



Bristol Water Plc

Drought Contingency Plan

Final Version March 2008

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Section 1.	Non Technical Summary	1
1.1	Drought Contingency Plans.....	1
1.2	How the Supply System Operates	2
1.3	Drought Monitoring and Decisions	4
1.4	Actions in Response to Drought.....	5
Section 2.	Executive Summary.....	7
Section 3.	The Drought Contingency Plan.....	11
3.1.1	New actions and activity for 2007 Drought Contingency Plan.....	11
3.1.2	Issues arising from the 2003 Drought Contingency Plan.....	12
3.2	System Description.....	13
3.2.1	The Availability of Resources	13
3.2.2	The Level of Service.....	16
3.3	Drought Scenarios	17
3.3.1	Scenario Analysis	18
3.3.2	Control Curves.....	20
3.4	Measures to Manage Demand and Supply	21
3.4.1	Demand Management.....	22
3.4.2	Supply Management.....	26
3.4.3	Impact of Drought Management Measures	31
3.4.4	Expected Frequency of Drought Measures	33
3.4.5	Time required to implement drought contingency measures	34
3.4.6	Forecasting the likely impact of drought.....	35
3.5	Triggers to Implement Drought Management Measures.....	37
3.5.1	Trigger Points from Drought Control 1.....	38
3.5.2	Trigger Points from Drought Control 2.....	39
3.5.3	Trigger Points from Drought Control 3.....	41
3.5.4	Trigger Points from Drought Control 4.....	41
3.5.5	Drought De-Escalation	42
3.6	Management and Communications	44
3.6.1	Internal Management.....	44
3.6.2	Regulatory Communications.....	44
3.6.3	Communication with British Waterways	45
3.6.4	Communication with Customers and Other Stakeholders.....	48
3.7	Environmental Status and Monitoring.....	50
3.7.1	Monitoring Plan for Reservoirs	51
3.7.2	Monitoring Plan for Rivers Affected by Drought Plan Actions.....	51
Section 4.	APPENDICES	
Appendix 1	Plan of Company Supply Area	
Appendix 2	Tables of Drought Management Options	
Appendix 3	Reservoir Control Curves	
Appendix 4	Results of Stakeholder Consultation	
Appendix 5	Drought Order Application - Non-essential Water Use Ban	
Appendix 6	Drought Permit Application – River Chew	
Appendix 7	Drought Permit Application – Cheddar Yeo	
Appendix 8	Drought Permit Application – Congresbury Yeo	
Appendix 9	Drought Permit Application –Bristol Floating Harbour	
Appendix 10	Agreed Scope of Environmental monitoring	
Appendix 11	Glossary of Terms	

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Section 1. Non Technical Summary

1.1 Drought Contingency Plans

All water companies in England and Wales are required by Statute to have contingency plans for coping with periods of drought. The Bristol Water Drought Contingency Plan will sets out the action we will take to maintain a mains delivered supply of water to customers during a period of drought.

As required, the Bristol Water Drought Contingency Plan has been developed in liaison with the Environment Agency, and other key stakeholders were consulted at an early stage. We have reviewed the consultation responses from stakeholders and addressed their comments and requirements in this final version of the plan, together with an specific directions made by the Secretary of State regarding the content of our plan.

Although significant droughts are relatively infrequent in the region, records indicate that these events may be expected between five to seven times per century. One or two of these historic droughts have been intense and prolonged and if repeated in future, could threaten the security of public water supply if no action was taken in mitigation.

As is the case with other water companies, Bristol Water does not undertake to provide an unrestricted supply of water under all of these climatic circumstances, as this would result either in greatly increased water bills, or be potentially damaging to the environment. Instead, we are currently committed to providing our customers with a target level of service such that restrictions to their water use should not occur more often than once in fifteen years on average.

No two droughts are the same and there is no way of knowing in advance how severe or prolonged the effects of the drought may be. The Drought Contingency Plan we have produced is sufficiently flexible to be able to cope with a range of droughts up to the worst event observed in our ninety-five year historical record. The range of measures proposed for coping with these droughts include:

- Enforced restriction to customers' use of water through hosepipe bans and bans on non-essential use of water.
- Significant actions by the Company to reduce system pressures, deployment of additional sources and further leakage control.
- Small reductions of water discharged from reservoirs to rivers to conserve water for public supply (while still maintaining adequate flows to rivers).
- Implementation of a large-scale temporary engineering scheme to take water from the Floating Harbour, Bristol to Barrow Gurney reservoirs for treatment.

We are all at risk from the impact of drought, so it is reasonable that actions to mitigate the effect of drought are shared amongst stakeholders. If both customers and the company respond by implementing the actions set out in our plan, we would expect to avoid the possibility of a wider failure of the water supply system. If the response is not sufficient, then emergency measures such as the use of rota cuts and standpipe could be required.

1.2 How the Supply System Operates

There are two major sources of water for the Company's supply area, and these sources are utilised flexibly to obtain the maximum benefit to our customers. Water resources in the Company area alone are not sufficient to meet the normal demand so approximately 50% is imported from the River Severn.

To the north of the Company area, water from the River Severn is abstracted from the Gloucester-Sharpness canal.



In the south of our area of supply, the large Mendip reservoirs at Chew, Blagdon and Cheddar will provide on average 40% of the water required to meet demand. It is this stored water that is critical in meeting the increased water use during hot or dry periods. There are no European habitats sites affected by drought management actions arising from drought permits or orders. However, the three principal reservoirs are all Sites of Special Scientific Interest, and Chew is a Special Protection Area. A monitoring programme for water parameters will be agreed with the Environment Agency for these sites

The remaining water supplied by the Company comes from a number of small groundwater sources, located across the area.

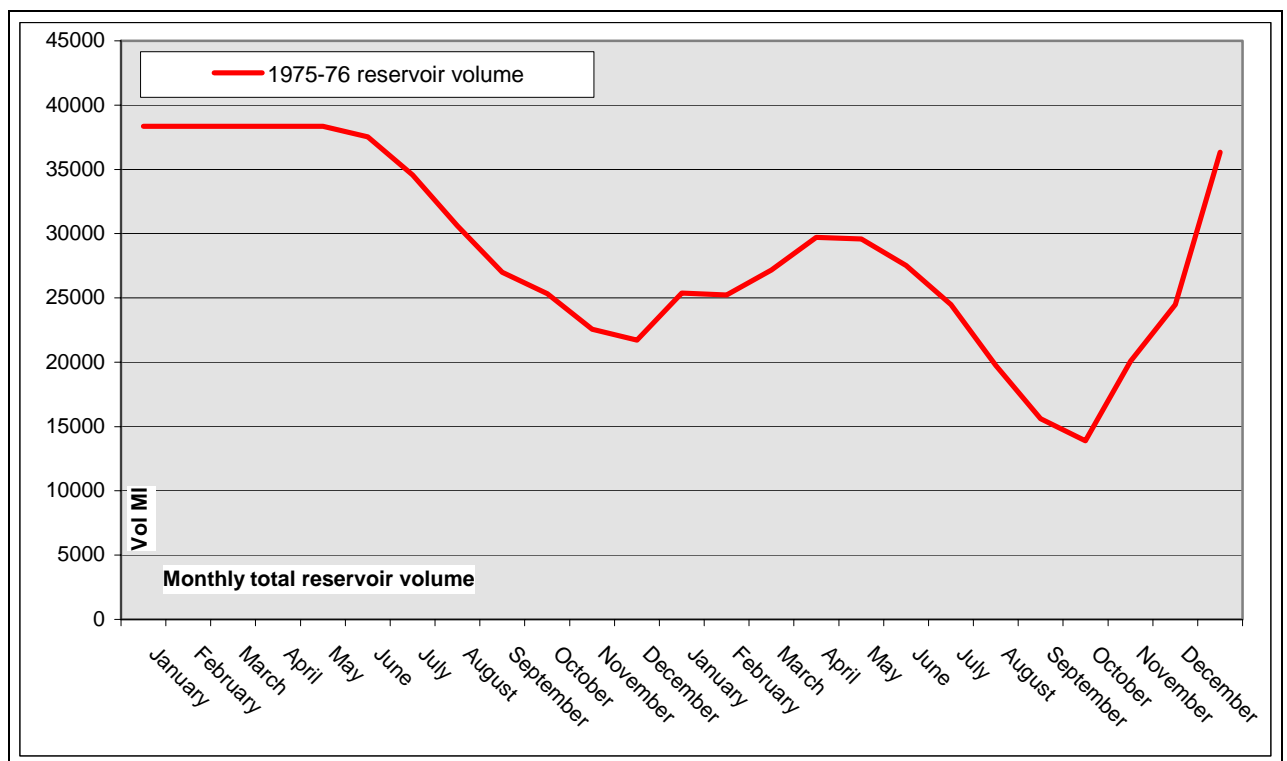
Water resources are utilised in order to maximise their potential yields at the appropriate times of the year. For example, the groundwater sources are operated at a high output early in the season up to mid summer, when underground water levels are high. This permits stored water volume in the Mendips to be conserved for use later in the season.

After mid summer the output of the groundwater sources normally declines. At this point in the year, maximum use is made of the water stored in the Mendip reservoirs to meet the high peaks in demand that occur during a hot summer.

In addition to the water taken from the reservoirs during summer, we also increase the water taken from the River Severn. This water is used to meet the increased demand in the north of the Company area. The water is also transferred across the network to partially meet demand in the southern half of the Company area. By operating in this way, we can exert some control on the rate at which the levels of reservoirs fall during the summer.

The volume that we are allowed to abstract from the Severn is strictly controlled by the Environment Agency. This sets a limit on how much water we can move through our network to balance the demand upon the Mendip reservoirs, particularly in summer when we operate at reduced abstractions from the Severn. This is offset by the ability to make more use of River Severn water during the winter.

Because of the flexibility of the resources system, analysis of past events indicates that the Company is vulnerable primarily to low intensity droughts that last for more than a single year, or to dry winter periods. This is illustrated in the predicted plot of reservoir volume for the two-year drought 1975-1976 noted for the dry winter of 1975.



As is the case with all other water companies, we depend upon the increased rainfall normally expected over the winter period to re-charge the reservoirs. However, the flexibility to use the water available from the River Severn mitigates this dependency to a considerable extent. The predicted reservoir volume for the 1975-76 drought illustrated above would be just above 5000MI if our system did not have this degree of flexibility.

