# Putting the water into waterways

## Water Resources Strategy – Consultation Document

Canal & River Trust

September 2014

# Executive summary

Delivering a long term security of water supply to the waterway network will help the Canal & River Trust achieve its vision of *living waterways that transform places and enrich lives*. To enable this, we are developing a Water Resources Strategy to allow us to plan successfully for the future. The strategy sets out our aspirations for the next five years, but looks as far ahead as 2050 to understand the longer term pressures and challenges.

The consultation outlines the key issues that we wish to understand and manage better, and seeks the views of all our customers and users to help influence the work we do in the future. It is the first time that these issues have been openly presented by the Trust and we believe this embodies our values of being caring, open, local, involving and demonstrating excellence in our work.

The consultation document introduces and explains the key concepts and definitions in our approach to managing water resources, such as **hydrological units** (sections of waterway that share a common source(s) of water supply to meet demands for water), **navigational drought** (interval of time where closure within a particular hydrological unit is required as a result of a shortage of water resources), **levels of service** (the frequency we would expect a navigational drought to occur) and **navigational drought closure** (navigation being available for less than five hours in a day, on seven or more consecutive days due to drought). Views on these definitions are sought from customers and users.

## Our Values

Caring
Open
Local
Involvement
Excellence

Image: Jack Perks

**"Water is vital to the Canal & River Trust It is the lifeblood of the canals and rivers that we care for, and it needs to be carefully managed, particularly in times of drought."**

Canal River Trust, March 2014

The consultation explores the various levels of service currently in place for the Trust's network, and presents a range of costings for three differing levels of service for three key hydrological units, to illustrate the range of investment the Trust might need to make in the future. These estimates are presented in terms of the whole-life costs for a variety of different schemes (such as reducing canal losses, installing new backpumps to recirculate water, or accessing new sources of water). The way the Trust will assess and prioritise future investments in water resource improvements, on the basis of their benefit-cost ratio is also presented. Currently, the aspirational level of service is 1 in 20 years, i.e. the Trust maintains and operates the canal network so that drought closures are implemented, on average, less than once every twenty years. Another way to express this is in terms of a drought closure having a 5% probability of occurring in any single year. Views are sought on whether this level of reliability is appropriate for our range of customers and users, and if our approach to prioritising investment is acceptable.

The possible impact of future pressures on the Trust's water resources are explored in the consultation, with a focus on restorations and new canals, climate change, new legislation, changes to boating patterns, water transfers, water sales and water rights trading. The document outlines how we propose to investigate and quantify the impact of these pressures, primarily through further research, hydrological modelling, and reference to industry best practice.

The consultation also describes the Trust's views on three key issues that are frequently raised by our customers and users whenever water resources and droughts are being debated, namely: lock leakage, side ponds and dredging. There is often a misconception about the effect of these three issues on our overall water resources reliability. The consultation takes the opportunity to clarify a number of areas of misunderstanding and it presents our current view on these issues, as the viewpoints/perceptions can be quite different to the technical facts.

Finally, the consultation explains our proposals for a five-year update cycle for the Trust to produce and implement its Water Resources Strategy. This will incorporate each of the themes and priorities summarised above, allowing progress to be made in key areas, whilst ensuring that lessons are learned and feedback improves the overall management of water resources across the 2000 mile network of canals and river navigations. This will help the Trust to deliver its vision of living waterways that transform places and enrich lives.

Comments are invited to the consultation by email, post or online at **www.canalrivertrust.org.uk/about-us/consultations**, and the consultation period runs for 8 weeks, from **9 September** to **4 November 2014**.

# 01 Introduction – why we need a Water Resources Strategy

Water is vital to the Canal & River Trust (the Trust). Without enough, navigation would not be possible, the natural environment and canal side/boating businesses would suffer and the experience for many of our different towpath visitors (such as cyclists, walkers, anglers) would also be much poorer. The Trust has a vision of living waterways that transform places and enrich lives. To ensure we deliver this vision, and the six strategic goals that accompany it, it is vital that the Trust delivers long term security of water supply to our canal network. To achieve this and building on previous work, we are developing a Water Resources Strategy (WRS) to allow us to plan successfully for the future.

The primary reason we have to carefully manage water resources is that the Trust needs a reliable supply of water to meet the various demands of an inland waterway network. These demands include visible uses of water, such as each time a lock is emptied to allow a boat to pass up or down a lock flight (there are nearly 1,600 locks across the network, which are used around 4 million times each year). However, there are also unseen demands for water, such as seepage and leakage through the canal bed (which may have a clay lining that was originally put in place over two centuries ago), use by vegetation and evaporation.

Due to the size and diversity of the waterway network we manage, we have split it up into 'hydrological units'. These units allow us to manage water resources more effectively and help us with strategic analysis. Hydrological units are defined in Section 4, p7.

Within this consultation we have set out the overarching vision for how the Trust intends to manage water resources across the network through to 2050. We discuss 'levels of service' and their indicative costs, consider future pressures on water supply and demand, detail our proposed actions over the next five years and look at a variety of other water resource related issues.

The canal network is unique in the water supply sector due to its large geographical range and its age. The water supply companies in England and Wales undertake the most similar activities and operations to us and as such we aspire to work as closely as possible to water industry guidance and best practice whilst having no statutory obligation to do so.

# 02 Why are we consulting?

This is the first time that the Trust has formally consulted customers, users and stakeholders on water management issues. However, for this strategy we have undertaken a number of stakeholder engagement activities (please refer to Appendix 3, p46 for a list of the groups we have engaged with already) and are completing the process with this formal Consultation.

As the Canal & River Trust we feel that it is very important to be open and involving wherever we can, demonstrating both transparency and technical excellence in all that we do. We have asked 15 questions in this document (contained within boxes) which are summarised in Appendix 5, p48. We would greatly appreciate your comments on these and any other views that you have in relation to our Water Resources Strategy. We look forward to hearing your views, which will inform and influence our future work.

# 03 How can you respond?

There are several ways that you can respond to this consultation. You could either e-mail us at **water.information@canalrivertrust.org.uk**; write to us using the following address:

**Water Management Team**
**(Strategy Consultation Response)**
Canal & River Trust
Canal Lane
Hatton
Warwick
CV35 7JL

or complete the questionnaire on-line:
**www.canalrivertrust.org.uk/about-us/consultations**

# 04 Key concepts and definitions

The Trust has a duty to maintain its navigations under Section 105 of the Transport Act 1968. The 1968 Act classifies waterways into three categories: cruising waterway, commercial waterway and remainder waterway. The list of cruising and commercial waterways is in Schedule 12 of the Transport Act 1968.

The categories can be defined as:

- **Cruising waterways –** the Act requires the Trust to keep these waterways in a suitable condition for use by cruising craft
- **Commercial waterways –** the Act requires the Trust to keep these waterways in a suitable condition for use by commercial freight-carrying vessels
- **Remainder waterways –** any waterway which is not a cruising or commercial waterway

In order to meet the duty for cruising and commercial waterways, the Trust must ensure that there is a sufficient depth of water in canals for navigation. The Trust's duty for remainder waterways is to ensure they are dealt with in the most economical manner possible consistent with the requirements of public health and the preservation of amenity and safety. It is therefore very important that we manage water resources carefully to ensure that we meet all our duties.

Even with careful management and planning, there will be occasions when restrictions and stoppages will need to occur. These can be due to a variety of factors such as operational reasons (e.g. for necessary engineering works), instances of misuse or vandalism (e.g. lock paddles being left open and pounds emptying), flooding and for a lack of water resources (through drought).

Drought is a natural phenomenon that historically has had an impact on navigation across the waterway network. Drought events in recent years have highlighted how prolonged periods of dry weather can have an impact on public water supply, agriculture, the environment and of course navigation.

There are various definitions of drought available. It is impossible to agree on a single definition of what drought actually means for all purposes. This is because drought impacts on different individuals or groups in different ways.

Droughts can typically be characterised into three classes:

- **'Meteorological drought'** can be defined as a period of time of lower than expected rainfall.
- **'Agricultural drought'** can be defined as a period of time where agricultural output is reduced as a result of insufficient water.
- **'Hydrological drought'** can be defined as a period of time where stream flows fall below an expected rate.

None of these adequately covers the impact of a drought on navigation. Therefore, we have defined a **'navigational drought'** as:

- **An interval of time where closure within a particular hydrological unit is required as a result of a shortage of water resources**

Due to the size and diversity of the waterway network we manage, we have split it up into **'hydrological units'**. These units allow us to manage water resources more effectively and help us with strategic analysis. We have defined hydrological units as:

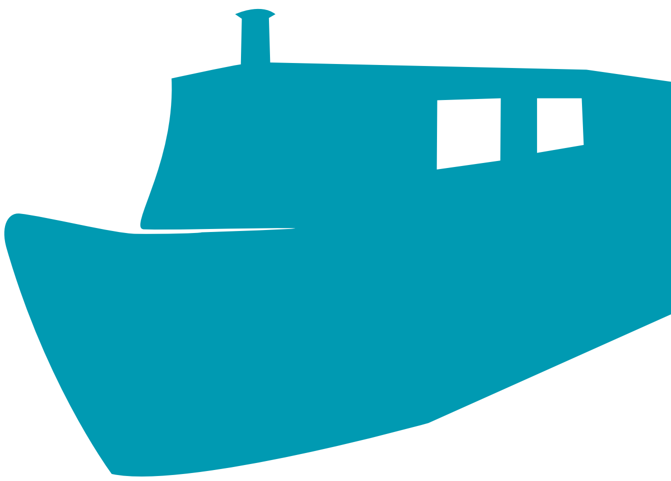
- **Sections of waterway that share a common source (or group of sources) of water supply to meet demands for water**

In 2008, we defined 14 priority hydrological units (please refer to Figure 1, p8). We used these for the assessment and analysis within our National Water Resource Plan 2008 (NWRP 2008). Since this time, we have developed our thinking and now feel that it is necessary to ensure that the Trust's entire network is incorporated within hydrological units. The number of hydrological units within England and Wales has therefore increased from 14 (NWRP 2008) to 53 to ensure complete coverage (please refer to Figure 2, p9 and Appendix 2, p42).

