December 2015

Trust in water

Water 2020: Regulatory framework for wholesale markets and the 2019 price review

Appendix 2: Water resources – supporting evidence and design options

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Introduction

In this appendix, we provide more detail of:

- our analysis of the relevant evidence;
- options for market design; and
- our proposals to promote markets for water resources.

We discuss:

- our definition and description of water resources;
- an explanation of how the water resources sector currently functions and the broader regulatory framework within which it operates;
- evidence regarding the scope for making greater use of market mechanisms in water resources, and the implications of this evidence for market design;
- potential design options for encouraging greater use of market mechanisms in relation to the procurement of water resources by incumbent water companies;
- our assessment of the potential design options;
- our current preferred design option, which focuses on wholesale water trading between incumbents, and between incumbents and new entrants;
- a discussion of design issues related to the extension of our wholesale water trading model to a bilateral model in areas served by water companies operating wholly or mainly in England. This is where water resource providers contract directly with water retailers. As the Welsh Government does not currently intend to bring the relevant parts of the Water Act 2014 into force, bilateral markets will not come into effect in areas served by water companies that are wholly or mainly in Wales; and
- an overall summary of the potential market interactions and regulatory measures under both the wholesale water trading and a bilateral model for water resources.

Definition of services and functions

The provision of water resources is a key element of the value chain for the public water supply (PWS), as illustrated in the figure below.

Figure 1: Water and wastewater value chain – water resources

However, water resources are also used outside the PWS, such as for:

- agriculture;
- private supplies for industry and households; and
- recreational and environmental activities.

The table below summarises the key features of water resources for the PWS.

Table 1: Summary of key features of water resources for PWS

Feature	Summary
Financials	Across the water and wastewater value chain, water resources accounts for approximately 17.8% of operating expenditure and 3.4% of the modern equivalent asset value (MEAV). Source: 2013-14 Regulated Accounts.
Main sources of water	**Boreholes:** holes bored (drilled) into the ground to abstract water from underground aquifers accounts for approximately 32% of supply across England and Wales. **Bulk supplies:** supply of water from one appointed company to another, also often referred to as 'water trades' (approximately 4%). **Impounding reservoirs:** basins constructed in stream or river valleys to hold back flow, so that water can be stored for future use (approximately 24%). **River abstractions:** taking water from a river (approximately 40%). Source: PR14 August 2013 data request.

Feature	Summary
Major assets	615 dams and impounding reservoirs. 2,543 intake and source pumping stations. 1,750 km of water mains or conveyors associated with the transfer of raw water between sites. Source: Table W5, companies' PR14 business plans.
Operational structure	Companies' water resources are organised around water resource zones (WRZs). A WRZ is the largest possible zone in which all water resources – excluding external transfers – can be shared. It is defined through the water resources management plan (WRMP) process. As WRZs reflect geographical and hydrological factors, there are often a number of WRZs across companies' appointed areas.
Supply chain definition	Identify sources of raw water, obtain permission for its extraction or collection, and input it to the raw water distribution system. Source: Ofwat regulatory accounting guidelines.

Ownership of water resources extends further than just water companies. Other significant users/owners of water resources include:

- canals;
- farmers;
- landowners;
- non-governmental organisations (NGOs); and
- large industrial users, such as brewers and the electricity supply industry.

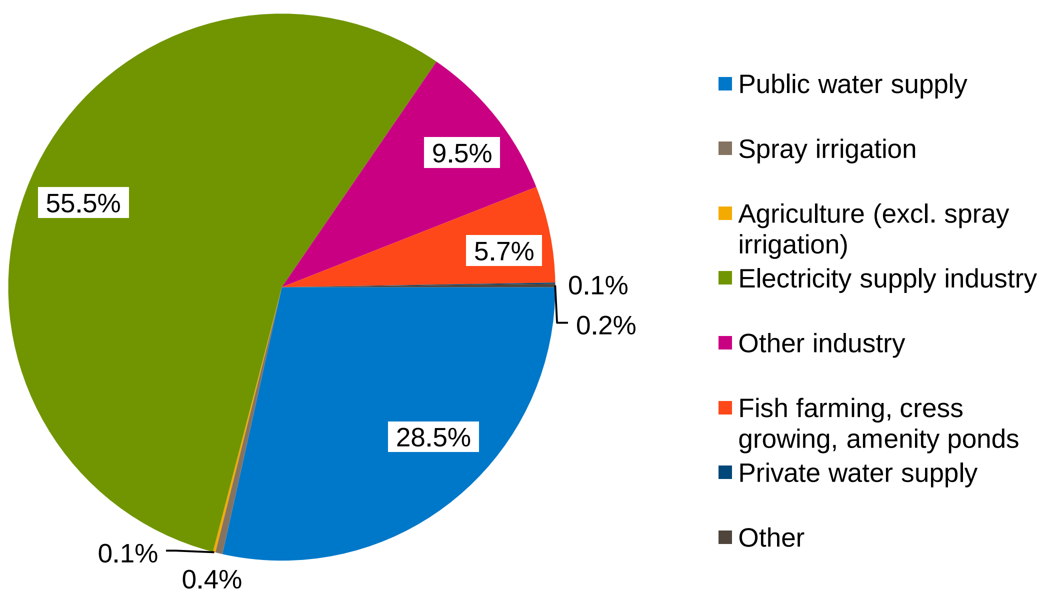
Organisations and individuals that wish to abstract large quantities of water (typically above 20 m^3 a day) apply for abstraction licences from the Environment Agency for the right to do so. Abstraction licences incur an annual charge based on:

- the authorised volume; and
- whether or not the water abstracted is for non-consumptive use (for example, for hydropower) or for consumptive use (for example, for spray agriculture).

Major abstractors include the:

- electricity supply industry (56% of abstractions by volume)[1];
- public water supply – that is, water companies (28.5%);
- other industry (9.5%); and
- agriculture (6.3%).

Figure 2: Overview of abstractions (both consumptive and non-consumptive) across the water resources sector (2000-13 average)



Source: Ofwat analysis of Environment Agency's abstraction licence data.

[1] While the electricity generation sector is by far the largest licensed abstractor of water (from all sources) of all sectors, in practice, however, it takes around a third of this with the majority of the water abstracted from tidal (brackish water) sources. Five per cent of the freshwater abstracted by the sector is used for thermal generation and 95% for hydropower. Of the 5% used in thermal generation, at least half is returned to the environment. See 'Water use and electricity generation', Environment Agency, December 2013.

Current features of regulation and markets

As part of appointed companies' statutory duties, they are required to provide for water demand in their appointed areas to meet their supply obligations. The companies are required to set out their plans to meet these obligations in Water Resources Management Plans (WRMP) and Drought Plans.

Within our current regulatory framework, the revenues companies can earn from water resources are included within the overall allowed revenue we set as part of our binding water wholesale price control. Therefore, while we do not directly control the individual prices companies can charge for water resources, the total amount of income they can generate is capped. The allowed revenue is based on the revenue that, in our view, an upper quartile efficient company would require to provide the regulated services, given the costs incurred in providing them. All water resource assets operated by the companies are regulated assets.

There are a number of other economic incentives that apply to water companies in water resources.

- **Water trading incentives** for both new water exports and new water imports were introduced at the 2014 price review (PR14). For all new qualifying exports in 2015-20, we allow exporters to retain 50% of the lifetime economic profits (that is, the profits over and above the normal return on capital invested). Importers also benefit from total expenditure – totex – efficiency sharing incentives, and we allow them to retain 5% of their costs from new qualifying imports during 2015-20 as an incentive payment. The benefits will be larger if the trades start earlier in 2015-20. To protect customers, there is a cap on total annual import incentive rewards of 0.1% of water activity turnover in any year of the control period; and trading and procurement codes to make sure companies are transparent about water trading.

- **The abstraction incentive mechanism (AIM)** has the objective of encouraging water companies to reduce the environmental impact of abstracting water at environmentally sensitive sites when water is scarce. We plan to implement the AIM in reputational form from 1 April 2016. We have an aspiration for the AIM to become financial at PR19 to drive increased benefits for the environment, but we want to learn from the experience of the reputational AIM first. The AIM complements our water trading incentives by discouraging exports from environmentally-sensitive sources not covered by other regulatory processes. Our consultation on the AIM opened on 26 November 2015 and is available on our website.

As well as the economic framework, there are broader regulations that apply to water resources, and the most important regulations apply to abstraction. Abstraction licensing was introduced in the mid-1960s and today all large abstractions require authorisation. The current regime inhibits the trading of water resources as it can be costly and slow, and is therefore unable to quickly and effectively respond to demands to trade water. It makes it difficult to transfer licences from one party to another, which therefore makes the transfer of water resources between licensees burdensome. This means that the current controls on taking water from rivers and groundwater are not flexible enough to cope with future challenges, including climate change and population growth.

Defra is currently reviewing the abstraction licence regime. It has consulted on proposals for reform, namely: “current system plus” and a “water shares” option that would be designed, among other things, to enable short-term trading. Defra has yet to announce its preferred approach and implementation of reform is not expected to be completed before the early 2020s.

A summary of the other key wider regulations applicable to water resources is set out in the following table.

Table 2: Overview of key wider regulations applicable to water resources

Regulation	Summary
Abstraction charges	These are levied on abstraction licence holders by the Environment Agency to cover the costs of administering its water resource functions and fund any compensation payments when licences are revoked or amended. For most users, charges are based on licensed, rather than actual, use with costs calculated based on a range of regional and national factors, some of which reflect potential environmental impact. See Environment Agency charging scheme.
Restoring Sustainable Abstraction (RSA)	The RSA programme is the mechanism by which the Environment Agency identifies environmentally damaging abstractions and revokes or amends them. Until recently, all compensation claims arising from the RSA programme were funded through abstraction charges. The Water Act 2014 specifically excludes the possibility of compensation claims arising from RSA changes to public water supply, with the expectation that alternative public water supplies will be funded through the price review.
River Basin Management Plans (RBMPs)	RBMPs set statutory objectives for river, lake, groundwater, estuarine and coastal water bodies and include an obligation to prevent deterioration. RBMPs are a requirement of the Water Framework Directive and must include controls on abstraction and impoundment, which in England and Wales are fulfilled by pre-existing abstraction licensing controls. Because water is linked to land, RBMPs also inform decisions on land-use planning. RBMPs are drawn up for the ten river basin districts in England and Wales and updated on a six-yearly cycle.

Regulation	Summary
Statutory Drought Plans	Statutory Drought Plans set out the short-term operational steps a company will take before, during and after a drought to maintain supply and protect the environment. Water companies are required to update plans each year or when directed to do so by the Secretary of State.
The Habitats and Birds Directive	This directive aims to protect the threatened habitats and species and ensure conservation interests are taken into account when development proposals are being considered. A key policy tool in the directive is the designation and management of protected sites – areas of land, inland water and the sea that have special legal protection to conserve important habitats and species. Strict legal protection is designed to prevent activities – including abstraction and discharge – damaging designated area even where they arise outside of the site boundary.
Water Resources Management Plans (WRMP)	These are prepared by water companies every five years, in parallel with price reviews, for their WRZs. Water companies have a statutory duty to prepare, consult, publish and maintain a WRMP. WRMPs predict future supply and demand (the 'baseline' forecast) for 25 years and, if there is a supply shortfall, set out the options for helping bring supply and demand into balance, and the preferred investment programme.

Scope for markets

In this chapter, we examine the scope for making a greater use of markets in relation to water resources. We address in turn:

- forms of constraint on water resources markets;
- investment requirements and capital intensity;
- evidence relating to economies of scale;
- unit cost differentials across providers;
- transport costs; and
- other factors that affect the scope for making greater use of markets.

Forms of constraint on water resources markets

Constraints are market factors that prevent an undertaking from profitably sustaining prices above competitive levels, and are a means to understand the nature of markets in different parts of an industry's supply chain. We have identified three main potential forms of constraints that could operate in relation to water resources.

- **Markets between incumbent water companies for the provision of water resources.** This would primarily operate through bulk supplies (water trades) and could occur where one water company has (or can develop) a water resource at a sufficiently lower cost than that of another, typically within reasonably close proximity to offset any transport costs.

- **Markets between incumbent water companies and third-party businesses for the provision of water resources.** This could occur where another business (for example, a new entrant into water resources, or another business with access to water resources, such as a farmer or brewer) is able to provide water resources at a more competitive rate than the local incumbent. The Water Act 2014 creates scope for this type of entry in the water resources market. New entrants could either sell their resource to an incumbent water company, or to an independent retailer in areas served by water companies wholly or mainly in England, under the bilateral model envisaged by the Act.

- **Other market constraints.** For example, water provided by water companies may be substitutable, from the perspective of some purchasers, with self-supply of water resources, water recycling, and/or demand-management technologies. Depending on the extent of this substitutability, this could provide some constraint in relation to water resources.

In the following sections, we set out evidence of relevance to the above.

Investment requirements and capital intensity

The need to invest capital to enter into the supply of water resources is not necessarily a barrier to entry. However, investment requirements can create barriers where:

i. the investment is sunk; or
ii. there are limits on access to finance.

Sunk costs of entry are those costs which must be incurred to compete in a market, but which are not recoverable on exiting.

Much of the investment required to enter into water resources is likely to be sunk. However, the significance of the sunk cost is likely to vary considerably by type of resource. For example, a new reservoir would require significant investment in capital assets, such as new dams, pipework, control rooms, valves and sluices. It is also likely to incur:

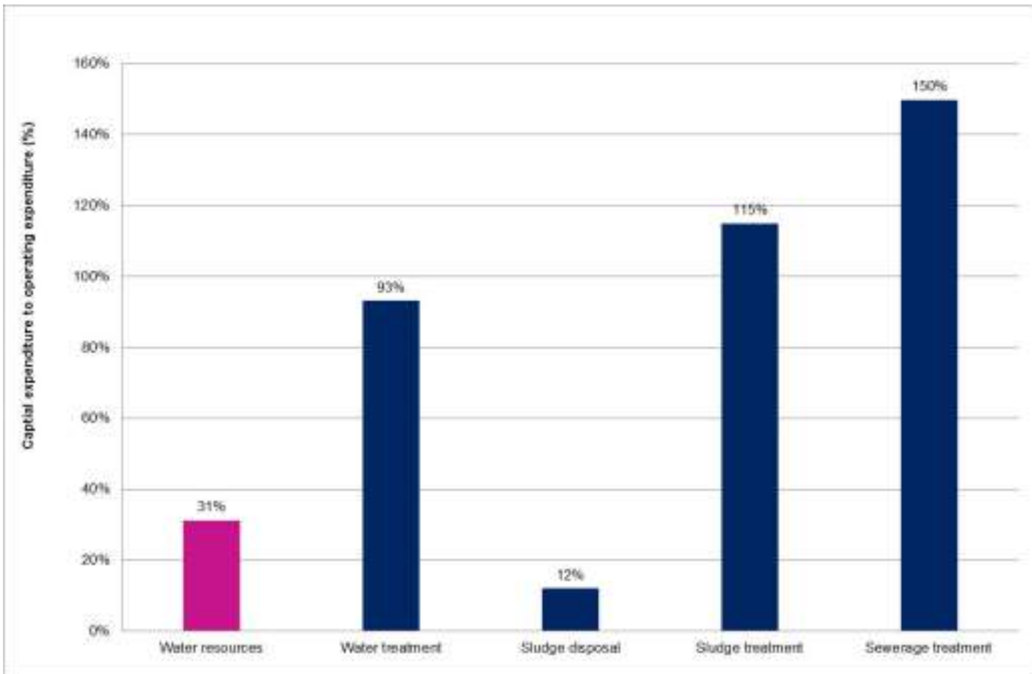
- significant planning and design costs;
- upfront regulatory costs, such as environmental impact assessments; and
- costs associated with securing planning and environmental permissions, such as abstraction licences and discharge consents.