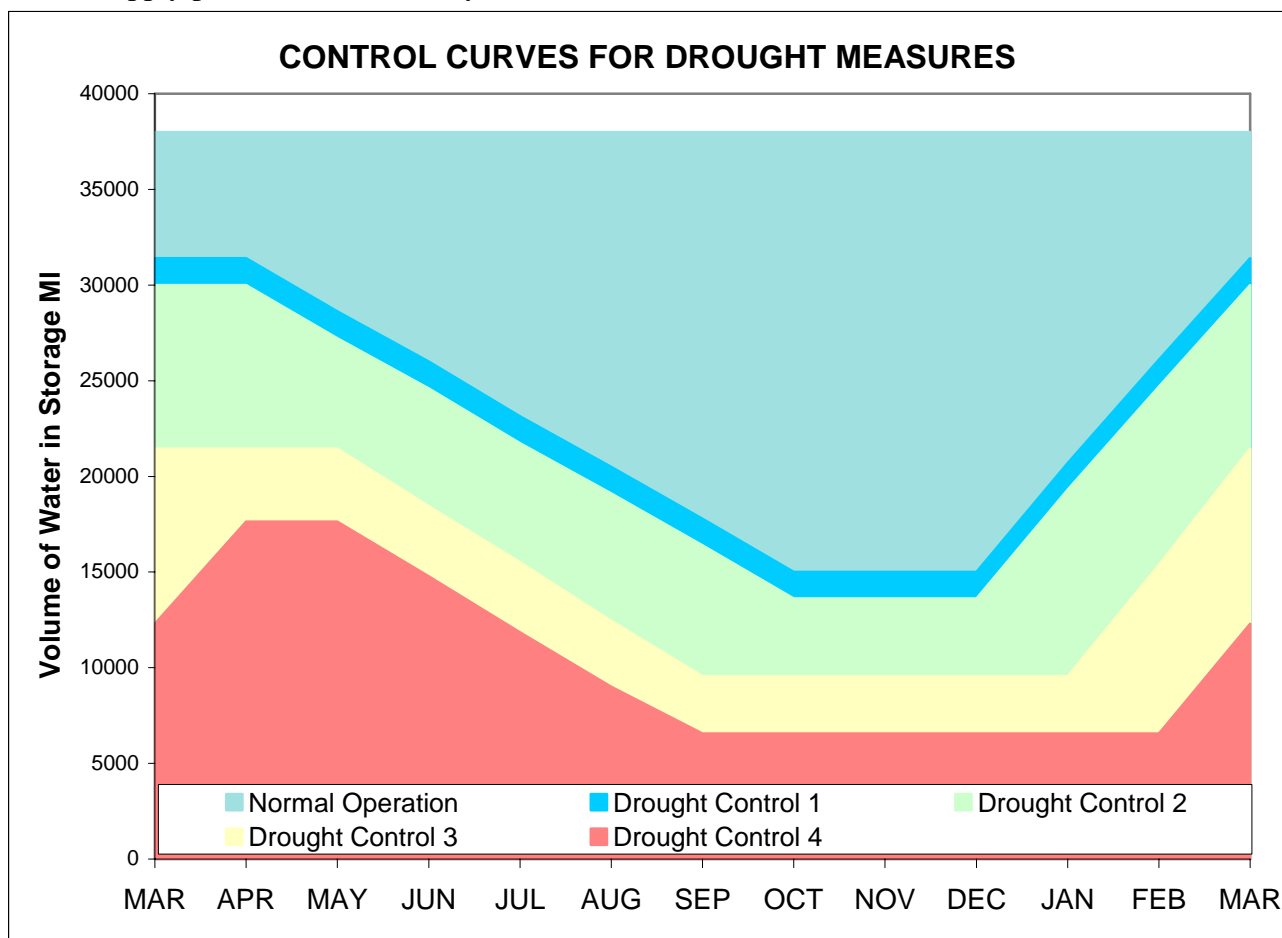
1.3 Drought Monitoring and Decisions

Droughts vary widely in their nature and the impact they cause on reservoir volume. Because of this, the volume of stored water at various points in the year is a good indicator of drought severity.

We have modelled the effect upon reservoir storage of a wide range of droughts. This modelling has been used to determine a series of profiles of reservoir levels throughout the year relating to differing conditions from normal operations to severe droughts. These profiles are known as control curves. If stored water volume were to remain above the control curve representing normal operation, then the normal abstraction and operational efficiency rules would apply.

If reservoir volume fell below the lowest control curves, then the risk of supply failure would increase substantially, unless significant action was taken to reduce demand, or utilise alternative sources of water. These actions are summarised in the table overleaf. Reservoir volume below the lowest control curve would be very unusual, and not expected to occur more than once in fifty years under the current scenario for water demand and availability of resources.

Between these two extremes, additional control curves have been created, each representing an increasing level of risk to supply during the developing drought. The actual volume of water in storage is compared to these control zones throughout the year. If reservoir storage volume decreases so it is within any of the lower zones during the year, decisions will be required on the actions needed to conserve water and minimise the risk of a water supply problems later in the year.



1.4 Actions in Response to Drought

The table below sets out the actions that would be considered for each of the drought control bands shown in the plot above. It would be usual for the particular actions associated with a control band to be implemented as early as considered to be effective.

Most actions focus on seeking to reduce the demand for water by a campaign of public awareness, or direct appeals for restraint. There would also be increased operational activity to find and repair leaks more rapidly, and trace unauthorised or inefficient use of water. If further actions were required, there would be restrictions on the discretionary use of water, such as use of hosepipes and sprinklers. If conditions required, we could apply for drought orders to completely ban the non-essential use of water. We would monitor, and bring prosecutions against individuals and companies that failed to comply. In the most extreme droughts that may occur less than once in fifty years, we may need to apply for permits to reduce the flow of water in rivers, or develop an emergency abstraction scheme from Bristol City Docks.

DROUGHT CONTROL BAND	DEMAND RESTRAINT ACTIVITY	OPERATIONAL AND PLANNING ACTIVITY	DEPLOYMENT OF ADDITIONAL RESOURCES
Normal Operation	Normal background Water efficiency advertising	System operation based on minimising costs	None
1 Briefing of EA Drought Coordinator as required	Enhanced publicity & media campaign to conserve water linked to situation	Increased monitoring Intensify leakage reduction & pressure reduction effort Maximise Leakstop publicity	Plan return to service of disused sources Ensure current groundwater and River water abstractions are maximised
2 Briefing of EA, CCW, Stakeholder groups	Full publicity and media campaign with direct appeals for restraint Probable Hosepipe and sprinkler ban	Unauthorised usage monitoring and prosecution Application for drought permits & orders	Reinstate disused sources with temporary treatment Manage TW to cope with reduced water quality
3 Briefing of EA, CCW, Stakeholder groups	Intense publicity and media campaign Ban on public Non essential water use and hosepipe ban	Implement schemes to allow abstraction at low reservoir levels Plan Emergency Docks abstraction scheme	Reduce Compensation flows to rivers Manage TW to cope with reduced water quality
4 Briefing of EA, CCW, Stakeholder groups	Hosepipe and nonessential use ban Intense media campaign for restraint	Planning supply security for vulnerable customers Deploy emergency overland pumping schemes in reservoirs	Implementation of emergency Docks abstraction scheme Engineering works to permit draw off from reservoirs at low volume

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Section 2. Executive Summary

This document indicates how Bristol Water intends to manage water resources and balance the requirements of customers and the environment during periods of drought. The Company has always maintained a publicly available contingency plan for coping with dry weather. The Water Act 2003 has resulted in a number of significant changes, both to the contents of these plans and the requirement for wider consultation when developing a plan. The Company Drought Contingency Plan has been reviewed and updated within the context of the new legislation.

- We have involved the Statutory Consultees identified in the Drought Plan Regulations, and a wider group of stakeholders during the development of our plan. There are no licensed water suppliers in our Company area.
- No material has been excised from the public version of our plan on grounds of commercial confidentiality. On the direction of the Secretary of State, the schematic indication of the mains network has been removed from the map of the supply area.
- Although we have not carried out a formal Strategic Environmental Assessment (SEA), we consider the draft Drought Contingency Plan has fulfilled many of the requirements of a formal SEA in respect to the level of consultation, environmental analysis, monitoring and mitigation proposals. Our screening indicated that a formal SEA is not required for the Drought Contingency Plan because:

None of the temporary proposals in our plan affect or are affected by wider development issues.

The actions listed in our plan are short-term tactical operational activity, and will be put in place as temporary measures only (typically less than six months).

The actions we propose will be put in place only on the basis of over-riding public interest in order to maintain a continuous mains supply of water for human health. The actions will help to delay a widespread civil contingency caused by a supply failure. There would not be a large range of alternative options at this stage.

Any drought permits or orders will be available only on a temporary basis. River flows, discharges and reservoir levels will return to normal when the drought ends, as they have in past droughts.

The plan is required by statute to be reviewed and updated every three years, allowing new issues, or better environmental data to be considered and consulted upon at frequent intervals. This provides a higher level of review than would be afforded by a single SEA. This process does not exclude SEA for future plans, if this becomes a requirement.

- Our plan assumes full conjunctive use of all resources in the Company area as detailed in the 2004 Water Resource Plan. This is made possible by the high degree of connectivity and flexibility in the raw and treated water mains systems. This will be improved further as large transmission mains projects are completed over the

next five years The largest components of the resource systems are the Mendip reservoirs and the Sharpness abstraction (River Severn).

- The drought control curves and the model predictions are based on long-term inflow sequences from actual and synthesised data back to 1910. This includes the dry periods of 1921 and 1933. These are years that experienced the most severe droughts within the period of record.
- This plan details an operational response to drought, and as such does not directly address issues of climate change as these are considered when assessing the level of service in the Water Resources Plan. There is a risk that climate change may result in more severe or more frequent drought. The mitigating actions in this plan will still be valid, but may be required more frequently unless demand for water falls, or new resources are developed.
- Estimates of the effects of demand restrictions on water consumption have been based on the UKWIR best practice methodology, and the demand forecast data is consistent with the 2004 update to the Water Resource Plan (this is available for consultation on the Company web site).
- In a very severe or prolonged drought, we now propose that three short river sections may be subject to reduced flows due to reduction of compensation releases at certain times of year. We are working with the Environment Agency to develop the appropriate monitoring plans for these areas to establish if there will be any environmental effects.
- The proposal to make a temporary emergency abstraction from the Floating Harbour in the centre of Bristol has been agreed in principle with the key stakeholders. We will continue to work with them in planning this new scheme.
- We consider that if all of the drought measures were implemented as stated in the plan, the Company would be able to maintain a mains supply of water under conditions that would be similar to the worst drought the region has experienced during the last 95 years.
- The interventions and mitigations proposed in this plan are based on the expectation that they will deliver the scale of outputs stated. However, because of the range of variables occurring during drought, there can be no guarantee of these out-turns.
- There are a significant number of changes compared to previous versions of the Drought Contingency Plan. Because of this, the 2007 plan has been considerably re-structured, and now contains a non-technical summary. This has been provided primarily because the new plan is expected to have a wider audience as part of the consultation process.
- The Drought Contingency Plan is a ‘living’ document that will be updated and re-submitted for public consultation every three years, following formal publication. This will allow issues such as climate change, increased demand for water and changing operational circumstances to be fully addressed.
- The Drought Contingency Plan will be published as an electronic document and made freely available from the company web site, or as a paper document upon request.

