process. This stage brings together the objectives for leakage target setting, as identified by the stakeholders, with the details of the alternative approaches. Using the technique of Multi Criteria Decision Analysis, alternative options are evaluated in a structured and open manner to the various options to be ranked and short-listed;
- d) Prioritise the methods that compare favourably with the ELL and analyse these further. The final stage in the current study will be to investigate the short listed options in more

- Assumptions on underground supply pipe leakage;
- Application of maximum likelihood estimation technique (variation pre and post water balance reconciliation);
- Any other factors that influence PCC estimates including those briefly considered in the original UKWIR study (summer visitors and mains pressure).

The report should provide robust explanations of the variations that exist between water company estimates of both mPCC (measured) and uPCC. The report should also identify the key variables that drive differences in reported PCC estimates, whether they are caused by external factors such as weather or by the application of different methodologies, and identify areas of the companies' estimation techniques that could be improved further towards best practice including an assessment of the costs and benefits of doing so.

1.5.2 Environmental and social costs

This project will seek to improve the guidance on how to take account of external environmental and social costs (as opposed to the environmental and social costs included in internal costs – such as power and chemicals) within the ELL best practice leakage target setting process. In particular, the project includes work on the carbon footprint to provide an example of how to apply this analysis to help make practical decisions in areas where economic, environmental and social factors are interacting.

The project will obtain information from all companies in the industry and identify authoritative sources of policy in the area of environmental and social cost and carbon footprinting.

The resulting report will provide guidance to water companies on what costs to include in leakage planning and management decision making, how to assess and value them, provide practical examples of best practice from inside and outside the water industry. It will also provide information on the sensitivity of leakage estimates to possible errors in cost calculation.

1.5.3 Measuring success of demand management interventions

This project aims to assess the feasibility of prescribing water efficiency based targets that could be applied across the water sector and to appraise the regulatory impact of the recommended approaches.

The project will include a literature review of the successes and failures of using benchmarks and applying targets to promote water and energy efficiency. It will determine the potential role for benchmarks and targets to promote water efficiency activity and recommend a preferred set of target / benchmark options for more detailed appraisal. The project will then appraise specific options for water company benchmarks and/or targets for water efficiency on a per capita, individual household, total households and total quantity of water put into supply basis, and evaluate their feasibility, use, impacts and consequences.

1.6 Current leakage management in England and Wales

Active management of leakage (as opposed to passive reaction to bursts) has been practised in the UK since 1980. The water industry has been in the lead for research into the topic throughout that period. The modern concepts of active leakage control were first presented in "Leakage control policy and practice" published by the Department of Environment in 1980⁽⁶⁾. This has regularly been updated by the water industry through the Managing Leakage⁽¹⁾ series of reports and the Tripartite⁽³⁾ report.

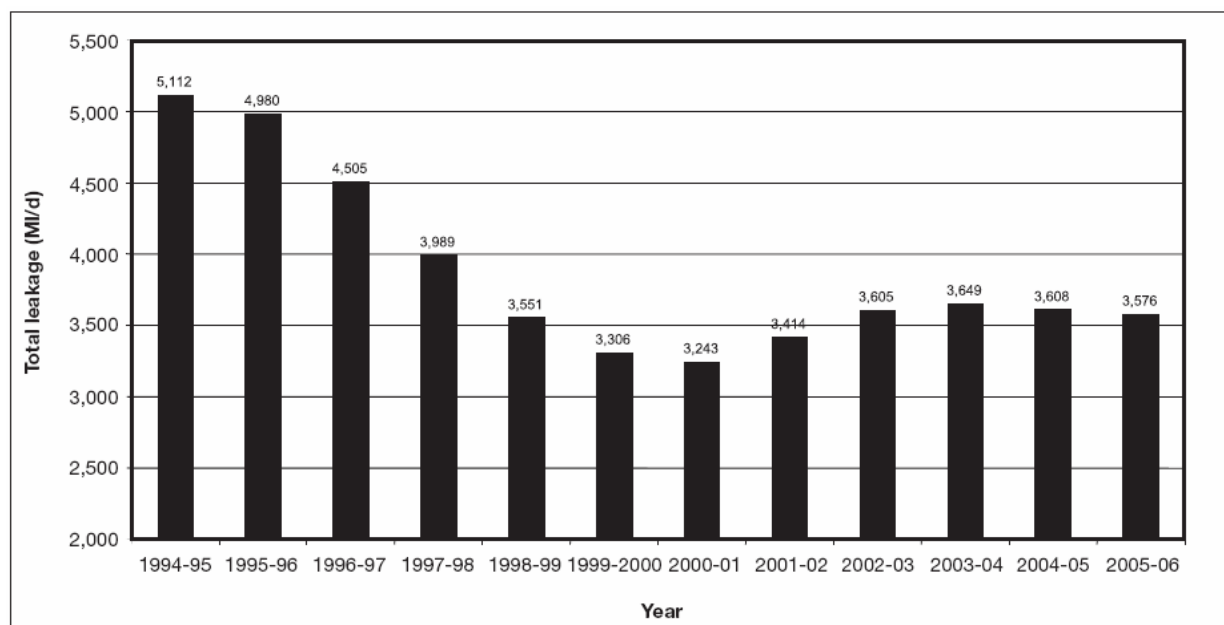


Figure 1.1 Leakage levels in England and Wales since 1994

The leakage levels for England and Wales over the last 12 years⁽⁷⁾ are shown in Figure 1.1 which shows that between 1994-95 and 2000-01 leakage was reduced by around 1,900 MI/d, with most companies ultimately reporting leakage against and in line with their own targets based on their own economic analyses. There were then two consecutive years of leakage rises in 2001-02 and 2002-03. These increases in leakage were mainly caused by higher reported leakage levels by Thames Water and Severn Trent Water following the introduction of improved water balance and a better leakage reporting methodology. After that the amount of water lost from the supply networks remained stable in 2003-04 and reduced in 2004-05 and 2005-06. The total leakage reported for the industry is currently around 3,600 MI/d.

A majority of companies in England and Wales are now at or below their target economic level of leakage⁽⁷⁾. The reported levels of leakage for 2005-06 and the target levels of leakage for each company in 2005-06 and 2009-10 are shown in Table 1.1. These show a reduction in leakage of 288 MI/d (8%) to 3,320 MI/d by 2010 from the 2004-05 reported level of 3,608 MI/d. This is a level of leakage around 35% lower than the recorded peak in 1994-95.

Table 1.1 Leakage and target levels of leakage in England and Wales

	Leakage levels (MI/day)		
	Reported	Target levels	
	2005-06	2005-06	2009-10
Water and sewerage companies			
Anglian	214	215	210
Dwr Cymru	224	225	195
Northumbrian - North East	157	160	150
Northumbrian - Essex & Suffolk	67	69	66
Severn Trent	542	505	520*
South West	84	84	84
Southern	93	92	92
Thames	862	830	690
United Utilities	477	470	465
Wessex	73	74	74
Yorkshire	297	295	295
Water only companies			
Bournemouth & West Hampshire	22	22	22
Bristol	53	54	54
Cambridge	14	14	14
Dee Valley	11	11	10
Folkestone & Dover	8	8	8
Mid Kent	28	28	27
Portsmouth	30	30	30
South East	69	69	69
South Staffordshire	73	75	75
Sutton & East Surrey	24	25	25
Tendring Hundred	5	5	5
Three Valleys	149	150	140
* Note: the target reflects methodological changes resulting from the ongoing review of water balance components.			

The water companies continue to research methods and technologies to improve the efficiency of leakage management. Much of the research into leakage is managed through UKWIR (UK Water Industry Research Ltd). Current and recent leakage research includes:

- A comparison of leakage practice and leakage levels in the UK and Netherlands;
- Cost effective leakage survey practice;
- Background leakage;
- Factors affecting natural rate of rise of leakage;
- Leakage from pe pipework systems;
- Leakage from trunk mains and service reservoirs;
- Linking distribution mains rehabilitation to leakage and burst performance;

- Managing seasonal variations in leakage;
- Separating customer night use from leakage in night flow analysis.

The range of research being undertaken covers a wide range of issues relating to the impact on long term leakage target setting, changing issues for 'find and fix' efficiency, increasing housing developments, network growth, mains renewal, and the potential future issues for leakage control from the increasing use of plastic pipes.

1.7 This report

This report has been prepared to present the findings of the work to the steering group for comment and discussion.

The report has the following sections.

- Section 2 of the report reviews the current ELL best practice set out in the Tripartite Report.
- Section 3 reviews target setting approaches in other sectors.
- Section 4 describes 24 different potential alternative leakage target setting options.
- Section 5 identifies describes how the 24 potential options are short-listed to 8 options for more detailed consideration.
- Section 6 analyses the 8 options in more detail.
- Section 7 discusses the suitable options and a way forward for leakage target setting.
- Section 8 gives details of a partial impact assessment of the recommended options.
- Section 9 presents the conclusions from the work and the recommendations for the next steps.

2. REVIEW OF TRIPARTITE REPORT BEST PRACTICE

The Tripartite Report⁽³⁾ sets out 'Best Practice Principles' in the economic level of leakage calculation. It was produced in 2002 and is now taken as the best practice 'process' for calculating the ELL target. Potential alternative leakage target setting options will be benchmarked against this best practice process. It is therefore important to review the best practice process to identify potential improvements which may make the existing ELL process more robust. The sections below examine each of the steps in the process and identify areas of inconsistency with current processes, areas of lack of clarity or where potential improvements could be made.

2.1 ELL target setting process map

The best practice process⁽³⁾ for calculating the economic level of leakage (ELL) is illustrated in the following flow chart:

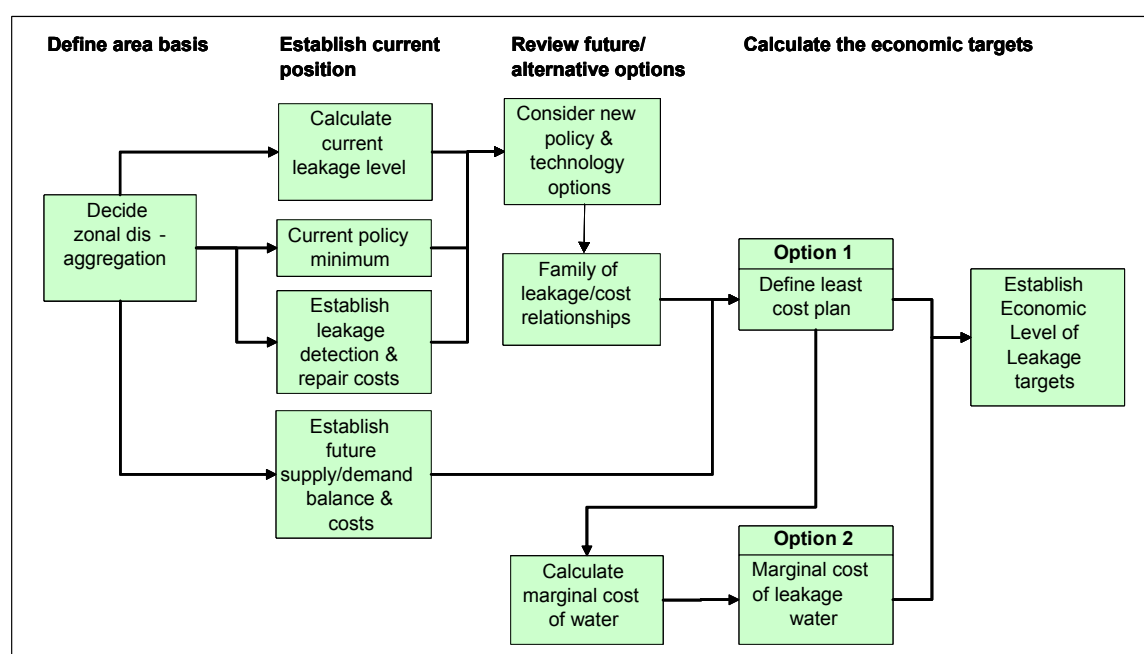


Figure 2.1 Best practice process for calculating the ELL

For each of the key stages, shown in Figure 2.1, the Tripartite Report recommends best practice for obtaining, calculating or modelling the data needed to derive the ELL. In some cases alternative options are provided which are considered to be less robust, but recognise that in some instances data or system design may be limited. In the following sections we consider each of the key stages and raise issues about the way the best practice is implemented in the context of leakage management and regulatory needs today.

2.2 Definition of target

The report identifies a number of options for defining the leakage target including figures expressed as a flow rate (e.g. megalitres per day), as a volume per property (e.g. litres per property per day) and as a volume per length of main (e.g. cubic metres per km per year). The best practice suggests that targets should be set on the basis of 'per-property' or 'per-km', as over time the increase in the number of properties will make maintenance of constant volumetric (e.g. MI/d) targets increasingly difficult.

The current practice is to set targets (current and future) on a volumetric basis (MI/d), as future targets are not (generally) allowed to increase.

Company leakage targets should also be based on the average over a number of years. Over or under achievement of the target, due to external factors, should not cause the following target to change.

Issues for consideration:

- *Possible need for clarification on dealing with new (and aging) housing stock when developing long term leakage profiles.*
- *Potential to change the best practice to clarify the units for target setting.*

2.3 Zonal dis-aggregation

Best practice suggests that the ELL should be calculated at Water Resource Zone (WRZ) level which is consistent with setting the ELL in the context of the overall supply demand balance. It does not suggest that the ELL should be calculated at company level. Targets are set at company level, but company targets should be the aggregate of the ELL derived from the WRZs.

Issues for consideration:

- *Is the WRZ a suitable area for which to set leakage targets in the future and should targets be published for these areas?*

2.4 Calculate current leakage levels

'Top-down' and 'Bottom-up' best practice is presented in the report and should be consistent with the 'June Return' methodology, which includes a method for reconciling differences between the top-down and bottom-up approaches. Leakage trends during the year should be presented.

2.5 Determine current policy minimum level of leakage

The 'current policy minimum' is defined as the lowest level of leakage which can be achieved using the leakage control policy that is currently in place. It is a key input in the development of the leakage cost curve and will have a substantial impact on the resulting economic level of leakage.

The report states that:

Policy minimum leakage estimates should be based on company specific District Meter Area (DMA) data and should accurately reflect the lowest level of leakage that can be achieved in each DMA through intensive active leakage control using conventional active leakage control methods and 'reasonable' effort. The policy minimum will depend on the leakage control policy and system conditions. Each company should ensure that the approaches used for calculating current leakage and policy minimum leakage from measured night flows are consistent with each other.

The policy minimum is a key parameter in the ELL calculation and there is evidence that a variety of policy minimum calculation or estimation techniques are used to derive the policy minimum value, from modelling, assessing historical value to measurement.

Issues for consideration:

- *Should the best practice be updated to provide revised best practice based on the last five years experience?*
- *Should an estimate of uncertainty be reported?*

2.6 Establish leakage detection and repair costs

The analysis of leakage control activities and development of leakage cost relationships is required in order to predict how the ongoing costs of leakage control will change if a different level of leakage is maintained. This also allows the transitional costs incurred in achieving the new target level of leakage to be assessed. The relationship is developed for the current leakage control policy (current leakage detection methods and technology). Costs of operating at different levels of leakage are calculated assuming the method of leakage control is unchanged and leakage is reduced through applying more of the same effort. The cost analysis should include the operating costs (including capital maintenance) of monitoring leakage, detecting and locating leaks and repairing leaks.

The report identifies that two distinct approaches are used by water companies to evaluate and model leakage control activities and costs. The first considers total costs which are split into steady state costs (the cost of maintaining leakage at a given level) and transitional costs. The second considers unit costs and estimates the cost of reducing leakage assuming a natural rate of rise. The report makes a number of recommendations in relation to establishing the leakage/cost relationships:

- i) Actual company costs should be used which are consistent with leakage costs;
- ii) The model should give the current expenditure at the current level of leakage;
- iii) The form of leakage/cost relationship (curve/equation) is less important than the use of reliable input data;
- iv) Input parameters should be clearly defined and understood. The more parameters required by the method, the greater the ability to influence results and the greater the need for reliable data;

- v) The cost per repair should be assumed to be independent of the level of leakage unless evidence can be provided to the contrary;
- vi) Actual costs versus levels of leakage should be compared to modelled values over a number of years;
- vii) The relationship between costs and the level of leakage should be based on reliable and up to date data. This should be based on a minimum of a 12-month period.

Issues for consideration:

- *The best practice does not give clear guidance on which of the modelling methods is most appropriate. At the time of the report, the consensus was that the form of the relationship in the model was assumed to be less important than the use of reliable input data. It may be worth re-assessing this assumption as input data should now be more reliable. Also, as companies drive leakage down to nearer the policy minimum value and if costs increase, then the form of the relationship or algorithm may become more important.*
- *The complexity of the models has also been cited as a potential weakness in the target setting process. Should the modelling be more transparent, or subject to more formal auditing?*

2.7 Consider new policy and technology options

The analysis should include the potential impact of introducing changes to the leakage control policy and the technology used (e.g. the introduction of leakage performance contracts for leakage detection contractors, reducing run times, expanding DMA coverage, etc). This is normally carried out in the cost modelling stage by identifying the potential impacts of a new policy (or policies) on key parameters such as leakage level, policy minimum, bursts, NRR (natural rate of rise) etc and then modelling the impact of the new policy/technology over 10 years. The report suggests that:

- i) The ELL should be determined for the current leakage policy to give a baseline. Other leakage policies may then be evaluated against this baseline;
- ii) New policy options that should be considered include improvements in district metering, pressure management, leak survey technology, efficiency of leakage surveys, repair times and costs, additional household metering and system rehabilitation/replacement;
- iii) For each option the operating and capital expenditure should be balanced against the impact on leak location costs, level of leakage, policy minimum leakage and leak breakout rate;
- iv) The interactions of different policies and the target level of leakage must be taken into account to avoid double counting;
- v) A five to ten year analysis period is recommended;
- vi) The economic level of leakage should be assessed using the least cost leakage control policy.

This stage in the process is still valid and may become more important following the study into inclusion of environmental and social costs. Options previously examined and ruled out may become more economic if circumstances change.

Issues for consideration:

- *The new policy option section suggests mains renewal or rehabilitation as a potential option. Clearer best practice is needed on including mains renewal and mains deterioration in the ELL analysis.*

2.8 Environmental and social costs

A best practice framework is provided for including environment and social costs in the report. However, this is probably the weakest area of the current practice for deriving an ELL. The issue of environment and social costs is subject to a new review (being led by Ofwat), which will be starting shortly.

Issues for consideration:

- *Clearer guidance is needed on which environmental and social costs to include in the analysis and how these should be included.*
- *Robust data on the costs and impacts appears to be sparse and may need strengthening.*

2.9 Develop a family of leakage/cost relationships

From the preceding stages a family of leakage/cost relationships are developed. These are used to provide leakage and cost profiles which feed into the subsequent short and long term least cost planning analysis.

Issues for consideration:

- *None.*

2.10 Establish future supply/demand balance and costs

The economic level of leakage is set within the context of the balance between supply and demand (the so-called supply/demand balance) for a company. Within the supply/demand balance leakage is a “volume of water lost”. A reduction in leakage will reduce the total volume of water that is treated and pumped into supply, resulting in a reduction in the operating costs. Additionally, there may also be a reduction in the future capital investment requirements (and associated operating costs) if supply/demand balance investment is required within the planning period.

Issues for consideration:

- *None.*

2.11 Establish economic level of leakage (ELL) targets

The Tripartite Report recommends that a least cost planning approach, which minimises the net present value of costs of managing the supply-demand balance over a 25 year planning horizon, should be used. This approach is consistent with the more recent best practice on the economics of balancing supply and demand⁽⁹⁾ (EBS) and the Environment Agency's Water Resource Planning guidance⁽¹⁰⁾.

The Tripartite Report also includes an alternative approach using the long run marginal cost of water, which will provide consistent values to the least cost planning approach if appropriate values for the marginal cost of water are used. This approach only considers the trade-off between leakage and resource/treatment options. The report recommends it should be used at least annually to assess the impact of changing leakage management costs on the economic level, although formal reporting to Ofwat should remain on the current 2-year cycle.

Company leakage targets should be based on the average over a number of years. This is in recognition that over or under achievement of the target may be due to short term external factors which should not cause the target to change.

Issues for consideration:

- *None.*

2.12 General comments on the best practice processes

The Tripartite Report provides flow charts for each of the key stages which list processes and sub-processes in order of decreasing robustness of best practice. This allows a range of best practice to be used and there is little incentive (except through the 'Reporter' process) to move towards best practice.

Issues for consideration:

- *Should a method of allocating reliability and accuracy scores to each sub-process be developed to provide an incentive to move towards best practice?*
- *At the present time the Tripartite Report contains both technical discussion and best practice guidance which can be confusing and lead to misinterpretation. The report should also be re-produced or re-written to provide clear unambiguous guidance.*

2.13 Summary of recommendations from the review of the Tripartite Report

There are a number of areas where the clarity or the implementation of the best practice in the Tripartite Report could be improved. These are:

- a) The best practice guidance should be changed to clarify which units should be used for leakage targets;
- b) Levels of uncertainty around the ELL target should be calculated and reported;
- c) There should be clarification on dealing with new (and aging) housing stock when developing long term leakage target profiles;

- d) Consideration should be given to setting and publishing targets at Water Resource Zone level;
- e) Best practice guidance for policy minimum assessment should be updated based on the last five years experience;
- f) An estimate of uncertainty should be reported for policy minimum;
- g) Consideration should be given to updating the best practice relating to the form of the 'leakage – active leakage control cost' relationship or algorithm;
- h) The complexity of the models has also been cited as a potential weakness in the target setting process, consideration should be given to ensuring that future ELL models are more transparent, or subject to more formal auditing;
- i) The new policy option section suggests mains renewal or rehabilitation as a potential option. Clearer best practice is needed to explain how mains renewal and mains deterioration should be included in the ELL analysis;
- j) The issue of environment and social costs is subject to a new review (being led by Ofwat), which will be starting shortly. The results of this review should be incorporated into the ELL best practice guidance;
- k) Robust data on the costs and impacts needs to be strengthened;
- l) A method of allocating reliability and accuracy scores to each sub-process should be developed to provide an incentive to move towards best practice;
- m) The Tripartite Report should be re-produced or re-written to provide clear unambiguous updated guidance.

3. DEVELOPING AND SELECTING ALTERNATIVE APPROACHES TO LEAKAGE TARGET SETTING

This section of the report summaries the background to developing alternative approaches to leakage target setting. It comprises 3 sections, each of which is presented in more detail in the appendices:

- Target setting approaches in other sectors (Appendix A);
- Potential alternative approaches to leakage target setting (Appendix B);
- Short-listing options for further consideration (Appendix C).

3.1 Target setting approaches in other sectors

The approaches used to set targets in other sectors: either in the water industry or outside of the water industry were reviewed Appendix A has complete details, which are summarised below.

3.1.1 Leakage target setting outside the UK

Most leakage target setting processes outside the UK appear either to be set on a 'political' basis (i.e. reduce leakage from X% to Y%) or based on a process of benchmarking performance using simple leakage indicators. There is work going on within the International Water Association (IWA) to develop an economic version of the Infrastructure Leakage Index (ILI) which could be used to set targets and this is discussed detail in Appendix B.3.

3.1.2 Target setting to meet environmental legislation

This review identified that:

- a) Most environmental targets are set to eliminate the potential impacts of substances discharged to the environment;
- b) Some aim to eliminate discharges of the most polluting substances;
- c) Emission targets are based on the lowest emissions achievable by the use of the best available technologies.

3.1.3 Context value added (CVA) measures used in the education sector

Understanding the "context" of level of leakage is an important issue in the understanding of the level of leakage – be that density, age and condition of pipes, traffic flows. However, additional contexts include environmental and social factors. One important environmental factor is the risk to the quantity and quality of water resources. The important benefit of using a CVA approach to both target setting and to understanding performance is that the distribution zones and their level of leakage can be compared like-for-like. Hence poor

leakage management performance (and good leakage management performance) can be better understood.

The process of target setting can also be enhanced by taking context features into account. There will be specific context issues that will explain lower or higher figures and it will make sense to understand these figures with the background or the context of the system. Targets can be set based upon best practice as identified in comparable contexts. The use of a “valued added” component provides an opportunity to set targets that take account of continued improvements in best practice. So, over a 5 year planning process, targets set in year one, based on known best practice at that time can be adjusted or assessed to reflect the “added value” that a company can achieve.

3.1.4 Levels of retail “shrinkage” or “leakage”

In some stores the term shrinkage is still known as “leakage”. The application in the water industry of the retail shrinkage example is limited by the fact that in the retail business the “economics” and “risk assessments” take place in the context of a multi-store and multi-product basis. In the water industry there is one product but there are differences between water distribution zones. It would be possible to take an approach to “contextual” circumstances based on comparing the “like for like” of different distribution zones. Using these comparisons, instead of the rather generalised and crude “company comparisons”, it would be possible to look at setting targets for specific distribution zones based upon comparable benchmarks.

A further application of the shrinkage approach might be one that presents the economic case based on the “retail” value of the product, which would be the price of water to customers.

3.1.5 Pest control

Pest management in agriculture makes use of economic based decision making. Here the cost of pest control can be balanced against the economic gain from increased yields, and also incorporate aesthetic, environmental and social factors.

The market value of product is used in the equation as opposed to the production cost. The concept also differs from the control of water leakage in that pest control measures are not always applied continuously and therefore an “Action Threshold” has been defined as “The pest density at which control measures should be implemented to prevent it from reaching the point where economic loss occurs”.

3.2 Potential alternative approaches to leakage target setting

This potential alternative leakage target setting approaches that have been identified are identified and discussed in more detail in Appendix B. The range of options identified builds on previous work completed by the Tripartite Group and by the Environment Agency. A number of the suggested approaches are based on the current economic level of leakage (ELL), but make use of alternative methods for placing a value on the lost water or an additional incentive to reduce leakage. The range of options are shown in Figure 3.1.