Further to this, we have characterised the waterways across the network into three types of hydrological unit:

- **Reservoir/groundwater/surface water feeder supported systems –** these are waterways often seen as the 'classic artificial canals', where they are man-made channels often crossing river catchments. They are mainly supplied by reservoirs or groups of reservoirs (with reservoirs typically being located on or near the canal summit pounds). However, other sources of water can include pumped groundwater sources or surface water streams flowing directly into the canal.
- **River fed systems –** these are either canalised river sections or man-made canals sometimes linked to rivers, but are predominately fed by the upstream river catchment.
- **River navigations –** these are sections of river that have had relatively minor, or even no alteration to allow for navigation. The channel may have been widened or dredged to provide the required dimensions for navigation and locks are required to allow for gradient changes. Weirs are often required, particularly near locks to create sufficient depth for navigation. The demands of displaced lockage are entirely met by the catchment flows from upstream.

Previously, the majority of the work has been focused on reservoir/ groundwater/ surface water feeder supported systems as they require more water resources management effort and have greater interconnectivity within and between hydrological units. We have focused much less on the water resource reliability of the river fed systems and river navigations. This is due to the reliance of river fed systems and river navigations on the flow regime within the river catchments which are outside of our direct control.



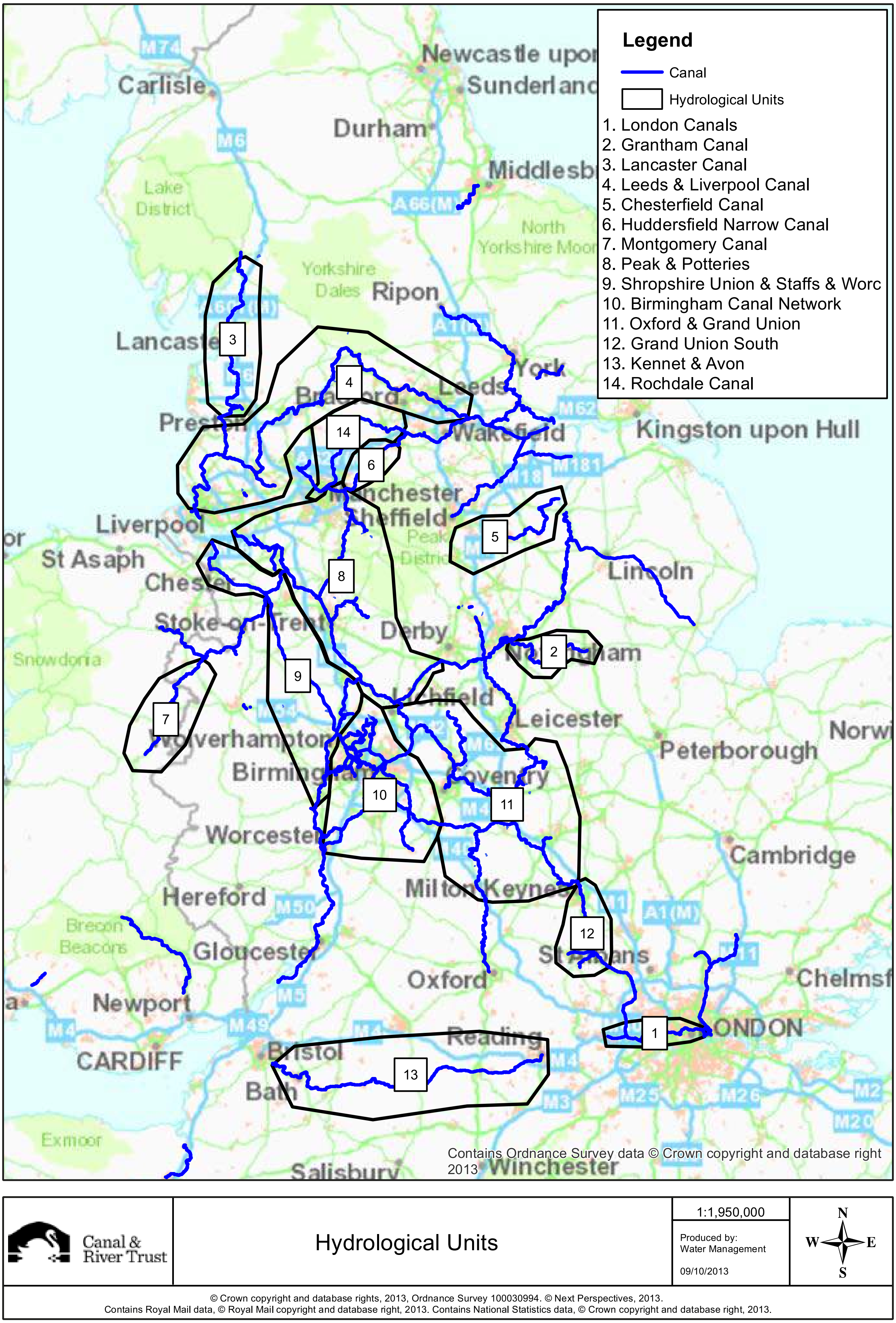



Figure 1: The original 14 hydrological units (based on NWRP 2008)

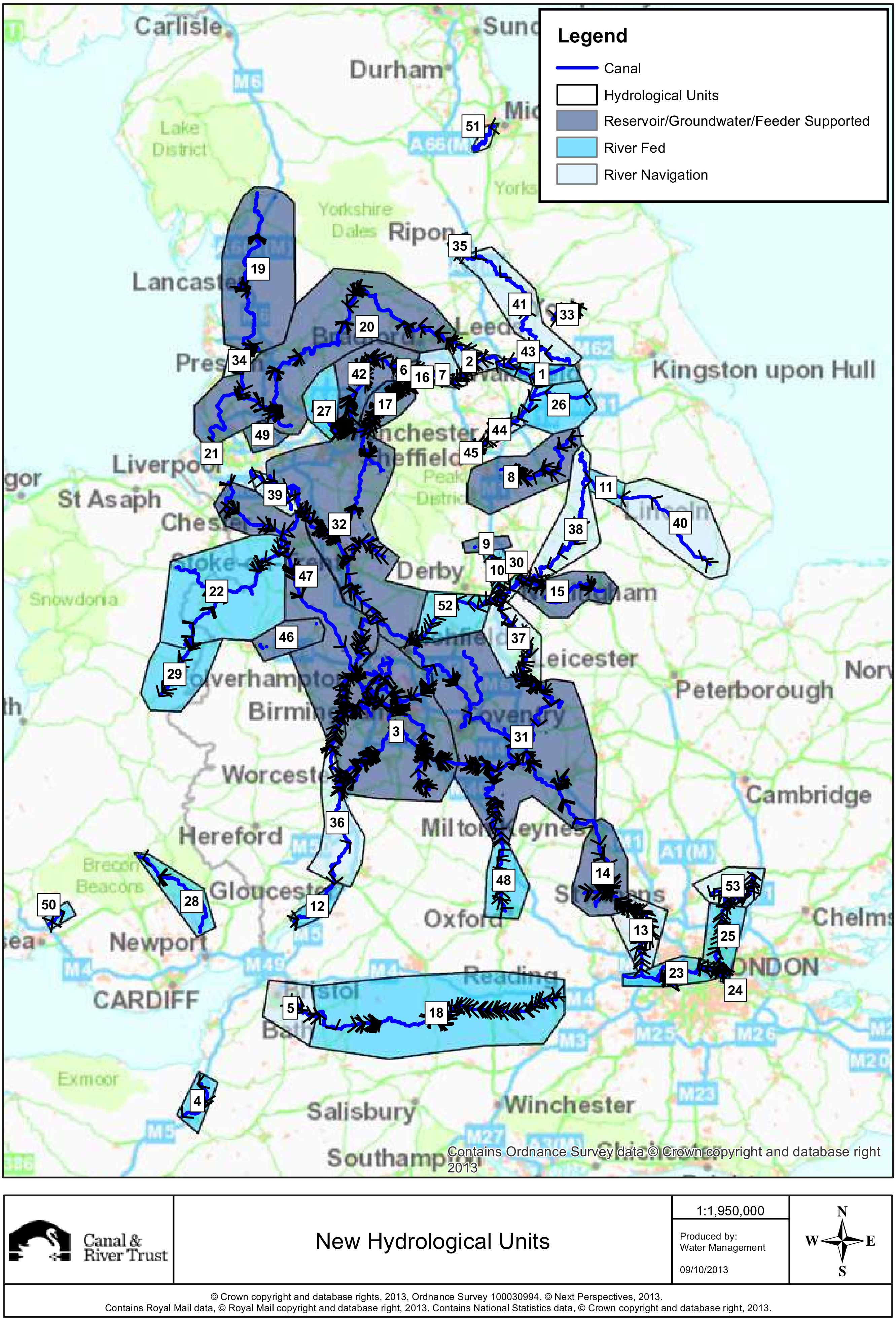



**Figure 2: The current 53 hydrological units***

* New Hydrological Units (see Appendix 2, p42 for details)

As droughts can happen at any time, it is important for the Trust and its customers to understand the frequency with which drought may have an impact on our activities. This is determined using the concept of 'level of service'. This concept is complex as there are many differences and complexities across the waterway network such as varying rainfall, reservoir storage, differing demands and expectations of canal users. There is also a financial cost associated with maintaining supply to meet demand and an even greater cost attached to increasing supply (i.e. increasing the level of service).

We have defined the concept of level of service as:

- **How frequently the Trust expects a navigational drought to occur**

In order for us to analyse the frequency of drought, we have also created a definition for drought closure. We have defined a navigational drought closure as:

- **Navigation possible for a period of <u>less</u> than five hours per day, at a particular location (lock or pound) within a hydrological unit, on seven or more consecutive days as a result of drought**

**Q1** Consultation question – key concept definitions

**Do you think these definitions for level of service and navigational drought will be understood?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

# 05 Why do we need a level of service?

It is important for us to develop and establish a level of service to help with the following:

- **Strategic planning and future investment decisions –** Strategic planning provides an indication of the level of investment needed in the long term to maintain a specified level of service.
- **Prioritising works and asset management –** By having a level of service there is an understanding of what the water resource requirements are for any section of the waterway network and this is incorporated into maintaining the waterway infrastructure in an appropriate condition.
- **Providing a baseline for the assessment of developments with a water demand –** A level of service provides a baseline for the determination of water availability for new marina developments and water sales. For example, it is inappropriate to sell water if we do not know how much water there is available to sell.
- **Future pressures –** With the uncertainties of climate change, a level of service provides a baseline from which a range of future scenarios can be predicted and therefore strategic decisions can be made.
- **Communicating internally and externally –** Having an agreed level of service provides a tool for communicating risk within the Trust and to external stakeholders.