We have carried out the actions detailed in the Drought Plan Regulations (DEFRA 2005). These regulations define the statutory process for consultation, representation and review. In essence we have complied with the requirements as set out below:

- To consult as widely as possible with the bodies suggested prior to developing the draft plan, particularly with the main statutory consultees.
- To produce a draft Drought Contingency Plan for submission to the Secretary of State, in accordance with the Drought Plan Directions.
- To consider all formal representations forwarded to us, or the Environment Agency from the Secretary of State after the consultation period.
- To demonstrate how representations have been considered, or taken into account within their plans.
- To comply with any direction from the Secretary of State to hold an enquiry and or requirement regarding the content of the final drought plan.
- To publish, and disseminate the final plans by appropriate means.

In addition, following our widespread consultation with stakeholder organisations and the wider public, DEFRA has reviewed the representations and directed us to further address particular issues. These include:

- Addressing points raised by stakeholders in any representation made to DEFRA during the consultation.
- Information on how any water shared with other water undertakings will be managed during a drought.
- Clarification of how much time will be required to implement the mitigating actions identified in our plan.
- Information on what techniques will be used to forecast the impact of drought as it develops.
- Detail of any additional measures that could be employed to delay or reduce the possibility of an application for emergency drought orders requiring supply cuts or standpipes.
- In relation to the drought orders identified pursuant to section 39B, to provide further details of:

The ecological and morphological features of the affected sites impacted by changes in flow.

An assessment of the impact of a drought order or permit implementation on the affected site.

Details of any mitigation required in order to reduce the environmental impact of the drought order or permit on the site.

Each of these points has now been addressed in this version of the plan.

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Section 3. The Drought Contingency Plan

This Drought Contingency Plan, for 2007 is considerably more detailed than past versions. We have consulted widely prior to the release of the Draft Drought Contingency Plan. Following the statutory period allowed for consultation of our draft plan, we received a number of representations from stakeholder groups. These included:

- Environment Agency
- Natural England
- Consumer Council for Water
- Ofwat
- National Farmers Union

In general the responses we received were directed at the following aspects of the draft plan:

- Issues concerning appearance and presentation
- Comments requesting additional background information or clarification
- Issues regarding stakeholder and public communication during dry periods
- Recommendations in regard of improved environmental assessment
- Request to consider improved monitoring requirements

We have responded to all of the stakeholder comments and include these submissions and our statement of response in the appendices. We have enhanced our plan and added additional material where appropriate in the light of these submissions.

3.1.1 New actions and activity for 2007 Drought Contingency Plan

Environment Agency guidance indicates that a satisfactory plan must acknowledge the possibility that drought permits are appropriate tools to prolong water supplies during a severe drought. For this reason we have now included in our plan proposals for use of drought permits or orders to allow the following to take place.

Emergency schemes A proposed emergency abstraction of up to 50 Mld from Bristol docks to Barrow reservoirs, largely using existing mains.

River Chew Reduce compensation flow to conserve reservoir volume.

Cheddar Yeo Reduce compensation flow to conserve reservoir volume.

Congresbury Yeo Reduce compensation flow to conserve reservoir volume.

This is the first time these actions have been considered by the Company, and we acknowledge there may be environmental implications. We have sought to minimise these by appropriate timing. It is our intention to work with the Environment Agency to identify current baseline conditions, and the probable effects of changes to compensation discharges. The details of our proposals, samples of drought permit applications and environmental monitoring plans are included in the appendices.

3.1.2 Issues arising from the 2003 Drought Contingency Plan

Following the submission of the 2003 plan, the Environment Agency sought clarification regarding some technical aspects of that plan. The points then raised have now been resolved as part of the general liaison between Bristol Water and the Environment Agency, and are listed below.

Frequency of restrictions to customer water use (hosepipe bans etc.)

In our Water Resources Plan, we state that we would be cautious with stored water during a drought. As a consequence, there is a risk that restrictions to use may need to be considered more frequently than the target level for calculating Deployable Output would suggest. This is because projections of reservoir volume cross the drought control curve 6 times in 100 years. In most cases, the volumes recover quite quickly when past events are observed. However during a drought event, we would not have the benefit of hindsight and therefore would be likely to consider imposing demand restrictions. We assess this decision to enforce restriction on customer is likely to occur on average once in every 15 years.

Mendip reservoir storage volumes

We have re-surveyed the depth and silt volume in all reservoirs in 2007. this survey indicated no significant reduction in storage volume except at Chew Magna (this reservoir is for storage of compensation water and not part of the overall resources system).

Control Curves

We treat the storage of our large individual raw water reservoirs as part of a conjunctive use scheme, within a single resource zone. As water can be utilised from any of the reservoirs, or moved between reservoirs we group the storage of all reservoirs and treat them as if they were a single source of stored water for planning purposes, and to optimise operating costs. Individual reservoirs are managed on a draw-down/refill trend to minimise the probability of premature overflow or failure at a single reservoir.

River Severn

We are working with the Environment Agency on their revised Drought Contingency Plan for the Severn and note that additional abstraction reductions on the Severn may be required in future. As the Agency finds these difficult to quantify, we have considered the circumstances in which the Company could reduce abstraction if the Agency enforce a Drought order on the Severn. This may require the Company to impose a hosepipe ban when the Company reservoir volume is above the relevant control curve.

River Avon emergency abstractions

We are no longer considering an abstraction from the Avon at Newton Meadows. We propose instead to investigate an emergency scheme to abstract water from the Floating Harbour in the centre of Bristol. The abstraction point is adjacent to the discharge to the tidal Avon, and would result in minimal environmental impact.

Drought de-escalation

We have included further detail in this plan on the actions to be taken as drought diminishes and systems return to normal operation.

3.2 System Description

Bristol Water's area of supply covers 1000 sq miles and includes a population of over a million people. The area includes Bristol and many satellite towns and villages within a 20-mile radius of Bristol. The Company has the following sources of water:

- A number of minor groundwater sources such as springs, wells and boreholes.
- Three major impounding reservoirs collecting water from the Mendip hills catchments.
- A major water import from the River Severn via the Gloucester and Sharpness canal.

There is a high level of connectivity both in the raw water mains networks and the treated water bulk transfer systems. Therefore, within the company supply area, there is a considerable degree of flexibility that permits the sharing of resources, and allows their optimum use according to seasonable availability. Consequently, the whole Company area is operated as a single resource zone in which water resources are used conjunctively. The key system features are illustrated on the plan contained in the Appendices. Further details of the system operation can be found in the Company Water Resources Plan (2004), available on the Bristol Water web site.

3.2.1 The Availability of Resources

The quantity of water available during a drought (the Deployable Output) has been determined in the Company Water Resources Plan, submitted to the Environment Agency in 2004. This document defines in considerable detail the parameters that form the basis of the Drought Contingency Plan. These are:

- The volume of reservoir storage available, contracted water reservations and effects of any reduction in abstraction quantity imposed by the Environment Agency.
- The probable quantity of inflow to the Mendip reservoirs during dry weather from the use of a calibrated rainfall/run-off model for the catchments.
- The likely output from the groundwater sources from analysis of dry year output, including the 1975/76 drought.
- The water available from the River Severn, using the 1975/76 drought as a model to determine the restrictions on abstraction that would be imposed on the Company abstraction at Sharpness.
- The dry weather demand, and assessment of discretionary water use (garden watering for example). This was based on data from the last recorded drought to significantly impact the Company (1995/96).

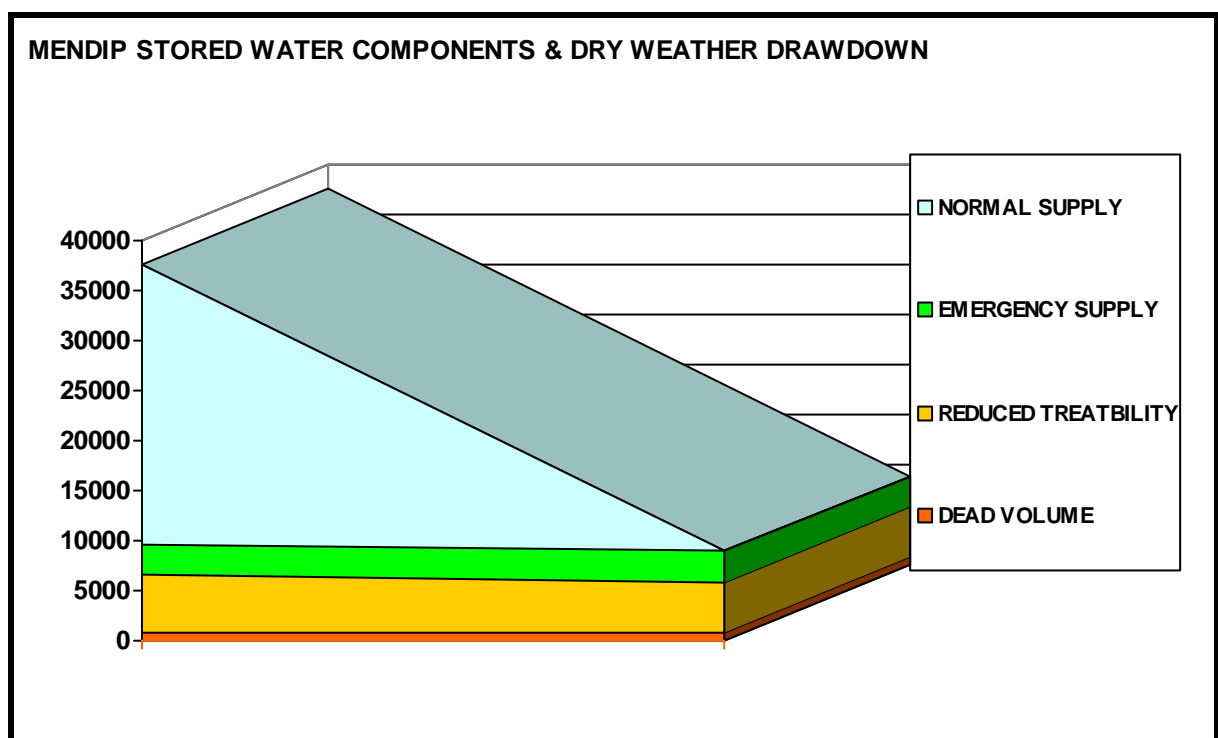
Reservoir storage is critical to the resource system. In total approximately 40% of the Deployable Output, is derived from the yield of the three Mendip reservoirs. During the summer months, water from the reservoirs is used to meet the peaks in water consumption, and the volume of water held in storage will fall rapidly. The theoretical maximum volume of all of the major reservoirs is 38000MI. However, for a number of physical reasons, not all of this water can be readily removed, or extracted at the required rate without some form of remedial work.