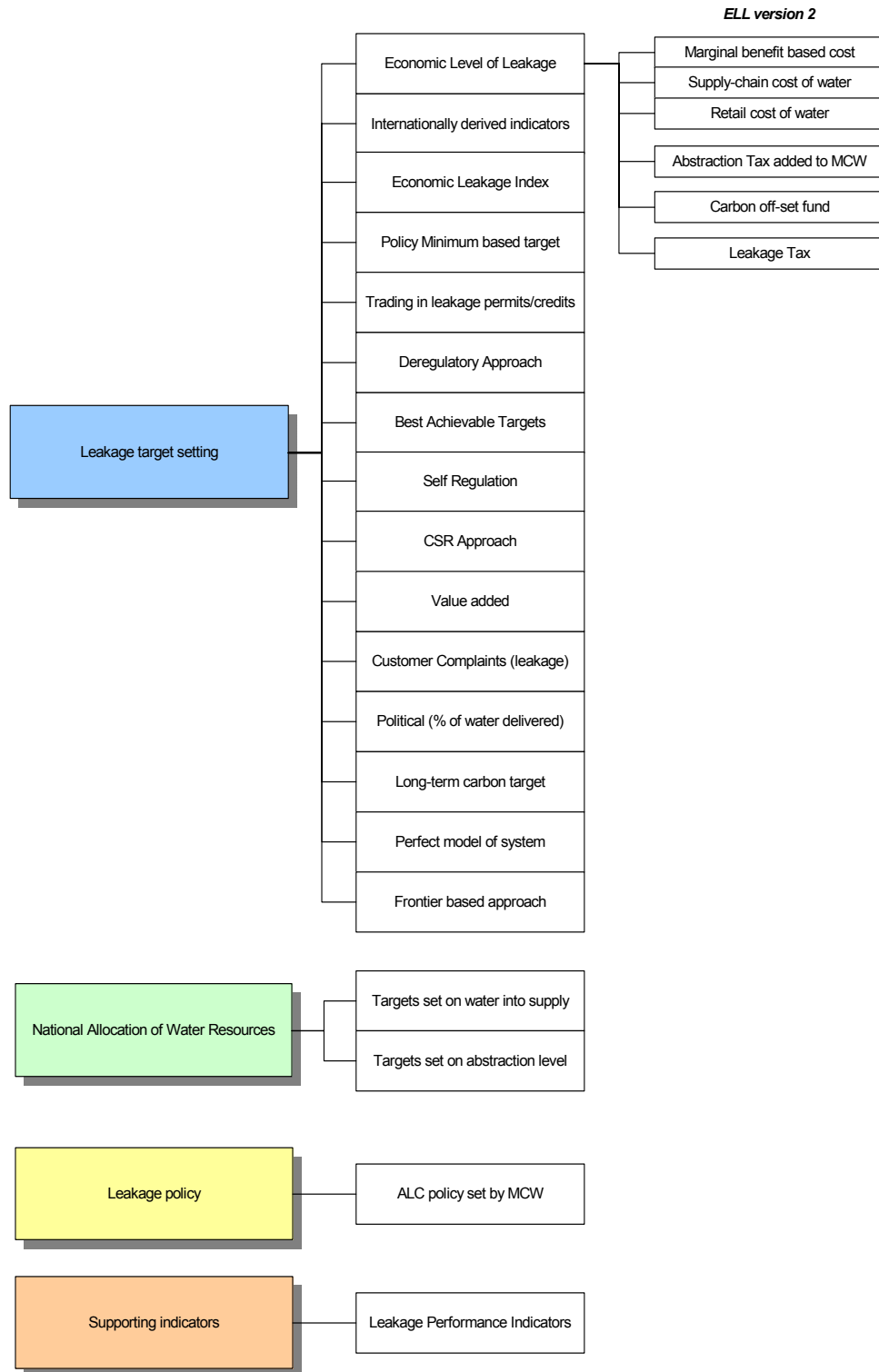


Figure 3.1 Leakage Target Setting Approaches

3.3 Short-listing options for further considerations

In order to meaningfully compare the alternative options for leakage target setting it is necessary to reduce the number of options. The 24 potential options for alternative leakage target setting need to be narrowed down and the method chosen to select a short list of options is multi-criterion decision making (MCDA). Using this technique, alternative options are evaluated in a structured and open manner to allow the various options to be ranked and short-listed.

The method used and the detail of the MCD analysis are presented in full in Appendix C.

The steps in the process were to:

- a) Agree the decision context, i.e. agree the attributes that alternative options need to have to be effective in setting leakage targets. These were used in comparing different options. This is explained in Appendix C.2;
- b) Identify the options to be appraised in the analysis. These are listed in Appendix B;
- c) Define the criteria for assessing each option. These were based on the aims and objectives, and were weighted to reflect their relative importance. This is explained in Appendix C.3;
- d) A performance matrix was created from the options and assessment criteria and then the options were scored. Scales for each criteria were constructed, weighted and weighted averages calculated. This is included in Appendix C.4;
- e) The overall weighted scores were calculated and then the options selected for further consideration (Appendix C.5).

The options which come out of the analysis as the main contenders are:

- The current ELL approach
- The ELL – Supply chain cost of water
- The ELL – Abstraction tax
- The ELL – Abstraction Incentive charging
- The trading in leakage permits
- The targets set on water into supply
- The targets set on abstraction level.

However there may be elements in some of the options further down the list which may add to the options under consideration, for example some elements of Context Value Added, Long term sustainability target and Internationally derived indicators. These options may address some of the weaknesses in the proposed options.

These options were then discussed with the steering group and peer reviewed amongst the group. As a result of the discussions it was decided that the 'Trading in leakage permits'

option would be too complex for further consideration and was dropped from the list. The 'Frontier based approach' which was added as a potential option too late for the MCDA process was elected for further consideration. The 'Corporate Social target' option, which scored marginally lower than the above list was also selected for further consideration.

This gave a final list of options for further investigation, which are shown below:

- ELL – current benchmark;
- ELL – Supply chain cost of water;
- ELL – Abstraction tax (including abstraction incentive charging);
- Corporate Social Responsibility approach;
- Frontier based approach;
- Targets set on water into supply;
- Targets set on abstraction level.

4. FURTHER INVESTIGATION OF POTENTIAL OPTIONS

4.1 Approach

This stage of the study investigates a limited number of options short-listed for detailed appraisal. The options are selected through the initial screening using multi-criterion decision making (MCDA) and the independent consideration of each option. This process allows the list of 24 potential options to be narrowed down to the eight options identified in Section 5 of this report. Working with this smaller set of options allows the issues surrounding the approaches to be investigated in significantly more detail. More detailed comparison was undertaken by applying the approaches to notional water resource zones, identifying practical issues surrounding their possible application.

For this analysis four notional water resource zones were developed, drawing on the data held within WRc. For reasons of confidentiality these zones do not relate to real zones within England and Wales, but have been designed to contain the features of real zones. These model zones allow the likely impacts on leakage levels and costs to be investigated.

The conclusions drawn from this element of the study allow some of the practicalities to be identified but to enable a full extrapolation to the likely impacts on England and Wales as whole, it will be necessary to implement more detailed pilot studies within water companies.

4.2 Definitions of model water resource zones

To enable the likely impact of the alternative leakage target setting approaches to be investigated it has been necessary to develop four indicative water resource zones to trial the various approaches. Each zone has been set to the same size (1,000,000 properties) to facilitate comparison between the zones. It has been assumed that all zones are currently operating at their economic level of leakage.

In the following examples the supply-demand position may have similarities with real resource zones, but it is emphasised that the leakage levels and leakage costs do not relate to the same zone.

The zones exhibit the following characteristics, which are also summarised in Table 4.1:

- a) Zone A: this zone has a small current excess capacity which will require additional capacity to be added in 2014-15. The current level of leakage is 162 MI/d based on an operating cost of water of 5 p/m³. The marginal cost (capital, operating, environmental and social) of the next resource is 25 p/m³.
- b) Zone B: this zone is currently in deficit, with schemes proposed to increase capacity in 2009-10 to balance supply and demand. The next resource is a new reservoir, which will be required in 2019-20. The current level of leakage is 103 MI/d based on the current operating cost is 4 p/m³. The marginal costs (capital, operating, environmental and social) of the first scheme 20 p/m³, with the reservoir being 35 p/m³.
- c) Zone C: this zone has current excess capacity, with no additional supply-demand investment required before the end of the 25-year planning horizon. The current level of

leakage is 132 MI/d based on the marginal operating cost is 6 p/m³. Although not required within the planning horizon, the next scheme that would be required is a groundwater scheme with a marginal cost (capital, operating, environmental and social) of 12 p/m³.

- d) Zone D: this zone has a small excess capacity that will require additional capacity in 2019-20. The marginal cost (capital, operating, environmental and social) of this scheme is 30 p/m³. The current level of leakage is 132 MI/d based on the current marginal operating cost is 5.5 p/m³.

Table 4.1 Summary of model water resource zones

Summary of Zones	Zone A	Zone B	Zone C	Zone D
Current supply-demand position	Small excess capacity	Excess demand	Excess capacity	Excess capacity
Date supply-demand scheme(s) required	2014-15	2009-10, 2019-20	after 2029-30	2019-20
Marginal operating cost of water	5 p/m ³	4 p/m ³	6 p/m ³	5.5 p/m ³
Marginal cost (capital, operating, social & environmental) of next scheme(s)	25 p/m ³	20 then 35 p/m ³	12 p/m ³	30 p/m ³
Retail cost of water	100 p/m ³	95 p/m ³	110 p/m ³	100 p/m ³

4.3 Application of alternative target setting approaches to model resource zones

Each of the eight alternative approaches has been applied consistently in each of the four model zones. For options based on an adjustment to the cost of water (or value of leakage reduction) within the current economic level of leakage framework the modelling was relatively straightforward; the target was derived as the point where the marginal cost of water equalled the marginal cost of active leakage control. The WRc APLE™ model was used to derive the ELL based on changes in the marginal value of water. An abstraction tax of 15p/m³ was used in all resource zones; this is consistent with the value developed in the Appendix of the Tripartite Report.

For the non-ELL based approaches it was necessary to make additional assumptions for modelling purposes:

- As a willingness to pay analysis was not available for setting corporate social responsibility targets these were set at a level that was similar to the long-run ELL as it has been assumed that for corporate reasons companies would look to achieve their target earlier than is required for supply-demand reasons. It is possible that WTP studies could result in targets that are higher or lower than the long-run ELL. For the purpose of this study it has been assumed that corporate social responsibility targets are more likely to impact on the timing of reductions than in the absolute level.

- Zone C was assumed to be the frontier company, and although a full normalisation of the data was not possible targets were set for the other zones so that their leakage performance was similar to Zone C.
- Abstraction level or water into supply targets would ideally require a detailed modelling of the supply-demand balance within the zone; it has been assumed that these approaches would provide companies additional incentives to move towards their long-run ELL (i.e. the ELL using the LRMC of the resource scheme needed to maintain the long term supply demand balance).

The level of analysis possible within the current study was limited by the availability of reliable data to inform the modelling of how companies may react to the alternative target setting approaches; consequently many of the decisions have been based on economic principles. Where companies would be required to set leakage targets based on willingness to pay, abstraction levels or water into supply targets, for example, the economics would clearly be a key factor.

To quantify the possible impact of the various approaches on the long-term leakage profiles the following key output was prepared for each zone:

- a) Profiles of leakage targets that would arise from the application of the alternative approaches within each zone. In addition to the eight alternatives, an additional profile based on the retail value of water (which is in effect an application of the supply-chain cost of water and would result in the ELL a customer would derive) has also been included;
- b) Estimated annual cost of active leakage control to achieve the target at the end of the planning period (2029-30);
- c) Estimated additional cost to customers by 2029-30 due to increase cost of active leakage control. To derive this indicator it has been assumed that achieving the ELL will have no additional cost to customers, and that any corporate social responsibility target below the ELL would not be funded by an increase in customer bills; and
- d) Percentage reduction in leakage by 2029-030.

The steady state leakage vs. cost relationships are shown for each zone. A number of the zones demonstrate the relatively flat relationship, which would suggest that changes in levels of leakage could be achieved for very little additional cost. When moving to lower levels of leakage it is necessary to consider the transitional costs – these can significantly increase the cost of moving to lower levels of leakage.

These key output measures provide indication of the likely impact on leakage levels and costs resulting from the application of the alternative approaches, and are summarised in Table 4.2.

Table 4.2 Summary of key impacts of alternative approaches in the model water resource zones

Key Measures	Zone A	Zone B	Zone C	Zone D
Leakage target at 2009/10 (MI/d)				
Status quo	162	103	132	132
ELL	162	103	132	132
Supply chain	113	92	115	99
Retail cost	94	78	88	88
Abstraction tax	118	92	104	105
Frontier	113	99	132	109
CSR	136	98	111	102
WIS	113	92	115	99
Abstraction level	162	103	132	132
Leakage target at 2019/20 (MI/d)				
Status quo	162	103	132	132
ELL	113	92	132	99
Supply chain	113	92	115	99
Retail cost	94	78	88	88
Abstraction tax	105	86	104	99
Frontier	100	92	132	95
CSR	110	90	111	99
WIS	107	88	115	97
Abstraction level	113	92	132	99
Leakage target at 2029/30 (MI/d)				
Status quo	162	103	132	132
ELL	113	92	132	99
Supply chain	113	92	115	99
Retail cost	94	78	88	88
Abstraction tax	105	86	104	99
Frontier	100	92	132	95
CSR	110	90	111	99
WIS	107	88	115	97
Abstraction level	113	92	115	99
Cost of ALC at 2029/30 (£M/yr)				
Status quo	12.2	18.7	9.2	8.2
ELL	21.3	23.7	9.2	21.6
Supply chain	21.3	23.7	12.1	21.6
Retail cost	55.4	43.5	54.3	60.0
Abstraction tax	28.1	28.6	16.4	21.6
Frontier	36.3	23.7	9.2	29.0
CSR	23.6	25.3	13.5	21.6
WIS	25.9	27.0	12.1	24.4
Abstraction level	21.3	23.7	12.1	21.6
Cost of to customers at 2029/30 (£M/yr)				
Status quo	-	-	-	-
ELL	-	-	-	-
Supply chain	-	-	2.9	-
Retail cost	34.1	19.8	45.1	38.4
Abstraction tax	6.8	5.0	7.2	-
Frontier	15.0	-	-	7.4
CSR	-	-	-	-
WIS	4.6	3.3	2.9	2.8
Abstraction level	-	-	2.9	-

4.3.1 Zone A

This zone has a small current excess capacity, and so under the standard ELL methodology the short-term ELL of 162 MI/d is derived based on the current marginal operating cost of water of 5 p/m³. The retail cost of water is 100 p/m³.

The zone will require additional capacity in 2014-15, at a marginal cost (capital, operating, environmental and social) of 25 p/m³. This new source provides incentives for the company to reduce leakage, and hence defer the need for this new source.

Key impacts of the alternative approaches:

- The current ELL approach indicates that the target level of leakage should be maintained at 162 MI/d until the need for the next resource.
- Many of the non-ELL based approaches result in a reduction in leakage target in the years before 2014-15 as these are not constrained by the timing of the supply-demand balance.
- Many of the approaches result in a lower longer-term target:
 - The marginal cost of the next resource (including capital, operating, social and environmental impacts) results in a leakage reducing to 113 MI/d.
 - Application of an abstraction tax of 15 p/m³ results in a leakage target of 105 MI/d.
 - All other approaches result in a longer-term target between the long-term ELL, with the retail cost of water resulting in the lowest target of 94.
- Moving to lower levels of leakage has an equivalent impact on costs to achieve the target. Most of the reductions result in an approximate doubling of active leakage control costs from £12million/year to £20 to £30million/year. The cost to achieve the retail cost of water target is significantly higher at £55million/year.

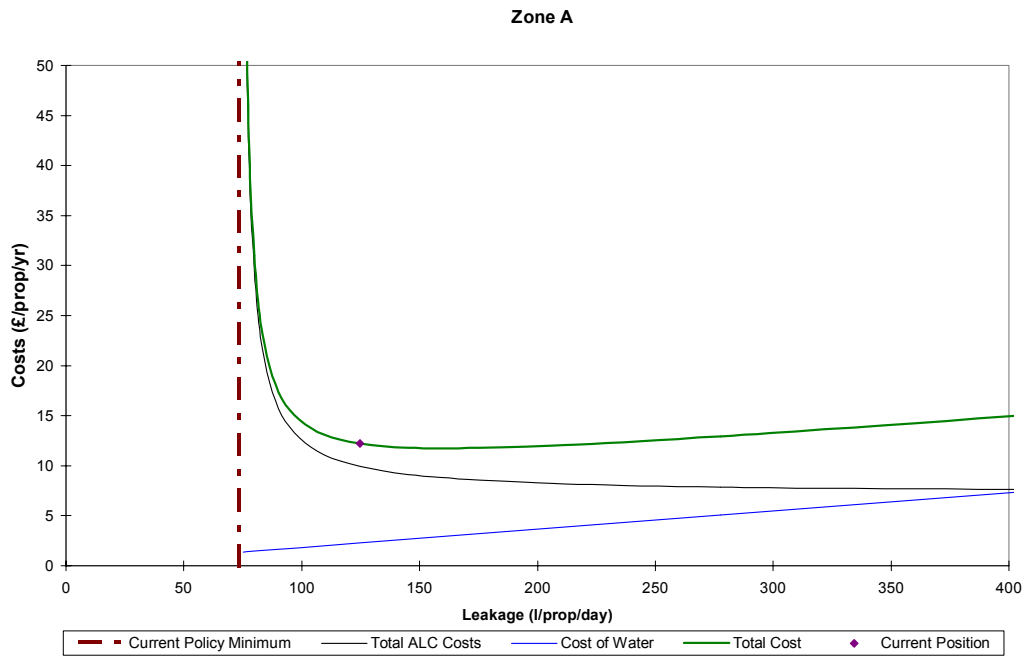


Figure 4.1 Zone A – leakage/cost relationship for current policy

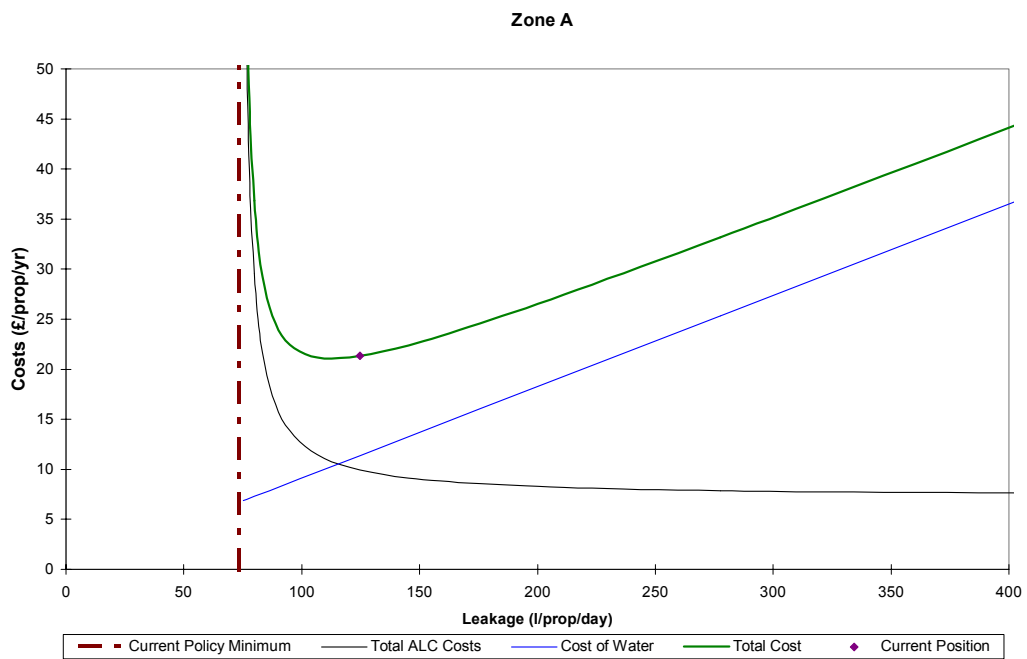


Figure 4.2 Zone A – leakage/cost relationship for next scheme

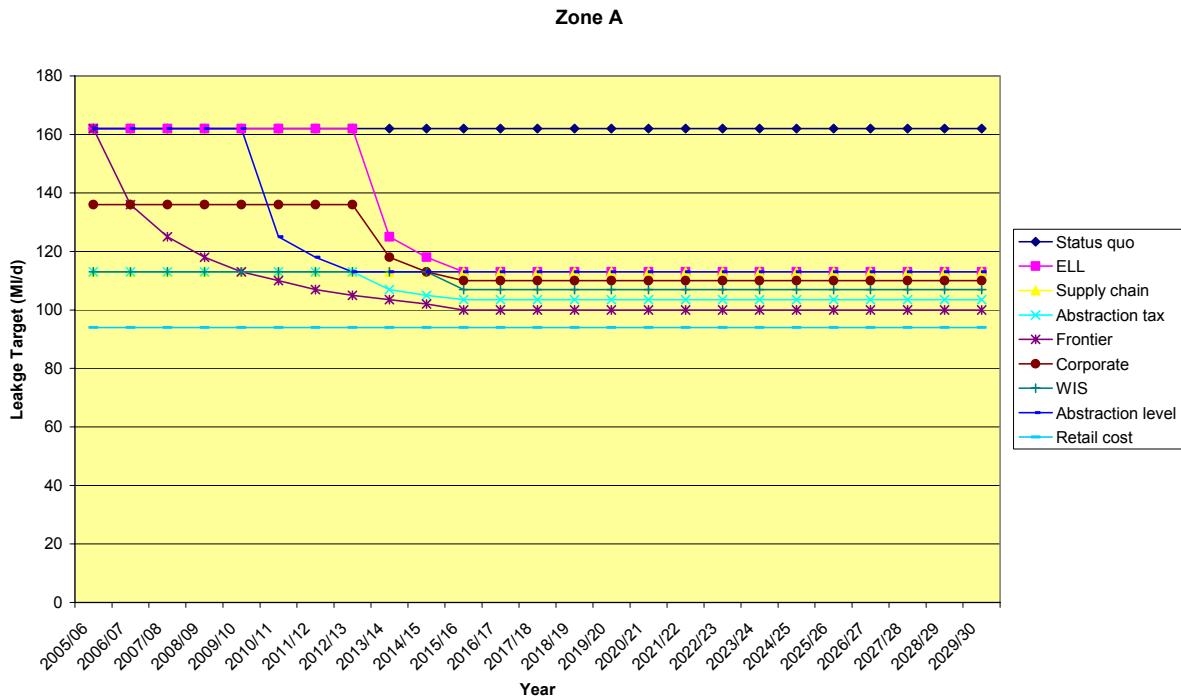


Figure 4.3 Zone A: Leakage profiles

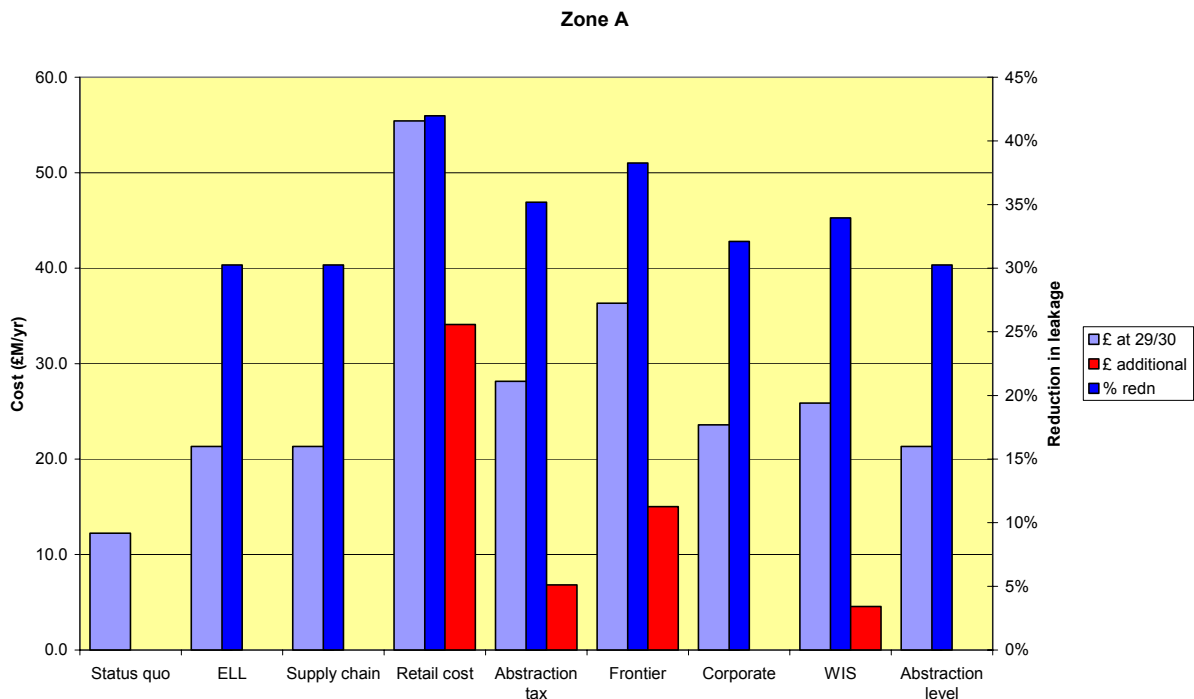


Figure 4.4 Zone A: Key impacts by 2029-30

4.3.2 Zone B

This zone is currently in deficit, and so under the standard ELL methodology the short-term ELL of 103 MI/d is derived based on the marginal cost of water (capital, operating, environmental and social) of the next resource of 20 p/m³. The retail cost of water is 95 p/m³.

The zone will require additional capacity in 2019-20, at a higher marginal cost (capital, operating, environmental and social) of 35 p/m³. This new source provides incentives for the company to reduce leakage further, and hence defer the need for this new source.

Key impacts of the alternative approaches:

- The current ELL approach indicates that the target level of leakage should be maintained at 103 MI/d until the need for the next resource.
- Many of the non-ELL based approaches result in a reduction in leakage target in the years before 2019-20 as these are not constrained by the timing of the supply-demand balance.
- Many of the approaches result in a lower longer-term target:
 - The marginal cost of the next resource (including capital, operating, social and environmental impacts) results in a leakage reducing to 92 MI/d.
 - Application of an abstraction tax of 15 p/m³ results in a leakage target of 86 MI/d.
 - All other approaches result in a longer-term target between the long-term ELL, with the retail cost of water resulting in the lowest target of 78 MI/d.
- Moving to lower levels of leakage has an equivalent impact on costs to achieve the target. Most of the reductions result in a 25% increase of active leakage control costs from £19million/year to approximately £25million/year.
- The range of leakage targets and costs is relatively constant across the different approaches.
- The cost to achieve the retail cost of water target is significantly higher at £43million/year.