On the other hand, water abstraction from rivers and boreholes is likely to incur much lower costs, and it may be possible to reuse some assets (for example, a borehole pump).

To illustrate the relative capital-intensity of water resources, the following two figures show the ratio of capex to opex across the wholesale part of the value chain and average asset lives. This is based on accounting separation data from the regulatory accounts and reveals that water resources:

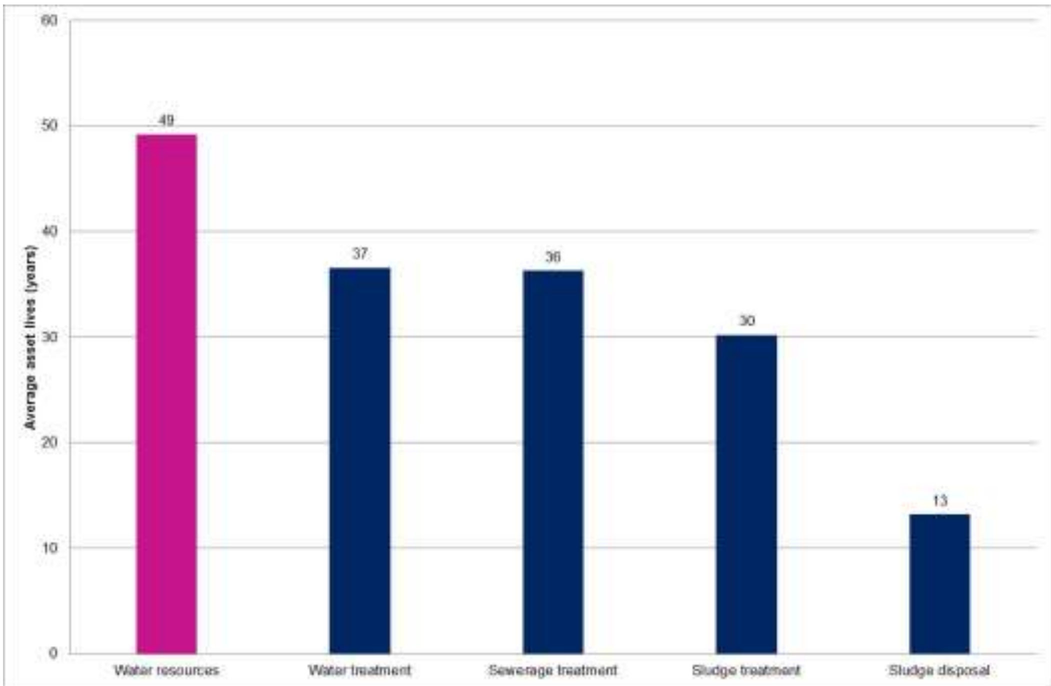
- has a low proportion of costs accounted for by capital relative to opex (31% in 2013-14); but
- has relatively long average asset lives at 49 years (also using 2013-14 data).

Figure 3: Comparison of the ratio of capital expenditure to operating expenditure



Source: Ofwat analysis of 2013-14 company regulatory account data.

Figure 4: Comparison of average asset lives across the wholesale part of the value chain



Source: Ofwat analysis of 2013-14 company regulatory account data.

All else being equal, the relatively low capital-intensity of water resources is consistent with investment requirements not raising barriers to the use of markets. The long average asset lives, however, imply that stranded asset risk might be a particular concern and could reduce the overall scope for new entry. We note, however, that the data represents averages and that variations between the capital required for different sources may mean that the average does not represent the extent of the likely barriers for particular types of water resources.

Given the long asset lives, there is a question as to whether incumbents benefit from regulatory protection of the regulatory capital value (RCV), which may mean that, compared with a new entrant, they may be able to access finance at a favourable cost. We will need to take account of these impacts in designing regulatory arrangements for new water resources.

Economies of scale

Economies of scale will influence the structure of markets, such as the efficient number of suppliers, and ease of entry into a market. Economies of scale exist where average unit costs fall as output rises. If scale economies are significant, they can act as a barrier to entry, as a potential entrant would need to enter the market on a relatively large scale (in relation to the size and value of the market) to compete effectively.

To investigate the impact of economies of scale in water resources, we examined the relationship between capacity and the estimated total unit cost of potential new water resources identified by companies in their 2014 WRMPs. WRMPs only set out resource options for WRZs that are forecast to have a supply/demand deficit during the relevant 25-year planning period. We examined the data for:

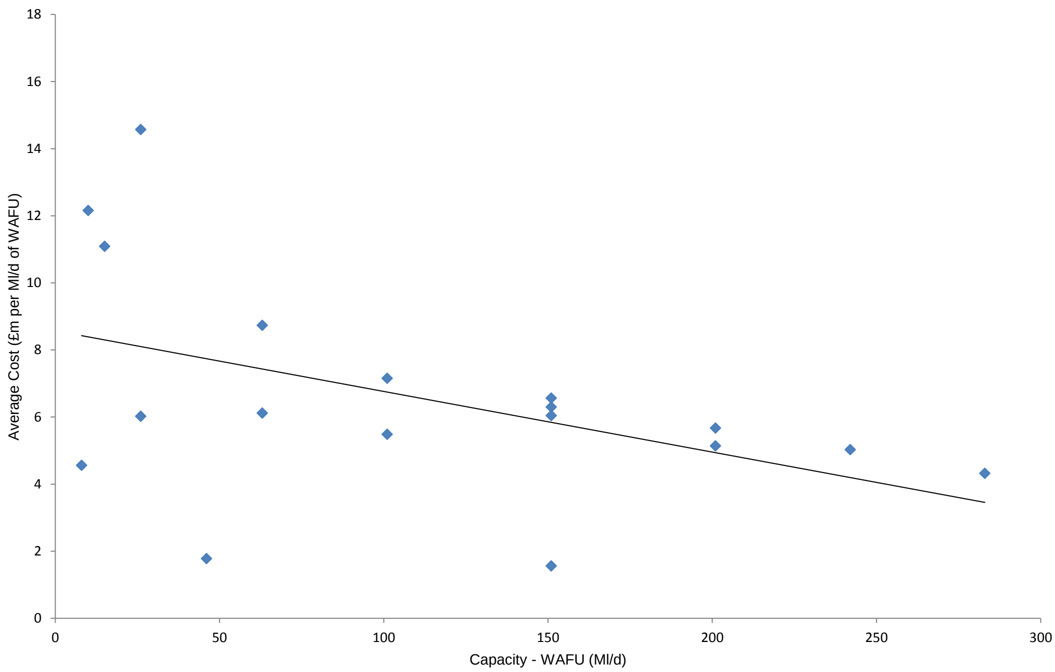
- new reservoirs;
- new surface water (that is, river abstractions); and
- new groundwater (that is, boreholes).

The results of our analysis suggest that there is evidence of economies of scale in the case of new reservoirs and new surface water, but not new groundwater. More specifically:

- for new reservoirs, we have 17 data points and, consistent with the presence of economies of scale, average unit costs decrease in line with capacity in a linear fashion (p = -0.47, R^2 = 0.217);
- for new surface water, we have 36 data points and, consistent with the presence of economies of scale, average unit costs also decrease in line with capacity, although the relationship is not quite as strong as for new reservoirs (p = -0.43, R^2 = 0.182); and
- for new groundwater, we have 44 data points but found no evidence of economies of scale. In part, this likely reflects the wide range of investments that are required to investigate, develop, secure permissions for, and commission different groundwater sources. Compared with these, the cost of the assets required to run the borehole, like borehole pumps, are likely to be relatively insignificant.

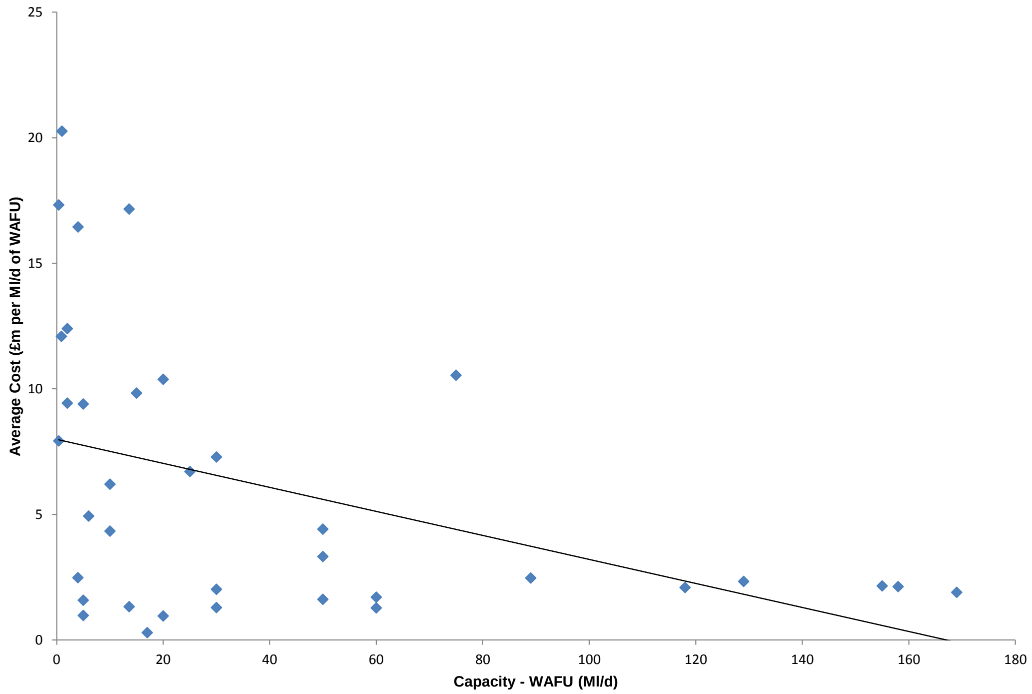
The two figures below show the relationship between capacity and average unit cost for new reservoirs and new surface water respectively where we found evidence to suggest the presence of economies of scale.

Figure 5: Capacity vs average lifetime cost – new reservoirs



Source: Ofwat analysis of 2014 WRMPs.

Figure 6: Capacity vs average lifetime cost – new surface water



Source: Ofwat analysis of 2014 WRMPs.

In summary, our analysis of economies of scale in water resources has the following implications.

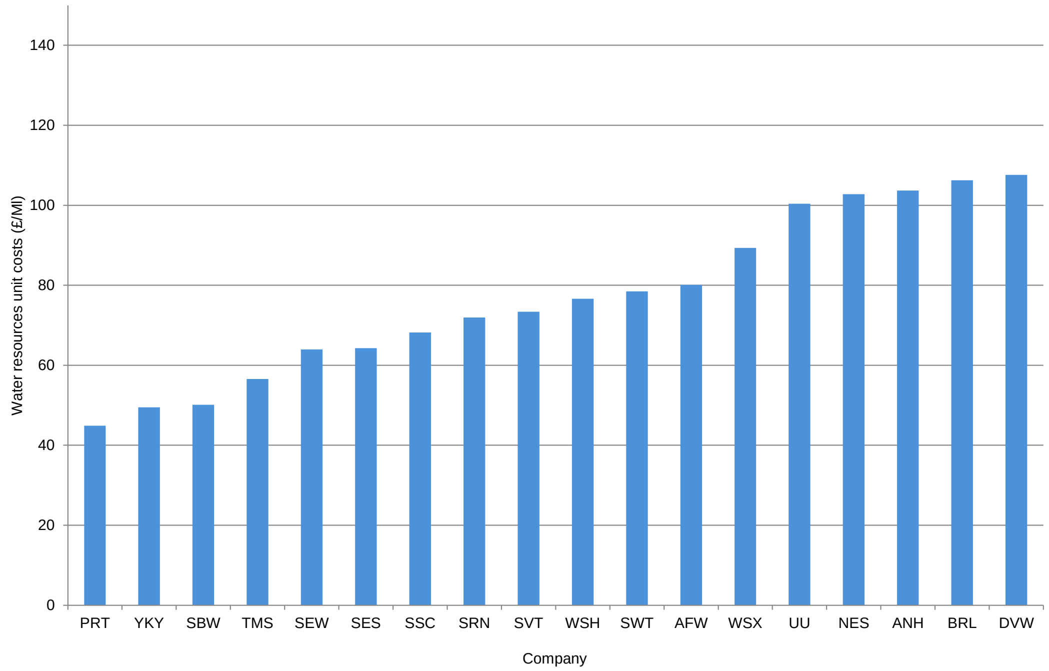
- Scope for 'small-scale' entry and rivalry may be limited, particularly in the case of new reservoirs. There may be more scope for small-scale entry in the case of boreholes (groundwater), although we note that the ability to develop new groundwater sources will depend on the WFD status of the groundwater body in question.

- This would not necessarily preclude an entrant from building a reservoir (or other storage asset) at a large scale to compete with incumbents to provide either new or existing water supplies, particularly in regions with significant water scarcity. It is likely to limit number of market participants in a particular area. It would also require a supplier to secure a sufficient customer base and this could make entry on a large scale difficult.

Cost differences

Significant differences in the prevailing level of costs between companies may provide an indication of potential unrealised gains from markets. The next figure shows the average cost per unit of water resources (in £ per Ml) by company, using the 2013-14 regulatory accounts. The costs have been calculated based on company opex plus current capital depreciation.

Figure 7: Water resources unit costs (£/Ml)



Source: Ofwat analysis of 2013-14 company regulatory account data.

The chart shows that **there is significant variation across the companies**, with the lowest-cost company having unit costs that are around one-third those of the highest cost company. We also note that the cost differences between neighbouring companies can be significant. For example, Portsmouth Water's costs are 40% below those of Southern Water.

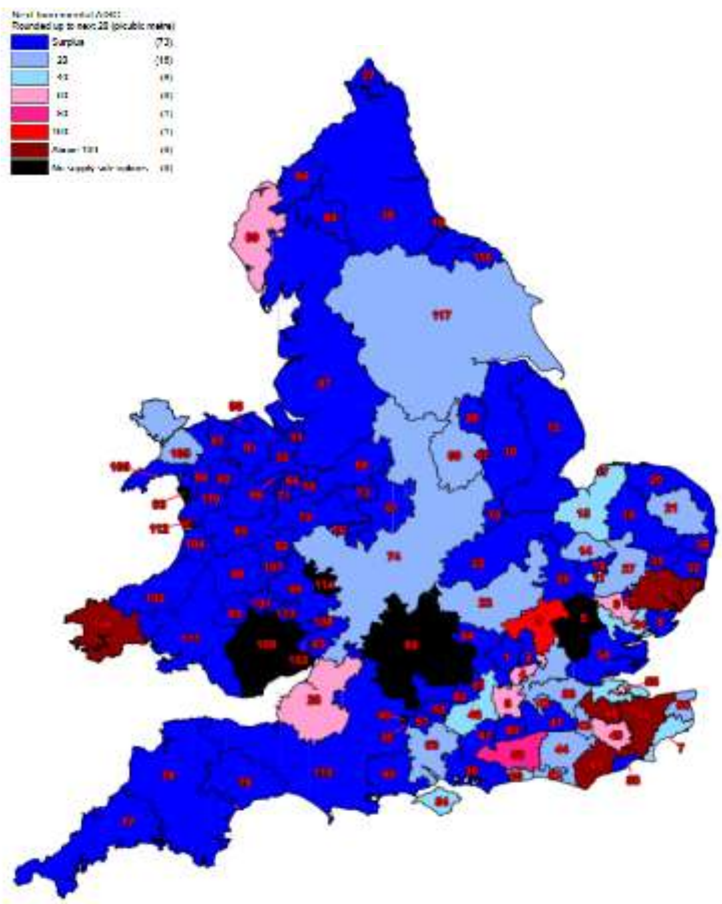
We acknowledge, of course, that differences in average unit costs can be driven by a range of factors, and also that these costs are only an indication of the potential for gains from water trading. A full analysis would need to examine the marginal cost of resource provision in different regions, and account for the cost of transporting water between regions.