# What is our current level of service?

In May 2005, British Waterways (BW) decided that new marinas and water sales would be evaluated against an aspirational minimum standard of a 1 in 20 year level of service (i.e. maintain and operate the canal network so that drought closures are implemented, on average, less than once every twenty years, or with a 5% chance of occurring in any single year). New marinas are approved if their impact on water resources does not reduce the level of service below the minimum standard of 1 in 20 years. With regards to water sales to third parties, as a general rule, agreements have clauses where a supply of water cannot be guaranteed. This means that achieving a minimum standard of 1 in 20 years for boaters takes priority over the supply of water for sale. However, some specific water sales have more robust contracts with minimum supply clauses (for example, some supplies to water companies). When the Rochdale Canal was reopened following restoration in 2002, it was agreed that this canal would not meet the minimum 1 in 20 year standard and that a lower level of service would be acceptable.

For our National Water Resource Plan (NWRP) in 2008, we quantified the current water resource position of the main hydrological units (14 at that time, please refer to Figure 1, p8) and then identified a range of future scenarios (Best, Average and Worst Case) against the four primary pressures[1] that would impact on the supply/demand balance. These pressures were:

- **Climate Change (available resource)**
- **Funding (asset deterioration)**
- **Environmental legislation and standards (decreasing abstractions)**
- **Increased usage of the waterways (increased lock usage)**

Six hydrological units were identified to have insufficient water during a 1 in 20 year drought event, either at that present time (the 'current baseline') or at any point up to the year 2030 (the planning horizon over which the 2008 NWRP examined the future scenarios) in the 'best case' scenario. The 'best case' scenario analysis was used as the basis for this investigation to understand the indicative costs of providing a level of service, given the assumption that addressing 'best case' scenario was the absolute minimum level of intervention that might be necessary.

As the primary recommendation of the 2008 National Water Resource Plan, we undertook detailed investigations for five of the 'failing hydrological units' and this was documented in five individual Water Resource Plans (WRP's) completed in 2011. These hydrological units were; the Kennet & Avon (K&A), Leeds & Liverpool (L&L), Peak & Potteries (P&P), Oxford & Grand Union (Ox&GU), and the Staffs & Worcester and Shropshire Union (SWSU).

It was agreed in March 2008 that an individual WRP for the sixth failing hydrological unit (the Rochdale Canal) would not be completed. This was because the water resource reliability of the hydrological unit was already considerably lower than the minimum standard; BW inherited this level of service when it took responsibility for management on behalf of The Waterways Trust (who owned the Rochdale Canal).

The individual 2011 WRP's recommended improvement schemes that were costed and prioritised based on their whole life cost and water resources benefit. Implementation of these recommended schemes should ensure that the Trust meets current and forecast future deficits in the supply/demand balance of these hydrological units for the 'best case' scenario[2].

[1] Appendix 1, p40, gives details of Best, Average and Worst cases and the four associated primary pressures

[2] Only the 'best case' scenario was considered as it has the least uncertainty and allows schemes to be implemented on a 'no regrets' basis.

# 07 What are the costs to achieve different levels of service and should different hydrological units have different level of service?

As each hydrological unit is unique in relation to waterway demands and water supply, it is important that we consider whether different hydrological units should have different levels of service. As demonstrated below different levels of service cost more or less money. We must ensure that the Trust can afford the level of service we recommend.

Waterway users are likely to have differing expectations of how a specific level of service would impact on their use and enjoyment of any particular waterway. For example, a hire fleet operator that relies on their boats being able to cruise in order to generate income could be expected to have higher aspirations with regards to level of service than an infrequent casual pleasure cruiser. Therefore we need to consider whether different waterway users expect (or assume) a different level of service.

For this Water Resources Strategy consultation, we completed further detailed analysis for three hydrological units, Leeds & Liverpool, Peak & Potteries and Oxford & Grand Union, as examples that were predicted to be in deficit by 2030. The Kennet & Avon was not investigated further as the WRP 2011 deficits were calculated using a different modelling technique, so the findings are not readily transferable to other hydrological units.

The costs of three differing levels of service were investigated in each case: 1 in 10 years, 1 in 20 years and 1 in 30 years. Meeting a 1 in 10 year level of service would allow the reliability of the network to decrease (assuming the current baseline was already at or close to the 1 in 20 year level of service) and hence would close more often as a result of drought. A 1 in 30 year level of service would improve the reliability of the network and close less often as a result of drought. These were chosen as we have previously aspired to a 1 in 20 year drought level of service and the two others were investigated to show the resource and cost difference for a less or more reliable network.

Table 1 (below) and Figure 3 (opposite) shows the 'best case' projected deficit (Megalitre – $Ml^3$) for the three levels of service. This represents the range of deficits that would be required to be 'clawed back' by water resource schemes by 2030, in order to meet the stated level of service.

| | 2030 best case deficit for different levels of service (Ml/annum) | | |
|---|---|---|---|
| **Hydrological Unit** | **1 in 10 year** | **1 in 20 year** | **1 in 30 year** |
| Oxford & Grand Union | 1,320 | 2,230 | 3,220 |
| Leeds & Liverpool | 1,470 | 2,560 | 2,900 |
| Peak & Potteries | 640 | 1,200 | 1,420 |

**Table 1: Best case projected deficit (Ml) for the three levels of service**

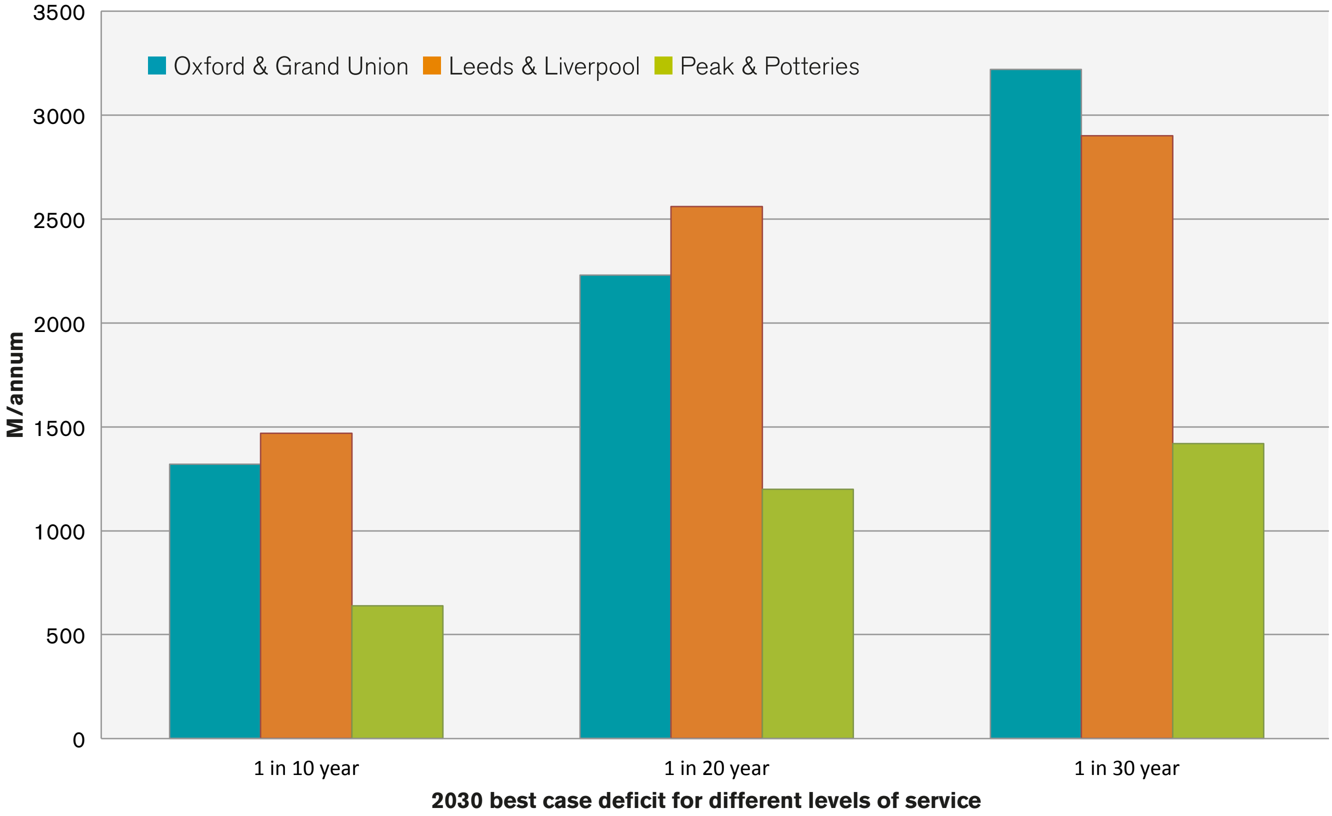



**Figure 3: Best case projected deficit (Ml) for the three levels of service**

Using the surplus/deficit projections and the costings of schemes from the 2011 WRP's, the relative cost of meeting different levels of service can be calculated and presented (please refer to Section 11, p26 for how these were calculated and how we intend to calculate future scheme costs).

Figure 4, p14 shows the costs for the Oxford & Grand Union, Leeds & Liverpool and Peak & Potteries hydrological units to meet the three differing minimum levels of service (1 in 10, 1 in 20 and 1 in 30 year) by 2030. The expenditure is the Net Present Value (NPV)[4]. Use of NPV (instead of capital costs alone) allows the whole life cost of a scheme to be analysed.

The 2011 Oxford & Grand Union WRP recommended schemes with a total NPV of £2.7million to achieve a 1 in 20 year level of service for that hydrological unit. Using the data from the 2011 study, it is estimated that to remove the deficit and meet a minimum 1 in 30 level of service, would increase the NPV spend to more than £9 million. The disproportionate increase in NPV can be explained by the fact that there are a number of lower yielding schemes with a low NPV that together can meet the level of service requirements/ forecast deficits. Conversely, the remaining higher yielding schemes required to address the larger deficit have a much higher NPV.