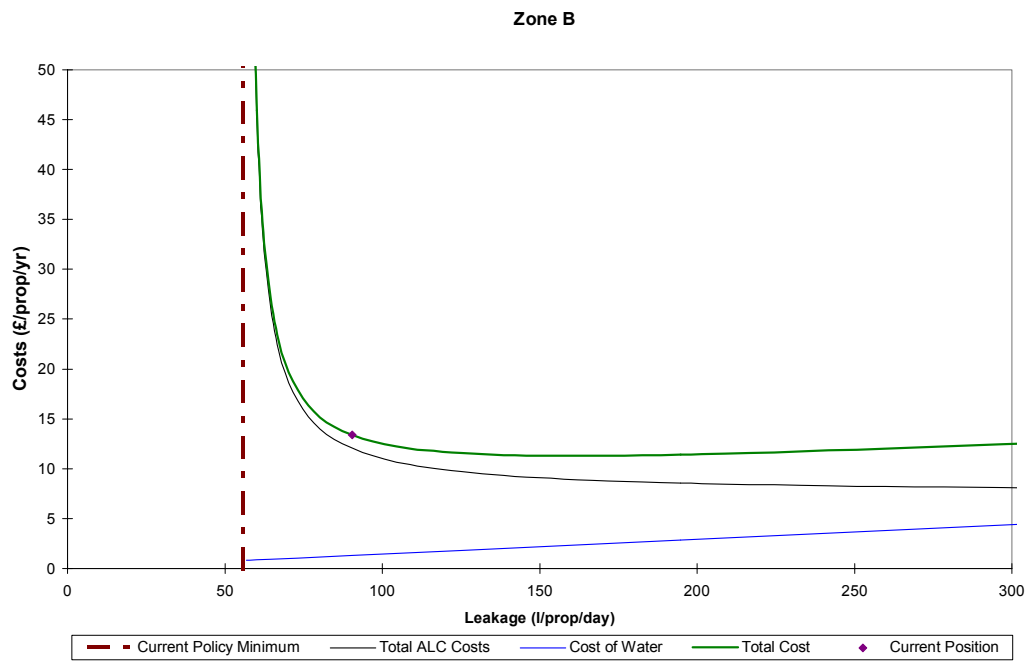


Figure 4.5 Zone B – leakage/cost relationship for current policy

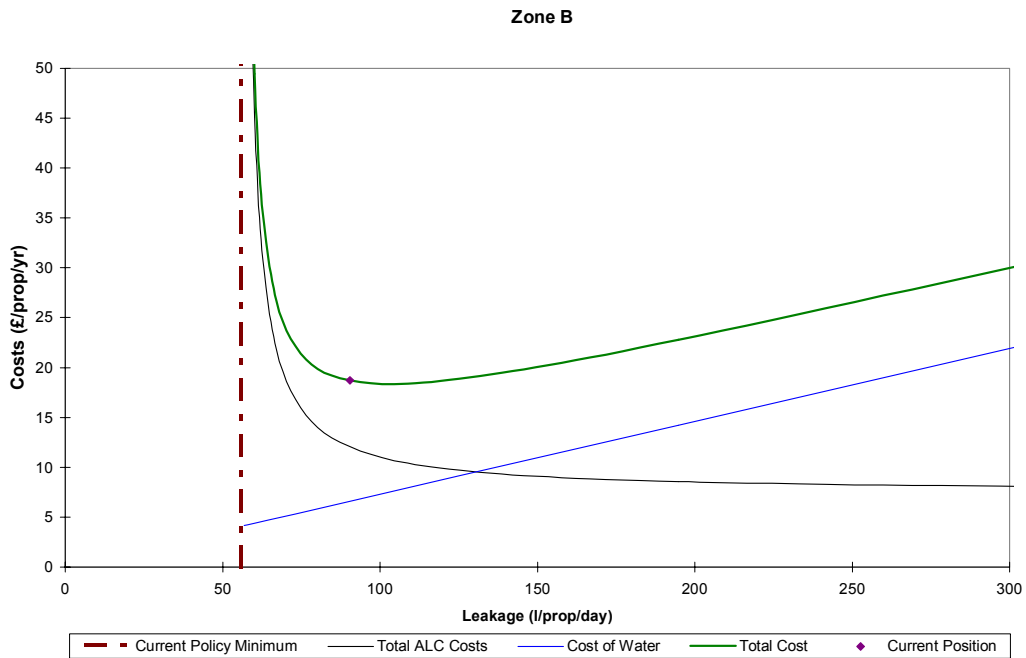


Figure 4.6 Zone B – leakage/cost relationship for the first scheme

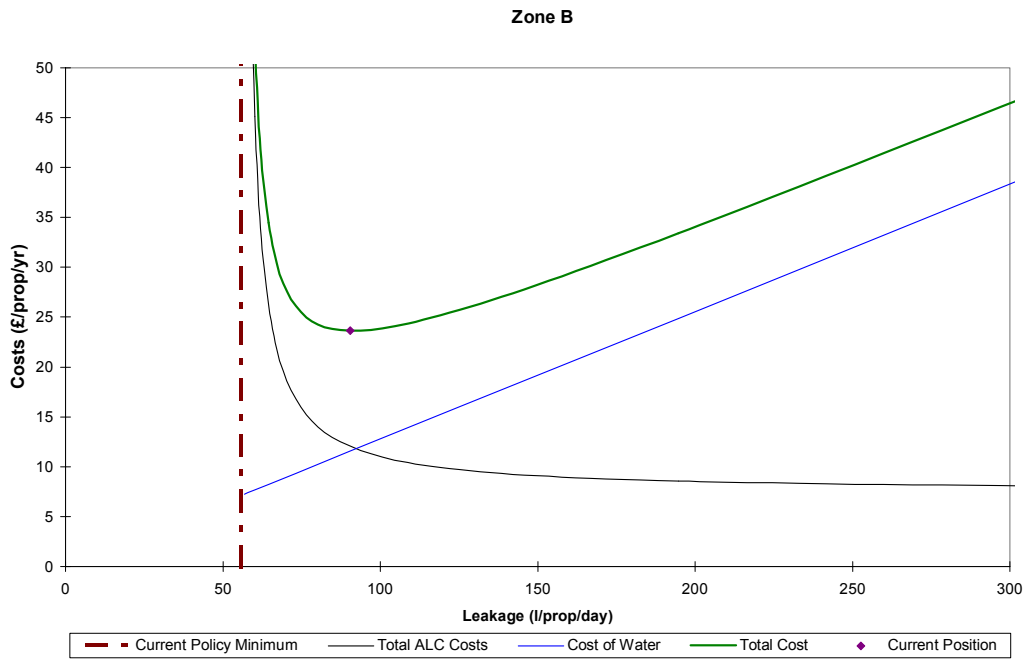


Figure 4.7 Zone B – leakage/cost relationship for next scheme

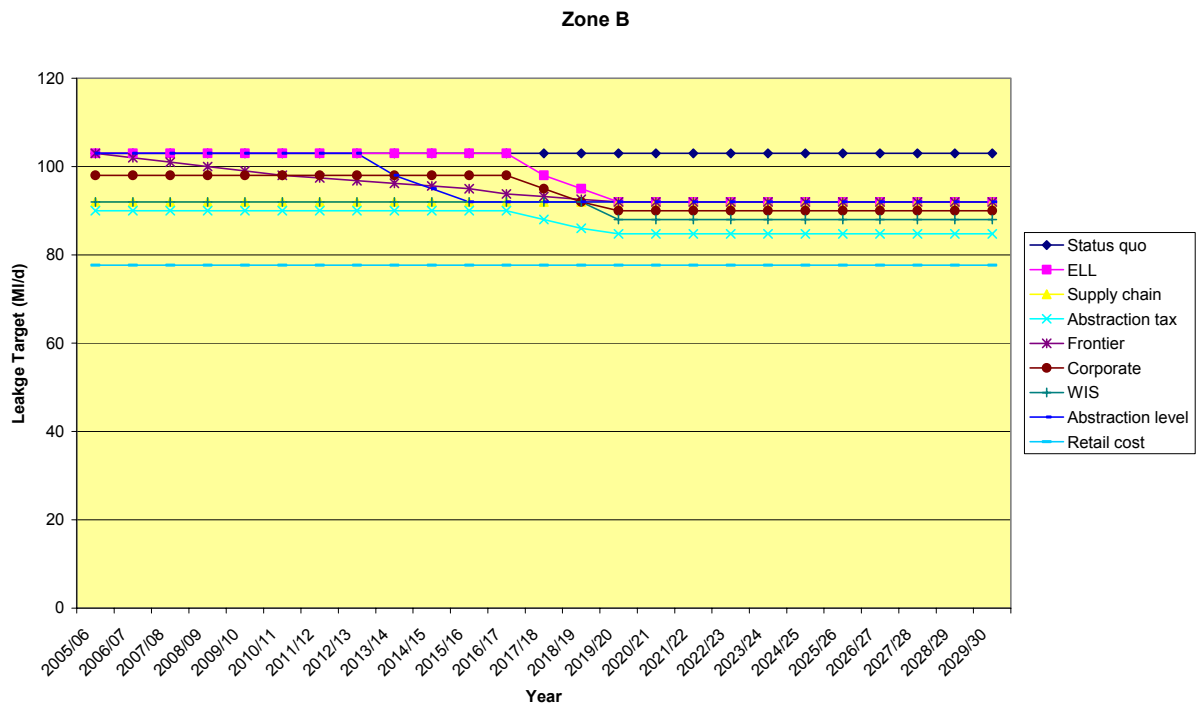


Figure 4.8 Zone B: Leakage profiles

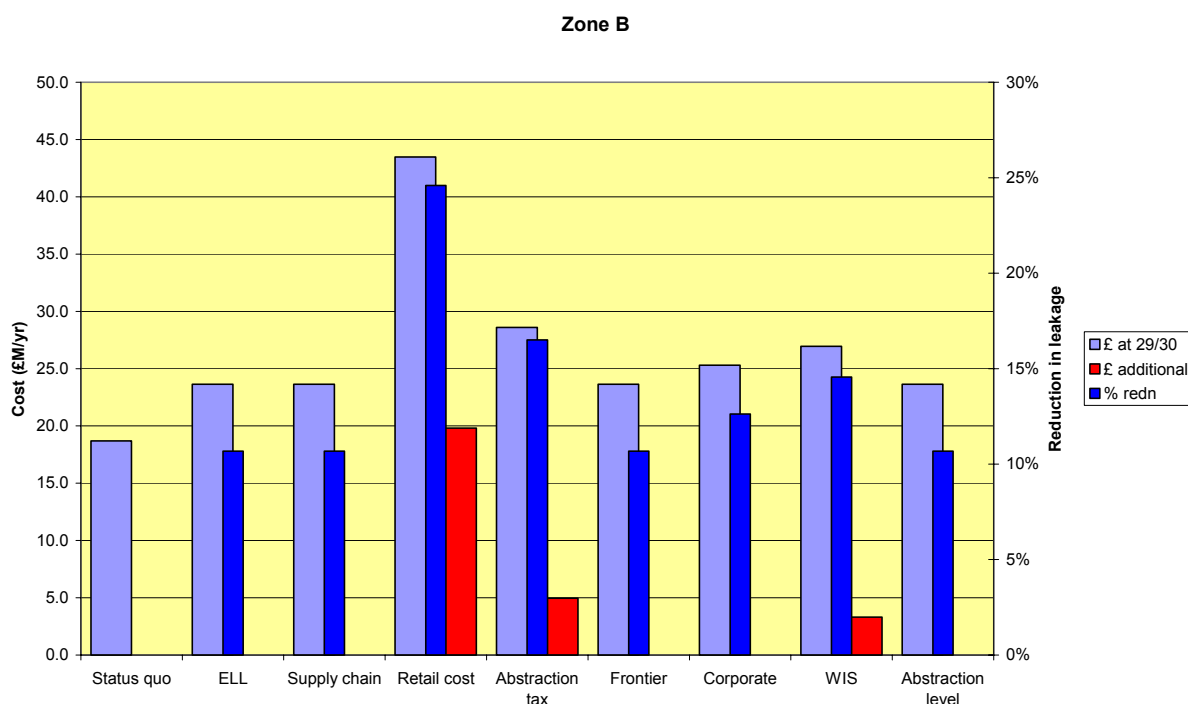


Figure 4.9 Zone B: Key impacts by 2029-30

4.3.3 Zone C

This zone has current excess capacity, with no additional supply-demand investment required before the end of the 25-year planning horizon. Under the standard ELL methodology the ELL remains at 132 MI/d based on the marginal operating cost of water of 6 p/m³. The retail cost of water is 110 p/m³.

This company has been used as the frontier company for setting leakage targets based on the frontier approach, and so the frontier profile is identical to the ELL profile.

The zone does not require any additional resources, however the next scheme that would be required has a marginal cost (capital, operating, environmental and social) of 12 p/m³. The cost of this scheme has been used to define the supply-chain cost of water.

Key impacts of the alternative approaches:

- The current ELL approach indicates that the target level of leakage should be maintained at 132 MI/d until the need for the next resource.
- Many of the non-ELL based approaches result in a reduction in leakage target in the years before 2019-20 as these are not constrained by the timing of the supply-demand balance.
- Many of the approaches result in a lower longer-term target:
 - The marginal cost of the next resource (including capital, operating, social and environmental impacts) results in a leakage reducing to 99 MI/d.

- Application of an abstraction tax of 15 p/m³ results in a leakage target of 104 MI/d.
- All other approaches result in a longer-term target between the long-term ELL, with the retail cost of water resulting in the lowest target of 60 MI/d.
- Moving to lower levels of leakage has an equivalent impact on costs to achieve the target. Most of the reductions result in a 25% increase of active leakage control costs from £19million/year to approximately £25million/year.
- The range of leakage targets and costs is relatively constant across the different approaches.
- The cost to achieve the retail cost of water target is significantly higher at £43million/year.

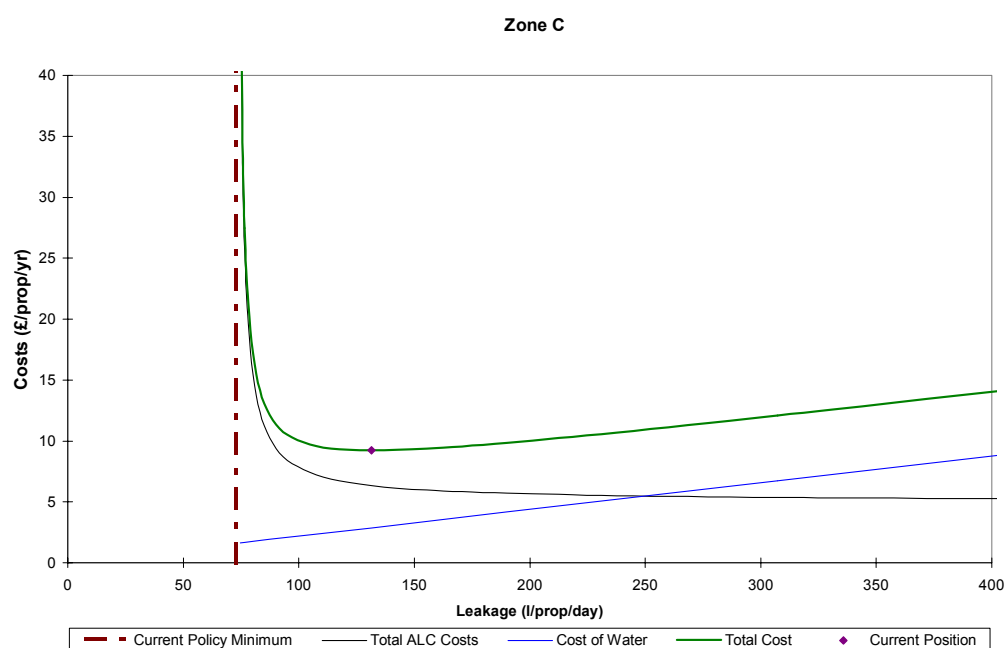


Figure 4.10 Zone C – leakage/cost relationship for current policy

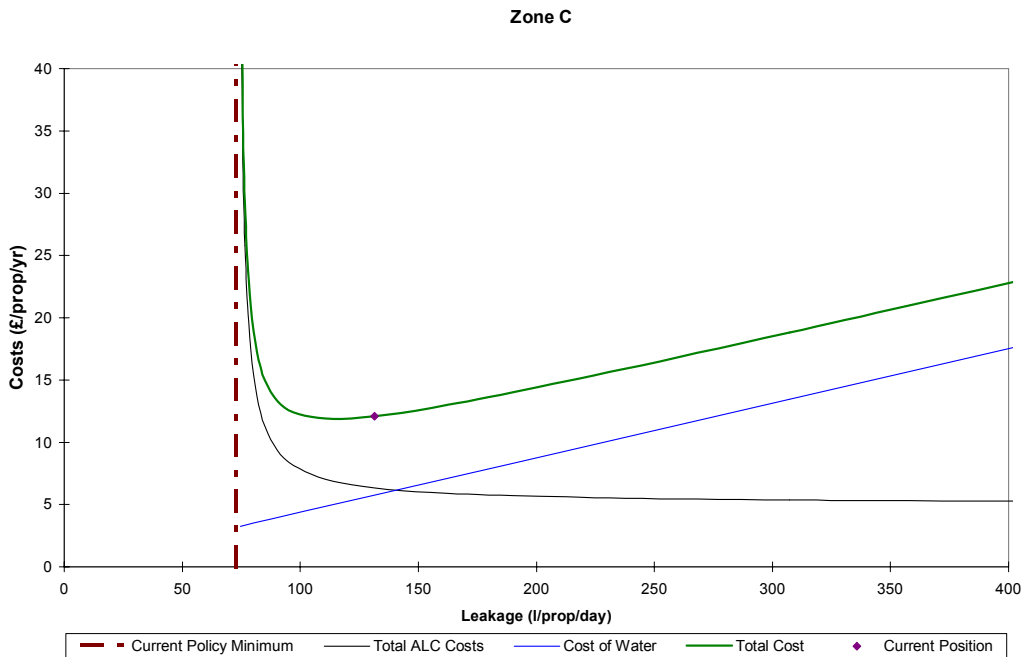


Figure 4.11 Zone C – leakage/cost relationship for next scheme

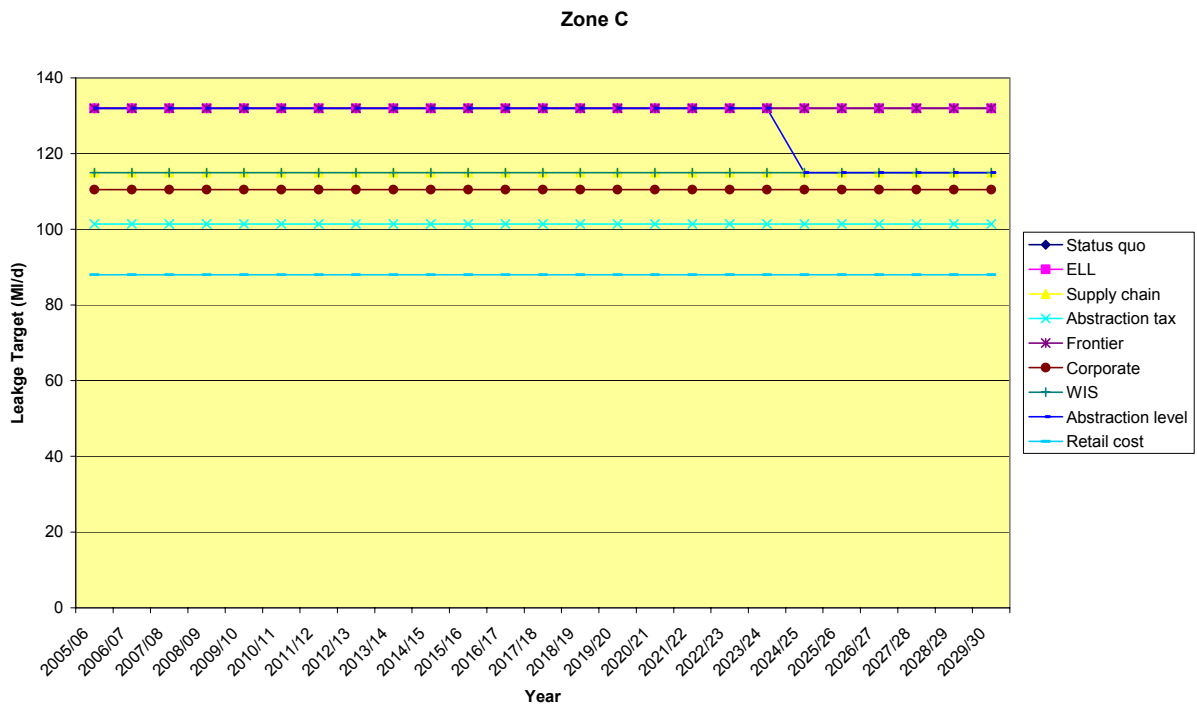


Figure 4.12 Zone C: Leakage profiles

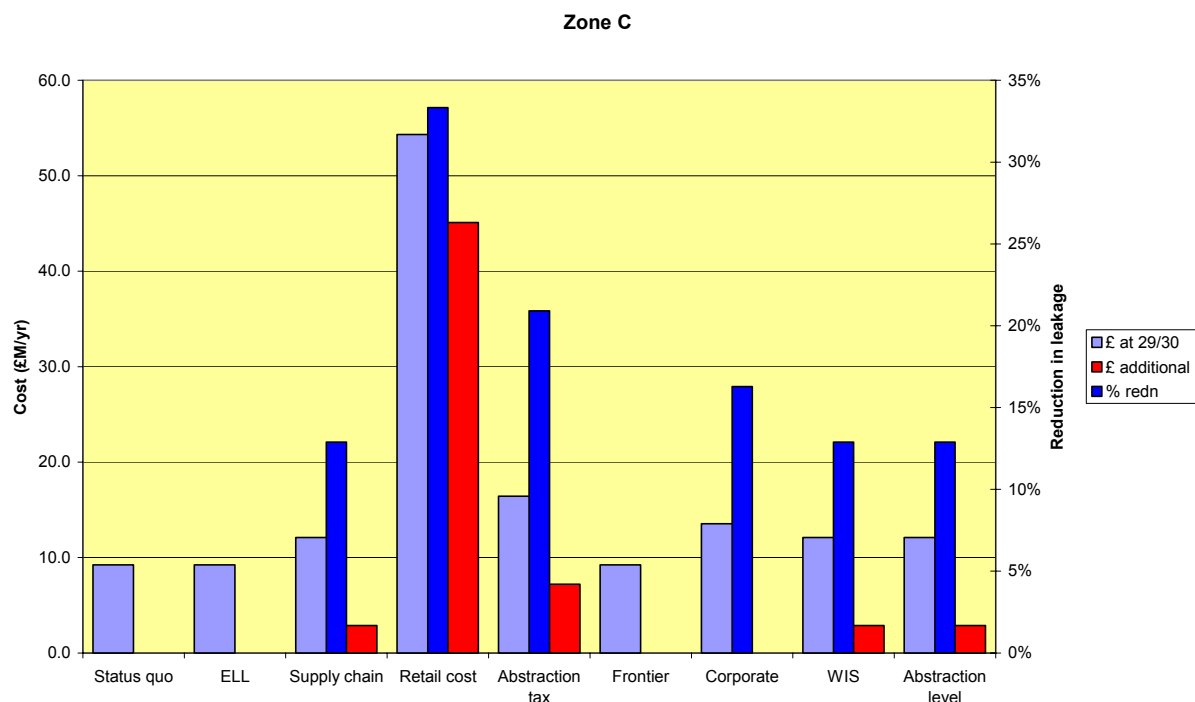


Figure 4.13 Zone C: Key impacts by 2029-30

4.3.4 Zone D

This zone has current excess capacity, with additional supply-demand investment required in 2019-20. Under the standard ELL methodology the ELL remains at 132 MI/d based on the marginal operating cost of water of 5.5 p/m³. The retail cost of water is 100 p/m³.

The zone will require additional capacity in 2019-20, at a marginal cost (capital, operating, environmental and social) of 30 p/m³. This new source provides incentives for the company to reduce leakage, and hence defer the need for this new source.

Key impacts of the alternative approaches:

- The current ELL approach indicates that the target level of leakage should be maintained at 132 MI/d for the whole planning period.
- Many of the non-ELL based approaches result in a reduction in leakage target below the ELL as these are not constrained by the timing of the supply-demand balance.
- This company has been assessed to be a frontier company, and so the frontier profile follows the ELL.
- Many of the approaches result in lower targets:

- The marginal cost of the next resource (including capital, operating, social and environmental impacts) results in a leakage reducing to 115 MI/d.
- Application of an abstraction tax of 15 p/m³ results in a leakage target of 99 MI/d.
- Use of the retail cost of water of 110 p/m³ results in a leakage target of 88 MI/d.
- Moving to lower levels of leakage has an equivalent impact on costs to achieve the target. Most of the reductions result in a doubling of active leakage control costs from £8million/year to approximately £20million/year.
- The range of leakage targets and costs is relatively constant across the different approaches.
- The cost to achieve the retail cost of water target is significantly higher at £60million/year.