We have also looked at the cost of developing new water resources. The following map shows the cost of developing the incremental scheme that companies propose to build in each WRZ in their 2014 WRMPs. We defined the incremental scheme as the supply-side option that provides a significant volume at lowest unit cost as measured by the average incremental social cost (AISC). Supply-side options cover:

- production;
- resources; and
- any links beyond the zone (interconnections).

Where companies have proposed only demand-side options (for example, leakage reduction) the WRZ is shaded black. Companies do not have to plan solutions for WRZs with a baseline surplus in 2039-40 (shaded dark blue). Further details on the criteria used to select the incremental options are set out in annex 2 of this appendix.

Figure 8: Water development costs across England and Wales (AISC)



Source: Ofwat analysis of 2014 WRMPs.

The figure shows that **water development costs vary materially across England and Wales**, with a difference between the highest and lowest cost schemes of some 200p/m^3. In addition, there are WRZs in surplus that have neighbouring WRZs that are in deficit, and WRZs with high development costs next to areas with low development costs (including in south-east England). The chart also indicates that, in **the long run, the costs of water resources at a WRZ level tend to increase**. In other words, as the least expensive water resources will have been developed first, and to provide new capacity, more expensive resources have to be commissioned – and so there is a rising long-term cost curve. Population growth and climate change are likely to further increase this pressure.

Reflecting this, the difference between the incremental cost of new water resources and average costs of existing resources is material, which will limit the extent to which new entry could displace existing resources. Supporting this, the proposed unfocused approach to the allocation of the RCV and the substantial RCV discount, discussed in the main document, means that incumbent operators do not need to recover the full replacement value of existing water resource assets. This further suggests that new entry (where full costs will need to be recovered) is unlikely to replace the use of existing assets.

We note that some of the variation in unit and development costs is likely to reflect factors unrelated to economic efficiency, such as differences in resource opportunities and underlying hydrological differences, and this also creates opportunities for efficient trading. However, the presence of transport and other costs means that comparisons of unit costs and development costs alone are not a sufficient basis to reach a definitive conclusion on the scope for markets.

Transport and other costs

There are complex trade-offs and interactions between water resources and other activities in the water value chain. For example, a company may choose a water source further from the main area of demand because it has lower treatment costs, which it uses to offset some of the extra transport costs of raw water. Alternatively, it may choose multiple sources of raw water closer to centres of demand that are more expensive to treat but reduce its water transport costs. The investment in transport and treatment capacity can also impact on distribution costs by reducing the need for investment in the local storage of treated water.

For a market in water resources to develop, the total costs, including the associated transport and other costs of any transaction, will need to be lower than the benefits generated by the transaction. Other things being equal, the geographic scope of a market is likely to be smaller in cases where transport and other costs are high, relative to the total cost of production. However, we note that a small geographic market does not necessarily imply a low level of potential rivalry within the relevant geographic area.

A well-known issue with the transport of water is that it is heavy, meaning that it is expensive to transport over long distances. The result is that water networks are developed more locally unlike their counterparts in electricity and gas, which tend to be interconnected on a national basis. This is because of the weight of water, which has a high density (1,000 kg/m^3); in contrast, natural gas at Standard Temperature and Pressure has a density of around 0.8 kg/m^3 although this is compressed when it is transported over long distances. This means that topography and the ability to utilise gravity to transfer water over longer distances is more important in the water sector.

This suggests that geographic markets for water resources are likely to be smaller and more related to topography and river systems and that the location of a resource as well as its cost of abstraction will be important. It also suggests that number of related trades between adjacent areas may be required to fully realise potential of the opportunities or that trading of abstraction rights rather physically transporting water will be beneficial.

For example, additional resource at one location (A) may be able to be transferred to a second location (B), which in turn allows resource to be shifted from the second location to a third location (C). In effect, water has been transferred from location A to C, although there is no direct transfer between A and C. It is also true that in some cases, water is currently transported significant distances in the sector, and where a third party provider has a water resource close to demand centre and distribution, it may be well placed to enter the market.

As part of our modelling of interconnection costs, discussed in annex 2, we estimate the total cost of interconnection pipes as a function of their capacity in Ml/d. This includes a consideration of maintenance and pumping costs. This suggests that, for interconnections to be viable, sufficiently large volumes need to be transferred over favourable topography. Nonetheless, our analysis suggests considerable scope to exploit further opportunities for trading.

Further, as noted above, there is some interaction between water resources and water treatment. Water treatment works are designed to treat a given water source, and may not be able to easily treat water abstracted from another source. Similarly, often different water sources are blended to make sure water quality standards are met and to avoid complex and expensive treatment processes. This implies that consideration will need to be given to potential incremental costs avoided or incurred from mixing water resources together and shows that the quality of any water resource and the cost of transporting it to suitable treatment will impact on the cost and benefits of using that water.

Overall, our analysis of transport and other costs shows that the location of water will be of central importance and suggests that geography will be an important constraint on the development of markets. Markets are most likely to develop where:

- there are significant differences in the costs of water resources (large enough to offset transport costs and other costs, like treatment);
- there is favourable topography;
- the distances involved are not too great;
- a number of related transactions may be required to realise benefits without requiring long distance transport of water;
- transactions can cover a sufficiently long period to justify the upfront investment; and
- sufficiently large volumes can be traded.

The interaction of these factors and the relatively high cost of new resources compared with existing resources, along with slow volume growth, means that it is unlikely that opening resource markets to new entry would be sufficient to constrain prices of water resources to competitive levels. However, these issues apply to both incumbent appointees and third party providers for new resources, and so suggest that markets are best focused on the supply of new resources. It also means that trading of abstraction rights, as proposed under the Government's abstraction reform will offer valuable scope for efficient trading.

Other issues impacting the scope to use markets

We also have evidence from a variety of other sources on the other issues that may impact the scope for making greater use of markets in water resources. These sources include:

- our conversations with potential new entrants in the water resources sector, summarised in annex 1 of this appendix;
- responses to our July discussion document;
- papers submitted to Ofwat on behalf of water companies as part of the ‘marketplace for ideas’; and
- the recent work we commissioned from Deloitte LLP on water trading.

The key issues/barriers highlighted include the following.

- **Regulatory incentives distorting decisions to trade.** To the extent that there has been a ‘capex bias’ within the regulatory framework, this may have discouraged incumbent companies from obtaining bulk supplies of raw water from other water companies through interconnections, or from third-party suppliers. Our adoption of a totex approach to cost assessment and recovery at PR14 should help to mitigate this, but some ongoing bias towards ‘build’ over ‘buy’ solutions may remain.

- **Security of supply obligations.** Meeting security of supply obligations is a key requirement for water companies. Evidence suggests that the current regulatory obligations and incentives may encourage companies to favour their own water supplies, as these are perceived as more reliable. Companies may also be risk averse and prefer to manage the risks of loss of supply/poor quality directly rather than through contracting with third parties.

- **Cultural issues.** Regulatory and informational barriers to trading and security of supply obligations, such as those discussed above, may in turn have fostered a culture of a lack of interest in trading, which has become ingrained in the sector over time. This could also relate to a broader ‘within area’ focus about resource optimisation and decision-making.

- **Information asymmetry.** Information related to water trading opportunities may not be sufficiently transparent. For example, some of the potential new entrants we spoke to were not aware of the possibility of trading surplus water, and there was also some confusion regarding the difference between trading physical water resources and abstraction rights. This is also the case for more detailed information, such as that which water companies use to develop their WRMPs (for example, supply and demand forecasts, water scarcity in different regions, and the cost of developing new resources).

- **Immaturity of the market.** This is linked to the information asymmetry point above. The market for water resources as it stands is underdeveloped and there is only limited information and experience of market transactions. This means that there are likely to be significant transaction costs – for example, in contract drafting – which may limit further market development.

- **Abstraction regulation.** As already mentioned, the current abstraction framework inhibits trading of water resources, and is unable to respond to demands to trade water quickly and effectively. The current reform process also introduces additional uncertainty, which creates risk to service providers. If water service providers are uncertain about the allocation of water resources, they are likely to be reluctant to engage in long-term trades, particularly as sellers. Further, the proposed time limiting of licences may also have an impact on the financial viability of potential markets, as investment will occur only if the licence is of sufficient duration to be able to recoup any investment in infrastructure. In the medium term, once reforms are complete, the new framework should provide improved scope for trading.

- **Pricing issues.** Bulk supply prices and revenues have typically been set in relation to average supply costs, rather than marginal costs. In addition, the lack of scarcity pricing creates uncertainty over the relative value of water at different geographic locations and different times.

- **The planning system.** The planning system may limit the scope for markets between water companies and potential entrants. Large-scale schemes, particularly reservoirs, require significant investment to obtain planning permission and to meet environmental requirements. However, such planning constraints will apply to both incumbents and entrants for new resources.

- **Statutory works powers.** Water companies have statutory powers to build and maintain infrastructure, such as powers to lay pipes across third party land that would not be available to potential entrants.

- **Industry structure.** The vertically integrated nature of the sector might act as a barrier to trading, insofar as incumbents have the ability and incentive to act in a potentially anti-competitive way to deter new entrants.

Key implications for design

Overall, we consider that the available evidence points to there being scope to make greater use of markets in water resources.

- A range of evidence suggests that the low levels of bulk supply trading between water companies observed over time cannot be fully explained by economic fundamentals, but rather is because of the presence of various barriers to trading. Consequently, from a design perspective, this suggests that **we should consider what steps we can take to help mitigate and reduce these barriers, to further promote efficient trading**.

- **The potential gains in relation to water trading between incumbents appear to be substantial.** Our updated modelling results (see annex 2) suggest that the scale of potential cost savings available from greater interconnection is around £915 million (2012-13 prices) over the lifetime of the assets compared with the cost of the schemes proposed in water companies' 2014 WRMPs.

- **Access to information** has been mentioned as a potential barrier to market participation by several parties, both incumbents and potential entrants. Therefore, tools designed to address this (which could include increased provision and sharing of information, but might also be assisted by the introduction of a separate binding price control in relation to water resources) are likely to be of benefit.

- Other key barriers that have been mentioned include:
    - concerns about impact of security of supply obligations;
    - insufficient **financial incentives for trading** and/or interconnector development;
    - water quality issues;

  - pricing issues (that is, the lack of a robust marginal price methodology that accurately reflects water scarcity); and
  - potential uncertainty relating to abstraction reform[2].

  In combination, these barriers may lead to a bias towards companies favouring their own solutions rather than relying on third party contracting. This is likely to be reinforced by a perception on the part of companies that contracting options are subject to more regulatory uncertainty relative to 'in house' options that are incorporated within the RCV. Consequently, **tools that help address any perceived bias towards 'in house' provision (or build versus buy) may be of help**.

- Increased water trading between incumbent companies is likely to be the initial focus of market development, but there is also scope for markets to play a greater role in the development of new water resources, consistent with the provisions of the Water Act 2014.

- Markets in the provision of new water resources could emerge in two main ways. The first is incumbent companies (as water wholesalers) contracting with third party providers of new resources, in place of building new resources 'in house'. Second, as markets develop in the non-household retail market, non-incumbent water resource providers could contract directly with retailers as envisaged by the Water Act 2014 (the bilateral market model) in areas served by water companies that are wholly or mainly in England. We see **benefits in developing a framework that allows for both of these approaches**.

[2] A key area of uncertainty relates to the future changes planned to the abstraction licence regime. As the abstraction reform process is being led by Defra, we have not considered it further within our market design options, but it should be kept in mind that it is an ongoing area of concern for companies, which may impact on water trading.

Market design options for encouraging greater use of market mechanisms by incumbents

We have considered a range of design options to address the identified barriers and challenges relating to the development of markets in water resources, as discussed above. These design options have been considered in terms of the following four dimensions.

- Price controls.
- Informational remedies.
- System operation.
- The trading regime/incentives.

The proposals set out in this section are mainly focused on mechanisms for encouraging greater use of wholesale water trading – either through bulk supply trading between incumbents, or through the entry of independent third parties that wish to supply water resources to incumbents. The case study on page 31 provided an example of the market model in a scenario where a hypothetical brewery has spare water resources available and enters into a contract with the incumbent water company in its area to sell it untreated water.

At the end of this appendix, we discuss design issues related to extension of the wholesale water trading model to a bilateral model in areas served by water companies operating wholly or mainly in England. This is where water resource providers contract directly with water retailers. As the Welsh Government does not currently intend to bring the relevant parts of the Water Act 2014 into force, bilateral markets will not come into effect in areas served by water companies that are wholly or mainly in Wales.

We set out at a high level how a bilateral market model could work in practice in areas served by water companies operating wholly or mainly in England, and the additional reforms that we consider are likely to be necessary in future to facilitate the development of this market. We also provide a hypothetical case study to show how the bilateral market model could work in practice.

Figure 9: Market design options for water resources

<table>
<tr><th></th><th>1</th><th>2</th><th>Preferred option
3</th><th>4</th></tr>
<tr><td>Separate price controls</td><td colspan="2">Non-binding network plus and water resources sub caps</td><td>Separate binding price controls for water resources and network plus</td><td>Separate binding price controls for each element of the upstream water value chain</td></tr>
<tr><td>Information remedies</td><td>No additional information requirements</td><td>Companies publish more accessible WRMP data based on Ofwat stipulations</td><td colspan="2">Market information database and ongoing assessment of third party resource options</td></tr>
<tr><td>System operation</td><td colspan="3">System operator functions undertaken by WaSCs / WoCs and other market participants</td><td>Independent system operator (ISO)</td></tr>
<tr><td>Trading regime/ incentives</td><td>Maintain water trading incentives</td><td colspan="2">Potentially enhance water trading incentives. Introduce mechanisms to increase transparency and certainty of funding for contracted supplies</td><td>Mandatory trading pools. Interconnector incentive scheme to replace water trading incentives</td></tr>
</table>

Option 1 ('no change')

Option 1 relates to a continuation of the status quo in all four dimensions, as follows.

- **Non-binding network plus and water resources sub-cap price control.** As previously mentioned, we do not currently set the individual 'prices' that companies charge for specific water resources service elements. In developing our design options, we considered the extent to which disaggregated price limits should be binding on the companies, as there are varying degrees to which a control may be binding[3]. Under option 1, we would set a non-binding indicative

[3] The form of the price control for monopoly water and sewerage services in England and Wales – a discussion paper. http://www.ofwat.gov.uk/future/monopolies/fpl/prs_inf_1010fplform.pdf

sub-cap for water resources activities, which companies would report against, but the price control would continue to apply to the total wholesale water business. As we have already committed to implementing such non-binding sub-caps under PR14, this implies 'no change' from the status quo.

- **No additional informational remedies.** Under option 1, we would not require any additional or revised information on water resources from companies.