For example, clearing feeder channels is relatively inexpensive but doesn't yield high volumes of water. In comparison, backpumping schemes can significantly reduce the volumes of water that need to be supplied to the canal from reservoirs. However, backpumping schemes require a large initial capital investment (for construction); they also have a high on-going operational cost (electricity and maintenance). To meet a higher level of service requires more water and this water becomes harder to find and becomes progressively more costly per unit volume. Meeting lower levels of service can often be achieved with relatively 'quick fixes'. To achieve a level of service of 1 in 10 year by 2030 for the Oxford & Grand Union, an investment of almost £2 million in schemes would still be required.

[3] & [4] See Appendix 4, p47, Glossary for definition.

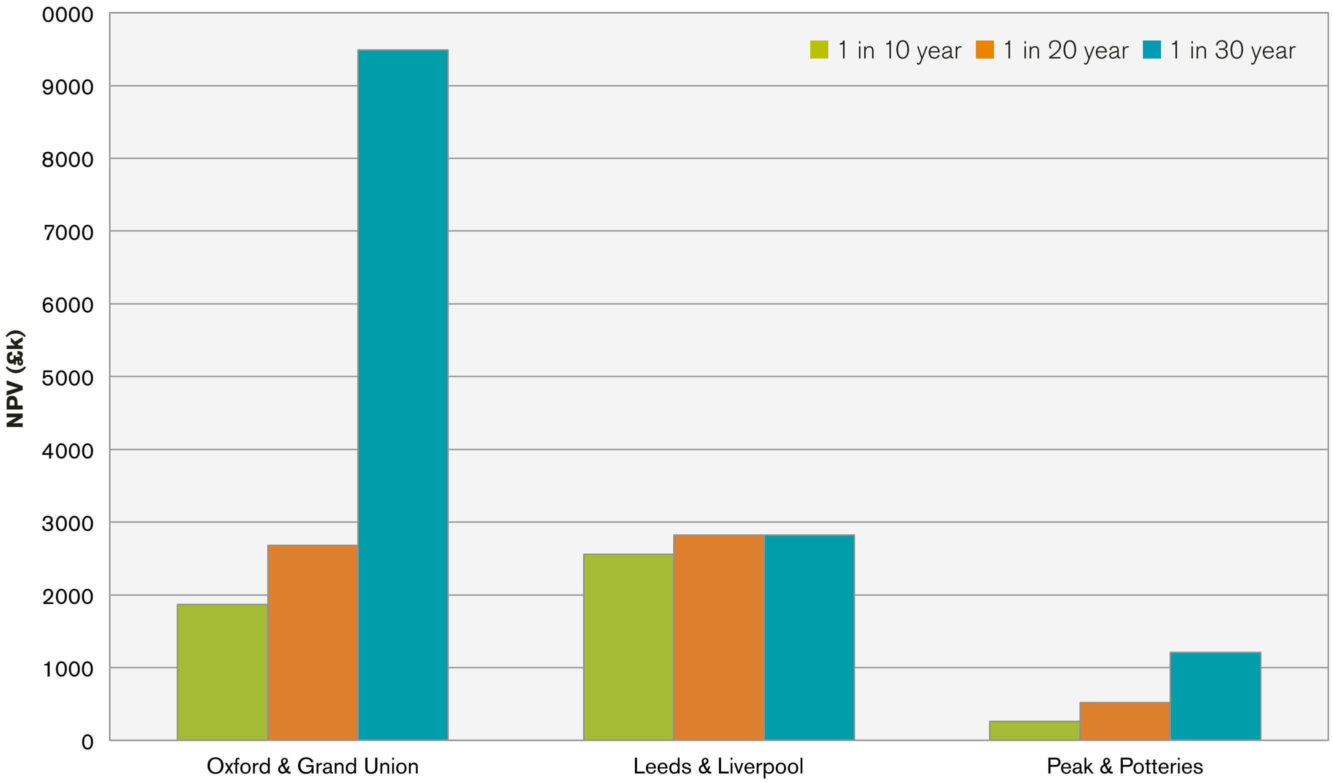



**Figure 4: Costs for the Ox&GU, L&L and P&P to meet three differing minimum levels of service (1 in 10, 1 in 20 and 1 in 30 year) by 2030**

The 2011 Leeds & Liverpool WRP recommended that £2.8 million NPV investment in schemes was required to recover the deficit projected by 2030 in a 1 in 20 year drought. If the level of service was increased to 1 in 30 years the investment required is estimated to be the same as for a 1 in 20 year level of service. This can be explained by the fact that the WRP recommended a high yielding scheme that had a relatively low NPV.

The recommended schemes did not just recover the deficit in a 1 in 20 year drought but also a drought with a return period of 1 in 30 years. Lowering the level of service to a minimum 1 in 10 years will not reduce costs significantly (it is reduced by £0.25 million).

For the Peak & Potteries, in comparison to the other two hydrological units, the NPV required is much lower. This is partly due to the projected deficits being lower but also because the options for schemes are more cost effective than for the Oxford & Grand Union and Leeds & Liverpool. The P&P 2011 WRP reported that an estimated £0.5 million NPV investment would be required to remove the deficit projected in 2030 for a drought with a 1 in 20 year return period.

In comparison, if the level of service was raised to 1 in 30 years the level of NPV investment would more than double to over £1.2 million. If the level of service was to be reduced to a 1 in 10 year return period the level of investment required would decrease to approximately £0.3 million.

As the analysis for the three hydrological units presented above shows, the investment required for water resources schemes to meet the current 1 in 20 year level of service varies across the network. Using the information collected for the NWRP 2008, the majority of hydrological units require no additional investment to meet the 1 in 20 year standard in the best case modelling scenario, with the assumption that the current infrastructure is maintained at a steady state.

The 2011 WRP's recommended schemes for 'failing hydrological units' to recover the deficits assuming the current 1 in 20 year level of service by 2030. This ranged from as low as £0.5 million up to more than £2.5 million. The costs of raising or lowering the level of service will not result in a linear rise or fall in the investment required. This is because increasing water supply or reducing canal demands is a unique challenge for each of the failing hydrological units. Some hydrological units, by their nature, have fewer options (if any) to improve their supply/demand balance.

Additionally, each of the potential water resource schemes has differing whole life costs and water resource yield. For example, to meet a 1 in 30 year level of service will cost an estimated £9 million NPV for the Ox&GU in comparison to around ~£1 million NPV for the P&P hydrological unit.

Following the above results and analysis, which sets out a range of indicative costs for differing levels of service, along with feedback from stakeholder engagement activities carried out in 2013, we recommend that we continue to use our aspirational level of service of a 1 in 20 year drought for the Trust's network. However, it is proposed that the Trust should be able to set out different levels of service for different parts of the network if the 1 in 20 year standard is not technically feasible or financially achievable.

**Q2** Consultation question – aspirational level of service

**Do you agree that the Trust should maintain the same aspirational minimum level of service of a 1 in 20 year drought and that this should apply across the network?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

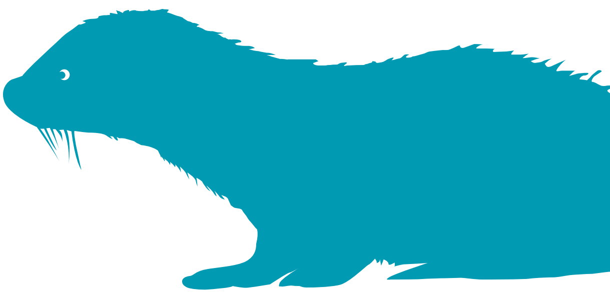
If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)



# Impacts of Restorations and new canals on level of service

The most recent canal restorations to be completed were the Droitwich Canals which reopened in 2011 after lying derelict for more than seventy years. These canals join the Worcester & Birmingham Canal and the River Severn Navigation. There is the potential for other restorations to link to the Trust's existing network or be unconnected. Some examples include – the Cotswolds Canals, the Wiltshire & Berkshire Canal and the Hatherton & Lichfield Canals. Elsewhere, brand new canals have been proposed, for example, the Bedford & Milton Keynes Canal (which is proposed to link the Grand Union Canal in Milton Keynes with the River Great Ouse in Bedford) and the Daventry Canal Arm (linked to the Grand Union Canal).

Restorations (or new canals) are likely have an impact on the water resources of the existing canal network (if connected), as well as generating a water demand within the restoration itself. If an adequate independent supply of water is not available for a restoration scheme then a supply taken from the existing canal network may reduce the level of service that can be met.



The Trust believe that supporting restoration schemes will contribute to the Trust's charitable object, **"To promote, facilitate, undertake and assist in, for public benefit, the restoration and improvement of inland waterways".**

Furthermore,
**"The Trust believes that increasing the size of the navigable waterway network for public benefit is not only a key charitable purpose but also a powerful way to demonstrate our work and the benefits waterways brings to millions whilst growing support for our cause."**

(Canal & River Trust, Shaping Our Future, July 2012).

However, prior to the Trust fully approving a request for a restoration to connect to the existing network, an appropriate water resources assessment should be undertaken. This will determine whether the restoration itself can achieve the agreed minimum level of service and whether the proposal will have an acceptable impact on the existing network (i.e. not resulting in the existing network failing to meet the agreed level of service).

Our current advice with regards to third party new developments is that the Trust will support restoration schemes (and new canal developments) as long as the existing infrastructure maintains a minimum 1 in 20 year level of service. However, the new development (or restoration) could have a lower level of service provided that the proposers supply their own water without reducing the standard of supply of the existing network. As mentioned before, the restored Rochdale Canal has an agreed lower level of service than the aspirational 1 in 20 year as the existing water supply infrastructure is inadequate to meet such demands.

It is proposed that the Trust should take a balanced approach to supporting restoration schemes whilst not increasing the risks to the existing canal network. It is therefore vital that projects can demonstrate their potential requirements for water to allow the Trust to assess the benefit or potential impact to the operational network. There should be no net impact on long term water resource levels of service due to a restoration or new canal.

**Q3** — **Consultation question – restorations and new canals**

**Do you agree that the Trust should expect a water resources study to be undertaken for any proposed restoration or new canal, to assess the supply and demand of water and that there should be no net impact on levels of service of the existing canal network due to a restoration or new canal?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

# Measuring level of service and baseline data

The majority of reservoir/groundwater/surface water feeder supported hydrological units currently fall within the interconnected canal network covered by our Water Resources Model (a cost-optimisation hydrological software package designed specifically for British Waterways by ABP Marine Environmental Research Ltd in 2001). This hydrological modelling is currently the primary tool used to assess water availability to meet canal demands. Statistical probability analysis of the model outputs show the frequency that a critical drought threshold is reached and therefore the level of service that can be achieved in each modelled hydrological unit.