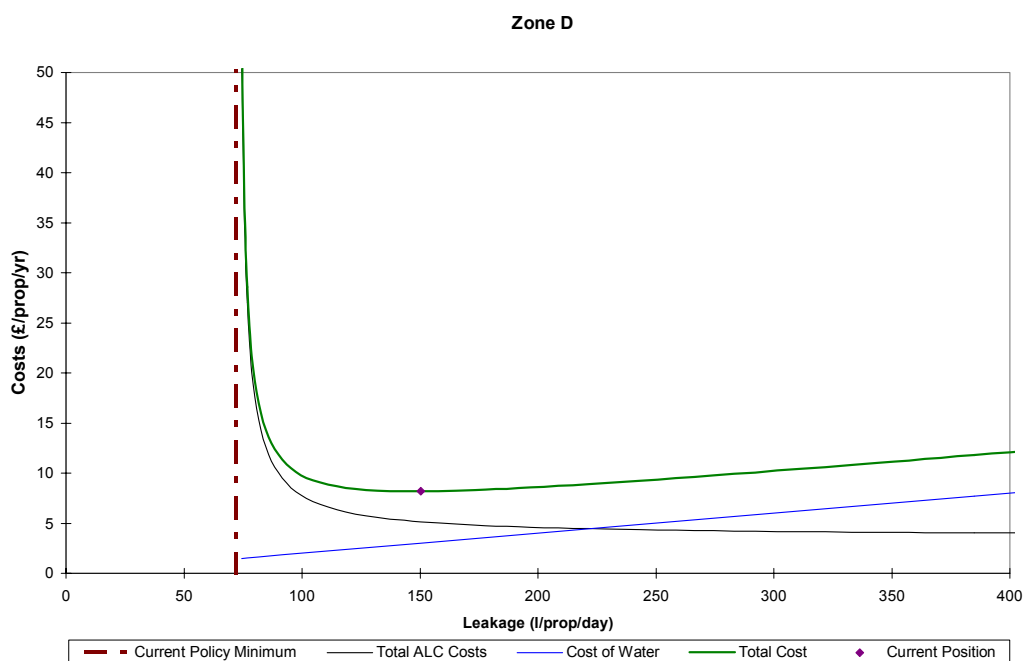


Figure 4.14 Zone D – leakage/cost relationship for current policy

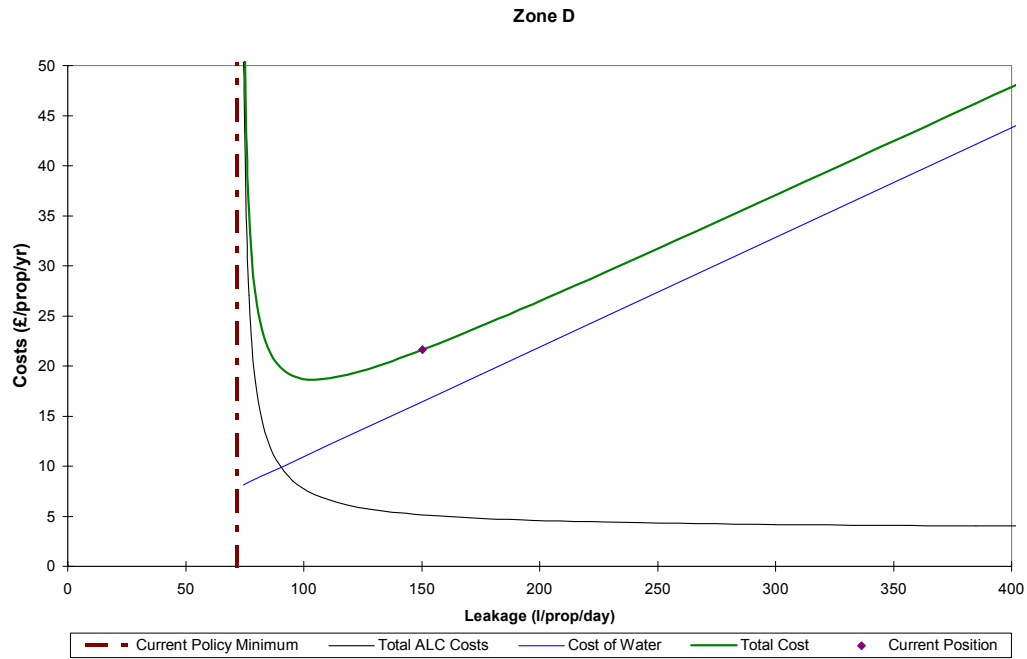


Figure 4.15 Zone D – leakage/cost relationship for next scheme

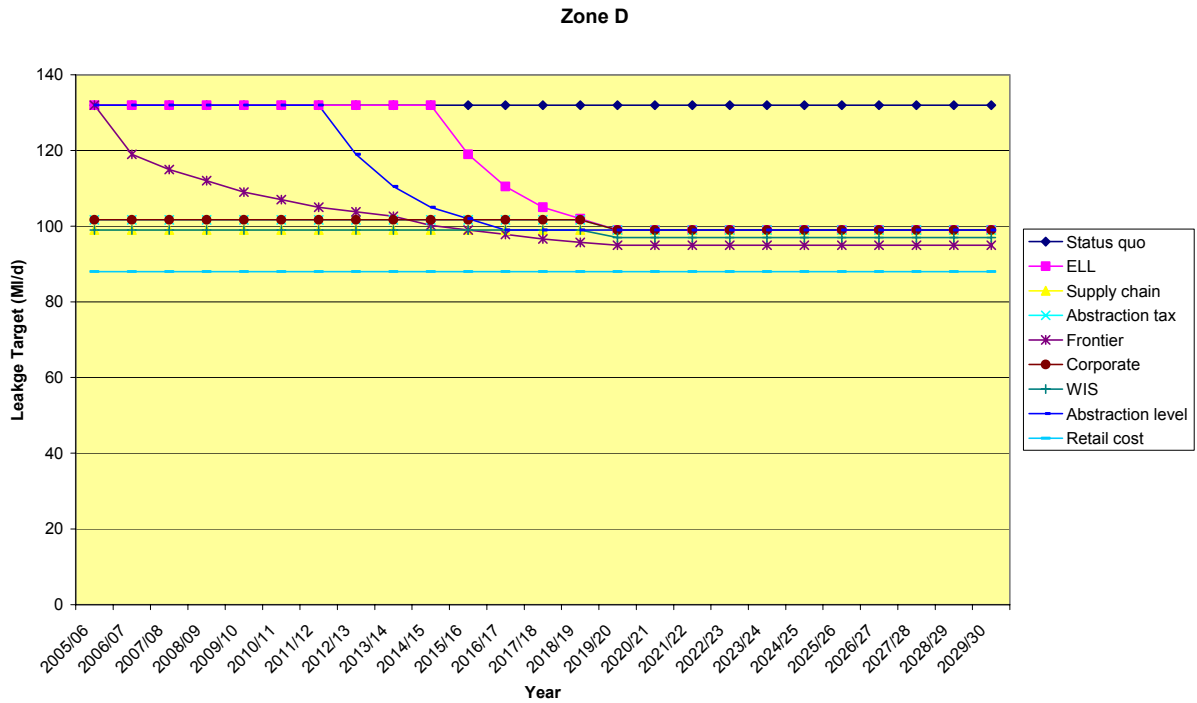


Figure 4.16 Zone D: Leakage profiles

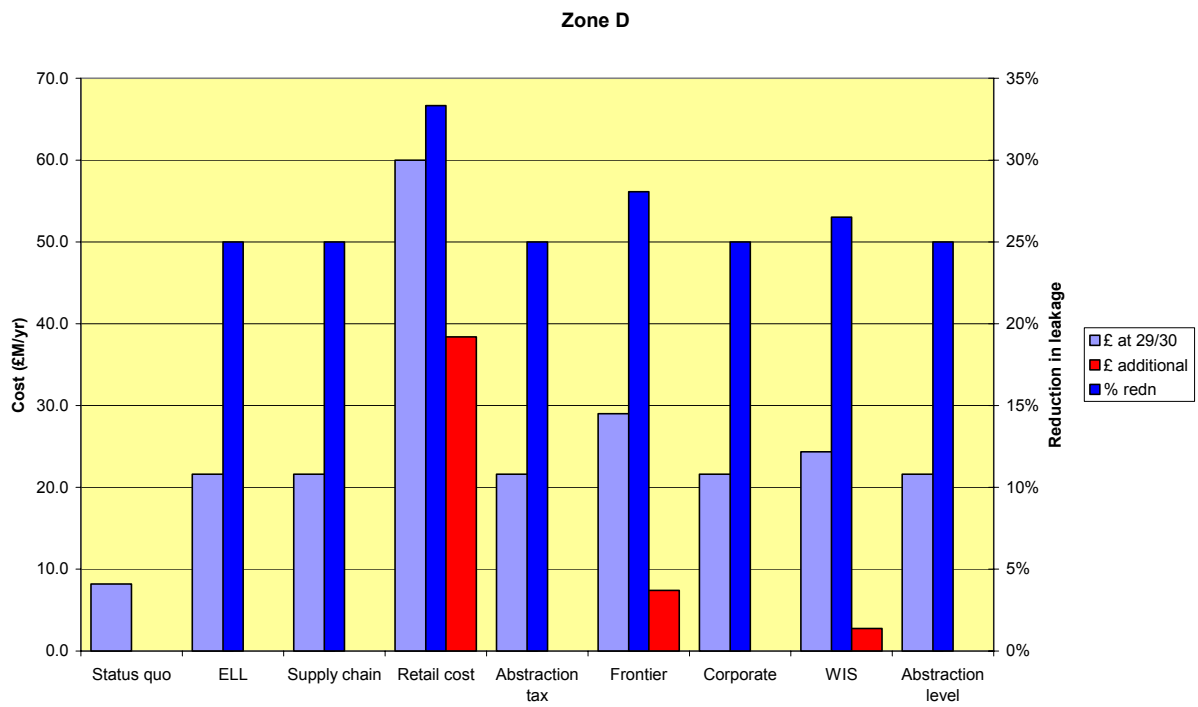


Figure 4.17 Zone D: Key impacts by 2029-30

5. DISCUSSION OF POTENTIAL OPTIONS

5.1 Key findings from modelling the eight options

Despite the differences between the model resource zones and the alternative approaches there is a high degree of similarity between the leakage profiles that have been derived.

Environmental and social impacts have not been explicitly modelled in the scenarios investigated in the previous section. These should be included when the parallel study investigating the inclusion of externalities has been completed. The impact of including externalities may increase both the cost of active leakage control and the cost of water.

The key points arising from the modelling are:

- A profile based on the current ELL approach results in the lowest cost (capital, operating, environmental and social). The profile in any reductions in leakage is driven by the timing of the supply-demand balance.
- Where resource development is proposed this results in a reducing leakage profile.
- The majority of the other methods of target setting result in targets closer to the long-run ELL, although as their profiles are not constrained by the supply-demand balance these approaches often result in an early reduction in leakage.
- Application of a leakage tax of 15 p/m³ generally results in reductions of leakage to levels similar to or below the long-run ELL. The abstraction tax effectively adds an external environmental benefit value to the water abstracted, in the modelling no additional social cost of leakage control has been added, this would need to be considered before implementation of such a scheme. Application of this level of tax across a public water supply companies in England and Wales will increase abstraction charges by some £800 million/year.
- Application of the corporate social responsibility target is highly speculative, but suggest that leakage reductions towards the long-run ELL would be achieved.
- Application of the retail cost of water results in the lowest leakage targets in all zones.
- Moving to lower levels of leakage has an equivalent impact on costs to achieve the target. Most of the reductions result in an increase of active leakage control costs of between 25 to 100%.
- Where the approach results in leakage targets below the ELL it is assumed that the customers would see an increased bill to reflect the additional costs borne by the company. The exception is for the corporate social responsibility target where it has been assumed the additional leakage control costs would be funded by shareholders.
- The cost to achieve the retail cost of water target is significantly higher, often by a factor of five.

5.2 Measuring up to the objectives

The eight options investigated scored relatively highly against the criteria defined in section 5. There are some additional desirable outcomes, such as delivering a 'sustainable' level of leakage target, which although undefined, suggests a target which includes environmental impacts, takes account of public perceptions and is lower than the current ELL.

Table 5.1 summarises the key indicators from the evaluation of the options in section 6.

Table 5.1 Summary of indicators for options

Option	Weighted mean score from MCDA (table 5.7)	Long term leakage level lower than current ELL (NB 1)	Cost at 2030 compared to current ELL	Cost to customer in 2030 compared to current ELL
Current ELL	5653	N/A	N/A	N/A
ELL – Supply chain	5703	✓	Similar	Similar
ELL – Abstraction tax	5707	✓✓	Higher	Higher
Frontier approach	N/A	✓✓	Higher (NB 2)	Higher (NB 2)
CSR approach	4999	✓ (NB 3)	Similar	Similar
WIS target	5360	✓	Higher	Higher
Target set on abstraction level	5431	✓	Similar	Similar
ELL – Retail cost	5454	✓✓✓	Very high	Very high

NB 1 ✓ = slightly lower, ✓✓✓ lowest.

NB 2 For the Frontier approach, those companies furthest away from the Frontier company in terms of leakage level and efficiency will be impacted most.

NB 3 This will depend on the approach taken by the individual company, if the company decided that it also wanted to be at the Frontier level then the leakage target would probably be lower.

Those options which score well for lower leakage levels (ELL Abstraction tax, Frontier approach, (CSR), and ELL Retail cost) have higher internal costs and higher costs to customers. However the ELL Retail Cost option incurs very high costs and should probably be dropped as it has only been included as an extreme option to provide a likely baseline which provides the lowest leakage targets of all option.

The WIS target option also achieves a leakage lower than the ELL but incurs higher costs and should also probably be dropped.

The Abstraction level target, CSR approach and ELL Supply chain cost, although achieving similar leakage reductions to the WIS target, do so at lower cost and should therefore be considered further in more detail.

The ELL Abstraction tax and Frontier approach both score well for leakage reduction, but incur higher costs. However the increase in cost for the Frontier approach will be relative to how far each company is away from the Frontier. The ELL Abstraction tax also has the benefit of providing additional incentive to reduce abstraction from the environment (although changes to Abstraction licence collection will be problematic for the Environment Agency). Both of these options should be considered further in more detail.

One of the key observations is that all of the options fail to produce a long term leakage target which continues to fall, they all plateau, including the most aggressive target. This is due to the leakage levels being limited by base level of leakage, which is discussed further in the next section.

5.3 Introducing context and long term Best Achievable Technology targets

The single most important limiting factor in continuing to drive down leakage in the long term becomes the policy minimum or 'base level' of leakage. The base level of leakage is determined by the characteristics of the network, and is due to the small leakage from joints, fittings and small breaches in pipe walls which are undetectable. These are either small leaks which are effectively built into the system by poor workmanship or poor product design, or they result from low growth rate failures which take a long time to become detectable.

None of the 'economic' target setting processes drives down the background leakage level, largely because long term estimates of base levels of leakage are conservative or low risk. However a target setting process which addressed this would have a long term impact on leakage levels. As the background leakage level reduces, the economic target level of leakage will subsequently tend to reduce.

New network systems should have a lower background leakage level than aged networks. A network should have minimal leaks upon commissioning and a low rate of deterioration and leak break out. Over time, as a network is replaced, the background level of leakage should reduce; however the reduction will be balanced with leakage increase in the rest of the ageing network, this however is limited by:

- the rate of network renewal
- the background leakage level achieved in a new network.

The first of these (rate of network renewal) is currently driven by economic justification for renewal to maintain (or improve) levels of service and network performance (risk) relating to pressure, interruptions and bursts, and in a few cases a reduction in leakage. Currently this results in companies replacing between 0.2 and 0.8% of the network per annum.

The second of these (the Background Leakage Level for new networks) is related to working practice and product performance, for the installation of mains, communication and supply pipes, fittings and joints.

Both of these are influenced in the long term by the development of new technologies and working practices, i.e. making the most of best available technology and processes. They are also influenced by the 'context' of the local environment or existing network, i.e. an old vulnerable network in aggressive ground conditions would need a different target to a newer network in benign ground conditions.

It is suggested that when long term (25 or more years) leakage glide-path targets are set, they should take into account the network renewal, growth and condition factors discussed above, ensuring that improvements in technologies and practices are factored in.

5.4 Recommended options

At the steering group meeting on the 13th July 2007, the potential options to be taken forward for consultation were debated. It was agreed that the options fell into 2 categories:

- Regulatory target setting
- Long-term leakage goals.

These categories are summarised below. They are then discussed in more detail, along with a partial impact assessment in section 6.

5.4.1 Regulatory target setting

These would replace the current ELL targets and allow the regulators to set minimum standards and encourage companies to outperform in terms of leakage reduction. The options are:

- Modified versions of the current ELL approach
 - These options are based the current approach to setting leakage targets which balances the additional costs of reducing leakage with the additional benefits of the reduction. The approaches require a detailed analysis of the costs of the leakage management policy and the supply-demand position within the resource zone. The cost of active leakage control to achieve different levels of leakage is derived using a modelling approach that is validated against the current costs and level of leakage. The relationship that is developed allows the costs of alternative leakage policies to be estimated. The approaches differ in how they attach a cost to the lost water or benefit of a reduction to the losses. The current ELL approach would be modified through improvements in best practice plus, either:
 - The full inclusion of Environmental & Social costs and benefits.
 - The inclusion of a volumetric abstraction charge. (Note, this is the ELL abstraction tax option discussed in preceding sections of the report, but the 'tax' elements have been removed leaving the option as a volumetric charging mechanism, and the name has changed to reflect this).
 - The inclusion of limits on the volume of water abstracted.

- Frontier approach
 - Leakage targets would be set based on the normalised leakage performance of the water companies. Frontier targets would be set for each company based on their current level of performance compared to the performance of the leading companies.

Both of these approaches allow the regulator to set baseline targets and allow the companies to out-perform the target (for example through aiming for a lower level of leakage on CSR grounds, or if local WTP studies identify that consumers are willing to pay for lower levels) without penalty.

5.4.2 Long-term target level of leakage

This recognises that there will be network improvements as a result of mains renewals and network growth which should result in a lower economic level of leakage as a result of reduced background levels of leakage. Companies should be encouraged to estimate or model the change in economic level of leakage over the next 25 to 50 years taking into account these factors, as illustrated in Figure 5.1.

This should be carried out as part of the EBSD⁽⁹⁾ (Economics of Balancing Supply and Demand) water resource management planning process. During this process the most cost effective or the most cost beneficial set of resource augmentation, leakage reduction and demand management interventions is derived to meet future supply demand constraints. This results in a leakage glide-path as leakage is reduced where it is identified as part of the optimal solution to balancing supply and demand.

It is recommend that as part of the EBSD process, network renewal, network growth and network condition should be built into the modelling to ensure that improvements in technologies and practices are factored into the leakage glide-path.

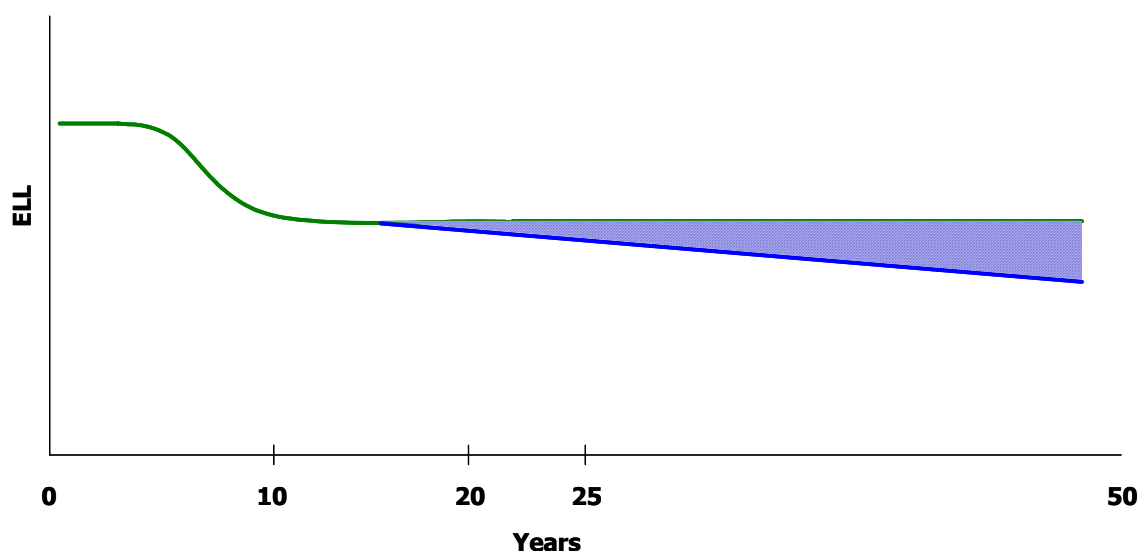


Figure 5.1 Long-term ELL target indicating potential impacts of network improvements

6. PARTIAL IMPACT ASSESSMENT OF RECOMMENDED OPTIONS

In this section the four recommended options (see section 5.4) are discussed in more detail. Each option is described and then a partial impact assessment has been carried out to identify the potential pros, cons and issues with each of the options. The partial impact assessment is based on a theoretical zone (Zone A used in section 4 of this report) and the assessment assesses the potential impact on potential leakage levels and costs (to the company and customer). The options have been identified as options A, B, C and D as follows:

- Option A: Modified ELL – inclusion of full environmental and social impacts.
- Option B: Modified ELL – inclusion of volumetric abstraction charges.
- Option C: Modified ELL – inclusion of limits on abstraction levels.
- Option D: Frontier based targets (relative leakage efficiency targets).

The options are described in sections 6.1, 6.2, 6.3 and 6.4. The partial impact assessment is described in section 6.5.

6.1 Option A: Modified ELL – inclusion of full environmental and social impacts

Using the guidance currently being developed in the parallel project on environmental and social impacts, the full environmental and social impacts resulting from reducing leakage through active leakage control should be built in to the ELL calculation. The ELL should be calculated and presented as a glide-path target level over the water resource planning period.

The impact of including full environmental and social costs and benefits should be assessed once the parallel project is completed. At this moment in time it is not possible to predict whether this will result in a lower ELL. It is likely to produce a lower ELL in those areas where the value of abstracting less water from the environment is higher than the social cost of reducing leakage.

This option is essentially the same as outlined in the Tripartite, but with a more robust estimate of environmental and social impacts, and therefore could be implemented quickly.

6.2 Option B: Modified ELL – inclusion of volumetric abstraction charges

Within the current ELL framework water companies may include the abstraction charge in the marginal cost of water calculation. However, since water companies pay an abstraction charge based on their licensed quantity and not the actual volume abstracted, the marginal benefit is really zero in financial terms. Under the current charging structure there is therefore no financial incentive (in the form of abstraction charges) for a water company to reduce leakage.

Under this option it is proposed that an additional charge is added to the fixed charge to reflect the environmental impact of the abstraction. This additional charge would be based on the volume of water abstracted; the water company could reduce the cost impact by reducing leakage and therefore abstraction.

The charge would be set using a tariff system which provides an incentive to companies to reduce leakage, and hence reduce abstraction, resulting in a lower abstraction charge. This could be achieved through a rising block tariff where the first block of abstraction is set at fixed licence charge, but the next blocks have a higher unit charge.

The volumetric abstraction charge would be set by the Environment Agency and be based on the environmental value of reduced abstractions. Therefore it is likely to vary from river basin to river basin.

Companies would need to modify the assessment of E & S impacts in the ELL as the environmental value would be built into the volumetric abstraction charge and hence the cost of water. Companies would need to ensure that full social impacts are taken into consideration.

All revenue raised by the volumetric abstraction charge above that required by the Agency would be “ring-fenced” and kept to finance improvements in leakage control or water efficiency.

One of the key aspects of this approach is to develop a tariff/charging structure that meets the following requirements:

- To meet the funding requirements of the Agency; there should be a fixed component that funds (on average) the operation of the water resource activities. These issues should be no more complex than the water industry face when setting measured tariffs.
- Raising additional revenue through abstraction changes is currently not permitted. A rising block tariff is proposed that provides the necessary incentive to abstractors to reduce abstraction but not to raise excess revenue. This could be through an initial free tranche of water, with the unit price increasing as the level of abstraction approaches the licensed limit.
- Agency already use a “2-part” licence for spray irrigators, where the total charge is calculated as using 50% of the licensed quantity plus 50% of the actual abstracted volume. In effect this provides spray irrigators a reduction when compared to other abstractors as all other charges are based on licensed volumes.
- The marginal cost (i.e. the unit cost at the current point in the demand curve) should provide sufficient incentive for the company to reduce abstraction.

The Tripartite Report⁽³⁾ presented a worked example calculation of the environmental benefit of reducing abstraction. This example used a marginal cost of 12 p/m³; since this was over 5 years ago it has been decided to use a marginal environmental benefit of 15 p/m³ for the purpose of the current study.

It is not considered feasible to raise the current standard unit charges for abstraction (which lie within the range of 1-2 p/m³) as these would have a significant impact on water company

costs which would be passed onto customers. It is possible, however, to design a tariff structure that could meet the following dual objectives:

- Maintain total revenue at approximately current levels to fund the Environment Agency.
- Provide incentives for water companies to reduce abstraction (at a marginal cost of 15 p/m³).

Model Resource Zone A was used to examine how an abstraction tariff and incentives could be designed to meet these two objectives.

Zone A has a current level of leakage of 162 MI/d, with a total level of abstraction of 810 MI/d. It has been assumed the company holds licences with a total abstraction limit of 1620 MI/d. The current abstraction charge is £5.9 million/year (based on a standard unit charge of 1 p/m³).

Under this approach a revised tariff is proposed:

- The company pays a reduced “fixed” standard unit charge of 0.25 p/m³ on the licensed quantity, which results in an annual charge of £1.5 million/year.
- Additionally the company pays a charge for any abstraction above 715 MI/d at 15 p/m³. For this worked example this level was set as the sum of the policy minimum level of leakage (67 MI/dl) and customer demand (648 MI/d) for the zone.

If the company make no reduction to its level of leakage the abstraction charge increases by £6.2 million. This potential increase provides the incentive for the company to reduce leakage.

If the abstraction charge is incorporated in to the ELL calculation, the ELL falls to 118 MI/d. If the company reduces leakage to 118 MI/d the abstraction charge increases by £1.4million above current levels, but represents a saving of £4.8million. In practice it is likely that there could be a range of different effects across the country.

Moving to the long-run ELL of 105 MI/d results in a reduction in abstraction costs by £0.1million.

Further detailed analysis would be required to ensure tariffs were set appropriately across the Agency regions. It is likely that the environmental unit charge would be set at the catchment (or River Basin) level reflecting the environmental impact of the abstraction. A standard value of, say 15p/m³, across the country would not be appropriate.

It would be necessary to re-assess tariffs on a regular basis to take account of changes in volumes abstracted and the level of revenue raised. Some of the annual fluctuations could be smoothed out by using rolling averages of abstracted volumes.

The national impact can only be addressed by undertaking a detailed modelling exercise containing a sample of water resource zone across Environment Agency regions. This worked example does, however, illustrate the principles of the approach and demonstrates that a tariff could be designed that provides appropriate safeguards for Agency funding, limits the impacts on water company abstraction charges whilst still providing incentives for reducing abstraction.

Potential benefits:

- The approach provides a method to internalise the environment and social impacts arising from the loss or improvement to the water environment covered by the abstraction licence.
- Develops additional funding (from within the water industry/customers) to fund additional leakage and/or water efficiency research and development.

Potential challenges:

- Working within the regulations that currently restrict the levels of charges that the Agency can apply, and the strict timescales for developing the charges for the following year.
- Fairness and Equity – it is proposed that the licence changes would only apply to public water supply; is it appropriate that the charges for this sector of abstractors is significantly different to the other abstractors.

6.3 Option C: Modified ELL – reduction of abstraction level

This approach links with CAMS and the implementation of the Water Framework Directive (WFD). The approach is similar to the WIS targets, but with the target set based on the environmentally sustainable level of abstraction from the catchment. The Agency is currently undertaking a programme to Restore Sustainable Abstraction by working with abstractors to investigate and where necessary appraise options to remedy damaging, licensed abstractions. Where a licence change is proposed the licence holder may be eligible for compensation. The Government has asked the Agency to use the charging scheme in the future to raise the funds to pay compensation.

This approach recognises that it is not leakage that has the potential to cause environmental damage; it is the level of abstraction from the environment. The aim of this approach is to provide incentives to introduce demand management measures alongside leakage reduction.

The current regulations that govern the abstraction licences and charging mechanisms could limit the early application of this approach. It is considered that there are two possible options that could be investigated for use within the current regulations:

- Restrict licence through a development of the RSA (Restoring Sustainable Abstraction) programme. Although this approach may result in additional compensation payments it would provide the water companies funding to replace the water, through options such as leakage reduction or water efficiency for example.
- The approach could also be implemented using an incentive charging based licence. For the agreed volume of water, charges are based on the current unit rates. If the company takes above the agreed level then the unit charge increases significantly. In its “Tuning Water Taking” report DEFRA recognises that some form of incentive charging could form a basis for charging in the future (however the main text of the report focuses on licence trading). This would not result in compensation payments but may require additional legislation, and is in effect, very similar to the previous approach.

The Regulator(s) would define an abstraction target which reflects the sustainability of the abstraction. This is likely to be below the current licensed abstraction in many catchments in

the South of England. It is envisaged that initial targets will be phased in over a number of years to allow water companies to make the necessary investments to achieve the target.

The potential impact of this option has been explored within Zone A and the results are reported in section 6.5.

Potential benefits:

- Works within the current regulatory framework.
- Impacts on leakage and water efficiency.

Potential challenges:

- The abstraction limit needs to be set at a sustainable level – the RSA programme has already considered this – is it likely that a lower limit could be justified?
- The water companies may be eligible for compensation resulting from any reductions to abstraction licences. The company may seek alternative sources and not make further reductions in leakage.

6.4 Option D: Frontier based targets (Relative leakage efficiency target)

Regulatory targets can be set which are based on benchmarking and comparing companies' performance in a particular area. The performance of all companies is normalised, by taking account of factors outside the companies' control, such as, for example, population density. The companies with lower performance are then set targets based on the performance of the best, or frontier, companies.

Under this approach leakage targets would be set based on the performance of a group of the best companies. The normalisation process would need to take into account factors which influence a company's ability to reduce leakage (such as network condition). The leakage target would effectively target companies to achieve certain levels of active leakage control efficiency or performance. As such, the target would be a short-term target which would be re-assessed on a periodic basis. A long-term target should also be set which defines a leakage 'glide-path' over the company's planning period which takes into account the supply demand balance situation and the improvements to the condition of the network.

6.4.1 Conceptual model for the Frontier based or 'Relative leakage efficiency' target

It is proposed that the method is based on a normalised ranking of leakage performance. Starting with the actual leakage performance (possibly modified by taking the 3 year rolling average to smooth out seasonality effects) the following factors would need to be taken into account to normalise the leakage performance:

- Connection density.
- The policy minimum or background level of leakage (the difference between this and the actual level of leakage being the volume which can be targeted through active leakage control methods).

- Network ‘vulnerability’; an explanatory factor would be used to factor in the condition of the network and how prone the network is to leakage breakout (due to condition or operational activities), this might be defined by factors such as:
 - Network age (e.g. the proportion of mains greater than 50 years old);
 - Burst frequency;
 - Leak breakout rate;
 - Company size.

Once the leakage performance has been normalised to produce a leakage efficiency factor, the companies’ performance would be ranked and graded based on each company’s performance relative to the ‘frontier’ group of companies.

Long-term leakage targets should be set as part of the EBSD process (described earlier). As part of the water resource management planning process a leakage glide-path should be derived based on the supply demand balance, but also taking into account network renewal, network growth and network condition. The methods used to derive the leakage glide-path should ensure that improvements in technologies and practices are factored into the leakage glide-path.

It is beyond the scope of this study to define the precise normalisation or grading processes, but an example is included below to explain the concept and explore the feasibility.

6.4.2 Example of the Frontier based or ‘Relative leakage efficiency’ target

This example uses published data on leakage levels, property numbers, network lengths, and an estimated ‘network factor’ based on mains age profile, to normalise the leakage data and derive a ‘Leakage efficiency factor’. It is for illustrative purposes only and a formalised normalisation process would need to be developed and agreed by the regulators and water companies.

Figure 6.1 shows the leakage levels of all the companies as reported by Ofwat in the Security of supply, leakage and water efficiency report for 2005-06⁽⁷⁾. This shows a wide range of leakage performance.