- **System operation functions undertaken by WaSCs/WoCs and other market participants.** Responsibility for managing and operating the network infrastructure used to supply water resources would remain with the WaSCs/WoCs (or any other market participants), as under the existing regime.

- **Trading incentives maintained.** Under option 1 water trading incentives for importers and exporters would be maintained as they are at present.

Option 2

Option 2 proposes changes in the areas of informational remedies and the trading regime in order to improve transparency and certainty for market participants.

- **Non-binding network plus and water resources sub-cap price control.** As for option 1 above.

- **Companies to publish more accessible WRMP data as specified by Ofwat.** To increase transparency, companies would publish more information on their WRMPs in a way specified by Ofwat. For example, currently the WRMP tables are typically not published, or are published in a redacted form (for example, information on the costs and characteristics of feasible options is redacted). This proposal would look to increase the transparency and scope of accessible information. The exact data released would be decided in consultation with stakeholders. This would result in greater consistency in terms of the type and form of information that is available to market participants.

- **System operation functions undertaken by WaSCs/WoCs and other market participants.** As in option 1 above.

- **Introduce mechanisms to increase transparency and certainty of contracted supplies.** Under this option, we would consider whether to enhance existing water trading incentives. In addition, under this option we would consider a range of other mechanisms to increase the transparency and certainty of contracting for traded water. For example, these could include:
  - a standardised contract template to support water trading through reduced transaction costs;
  - developing mechanisms to help fund interconnector schemes;
  - developing clearer, non-discriminatory rules for supply curtailment, particularly where this affects cross-border supply; and
  - encouraging smarter contracting and hedging – for example, through the publication of case studies and worked examples.

Option 3

Option 3 builds on option 2 above, but with the addition of a separate binding price control for water resources, and publication of information through an information database.

- **Separate price control for water resources.** Under the current framework, it is challenging to distinguish between the costs associated with different wholesale water activities. To address this, option 3 would introduce a fully separate price control for water resources to:
  - help facilitate markets;
  - assist with the setting of more targeted regulatory incentives; and
  - increase focus by both companies and the regulator on water resources.

- **Market information database.** To address information asymmetry issues and facilitate the identification of trading opportunities, option 3 would establish a market information database under the custody of a central entity. Institutional arrangements would need to be developed, but one possibility would be for the database to be managed by Ofwat initially, with a view to the entity becoming an independent agency in the future, if the proposal proves effective. The information required would include resource cost or price and technical data, together with supply and demand projections for each company and/or WRZ, in a standardised format. All qualifying water resources market participants (that is, both incumbents and new entrants) would have access to the database and would be required to submit relevant information to it, while other interested parties would be permitted to submit information on a voluntary basis. The database could be updated annually or on a rolling basis. Participants would be responsible for the suitability and quality of the information, while the host entity would be responsible for ensuring the security and confidentiality of the information. Costs of information provision could be recovered through an annual charge on market participants or through the price control review process.

- **Bid assessment process for third party resource options.** Alongside the market information database, option 3 would also introduce a standardised process for the **ongoing** submission and assessment of bids for new water resources from third parties (note that this would include both independent providers and appointed companies bidding to provide resources 'out of area'). Under the proposed framework, bidders would be requested to satisfy a minimum set of bid criteria (for example in, relation to technical aspects of the proposed scheme, water source and quality, price, and impacts on the environment and security of supply) and incumbent companies would be required to assess each bid using a principles-based methodology, which Ofwat would design in consultation with the sector. The outcome of each bid assessment (that is, acceptance or rejection) would be added to the information database, and bidders could seek recourse from Ofwat in the event of a dispute regarding the outcome of the assessment process. (The details of the recourse process would need to be further developed in consultation with the sector.) To incentivise further a transparent and efficient bid assessment process, companies could be rewarded or penalised for the quantity and/or quality of their bid assessments via a price control adjustment mechanism, although the design of such a mechanism would require further consideration.

- **System operation functions undertaken by WaSCs/WoCs and other market participants.** As in options 1 and 2 above.

- **Introduce mechanisms to increase transparency and certainty of contracted supplies.** As in option 2 above.

Option 4

Option 4 would see further significant changes from the current regulatory framework.

- **Separate binding price controls for each element of the wholesale water part of the value chain.** As well as a binding control on water resources, option 4 would introduce separate binding controls for each element of the wholesale part of the water value chain.

- **Market information database and bid assessment process for third party options.** As for option 3 above.

- **Independent system operator (ISO).** Under this option, system operator functions would no longer be undertaken 'in house' within WaSCs/WoCs. Instead, an ISO would co-ordinate water resources trading across all market participants. There could be an ISO for each incumbent company's area, or there could be multiple ISOs to match catchments.

- **Mandatory trading pools and interconnector incentives.** Option 4 would introduce a pool-based system to facilitate water trading, similar to that proposed in the Cave review. To increase incentives for water trading, a specific financial incentive would also be developed for the construction of interconnectors. While the detailed design of this incentive would need further consideration, it would be likely to replace the existing water trading incentives.

Assessment of options

In this chapter, we summarise our assessment of the four design options considered for water resources, and set out our preferred option. Our assessment of the above options is based on the following three high-level criteria.

- How well the option will help us to achieve our objectives.
- How well the option addresses known problems.
- How practical it is to implement.

The following figure summarises our high-level assessment of the options against the three assessment criteria described above.

Figure 10: Our assessment of the market options for water resources

	1	2	3 (Preferred option)	4
Achieving our objectives	Non-binding network plus and water resources sub-caps would provide poorer quality information than separate binding controls with a lesser impact on promoting markets.	Non-binding network plus and water resources sub-caps would provide poorer quality information than separate binding controls with a lesser impact on promoting markets.	Separate water resources control would focus attention on water resources. Separate controls and information database would provide better information for market participants.	Mandatory pool focuses on process and not on outcomes. Regulator lead competition for the market would not encourage company ownership of process.
Addressing known problems	No change relative to status quo and therefore does not address identified problems.	Information transparency identified as a key barrier to an effective market. Build versus buy bias addressed through regulatory transparency.	Information transparency that is more independent is more effective. Build versus buy bias addressed through bid assessment framework. Separate price control would make clear the return on these assets.	Mandatory pool would eliminate incumbent control of markets. Separate price control would make clear the return on these assets. Case for ISO now not strong – addresses future potential concerns.
Practicality	Avoids creating additional regulatory burden.	Avoids cost and licence changes necessary for separate price controls. Practical issue of how mechanisms to increase information transparency and certainty are implemented.	RCV split needed. Licence change required for separate price control. Practical issue of how mechanisms to increase information transparency and certainty are implemented.	RCV split needed. Licence change needed for separate price controls. Mandatory pool would be difficult to implement under the Water Act 2014. Practical issue of interconnector incentive scheme design..

Preferred option

After assessing the four options above, our preferred option for regulatory design of the market for water resources is option 3, which we refer to as the 'wholesale water trading model'. Under this option, market design features would include:

- a separate binding price control for water resources;
- a market information database, possibly hosted by a third party, combined with requirements for a transparent bid assessment process for new water resources;
- system operator functions undertaken by WaSCs/WoCs and other market participants; and
- measures to improve regulatory transparency regarding the funding of trading contracts with third parties.

Our preferred option for regulatory design requires the use of a number of new tools to promote markets in the water resources sector. A report we commissioned from Deloitte LLP provides further details of how a market model to support water resources markets could function. In particular, it addresses the role of a market information database, and describes how third party resources options could 'bid in'. The case study below sets out the key elements of the model envisaged by Deloitte for reference purposes.

Hypothetical case study showing the operation of Deloitte's proposed wholesale water trading model for water resources

This case study considers the hypothetical situation of a large brewing company, A's Brewery, that wishes to enter the water resources market.

A's Brewery holds an abstraction licence and has its own borehole, which supplies water to its main brewery. Because of the success of efficiency measures introduced in recent years, it now has considerably more water available for abstraction each year than it needs for the running of the brewery. It therefore considers that it may be able to earn a profit from trading excess untreated water with the incumbent water company in its home region, B's Water & Waste (BWW), while also contributing to meeting growing demand for water from local households and other businesses.

A's Brewery applies for access to the market information database as a qualifying market participant. Once its application is approved by the database host (as noted above, this could be either Ofwat or an independent agency), it is able to easily view information on forward supply and demand projections in BWW's region, as well as cost and technical data for proposed future water resource projects to meet any anticipated supply/demand imbalance. On the basis of this information, A's Brewery concludes that there is a need for more water resource in the region and that it can provide untreated water to BWW at a competitive rate, relative to other options that are currently under consideration.

A's Brewery therefore develops a bid for the provision of untreated water resources based on bid criteria published by Ofwat (for example, setting out information on issues such as the technical and environmental aspects of the scheme, water source and quality, costs and reliability) and submits it to BWW for consideration. BWW reviews A's bid in line with the principles-based methodology and decides to approve the bid. The two companies then enter contract negotiations and, once the contract is finalised, work together on the technical aspects of the project such as connecting A's water supply to BWW's raw water distribution system for transportation to the nearest treatment works.

In addition to benefiting from cost savings versus more expensive resource options, BWW may also receive further remuneration through trading incentives and/or a price control mechanism to reward the efficiency of its bid assessment process. A proportion of the cost savings are passed on to water customers in BWW's region, while A's Brewery benefits from the revenue it receives for its excess water resource.

Further to the above, the following table summarises the rationale for the main elements of our proposed approach to facilitate the development of an effective wholesale water trading market for water resources. In the next chapter, we discuss other elements of our proposals (including access pricing and a balancing market), which will support the development of bilateral markets for areas served by water companies wholly and mainly in England.

Table 3: Rationale for use of regulatory tools

Regulatory tool	Rationale
A separate, binding water resources price control for incumbents.	A binding price control would help to support market development by revealing the costs of water resources, including clarity between water resource and other costs in the wholesale value chain such as transport, treatment and distribution. This means that third party providers will have more confidence about the costs of vertically integrated incumbent appointees and how these will be recovered over time, and so should facilitate the trading of resources. It will also reveal cost information to retailers and other stakeholders and enable increased focus on water resources.
Information remedies.	In their responses to our July discussion document, a number of companies noted that, at present, there might be insufficient information to identify viable water trades properly. A particular concern was that third party options were not necessarily kept 'live' for long enough to be used. In addition, in our stakeholder interviews, a lack of information was highlighted as a key issue. Our proposals for a market information database, accompanied by the ability for third parties to 'bid in' on an ongoing basis are designed to address this.
A framework and process to ensure trades/bids are assessed appropriately.	An incumbent WaSC or WoC could be a monopoly buyer in many instances and we are concerned about the potential for discriminatory behaviour. It is therefore important that there is transparency in how bids are assessed by incumbent companies.

Our preferred approach has the following implications for implementation.

- In the first instance, an information database would need to be designed and set up to collect and share relevant information. The database could be under the custody of a central entity, which could be Ofwat initially but could become an independent third party in the future.

- Second, companies may need to make changes to their systems to collect and report additional data on water resources and to implement the requirements of the bid assessment process. Our aim is for the data required for the database to be closely aligned to the WRMP process.

- Finally, the separate price control would require a licence modification, and it is also likely that we (together with companies) would need to take forward further work to improve the related cost data in advance of PR19. We will also investigate options to make sure the benefits of third party entry are shared appropriately with customers.

Further information regarding the potential implications and impacts of our preferred option is set out in the draft impact assessment in appendix 6.

Water resources in a bilateral market model

As discussed above, our current design proposals mainly focus on increasing the use of market mechanisms by incumbent water companies through the development of a wholesale water trading market for water resources.

Over the longer term, however, we consider that bilateral markets – in which third party providers in the water resources sector contract directly with new entrant retailers – will also represent an important avenue for market participation for areas wholly and mainly in England. As the Welsh Government does not currently intend to bring the relevant parts of the Water Act 2014 into force bilateral markets will not come into effect in areas served by water companies that are wholly or mainly in Wales.

In this chapter we briefly discuss how a bilateral market model would operate and the reforms that are likely to be needed to facilitate the emergence of a bilateral market, both now and in the future in areas served by water companies wholly and mainly in England.

Under a bilateral market model, third party providers of water resources contract directly with independent water retailers rather than with vertically integrated incumbent water companies. This could be done through a direct supply or through a netting arrangement, whereby bilateral trades are completed based on swapping water transported to one part of the network with water taken off elsewhere.

While there are few independent water retailers at present, non-household retail customers will be free to choose their water retailer from April 2017, thereby facilitating the development of competition and new entry in the water retail sector. New entrant retailers will be able to choose whether to receive their wholesale water supply from incumbent water companies or to contract directly with independent water resource providers, under the provisions of the Water Act 2014.

Promoting bilateral markets

There are two key areas where development will be needed to facilitate the development of bilateral markets in areas served by companies wholly and mainly in England.

- **Access pricing.** Third party providers that wish to supply water resources directly to retailers under a bilateral market framework will need access to the distribution networks, and, potentially, raw water transport and treatment facilities of incumbent companies. In turn, they will need to pay incumbents an access price for their services to cover relevant costs incurred (for example, in relation to capital, operational and maintenance cost of the network). It will be important that the access pricing framework is robust and enables efficient entry. We discuss our proposed approach to access pricing in our main consultation document and the separate access pricing appendix.

- **Balancing market.** Under a bilateral market model, contracts for water resources between upstream providers (as sellers) and downstream water retailers (as buyers) will typically be agreed in advance, potentially for lengthy periods. However, decisions regarding actual water use are made by customers in real time, and there is no guarantee that the metered usage of customers will correspond exactly to the contracted volumes agreed bilaterally between counterparties. To deal with any imbalances in physical volumes versus contracted volumes, a balancing market or mechanism will be required, in which non-incumbent companies can effectively buy or sell small increments of additional water in order to match their contracted positions.

In energy markets, balancing mechanisms are run by the system operator, who buys and sells gas and electricity on behalf of market participants to keep the transmission network in balance, and passes these costs on to parties based on the size of their imbalances. While there are clearly many important differences between energy markets and water markets – for example, in relation to the physical features of the products and transportation networks – there are likely to be some helpful parallels in terms of the economic principles for the design of an efficient balancing regime.

We are not putting forward proposals for balancing market design at this stage. This will require further analysis and will be addressed later in our Water 2020 work programme, although we would welcome any initial comments from stakeholders at this stage.

The case study below sets out some of the key elements of a bilateral market model from the perspective of a new entrant in the water resources sector.

Hypothetical case study showing the operation of a bilateral market model

This case study considers the hypothetical situation of C's Fresh Water, an independent upstream water resource provider, and Utilities-R-Us, a national utility retailer, which is interested in expanding its current service offering of energy, phone and broadband to include water retail.

C's Fresh Water has surplus water resources available that it is interested in supplying to Region D (operated by incumbent company D's Water & Waste) while Utilities-R-Us has also identified some potential large non-household customers in Region D. The two companies decide to negotiate a bilateral contract for the supply of water resources in Region D, between C's Fresh Water as upstream entrant/water wholesaler and Utilities-R-Us as downstream entrant/water retailer.