Water resource assessments of river fed systems and river navigations have been carried out as part of ad hoc studies. The level of service in these systems is dependent on the flow regime of the river(s) and there is generally little or nothing that the Trust can do to influence this.

Unfortunately, the current Water Resources Model is coming to the end of its functional life because the software is no longer compatible with modern supported software packages (for example, latest versions of GIS[5]). A project is currently being undertaken to replace the Water Resource Model with an industry standard modelling package called 'Aquator'[6].

During the production of this strategy consultation, various different analysis techniques were considered to create an improved methodology which will determine the frequency with which droughts are likely to occur and provide more accurate baseline data. The analysis was also used to determine the duration, intensity and severity of the drought events.

We propose that all reservoir/groundwater/surface water feeder supported and river fed hydrological units will be modelled in the future with the Aquator modelling software package. River fed hydrological units generally do not have any reservoir storage; their water supply comes from a complex combination of hydrological conditions and hydraulic control. Where appropriate we will construct spreadsheet models for river navigation hydrological units so that their water resource positions can be assessed.

The modelling programme is phased to make the most effective use of the modelling resources within the Trust's Water Management Team, and is based on our current understanding of the risks to the water resources. Within five years, all hydrological units currently within the Water Resources Model and MISER[7] will be created within Aquator. In addition to this, due to increasing regulatory pressures, we also propose to construct a detailed model of the Monmouthshire & Brecon Canal and the Gloucester & Sharpness Canal (these are river fed hydrological units). This is shown in Appendix 2, p42. The remainder of hydrological units will be modelled in subsequent phases and a detailed programme will be given in future Water Resources Strategy documents.

**Q4** — **Consultation question – our five year modelling plan**

**Do you agree with the current five year modelling plan?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

[5], [6] & [7] See Appendix 4, p47, Glossary for definition.

It is inevitable that there will be uncertainties in strategic modelling. Uncertainty can originate from supply and demand data, as well as model conceptualisation and model output analysis. Therefore, it is important to reduce uncertainties wherever possible. In recent years we have focussed efforts on developing the quality of modelling reservoir inflow data and model conceptualisation accuracy. In addition, canal loss rate estimates are also a key area where our knowledge of canal demands has improved but there is still more work to do here.

Water supply companies, our closest industry comparison, use techniques outlined in Environment Agency and Defra guidelines to determine their strategic water resource requirements, including the use of concepts such as headroom[8]. We intend to continue to monitor these guidelines and incorporate techniques where there is a benefit to the Trust in terms of the accuracy of strategic water resource modelling.

## Q5

**Consultation questions – uncertainties**

**Do you agree that we should continue with our current approach to minimise risks associated with uncertainty by concentrating on improving understanding and quality of water supply and demand profiles?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

## Q6

**Do you think that we should use, where appropriate, techniques outlined in Environment Agency and Defra guidelines to determine our strategic water resource requirements, including the use of headroom to account for uncertainty within our modelling output?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

[8] See Appendix 4, p47, Glossary for definition.

# 10 Future pressures

It is critical that we assess the role of future pressures on our water resources to be able to plan effectively. We have reviewed the current best practice and relevant industry guidance and considered how the pressures can be assessed using our water resource modelling software. Few future pressures can be quantified with certainty. Therefore, our modelling is likely to be partly an exercise to determine the likely range of impacts on our network.

The pressures we have considered are:

- **Climate change**
- **Increased boating**
- **Reduced funding causing asset deterioration that impacts on water resources**
- **Environmental legislation reducing our water availability**
- **Water transfers (strategic transfers, primarily in response to drought)**
- **Water rights trading (which will be modified through the Abstraction Reform process)**
- **Water sales (selling surplus water from our network)**
- **Expanding our network (new or restored waterways) – See Section 8, p15**

## Climate change

Climate change is renowned as being uncertain. It is proposed that only the impact of climate change on feeders (watercourses flowing into the canals, including from groundwater sources) and reservoir inflows will be assessed. The impacts on canal losses, lockage or third party water sales will not be assessed, because the evidence of direct links between a changing climate and these parameters is not sufficiently robust to act as a useful decision making tool.

We intend to develop a bespoke approach to modelling the effects of climate change that is appropriate to the uncertainties associated with climate change science, the available resources and the technical requirements of the wider modelling solution used. We plan to use the assessment made by water companies (specifically United Utilities and Severn Trent[9]) as a benchmark and possibly adapt their approaches to our unique requirements.

We intend to complete the above task using the following documents, and subsequent updates, where relevant and appropriate:

- **Environment Agency (EA) Guidance for Climate Change Assessment (EA, 2012a)**
- **Environment Agency Water Resource Management Plan Guidance (EA, 2012)**
- **Future Flows project (CEH et al., 2012)**
- **UK Climate Change Risk Assessment work (Defra, 2012a)**
- **Climate Change Approaches in Water Resource Planning (EA, 2013).**

## Increased boating

The pattern of network usage via boating is dependent on a variety of factors including weather conditions, water availability, cost and availability of moorings, licence fees, insurance, diesel and other running costs, to name a few. We propose to assess the impact of increased network usage using scenarios of no change (0%), together with 1% and 2% annual increases in lockage from 2015-2050.

[9] These Water Companies cover geographical areas that substantially overlap with the Trust's network and they both use the Aquator modelling software

### Reduced funding causing asset deterioration

We have assumed that there is a direct link from funding to asset condition which will impact on water resources in the long term. As an example, a lower income is likely to mean that less money will be spent on maintenance of our feeder channels. This reduction in maintenance is likely to mean that some feeders may deteriorate over time. Feeders in a poor condition will have a lower transfer capacity and will not be able to provide the canal network the maximum amount of water previously received/conveyed when the feeders were maintained at a higher standard.

The Trust has a range of sources of income, including the contract with Government which is secured until 2027. Relevant teams within the Trust will be consulted to estimate the income we might expect to receive from each of our income sources, through to 2050.

The Trust's Asset Management Team will be able to advise on how changes in funding will affect future works, which will impact on water resources, resulting in a range of percentage reductions for feeder water resource yield across the network. Model outputs will therefore incorporate potential changes in funding should future income reduce and/or fail to increase with inflation.

### New environmental legislation reducing our water availability

The Water Resources Act 1991 (Section 26) controls the abstraction and impoundment of water. This legislation was updated in November 2003 by the Water Act 2003 (c.37 Section 5) and several key changes were made to the licensing system. Some of these have been enacted and others are still awaiting a commencement order.

The main change that will impact the Trust is the removal of the exemption for surface water transfers into canals. It is currently thought that the commencement order for this section of legislation will be implemented no earlier than April 2015. There is likely to be a two year window for applications to be made and between three and five years for the Environment Agency to determine the applications. Natural Resources Wales are likely to need less time than the Environment Agency to determine the applications. However, by 2021 we should have all the abstraction licences that are required by law.

There is a risk that a number of our existing abstractions will be reduced or have conditions placed upon them that will restrict the quantities of water we can abstract. We have analysed all of our feeders by likelihood/severity of reduction and can now assess each feeder for the impact of potential reductions using a risk-based approach.

As mentioned above, the assessment of licencing is being undertaken over a period of up to seven years. As such, the amount that feeder abstractions may be reduced by and how this is applied to the inflow sequences to models will need to be developed over the next three years alongside developments within the licencing process.

We intend to follow one of the two following methodologies:

1. **Feeders will be assessed into three categories:**
   a. Severe reductions to our abstraction required
   b. Moderate reductions to our abstraction required
   c. No reduction expected to our abstraction.

Each of these three categories will have a reduction reflecting the severity of reduction in our abstraction. This reduction will then be applied to all feeders which fall into that category.

2. **Each feeder will be assessed for its risk.**
   Using current information that we have gathered in preparation for Water Act 2003 licencing, each feeder will be reviewed and an appropriate change applied where the abstraction has been highlighted as being at risk from licence conditions.

### Water transfers, water rights trading and water sales

- **Water transfers** involve strategically moving water through our network to be utilised by someone else. Transfer agreements can either be temporary for specific times of the year (i.e. for use in a drought) or constant throughout the year. Before any transfer could take place, a detailed feasibility study would be required. These must be investigated on a case by case basis. It is always expected that for a water transfer, the third party is providing the initial source of water to be transferred.
- **Water rights trading** is the process of exchanging and dealing with abstraction rights. At present, the Trust is exempt from licensing for surface water abstractions but this will change once the Water Act 2003 is enacted, and will dramatically increase the number and extent of abstraction licences that we hold and could potentially trade.

- **Water sales** are contracts we enter into with third parties to sell our surplus raw water (typically this is water that is surplus to the amount needed to meet the level of service). These are very site specific and need to be investigated on a case by case basis.

The configuration of our navigation network has the potential to act as a route for water transfers and to enable water rights trading. We propose that we should continue to be involved in the assessment process for water transfers but we will not include this within the Water Resources Strategy given the early stage of the feasibility assessments for such projects and the high degree of uncertainty.

At present it is not possible to assess the potential impact of water rights trading as we do not have a significant number of licences to trade, therefore, we cannot include this within the Water Resources Strategy. Furthermore, we would only seek to trade our water rights where we were confident we had sufficient water to meet current and future demands, and as the previous sections of this consultation have highlighted, we do not expect this to be a common situation.

Additionally, water sales do not need to be included within the Strategy other than in an assessment of the baseline water resource situation (i.e. to ensure any existing water sales are accounted for as a demand for water). Water sales contracts can be adjusted to suit water resources if necessary, with decisions made using cost-benefit analysis.

## Expanding our network

Although there is the potential for our network to expand, it is understood that the majority of current projects are many years away from being complete. Consequently, we do not intend to assess interactions with new waterways as a future pressure within the Water Resources Strategy due to the uncertainty and complexity in the range of possible restorations and new canals, but will examine each proposal on a case by case basis. (See Section 8, p15)

In summary, the future pressures we intend to take forward and assess in detail within the first Water Resources Strategy are the same as within the NWRP, 2008. They are:

- **Climate change**
- **Funding**
- **Environmental legislation (potential reduction in abstraction volumes)**
- **Increased network usage**

We propose that each of the above pressures will be assessed by a range with an upper and lower boundary. Inflows and lockage within the model will be scaled by percentages to reflect future pressures to the year 2050. These modifications will be made to the 17 models which will be constructed within the first three years of phase 1 of the strategy.