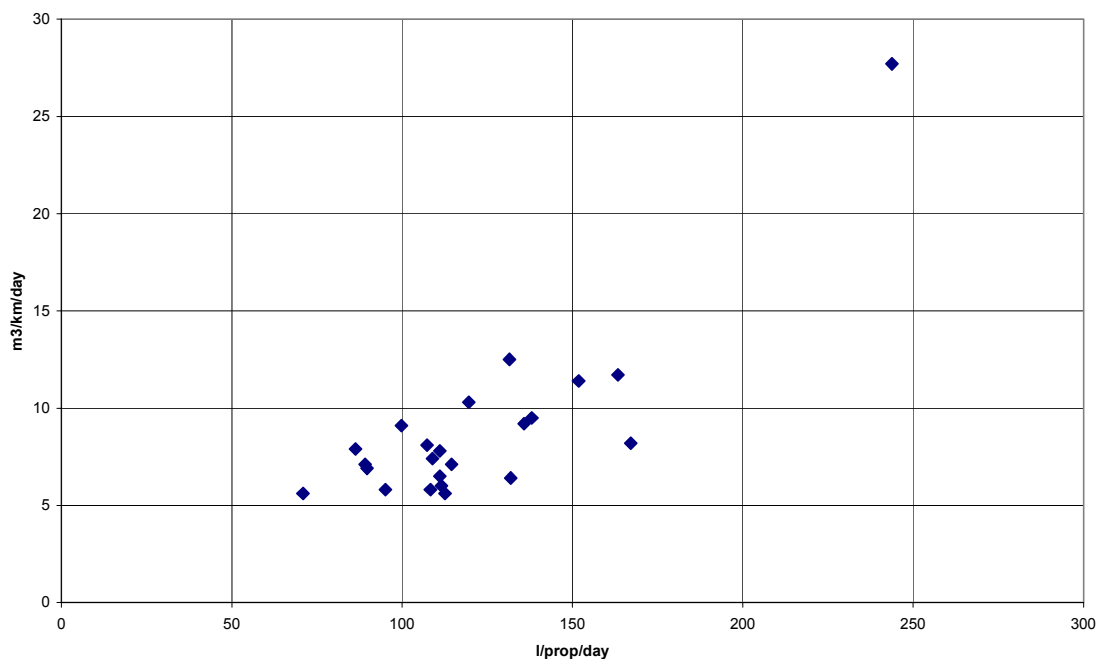


Figure 6.1 Leakage expressed in terms of properties and network length

Figure 6.2 shows the 'normalised' leakage efficiency factor for each company. The different colours used in the figure relate to the relative efficiency band for each company. The banding is based on a percentage difference from the benchmark level defined by the 'frontier' group of companies. The benchmark level of performance is based on 20th percentile value of the leakage efficiency factor. In this case the 'frontier' group of companies are companies X, H, T, C, D, R, G and S. Although the identity of the companies has been made anonymous, this group consists of both water only and water and sewerage companies.

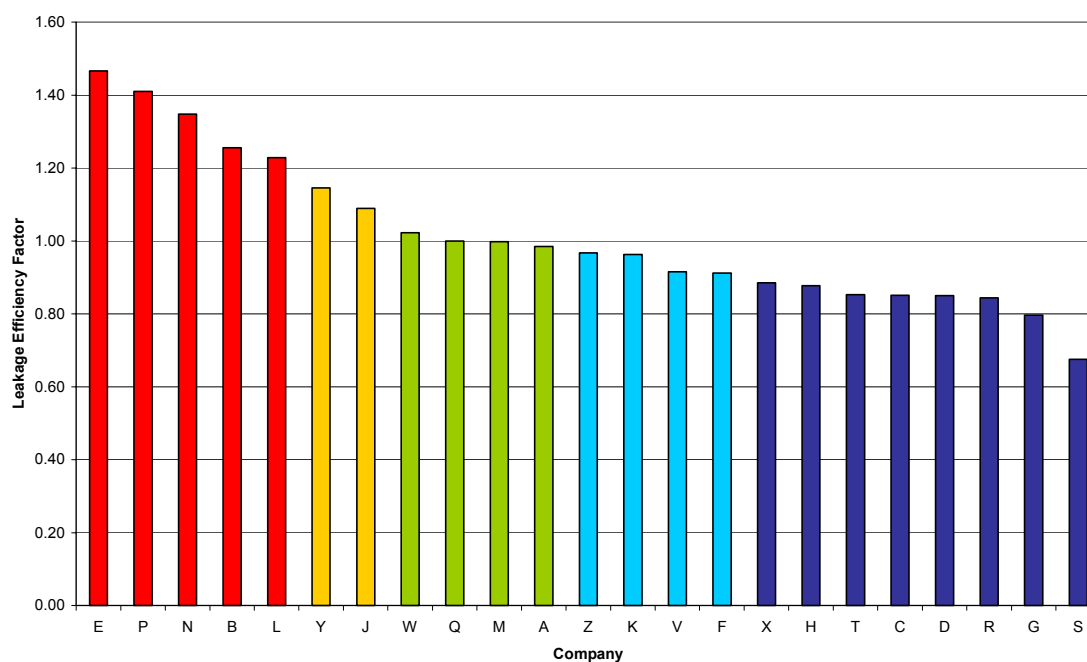


Figure 6.2 Leakage efficiency factors for each company

The banding is then defined in a similar manner to the banding used in the operational efficiency analysis used by Ofwat (Water and sewerage service unit costs and relative efficiency report 2004-05⁽³²⁾). The banding is shown in Table 6.1 for bands A through to E. Companies operating in band A should be the most efficient at leakage control.

Table 6.1 Frontier target band definitions

Band definition	Companies
A – Within 5% of benchmark	X, H, T, C, D, R, G and S
B – Between 5% and 15% of benchmark	Z, K, V, and F
C – Between 15% and 25% of benchmark	W, Q, M and A
D – Between 25% and 35% of benchmark	Y and J
E – Greater than 35% of benchmark	E, P, N, B and L

Targets for improvement would then be set for companies to move from band E to band D, band D to band C and so on. The specific target could be set at the lower bound of each band, the mean or median expressed as the leakage efficiency factor and then converted to a specific leakage target in MI/day. The bands would be likely to change each time the leakage performance is re-assessed, leading to continuous improvement over time.

Potential benefits:

- This approach does not rely as heavily as others on models as the targets are set based on actual performance of other companies.

Challenges:

- The mechanics for moving from the current performance to the frontier need to be developed to define over how many years the movement from one band to another should be set.
- The normalisation methodology needs to be developed in collaboration with the water companies and regulators.

6.5 Results of the partial impact assessment

Before making any final recommendations to change from the current method of setting economic level of leakage targets it will be necessary to undertake a Regulatory Impact Assessment (RIA). The RIA will help to identify if the proposed approach supports the government's aim of only regulating when necessary and, when it is, to do so in a way that is proportionate to the risk being addressed, and to deregulate and simplify wherever possible.

The full RIA will identify the impacts that could result from the implementation of the proposed target setting approach. These impacts will be assessed for the country as whole, and will need to identify:

- The impact on leakage levels and/or levels of water that remain in the environment (streams/rivers) that would otherwise have been abstracted,
- The additional costs on the companies, particularly any additional leakage control costs to achieve lower levels of leakage (if lower levels are set by the new approach),
- Other impacts, such as disruption, impact to carbon footprint and the role of the Regulator(s).

In order to undertake a full RIA on the proposed short-list of options it will be necessary to undertake additional analysis, drawing on a wider level of company specific data that allows the impacts to be extrapolated to the whole country.

It has, however, been possible to undertake a partial impact assessment on Model Zone A by making a number of assumptions and extrapolating the data held by WRc. This analysis has been undertaken in more detail than that presented in section 4, and has only examined the impacts of options A, B, C and D. As explained in section 4, Zone A has a small current excess capacity which will require additional capacity to be added in 2014-15. The current level of leakage is 162 Ml/d based on an operating cost of water of 5p/m³. The marginal cost (capital, operating, environmental and social) of the next resource is 25p/m³. The company has been assumed to be operating at a low level of efficiency (Band E).

In the analysis, it is assumed that option A (ELL with full environmental and social costs) is the minimum that regulators and companies will implement. Therefore the increases in costs for option B, C and D, are those costs in excess of option A.

The key impacts that differentiate between the approaches are:

- Impact on leakage: it is important to consider both the short-term impact and long-term leakage targets, together with the profile that leakage will take between these values.
- Impact on costs: if a leakage target setting approach results in lower levels of leakage then it is inevitable that the water company will be faced with higher costs of active leakage control to achieve the target.

Table 6.2 presents details of the partial impact assessment, with the resulting leakage profiles shown in Figure 6.3.

Table 6.2 Partial impact assessment

Option	Short-term leakage ⁽¹⁾		Long-term leakage ⁽²⁾		Annual cost ⁽²⁾		Incentive for continuing reductions
	(MI/d)	Reduction from current level (MI/d)	(MI/d)	Reduction from current level (MI/d)	(£ million)	Increase above option A (£/prop/yr)	
A) ELL with improved E&S assessment	162	-	113	49	21	-	No
B) ELL with volumetric abstraction charging	118	44	105	57	28	7	Yes
C) ELL with abstraction limit	125	37	113	49	21	-	No
D) Frontier based targets	140	22	100	62	36	15	Yes

Note: 1) The short-term target is the target that would be set for 2010/11 (3 years from current year).

2) The long-term target or cost is the value at the end of the current planning horizon (2029/30).

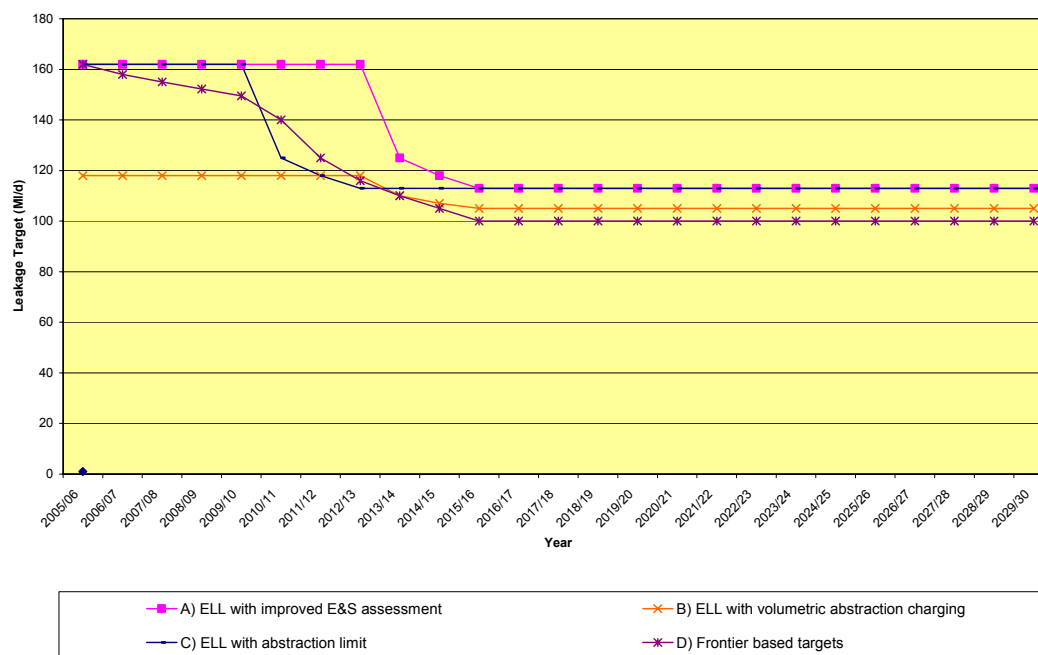


Figure 6.3 Zone A Partial Impact Assessment Leakage Profiles

The following key conclusions can be drawn from Table 6.2, Figure 6.3, the MCDA and modelling work carried out previously in the report:

Option A: ELL with improved Environmental & Social assessment

- The approach uses economic principles to derive a target, and is consistent with the Water Resource Planning process.
- The clarity of the methodology of the ELL process could be improved and recommendations have been made in this report for improvements. The methodology for the inclusion of the environmental and social impacts will become clearer once the parallel study into externalities has been completed.
- The approach scored well against the ‘Better regulation’ principles, although the communication of the final methodology to consumers could be improved upon.
- There is no reduction in leakage until the supply-demand scheme leads to a reduction from 2012/13.
- The long term leakage target is 113 M/d which is driven by supply-demand balance and hence the LRMC (incl. E&S) of water.
- The profile in leakage reductions is likely to be driven by the timing of the supply demand balance.

Option B: ELL with volumetric abstraction charging

- The approach uses economic principles to derive a target, and is consistent with the Water Resource Planning process.
- The clarity of the methodology of the ELL process could be improved and recommendations have been made in this report for improvements.
- More work is required to develop fully the details of the volumetric charge structure. Some suggestions have been made and used in the modelling in this report, but these need more work and would need to be applied to individual regions.
- The approach scored well against the 'Better regulation' principles, although the communication of the final methodology to consumers could be improved upon. Although there are some issues with 'Fairness and Equity' – it is proposed that the licence changes would only apply to public water supply; is it appropriate that the charges for this sector of abstractors is significantly different to the other abstractors.
- The approach provides method to internalise the environment and social impacts arising from the loss or improvement to the water environment covered by the abstraction licence.
- There is an immediate incentive to reduce leakage following the introduction of volumetric charging. It is likely that the Environment Agency would phase in changes to abstraction charges, so the incentive to reduce leakage would also be phased in.
- The long-term target is 105 MI/d. This long-term target is lower than Option A as it has been assumed the Environment Agency view of Environmental costs would be tougher than company view.
- Although the leakage profile flattens out in this modelling exercise it is likely that there would be continual incentives to make reductions in leakage in environmentally sensitive areas. These incentives would be driven by changes to the tariffs.
- There are some challenges to identify how to work within the regulations that currently restrict the levels of charges that the Agency can apply, and the strict timescales for developing the charges for the following year.

Option C: ELL with abstraction limit

- The approach uses economic principles to derive a target, and is consistent with the Water Resource Planning process.
- The clarity of the methodology of the ELL process could be improved and recommendations have been made in this report for improvements. The methodology for the inclusion of the environmental and social impacts will become clearer once the parallel study into externalities has been completed.
- The approach scored well against the 'Better regulation' principles, although the communication of the final methodology to consumers could be improved upon.

- The method allows the company to meet targets through both leakage and other demand reduction strategies, such as water efficiency.
- This approach effectively reduces the water available for use within the supply-demand balance, and so brings forward the need for supply-demand investment. The licence reduction simply changes the timing of the supply-demand balance.
- The leakage profile is identical to the long-run ELL, except that the reduction is brought forward by three years.
- The long-term leakage target is 113 MI/d.
- The abstraction limit needs to be set at a sustainable level, the RSA programme has already considered this and for the approach to work there would need to be justification for a lower abstraction limit in some areas.
- The water companies may be eligible for compensation resulting from any reductions to abstraction licences. The company may seek alternative sources and not make further reductions in leakage.

Option D: Frontier based targets

- The approach does not directly use economic principles to derive a target. However the approach sets targets based on benchmark companies that are more efficient, and these companies will be working economically.
- The approach sets the targets based on the operational efficiency of companies and, removes the 'contextual' limitations on meeting absolute targets, e.g. infrastructure condition, local geology, etc. The 'capital' issues such as 'network improvement', burst reduction, could be dealt with through the common framework for capital maintenance planning and the economics of balancing supply and demand, and should be used to set long term leakage glide-paths based on the network condition and supply/demand needs.
- The mechanics for moving from the current performance to the frontier need to be developed to define over how many years the movement from one band to another should be set.
- The normalisation methodology needs to be further developed in collaboration with the water companies and regulators.
- The approach scores well against the 'Better regulation' principles, with the targeting being specifically focussed on leakage control performance.
- The process of normalisation and data sharing should allow knowledge sharing which could help improve overall leakage management efficiency.
- For modelling purposes it has been assumed that the water company is currently at Band E, i.e. a low level of efficiency. If the company had started in Band A the reductions in leakage (and resulting increase in costs) would not be as great as those suggested.

- This approach results in leakage reductions that are relatively slow. The targets are set to move the company from Band E to Band D in year 1, D to C in year 2, etc. The company takes a minimum of four years to reach Band A, although Band A may itself be getting more efficient, so it may take longer.
- In addition to the Frontier approach, which sets targets based on relative ALC efficiency, leakage reductions are also driven by the supply-demand balance (LRMC).
- The long-term target is below the long run ELL as it will incorporate the increase in efficiency.
- The long-term target is 100 MI/d, but may continue to fall if, driven by the comparison with other companies, ALC efficiency continues to improve.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

A wide ranging review of alternative leakage target setting options has been carried out. From this process, 24 potential alternative options have been identified and described. The 24 options have been evaluated using a MCDA technique, the most appropriate options were then discussed with the project steering group and compared against the current ELL process. Leakage and cost modelling was then carried out on the most promising options. The conclusions arising from the study are:

7.1.1 There are four preferred alternative target setting concepts that provide benefits, are based on economic principles and could be applied consistently with the water resource planning process. The four alternative options are:

- Option A: Modified ELL – inclusion of full environmental and social impacts.
- Option B: Modified ELL – inclusion of volumetric abstraction charges.
- Option C: Modified ELL – inclusion of limits on abstraction levels.
- Option D: Frontier based targets (relative leakage efficiency targets).

7.1.2 The full impact of Option A cannot be determined until the results of the parallel project investigating the application of environmental and social costs to the ELL have been published. The leakage profile or glide-path produced by this option will be driven by the timing of the supply demand balance and the long run marginal cost (including environmental and social costs) of water.

7.1.3 Option B provides a method to internalise the environmental and social impacts arising from the loss or improvement to the water environment covered by the abstraction licence. The method puts these external costs onto the operating costs of the water company. This allows the company to balance the variable costs of abstraction against the costs of leakage control. It also provides the opportunity to offset capital expenditure against reduced long term operational costs. This may accommodate the option of using mains renewal to reduce abstraction and active leakage control costs.

7.1.4 In the partial impact assessment and modelling, Option B results in the second lowest long term leakage profile, and also provides a continuing incentive to reduce leakage levels.

7.1.5 Option C to all intents and purposes reduces the water available for use within the supply demand balance and so brings forward the need for supply demand investment. The abstraction limit would need to be set at a sustainable level, the RSA (restoring sustainable abstraction) programme has already considered this and for Option C to work there may need to be justification for a lower abstraction limit in some areas.

- 7.1.6 For Option C, water companies may be eligible for compensation resulting from any reductions to abstraction licences. There is the risk that the company may seek alternative sources and not make further reductions in leakage.
- 7.1.7 In the partial impact assessment and modelling, Option C had no impact on the long term leakage profile, although it did bring forward a reduction in leakage to balance supply and demand.
- 7.1.8 Options B and C provide incentives to reduce the volume of water abstracted, this can be achieved through leakage reductions, but could also be achieved through the use of other demand management options (such as water efficiency). Both options B and C would be applied at a catchment level.
- 7.1.9 Option D sets the leakage target based on the operational efficiency of companies and removes the 'contextual' limitations on meeting absolute targets, e.g. infrastructure condition, local geology, etc. Leakage targets would be set based on the performance of a group of the best companies. A normalisation process would be established to take into account factors which influence a company's ability to reduce leakage (such as network condition). As such, the target would be a short-term target which would be re-assessed on a periodic basis.
- 7.1.10 Under Option D the 'capital' issues such as 'network improvement' and burst reduction, could then be dealt with through the common framework for capital maintenance planning (CFCMP), whilst the economics of balancing supply and demand (EBSD), should be used to set long term leakage glide-paths based on the network condition and supply/demand needs.
- 7.1.11 In the partial impact assessment and modelling, Option D results in the lowest long term leakage profile. Although the impact of this leakage target approach on each company will depend on how far each company is away from the frontier company. This approach provides a continuing incentive to reduce leakage levels.
- 7.1.12 The clarity of the underlying ELL methodology used in options A, B and C could be improved.
- 7.1.13 Options A, B, C and D scored well when assessed against the 'Better Regulation' principles. Communication of the final methodology to consumers will need more work to ensure that the goals and the methodology of the leakage target setting process are easily understood. There are some issues relating to 'fairness and equity' for options B and C which require further investigation, these options require changes to abstraction licensing which would only apply to public water supply.
- 7.1.14 The impact on costs has been assessed in the partial impact assessment. The long term costs for options B, C and D have been compared to the cost on implementing option A. The largest impact on cost came from implementing Option D, although in the example used it was assumed that the company started from a position of low efficiency, hence large improvements in efficiency were required. The smallest impact on cost was from Option C, although the leakage reduction and therefore leakage reduction costs were incurred earlier than for Option A. The cost impact for Option B was between those for options C and D.

- 7.1.15 There is uncertainty surrounding all four options. For Option A there is uncertainty over how the approach will impact on both sides of the ELL equation. For Option B, there is some uncertainty over how the approach would be implemented within current regulatory constraints and over changes to charging method; there is also uncertainty over the impact to abstraction licence income for the Agency. For Option C, there is uncertainty of the regulatory changes needed (is this simply an extension of the current RSA programme?), and whether this will result in lower leakage or simply bring new resources schemed forward. For Option D, there is some uncertainty over how robust the normalisation can be made.
- 7.1.16 Before making any final recommendations to change from the current method of setting economic level of leakage targets it will be necessary to undertake a Regulatory Impact Assessment (RIA). The RIA should seek to identify if the proposed approaches support the government's aim of only regulating when necessary and, when it is, to do so in a way that is proportionate to the risk being addressed, and to deregulate and simplify wherever possible.

7.2 Recommendations

- 7.2.1 For each of the modified ELL options (Options A, B and C) a number of changes to the current ELL approach as set out in the Tripartite Report are recommended. These are:
- a) ELL Targets should be set at Company level, based on calculated economic levels of leakage at water resource zone (WRZ) level. This would provide a company with the opportunity to reduce leakage below the target level in one WRZ (because it is relatively easy and cost-effective to do so) to make up for a shortfall in leakage reduction in another WRZ (where prevailing ground conditions/access is more difficult), on the proviso that the company could still meet its levels of service obligations in the WRZ with the shortfall.
 - b) Companies should be required to achieve the target ELL and hence operate at the most efficient level of leakage. Companies who are operating below their ELL should not be required to maintain this lower level. (Currently if a company is operating below its ELL target, it must maintain this lower level of leakage). Companies may maintain a lower level of leakage at their own discretion, which should be seen as out-performance of the target level. Companies may wish to do this where there is actual or perceived value in doing so, for example if the company's corporate and social responsibility commitments identify that lower levels of leakage are desirable, or if local consumers are willing to pay for lower levels of leakage.
 - c) Levels of uncertainty around the ELL target should be calculated and reported.
 - d) Best practice guidance for policy minimum assessment should be updated based on the last five years experience, and an estimate of uncertainty should be reported for policy minimum.
 - e) A method of allocating reliability and accuracy scores to each sub-process should be developed to provide an incentive to move towards best practice.

- 7.2.2 The four identified options (A, B, C and D), plus a 'do nothing' option should be subject to a full regulatory impact assessment, once other parallel projects have been completed and reported. The full regulatory impact assessment should investigate the impact on leakage levels, the cost (monetary or carbon) impact to companies and customers, and quantify the value (monetary or carbon) of the resulting levels of leakage.
- 7.2.3 The four identified options for alternative leakage target setting should be consulted on more widely in the industry.
- 7.2.4 Following the completion of the full RIA and consultation one of the preferred options should be put in place as the new approach to setting leakage targets. The Tripartite Report should then be updated to provide guidance on the new approach.
- 7.2.5 Regardless of the option taken forward it is recommend that as part of the EBSD process, network renewal, network growth and network condition should be built into the modelling to ensure that improvements in technologies and practices are factored into the long term leakage glide-path. Companies should be encouraged to estimate or model the change in economic level of leakage over the next 25 to 50 years taking into account these factors. This should be carried out as part of the EBSD(9) (Economics of Balancing Supply and Demand) water resource management planning process.

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APPENDIX A TARGET SETTING APPROACHES IN OTHER SECTORS

This section reviews some of the approaches used to set targets in other sectors: either in the water industry or outside of the water industry. The information in this section has been used to inform the selection of alternative target setting options in the next section of the report.

A.1 Leakage target setting outside the UK

Information was gathered from a range of countries relating to international experience of leakage target setting.

Leakage indicators are increasingly being used by water companies (USA, Australia, Norway, South Africa, Italy, Canada) to assess leakage levels within their own companies, or benchmarking. Most are following the IWA (International Water Association) water balance methodology. Some of these countries are using the IWA's ILI (Infrastructure leakage index – see Appendix B.2) to compare and benchmark internationally.

Some countries have set leakage targets based on percentages (Bogota in Colombia and some companies in Italy).

Water companies in Holland have an extremely low level of leakage⁽²⁹⁾, but have no regulatory targets in place for leakage. In this instance companies benchmark their performance against each other.

There is some evidence of companies setting internal targets based on an economic approach. For example Cyprus where the cost of water is high due to supplies based on desalination.

Most leakage target setting processes outside the UK appear either to be set on a 'political' basis (i.e. reduce leakage from X% to Y%) or based on a process of benchmarking performance using simple leakage indicators. There is work going on in the IWA to develop an economic version of the ILI (this is discussed in Appendix B.3).

A.2 Target setting to meet environmental legislation

A.2.1 EU Legislation

Water

In the 1970s and 1980s, a number of EU Directives on water quality were adopted including the Dangerous Substances Directive⁽¹⁴⁾, the Freshwater Fish Directive⁽¹⁵⁾, the Shellfish Directive⁽¹⁶⁾, the first Bathing Water⁽¹⁷⁾ and Drinking Water Directives⁽¹⁸⁾ and the Groundwater Directive⁽¹⁹⁾. These Directives introduced standards for water quality that were intended to protect the environment and human health from the effects of individual substances. The standards introduced by the Directive are based on the total concentration of an individual substance that can be present in the environment without causing harm. These are usually

derived by applying a safety factor (which takes account of the environmental fate and behaviour of a substance) to data on the toxicity of a substance.

In the 1990s the focus switched from controlling the levels of substances in the environment to controlling the discharge of substances. The Urban Waste Water Treatment Directive⁽²⁰⁾ requires the identification of water bodies and catchments that should be protected and specifies the level of treatment that discharges to such waters must receive. The IPPC Directive⁽²¹⁾ requires the installation of the best pollution abatement equipment to the most polluting industrial installation, providing that the costs of doing so are not excessive. Some leeway is allowed, providing that equivalent reduction in polluting emissions is achieved.

Two Directives have also been adopted requiring that certain valuable habitats supporting endangered wildlife be protected. The first of these⁽²⁸⁾, adopted in 1979 relates to the protection of wild birds and their habitats. This requires Member States to maintain the population of all *“species of naturally occurring birds in the wild state”* in the European territory *“at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements”*. The Directive identified 181 species of wild birds that must be protected and requires Member States to classify the most suitable territories (land and sea) as special protection areas for the preservation of these species, with particular attention being paid to the protection of wetlands. Member States must strive generally to avoid pollution or deterioration of habitats and are to undertake more specific measures to conserve special protection areas. There are currently 237 Special Protection Areas (SPAs) designated in the UK under the Birds Directive.

The Habitats Directive⁽²⁸⁾ was adopted in 1992 and also requires the identification and protection of *“terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features whether entirely natural or semi-natural”*. The Directive list 168 habitat types that should be protected together with a number of animal and plant species; the protection of which requires the designation of their habitat as a special conservation area. The UK has identified 567 areas as *“special areas of conservation”* (SACs).

The Environment Agencies have recently reviewed all discharge and abstraction consents impacting on SPAs (Special Protection Areas) and SACs (special areas of conservation) and revised them when appropriate. The procedure for granting a consent for an abstraction or discharge (or other change for which permission must be granted) to a designated Habitats or Bird Directive site is complex. Essentially, no adverse impact to the site should be caused, either alone, or in combination with other activities that may impact upon the site. The likely impacts considered will depend on the type of activity. For example, the impacts considered for abstractions would be:

- Habitat loss;
- Physical damage to habitat and species;
- Turbidity and siltation;
- Disturbance (noise or visual);
- Changes in water levels/table;
- Changes in velocity or flow regime;
- Changes in surface water flooding.

The specific impacts considered will depend on the habitat site as not all impacts will adversely affect all habitat types.

The Nitrates Directive⁽²³⁾ was adopted in 1991 and aims to protect water sources, particularly those used for the abstraction of drinking water and those likely to become eutrophic, from pollution from the application and storage of fertilizer and manures on agricultural land. Member States are required to identify waters actually or potentially affected by nitrate pollution (nitrate vulnerable zones – NVZs) and to establish action programmes in these areas to control the amount and quantity of fertilizers and manure applied, the storage of fertilizers and the establishment of codes of good agricultural practice. 55% of England has been identified as a nitrate vulnerable zone. The European Commission has issued infringement proceedings against the UK relating to the designation of nitrate vulnerable zones and the establishment of action programmes.