As the total volume in storage falls below approximately 10,000 MI, the level of water in each of the individual reservoirs is such that a number of significant problems will develop.

Pump intake pressures would fall causing pumps to fail, water quality would deteriorate and large quantities of blue-green and filter blocking algae grow due to the release of nutrients, together with an increasing concentration of protozoan parasites, such as *Cryptosporidium*. This causes increasing operating difficulties, ultimately requiring temporary engineering works to maintain output. Such works range from the basic, such as additional temporary boosters to complex schemes, requiring overland pumping arrangements or use of temporary treatment plant.

Other issues that need to be considered include the element of dead volume, or water that can't flow towards the draw off because of the topography of the reservoir bottom. In addition planning considerations require a volume equivalent to one months demand from the reservoirs to be retained as emergency storage (approximately 3,100MI).

The calculation of the theoretical output of the resources system for the Water Resources Plan takes all of these issues into account. However, water that could be produced adopting the range of additional measures outlined above is excluded from the normal yield of the system. These extra measures to access the remaining 10,000 MI water form part of our drought contingency plan and are not part of the water deployable at the target level of service. The components of reservoir storage are illustrated in the figure below.



Based on the 2004 Water Resources Plan, the maximum volume of water that the combination of river supply, groundwater and reservoirs and deliver over a dry year is detailed in the table below, expressed as an average value in millions of litres per day (MI/d).

SOURCE OR WATER USE	VOLUME IN MI/d
Groundwater sources total dry weather yield	67
Mendip reservoir system combined dry yield	94
River Severn Sharpness dry weather yield	210
Contracted non potable industrial supplies	- 16
Operating use of raw water (filter washes etc.)	-6
DEPLOYABLE OUTPUT (see conditions below)	349

Further detail is provided in the Company 2004 Water Resources Plan, from which the table above has been taken. The analysis follows a standardised methodology required by the Environment Agency, and makes the following assumptions.

- That all sources can deliver water at their theoretical dry weather maximum yields throughout the year.
- That there is no major loss or damage to any part of the supply and treatment system resulting from vandalism, terrorism, civil commotion, or extreme weather conditions.
- That the poor quality water supply from the River Axe will be utilised, and is assumed to have no adverse effect on the operation of treatment works (a new treatment works to address the problem of poor quality water will be completed by winter 2008).
- That the HYSIM resources model used to predict the inflows from the catchments to reservoirs provides reliable inflow estimates.

In addition, there are further contractual and agreed system constraints listed below:

- Bristol Water has a voluntary agreement with the Environment Agency to reduce abstractions from the Tetbury area of the Company area by 10 Mld
- The effects of reduced output of sources due to water quality or equipment failures reduce the available water by an average of 11 Mld in a year (referred to as outage in the Water Resources Plan).
- The Company has a contractual agreement to provide a secure potable water supply to Wessex Water of 11.3 Mld. The contract stipulates this full volume should be made available to Wessex Water when required even during periods of drought. The only exclusions are operational emergencies and *force majeure* (excluding drought). If conditions require the EA to seek a drought order to minimise abstraction on the River Severn, we can then reduce the Wessex Water supply by the same percentage reduction required by the EA (i.e. if a 5% reduction in licensed abstraction is required, we may reduce the Wessex transfer by 5% of the contracted 11.3 Mld volume).

These issues combine to reduce the water available to our customers to approximately 317 MI/d during a dry year, compared to the potential demands of over 300MI/d during a dry year.

3.2.2 The Level of Service

The target Level of Service defines the theoretical frequency that some form of restriction to customer demand will be required to maintain a given Deployable Output. As is the case with all other water companies, Bristol Water cannot undertake to provide an unrestricted supply of water, at an affordable cost, under all climatic conditions. The method to determine the maximum Deployable Output delivered by the resources system during dry weather depends upon the output of calibrated hydrologic models. These have been used to produce a synthetic inflow record for the main reservoirs from 1910. This data is then used for the behavioural analysis of the supply and demand components of the conjunctive use system.

Droughts have widely differing characteristics, and regional effects. However, the following define the broad categories of drought that could have a significant effect on the Company resources system.

- A very severe single season drought – example 1921/22
- A severe two-season drought - example 1943/44 and 1975/76
- An acute winter drought – example 1933 (this was part of the 1933/34 drought)
- A very severe two-season drought – example 1933/34

We have reviewed the range of droughts in the historical record from 1910 to date, and have modelled the effects that these might have on the behaviour of the resources system and reservoir storage. This has been carried out under various scenarios for water demand. The result is a Deployable Output at a target frequency for which customer demand restrictions would be required either to avoid, or as a precursor to wider measures (drought permits and emergency schemes).

Within the historic period, there are two drought occurrences with the potential to cause reservoir storage to fall significantly below 9,750 MI for a period. If this were allowed to occur without any attempt to intervene, there would eventually be an unacceptable probability of a supply failure. These two critical events are the type of drought that develop over two years, and in the record are typified by:

- The very severe two-season drought 1933/34 – Probability of occurrence significantly less once in 100 years based on the climate record from 1910.
- The severe two season drought 1943/44 - Probability of occurrence approximately once in 50 years based on the climate record from 1910.

The resources system is also challenged by severe single season events, of the type represented by the 1920/21 drought (the most severe of its type in the record). However,

the behavioural analysis shows reservoir levels recover rapidly, unless the drought persists to become a two-season event.

From the behavioural analysis for the current assessment of Deployable Output, restrictions to customer water demand would have been required twice since 1910. We therefore anticipate a theoretical requirement to impose restrictions to customer use once in every 50 years. The pattern of reservoir draw-down indicates that the restrictions to demand would only be strictly required in the second season of the two season drought.

These restrictions would include hosepipe and sprinkler bans or restriction on non-essential use as detailed elsewhere in this plan. Although the review of past events is helpful, no two droughts have the same effect on the system, and past events will never precisely predict future system performance during drought. In addition, there are a variety of other operational risks, such as River Severn abstraction restrictions or water quality issues. For this reason, the company has developed control curves to mitigate the effects of drought, and avoid drawing reservoirs down to below critical levels. These control curves give rise to the possibility that some form of action to reduce customer demand may be required more frequently than once in 50 years.

A pragmatic and cautious approach is needed to conserve resources during a drought. This may result in the application of demand restrictions that, as events develop, turn out not to have been required. As a consequence, there is a possibility that demand restrictions may be considered at a statistical frequency of once in 15 years. This approach is intended give a fair indication to customers of the maximum degree of inconvenience they might expect.

3.3 Drought Scenarios

The effects of drought on the resources system can be modelled using as a basis the same assumptions and methodology outlined in the section above. The four main drought scenarios based upon the behavioural analysis of the system are:

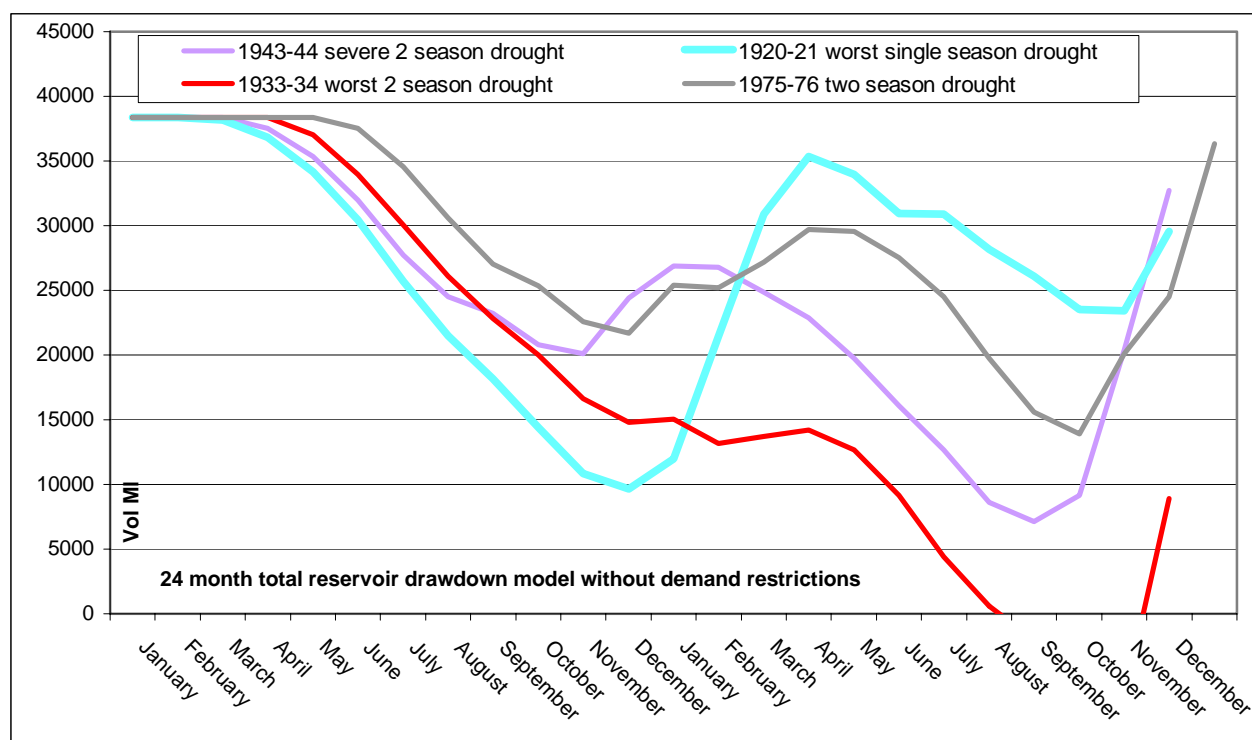
- A very severe single season drought – example 1921/22
- A severe two-season drought - example 1943/44 and 1975/76
- An acute winter drought – example 1933 or 1991
- A very severe two-season drought – example 1933/34

These represent the four worst dry periods with the greatest impact on the resources system within our analysis of the period of record from 1910. There are other dry periods, but none are predicted to have the same impact as those selected. However, it is important to note that prior to 1960, a consistent set of reservoir inflow records does not exist. The reservoir inflow data prior to 1960 has been based on records of catchment rainfall using modelling techniques to predict inflow.

3.3.1 Scenario Analysis

The analysis of the data indicates that with the current set of resources, the greatest impacts are from two-season droughts. This might be two very dry summers in a row, or a dry summer with a winter drought. The occurrence of a winter drought is observed more often, and has the most significant effect. Starting from a position of full storage, the Company considers that it is primarily two-season critical. In other words, the resources system is affected more significantly by an extended dry period that is greater than a single summer. We do not observe a drought sequence extending beyond two years in the Company records from 1910.