We intend to assess the weekly reservoir holdings to determine the water resource position for the modelled hydrological units. This assessment will determine whether each hydrological unit is forecast to be in a surplus or deficit by 2050, against the agreed level of service.

As we develop the new water resource position for each hydrological unit identified during the first five year cycle of the water resource strategy, we will begin assessing potential schemes which may benefit any hydrological unit which has been identified as being in a deficit against the agreed level of service in 2050.

| Year One (2014/15) | Year Two (2015/16) | Year Three (2016/17) | Year Four (2017/18) | Year Five (2018/19) |
|---|---|---|---|---|
| • Undertake detailed research into climate change factors to develop a bespoke approach to assessing the impacts of climate change on the Trust's network.<br>• Consult the planning and asset teams to discuss future funding and its impact on water resources. | • Define the percentage reductions which will be applied to the feeders which will be affected by changes in funding.<br>• Define which methodology for producing the percentage reductions to all feeders which will be affected by Water Act licencing is most appropriate. | • Apply the 0.0%, 1.0% and 2.0% increase on the 2015 lockage to produce lockage figures for 2050.<br>• Apply the bespoke approach for climate change (determined in Year One) to derive flow factors for feeders.<br>• Apply the decided approach for reductions in feeder flows due to Water Act curtailment to derive appropriate flow factors for the feeders. | • Finalise the input sequences into the model by applying all factors.<br>• Run the model for the different scenarios to assess the impact of future pressures. | • Run the models to assess the benefit of potential schemes which could be implemented to provide the water required to ensure we will meet the level of service in 2050. |

**Table 2: Our proposed five year plan for modelling future pressures**

Our proposed plan of modelling future pressures will be undertaken alongside our plan for establishing baselines (please refer to Table 2, above). From the baseline models, we can apply the future pressures which will provide the predicted surplus/deficit for 2050 relative to the agreed level of service.

## Q7

**Consultation questions – future pressures**

**Do you agree with how we intend to progress with the future pressures we have listed and our modelling plan?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

## Q8



Do you think we have missed out any future pressures? If so, please tell us about them.

11

# How will we decide on water resource improvement schemes?

Our modelling approach (Table 2, p24) will assess the benefits, in terms of improvements in the level of service, of various schemes to enhance water supplies and/or reduce water demands.

We propose to follow the flow diagram below to subsequently decide which water resource improvement schemes should be implemented.

**Determine scheme(s) to address the water shortage and quantify their yields**
could be new water supplies or a reduction in the water demands. Hydrological analysis is required.

▼

**Model schemes to establish the overall improvement in the hydrological unit**
preferably over a long-term modelling period (90 years of historical sequences), if the relevant data is available.

▼

**Rank according to the agreed level of service the yield benefits**
including individual and combinations of schemes.

▼

**Calculate the whole life costs of the scheme(s) (or Net Present Value, NPV)**
combine capital costs with operational costs at a discounted rate of 3%. Refer to p27 for more information.

▼

**Apply an overall risk factor to the scheme costings**
accounts for the broad uncertainty within the range of schemes.
Also takes account of innovative schemes which have not been created before and external factors (e.g. land access, heritage, consents) which may effect the cost of the final delivered schemes.

▼

**Combine the yield with NPV costs for each scheme. Prioritise within each hydrological unit, based on the ranked cost (£ per Ml/d)**

▼

**The Trust's Engineering and Asset Managers review prioritised list of schemes**
can advise on any practical and pragmatic concerns.

▼

**Establish the investment profile required to implement all the schemes in all hydrological units**
timings for when investment is needed.

▼

**Investment decisions on schemes made by Directors and plan approved by Board of Trustees**
taking account of how we prioritise water resource schemes against all other areas of the Trust's expenditure

Figure 5: Flow diagram for deciding on water resources improvements

## Social and environmental costs and benefits

The formation of the Trust and its declared charitable objectives has led to broader thinking in terms of cost benefit analysis. Consideration should ideally also be given to social and environmental costs and benefits.

As such, it was deemed appropriate to investigate other options for assessing the suitability of water resource schemes (in addition to NPV costs and the water resource benefits) for attaining/maintaining a particular level of service. Four methods for assessing the social and environmental costs and benefits were reviewed. These were: Valuing Ecosystem Services (Defra, 2007), Value Transfer Guidelines (eftec, 2009), Benefits Assessment Guidance (eftec, 2012) and Study Social Return on Investment (Cabinet Office of the Third Sector, 2012).

After reviewing the guidance on the above methods of assessment of social and environmental costs and benefits, it was clear that any meaningful analysis would require extensive input from specialists in the fields of social studies and environmental economics added to which there is still considerable uncertainty and debate around the suitability of these different assessment techniques for assessing benefits.

Therefore, we propose that future water resources schemes continue to be prioritised based solely on whole life costs (NPV) and water resources benefits (£ per Ml/d) as these methods are robust, transparent and well understood. As individual schemes are progressed, detailed environmental appraisals will be undertaken and the Trust's objective to seek environmental enhancement will be pursued together with opportunities for wider social benefits in line with the Trust's charitable objectives.

The Trust has recently embarked on a partnership with Cardiff University's Sustainable Places Research Institute to examine the social, environmental and economic impacts of waterways across the UK. We recommend that the outputs of this collaboration are reviewed as part of the next cycle of the Water Resources Strategy.

## Quantifying whole life costs of schemes

It is important to calculate the whole life costs (or Net Present Value, NPV) of proposed water resources schemes as improvements in the supply/demand balance can often be found through a wide range of schemes. Some schemes will have a high capital cost (but comparatively low operating cost) and others will have a low capital cost (but high operating cost). Calculating the NPV allows a meaningful comparison of the cost of different schemes (to prioritise investment).

We intend to calculate the NPV for both capital and operational expenditure over a design life of 35 years. This period was chosen because:

- **it gives a reasonable balance between the design lives of a typical range of schemes;**
- **it caters for schemes that have a very high proportion of either capital or operational costs within their NPV;** and
- **it does not place an excessive emphasis on future costs that will occur many years from now.**

To estimate the capital costs for each scheme, we intend to complete the following actions –

- **Historic works cost data will be analysed to determine broad construction cost rates**
- **Actual costs and quotations for specific items will be investigated**
- **Typical costs for the management of the project will be estimated – design and project delivery**

Estimating the operational costs over the design life of a scheme has two key elements. There are running costs and routine maintenance, which includes replacing consumable items. The majority of schemes will not have high running costs as once they are complete, they will function as they are designed to (e.g. a new gravity feeder or a replacement crest on a waste weir). Schemes that involve pumping however are likely to have high running costs. Pumping schemes consume electricity and incur Carbon Tax costs. Energy costs will be estimated at 22.5 pence/kWh (over the 35 year design life). Carbon Tax costs will be calculated using the methods recommended by the Carbon Trust (Carbon Footprinting Guide, 2012) and an estimated figure for the production of carbon at £12 per tonne.

All schemes will involve routine maintenance costs. These will be calculated based on the Trust's Planned Preventative Maintenance costs.

Once all the costs have been calculated for each scheme, the capital costs will be added to the operational costs and a discounted rate of 3% per year applied over a 35 year horizon to find the NPV. NPV calculations are a standard approach used to appraise long-term investment projects. The discounted rate is used to compare the present value of money to the value of money that it would be in the future, taking inflation and interest rates into account.

## Q9

**Consultation question – whole life costs of schemes**

**Do you agree with our proposal to assess future water resource schemes based on whole life costs (NPV) and water resources benefits (£ per Ml/d), rather than only capital cost?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

# 12 Phasing of water resources schemes

As described above, as part of the 2011 Water Resource Plans, modelling was undertaken on a range of possible schemes which would claw back the predicted deficit in 2030. Using the modelled schemes, indicative investment profiles were generated which provide clarity on the specific phasing of schemes for each of the affected hydrological units, based on the magnitude of the increasing deficit as modelled over the period to 2030. An indicative investment profile can be seen in Figure 6 (below).

Each water resource scheme can be modelled to assess the total quantity of water it will yield, and the

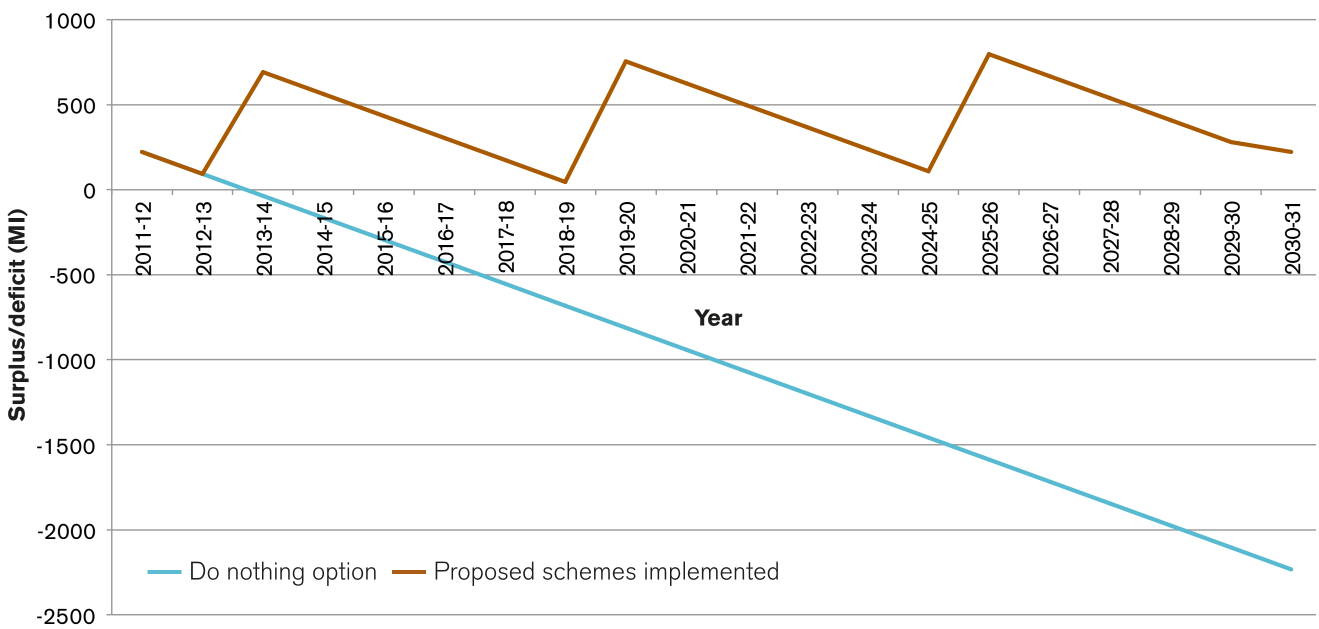



Figure 6: Indicative investment profile

NPV cost. From this list of schemes we can assess which schemes will provide the optimum benefit to the system which is then planned for implementation to coincide with the predicted year which the Trust will no longer be able to meet the agreed level of service for the specific hydrological unit. This approach gives the 'saw-tooth' effect visible in Figure 6, p28, as each scheme is implemented to address the deficit at that time. We intend to continue to use the same procedure for new water resources schemes, as it is a proportionate response to the modelled deficit, and ensures we are not over-investing or under-investing.