The most recent legislation to be adopted by the EU to protect the water environment is the Water Framework Directive (WFD)⁽²⁴⁾. The WFD requires all water bodies to be of at least “good ecological status” (or “good ecological potential” in the case of heavily modified or artificial water bodies) by 2015, except in certain, specified, exceptional circumstances. What comprises “good ecological status” will depend on a number of factors including the biological, chemical and hydromorphological characteristics of the water body concerned. For the first time the Directive applies to all water bodies, surface waters and groundwater bodies. The Directive identified a number of eco-regions. Member States have been working together within each eco-region to identify reference conditions from which classification boundaries for good ecological status can be derived. The reference conditions will be calibrated across the different eco-regions and water body types to ensure that they are consistent throughout the EU. A Council Decision currently identifies a number of priority and priority hazardous substances as required by Article 16 of the Directive. Emissions, discharges and losses of priority substances must be reduced. For priority hazardous substances they must be eliminated. The Commission has recently put forward a proposal for a Daughter Directive which will establish EQSs for the priority and priority hazardous substances in surface waters which is currently going through the adoption process. These have been established on the same basis as those in the Dangerous Substances Directive, but based on more up to date data.

Air

The EU has adopted a variety of approaches to controlling air pollution, including:

- Ambient air standards – these have been established for SO₂, NO_x, particulate matter, lead, benzene, carbon monoxide and ozone to protect human health and the environment. The standards are based on a number of factors including the degree of exposure of sectors of the population and sensitive sub-groups, sensitivity of flora, fauna and habitats, exposure of historic heritage, and economic and technical feasibility;
- Product standards – these control the concentration of certain substances in products, for example the sulphur content of gas oil or lead in petrol. The Directive controlling the levels of pollutants in vehicle exhausts would also fit in this category. The aim of these Directives is to reduce emissions to air based on what is technically and economically feasible;
- Emission limit values – these are in place for certain types of stationary plant (e.g. waste incinerators, large combustion plants) and set limits on the quantities of pollutant that can

be emitted – again based on what can be achieved by the most advanced, economically feasible, technology;

- Upper limits on emissions from certain types of plant – for large combustion plants upper limits have been set on the total amount of emissions of SO₂ and NO_x that can be discharged from this sector in each Member State. This is a further incentive for Member States to reduce the emissions of these two pollutants further; and
- Reductions in production of certain polluting products – for example the Directive on ozone-depleting substances sets quotas for the production of these substances in each Member State.

Waste

The Landfill Directive⁽²⁵⁾ sets targets for the reduction in the quantities biodegradable municipal waste disposed for in landfill. These targets were developed to encourage recycling of biodegradable waste and to reduce the amounts of methane emitted to air by landfills. The scientific basis behind the targets is difficult to ascertain as they were made less challenging during the process of negotiation of the Directive.

The Landfill Directive has also established criteria for the wastes that can be accepted for the various types of landfill (inert, non-hazardous and hazardous). The full criteria (WAC) were initially developed by a Sub-Group of the Technical Adaptation Committee provided for by the Waste Framework Directive⁽²⁶⁾. In summary, the approach of the sub-group was to model the effect of a landfill scenario on groundwater. For an agreed scenario, they examined the impact of leachate on groundwater receptors in relation to landfill dimensions, infiltration and hydrogeology. From this they determined the waste quality and leachability necessary to avoid exceeding water quality parameters at the receptors.

A.2.2 UK Legislation

In the UK the majority of environmental legislation, particularly that relating to environmental quality standards, arises from European legislation.

The Water Resources Act 1991⁽²⁷⁾ requires all discharges to surface water to be subject to a discharge consent. When setting a discharge consent the Environment Agencies will take account of the concentration of pollutant in the river (from ambient or other sources – both upstream and downstream) and the dilution available. A discharge consent will be granted only if the appropriate environmental quality standards will not be exceeded downstream of the discharge. For IPPC installations, the Agencies will also take account of whether the best available technologies are being used to minimise the quantities of pollutants discharged. The Water Industry Act 1991 requires discharges to sewer to be subject to a trade effluent consent. In setting such consents, the sewerage undertaker (or Environment Agency in the case of IPPC installations) will take account of the ultimate discharge consent placed on the sewage undertaker at the point of ultimate discharge together with the ability of the treatment works to remove the pollutant from the discharge. The route for sludge disposal must also be considered if the pollutant is not degraded in any treatment process, as its presence in significant quantities may have an impact.

It is only with the introduction of the Water Framework Directive that any requirements have been placed on Member States with respect to abstraction licensing. Other than requiring the prior authorisation of abstractions, few detailed controls are imposed at an EU level. However, abstraction will have an impact on the achievement of good ecological status of water bodies and therefore controls will need to be introduced. The Environment Agency is well prepared in this area having already started to develop a series of Catchment Abstraction Management Plans for each river catchment in the UK. These identify the status of water resources within the catchment, where abstractions are to be reviewed, where no new abstractions can be permitted, where they can be allowed with restrictions (and the level of restrictions that may apply), and where resources are plentiful. The abstraction licence will be granted to protect the environment and may contain restrictions to be imposed in circumstances of low flow.

A.2.3 Summary of findings relating to environmental legislation

- a) Most environmental targets are set to eliminate the potential impacts of substances discharged to the environment;
- b) Some aim to eliminate discharges of the most polluting substances;
- c) Emission targets are based on the lowest emissions achievable by the use of the best available technologies.

A.3 Context value added (CVA) measures used in the education sector

A.3.1 CVA measures

Value added measures have been used in the Achievement and Attainment Tables (formerly known as Performance Tables) in comparing school performance and in setting targets since 2002. They measure the attainment of pupils in comparison to pupils with similar prior attainment. This is fairer than using raw outcomes since schools can have very different levels of attainment on pupil entry.

However, there are many other factors that are related to the progress that pupils make in a school, such as levels of deprivation or special educational needs. "Contextual value added" aims to take account of these factors when measuring the effectiveness of a school or the progress made by individual pupils: this provides a means of comparison and target setting in the context of a like-for-like understanding of performance

Measures of absolute attainment (raw results) are therefore complemented by measures of the progress made by pupils "the value added (VA)" from one key stage to another. 'Simple' VA measures, which have been in use for some years now, are thus based on pupils' prior attainment. For example, at KS2 progress is measured from KS1 assessments, or at GCSE measured from the KS3 tests.

CVA, therefore, not only measures progress based on prior attainment but also adjusts to account for the impact of certain external factors which are known to have had an impact on the progress of individual pupils.

This means that CVA gives a much fairer statistical measure of the effectiveness of a school and provides a solid basis for comparisons. Nevertheless, no single measure of performance

can tell the whole story about a school's effectiveness and CVA must not be viewed in isolation. Attainment level data continues to play an important role in painting the full picture of a school's performance and in helping the school management to set its targets.

A.3.2 The use of CVA in the education sector

'Simple' value added measures arise from a national median line. The value added score for each student is the difference (positive or negative) between their own 'output' point score and the median (middle) output point score achieved by others with the same or similar starting point, or 'input' point score.

Taking account of contextual factors needs a more complex model, but the principle remains the same as for the 'simple' value added median line approach. A prediction for the pupil based on national patterns; their contextual value added score being the difference (positive or negative) from this prediction (see Table A.1). The particular technique used to derive a contextual value added score is called multi-level modelling (MLM).

Table A.1 Characteristics for which context adjustments are made

	Characteristics for which "context" adjustments are made
Gender	We allow for the different rates of progress made by boys and girls by adjusting predictions for females.
Special Educational Needs	Pupils who are school action SEN, and those who are on Action Plus or have a statement.
Ethnicity	Adjustments for each of the 19 ethnic groups recorded in PLASC.
Eligible for Free School Meals	Pupils who are eligible for free school meals. The size of this adjustment depends on the pupil's ethnic group. This is because the data demonstrates that the size of the FSM effect varies between ethnic groups
First Language	Adjustment for the effect of pupils whose first language is other than English. The size of this adjustment depends on the pupil's prior attainment. This is because the effect of this factor tends to taper, with the greatest effect for pupils starting below expected levels and lesser effects for pupils already working at higher levels.
Mobility	Pupils who have moved between schools at non-standard transfer times.
Age	Look at a pupil's age within year based on their date of birth.
In Care	Those pupils who have been 'In Care' at any time whilst at this school.
IDACI	A measure of deprivation based on pupil postcode.

When calculating a school score for 'simple' value added the average (mean) of all pupil scores within that school are taken. With contextual value added the average is still used but

an extra step known as the shrinkage factor is added. The shrinkage factor is determined by the number of pupils in a school's cohort (see Figure). It helps us to better estimate contextual value added for schools with small numbers in the calculation.

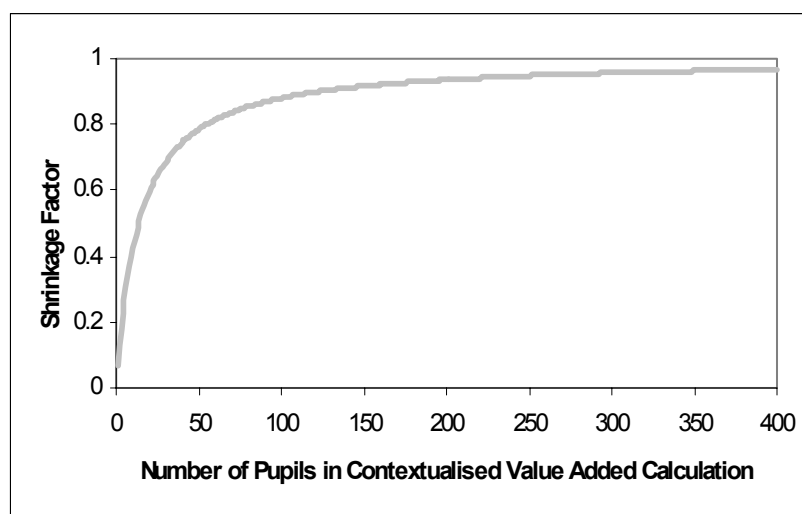


Figure A.1 Shrinkage factor

A.3.3 Possible use in the water industry

Understanding the “context” of level of leakage is an important issue in the understanding of the level of leakage – be that density, age and condition of pipes, traffic flows. However, additional contexts include environmental and social factors. One important environmental factor is the risk to the quantity and quality of water resources. The important benefit of using a CVA approach to both target setting and to understanding performance is that the distribution zones and their level of leakage can be compared like-for-like. Hence poor leakage management performance (and good leakage management performance) can be better understood.

The process of target setting can also be enhanced by taking context features into account. There will be specific context issues that will explain lower or higher figures and it will make sense to understand these figures with the background or the context of the system. Targets can be set based upon best practice as identified in comparable contexts. The use of a “valued added” component provides an opportunity to set targets that take account of continued improvements in best practice. So, over a 5 year planning process, targets set in year one, based on known best practice at that time can be adjusted or assessed to reflect the “added value” that a company can achieve.

A.4 Levels of retail “shrinkage” or “leakage”

A.4.1 Definitions

“Shrinkage” or “leakage” in retail is an attempt to quantify stock losses by calculating the difference between ‘stock + sales that should have been achieved’ and the ‘stock + sales actually achieved’ by the shop branch or business. Shrinkage figures are affected by a number of factors including administrative errors, mistakes in processing sales, but largely include theft either from staff or by shoplifting. The formula for measuring shrinkage is:

Shrinkage = actual stocks (at retail selling price or rps) – calculated closing stock

Closing stock (at rps) = opening stock at rps + purchases at rps – retail sales + agreed markdown – agreed markups

A.4.2 The use of retail shrinkage

In most stores, managers are given shrinkage targets, expressed as a percentage of sales. Shrinkage is calculated as above – the difference between the potential sales based on the delivery of stock and the actual sales made by the store. The targets are set based upon a “like for like” comparison with stores with a similar or comparable line of product and with a comparable socio-economic environment. Targets are set in the context of understanding what best practice is for the retail sector in question. In this way benchmarking provides a context based understanding for the setting of targets.

In developing a strategy for managing shrinkage, targets are based on the circumstances of the store – a risk assessment of the local threats for increasing theft and an understanding of which products are in greater threat of being stolen. In simplistic terms the higher the rate of shrinkage in a particular product line the greater the security or preventive measure will be applied. Frequently overall shrinkage will reduce by effectively targeting preventative measures in the high risk stores and with the high risk products. For example, at Tesco the ratio of security staff to full time staff in a store is roughly 8 for every 400, whilst at HMV stores it is 1 for every 8. High risk product lines will be defined as those of a high individual price (i.e. those of high value) and those at a lower price but with a high shrinkage level or turnover, such as CDs.

As mentioned before, shrinkage targets and the “economic acceptable level” are determined by competitive benchmarking between competitor companies and targets are driven by a self imposed incentive to ensure that stores remain competitive. Retail associations provide this information on a regular basis, such as the European Retail Theft Barometer, prepared by the Centre for Retail Research.

A.4.3 Potential use in the water industry

In some stores the term shrinkage is still known as “leakage”. The application in the water industry of the retail shrinkage example is limited by the fact that in the retail business the “economics” and “risk assessments” take place in the context of a multi-store and multi-product basis. In the water industry there is one product but there are differences between water distribution zones. It would be possible to take an approach to “contextual”

circumstances based on comparing the “like for like” of different distribution zones. Using these comparisons, instead of the rather generalised and crude “company comparisons”, it would be possible to look at setting targets for specific distribution zones based upon comparable benchmarks.

A further application of the shrinkage approach might be one that presents the economic case based on the “retail” value of the product, which would be the price of water to customers.

A.5 Pest control

Pest management in agriculture makes use of economic based decision making. Here the cost of pest control can be balanced against the economic gain from increased yields, and also incorporate aesthetic, environmental and social factors. The concept of an ‘Economic Injury Level’ (EIL) has been developed and can be defined as “The lowest population density of a pest that will cause economic damage; or the amount of pest injury which will justify the cost of control.”⁽¹¹⁾.

A simplified form of the EIL equation is:

$$EIL = (C/V) (1/L)$$

Where:

C = Pest Management Costs (cost per unit measure)

V = Market Value of Product, Managed Resource, etc. (cost per unit measure)

L = Loss Caused to Product, Managed Resource, etc., per Pest (loss per unit measure per pest)

Note that the market value of product is used in the equation as opposed to the production cost. The concept also differs from the control of water leakage in that pest control measures are not always applied continuously and therefore an “Action Threshold” has been defined as “The pest density at which control measures should be implemented to prevent it from reaching the Economic-injury Level (point where economic loss occurs).”

APPENDIX B POTENTIAL ALTERNATIVE APPROACHES TO LEAKAGE TARGET SETTING

This section summarises the alternative leakage target setting approaches that have been identified. A number of the suggested approaches are based on the current economic level of leakage (ELL), but make use of alternative methods for placing a value on the lost water or an additional incentive to reduce leakage.

It will also be necessary to consider how companies have applied the current best practice principles laid out in the Tripartite Report. The report presented a range of alternative methods for each individual process in the overall framework. There are currently no incentives for water companies to move from “good” practice to “best” practice; some of the perceived weaknesses in the ELL may be due to its application. It is considered that the current principles laid out in the Tripartite Report could be made more prescriptive, with a method of scoring a level of best practice,

One of the weaknesses of the current approach is that it does not specifically address the issue of the carbon footprint of leakage and leakage management. This is being investigated in an ongoing parallel study.

The alternative options are summarised in Figure , and discussed in the following sections.

The current descriptions are high level which is sufficient for a fair like-for-like comparison. The preferred options will be developed in more detail in later stages of the project.

There may be features of some of the options that are not selected for detailed investigation that add to the options under consideration, Examples are some elements of Context Value Added, Long term sustainability target and internationally derived indicators. These options may address some of the weaknesses in the proposed options and may be combined with other options.

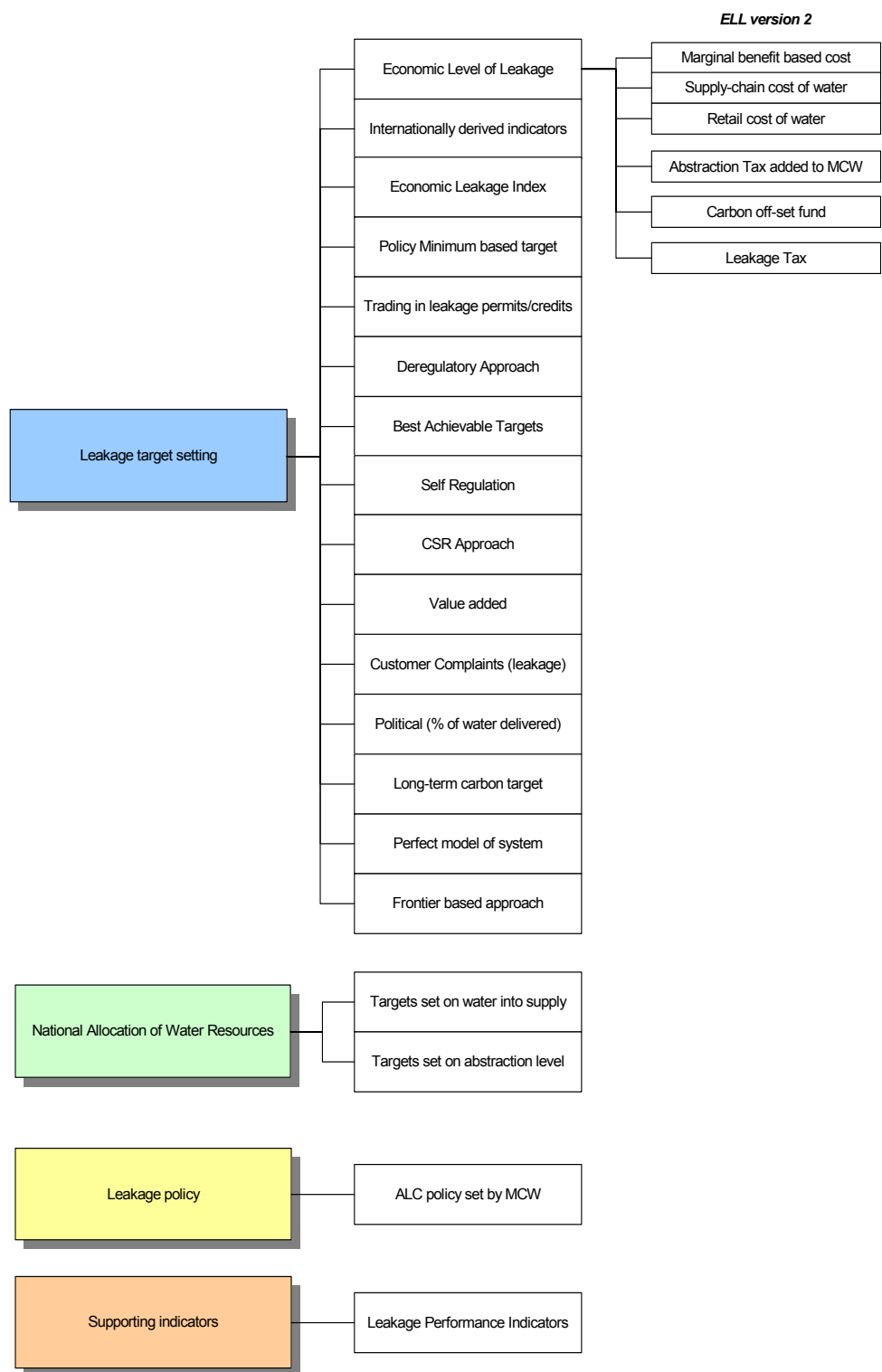


Figure B.1 Leakage Target Setting Approaches

B.1 Economic Level of Leakage (ELL)

The current approach to setting leakage targets balances the additional costs of reducing leakage with the additional benefits of the reduction. The approach requires a detailed analysis of the costs of the leakage management policy and the supply-demand position within the resource zone.

The cost of active leakage control to achieve different levels of leakage is derived using a modelling approach that is validated against the current costs and level of leakage. The relationship that is developed using the best practice principles allows the costs of alternative leakage policies to be estimated. It is considered that clearer guidance could be provided on the development of the relationships but that a fundamental change is not required.

There are, however, a number of different approaches that could be used within the ELL to derive the benefit of a reduction in leakage. All approaches rely on the same leakage vs. cost relationship to estimate the cost of reducing leakage but differ in how they attach a cost to the lost water or benefit of a reduction to the losses.

Many companies are now working close to their ELL, with further reductions in leakage only being economic for those companies proposing a new resource. Significant reductions in leakage may only be achievable if companies adopt a change in leakage management that results in a reduction in the policy minimum level of leakage

The following sections summarise the ELL and then present details of alternative approaches to estimating the benefits of reductions in leakage. Most of the approaches increase the value of water, or the benefit of a reduction in leakage, and so would generally lead to lower ELLs.

B.1.1 ELL: Marginal benefit based cost

Objectives of approach

The current approach requires a detailed analysis of the costs of the leakage management policy and the supply-demand position within the resource zone.

Proposed methodology

The Tripartite Report recommends an approach based on the marginal benefit of a reduction in leakage through either a least cost planning or marginal cost approach. The change in capital, operating, and environmental and social costs for alternative leakage targets is compared with the change in costs of leakage management. The ELL is the point at which the marginal cost of leakage management is equal to the marginal benefit in reduced losses.

For PR04 many companies used an analysis based on the marginal operating cost of water, where the benefit of a reduction in leakage was assessed to be between 5 and 10 p/m³. When the supply-demand balance requires additional resources within the 25-year planning horizon companies included the marginal capital cost and any social and environmental impacts; this generally increased the cost to approximately 25-50 p/m³.

Issues to resolve

The ELL is a well developed methodology that has now been applied by all water companies for a number of years. The Tripartite Report presents the Best Practice Principles that companies should apply but there is no single methodology. Differences in methodologies between companies make comparison of approach and results difficult.

An ongoing study is reviewing the approach to assessing the environmental and social benefit of leakage control to enhance this section of the Tripartite Report.

B.1.2 ELL: Supply-Chain cost of water

Objectives of approach

The ELL calculated using the best practice principles set out in the Tripartite Report will be based on the marginal cost of water. Traditionally the marginal operating cost of water is 5-10 p/m³ which increases to approximately 25-50 p/m³ when capital, environmental and social costs are included. As an integrated supply and distribution company the water company will value the benefit of a reduction in leakage based on the impact this has on the supply-demand balance.

As the water passes through the system it increases in value; this is illustrated in Figure . If the water company had separate treatment and distribution functions the economic incentives to reduce leakage in the distribution network may be greater.

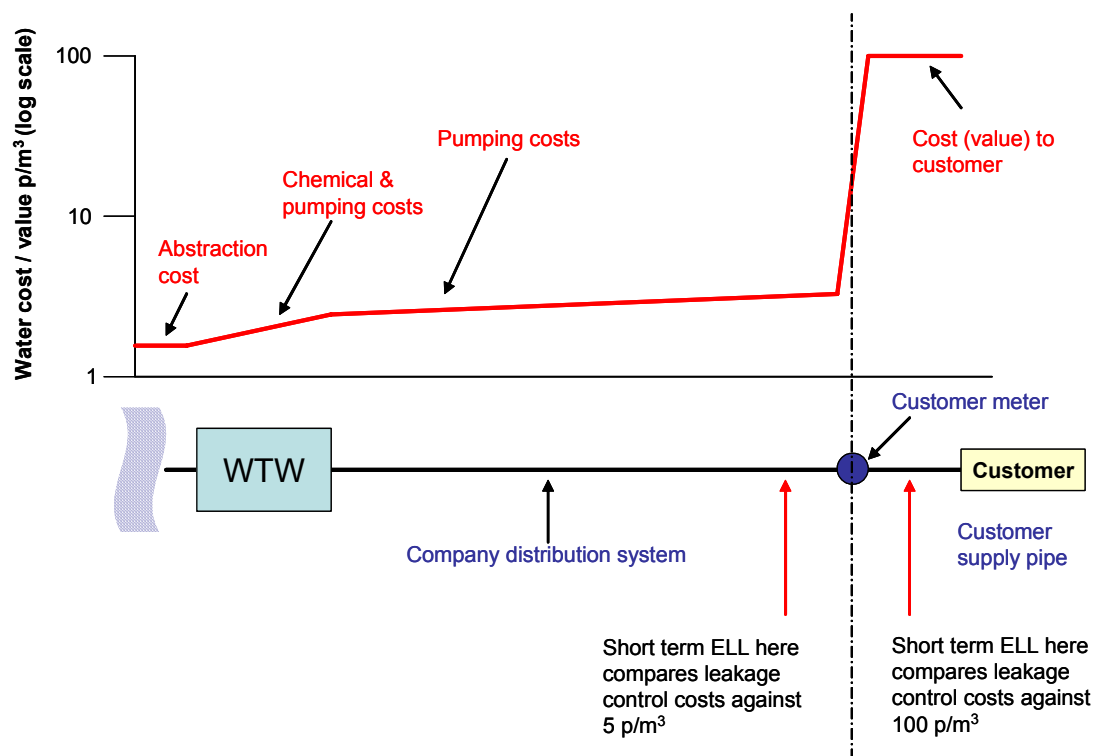


Figure B.2 Value of water increased through the supply chain

The aim of this approach is to apply set leakage targets assuming a notional split of water companies into production, distribution and sales.

Proposed methodology

In this approach the ELL for distribution leakage would be set based on the assumption that the distribution company was separate from the remainder of the water company.

Each water company would be required to assess its marginal cost of water at the point of production, distribution and supply. This could make use of existing Ofwat reporting of the long run marginal costs (LRMC), although the exact definition would need to be reviewed and may need revising for the purpose of setting leakage targets.

The company would then need to generate the ELL at each point of the network (production, distribution and sales). The company target would be based on the ELL at the appropriate point in the network. The ELL for the sales company is equivalent to using the retail value of water as discussed in the next option.

Issues to resolve

The possible impact of this approach is unclear; it would be necessary to undertake a trial in a number of companies to determine if the resulting leakage targets were significantly different to the existing ELL.

This approach increases the complexity of leakage target setting, by requiring three different costs of water to be calculated. For each calculation it will be necessary to include operating, capital, environmental and social costs.

B.1.3 ELL: Retail cost of water

Objectives of approach

When the water reaches the customer meter its value increases to the retail value of water, approximately 100 p/m³. This is illustrated in Figure . If, for example, the customer is on a large site with its own distribution network the ELL for the customer will be much lower than that for the supplying water company.

A number of other sectors use the retail value of their product when determining their economic level of losses or shrinkage. Within the agricultural industry, for example, farmers must decide the optimal level of application of pesticide. A similar relationship applies. The application of pesticide results in higher costs but reduces the level of loss of the product. In assessing the economic level of pesticide application the accepted approach is to use the retail value of the crop to determine the benefit. An equivalent approach is used within retail shopping to determine the economic level of losses through theft; the shop must decide on a economic level of security to reduce these losses.

Both the pest control and retail shopping examples use the retail value of the product when determining the economic level of losses. Within the current ELL the water companies effectively use the value of their raw product. There is clearly a difference between the sectors, since if a water company reduces leakage it may not necessarily be able to sell the "saved" volume of water whereas if a farm reduces losses to pests then it is very likely to be able to sell its additional product.

Although the economic basis of the current approach may be correct, it may highlight why customers do not consider the water companies are doing enough to reduce leakage from their network. A customer will value water at 100p/m³ whereas water companies place a much lower value on it. Is it sensible that the ELL on either side of the customer's meter is so significantly different?

Proposed methodology

In this approach the water companies would use their existing ELL methodology but using the retail price of water as the marginal benefit of leakage reduction. As the companies already report their retail value of water there are no additional data requirements.

Issues to resolve

This approach would be relatively straightforward to apply and for most companies will result in a lower leakage target. However, it can only be applied meaningfully at the company level as it is based on the retail value of water across the company and so would not allow zonal leakage targets to be set.