The plots below illustrate how the total volume of water in our reservoirs would theoretically respond over a two-year period if we were subject to the most severe drought scenarios within our record from 1910.



It important to note that this prediction of reservoir drawdown in response to drought is based on the following planning assumptions:

- The Deployable Output declared in the WRP is maintained throughout the period.
- No restrictions to customer water use have been applied in the period.
- Groundwater sources are operated at their theoretical dry year output over the period.
- Reduced abstraction due to drought orders on the River Severn of 5% is included.
- Bulk supplies are maintained at their full contract rate for the period.
- Modelled drought year catchment inflow to reservoirs (1975-76 uses observed inflow).

From the simulation of reservoir levels, it can be seen that the droughts with the most potential to disrupt supplies would those similar or worse than the 1943/44 or 1933-34 two-season droughts. Fortunately such droughts are rare. Based upon a probabilistic analysis of

data from 1910, the expected frequencies of the type of droughts modelled in the scenario are as follow:

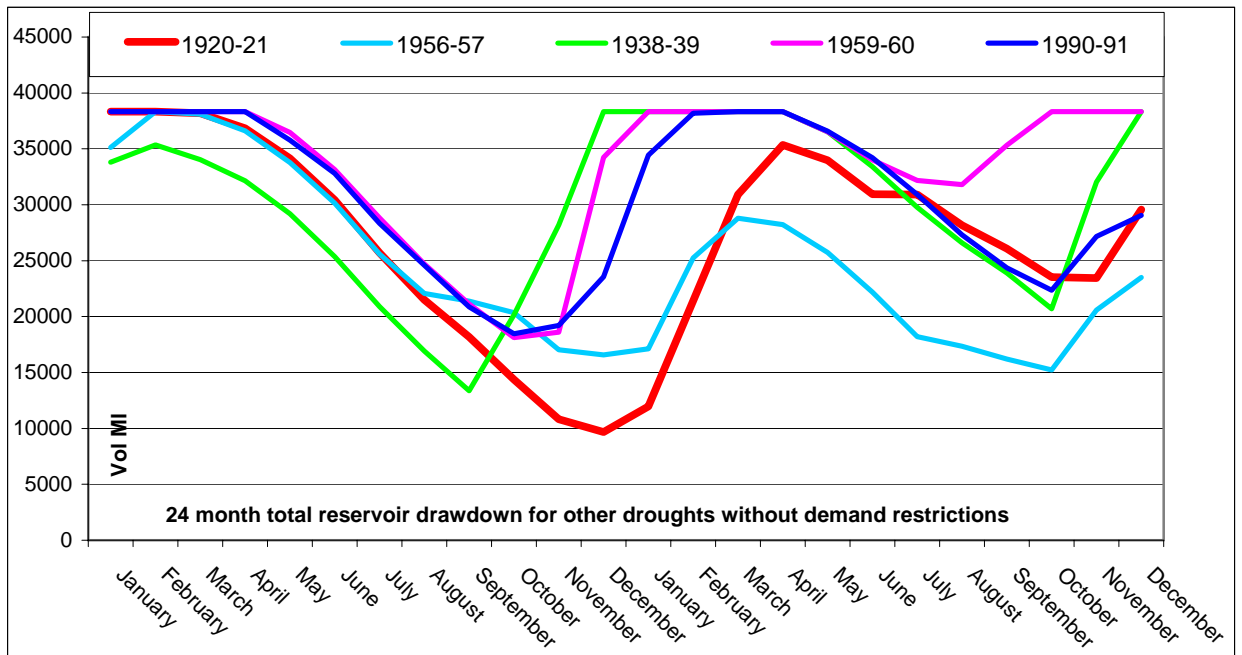
- Less than once in 100 years for a severe single season drought – example 1921/22.
- Approximately once in 50 years for a severe two-season drought - example 1943/44.
- Approximately once in 200 years for an extreme 2 season drought – example 1933/34.
- Approximately once in 20 years for a moderate two-season drought – example 1975/76.

The drought of 1933-34 was so severe an event for the region that if it was to be repeated today, there could be a possibility of a supply failure if action was not taken to mitigate the effects. The actions outlined within this Drought Contingency Plan are tested against this drought scenario in particular. The intention would be put in place a sequence of drought measures that would ensure that a continuous mains water supply would remain available even for the worst drought in the record.

With the resources available to the company today, the drought of 1975-76 appears to have a relatively limited effect. However, it included in the scenario for comparison purposes because it is the most recent significant drought for which we have recorded inflow data, as opposed to model data.

The 1943-44 drought represents the target level of storage used to calculate the Deployable Output within the Water Resources Plan. As explained in section 3.2, we would expect to impose a hosepipe ban as a minimum measure in an attempt to avoid further drought contingency activity. However, if reservoir volume continued to decline alternative measures would have to be planned in anticipation of a second very dry winter and third dry summer. However, such events would be entirely without precedent within our 95year climatic record from 1910.

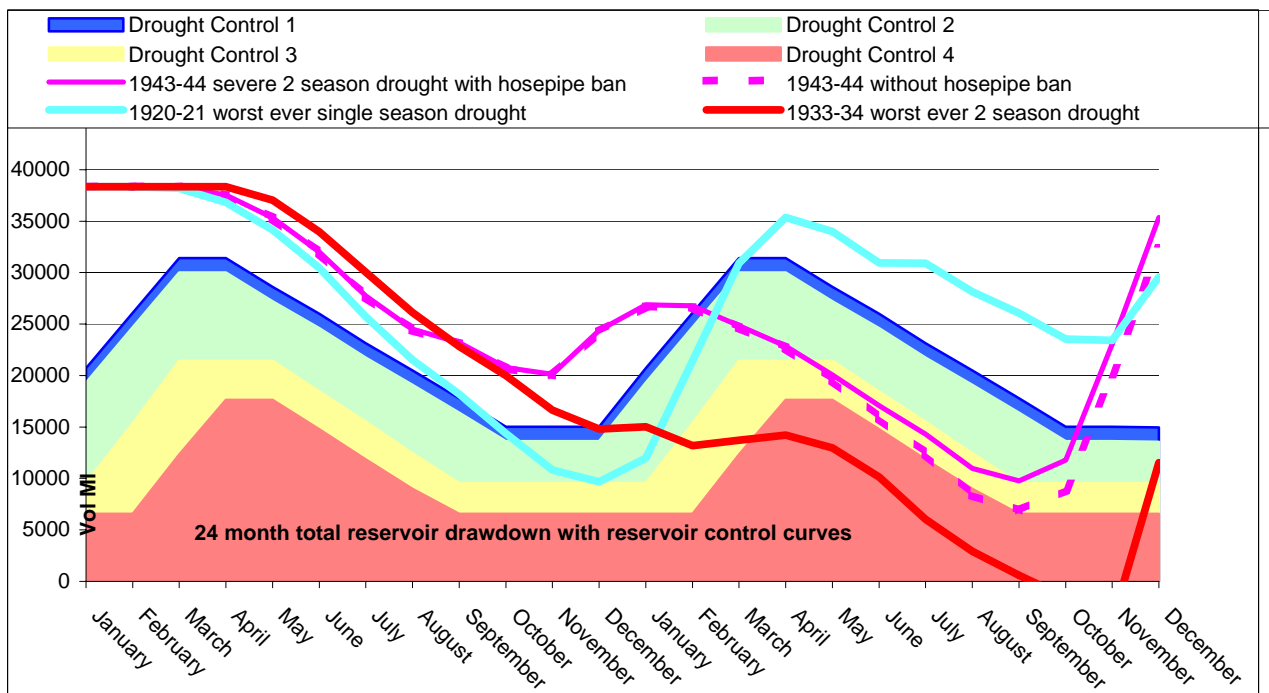
There are a number of other droughts within the record but none are worse overall than the two season droughts of 1933-34 or 1943-44, or the single season drought of 1921. The predicted performance of reservoir storage under the impact of these droughts is indicated in the plot below.



3.3.2 Control Curves

In order to manage reservoir levels and inform our decisions regarding the use of sources, the Company uses reservoir volume control curves. These guidelines are based upon the predictions of reservoir behaviour during the worst droughts. Other information is taken into account such as required storage volumes, and the effects of any proposed drought contingency measures. These may include hosepipe bans, improvements to supply or emergency schemes.

The plot below illustrates reservoir levels in relation to control curves and how levels would fall in response to the types of severe drought observed in the past (if no actions to reduce demand, or increase supply were taken).



Drought control curves may be used as triggers to plan and implement the type of measures to manage supply and demand discussed below. The curves are guides to planning and activity and not definitive triggers for action. For example, reservoir volume may fall below the curve indicating a hosepipe ban is required. This may not immediately result in a hosepipe ban if the event was to occur in December (although it is very likely that alternative activity would be occurring to mitigate demand).

- **Drought Control 1**
When total reservoir volume is above this line, the system is operated in order to balance costs against resources. As this control curve is approached, the maximum use would be made of water from the Severn, irrespective of the pumping costs. Below the line, all non-reservoir sources would be maximised in order to conserve the stored water. Depending on the time of year, there would be significant publicity, or the start of a media campaign, as the Company begins preparation for a possible drought.
- **Drought Control 2**
When total reservoir volume is above this line, a hosepipe ban, or other imposed restrictions to customer supply would not be required if all resources were available. When reservoir volume falls below the line, restrictions to customer supply are likely to be implemented if it was considered that they would be effective. It is also likely that a range of other drought management measures would have been implemented or planned, including initial applications for drought permits and Drought orders.
- **Drought Control 3**
When total reservoir volume approaches or falls below this line, demand is such that restrictions to domestic customer use has not been sufficient to reduce the drawdown of reservoirs. Additional measures will be required. These will include schemes to access the small volumes of water remaining at the bottom of reservoirs, such as overland pumping or suction assist pumping. We would also implement any measures permitted under drought permits.
- **Drought Control 4**
When total reservoir volume approaches or falls below this line, drought is extreme, and further measures will be required to reduce the risk of supply failure at a later date. With all other supply and demand management measures in place, a large-scale emergency engineering scheme would be implemented. This would take a period of six months to complete, and the positioning of the control curve reflects this.

3.4 Measures to Manage Demand and Supply

As a potential drought develops and intensifies, the Company proposes a phased implementation of measures to constrain demand and utilise alternative supplies. These measures will range from low-level background information and appeals to large scale temporary engineering schemes. These are summarised in the appendices. The decisions as to what action to take will be subject to the quantity of water in reservoirs relative to the control curves and other factors. The Resources Committee meets monthly to review these issues. During a drought, additional meetings would be held encompassing senior managers and executive directors.