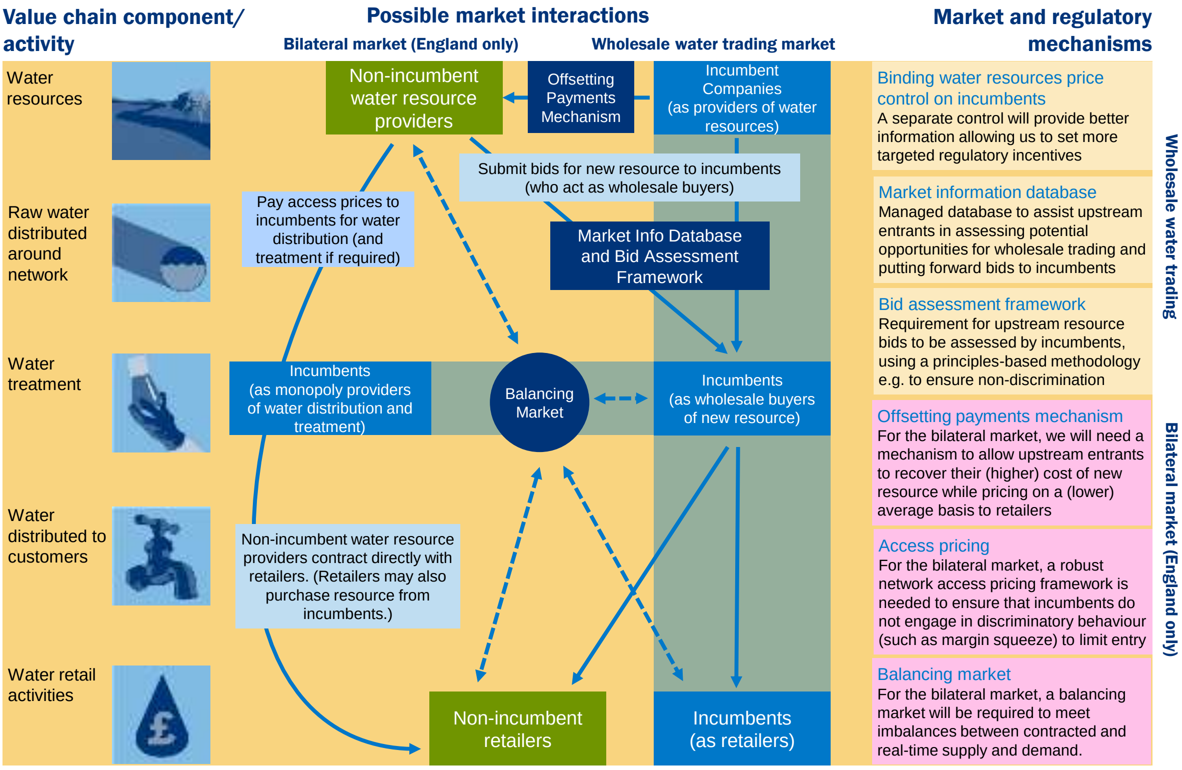
In advance of negotiating the contract, C's Fresh Water seeks access pricing terms from D's Water & Waste for the use of the latter's distribution network and treatment facilities in Region D. The access prices it receives are factored into the contract terms it agrees with Utilities-R-Us.

Once the bilateral contract is in place and Utilities-R-Us has signed up its target customers in Region D, C's Fresh Water begins flowing water into D's distribution network. Since the volumes contracted bilaterally between the two parties may not correspond exactly to the physical volumes of water used in real time, balancing services are procured through the system operator, which is also operated by D's Water & Waste.

Overall summary of our proposals on wholesale water trading and bilateral markets

The following figure illustrates how we envisage market interactions might occur under the wholesale water trading market and bilateral market model. It also summarises the main market and regulatory mechanisms we are proposing in relation to each of these two areas.

Figure 11: Market interactions under wholesale water trading and bilateral market models



Annex 1: Water trading stakeholder engagement

About this annex

To inform our market design proposals for water resources, we conducted telephone interviews with several stakeholders that are involved in the wider water resources sector. The purpose of the interviews was to understand stakeholders' views on water trading: abstraction licence holders selling their water to others. We carried out the interviews in October 2015.

Our approach

We contacted stakeholders across a range of different sectors that are currently operating in the wider water resources market. The parties we spoke to were as follows.

- **Albion Water.** Ofwat licensed Albion Water in 1999 as the first new appointee to the water sector under the new appointment and variations (NAV) framework. Legally, Albion Water has the same powers and responsibilities as any other water company in England and Wales. It provides water, wastewater, drainage and wider environmental services.

- **The British Beer and Pub Association.** The drinks and hospitality industry's largest and most influential trade association representing 90% of UK brewing (by volume) and around 20,000 pubs.

- **The Central Association of Agricultural Valuers**. A specialist professional body representing more than 2,700 members throughout the United Kingdom. The members are agricultural and rural valuers that provide professional advice and valuation expertise on a wide range of issues, including:
  - tenancy matters;
  - sales and purchase of farms and land;
  - taxation;
  - compulsory purchase;
  - auctioneering;
  - conservation issues; and
  - farming structures.

- **The National Farmers Union.** The National Farmers Union represents English and Welsh farmers, and provides professional representation and services to its 55,000 members across England and Wales. The National Farmers Union estimates that more than 70% of full-time farmers are National Farmers Union members.

- **Scottish and Southern Energy Water.** Similar to Albion Water, Scottish and Southern Energy Water is a NAV appointee and, as such, it installs, owns and maintains the water and sewerage systems in particular areas under this framework. Scottish and Southern Energy Water has all of the same duties and responsibilities in the areas it covers as incumbent water companies have.

- **A utility services provider** working in the regulated utilities sectors and specialising in:
  - construction;
  - repair and maintenance;
  - developer services; and
  - water metering.

The interviews focused on water trading: abstraction licence holders selling their water to others. In particular, we asked the following questions.

- How likely are you to consider trading water?
- What are the barriers to you trading water?
- What would help facilitate more water trading?

Given the relatively low number of interviews held, we cannot draw strong conclusions; however, these interviews do give us a broad sense of views and issues facing potential entrants.

Interview findings

How likely are you to consider trading water?

Generally, stakeholders were interested in the subject of water trading. Some already knew about it and are involved in it; others learned about it for the first time during the interview. We spoke to representatives from the farming, brewing and water sectors, which all stated that they intend to start, continue or increase trading. One stakeholder stated that it would not trade but its clients might. No stakeholders were completely against water trading.

Table 4: Stakeholders' responses on the likelihood of them trading water

Stakeholder	Response
Albion Water	Wants to increase its level of trading by setting itself up as a new appointment/variation (NAV) to buy water from its customers that have surpluses and sell it to customers that have shortages. Has identified excess water in the relatively water-stressed south east of England, which could be traded. Sees water trading as a great commercial opportunity and could be a way to reach objectives such as reducing water consumption, protecting the environment and making better use of scarce resources.
British Beer and Pub Association	Some breweries are large water users and extract their own water (for example, through boreholes). These breweries are the most likely to participate in water trading as they may have excess water to trade and in many cases the volume of water involved is likely to be sufficient enough for trading to be viable. The brewing industry has made significant progress on water efficiency in the past 20 years (~60% reduction) so there may be a significant number of breweries with surplus water for trading.
Central Association of Agricultural Valuers	Growing interest in water trading among its members. Small farmers are most likely to trade with neighbouring farmers; however, there is scope for large farmers with substantial infrastructure to trade with water companies.
National Farmers Union	Water trading could be a longer-term opportunity for its members but currently does not happen very often.
Scottish and Southern Energy Water	Does not consider water trading with third-party providers is an option at the moment. Would like to be involved in trading with incumbent water companies, both within the regions in which Scottish and Southern Energy Water operates, and with adjacent regions.
Utility services provider	Will not participate directly in water trading as it does not have access to its own water supply. Thinks that some of its industrial clients might be willing to sell their excess water. Expects that farmers could become potential sellers once the mechanisms of water trading have been sufficiently explained to them.

What are the barriers to you trading water?

The barriers to water trading that stakeholders identified were a lack of awareness and information, insufficient incentives for buyers and sellers, the high upfront investment costs, lack of flexibility, and the unpredictable nature of water use requirements.

Table 5: Stakeholders' responses on the barriers to water trading

Stakeholder	Response
Albion Water	Incumbents' lack of co-operation: incumbents are reluctant to engage in water trading and prefer expensive capex solutions (investing in new infrastructure) to possibly cheaper opex solutions (such as water trading). Upfront investment costs.
British Beer and Pub Association	Lack of information. Confusion between water trading (promoted by Ofwat) and abstraction licence reform, including trading (in Defra's remit). Large upfront investment costs needed to connect breweries' water supplies to the water companies' networks. Difficulty identifying potential traders/counterparties.
Central Association of Agricultural Valuers	High transport costs. Current small scope of water trading means that there is little economy of scale, which therefore reduces the distance over which water can be traded in a cost-efficient way. Inherent unpredictability of farmers' water needs. Farmers are reluctant to enter into contracts as they do not want to have to sell water they might need when water is scarce.
National Farmers Union	Agricultural water users find it hard to trade, as they are unable to trade any headroom they have because of restrictions written into their abstraction licences. The Environment Agency only allows farmers to trade water volumes that they currently use for cropping, so in order to trade they would have to reduce the amount of water they use for agricultural purposes. Farmers generally need water at the same time as each other, so trades between farmers are relatively rare as surpluses and deficits do not often coincide. Food security is a concern: what would be the implications of a significant number of farmers deciding to sell their water rather than using it to grow food?
Scottish and Southern Energy Water	Reluctance of incumbents to engage in water trading. Lack of a functioning framework. Reluctance of incumbents to communicate their costs and access prices. Lack of information about supply and demand.
Utility services provider	Lack of education as most potential market entrants are not aware of their options. Lack of flexibility, as most stakeholders appear to be risk averse. Lack or insufficiency of incentives. Large upfront investment costs.

What could help facilitate more water trading?

The main things that stakeholders suggested could help facilitate more water trading are:

- communicating clear information;
- putting buyers and sellers in contact;
- offering stronger incentives;
- exploiting synergies between water demand in different sectors; and
- ensuring a level playing field.

Table 6: Stakeholders' responses on ways to facilitate water trading

Stakeholder	Response
Albion Water	Government should push harder for more water trading, as it appears to be a cost-efficient solution. Legislation should address the relationships and interactions between incumbents and new entrants, and incentivise incumbents to consider water trading as a viable option. Ofwat should set stronger incentives for buyers and sellers.
British Beer and Pub Association	Ofwat should communicate useful information on who is interested in buying and selling, and where the water deficits and surpluses are. Ofwat should create a virtual market so that interested parties can discuss potential trades and share information.
Central Association of Agricultural Valuers	If water trading were to take place between farmers and water companies, contract templates might have to be written to ensure fair terms.
National Farmers Union	Agricultural and energy sectors need water at different times of the year (the former mainly in spring and summer, the latter mainly in autumn and winter). Ofwat should consider what more it can do to encourage trading between these two sectors.
Scottish and Southern Energy Water	Ofwat should establish measures which decrease the powers that incumbents have over new entrants, as Scottish and Southern Energy Water considers it is not currently competing on a level playing field. Ofwat could create a regulatory framework that encourages incumbents to: • systematically consider trading with new entrants; • effectively communicate their access prices; • reveal their true costs; and • give accurate information about supply and demand. Ofwat should also compel incumbent water companies to give appropriate access to their networks to allow trades.

Stakeholder	Response
Utility services provider	Ofwat should communicate clear and simple information to potential traders. Ofwat could create a website directed at potential market entrants. Ofwat should make sure that it clearly explains the economic and legal frameworks. Ofwat should offer stronger incentives to buyers and sellers.

Summary

Based on stakeholders' responses from these calls, it appears that **most are interested in, or already engaged with, water trading**. We spoke to representatives from the farming, brewing and water sectors who all stated that they **intend to start, continue or increase trading**. One stakeholder stated that it would not trade but its clients might. **No stakeholders were opposed to water trading, but instead all supported our work in promoting it further.**

Stakeholders think the main barriers to water trading are:

- **lack of information** about how to trade;
- **lack of awareness** about who wants to trade;
- **a risk-averse approach from all parties:** holding onto surplus water rather than trading;
- **insufficient incentives for buyers and sellers**;
- **high transport costs** of water;
- **unpredictability of water use** due to weather, product demand, etc;
- incumbent water companies' **lack of co-operation**;
- a perception that some groups are **not competing on a level playing field**; and
- **high investment costs** of establishing trading.

Stakeholders think the main ways in which more trading can be facilitated are:

- **communicating clear and simple information** to potential traders about the economic and legal frameworks involved;
- offering **more attractive incentives** to buyers and sellers;
- drawing up **contract templates** that interested parties could use;
- **encouraging government (Defra) to promote trading** as a cost-efficient option;
- creating a **regulatory framework that encourages trading** by all parties; and
- creating an environment (perhaps a **virtual market**) where buyers and sellers can discover who wants to trade, how much, and on what terms.

Annex 2: Ofwat's interconnection model

Introduction

We have developed an interconnection model in order to calculate the potential cost savings available from greater interconnection between and within companies in England and Wales. The cost savings represent the savings available from interconnection compared with the costs of the schemes proposed in water companies' final 2014 WRMPs. This annex:

- sets out our methodology;
- provides an overview of the model;
- sets out a worked example of our approach;
- examines a number of key modelling challenges;
- sets out our base case result in detail; and
- provides results based on different assumptions of key inputs.

Our methodology

In 'A study on potential benefits of upstream markets in the water sector in England and Wales', Ofwat, March 2010 we reported that the potential cost savings available from greater interconnection between and within companies in England and Wales was up to £959 million (2007-08 prices) in net present value terms over the lifetime of the assets. Our modelling is an update of this analysis using the data from the final 2014 WRMPs.

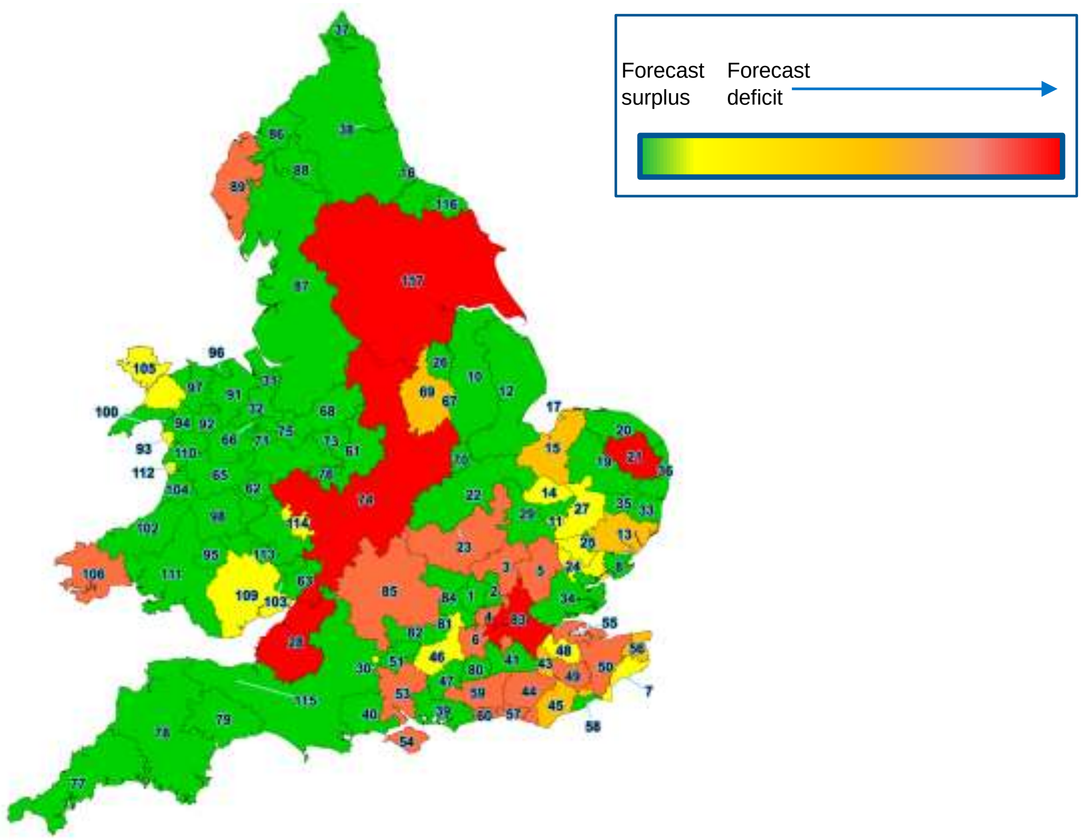
Our approach was to assess, for each WRZ with a forecast deficit in 2039-40, if cost savings could be achieved by meeting its deficit through a new interconnection from a WRZ with a forecast surplus, rather than by the schemes presented in a company's 2014 WRMP. This assessment factored in the estimated cost of developing the interconnection itself.