There is a degree of circularity in the calculation, since the cost of leakage control (including any capital solutions such as mains renewal), will need to be funded through price limits. The additional leakage activities will result in higher prices and hence even lower leakage levels.

This approach removes the link between leakage target setting and the supply-demand balance. Although companies with a large investment programme may have higher costs which would lead to lower leakage, the costs do not take account of zonal issues.

There is clearly a difference between the pest control/ retail shopping sectors and the water industry, since if a water company reduces leakage it may not necessarily be able to sell the "saved" volume of water whereas if a farm reduces losses to pests then it is very likely to be able to sell its additional product.

B.1.4 ELL: Abstraction Tax added to Marginal Cost of Water

Objectives of approach

This option is based on principles of the landfill tax; where the tax revenue is used to fund environmental improvements. The landfill tax provides two key benefits to the waste industry:

- The tax provides an incentive to reduce waste through greater use of recycling, since the cost to use landfill is increased.
- The fund generated through the application of the tax is used to fund the development of new technology that can be used to reduce the level of waste further.

Within the current ELL framework water companies may include the abstraction charge in the marginal cost of water calculation. However, since water companies pay an abstraction charge based on their licensed quantity and not the actual volume abstracted, the marginal benefit is really zero in financial terms. Additionally, since the level of abstraction charge is also very low at less than 1 p/m³, it has only a minor impact on the ELL.

Proposed methodology

Under this approach the abstraction tax would be linked to the actual volume taken and any revenue would be retained in a separate fund. This fund would then be used to finance research into leakage reduction and water efficiency technology. It may also be appropriate to use the fund to finance improvements to the water environment, to alleviate low flows for example.

At one extreme the Environment Agency would retain its current charging framework, where the standard unit charge is set at a level to ensure cost recovery. These charges would still be based on licensed quantities. The abstraction tax would also be set by the Environment Agency, and could be set at different levels for the different Agency regions. As the tax would be separate to the charges, it is proposed the tax is only levied on water companies, although the fairness and validity of this would be subject to consultation. The abstraction tax would be based on the actual level of abstraction.

Alternatively the charging framework could be designed to be revenue neutral to the water companies, but still provide incentives for companies to reduce abstraction. This could be achieved through a rising block tariff where the first block of abstraction is free, but the next blocks have a higher unit charge.

All revenue raised by the abstraction tax above that required by the Agency would be “ring-fenced” and kept for environmental improvements. If the tax was only applied to water companies it would be possible to use the fund to finance improvements in water efficiency or leakage control.

Full details of the charging options and framework to ensure funding for the Environment Agency will be developed in later stages of the project.

Issues to resolve

Any modifications to abstraction charges along the lines of an abstraction tax would require legislative changes. It would be necessary to re-visit the previous studies on incentive charging for abstraction, since robust measurements of volumes of abstraction would be required. It would also be necessary to consider the impact on the ongoing studies to estimate the level of compensation that may be payable to restore sustainable abstraction. Clear rules would also need to be developed to administer the fund generated.

B.1.5 ELL: Carbon off-set fund

Objectives of approach

Under this proposal each water company would be required to fund environmental improvements that offset the carbon produced by their level of leakage. The approach could potentially require the water company’s operation to be carbon neutral. This approach internalises the carbon impact into the company’s financial analysis, but would not necessarily result in a lower level of leakage.

Proposed methodology

The water company would be required to calculate the carbon footprint of its level of leakage, and to fund environmental improvements that off-set this level of carbon. There are a range of

carbon offsetting approaches, but most use investment in energy efficiency or carbon sequestration (such as planting trees) that balance the level of carbon produced.

This approach would require an agreed set of principles of carbon offsetting that would be applied by the water companies.

Issues to resolve

It is currently unclear what impact a carbon accounting based analysis would have on leakage management, since both active leakage control and water supply have a carbon impact. It is feasible that this approach may result in a higher level of leakage if, for example, the carbon impact of the Active Leakage Control (ALC) (such as the vans used by leakage teams) is higher than the impact of the electricity used to treat/pump the water.

A trial across a number of companies would be required to determine the impact this approach would have on leakage targets.

B.1.6 ELL: Leakage tax

Objectives of approach

This approach is similar to the abstraction tax based proposal but is focussed on the level of leakage. The water company would be required to make a payment into a leakage tax fund based on level of losses. This approach would not require the same level of legislative changes that the abstraction tax would require and, since leakage already forms part of regulatory returns, its level is recorded and audited.

The application of a leakage tax effectively increases the benefit of a reduction in leakage and would therefore result in a lower ELL for all companies.

Proposed methodology

The water companies would be advised of the level of leakage tax (in p/m³) that would be used in advance of the reporting year. It is suggested that companies would be advised of the level by October in the year before. This would allow water companies to develop an appropriate leakage policy. The leakage tax could be applied at the same level across England and Wales, or could be set at a regional level.

Companies would factor the leakage tax into their existing ELL analysis when setting their leakage targets.

At the end of the reporting year the companies would make a payment into the leakage tax fund equivalent to their reported level of leakage. This fund could be used to fund improvements to water efficiency or leakage management.

Issues to resolve

It would be necessary to define a clear set of principles to set the leakage tax; should this be applied to the entire volume of leakage, or the level of leakage above base or background. Clear rules would also need to be developed to administer the fund generated.

B.2 Internationally Derived Indicators

Objectives of approach

The IWA Water Losses Task Force has promoted a standardised terminology and set of performance measures that have been used both internationally and within the UK to understand and benchmark leakage performance.

The IWA approach is based on an understanding of leakage in a particular area, and the activities that can be undertaken to impact on the level of leakage in that area. Within the context of leakage target setting the key component of the IWA methodology is the development of the Infrastructure Leakage Index (ILI).

The ILI is calculated as the ratio of current annual real losses (CARL) and unavoidable real losses (UARL); it provides a comparison of the actual losses with a theoretical assessment of the level of leakage that could be achieved when using best practice. For example, an ILI of 2.0 suggests current losses are twice the level that could, without any consideration of the economics, be achieved. Within the UK, ILI figures generally lie within the range of 1.5 to 3 with one company having an ILI of over 6.

The UARL is based on the following equation which models the losses from the length of mains (L_m in km), the number of service connections (N_c), the total length of service connections from the edge of the street to customer meters (L_p in km), and the average operating pressure (P in metres) when the system is pressurised.

$$\text{UARL} = (A \times L_m/N_c + B + C \times L_p/N_c) \times P$$

Where the values for A, B and C are 18, 0.8 and 25 respectively, and are based on statistical analysis of international data, including 27 different water supply systems in 20 countries.

In addition to the UK the ILI has been applied extensively internationally; it is often the first indicator that is calculated when a water supplier decides it must address its level of losses. The ILI has been calculated at the company and zonal level, and can be used to compare performance within companies as well as between companies.

More details of the approach have been published by the IWA⁽³⁰⁾⁽³¹⁾. The approach has been tested in many countries around the world and has now been endorsed by AWWA and has become the American and Canadian standard. Additionally it is now been adopted across Australia for reporting and comparison of performance.

Proposed methodology

All water companies would be required to calculate their ILI, which should be relatively straightforward as the approach requires a minimal amount of data that should be readily available.

Although it is possible that all companies could be set an identical ILI target this would not take account of the economics of leakage reduction; companies within water stressed areas would be expected to have lower ILIs than companies with excess water. It is more likely the approach could be used to supplement a target setting approach based on the ELL (or similar), allowing comparison of leakage performance between companies on a like-for-like basis.

Issues to resolve

In its current form the ILI specifically excludes any analysis of the cost of achieving leakage levels and makes no allowance for infrastructure condition or the supply-demand position.

As the calculation of ILI is adjusted for the pressure within the zone, the ILI is not reduced if a company implements pressure management; the ILI is therefore more focussed on the performance of active leakage control and background leakage.

An enhanced methodology based on ILI, which should resolve some of these issues; these enhancements are due to be presented at the IWA Water Losses September Conference in Bucharest.

B.3 Economic Leakage Index (ELI)

Objectives of approach

The ELI has been developed to take account of the costs of achieving leakage reductions and the value of lost water saved within an ILI based indicator. This approach combines the concepts of the ILI with those of the ELL to develop a single indicator that allows a like-for-like comparison between companies and countries.

The approach combines the cost of active leakage control (e.g. the cost per sweep of a DMA), the Natural Rate of Rise (NRR) and the calculation of the UARL. The economic intervention frequency is then calculated based on the marginal value of water; this is then used to derive the Economic Level of Real Losses (ELRL). This economic level of losses will normally lie between the UARL (the lowest achievable level of losses) and CARL (current losses) unless the value of water is very high. The Economic Leakage Index (ELI) is the ratio current losses to economic losses.

Where the value of lost water is high, the economic level of losses will be close to the UARL. Where the value is low, the economic level of losses will be further away from the UARL. The ELI is a measure of current performance when compared to this economic level.

The ELI approach has been applied internationally/within the UK (references to be added).

Proposed methodology

All water companies would be required to calculate their ELI, which should be relatively straightforward as it requires a minimal amount of data which should be readily available. This approach also requires an assessment on the value of the long run marginal cost of water.

It is possible that all companies could be set an identical ELI target, alternatively the approach could be used to supplement a target setting approach based on the ELL, allowing comparison of leakage performance between companies.

Issues to resolve

Like the ILI, the ELI is focussed on active leakage control performance and background leakage; it does not take account of pressure management or infrastructure renewals. The approach could use company specific burst rate or be adjusted by companies one projected

capital maintenance expenditure to ensure that the economic level of real losses is the upper bound of the ELL.

The ELI could benefit from enhancements to the ILI that are currently being developed by members of the IWA Water Loss Task Force.

B.4 Target Set on Policy Minimum

Objectives of approach

The policy minimum is the sum of the lowest levels of leakage that have been achieved within each DMA over the last three years. It is not possible for companies to work at this level, since it would require all DMAs to be at their lowest level simultaneously. A company working at its ELL will typically be 30-50% above its policy minimum level of leakage.

The leakage target would be set by Regulators and would reflect water availability within the area; e.g. 20% above policy minimum in resource stressed areas to (say) 50% above policy minimum in other areas. Targets could be based on an economic analysis or set pragmatically.

Proposed methodology

The current methodology, proposed in the UKWIR Report, requires that companies undertake three sweeps across a DMA, and repair all identified leakage, to determine the policy minimum for the DMA. This approach is generally unworkable so most water companies examine leakage records to identify the lowest level of leakage that has been achieved in the last three years. To allow a fair target setting approach it would be necessary to agree a consistent methodology for assessing the policy minimum. This should be based on recent performance and not require additional activity.

Each company would be set a target level of leakage that is a percentage above their policy minimum. This would take the level of water stress into account. The policy minimum from the previous year would be used to set the target.

At the end of the reporting year the water company would present its actual level of leakage together with the policy minimum level which would be used for the setting the next year's target.

Issues to resolve

A clear, open and transparent methodology to determine the policy minimum would be required.

B.5 Trading in Leakage Permits/Credits

Objectives of approach

A more "hands off" approach to leakage target setting could be developed based on the trading in pollution permits. In the leakage context, the Regulator would assign leakage permits to each company. These define the level of leakage that a company is allowed.

Initially this level of leakage would be set nationally and then distributed to water companies by an agreed process (number of service connections for example).

Leakage permits could be traded to allow those companies with low leakage to benefit from their efficient leakage process. Future leakage reductions could be achieved by the Regulator either assigning a life to permits, which could say decrease in size by a given percent every 5 years. Alternatively the Regulator could buy leakage permits at the market rate.

Before buying/selling leakage permits, water companies would need to make their own analysis of uncertainty of leakage reduction costs and levels. This approach therefore internalises much of the uncertainty surrounding leakage.

Proposed methodology

The initial distribution of leakage permits could potentially be very difficult. If permits were based on current leakage performance then companies who had invested in reducing leakage may be disadvantaged. Alternatively licences could be assigned based on a model of the network and a notional “ideal” level of leakage.

It is anticipated that, to ensure a market could exist, the leakage permits would not be assigned to a geographic area. It is expected the permits would have a life-span of at least 5 years, although it may not be necessary to have any expiry date.

Issues to resolve

Although this approach appears to work for emissions trading there are a number of key issues that would need to be resolved before leakage trading could take place.

One of the key issues is the initial distribution of leakage permits on a fair and equitable basis. It would also be necessary to ensure that the larger water companies were not able to dominate the market.

The total volume of leakage covered by the permits would need to be carefully considered.

B.6 Deregulatory Approach

Objectives of approach

Many of the approaches would require an increased regulatory burden. There is an alternative “deregulatory” approach which relies on self-regulation. In this approach the Regulator sets level of leakage for the catchment and then allows the individual abstractors to determine (or “share out”) what level of leakage is appropriate for each abstractor.

Proposed methodology

The Regulator(s) would set a level of leakage that is appropriate for the catchment. It would be necessary to calculate a value for each catchment, which would need to be aligned with Catchment Area Management Strategy (CAMS).

On an annual basis the level of leakage is reported by each abstractor, and then summed to the catchment level.

If the level of leakage for the catchment does not reach the target then all abstractors would be fined. It is therefore in the interests of each abstractor to check all other abstractors to ensure they are meeting their agreed level.

Issues to resolve

One of the key issues is to determine how to set an appropriate level of leakage for the catchment; leakage is monitored by water companies, but is not generally measured by other abstractors.

It is likely that the water companies would be dominant in the majority of catchments.

B.7 Best Achievable Targets

Objectives of approach

The majority of manufacturing industry does not consider an analysis of losses to be appropriate. The companies aim to design out losses to achieve the lowest technically achievable level. This is also the approach used in many discharges to the environment, where the level of the discharge is set at the lowest level that can be achieved using the current technology. Over time, the level of losses or discharges will decrease as technology improves.

Proposed methodology

It is proposed that leakage targets would be set by the Regulator(s) based on the level that could be achieved using the current technology. It would be necessary to consider the condition of the network, since the level of leakage that can be achieved in the short-term is dependent on the current infrastructure.

Long-term targets could be proposed that provide incentives for the water company to renew its network in order to achieve the proposed leakage targets

Issues to resolve

This approach requires an accurate assessment of the level of leakage that could be achieved; there is scope for dispute between the water company and the regulator over what could be achieved.

This approach is more suited to setting long-term targets.

B.8 Self Regulation

Objectives of approach

In some other countries leakage targets are not set by a regulator or Government body. The water industry could, through Water UK, develop a self-regulating role to monitor the performance of its member companies, including their performance in leakage.

Leakage performance would need to remain visible to all stakeholders to provide the necessary incentives for companies that choose to improve their performance. As an industry

body Water UK could set/agree targets that their member companies should achieve based on a range of economic or environmental factors.

Proposed methodology

Water companies would continue to report leakage levels on an annual basis, using an agreed approach that was subject to external audit.

The reporting of leakage would then be via Water UK with regular updates on the performance of individual companies, possibly through the use of league tables.

Targets would not be set by the regulators. Companies would set their own targets based on their own economic analysis, which would include the supply-demand issues. The companies would also then need to decide where they were aiming to position themselves in the league table.

Issues to resolve

This approach removes the role of the regulators from leakage performance. The regulator(s) may wish to retain potential sanctions that could be applied to companies with poor performance.

B.9 Corporate Social Responsibility Approach

Objectives of approach

The water companies may decide to reduce leakage to levels that are considered appropriate based on their corporate social responsibility (CSR). These levels may be below what is calculated to be economic based on the current framework, allowing for additional benefits of working at lower levels of leakage. These targets could be based on an understanding of the customers' willingness to pay for environmental improvements.

This approach formalises the previous approach based on self regulation by the inclusion of willingness to pay to allow the water company to quantify the amount by which leakage should be reduced below the traditional ELL.

Proposed methodology

Water companies would determine their economic level of leakage, using the current methodology, and then decide if a lower leakage target would be appropriate. Any lower target would be based on an assessment of customer's willingness to pay.

Leakage levels would need to be reported annually under this approach, so as to remain visible to all stakeholders. It is also likely that some form of league table would be required to provide those water companies that decide they wish to reduce leakage the ability to compare their performance with other water companies.

Issues to resolve

A robust assessment of customers' willingness to pay for reductions in leakage is difficult to obtain in isolation to other environmental/social improvements such as flooding and customer service improvements.

B.10 Context Value Added

Objectives of approach

Value added measures have been used in the Achievement and Attainment Tables (formerly known as Performance Tables) in comparing school performance and in setting targets since 2002. They measure the attainment of pupils in comparison to pupils with similar prior attainment; this is fairer than using raw outcomes since schools can have very different levels of attainment on pupil entry.

However, there are many other factors that are related to the progress that pupils make in a school, such as levels of deprivation or special educational needs. Contextual value added aims to take account of these factors when measuring the effectiveness of a school or the progress made by individual pupils; thereby providing a means of comparison and target setting in the context of a like-for-like understanding of performance.

Proposed methodology

The proposed methodology was discussed in Appendix A.2.3 of this report.

Issues to resolve

This approach is significantly different to existing approaches, a detailed methodology would need to be developed to allow the principles used in other sectors to be applied to leakage target setting. It is considered this would require a trial at a number of water companies.

B.11 Customer Complaints (leakage)

Objectives of approach

One of the objectives of setting leakage targets may be to meet customer expectations that water companies should reduce leakage to acceptable levels. A simple measure of customer's views on leakage performance would be to set targets based on the number of customer complaints related to leakage issues.

Proposed methodology

This approach would require that companies report the number of customer enquiries or complaints relating to leakage. The decision over assigning customer contact to leakage may be difficult, since the definition is unlikely to be straightforward. It will also be necessary to reflect customer concerns about leakage in neighbouring companies within the figures.

This approach would be expected to provide companies with additional incentives to educate customers and to reduce the time taken to repair visible leaks.

Issues to resolve

The most significant issues are how to distinguish a "leakage" complaint from other complaints and the impact the performance of neighbouring water companies would have on the indicator.

This approach is unlikely to lead to a reduction in leakage, as it would focus companies on visible leakage, and not on the leaks that were resulting in the largest losses.

B.12 Political (percentage of water delivered)

Objectives of approach

Many customers and stakeholders do not understand leakage levels in terms of MI/d or l/prop/day. When reported in the press they are often converted to percentage levels of losses. The UK water industry, particularly through the IWA, has spent many years arguing the case for not reporting leakage as percentages. These arguments are based on the fact that different levels of customer use will change the percentage leakage even if the actual level of leakage remains unchanged. The comparison of leakage performance in different countries based on percentages is particularly problematic since the levels of water use vary so significantly.

Proposed methodology

Leakage targets could be set based on a maximum percentage of either distribution input or water delivered.

Table presents the leakage performance for 2005-06 with a percentage based on water delivered. It can be seen that the majority of companies would report leakage between 15-20%.

The targets could be set nationally, or regionally based on water-stressed status.

Table B.1 Comparison of Leakage as percentages (Ofwat, 2005-06)

	Water delivered MI/d	Total leakage MI/d	Total leakage %
Water and sewerage companies			
Anglian	991.6	213.6	18%
Dwr Cymru	666.1	224.2	25%
Northumbrian – North East	598.6	157.1	21%
Northumbrian – Essex & Suffolk	422.9	66.6	14%
Severn Trent	1,616.5	542	25%
South West	381.7	84.3	18%
Southern	504.3	92.8	16%
Thames	2,168.4	862.4	28%
United Utilities	1,527.4	477.4	24%
Wessex	311	73.2	19%
Yorkshire	1,057.1	296.7	22%
WaSC total	10,245.6	3,090.3	23%

	Water delivered MI/d	Total leakage MI/d	Total leakage %
Water only companies			
Bournemouth & W Hampshire	141.2	21.5	13%
Bristol	242.6	53.2	18%
Cambridge	64.9	13.9	18%
Dee Valley	61.6	11.3	16%
Folkestone & Dover	39.1	8	17%
Mid Kent	142.1	27.8	16%
Portsmouth	157.4	29.5	16%
South East	334	69.1	17%
South Staffordshire	278.8	73.4	21%
Sutton & East Surrey	144.4	24.3	14%
Tendering Hundred	25.8	5.1	17%
Three Valleys	776.2	148.7	16%
WoC total	2,408.1	485.8	17%
Industry total	12,653.7	3576.1	22%

Issues to resolve

This approach takes very little account of the supply-demand position, Environmental & Social impacts or regional issues. Reporting leakage on a percentage basis gives a disincentive for water companies to implement water efficiency measures.

B.13 Long-term Sustainability Target

Objectives of approach

One of the drivers for long-term leakage reduction is the impact of climate change. Leakage targets could be presented on a similar basis to the commitments made by governments to reduce carbon emissions. It may be possible to align the long-term leakage reduction targets with the long-term commitments on carbon reductions.

Proposed methodology

Water companies would be set long-term (at least 25-years) leakage targets; this could, for example be based on a assessment of the level of leakage that could be achieved with an ideal network or could be based on, say on a 50% reduction by 2030.

Within the long-term framework it would be necessary to set interim targets to allow companies and their regulators to track progress towards the long-term target. It is likely that the water companies would set their own interim targets to achieve the long-term targets.

This approach is founded on the assumption that over time leakage should be reduced from its current level. Any commitment by water companies to long-term leakage targets would

require recognition within the regulatory regime which does not currently consider delivery of outputs beyond the current AMP period.

Issues to resolve

The Regulator(s) would need to be able to justify the long-term targets.

Interim targets would be set by the water companies, to allow them and the Regulator(s) to track progress. There may be potential conflict over the proposed reduction profile.

B.14 Perfect Model of System

Objectives of approach

A model would be prepared to enable the level of leakage from an “ideal” water company to be derived based on new assets all working perfectly. The model would include the forecast changes to the customer base and impact of climate change but would not include the current network condition. The level of leakage from this model would be a long-term target that the company should aim to achieve within, say, 50 years.

Proposed methodology

It would be necessary to develop and agree the basis of the ideal model; this would then be used to set the long-term targets for each company.

Each water company would set interim leakage targets that would allow it to monitor progress towards the long-term target.

Issues to resolve

Interim targets would be set by the water companies, to allow them and the Regulator(s) to track progress. There may be potential conflict over the proposed reduction profile.

B.15 Frontier based approach

Objectives of approach

Regulatory targets in other areas of water company performance are based on the best performance of other companies. The performance of all companies is normalised, by taking account of factors outside the companies’ control, such as, for example, population density. The companies with lower performance are then set targets based on the performance of the best, or frontier, companies.

Under this approach leakage targets would be set based on the performance of the best companies, possibly the lower quartile. This approach would result in leakage performance targets being set in a consistent manner to other performance targets, such as opex performance.

This approach does not rely as heavily as others on models as the targets are set based on actual performance of other companies.

Proposed methodology

Water companies would report their leakage performance based on the current regulator returns. The potentially most difficult step would then be to normalise the performance across all companies, taking account of the infrastructure (condition and pressure for example). This normalised leakage performance would then be used to prepare a ranked list of company leakage to allow a like-for-like comparison.

Leakage targets would be set for companies to move to the lower quartile of the ranked list. Companies already in the lower quartile would be required to maintain their level of leakage at the current level.

Issues to resolve

It is likely to be difficult to develop the normalised leakage performance, allowing for the various external factors. The Tripartite Report presented a range of leakage performance indicators. Following the Tripartite Report, the Water UK leakage group has been examining a wider range of leakage performance indicators. To normalise leakage performance it will be necessary to take account of the key factors, but to keep the methodology as clear and concise as possible.

The Regulator(s) will need to set a profile (or deadline) for the companies to achieve the lower quartile, and to regularly re-assess the leakage performance.

B.16 Targets set on Water Into Supply

Objectives of approach

The Tripartite Report recommended a National re-allocation of water resources, to reflect the needs of the companies and environment and reduce the impact of historic inheritance of abstraction licences. It has been concluded that this is not really feasible, although it is happening to some extent during the CAMS process.

However, a more straightforward approach would be to assign water into supply (WIS) targets, based on a company's customer base. Again, companies would be allowed a volume of water based on the needs of their customers. The flexibility of a WIS based target would not only provide incentives to reduce leakage but also to reduce demand.

Water into supply is already measured by companies, and unlike leakage does not require estimates to be made.

This approach provides incentives for demand management in addition to leakage reductions. This provides the companies with flexibility to decide the most cost effective means to ensure their customers' needs are met, through an optimal mix of leakage reduction, demand reduction or efficient use of water.

Proposed methodology

It would be necessary for the Regulator(s) to agree a formula for assigning appropriate water into supply targets based on the population served by the water company. This formula would need to include an assessment of the impact of weather on demand and also include an acceptable level of leakage.

Companies would then report the level of water into supply in their regulatory return.

It is likely that water companies would seek to explain any under-performance by reference to the weather during the report year.

Issues to resolve

This approach is heavily dependant on the formula used for assigning the WIS targets, and the assumptions incorporated, particularly on the impacts on weather.

B.17 Targets set on Abstraction Level

Objectives of approach

This approach links with CAMS and the implementation of the Water Framework Directive (WFD). The approach is similar to the WIS targets, but with the target set based on the environmentally sustainable level of abstraction from the catchment.

This approach recognises that it is not leakage that has the potential to cause environmental damage; it is the level of abstraction from the environment. The aim of this approach is to provide incentives to introduce demand management measures alongside leakage reduction.

It is considered that the approach could be implemented using an incentive charging based licence. For the agreed volume of water, charges are based on the current unit rates. If the company takes above the agreed level then the unit charge increases significantly. In its "Tuning Water Taking" report DEFRA recognises that some form of incentive charging could form a basis for charging in the future (however the main text of the report focuses on licence trading).

Proposed methodology

The Regulator(s) define an abstraction target which reflects the sustainability of the abstraction. This is likely to be below the current licensed abstraction in many catchments in the South of England. It is envisaged that initial targets will be phased in over a number of years to allow water companies to make the necessary investments to achieve the target.

Water companies will need to work within this limit, and set internal targets of water efficiency measures, domestic metering and leakage to enable the abstraction level to be achieved within the required timescales.

Issues to resolve

There are a number of regulator issues that would need to be resolved within the current abstraction licensing and charging regime as it would require targets to be set below the current licensed abstraction. There may be compensation payable if licences are revoked or reduced.

The weather will have a significant impact on the level of abstraction. This impact will need to be incorporated into any methodology.

B.18 Policy Set by Marginal Cost of Water

Objectives of approach

The marginal cost of water for the next resource/treatment option defines the leakage policy that the water company should be using. This approach removes the economic analysis, with a defined policy for each level of water availability (or cost). The Regulator would define the policy that the company should be using, given the resource position. For example a company with stressed water resources could be required to have a leakage policy based on small DMAs with telemetry, allowing a rapid repair and hence low levels of leakage.

The resource position could be defined based on the marginal cost of water, the Security of Supply Index, or Water Stressed Status.

The approach requires the direct involvement of Regulators in the operational activities of the water companies. This is not consistent with the current method of regulation within the water industry which is based on outputs and not the operational methods employed by the companies to achieve the outputs.

Proposed methodology

The Regulator(s) would develop a matrix of marginal cost of water and leakage management policy. This would be in the form of a simple look-up. This matrix would enable the Regulator(s) to determine an appropriate leakage management policy for each level of cost of water.

The water company would report the marginal cost of water and the current leakage management policy. The Regulator(s) would then determine if the water company was using an appropriate leakage management policy.

Issues to resolve

The approach could not be used as a target setting methodology but has some potential use as a means of validating the leakage management policy in place by companies.

This approach takes no account of the costs involved in moving from one policy to another.

B.19 Leakage Performance Indicators

Objectives of approach

The Leakage Performance Indicators Report of the Tripartite Group recommended a series of Leakage Performance Indicators (LPIs), which were classified as “primary”, “secondary” or “system” indicators. The primary indicators reflected, for example, the number of leaks found per inspector. The secondary indicators reflected supporting data, such as reaction time or age of flow data for example. Finally, the system indicators reflected the number of DMAs or number of pressure management areas for example.