**Q10** **Consultation question – phasing of schemes**

**Do you agree that we should continue to phase the delivery of our water resource schemes using investment profile plots?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

Image: Daniel Trim

# 13 Other issues

Dredging, side ponds and lock leakage are regularly cited by our customers/users/stakeholders as issues that we should be considering, because of the effect they are perceived to have on water usage. As such, we have reviewed them from a water resources perspective and have made recommendations. There are many aspects of these three issues that have not been rigorously studied in the past and many perceptions about potential water savings and cost that needed to be put to the test.

## Dredging

There are three aspects of dredging that we considered:

- **Dredging for navigation and water resources**
- **Dredging to create 'reservoir pounds'**
- **Dredging of reservoirs to recreate storage that has been lost due to siltation**

In terms of dredging for water resources, we propose to further explore the water management benefits of main-line dredging and spot dredging. The Trust has produced a Dredging Strategy and water resource requirements will be included, so that any water resources benefits are quantified and optimised.

We propose to investigate our network thoroughly to identify specific locations that would benefit from dredging of canal pounds to create 'reservoir pounds' e.g. summit pounds. We intend to examine the costs of the works and the benefits in terms of water resources. It should be noted that pound storage below the highest lock cill level is dead storage from a water resources perspective.

Based on previous experience from costing schemes for the Water Resources Plans 2011, reservoir dredging is very unlikely to be prioritised in favour of other water resources schemes as it is not cost effective to do so. An example is Toddbrook Reservoir where we estimated that dredging the reservoir could increase the capacity by ~220 Ml. When the scheme was costed (incorporating capital, operating and maintenance costs, assuming a 3% rate of return and a 35 year planning horizon), the scheme was estimated as £23.6million. This equates to a cost of £35.2million per Ml/d. This is well above the water industry standard figure of £1 million per Ml/d associated with creating new reservoir storage or the costs of alternative sources of supply (although we note that this industry figure is generally quoted as a capital cost) and was grossly more expensive than every other proposed water resource scheme for the hydrological unit being considered.

## Side ponds

Side ponds can be defined as:

- **Brick or stone built ponds at the side of a lock, used to hold water for the purpose of water saving**

These are not be confused with side pounds, which can be defined as:

- **Sections of canal used to increase the water storage between locks in a flight e.g. with a steep gradient**

The Trust presently does not have any form of position statement or strategy for managing, reinstating or operating side ponds. They have never been specifically identified nor inspected as assets in their own right and instead are considered as being part of the primary asset (the lock) they are associated with. Additionally, there is no accepted methodology for assessing the water resources benefits for them (or the risks of water wastage if used incorrectly). As such they have been given very little focus.

It is recommended that each site should be considered on a case by case basis and the costs and benefits to the wider business including water resources, environment and heritage should be investigated along with the downstream water resource requirements. Consultation within the Trust suggests that if side ponds were to be used/reinstated/created, then there should be clear instructions/assistance with their use to ensure water efficiency. Anecdotal evidence suggests that water was wasted in the past by incorrect use. An automated system that would only allow paddles/sluices to be operated if done so correctly, or the use of volunteer lock keepers at sites with side ponds (locking up when not manned), would help reduce this risk.

It is proposed that, where present, side ponds are identified and recorded as separate sub-assets on each primary lock asset, so that the Trust has a definitive register of locks with side ponds and that a simple spreadsheet analysis tool is developed that will be able to assess the water resources benefits of side pond reinstatement/usage.

## Lock leakage

There are various locations within the Trust's network where lock leakage is a significant issue. There are various types of lock leakage including lock gate leakage, paddle leakage, leakage under the cill and through the lock walls. Of these, lock gate leakage and paddle leakage have the greatest impact on water control and water resources, and are a very visible form of apparent water wastage to our customers.

The impacts on water resources of lock leakage in a flight of locks tend to depend on the need to transfer water down the flight to meet demands further down the system. If the need to transfer water down a flight is greater than the net lock leakage then there is generally no water resource benefit from repairing lock gates. A reduction in the net leakage rate in the gates will simply mean that there will be higher flows in the bypass structures to achieve the required transfer rate. However, this does not mean that there will be no benefits from lock gate repairs (such as heritage and flood control issues), and of course improving customer perceptions about the level of maintenance of the Trust's network.

The greatest water resource benefits from lock leakage repairs are when the need to transfer water is less than the net lock leakage rate. This is because the additional water passing down the flight is likely to be lost from the canal system in the trough pound. These benefits from repairs are greatest in systems where the water supply is limited and back pumps have been installed to recirculate and/or transfer the water. A significant lock leakage in this scenario results in inefficient pumping as the leakage water has to be recycled as well as the lockage water.

Lock leakage, and in particular, lock gate replacement is addressed in the Trust's Asset Inspection Procedures. At present, lock gates are assessed separately to the primary lock asset as their lifespan is much lower than the lock itself. Lock gates are assumed to last around 25 years and it is therefore necessary to replace about 4% of the gates annually. This means that about 150-200 lock gates need to be replaced every year (most broad locks have four gates, two head and two tail whereas narrow locks tend to have only one head gate and one tail gate). While other assets in the Trust are prioritised on risk (the product of condition and consequence of failure), lock gates are currently prioritised on condition only, of which water leakage is only one factor (and does not explicitly consider the need to transfer water down the flight).

Therefore it is proposed that the design of lock gates explicitly considers the following aspects. The height of the gates with respect to the freeboard above normal water level needs to be taken into account as well as the weirage required by the gate and how this is impacted by fenders. Additionally, the water resource impacts of lock leakage need to be investigated taking account of the position of the locks in the canal system and the need to transfer water past the structures, the impacts on the management of canal pound levels and the impacts on pump efficiency.

## Q11

**Do you agree with our proposals for dredging for water resources?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

## Q12

**Do you agree with our proposals for side ponds?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

## Q13

**Do you agree with our proposals for lock leakage?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

# 14 Cycle of the strategy

We intend to progress this and future Water Resources Strategies on a five year cycle. The first strategy will be released in 2014/15, based on this consultation and the responses received. It will set out how we will manage water resources over the next five years. The strategy will be updated and revised following feedback, progress made and any relevant changes or developments that affect the water resources of the Trust's network.

Every year, updates will be made to the following hydrological model elements where appropriate:

- **Water sales;**
- **Inflow sequences;**
- **Annual lockage values**
- **Reservoir storage tables;**
- **Any other change to the network assessed as requiring an update to the model.**

The Water Resources Strategy will be updated every five years. The cycle will involve the following activities:

## Q14

**Do you agree that we should produce a Water Resources Strategy every five years, based on the cycle described?**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why? (more space on p36-37 if required)

## Q15

**Do you have any further water resource related comments on our consultation? If so, please tell us about them.**

# Additional comment space

Please indicate which question you are referring to.

| *Question number* | *Additional Comments* |
|---|---|
| | |

Image: Jack Perks

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# Appendix 1

**Example of Future Scenarios that were considered in preparing the National Water Resources Plan (NWRP) 2008.**

Each of these pressures will be re-assessed as part of the new Water Resource Strategy development, as these assumptions are now out of date.

| | Best Case |
|---|---|
| **Climate Change** | Climate change does not affect the water supply or the losses from our system. |
| **Funding** | The current levels of funding are maintained and expenditure on water supply assets does not reduce. To retain the current asset condition more targeted spend on water assets may be required. |
| **Environmental legislation and Standards** | The environmental regulators and government see navigation as a legitimate priority for water supply and no abstractions are reduced or revoked. |
| **Increasing network usage** | The current national growth in boat numbers of 1.5% per annum continues and leads to a proportional increase in lock usage. |

| Average Case | Worst Case |
|---|---|
| The climate change factors have been averaged between the Best Case and the Worst Case. | The water supply and losses are both affected by climate change. The medium-high UKCIP 2002 climate change scenario has been used for the water resource impacts and similarly for the losses. |
| DEFRA funding is reduced by 4% over the next 10 years and commercial revenue targets are not met. After 10 years DEFRA funding is maintained at the reduced level. This will lead to a proportional reduction in yield of 4% from our controlled feeders. | DEFRA funding is reduced by 8% over the next 10 years and commercial revenue targets are not met. After 10 years DEFRA funding is maintained at the reduced level. This will lead to a proportional reduction in yield of 8% from our controlled feeders. |
| A review of catchment status in England and Wales by the Environment Agency has highlighted a number which are over abstracted or over licenced. Where these catchments coincide with one of our abstractions it is assumed that 2.5% of that supply will have to be given back to the environment by 2030. | A review of catchment status in England and Wales by the Environment Agency has highlighted a number which are over abstracted or over licenced. Where these catchments coincide with one of our abstractions it is assumed that 5% of that supply will have to be given back to the environment by 2030. |
| This is the average between the Best Case and Worst Case. | The commercial target of delivering 11,000 new off-line berths within 10 years is delivered. After 10 years it is assumed that the current growth in boat numbers is reinstated. |