3.4.1 Demand Management

The Company has three strategies to manage demand. These concentrate on the following activities, in priority order:

- Publicity ranging from background information to multi media advertising and appeals
- Network changes, from reducing system pressures to enhanced leakage control
- Enforced restrictions on consumption for domestic and business customers

3.4.1.1 Publicity and media

During normal seasonal conditions, background information on water efficiency, management of domestic water supplies, resources availability is made available. During dry or warm conditions the publicity effort is stepped up by making use of:

- press releases
- editorial articles or programmes in the local media
- advice on efficient use of water in the garden
- promotion of the use of cistern displacement devices to save water
- weather awareness and resource awareness briefings
- environmental and conservation awareness briefings
- articles and water efficiency advice on the Company web site

If the situation appeared to deteriorate, the next stage would be a full media campaign in the local press and radio involving detailed briefings, advice regarding appropriate water use and appeals for customers to reduce their water consumption and use cistern displacement devices. If a hose-pipe ban was in prospect or place, this would also be heavily advertised, with particular emphasis on the actions taken to enforce the ban and the penalties for non compliance. Further actions are detailed below in the section on management and communications.

The Company has used the UKWIR methodology provided in 'Evaluating the Impact of Restrictions on Customer Demand' in order to assess the likely reductions in demand from a well conducted media campaign. However, we consider that the greatest impact on customer behaviour will be achieved when the high-level media campaign is associated with a hosepipe ban. For planning purposes, the reduction in water consumption is expected to occur together with the implementation of a hosepipe ban.

3.4.1.2 Network operations

The company has maintained a leadership position on leakage control for many years and has consistently met or improved upon the agreed Ofwat target economic level of leakage during this time. Further effort to reduce leakage is possible, but would be costly, take time to implement and could result in higher bills. In addition, within the timeframe over which most droughts have occurred, it would be challenging to be able to recruit, train and deploy sufficient staff in time for them to have any significant effect on our mains leakage. Further details regarding leakage costs may be found in the company Water Resources Plan.

We have no historical data upon which to base an estimate of savings from extra leakage control, other than the audited annual results of the Leakstop initiative. We believe that by advertising and increased effort in this function, we could double the normal water saving above the normal level of 'good housekeeping from 0.5 Mld to 1 Mld.

Using existing resources, leakage activities will be enhanced to ensure losses from leaks are maintained below the economic level of leakage at all times during a drought and that we improve on our current standard of repairing 95% of detected bursts on company mains within 48 hours. We would expect an extra saving in water of 0.5 Mld from the additional level of activity over and above the normal level of 'good housekeeping'.

Over 25% of the network leakage occurs on customers own service pipes. Because of this we will target this component of leakage to a greater degree during drought conditions. The Company 'Leak-Line' leak reporting line number and free supply pipe repair scheme will be heavily promoted in the media campaign. All leak repairs would be accelerated as far as possible. Inspectors and Bye-laws officers will be briefed to issue waste notices if they observe leaks on customer premises. We would consider reducing the period during which the leak must be repaired under notice to seven days. However, we still need to allow a reasonable period for customers to repair service pipes themselves if they wish.

We consider most of the viable pressure reduction opportunities within our network have been taken. All Pressure controlled zones will be maintained where possible, however, some zones may have to be opened up to maintain supplies in peak seasonal demand periods. This will have the effect of reducing the effectiveness of pressure control, however, when the peak demand periods are over, the pressures would then be reduced again.

3.4.1.3 Restrictions on customer demand

If the situation requires, the Company would impose restrictions on customer demand. There are two ways in which we would do this:

- By declaring a ban on the use of hosepipes, sprinklers and car washing under section 76 of the Water Industry Act.
- By application to the Secretary of State under section 74 of the Water Resources Act for drought orders to limit the non-essential use of water as described in the Drought Direction 1991.

A hosepipe ban would be declared at an appropriate stage in the drought. As a precaution, we would begin the process of applying for drought orders. If granted, we would only implement the measures if the ban on hosepipe use did not appear to have sufficient impact.

The company would seek to maximise the publicity impact of any ban on the use of hosepipes by using press radio and television to broadcast and reinforce the message. In addition to the impact of the ban itself, we expect there would also be a reduction in general personal water consumption as result of the appeals for restraint etc.

The Company has used the UKWIR methodology provided in 'Evaluating the Impact of Restrictions on Customer Demand' (WR061) in order to assess the reduction in demand for water. The basis of this work was the discretionary demand attributed to hosepipe use and hot weather consumption identified from analysis of the 1995/96 drought. This was the

most severe hot and dry period to have affected the Company with the current resource balance. The summary of demand reductions is shown in the table below.

SUMMARY OF EFFECTS OF DEMAND RESTRICTIONS FROM WR 061			
DAILY REDUCTION IN DEMAND	APPEALS		HOSEPIPE BAN & APPEALS
	Mld		Mld
JUNE - AUGUST		-4.47	-22.47
MAY & SEPT		-3.05	-9.59
OCT - APRIL		-1.13	-2.46
ANNUALISED COMPONENTS Mld		-2.29	-6.36
ANNUALISED TOTALS Mld		-2.29	-8.65

The table illustrates the fact the greatest potential for demand reduction will occur during the hot summer months. For maximum effect, it would be preferable to impose a hosepipe ban in early summer, rather than late in the year. A drought may only be recognised once the peak period for garden watering is over. However, if the conditions warranted, we would not exclude the possibility that hosepipe bans or other water use restrictions could be imposed in the autumn or winter, even if the impact on demand may be limited..

Hosepipe Ban

In the scenario planning, we have applied the likely savings from a ban on the use of hosepipes and appeals for restraint over the summer months. This reduces the rate at which reservoirs will fall as illustrated by comparing the predicted reservoir level for the year 1943-44, with and without a hosepipe ban (illustrated in the plot of control curves in section 3.3 above).

The recent drought in south-east England has provided evidence that a the impact of a full hosepipe ban would reduce the volume of water delivered during the peak months between 2% and 11%.

Our planning estimate as set out above falls comfortably within this range, being approximately 9% of dry weather water delivered during June July and August and 4% during May and September. We feel our estimate is a suitably prudent value for the potential impact of restrictions. This is particularly so given that the per capita consumption and therefore the probable extent of discretionary water use is lower in the company area than in south-east England generally.

Ban on Non Essential Use (implementation of drought order)

The Drought Direction of 1991 lists the following water uses that may be proscribed by order of the Secretary of State:

- The watering by hosepipe or sprinkler of allotments, parks, sports fields or other recreational areas
- The filling of privately owned swimming pools and ornamental ponds
- The operation of ornamental fountains and cascades
- The operation of mechanical vehicle washers
- The washing of road vehicles, boats, rolling stock and aircraft
- The cleaning of windows by hosepipe or sprinkler, etc.
- The exterior washing of buildings other than windows
- The cleaning of industrial premises or plant, other than for hygiene reasons
- The use of automated cistern flushing systems during periods when buildings are substantially unoccupied

It is anticipated that these measure would be implemented if it was clear that measures already in place were not having the desired impact on demand. The estimate of water saved from the use of the prescribed uses Drought order is illustrated in the table below:

SUMMARY OF EFFECTS OF DEMAND RESTRICTIONS FROM WR 061	
DAILY REDUCTION IN DEMAND	NON ESSENTIAL USE BAN
	Mld
JUNE - AUGUST	1.7
MAY & SEPT	1.6
OCT - APRIL	1.06
ANNULISED TOTAL Mld	1.35

As may be observed from the list above, a non-essential use ban operates on a relatively small area of domestic and commercial water demand. In addition, in most of the commercial sectors such as car washing plants, there are already water efficiency measures, or water re-cycling in place. We do not believe that this allows significant scope for large savings in consumption.

We will seek wider powers under drought orders for restricting the non-essential use of water. The exercise of such powers needs to be used with discretion as some small businesses could be adversely affected. The volume of water savings is considered to be relatively small. However, the proscribed uses order may help to strengthen any existing hosepipe ban, and convince customers of the severity of the situation.

A report on the recent drought in south-east England has provided a single example of the impact of a non essential use ban for a very short period in a supply area with one of the highest PCC in the country. The estimate of the saving from this example was an additional 8% to 9% on top of the reduction in consumption achieved by a hosepipe ban.

We do not consider that such a high level of benefits would be likely to be achievable in our supply area. The figure is based on a single sample, and this together with the short period of application and degree of uncertainty reduces the reliability of the estimate. To base our plan on a single optimistic result could be considered imprudent if significant demand reductions did not materialise.

The observed impact of hosepipe bans is consistent with our predictions developed using WR061. This gives us confidence that our predictions of the impact of a non-essential use ban is also of the right order and does not need to be modified.

In addition to statutory controls on water use, our Business Care department would contact our larger customers to discuss any opportunities to reduce water consumption, as detailed in the section on communications and management.

3.4.1.4 Supplies to other water undertakings

The company has a supply agreement to provide up to 11.3Mld to Wessex Water through a pipeline to the city of Bath. The contract stipulates this full volume should be made available to Wessex Water when required at all times even during periods of drought. This transfer is regarded by Wessex Water as a 'secure supply' and part of their deployable output detailed in their Water Resources Plan.

The only exclusions for a reduction in this transfer are operational emergencies and *force majeure* (excluding drought). If conditions require the EA to seek a drought order to minimise abstraction on the River Severn, we can then reduce the Wessex Water supply by the same percentage reduction required by the EA (i.e. if a 5% reduction in licensed abstraction is required, we may reduce the Wessex transfer by 5% of the contracted 11.3 Mld volume).

Because of the contract conditions, we cannot assume that any portion of the contracted volume will be released for our use. However, as part of the communication and management of drought issues, we would approach Wessex Water to determine if they could reduce their take under appropriate conditions, but respect the fact they have the legal right to refuse our request. We recognise that during any drought affecting Bristol Water, Wessex Water would also be likely to be impacted to the same degree.

3.4.2 Supply Management

During a period of drought, the Company would expect to increase the availability of water above that estimated as the Deployable Output. We would do this by the four means detailed below, in order of priority:

- Re-establishing supply from currently disused low quality, low yield, high cost sources not included in the Water Resource Plan.
- Temporary engineering and improvement schemes to access or treat water from very low levels in reservoirs.
- Seeking of drought permits to allow us reduce the volume of water we are obliged to discharge from reservoirs into rivers, thus conserving the volume in reservoirs.
- Seeking a drought permit for a large emergency abstraction and associated temporary engineering scheme to take water from the Floating Harbour in the centre of Bristol.