Our approach was shaped by two observations.

1. Water scarcity varies significantly across England and Wales: while a number of companies face significant challenges to ensure supply and demand balance by 2039-40, there are areas of surplus next to areas of deficit (including in the south east). This is shown in the map below of the forecast baseline supply and demand balance in 2039-40 for every WRZ in England and Wales as of 2014 WRMPs. The 'baseline' forecast is what would happen without any intervention, that is, it does not take into account schemes to reduce demand or increase supply. The forecast incorporates known sustainability reductions and incorporates companies' level of service commitments.

2. There are areas with higher water resource development costs near to areas with lower costs with the potential to develop water resources for export. This is shown in our discussion of cost differences in the previous chapters. Notably figure 8 showed the range of different costs faced across England and Wales in building the next major supply side option identified in companies' 2014 WRMPs.

Figure 12: Forecast baseline supply and demand balance under average dry year conditions across England and Wales, 2039-40



Source: Ofwat analysis of 2014 WRMPs.

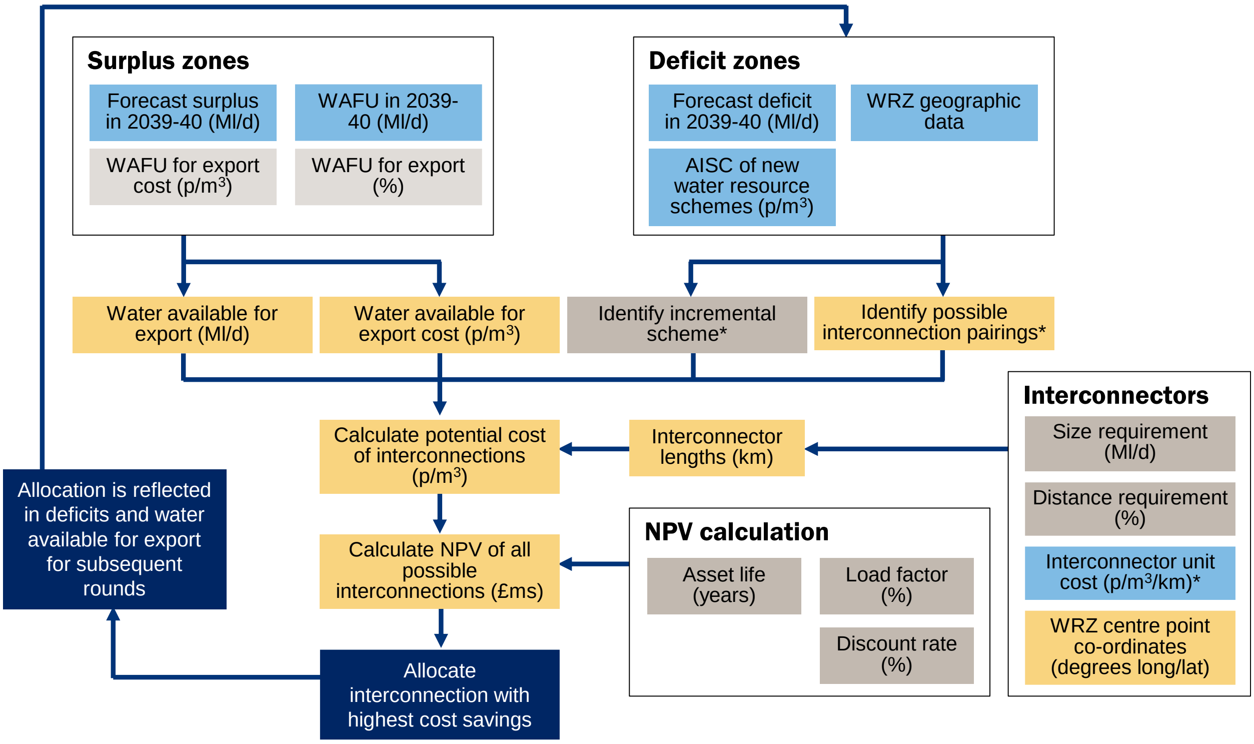
To simplify our analysis for each WRZ in deficit we only compared interconnection with the proposed incremental scheme from the 2014 WRMP. We defined the incremental scheme as the supply-side scheme that provides a significant volume at lowest unit cost as measured by the average incremental social cost (AISC). We assumed that the cost identified persists for the whole of the deficit. We also restricted potential interconnections to neighbouring WRZs and non-neighbouring WRZs that were within a 50 km radius. We discuss the choice of the incremental scheme and the scope of interconnection in more detail below.

We recognise that the model, and our static analysis approach, makes some substantial simplifications and assumptions, and only captures to a limited extent the potential scope of further interconnection across England and Wales. Our methodology does not claim that any individual interconnection we identify would be cost-beneficial, as a full assessment would require significant further information and modelling (this same caveat applied to the 2010 results). Instead, the objective of our methodology is to provide an indication of the scale of the potential value that could be generated through increased interconnection both within and between companies.

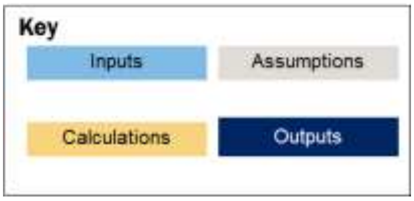
Overview of model structure

The objective of the model is to calculate the potential cost savings available from greater interconnection between and within companies in England and Wales. We will explain how this is done with reference to the inputs, modelling assumptions and results. The structure is illustrated below.

Figure 13: The interconnection model structure



* denotes a key modelling challenge discussed in further detail below



The model is iterative, as for each round the input data and assumptions are used to calculate the value of all possible interconnections and the interconnection with the highest cost savings is allocated. Later rounds reflect the allocations in previous rounds.

Inputs

The key inputs into the model are shown in the table below.

Table 7: Interconnection model inputs

Input (Unit)	Source	Description
Forecast surplus in 2039-40 (Ml/d)	Final 2014 WRMP data tables	This is the baseline surplus forecast for 2039-40. It is what would happen without any intervention – that is, it does not take into account schemes to reduce demand or increase supply. The forecast incorporates known sustainability reductions and incorporates companies' level of service commitments.
Water available for use (WAFU) in 2039-40 (Ml/d)	Final 2014 WRMP data tables	This is the volume of water an appointed water company can rely on feeding into its distribution system. It comprises the volume of water that the company can deploy plus bulk supply imports, less bulk supply exports and less reductions made for outage allowance. We use the forecast WAFU for 2039-40 to capture the forecast changes to WAFU through time. The forecast incorporates known sustainability reductions and incorporates companies' level of service commitments.
Forecast deficit in 2039-40 (Ml/d)	Final 2014 WRMP data tables	This is the baseline deficit forecast for 2039-40. It is what would happen without any intervention – that is, it does not take into account schemes to reduce demand or increase supply. The forecast incorporates known sustainability reductions and incorporates companies' level of service commitments.
AISC of new water resource schemes (p/m^3)	Final 2014 WRMP data tables	The AISC includes social and environmental costs (for example, cost of carbon emissions), as well as the economic cost in terms of capital and operating costs and is calculated on a whole life basis as the total cost divided by the total volume produced, both discounted to the same base year. In general, water companies select options on least cost principles based on the AISC. The AISC captures the cost per unit volume of water supplied or saved to support supply and demand balance and allows comparison of both different supply-side options and demand management schemes. We discuss our approach to selecting the appropriate scheme under 'Key modelling challenges' below.
WRZ geographic data	WRZ GIS data (provided under licence by the Environment Agency)	This is geographic data on the WRZs in the 2014 WRMPs collected and collated by the Environment Agency. As the data is an aggregation, some assumptions have had to be made to maintain contiguous, non-overlapping WRZs.
Interconnector unit cost (p/m^3/km)	Ofwat analysis	We developed an estimate of the total cost per unit length of the interconnector as a function of their capacity in Ml/d. This estimate includes maintenance and pumping costs. We drew on several sources of information to estimate this, including actual interconnector schemes, and our approach is set out under 'Key modelling challenges' below.

Assumptions

We set out the key assumptions required for the model in the table below. For each assumption, we present:

- a description of the assumption;
- its base case value; and
- our rationale.

Where appropriate, we have applied sensitivity testing to these assumptions.

Table 8: Interconnection model assumptions

Assumption (unit)	Base case value	Description
WAFU for export (%)	5%	This variable defines how much of WAFU of WRZs with a surplus is available for export. This assumption provides us with a proxy for of the potential scope of water that could be developed for export. It is required as WRZs with a surplus are not required to provide information on potential water resource development costs in 2014 WRMPs. We used WAFU as proxy for the size of the WRZ in terms of resources and its potential to develop further resources.
WAFU for export cost	10 p/m^3	This variable defines the cost of the WAFU that can be developed for export. This assumption is required as we do not have information on development costs in 2014 WRMPs that forecast a surplus. As a simplification, we assumed that additional resources in WRZs forecasting a surplus would have a relatively low cost of 10 p/m^3 as these are areas, are in general, less likely to facing water scarcity issues. This was also in line with the lower cost incremental schemes we identified in company WRMPs.
Surplus capacity cost (p/m^3)	0 p/m^3	This variable defines the cost of the surplus water. We have assumed an AISC of zero for this capacity as it is already provided. That said we recognise that variable operating expenditure will be incurred if additional water is exported. However, as a simplification we assumed that they are relatively small and captured in our estimates of interconnector costs.

Assumption (unit)	Base case value	Description
Incremental scheme (p/m^3)	WRZ specific	To simplify our analysis, we only compared interconnection with the incremental scheme for each WRZ in deficit. This is the scheme that provides a significant volume at lowest unit cost as measured by the AISC. The assumptions we used to choose the incremental scheme are discussed fully below under 'Key modelling challenges'.
Distance requirement (%)	50%	To simplify our analysis, we assume that the water for export is physically available in the centre of the WRZ and needs to be transported to the centre of the import WRZ. This variable defines the proportion of this distance that is connected using an interconnector. Our base assumption is that an interconnector would be required for 50% of the centre-to-centre distance. We considered this to be a plausible assumption given that most WRZs tend to have large trunk mains within the central part of their region but sometimes not at the edges.
Size requirement (Ml/d)	1 Ml/d	To simplify our analysis and ensure plausible results, we only considered interconnections over 1 Ml/d. This reflects the high unit costs for small capacities, because of the fixed costs associated with laying pipes and the economies of scale from larger pipes.
Asset life (years)	Indefinite	This variable defines the asset life of the interconnector. An interconnector has a long asset life, and even after it is decommissioned, its physical life could last for many years. Therefore, as a simplification, we have assumed that the asset life is indefinite.
Discount rate (%)	3.3%	This variable is used to calculate the NPV of the cost savings from interconnection. We have used the wholesale weighted average cost of capital post-tax for PR14 as our discount rate as this reflects the financing costs the companies face. We have adjusted the AISCs of the incremental schemes to reflect this discount rate.
Load factor (%)	70%	The load factor captures the number of days a year the interconnector will be in operation. Our base assumption is that the load factor is 70%, which implies the interconnector is in operation for 256 days a year. This assumption provides an allowance for outages (around 10% to 15%) and for the fairly small variations through the year in water demand. It also reflects the underlying economics, as interconnectors will be most viable where used regularly and with a steady flow.

Calculations

The key calculations in the model are shown in the table below. The table is structured around the key calculations shown in the above flow chart. Where applicable, we also show the supporting calculations underneath the main calculation.

Table 9: Interconnection model calculations

Calculation (unit)	Description
Water available for export (Ml/d)	
Water available for export (Ml/d)	Forecast surplus in 2039-40 (Ml/d) + WAFU for export (Ml/d)
WAFU for export (Ml/d)	WAFU 2039-40 (Ml/d) * WAFU for export assumption (%)
Water available for export cost (p/m^3)	
Total water available for export cost (p/m^3)	(Surplus capacity component cost + WAFU component cost) / Water available for export (Ml/d)
Surplus capacity component cost	Surplus capacity cost (p/m^3) * forecast surplus in 2039-40 (Ml/d)
WAFU component cost	WAFU for export cost assumption (p/m^3) * (WAFU for export (Ml/d))
Identify possible interconnection pairings	
Identify possible interconnection pairings	GIS system query (see 'Key modelling challenges' for more information).
WRZ centre point co-ordinates (degrees longitude/latitude)	
WRZ centre point co-ordinates (degrees long/lat)	Calculated as the geometric centroid of the WRZ (assuming uniform density) using a GIS system query.
Interconnector lengths (km)	
Interconnector length (km)	(Centre to centre distance (km)) * Distance requirement (%) Full equation for centre to centre distance: arcos((cos(Lat1)*cos(Lat2)+sin(Lat1)*sin(Lat2)*cos(Long1-Long2))*R where: Lat1, Long1 = latitude and longitude coordinates of the centre of the export zone expressed in radians Lat2, Long2 = latitude and longitude coordinates of the centre of the import zone expressed in radians R = the radius of the Earth (assumed to be the average radius of 6,371 km)
Calculate potential cost of interconnections (p/m^3)	

Calculation (unit)	Description
Interconnector cost (p/m^3)	Interconnector unit cost (p/m^3/km) * Interconnector length (km) Note the unit cost is dependent on capacity. See the discussion under 'Key modelling challenges' below.
Calculate NPV of all possible interconnections (£m)	
Cost savings over lifetime (£m NPV)	(Water resource cost differential (p/m^3) * p/m^3 to £/Ml conversion factor * interconnection volume (Ml/d) * discounted days) / 1,000,000 (to convert answer to £m)
Water resource cost differential (p/m^3)	AISC of incremental scheme (p/m^3) – (water available for export cost (p/m^3) + interconnector cost (p/m^3))
Interconnection volume (Ml/d)	Lesser of water available for export (Ml/d) and importer forecast deficit (Ml/d)
Discounted days	Discounted years * Days per year
Discounted years	If the asset life is indefinite: 1/ discount rate Else: (1-discount rate) $^{\text{asset life}}$/discount rate
Days per year	Load factor * 365.25

Outputs

The output of the model is a list of possible positive NPV interconnections. The model is iterative and the interconnection that has the highest cost savings is allocated first. After this interconnection is made, the water available for export from the exporter, and the deficit for the importer, are updated. Later rounds reflect this and subsequent interconnections, and the model then repeats the allocation process until no more cost savings can be made through interconnections.