A national set of indicators, with consistent definitions between companies, would assist the Regulators when assessing submissions by companies explaining why their ELL is “non-standard” or why they had not achieved their ELL.

Proposed methodology

It is not proposed to use the indicators to set targets; they may support one or more of the alternative approaches.

APPENDIX C SHORT-LISTING OPTIONS FOR FURTHER CONSIDERATIONS

C.1 Approach

In order to meaningfully compare the alternative options for leakage target setting it is necessary to reduce the number of options. The 24 potential options for alternative leakage target setting need to be narrowed down and the method chosen to select a short list of options is multi-criterion decision making (MCDA). Using this technique, alternative options are evaluated in a structured and open manner to allow the various options to be ranked and short-listed.

The steps in the process are to:

- a) Agree the decision context, i.e. agree the attributes that alternative options need to have to be effective in setting leakage targets. These will be used in comparing different options. This is explained in Appendix C.2;
- b) Identify the options to be appraised in the analysis. These are listed in Appendix B;
- c) Define the criteria for assessing each option. These will be based on the aims and objectives, and need to be weighted to reflect their relative importance. This is explained in Appendix C.3;
- d) Create a performance matrix from the options and assessment criteria and then score the options on the criteria. Scales for each criteria will be constructed, weighted and weighted averages calculated. This is included in Appendix C.4;
- e) Calculate the overall weighted scores and then select the options for further consideration (Appendix C.5).

C.2 Attributes for leakage target setting approaches

At the project inception meeting, the objectives that the ELL and potential alternative approaches to leakage target setting should aspire to were discussed and agreed by the steering group. These objectives or attributes help define the criteria by which existing and alternative leakage target setting processes should be judged. The key attributes are described below.

A leakage target setting process should:

- Be founded on economic principles;
- Be consistent with the long term Water Resource Planning process⁽¹⁰⁾;
- Have a clearly defined methodology and data requirements;
- Take account of short term issues;
- Be comprehensible to all stakeholders, including consumers;

- Follow the values of the Better Regulation Task Force: proportionality, accountability, consistency, transparency, targeting.

C.2.1 Be founded on economic principles

In recent statements, the Minister for Climate Change and the Environment has set out a clear steer that any leakage target setting methodology should be based in an economic framework. This view was supported by the steering group and is consistent with the current ELL target setting process ⁽¹⁾, the Water Resource Planning process ⁽³⁾, and the Economics of Balancing Supply and Demand ⁽⁴⁾.

C.2.2 Be consistent with the Water Resource Planning process

Water resources plans show how a water company intends to manage the balance between supply and demand for water over the next 25 years. The plans are complemented by the water company drought plans, which set out the short-term operational steps a company will take as a drought progresses.

Within water resource plans, companies should set out a forecast of demand for water for 25 years and compare this with a forecast of available water supply. This gives a calculated surplus or deficit of water for each year. Where there is a deficit, companies should choose water management options to meet the difference, considering resource development, demand management and leakage control options.

Future leakage levels impact on demand projections and on water management options for balancing supply and demand.

C.2.3 Have a clearly defined methodology and data requirements

One of the criticisms of the current process is that the methodology is complex and it allows scope for interpretation of data. Alternative processes should be clearly defined, with a clear methodology and data requirements.

C.2.4 Take account of short term issues

Leakage, supply-demand and water resource management are long term requirements. The drought in 2006 resulted in some concerns that consumers found it difficult to reconcile leakage targets (or levels) with water shortages and restrictions on water use. The leakage target setting process should be able to take account of short term issues like water restrictions during a drought.

C.2.5 Be comprehensible to all stakeholders, including consumers

This requirement links to the previous two requirements in that, whilst leakage management is a complex process, the leakage target setting process should be comprehensible to stakeholders. Particularly important is the ability to explain how the process relates to customers' short and long term needs.

C.2.6 Follow the values of the ‘Better Regulation Task Force’

The Better Regulation Task Force has developed its ‘Principles of Good Regulation’⁽¹²⁾ which regulators should bear in mind when devising, implementing, enforcing and reviewing regulations. The leakage target setting process should consider these principles which are set out below.

Proportionality

Regulators should only intervene when necessary. Remedies should be appropriate to the risk posed, and costs identified and minimised.

- Policy solutions must be proportionate to the perceived problem or risk and justify the compliance costs imposed – “don’t use a sledgehammer to crack a nut”.
- All the options for achieving policy objectives must be considered – not just prescriptive regulation. Alternatives may be more effective and cheaper to apply.
- “Think small first”. Regulation can have a disproportionate impact on small businesses, which account for 99.8% of UK businesses.
- EC Directives should be transposed without gold plating.
- Enforcement regimes should be proportionate to the risk posed.
- Enforcers should consider an educational, rather than a punitive approach where possible.

Accountability

Regulators must be able to justify decisions, and be subject to public scrutiny.

- Proposals should be published and all those affected consulted before decisions are taken.
- Regulators should clearly explain how and why final decisions have been reached.
- Regulators and enforcers should establish clear standards and criteria against which they can be judged.
- There should be well-publicised, accessible, fair and effective complaints and appeals procedures.
- Regulators and enforcers should have clear lines of accountability to Ministers, Parliaments and assemblies, and the public.

Consistency

Government rules and standards must be joined up and implemented fairly.

- Regulators should be consistent with each other and work together in a joined-up way.
- New regulations should take account of other existing or proposed regulations, whether of domestic, EU or international origin.
- Regulation should be predictable in order to give stability and certainty to those being regulated.
- Enforcement agencies should apply regulations consistently across the country.

Transparency

Regulators should be open, and keep regulations simple and user-friendly.

- Policy objectives, including the need for regulation, should be clearly defined and effectively communicated to all interested parties.
- Effective consultation must take place before proposals are developed, to ensure that stakeholders' views and expertise are taken into account.
- Stakeholders should be given at least 12 weeks, and sufficient information, to respond to consultation documents.
- Regulations should be clear and simple, and guidance, in plain language, should be issued 12 weeks before the regulations take effect.
- Those being regulated should be made aware of their obligations, with law and best practice clearly distinguished.
- Those being regulated should be given the time and support to comply. It may be helpful to supply examples of methods of compliance.
- The consequences of non-compliance should be made clear.

Targeting

Regulation should be focused on the problem, and minimise side effects.

- Regulations should focus on the problem, and avoid a scattergun approach.
- Where appropriate, regulators should adopt a "goals-based" approach, with enforcers and those being regulated given flexibility in deciding how to meet clear, unambiguous targets.
- Guidance and support should be adapted to the needs of different groups.
- Enforcers should focus primarily on those whose activities give rise to the most serious risks.
- Regulations should be systematically reviewed to test whether they are still necessary and effective, if not, they should be modified or eliminated.

C.3 Identify the criteria for assessing each option

Based on the objectives, a set of criteria for assessing the options has been identified. These are described in Table .

Table C.1 List of criteria for evaluation of options

Criterion	Brief description
a) Economic principles	The approach should use an economic framework to derive the target.
b) Consistent with WRP	The approach should be consistent with the Water Resource Planning process, i.e. future leakage levels should impact demand projections and water management options for balancing supply and demand over a 25 year timeframe.
c) Clear methodology	The approach should have a clearly defined methodology.
d) Clear data requirements	The approach should have clearly defined data requirements.
e) Address short term needs	The leakage target setting process should be able to take account of short term issues like water restrictions during a drought. The approach must consider the risks surrounding achievement of targets.
f) Comprehensible to customers	The principles of the approach should be able to be easily communicated to non-experts. This does not need to result in a "simple" approach – for example the public can understand the principles of a car, but the car itself is very complex.
g) Proportionality	The approach should be appropriate to the risk posed and should follow an educational rather than punitive approach.
h) Accountability	Regulators must be able to justify decisions using the approach which should establish clear standards and criteria against which targets can be judged.
i) Consistency	The approach should be predictable in order to give stability and certainty to those being regulated, and should apply consistently across the country.
j) Transparency	The approach should be open, simple and user-friendly.
k) Targeted	The approach should be focused on the problem, and adopt a "goals-based" approach with those being regulated given flexibility in deciding how to meet clear, unambiguous targets.
l) Cost to derive the target	The cost impact on the regulator and regulated of determining and setting the target.
m) Under company control	Water companies should be able to control the process of setting the targets.

Each of the criteria were weighted by each of the stakeholders on a scale of 1 to 10. The raw weights are shown in Table .

In order to allow direct comparisons to be made between the weightings and to allow the mean, maximum and minimum values to be determined the weightings were also scaled. The weights with the maximum value were scored at 10 and those with the minimum value were scored at 1, intermediate scores were scaled on a linear basis to derive the table of weightings shown in Table .

Table C.2 Raw weights for each criterion

	Criteria												
	a) Economic principles	b) Consistent with WRP	c) Clear methodology	d) Clear data requirements	e) Address short term variability	f) Comprehensible to consumers and all stakeholders	g) Proportionality	h) Accountability	i) Consistency	j) Transparency	k) Targeted	l) Cost of administering the target	m) Based on parameters which are under company control
Weighting													
Environment Agency	10	7	8	8	6	5	8	8	8	8	8	6	7
OFWAT	10	10	9	9	6	8	7	8	9	6	7	6	9
DEFRA WSR	10	8	8	8	7	8	8	8	8	8	8	8	7
Water UK	10	9	6	6	5	8	5	5	6	4	7	3	7
CCWater	9	9	7	7	1	10	5	5	5	7	6	3	2
Water Company	10	10	9	8	2	4	4	4	5	6	6	1	9
Water Company 2	10	10	9	9	0	5	5	5	5	7	7	2	9

Table C.3 Scaled weights for each criterion

	Criteria												
	a) Economic principles	b) Consistent with WRP	c) Clear methodology	d) Clear data requirements	e) Address short term variability	f) Comprehensible to consumers and all stakeholders	g) Proportionality	h) Accountability	i) Consistency	j) Transparency	k) Targeted	l) Cost of administering the target	m) Based on parameters which are under company control
Weighting													
Environment Agency	10.00	4.60	6.40	6.40	2.80	1.00	6.40	6.40	6.40	6.40	6.40	2.80	4.60
OFWAT	10.00	10.00	7.75	7.75	1.00	5.50	3.25	5.50	7.75	1.00	3.25	1.00	7.75
DEFRA WSR	10.00	5.50	5.50	7.75	3.25	5.50	1.00	5.50	5.50	5.50	5.50	1.00	3.25
Water UK	10.00	8.71	4.86	4.86	3.57	7.43	3.57	6.14	4.86	2.29	6.14	1.00	6.14
CCWater	9.00	9.00	7.00	7.00	1.00	10.00	5.00	5.00	5.00	7.00	6.00	3.00	2.00
Water Company	10.00	10.00	9.00	8.00	2.00	4.00	4.00	9.00	9.00	4.00	6.00	1.00	9.00
Water Company 2	10.00	10.00	9.10	9.10	1.00	5.50	5.50	9.10	9.10	5.50	7.30	2.80	9.10
Mean	9.86	8.26	7.09	7.27	2.09	5.56	4.10	6.66	6.80	4.53	5.80	1.80	5.98
Median	10.00	9.00	7.00	7.75	2.00	5.50	4.00	6.14	6.40	5.50	6.00	1.00	6.14
Max	10.00	10.00	9.10	9.10	3.57	10.00	6.40	9.10	9.10	7.00	7.30	3.00	9.10
Min	9.00	4.60	4.86	4.86	1.00	1.00	1.00	5.00	4.86	1.00	3.25	1.00	2.00

Mean, median, maximum and minimum scores are also shown in Table for the scaled weightings. These are presented graphically in Figure . This indicates that there were some criteria with good agreement for the importance of the criteria, such as ‘economic principles’, and some where range of importance was much greater, such as ‘comprehensible to all stakeholders’. Both the raw and scaled weightings were used in the subsequent analysis of options to test the sensitivity of the outcomes.

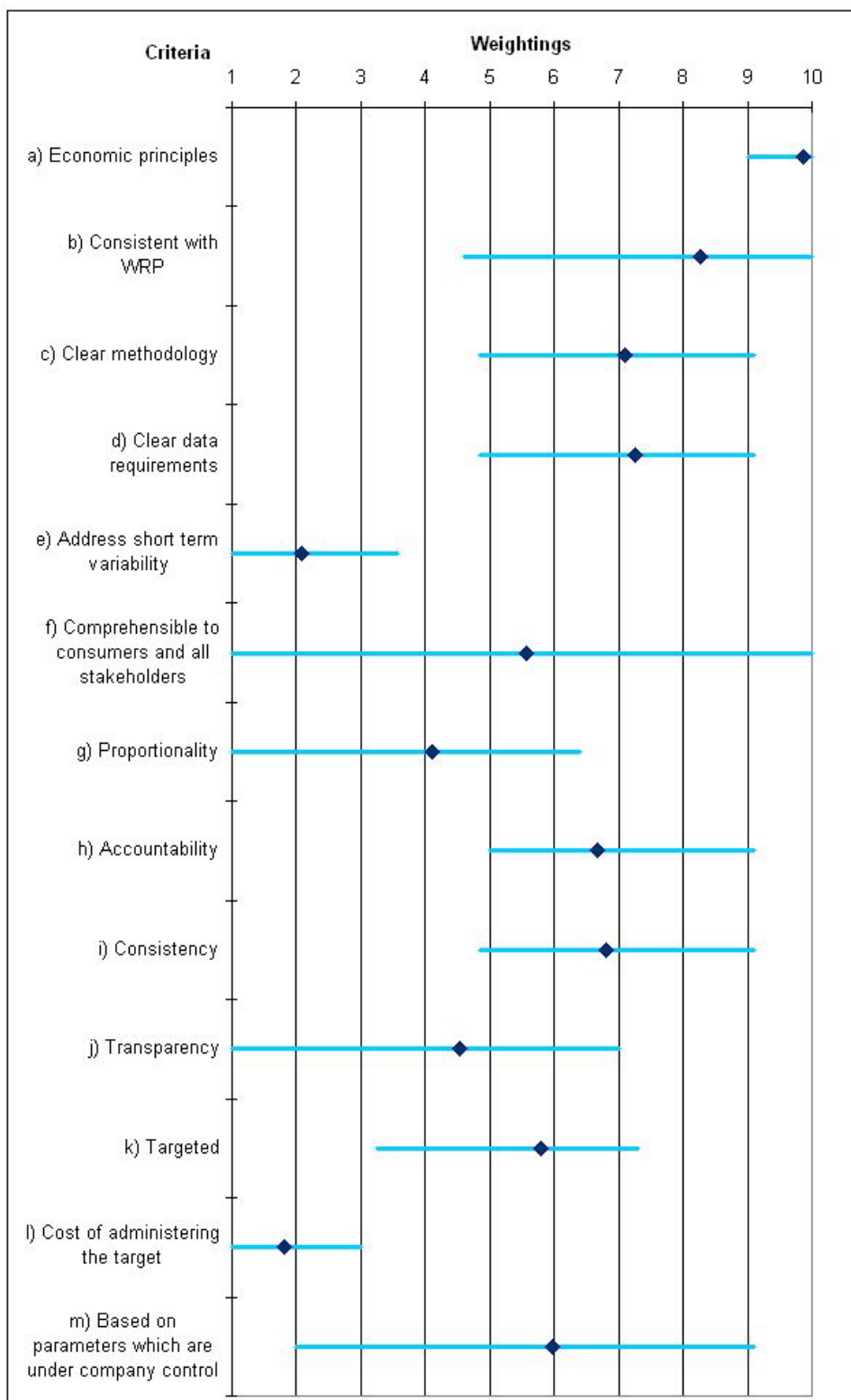


Figure C.1 Range of scaled weightings for each criterion

C.4 Multi criterion analysis process for selecting the initial list of preferred options

A performance matrix was created for the options and the criteria to place scores for each of the options against the agreed criteria. This process was carried out by the WRc team. The scoring was carried out completely independently of the weighting process, in this case the scoring was done before and without any knowledge of the weightings which were decided later. The raw scores are represented in Table .

Table C.4 Raw scores for each option

		Criteria												
		a) Economic principles	b) Consistent with WRP	c) Clear methodology	d) Clear data requirements	e) Address short term needs	f) Comprehensible to customers	g) Proportionality	h) Accountability	i) Consistency	j) Transparency	k) Targeted	l) Cost to administer the target	m) Under company control
Scoring system		1-10	Y/N	1-10	1-5	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-5	1-5
Options	Current ELL approach	8	Y	6	4	4	6	8	9	7	3	10	3	5
	ELL - Supply chain cost of water	8.5	Y	6	4	4	6	8	9	7	4	10	3	5
	ELL - Retail cost of water	4	Y	6	4	5	8	8	9	7	5	10	3	5
	ELL - Abstraction tax	8.5	Y	6	4	7	7	8	9	7	4	8	3	5
	ELL - Carbon off-set fund	9	Y	4	3	4	5	8	8	7	2	8	4	5
	ELL - Leakage Tax	4	Y	4	4	6	8	6	7	7	2	10	3	5
	ELL - Abstraction incentive charging	9	Y	6	4	4	7	8	9	7	5	10	3	5
	Internationally derived indicators	1	N	8	2	1	8	4	2	8	2	8	1	3
	Economic leakage index	4	N	4	2	1	4	5	4	7	2	9	3	3
	Target set on policy minimum	5	Y	7	3	6	4	8	7	7	3	9	2	5
	Trading in leakage permits	9	Y	7	4	7	6	9	9	8	7	7	4	3
	Deregulatory approach	7	Y	4	4	6	5	8	7	6	6	9	3	4
	Best achievable targets	5	N	5	2	2	8	4	2	6	3	10	2	2
	Self regulation	7	Y	7	4	4	4	4	1	9	7	5	2	5
	Corporate social target	9	Y	7	3	6	6	4	3	9	7	5	2	4
	Context Value Added	3	Y	6	4	3	6	8	9	7	6	9	3	5
	Target set on customer complaints	1	N	5	2	6	8	4	6	4	8	2	1	1
	Political targets	5	N	9	1	3	10	6	6	4	5	7	1	5
	Long term sustainability target	6	Y	8	3	2	5	5	4	8	6	8	2	4
	Perfect model of system	6	Y	8	3	1	2	3	5	8	7	6	4	4
Targets set on water into supply	6	Y	8	5	4	8	8	6	8	7	7	2	2	
Targets set on abstraction level	6	Y	8	5	6	8	8	6	8	8	8	4	2	
Policy set on MCW	4	N	5	2	2	2	5	3	4	4	3	2	4	

Each score is then scaled, based on an assigned relative preference scale. A scale of 0 to 100 has been used, with the preferred option assigned a value of 100 and the least preferred option assigned a value of 0. So in the case of the scores used in Table , the scores have been scaled as follows:

- Score of 1 – 10: where 1 = 0 and 10 = 100 on a linear scale;
- Score of 1 – 5 (for criteria l)): where 5 = 0 and 1 = 100 on a linear scale;
- Score of 1 – 5 (for criteria d and m) where 1 = 0 and 5 = 100 on a linear scale;
- Y = 100 and N = 0.

Applying the preference scales results in the following scaled performance matrix in Table .

Table C.5 Scaled scores for each option

		Criteria													Total Weighted Score
		a) Economic principles	b) Consistent with WRP	c) Clear methodology	d) Clear data requirements	e) Address short term needs	f) Comprehensible to customers	g) Proportionality	h) Accountability	i) Consistency	j) Transparency	k) Targeted	l) Cost to administer the target	m) Under company control	
Relative preference scale		0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100	
Weighting		1	1	1	1	1	1	1	1	1	1	1	1	1	
Options	Current ELL approach	78	100	56	75	33	56	78	89	67	22	100	50	100	904
	ELL - Supply chain cost of water	78	100	56	75	33	56	78	89	67	33	100	50	100	915
	ELL - Retail cost of water	33	100	56	75	44	78	78	89	67	44	100	50	100	914
	ELL - Abstraction tax	78	100	56	75	67	67	78	89	67	33	78	50	100	938
	ELL - Carbon off-set fund	89	100	33	50	33	44	78	78	67	11	78	25	100	786
	ELL - Leakage Tax	33	100	33	75	56	78	56	67	67	11	100	50	100	826
	ELL - Abstraction incentive charging	89	100	56	75	33	67	78	89	67	44	100	50	100	948
	Internationally derived indicators	0	0	78	25	0	78	33	11	78	11	78	100	50	542
	Economic leakage index	33	0	33	25	0	33	44	33	67	11	89	50	50	468
	Target set on policy minimum	44	100	67	50	56	33	78	67	67	22	89	75	100	848
	Trading in leakage permits	89	100	67	75	67	56	89	89	78	67	67	25	50	919
	Deregulatory approach	67	100	33	75	56	44	78	67	56	56	89	50	75	846
	Best achievable targets	44	0	44	25	11	78	33	11	56	22	100	75	25	524
	Self regulation	67	100	67	75	33	33	33	0	89	67	44	75	100	783
	Corporate social target	89	100	67	50	56	56	33	22	89	67	44	75	75	823
	Context Value Added	22	100	56	75	22	56	78	89	67	56	89	50	100	860
	Target set on customer complaints	0	0	44	25	56	78	33	56	33	78	11	100	0	514
	Political targets	44	0	89	0	22	100	56	56	33	44	67	100	100	711
	Long term sustainability target	56	100	78	50	11	44	44	33	78	56	78	75	75	778
	Perfect model of system	56	100	78	50	0	11	22	44	78	67	56	25	75	662
	Targets set on water into supply	56	100	78	100	33	78	78	56	78	67	67	75	25	891
	Targets set on abstraction level	56	100	78	100	56	78	78	56	78	78	78	25	25	886
	Policy set on MCW	33	0	44	25	11	11	44	22	33	33	22	75	75	428

For each option the scaled scores are multiplied by the weightings for each criteria (described in Appendix C.3) and added to give a total weighted score. This process was completed using the raw weighting from each stakeholder and the scaled weightings to investigate the sensitivity of the results, which are presented in the next section.

C.5 Selection of options for further investigation

Table C.6 shows the results from the scoring process using the raw weightings. Table shows the results for the scaled weightings, which also includes a column for the mean of the scaled weightings and a column for the scores without any weighting. In each table the top 3 scores for each column are identified. The final column in each table identifies highlights again which options have one of the three top scores for at least one stakeholder.

For reference the different stakeholders (ST) are identified using the following key:

- ST 1 = Environment Agency
- ST 2 = Ofwat
- ST 3 = Defra
- ST 4 = Water UK
- ST 5 = CC Water
- ST 6 = Water Company 1
- ST 7 = Water Company 2

Table C.6 Option scores using the raw weights

Option	Weighted Score - all criteria (top 3 in blue)							Selected
	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7	
Current ELL approach	6854	7498	7074	6132	5386	5036	5329	Yes
ELL - Supply chain cost of water	6942	7564	7162	6176	5463	5036	5329	Yes
ELL - Retail cost of water	6756	7422	7053	6001	5366	4696	4989	
ELL - Abstraction tax	7025	7702	7312	6280	5475	5016	5230	Yes
ELL - Carbon off-set fund	6018	6622	6177	5508	4690	4534	4743	
ELL - Leakage Tax	6028	6759	6381	5527	4766	4425	4672	
ELL - Abstraction incentive charging	7195	7828	7448	6418	5749	5190	5494	Yes
Internationally derived indicators	3852	4234	4045	3192	3056	2364	2678	
Economic leakage index	3561	3730	3597	2962	2614	2169	2410	
Target set on policy minimum	6311	6883	6460	5483	4674	4508	4721	
Trading in leakage permits	7028	7526	7260	6123	5648	4684	4862	Yes
Deregulatory approach	6383	6850	6590	5567	4986	4426	4650	
Best achievable targets	3849	4081	4053	3299	3199	2402	2691	
Self regulation	5883	6502	6124	5051	4628	4442	4636	
Corporate social target	6157	6770	6465	5399	4964	4375	4521	
Context Value Added	6412	6999	6621	5576	5043	4388	4692	
Target set on customer complaints	3566	3702	3815	2762	2841	1318	1453	
Political targets	5132	5543	5342	4399	3976	3311	3590	
Long term sustainability target	5857	6411	6062	5074	4761	4254	4523	
Perfect model of system	5150	5627	5289	4462	4160	3830	3994	
Targets set on water into supply	6665	7226	6976	5704	5669	4454	4786	Yes
Targets set on abstraction level	6679	7207	7013	5790	5685	4516	4763	Yes
Policy set on MCW	3210	3363	3191	2495	2134	2050	2205	

Table C.7 Option scores using the scaled weights

Option	No weight	Weighted Score - all criteria (top 3 in blue)							ST Mean	Selected
		ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7		
Current ELL approach	904	5105	5571	4617	5301	5386	6528	7063	5653	Yes
ELL - Supply chain cost of water	915	5176	5582	4677	5326	5463	6572	7123	5703	Yes
ELL - Retail cost of water	914	4849	5275	4444	5104	5366	6276	6866	5454	
ELL - Abstraction tax	938	5141	5605	4727	5394	5475	6552	7057	5707	Yes
ELL - Carbon off-set fund	786	4544	5075	4073	4836	4690	5883	6279	5054	
ELL - Leakage Tax	826	4242	4883	4032	4746	4766	5675	6166	4930	
ELL - Abstraction incentive charging	948	5367	5763	4908	5543	5749	6770	7354	5922	Yes
Internationally derived indicators	542	2598	2752	2326	2555	3056	3209	3723	2888	
Economic leakage index	468	2666	2543	2243	2471	2614	3113	3497	2735	
Target set on policy minimum	848	4576	4887	3935	4627	4674	5802	6281	4969	
Trading in leakage permits	919	5298	5446	4848	5247	5648	6455	6949	5699	Yes
Deregulatory approach	846	4721	4838	4253	4740	4986	5757	6279	5082	
Best achievable targets	524	2736	2632	2569	2744	3199	3093	3588	2937	
Self regulation	783	4325	4842	3992	4257	4628	5511	5978	4790	
Corporate social target	823	4499	4945	4259	4590	4964	5642	6093	4999	
Context Value Added	860	4662	4998	4147	4712	5043	6016	6598	5168	
Target set on customer complaints	514	2307	1905	2159	2083	2841	2431	2894	2374	
Political targets	711	3550	3584	3132	3624	3976	4288	4861	3859	
Long term sustainability target	778	4319	4700	3915	4301	4761	5477	6000	4782	
Perfect model of system	662	3974	4386	3625	3845	4160	5196	5546	4390	
Targets set on water into supply	891	4869	5121	4559	4788	5669	5928	6585	5360	Yes
Targets set on abstraction level	886	4934	5141	4704	4913	5685	6034	6609	5431	Yes
Policy set on MCW	428	2354	2217	1830	1985	2134	2677	3007	2315	

Both methods of combining the scores and weights result in the same top 7 options being selected for further investigation (assuming that the current ELL approach is selected as a benchmark). The options which come out of the analysis as the main contenders are:

- The current ELL approach
- The ELL – Supply chain cost of water
- The ELL – Abstraction tax
- The ELL – Abstraction Incentive charging
- The trading in leakage permits
- The targets set on water into supply
- The targets set on abstraction level.

However there may be elements in some of the options further down the list which may add to the options under consideration, for example some elements of Context Value Added, Long term sustainability target and Internationally derived indicators. These options may address some of the weaknesses in the proposed options.

These options were then discussed with the steering group and peer reviewed amongst the group. As a result of the discussions it was decided that the 'Trading in leakage permits' option would be too complex for further consideration and was dropped from the list. The 'Frontier based approach' which was added as a potential option too late for the MCDA process was elected for further consideration. The 'Corporate Social target' option, which scored marginally lower than the above list was also selected for further consideration.

This gave a final list of options for further investigation, which are shown below:

- ELL – current benchmark;
- ELL – Supply chain cost of water;
- ELL – Abstraction tax (including abstraction incentive charging);
- Corporate Social Responsibility approach;
- Frontier based approach;
- Targets set on water into supply;
- Targets set on abstraction level.