3.4.2.1 Re-commissioning of disused sources

The Company owns a number of sites linked to the distribution network with sources that are not in daily use for the following reasons:

- The sources are small and have a low yield
- They are subject to periods when water quality is unacceptable with legacy treatment
- They are high risk with respect to the presence of the *Cryptosporidium* oocyst
- Some would need expensive advanced treatment methods to overcome the issues above
- Others would need to be operated manually to avoid quality issues

The Company retains the abstraction licences for these sources. However, they are not required to maintain our Deployable Output, and would be uneconomic to operate on a daily basis. These sources are indicated in the table below:

Source	Expected yield	Action required for use
Gurney Slade	2.0 Mld	Temporary membrane Plant
Honeyhurst	2.3 Mld	Temporary membrane Plant
Shipton Moyne	4.0 Mld	Temporary pump and DWI operating rules
Cold Bath spring	3.0 Mld	Operating rules to avoid poor quality

It would be costly in both temporary plant and operating staff to bring some of these sources into supply. However, when taken together, they do provide a worthwhile resource of approximately 11 Mld during dry conditions for temporary or emergency use.

Shipton Moyne and Cold Bath Spring can be readily brought into use within the capacity of the existing plant (subject to water quality). However, Gurney Slade and Honeyhurst will require the emplacement of a packaged submerged membrane plant to cope with the turbidity of the water and the risk from *Cryptosporidium*. Although the installation of such plant is relatively simple, the manufacturer could only guarantee construction and commissioning within a six-month period.

All these sources were in use in the past and have the advantage that there are existing buildings, power supplies and mains connections available. This would facilitate any installation of temporary or upgraded plant on site. A scheme has been engineered by Black and Veatch to take account of the manufacturers lead time to complete the installation within six months assuming extension of the hard-standing and expanding the power capacity at site.

3.4.2.2 Temporary improvements to permit access to emergency storage

When the total volume held in storage at the Company reservoirs falls below 10,000 MI, the water levels at the three primary reservoirs at Chew Cheddar and Blagdon will be at a very low level. From past experience, this has caused the following problems:

- Release of nutrients from reservoir sediments causing large algal blooms
- Reduced treatability of water and high effluent discharges
- Colour, taste and odour problems in water leaving treatment works
- Blinding of screens, loss of output and pump failure
- Inability to maintain pump suction pressure causing loss of output
- Water collected in parts of the reservoir not accessible to the draw-off

There would be a range of measures that the Company would be able to use in order to overcome these issues. Some remediation would involve new pumping arrangements, or treatment arrangements. In other cases, there would be a requirement for constant plant attendance to skim filters, clean screens, dose chemicals or re-start failed equipment.

At Chew reservoir the likely range of works would include:

- Re-commissioning of the auxiliary draw-off siphon
- Temporary commissioning of siphon and associated pumps
- Constant manual RGF filter washes at the Stowey treatment works

- Frequent filter skims of the slow sand filters
- Significant extra manual attendance
- Temporary wash water recovery system to comply with discharge consents
- Temporary overland mains to transfer water trapped in parts of the reservoir

At Blagdon reservoir the likely range of works would include:

- Additional temporary intake screen capacity and temporary washing system
- Temporary pumps on the intake mains to maintain suction pressure
- Constant RGF filter washes at the Banwell and Rowberrow treatment works
- Frequent filter skims of the slow sand filters
- Constant manual attendance
- Temporary overland mains to transfer water trapped in parts of the reservoir

At Cheddar reservoir the likely range of works would include:

- Dosing of activated carbon direct to filters to adsorb substances causing taste and odour
- Frequent filter skims of the slow sand filters
- Constant manual attendance
- Additional dosing with powerful oxidants to help reduce water colouration and taste

We are not able to predict at what point any of the individual measures will be needed at each of the reservoirs. This will depend on the conditions at each individual reservoir at that time. It is probable that most, if not all of the measures indicated above would need to be in place to access the emergency storage in the last 20% of reservoir volume.

This emergency volume that is made accessible by this extra work is approximately 3000 Mld. This equates to an annualised daily addition to the Deployable Output of approximately 8 Mld.

3.4.2.3 Reductions in river compensation discharges

We propose to seek drought permits to allow us to reduce the compensation water under certain agreed conditions. The permits would provide for agreed monitoring arrangements to ensure that permanent environmental damage was avoided. However, this action represents a new proposal from Bristol Water, and we will continue to work with the Environment Agency to determine the appropriate level of environmental monitoring.

Construction of the Company's reservoirs has changed the system hydrology of the rivers Chew, Cheddar Yeo and Congresbury Yeo permanently. We maintain a defined statutory discharge of water to these rivers downstream of the dams, in place of the original river flow. Prior to the formation of the reservoirs, it is probable that the upper part of these rivers would have had substantially lower flows at certain times of year during drought than is currently being provided by the normal compensation arrangements.

The proposals at each of the sites are as described below.

- **River Chew** Reduce compensation flow released to stream at Chew reservoir from 14.4 to 7 Mld for the months of May, June and July and from 6.8 Mld to 3.4 Mld in winter, (annual total 1170 MI). The section of river affected is from Chew Stoke to Compton Dando, and is not a designated site under EU legislation.

- **Cheddar Yeo** Reduce compensation flow released to stream at Cheddar gorge collecting ponds from 6.8 Mld to 3.8 Mld during winter (annual total 540 MI, subject to River Axe statutory conditions being met). Reach affected is from the Cheddar Ponds compensation discharge to the confluence with the Axe. This section of river is not a designated site under EU legislation.
- **Congresbury Yeo** Reduce compensation flow released to stream at Blagdon reservoir from 8.6 Mld to 4.6 Mld summer (annual total 720 MI). Reach affected is from Blagdon compensation discharge to Iwood. This section of river is not a designated site under EU legislation

The proposed reduction in compensation flows has been timed to occur mainly in winter when there is the least potential for damage at Cheddar and Chew. The summer compensation at Blagdon will still provide a 100% increase in flow over the winter discharge. None of the river reaches affected are designated European Sites. Potential environmental stress due to the reduced compensations is expected to be very limited and of a temporary nature. Once the drought ends, these systems will revert to their usual operation.

Taken together, all of the measures to reduce compensation would provide approximately 2400 MI, extending the period of supply of the Mendip reservoirs by over three weeks. We do not anticipate that there will be a need to seek compensation reductions in anything other than the most severe droughts with a return period of less than once in 50 years. The probability of application of compensation reductions at all three sites is estimated at less than once in 100 years. The justification for this action would be the need to maintain a continuous mains supply during the most severe drought as a matter of public interest.

3.4.2.4 Emergency abstraction scheme Bristol City Floating Harbour

We propose to seek a temporary abstraction licence to take water from the Cumberland Basin area of the Floating Harbour. This water would be pumped to existing raw water storage reservoirs at Barrow Gurney. Here it would be blended with water from other sources to improve the quality prior to treatment at the recently upgraded Barrow water treatment works. At present, the proposals represent a high-risk scheme, with uncertainties regarding yield and water quality issues. However, we believe it is worth pursuing for the following reasons:

- Brunels' Floating Harbour takes a large proportion of the River Avon flow at Netham to maintain the water level in the non-tidal harbour basin that is subsequently discharged.
- Analysis of river flow in the Lower Avon indicates that significant water is available even during drought years such as 1976. This is confirmed in the river resource status in the Environment Agency Catchment Abstraction Management study, 2004.
- The volume to be abstracted would be insignificant compared to the volumes normally discharged, or lost via locking operations to the tidal Avon.
- From limited water analysis data provided, the water quality is poor, but not unacceptable, and is considered treatable, subject to further tests.

- The abstraction is intended to make use of the existing infrastructure and be at the point where the water is naturally discharged to the tidal Avon, thereby having no adverse environmental effects.
- The scheme would use existing treated water mains that would be isolated from the treated water system to be used as raw water mains during the emergency. This possible due to the degree of trunk mains capacity in that area of the network, albeit with some small additional risks to potable water supply.
- We have consulted with the City and Harbour authorities and have their agreement in principle that the abstraction could take place, subject to environmental, safety and financial agreements.
- The amount of temporary mains laying is less than three kilometres, most of which can be routed over open ground and fields.
- The required pumping plant can make use of existing locations and power supplies within the City docks area, or be located in a rural area adjacent to a working landfill site, minimising the schemes impact.

We believe the scheme could yield up to 50 Mld as a winter period abstraction. However, as stated there are uncertainties regarding effects of extreme drought and water quality. For planning purposes we have estimated a conservative abstraction of 30 Mld, once the scheme is commissioned.

Engineering consultants Black and Veatch have completed an engineering appraisal for this scheme and confirmed that it can be constructed within the six month target period, although in theory it could be done in much less time. The financial risks of the scheme are high, due to the high capital cost involved, and the possibility that the drought could end before the scheme had been fully completed.

3.4.2.5 Further Measures and Emergency Drought Orders

The company does not expect to use techniques such as rota cuts or supply via standpipes to for normal management of water use during conditions of drought. Modern water distribution systems and water quality requirements preclude these measures except as the last resort in the most severe emergency approaching a supply failure, or other operational reasons. However, there remains a possibility that conditions could be such that the drought management measures detailed do not produce the required outcome.

If that were to be the case, the region, if not the entire country would be in a state of emergency and we would be considering the need to implement our emergency plan. Under these circumstances we would make an application for an emergency drought order as a precaution. We would seek to delay having to use such emergency powers by the following actions:

- Use of maximum publicity when making the application for an emergency drought order to highlight the implications of failure to curb demand for water and generate further reductions in consumption.
- Further system pressure reductions where possible to below current service levels.
- Discussions with industrial customers to explore supply reductions.

- Discussions with Wessex Water to explore a supply reduction to Bath.
- Discussions with the Environment Agency to sanction further compensation reductions or increases in abstraction that could be environmentally damaging in the short term.

It is unlikely that in the absence of significant rainfall, that any of these measures would deliver a sufficient reduction in demand to prevent a supply failure. However, they could extend the period of time before an emergency condition occurs that would be socially and economically damaging.