Worked example

The example below is a hypothetical scenario where there are three neighbouring WRZs: two with deficits, and where there are potential importers; and one WRZ has a surplus, and is a potential exporter. All assumptions are as the base case set out above and the calculations follow the steps shown in table 10 above, with the underlying calculations shown in square brackets. Where applicable, we also show the supporting calculations underneath the main calculations.

Figure 14: Interconnection model worked example

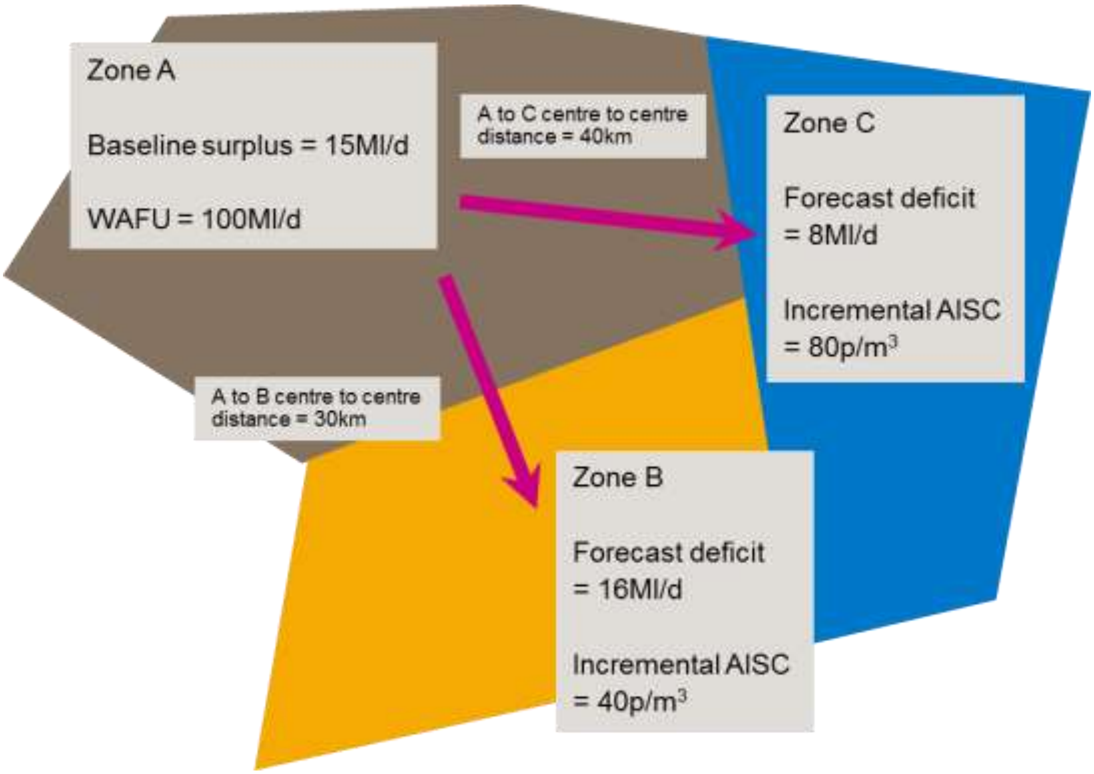


Table 10: Example inputs

Inputs (unit)			
WRZ	**A**	**B**	**C**
Forecast surplus in 2039-40 (Ml/d)	15 (Ml/d)	n/a	n/a
Forecast deficit in 2039-40 (Ml/d)	n/a	-16 (Ml/d)	-8 (Ml/d)
WAFU in 2010-11 (Ml/d)	100 (Ml/d)	n/a	n/a
Incremental water resource scheme (p/m^3)	n/a	40 (p/m^3)	80 (p/m^3)
Interconnector unit cost (p/m^3/km)	1.17 (p/m^3/km) (A to B interconnector) – dependent on interconnector volume (see discussion under 'Key modelling challenges' below) 1.67 (p/m^3/km) (A to C interconnector) – dependent on interconnector volume (see discussion under 'Key modelling challenges' below)		

Table 11: Example calculations

	A export to B	A export to C
Water available for export		
Water available for export (Ml/d)	20 (Ml/d) [15+5]	20 (Ml/d) [15+5]
WAFU for export (Ml/d)	5 (Ml/d) [100*5%]	5 (Ml/d) [100*5%]
Water available for export cost		
Total water available for export cost (p/m^3)	5 (p/m^3) [(0+100)/ 20]	5 (p/m^3) [(0+100)/ 20]
Surplus capacity component cost	0 (p/m^3) (Base case assumption)	0 (p/m^3) (Base case assumption)
WAFU component cost	100 (p/m^3) [10*10] (WAFU for export cost assumption = 10p/m^3)	100 (p/m^3) [10*10] (WAFU for export cost assumption = 10p/m^3)
WRZ centre point co-ordinates (degrees long/lat)		
WRZ centre point co-ordinates (degrees long/ lat)	2,50 to 2, 50.27, (decimal degrees)	2,50 to 2.51, 50.15, (decimal degrees)
Interconnector lengths (km)		
Interconnector length (km)	15 (km) [30*0.5]	20 (km) [40*0.5]
Calculate potential cost of interconnections (p/m^3)		
Interconnector cost (p/m^3)	17.55 (p/m^3) [1.17*15]	33.4 (p/m^3) [1.67*20]
Calculate NPV of possible interconnections (£m)		
Cost savings over lifetime (£m NPV)	21.63 (£m) [(17.45*16*7747.71*10) /1000000]	25.8 (£m) [(41.6*8*7747.71*10) /1000000]
Water resource cost differential (p/m^3)	17.45 (p/m^3) [40 – (5 + 17.55)]	41.6 (p/m^3) [80 – (5+33.4)]
Interconnection volume (Ml/d)	16 (Ml/d) [lesser of 20 and 16]	8 (Ml/d) [lesser of 20 and 8]
Discounted days	7747.71 (days) [255.7*30.49]	7747.71 (days) [255.7*30.49]
Discounted years	30.3 (years) [1/3.3%]	30.3 (years) [1/3.3%]
Days per year	255.7 (days) [70%*365.25]	255.7 (days) [70%*365.25]

In this example, the model would allocate a trade from A to C, rather than A to B as A to C has the higher cost savings of £25.8 million compared with £21.63 million. The cost savings are higher even though the trade is longer and for a lower capacity. This is driven by the higher water resource development costs in WRZ C, compared with WRZ B. As noted above, the model is iterative, so it is possible that the remaining water available for export could be allocated to partially meet WRZ's B deficit.

Key modelling challenges

Here we discuss how we approach a number of modelling challenges, including:

- identifying potential interconnection partners;
- selecting the incremental scheme; and
- estimating interconnector costs.

Identifying potential interconnection partners

For each WRZ where there was a projected deficit, we assumed that this could be met by interconnection(s) from a WRZ with a forecast surplus. There are 73 WRZs that forecast a surplus, so to keep the analysis manageable we restricted potential interconnections to:

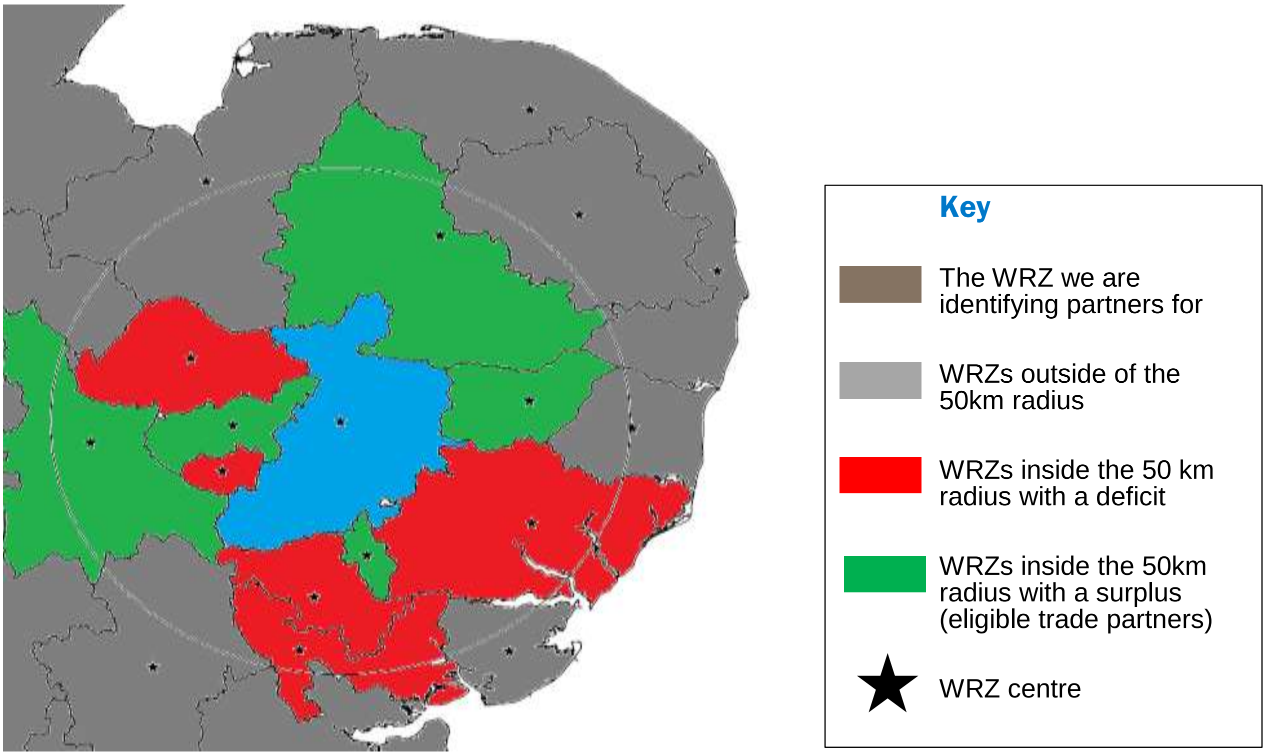
- neighbouring WRZs with a surplus which share a border; and
- non-neighbouring WRZs with a surplus whose centres were within 50 km of the centre of the recipient WRZ.

We used Geographic information system (GIS) software and the GIS dataset of WRZs to carry out the analysis. For each WRZ in deficit, we calculated the centre and then ran a query to find every potential interconnection partner that met the above criteria. An example of our approach for West Suffolk WRZ is shown in the figure below, where:

- the West Suffolk WRZ is shaded blue;
- the circle around this WRZ shows the 50 km distance from the centre of this WRZ;
- the grey areas indicate WRZs where the centre (denoted by stars) fall outside of the 50 km radius;
- the five WRZs shaded red meet the distance criteria but are forecasting a deficit and are therefore not potential trading partners; and

- the five WRZs shaded green meet the distance criteria and represent potential trading partners.

Figure 15: Example of identifying potential interconnection partners



Source: Ofwat analysis.

We restricted potential exporters to non-neighbouring WRZs with a surplus within a 50 km radius as this covers the typical length of interconnectors in the water sector. We also note that while we expect there to be capacity within intervening WRZs to move water, the availability of this becomes less certain as length increases. Also, our interconnection cost estimates will be less accurate where very long distances are required as there is less data available to construct these estimates. We tested this assumption as part of our sensitivity testing.

Selecting the incremental scheme

To simplify our analysis, we only compared interconnection with the incremental scheme for each WRZ in deficit in companies' 2014 WRMPs. This is the scheme that provides a significant volume at lowest unit cost as measured by the AISC. The AISC includes social and environmental costs – for example, cost of carbon emissions – as well as the economic cost in terms of capital and operating costs, and is calculated on a whole life basis as the total cost divided by the total volume produced, both discounted to the same base year. The AISC captures the cost per unit volume of water supplied or saved to support supply and demand balance, and allows comparison of both different supply-side options and demand management schemes. In selecting the incremental scheme, we excluded options that provide very small volumes because this would give misleading results. We have therefore exercised a degree of judgement about what volume is significant in relation to any deficit.

WRMPs divide options into:

- **customer** – working with customers to reduce consumption (includes metering and tariffs);
- **distribution** – both leakage reduction (effectively managing own demand) and new links within and beyond the zone;
- **production** – new/enhanced treatment; and
- **resources** – new sources of water.

We only selected the incremental option from:

- 'supply-side' options of production;
- resources; and
- any links beyond the zone.

We excluded the 'demand-side' options of customer management and leakage reduction to simplify the analysis as these schemes often have high unit costs or involve small or uncertain quantities, which could distort our results. For example, water efficiency programmes, such as those where companies give away free water-saving devices, can have varying effectiveness in influencing water use. However, we are not suggesting that demand-side and leakage measures are not important for restoring demand/supply balance.

Where the incremental option was an interconnection that was significantly large in size with respect to the forecast deficit, we did not assess whether other interconnections would generate larger cost savings, as we only wanted to look at interconnections beyond those that are currently active or proposed. We also considered it would be inappropriate to second-guess companies' chosen interconnection schemes in these circumstances. Further, our analysis is static and based on the position as of final 2014 WRMPs. For simplicity, we have not updated to reflect updates to these plans or other regulatory decisions.

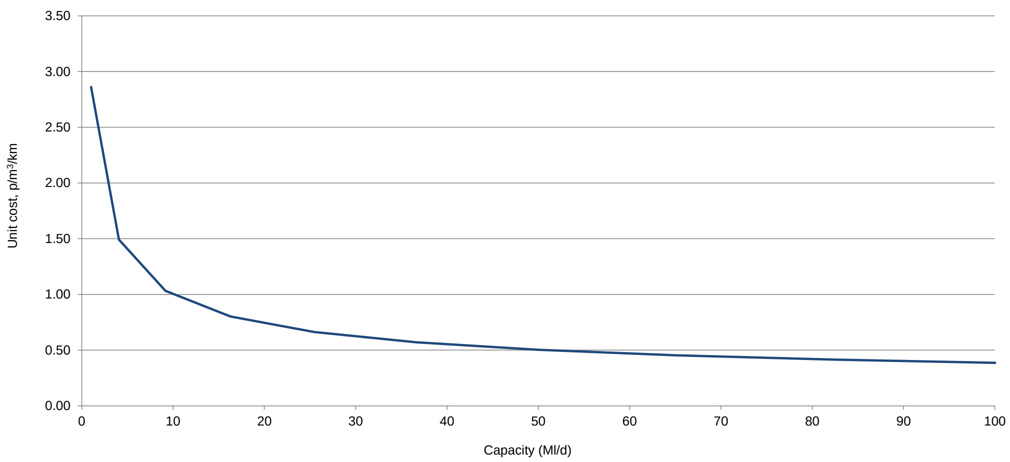
Estimating interconnector costs

We assume WRZs are linked by a new interconnector. We developed an estimate of the cost per unit length of the interconnector as a function of its capacity in Ml/d. We drew on several sources of information to estimate this.

- Existing internal analysis of interconnector costs, including pumping requirements.
- Detailed information on several large company main schemes, capturing their diameter, length, cost, velocity and flow.
- Updated information on power costs and maintenance requirements.

Based on this information, we estimate the unit cost per kilometre of an interconnector, including maintenance and pumping costs, to be approximately as presented in the figure below.

Figure 16: Estimate of interconnector costs



Source: Ofwat analysis.

The unit costs are high for small capacities because of the fixed costs associated with laying pipes and the economies of scale from larger pipes. We see this particularly in the estimates for capacities below around 10 Ml/d. These economies occur because pipe diameter is an important cost driver, whereas capacity increases with cross-sectional area, proportional to the square of diameter. Also, frictional losses are lower in a large pipe. However very large diameters present additional engineering challenges and we see unit costs decline more slowly beyond 60 Ml/d. For the interconnections modelled the appropriate level of unit costs is dependent on capacity.