# Appendix 2

**Hydrological units, including phase 1 modelling cycle**

| Map Ref | Hydrological unit | Hydroligical unit type |
|---|---|---|
| 1 | Aire & Calder, Knottingley & Goole Canals | River Fed |
| 2 | Aire & Calder Navigation | River Navigation |
| 3 | Birmingham Canal Navigations (BCN) | Reservoir/groundwater/feeder supported |
| 4 | Bridgewater & Taunton Canal (B&T) | River Fed |
| 5 | Bristol Avon Navigation | River Navigation |
| 6 | Calder & Hebble Canal | Reservoir/groundwater/feeder supported |
| 7 | Calder & Hebble Navigation | River Navigation |
| 8 | Chesterfield Canal | Reservoir/groundwater/feeder supported |
| 9 | Cromford Canal | Reservoir/groundwater/feeder supported |
| 10 | Erewash Canal | River Fed |
| 11 | Fossdyke Canal | River Fed |
| 12 | Gloucester & Sharpness Canal (G&S) | River Fed |
| 13 | Grand Union South | River Fed |
| 14 | Grand Union Tring | Reservoir/groundwater/feeder supported |
| 15 | Grantham Canal | Reservoir/groundwater/feeder supported |
| 16 | Huddersfield Broad Canal (HBC) | River Fed |
| 17 | Huddersfield Narrow Canal (HNC) | Reservoir/groundwater/feeder supported |
| 18 | Kennet & Avon Canal (K&A) | River Fed |
| 19 | Lancaster Canal | Reservoir/groundwater/feeder supported |
| 20 | Leeds & Liverpool Canal (L&L) | Reservoir/groundwater/feeder supported |
| 21 | Liverpool Docks | River Fed |
| 22 | Llangollen & North Montgomery Canals | River Fed |
| 23 | London Canals | River Fed |
| 24 | London Docklands | River Fed |
| 25 | Lower Lee/Lea Navigation | River Fed |
| 26 | Lower Sheffield & South Yorkshire Navigation, (Lower SSYN, S&K and NJC) Stainforth & Keadby Canal and New Junction Canal | River Fed |
| 27 | Manchester Bolton & Bury Canal (MB&B) | River Fed |
| 28 | Monmouthshire & Brecon Canal (M&B) | River Fed |
| 29 | Montgomery Canal South | River Fed |

| Model Software | Planned Modelling within 1st five year cycle of water resource strategy |
|---|---|
| Aquator | No |
| Spreadsheet | No |
| Aquator | Yes |
| Aquator | No |
| Spreadsheet | No |
| Aquator | No |
| Spreadsheet | No |
| Aquator | No |
| Spreadsheet | No |
| Aquator | No |
| Aquator | No |
| Aquator | Yes |
| Aquator | Yes |
| Aquator | Yes |
| Aquator | No |
| Aquator | No |
| Aquator | Yes |
| Aquator | Yes |
| Aquator | No |
| Aquator | Yes |
| Spreadsheet | No |
| Aquator | Yes |
| Aquator | Yes |
| Spreadsheet | No |
| Aquator | No |
| Aquator | No |
| Aquator | No |
| Aquator | Yes |
| Aquator | No |

Continued on p44 ▶

| Map Ref | Hydrological unit | Hydroligical unit type |
|---|---|---|
| 30 | Nottingham & Beeston Canal | River Fed |
| 31 | Oxford & Grand Union Canals (OX&GU) | Reservoir/groundwater/feeder supported |
| 32 | Peak & Potteries (P&P) | Reservoir/groundwater/feeder supported |
| 33 | Pocklington Canal | River Fed |
| 34 | Ribble Link | River Navigation |
| 35 | Ripon Cana | River Fed |
| 36 | River Severn Navigation | River Navigation |
| 37 | River Soar Navigation | River Navigation |
| 38 | River Trent Navigation | River Navigation |
| 39 | River Weaver Navigation | River Navigation |
| 40 | River Witham | River Navigation |
| 41 | Rivers Ure & Ouse | River Navigation |
| 42 | Rochdale Canal | Reservoir/groundwater/feeder supported |
| 43 | Selby Canal | River Fed |
| 44 | Sheffield & South Yorkshire Navigation (SSYN) | River Navigation |
| 45 | Sheffield & Tinsley Canal | River Fed |
| 46 | Shrewsbury & Newport Canal | Reservoir/groundwater/feeder supported |
| 47 | Shropshire Union and Staffs & Worcester Canals (SU&SW) | Reservoir/groundwater/feeder supported |
| 48 | South Oxford Canal (SOX) | River Fed |
| 49 | St Helens Canal | Reservoir/groundwater/feeder supported |
| 50 | Swansea Canal | River Fed |
| 51 | Tees Navigation | River Navigation |
| 52 | Trent & Mersey Canal | River Fed |
| 53 | Upper Lee & Stort Navigation | River Navigation |

| Model Software | Planned Modelling within 1st five year cycle of water resource strategy |
|---|---|
| Aquator | No |
| Aquator | Yes |
| Aquator | Yes |
| Aquator | No |
| Spreadsheet | No |
| Aquator | No |
| Spreadsheet | Yes |
| Spreadsheet | No |
| Spreadsheet | No |
| Spreadsheet | No |
| Spreadsheet | No |
| Spreadsheet | No |
| Aquator | Yes |
| Aquator | No |
| Spreadsheet | No |
| Aquator | No |
| Spreadsheet | No |
| Aquator | Yes |
| Aquator | Yes |
| Aquator | No |
| Aquator | No |
| Spreadsheet | No |
| Aquator | Yes |
| Spreadsheet | No |

# Appendix 3

**Stakeholders we have already engaged with**

- **Canal & River Trust –** Council Meeting, 4 July 2012
- **Canal & River Trust –** Trustee Meeting, 25 July 2012
- **Canal & River Trust –** Annual Meeting, 9 July 2013
- **Canal & River Trust –** Partnership Meeting and Environmental Advisory Group, 24 September 2013
- **National Association of Boat Owners (NABO) –** Annual General Meeting, 16 November 2013
- **Canal & River Trust –** Internal colleagues during drafting of consultation
- **Nick Reynard –** Centre for Ecology and Hydrology (CEH)
- **Pauline Smith –** Environment Agency (EA)
- **Association of Pleasure Craft Operators (APCO) –** Tim Parker, 27 June 2012
- **Inland Waterways Association (IWA) –** Clive Henderson, Paul Soper, 8th August 2012

Image: Jack Perks

# Appendix 4

## Glossary

**Abstraction –** The removal of water from any source, either permanently or temporarily.

**Abstraction licence –** The authorisation granted by the Environment Agency or Natural Resources Wales to allow removal of water from a source.

**Aquator™ –** The name of a water resources computer modelling system used by the Trust and some water companies e.g. United Utilities.

**Defra –** Department for Environment, Food and Rural Affairs.

**EA –** Environment Agency.

**GIS –** Geographical Information System is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data.

**Headroom –** Is a buffer between supply and demand designed to cater for specified uncertainties. Uncertainties are inevitable in planning but it is important to reduce them as far as possible. For more details see References: EA (Environment Agency), 2012b.

**Hydrological Unit –** Sections of waterway that share a common source (or group of sources) of water supply to meet demands for water.

**Level of service (LoS) –** How frequently the Trust expects a navigational drought to occur

**Megalitre (Ml) –** A million litres or 1000 cubic metres.

**Miser™ –** The name of a water resources computer modelling system used by the Trust and some water companies.

**Net Present Value (NPV) –** Net Present Value of a schedule of costs for a programme. NPV is a very widely used method to combine various costs occurring over a period of time into a single value for comparison with the NPV of an alternative programme.

**UKCIP –** United Kingdom Climate Impacts Programme.

**WRP –** Water Resources Plan.

**WRMP –** Water Resources Management Plan.

**Yield –** A general term for the reliable supply of water from a source.

# Appendix 5

**Summary of consultation questions**

**Q**

**For questions 1-7 and 9-14 we are asking if you:**

a) Strongly agree ☐ b) Agree ☐ c) Neither agree, nor disagree ☐ d) Disagree ☐ e) Strongly disagree ☐

If you disagree, please can you tell us your reasons why?

## Key concept definitions

**Q1:** Do you think these definitions will be understood?

## Aspirational level of service

**Q2:** Do you agree that the Trust should maintain the same aspirational minimum level of service of a 1 in 20 year drought and that this should apply across the network?

## Restorations and new canals

**Q3:** Do you agree that the Trust should expect a water resources study to be undertaken for any proposed restoration or new canal, to assess the supply and demand of water and that there should be no net impact on levels of service of the existing canal network due to a restoration or new canal?

## Our five year modelling plan

**Q4:** Do you agree with the current five year modelling plan?

## Uncertainties

**Q5:** Do you agree that we should continue with our current approach to minimise risks associated with uncertainty by concentrating on improving understanding and quality of water supply and demand profiles?

**Q6:** Do you think that we should use, where appropriate, techniques outlined in Environment Agency and Defra guidelines to determine our strategic water resource requirements, including the use headroom to account for uncertainty within our modelling output?

## Future pressures

**Q7:** Do you agree with how we intend to progress with the future pressures we have listed and our modelling plan?

**Q8.** Have we missed out any future pressures? If so, please tell us about them.

## Whole life costs of schemes

**Q9:** Do you agree with our proposal to assess future water resource schemes based on whole life costs (NPV) and water resources benefits (£ per Ml/d), rather than only capital cost?

## Phasing of schemes

**Q10:** Do you agree that we should continue to phase the delivery of our water resource schemes using investment profile plots?

## Dredging

**Q11:** Do you agree with our proposals for dredging for water resources?

## Side ponds

**Q12:** Do you agree with our proposals for side ponds?

## Lock leakage

**Q13:** Do you agree with our proposals for lock leakage?

## Strategy cycle

**Q14:** Do you agree that we should produce a Water Resources Strategy every five years, based on the cycle described?

**For question 15 we are asking:**

## Other comments

**Q15:** Do you have any further water resource related comments on our consultation? If so, please tell us about them.

# Appendix 6

## References


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# Get involved

There are several ways that you can respond to this consultation. You could either e-mail us at **water.information@canalrivertrust.org.uk**; write to us using the following address: **Water Management Team (Strategy Consultation Response)** Canal & River Trust, Canal Lane, Hatton, Warwick, CV35 7JL or complete the questionnaire on-line: **www.canalrivertrust.org.uk/about-us/consultations**

The consultation period runs for 8 weeks, from **9 September** to **4 November 2014**.


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