We note that the costs estimated above are likely to be an appropriate measure of the costs of interconnectors for most distances involved. However, the estimates of the interconnector costs may be less accurate where very short or very long distances are involved, since there is less data available to construct these estimates. Reflecting this, we limited the geographic scope of interconnection in our base case. Similarly, as we have limited information on the topological and geographical characteristics of the area where specific interconnectors are being built, our estimates are based on a level topography. As a result, we may be over-estimating the cost where there are other, lower cost options, such as using a river or existing infrastructure to transfer water and vice versa in areas where significant pumping is required.

Overview of base case results

In this section, we:

- report the results;
- discuss their implications; and
- compare them to the 2010 study.

Our base case results

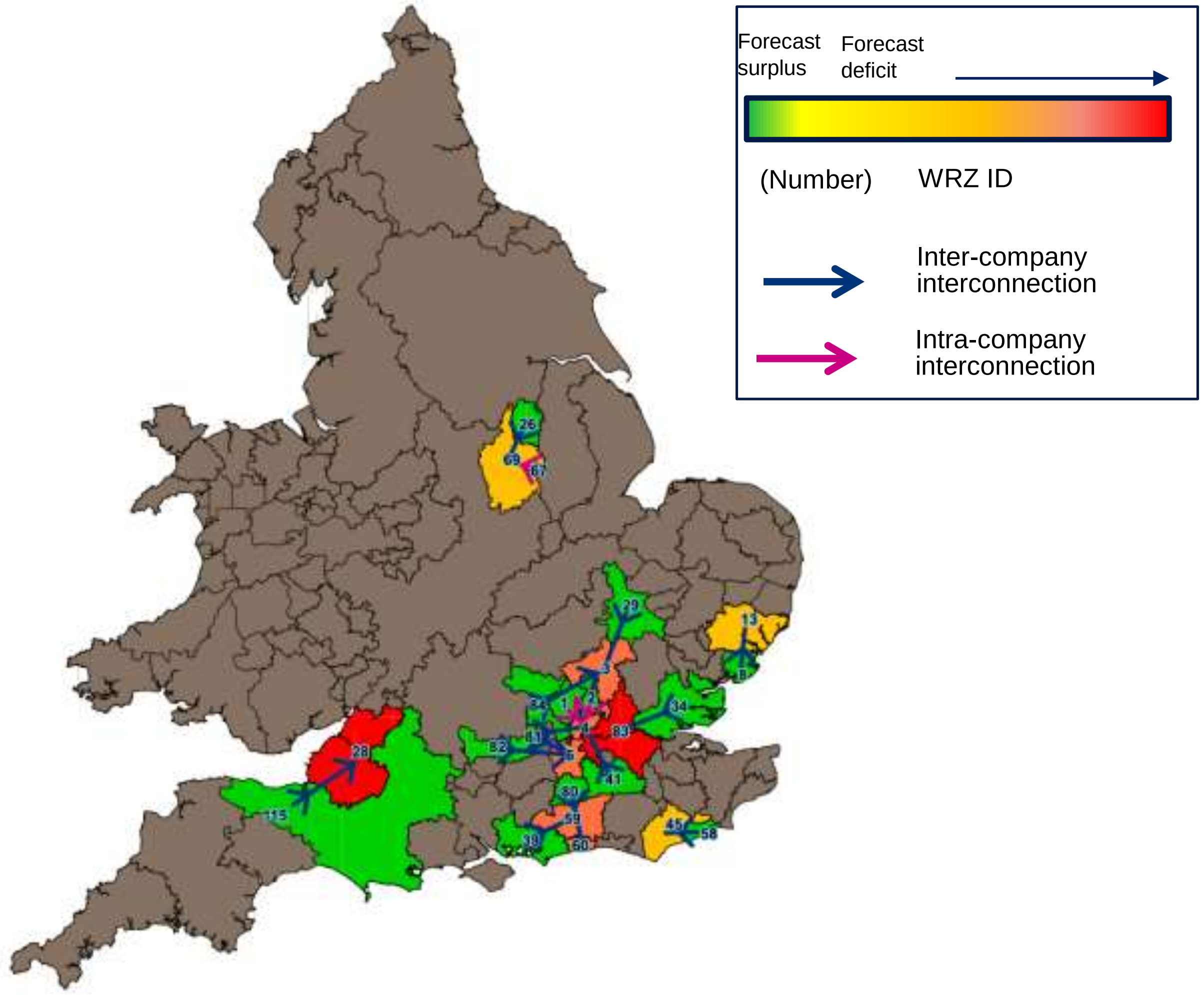
Our base estimate identified 16 interconnections that could save the water sector £914 million (2012-13 prices) over the lifetime of the assets compared with the cost of the schemes proposed in water companies' 2014 WRMPs. As noted above, our methodology does not claim that any individual interconnection we identify would be cost-beneficial as a full assessment would require significant further information and modelling (this same caveat applied to the 2010 results). Instead, the objective of our methodology is to provide an indication of the scale of the potential value that could be generated through increased interconnection both within and between companies.

All identified interconnections are shown in the table and then mapped in the figure below. In figure 17, the interconnections are shown graphically and arrows have been added to show the direction of the interconnection. The WRZ identification numbers (IDs) which were assigned for the modelling exercise are also shown. Note: the WRZs that are identified as importers or exporters are coloured according to their forecast baseline supply/demand balance in 2039-40 while all other zones are coloured grey.

Table 12: Interconnection model identified interconnections

WRZ ID	Import WRZ	WRZ ID	Export WRZ	Cost savings (£m over lifetime)
28	BRL – Bristol	115	WSX – Companywide (WW)	194
3	AFW – 3 Lee	84	TMS – Slough Wycombe Aylesbury	164
83	TMS – London	34	ESK – Essex	85
59	SRN – Sussex North	39	PRT – Companywide (Portsmouth)	78
13	ANH – East Suffolk	8	AFW – 8 Brett	77
6	AFW – 6 Wey	82	TMS – Kennet Valley	68
45	SEW – 3	58	SRN – Sussex Hastings	53
4	AFW – 4 Pinn	2	AFW – 2 Colne	46
4	AFW – 4 Pinn	1	AFW – 1 Misbourne	43
4	AFW – 4 Pinn	41	SES – East Surrey	41
3	AFW – 3 Lee	29	CAM – Cambridge	27
4	AFW – 4 Pinn	81	TMS – Henley	17
60	SRN – Sussex Worthing	80	TMS – Guildford	15
69	SVT – Nottinghamshire	67	SVT – Newark	3
6	AFW – 6 Wey	81	TMS – Henley	2
69	SVT – Nottinghamshire	26	ANH – West Lincolnshire	1
Total				914

Figure 17: Interconnection model identified interconnections



Source: Ofwat analysis.

Discussion of results

Thirteen of the identified interconnections were between different companies, while three were within company areas. Reflecting this, inter-company transfers contribute approximately 90% of the overall cost savings. This is not unexpected, as water companies already have appropriate incentives to develop efficient interconnections within their appointed areas.

As noted above, our overall estimate of £914 million (2012-13 prices) is not a precise estimate of the potential cost savings greater interconnection could deliver, and there are several reasons to think that this might be an underestimate of the savings and that there could be significantly more potential interconnections.

- Most interconnections identified by the model are in the south and east of England. This reflects the underlying water scarcity issues in this area that have fed into the model as overall two-thirds of the WRZs we look to supply with an interconnection are in the south and east of England. However, this is not to say that interconnections are not viable outside the south and east of England. In particular, it is important to stress that as we only have very limited data on water resource costs for WRZs in surplus, we have not able to assess the potential benefits of interconnections for these WRZs which could be substantial. For example, this includes most WRZs served by companies that are wholly or mainly in Wales.

- The estimate does not take into account further efficiency gains from interconnection. For example, interconnected WRZs can share reserve supplies reducing the net need for investment across the two WRZs. The size of this benefit will depend on the correlation of demand and supply variability in the two WRZs and has not been taken account of in the modelling work as it depends on the specific nature of the supply systems being joined.

- Where the incremental option was an interconnection that was significantly large in size with respect to the forecast deficit, we did not assess whether other interconnections would generate larger cost savings as we only wanted to look at interconnections beyond those that are currently active or proposed. This is not to say that other interconnections could not generate additional value; in particular – our analysis of these schemes showed that most were internal transfers and it may be the case that an inter-company transfer could be a better option and generate larger cost savings.

- The scarcity value of water is not taken into account in the estimates of water resource development costs contained in 2014 WRMPs. Information on the value of water is limited as there is only limited abstraction trading and effective wholesale water trading markets have not yet been introduced. If this was incorporated, the value of water is likely to be higher in areas of water scarcity than in areas of water surplus, increasing the benefits of moving water between these areas.

- Under the 2014 WRMP process, companies that are forecasting a baseline surplus for a given WRZ in 2039-40 are not required to identify options for new water resources in that WRZ. Reflecting this, we have had to base our modelling on conservative assumptions about the cost of such options and how much water could be made available. If there was a thriving wholesale water trading market, those WRZs would have clearer market signals to identify options for cheap water supply which they could export to more expensive WRZs.

- Our analysis did not look at the potential cost savings available from ‘chain’ or co-ordinated interconnections. This is where there is a chain of interconnections from WRZs with large surpluses to those WRZs with a large deficits through a series of intermediate WRZs. For example, additional resource at one location (A) may be able to be transferred to a second location (B), which in turn allows resource to be shifted from the second location to a third location (C). In effect, water has been transferred from location A to C, although there is no direct transfer between A and C. These options could potentially result in significant cost savings but were not captured as our modelling took a static approach to optimisation. For example, we note that a number of deficit WRZs in the south east are surrounded by WRZs also in deficit and therefore only have limited or no interconnection partners. In these areas, a chain of interconnections could bring significant benefits.

Comparison of the results with the 2010 results

In our 2010 study, using a comparable approach, we identified that the potential cost savings available from greater interconnection between and within companies in England and Wales was up to £954 million (2007-08 prices) in net present value terms over the lifetime of the assets. The cost savings were spread across 31 potential interconnections, 17 of which were between companies and 14 were within company boundaries. Our updated results are of a similar order of magnitude – £914 million (2012-13 prices), but the savings are spread across fewer interconnections (16).

These differences are driven by changes in underlying supply and demand and water resource development costs across England and Wales. This reflects changes in WRZs themselves since the last study, which was based on the draft 2009 WRMPs. In some areas, WRZs have been aggregated to form fewer, but larger, zones; whereas, in others, WRZs have disaggregated into multiple, smaller zones. Overall, these changes have seen the number of WRZs considered in our analysis increase from 106 to 117. There have also been changes in demand/supply conditions, as a number of WRZs in deficit in the previous study will have completed options to meet these deficits over the intervening period.

We have also updated our approach and assumptions. For example, in the previous study, to calculate the length of an interconnector we measured the centre-to-centre distance on a map and converted it to a distance on the ground. In contrast, we have used GIS software and a GIS dataset to calculate distances. We have also updated assumptions – for example, in the previous study it was assumed that 25% of WAFU would be available for export. We considered that this was likely to be an overestimate and therefore cut this back to just 5% of WAFU – this change means that a number of WRZs require multiple interconnectors to meet their demand. We have also not considered an interconnection where the incremental option itself is an interconnection that significantly meets the forecast deficit. These factors help explain why we have a reduced number of identified interconnections in this study.

Key sensitivities

Below we present the results of our sensitivity analysis on the value of the cost savings from interconnection. In each scenario, we change one key assumption, while leaving all other inputs the same.

Table 13: Range of cost savings from greater interconnection

Scenario	Description	NPV cost savings £m (change)	Interconnections (change)
Base case	Our base case as set out above	914	16
Discount rate sensitivities			
Discount rate increased by 0.1%	A higher discount rate means a higher return on capital and therefore higher costs, which results in lower cost savings.	860 (-54)	15 (-1)
Discount rate reduced by 0.1%	A lower discount rate means a lower return on capital and therefore lower costs, which results in higher cost savings.	970 (+56)	16 (0)
Distance sensitivities			
Interconnector spans 40% of the centre to centre distance	Shorter interconnectors lower the cost of interconnections, increasing the potential cost savings.	992 (+78)	17 (+1)
Interconnector spans 60% of the centre to centre distance	Longer interconnectors increase the cost of interconnections, decreasing the potential cost savings from each interconnector and making one unviable.	850 (-64)	15 (-1)

Potential interconnections limited to WRZ's 25 km away	Restricting the geographic scope of possible interconnections removes a number of potential interconnections and reduces the potential cost savings.	845 (-69)	13 (-3)
Potential interconnections widened to include WRZs 75 km away	The increased geographic scope gives more opportunities for interconnections, and cost savings.	1077 (+163)	17 (+1)
Interconnector sensitivities			
Asset life of 100 years	Small reduction in cost savings due to change in asset life.	882 (-32)	16 (0)
Interconnector costs reduced by 10%	Interconnectors are less expensive, and cost savings are higher.	945 (+32)	16 (0)
Interconnector costs increased by 10%	Interconnectors are more expensive and cost savings are lower, with one interconnector becoming unfeasible	881 (-32)	15 (-1)
Load factor of 65%	Assets are in use for less time so generate fewer cost savings.	848 (-65)	16 (0)
Load factor of 75%	Assets are in use for more time so generate greater cost savings.	979 (+65)	16 (0)
No minimum connection size	One very small additional interconnection is made.	915 (+1)	17 (1)
Minimum connection size 2 Ml/d	One small interconnection does not meet this size requirement.	911 (-2)	15 (-1)
Surplus water sensitivities			
AISC of surplus water costs 10 p/m^3	Increasing the cost of surplus water will decrease the cost savings possible, and makes some interconnections unfeasible.	769 (-145)	14 (-2)
WAFU sensitivities			
10% of WAFU for export	Increased WAFU for export means that deficits that can be met through fewer interconnections, which means a slight increase in cost savings but fewer trades in total.	983 (+70)	12 (-4)
No WAFU available for export	This means there is less water available for each interconnection. This reduces the potential cost savings and means that an extra interconnection is used to satisfy deficits.	754 (-159)	17 (+1)

WAFU for export costs 5 p/m^3	This means that the water available for export has a lower cost and allows for higher cost savings. The lower cost makes one additional interconnection viable.	957 (+43)	17 (+1)
WAFU for export costs 15 p/m^3	Fewer cost savings as the cost of water is increased. One interconnection is no longer viable with the higher costs.	876 (-38)	15 (-1)

Across all the scenarios, the cost savings (in 2012-13 prices) from greater interconnection ranges from £754 million to £1,077 million and the average estimate is £907 million. We do not have strong evidence to suggest a move away from our base assumptions is appropriate, and our results do not suggest that changes in assumptions will result in significantly different results. Therefore, we consider our base estimate represents our most reasonable estimate of the potential cost savings, subject to the caveats noted above.

Ofwat (The Water Services Regulation Authority) is a non-ministerial government department. We regulate the water sector in England and Wales. Our vision is to be a trusted and respected regulator, working at the leading edge, challenging ourselves and others to build trust and confidence in water.

Ofwat
Centre City Tower
7 Hill Street
Birmingham B5 4UA

Phone: 0121 644 7500
Fax: 0121 644 7533
Website: www.ofwat.gov.uk
Email: mailbox@ofwat.gsi.gov.uk

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Any enquiries regarding this publication should be sent to us at mailbox@ofwat.gsi.gov.uk.