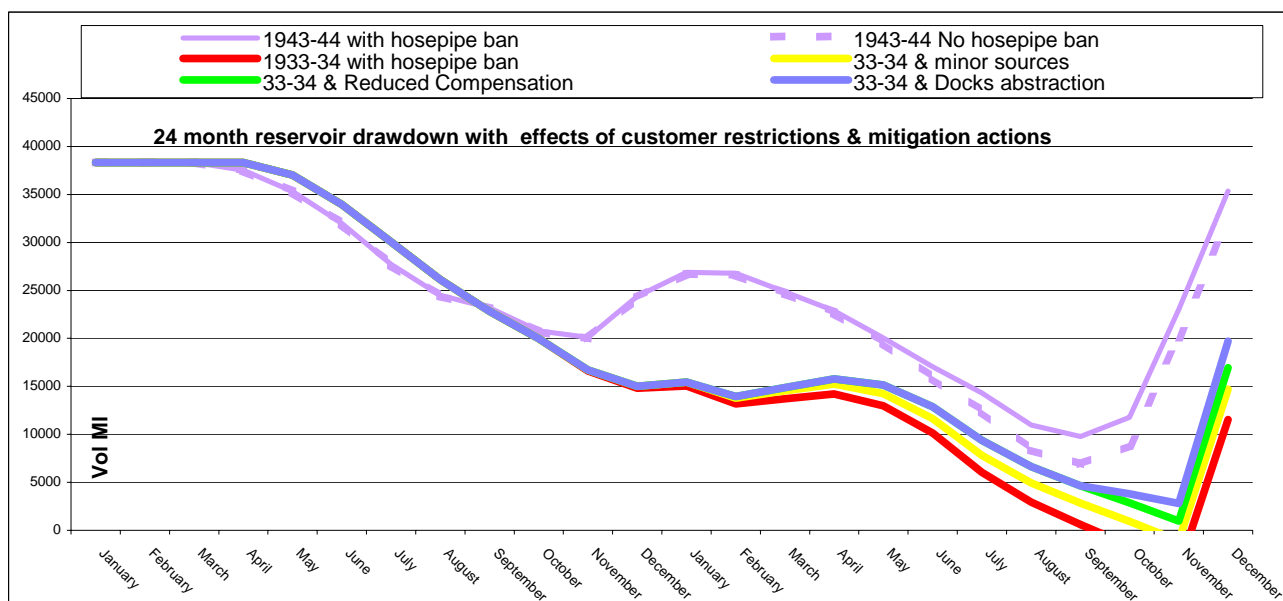
3.4.3 Impact of Drought Management Measures

The Company can give no undertaking to be able to maintain a continuous supply of mains water under any circumstances. However, we would expect to be able to show that the measures we propose above would mitigate the effects of a severe drought. From our analysis, a drought as severe as the worst experienced two-year event of 1933-34 has the potential to cause a supply failure if no measures were taken in response.

The table below summarises the impact, or effective yield that the measures detailed above would have on reducing demand or increasing supply, as a daily volume averaged across the year.

DROUGHT MEASURE	EFFECTIVE YIELD Mld	COMMENT
Disused and poor quality raw watersources returned to use	7	Simple to operate in terms of temporary plant
Hosepipe ban and appeals for customer restraint	8	Effective mainly in summer, reducing demand by up to 23 Mld
Ban on all non-essential use of water	1	Limited in effect and potentially damaging to small businesses
Further leakage reductions below economic level	1	Difficult to assess impacts of measures main effect from LeakStop
Emergency work to maintain reservoir output	8	High risk, accesses some remaining storage
Package membrane plant for disused sources with old TW	4	Honeyhurst & Gurney Slade
Reduction of compensation flows	6	Simple to implements, high cost for monitoring environmental effects
Emergency Floating Harbour Abstraction scheme	30	High yield, high cost, high risk, winter abstraction up to 50 Mld
TOTAL YIELD	65	If all measures effective over a year

Not all of these measures would be implemented at the beginning of the drought, as there would be a phased response as the drought developed. However, by the end of a severe drought, it is expected that all measures would have been implemented. The effects these measures would have as the drought develops can be seen in the plot below.



The plot illustrates the effects of the two worst droughts on the company storage level. For the 1943-44 drought, two lines are shown, the lower dashed line is where the reservoir storage would be if nothing was done to address the situation. The solid line illustrates the cumulative effect of a hosepipe ban and appeals for restraint implemented in the April of the second year. Note that the reservoir volume appears to be maintained above the level that requires further drought measures. However, in reality, it is probable that other measures would be being planned, if not already implemented if we were actually to be in this situation.

If the drought were as severe as the 1933-34 event and no action was taken other than maintaining the full deployable output, it is probable that the reservoirs could be close to empty by August in the second year of drought. Even with a hosepipe ban implemented from April in the second year, the reservoirs are likely to have failed by September. This scenario is indicated by a red line on the plot. Using this as a baseline, the other lines indicate the cumulative effects of the following:

- Yellow The impact of increased leakage reduction, a hosepipe ban and appeals for restraint from the second April. In addition the minor sources that could be easily be made operational with short lead times would be available from December of the first year(Cold Bath Spring and Shipton Moyne). With reservoir levels below 15000 MI in December, we would begin the deployment of temporary package membrane plants for Gurney Slade and Honeyhurst. However, these schemes would require 6 months for completion and would be likely to deliver water in the second year of drought.
- Green The cumulative impact of all of the measures described above and the effect of reducing compensation discharges in the manner described.
- Blue The cumulative impact of all of the measures described above and the effect of water from the emergency Floating Harbour abstraction scheme.

The schemes required to access water from the individual reservoirs when the total storage volume is below 10000 MI are implied within the within the scenario. In other words, it would not be possible to stop the reservoirs falling below 10000 MI during a 1933-34 type of drought. We would have implemented those particular schemes by the second May or June in order to continue to take water from the reservoirs when they are at low levels. This would mean the Company could maintain a continuous water supply even when reservoirs were below the levels ever experienced in the past.

If all of the drought measures were implemented in the manner proposed and were all effective, it is highly likely that it would be possible to maintain a mains water supply to our customers for droughts equivalent to the worst ever seen in our 95 year record. If the drought was worse than this, it is possible that the storage system would fail unless customers substantially reduced their demand for water. Such a drought would be very rare and is expected to occur less than once in one hundred years. This can also define the likely probability of the need to deploy standpipes or implement rota cuts for supply as less than once in one hundred years.

The analysis is based upon assumptions that any climate change impacts have not significantly increased the frequency or severity of drought events to date, and all operational assets can function at their full output over a long period.

3.4.4 Expected Frequency of Drought Measures

As previously indicated, droughts of varying degrees of severity can be identified within the Company record from 1910. The very worst droughts are fortunately seen rarely and their frequency has been indicated above. The method of analysis used indicates the worst drought occurred in a period of record of 95 years (1933-34). This does not actually equate to the 1933-34 drought having an expected frequency of once in 100 years. Statistical analysis of the inflow record reveals that some droughts such as 1933-34, and 1921-22 stand out as very extreme events, having return periods much less than would be indicated by the behavioural analysis.

To comply with the planning process, we have used behavioural analysis to give an approximate indication of how often the drought measures may be required. For instance, the behavioural analysis indicates all of the measures needed to cope with a drought of the severity of 1933-34 would be needed once every 100 years.

Using behavioural analysis, gives a good indication of what would have been required in the past, but only an indication of what will be required in the future. Control curves have been developed in order to pre-empt the worst effects of drought. This results in measures being considered or applied more frequently than the severity of the drought actually demanded. Based on the control curves, a guide to the theoretical expected frequency of the various control measures is provided in the table below.

DROUGHT MEASURE	POTENTIAL FREQUENCY	COMMENT
Disused and poor quality sources returned to use	Ten times in 100 years	Some could be implemented before hosepipe ban as precautionary measure
Hosepipe ban and appeals for customer restraint	Six times in 100 years	Hosepipe ban may have limited effect in winter months
Further leakage reductions below economic level	Six times in 100 years	Leaks repaired faster customer leaks targeted
Ban on all non-essential use of water	Three times in 100 years	Limited in effect imposed before or with permit to reduce compensation
Emergency work to maintain reservoir output	Three times in 100 years	Accesses remaining storage and allows use of poor quality water
Package membrane plant for disused sources with old TW	Three times in 100 years	Honeyhurst & Gurney Slade
Reduction of compensation flows	Three times in 100 years	Simple to implement, no impact on statutory sites
Emergency Floating Harbour Abstraction scheme	Twice in 100 years	Long lead time, may not be completed before drought ends

3.4.5 Time required to implement drought contingency measures

The measures identified in the table above vary considerably in scope and complexity. We have considered this within the context of our plan and made certain estimates regarding the time taken for the measures to yield results. These timescales have been taken account of in the cumulative impact of measures plot shown above.

For straightforward measures such as appeals for restraint or the implementation of a hosepipe ban, it is reasonable to assume that they would take a very short time of one to two weeks to action and have an immediate effect.

For schemes requiring only simple engineering or extra manpower such as increased leakage activity, or maintaining reservoir output, we have assumed that these could be implemented within a month and be effective once implemented. This also applies to schemes to return raw water sources to use where there is already sufficient treatment capacity (for example Cold Bath Spring at Barrow treatment works and Shipton Moyne)

In the case of schemes requiring complex or substantive engineering, we have engaged consultants Black and Veatch to produce an engineering design of the schemes, such that that they could be completed within a fixed time span of six months from inception. This work was carried out for the membrane plants at Gurney Slade and Honeyhurst, and the Floating Harbour to Barrow reservoir abstraction scheme. In the case of the membrane plants, the largest time element is the manufacturers' conservative estimate of six months for the construction, delivery and commissioning of the package plant components.

We have no experience of the time taken for schemes requiring regulatory consideration of permit applications. We have made an assumption that application for a drought permit to restrict non-essential use, or to reduce compensation flows would take up to 12 weeks. We would hope that such applications could be processed rather quicker than the 12 weeks we have allowed given that the requirement and pre-planning issues have been identified within this plan which has been developed in consultation with a range of stakeholders.

The table below summarises the implementation time we have allowed for each of our drought measures when assessing the impact of the measures:

DROUGHT MEASURE	TIME TO IMPLEMENT	COMMENT
Hosepipe ban and/or appeals for customer restraint	2 weeks	Simple to organise through PR and media links
Further leakage reductions below economic level	1 month	Straightforward re-deployment of staff and increased effort
Simple raw water poor quality sources returned to use	1 month	Minor testing and connection issues plus use of simple standby plant
Emergency work to maintain reservoir output	1 month	Straightforward purchase or hire of simple plant and deployment of staff
Permit for Ban on all non-essential use of water	3 months	Regulatory issues may cause delays
Permit for Reduction of compensation flows	3 months	Regulatory issues may cause delays
Installation of modular membrane plants	6 months construction	Plant manufactures longest expected lead time Power and hard-standing pre-placed
Emergency Floating Harbour Abstraction scheme	6 months construction	Design uses existing mains and packaged pumping plant assumes no regulatory delay

3.4.6 Forecasting the likely impact of drought

Droughts may vary considerably in length and intensity and as illustrated above, the company has a relatively robust resources system for all but the most severe events. However, resources systems that have significant quantities of storage and are able to resist short high intensity droughts may be vulnerable to longer low intensity events, or simply a succession of drier than average winters. This has two consequences:

- It may not be clear a drought is occurring until some way into the event
- It may be difficult to predict the impact of the drought with any certainty

Unfortunately, reliable long-term forecasts of rainfall and temperature are not available at present and this makes predicting the impact of dry conditions difficult in advance. In the absence of useful rainfall forecasts, a scenario approach based on the analysis of past observations has been adopted.

To enable the analysis of such scenarios, the company has invested in a sequence of calibrated rainfall/run-off models and simulated the inflows to the major reservoir systems for the catchment rainfall records from 1910 to the present day. This has provided us with an inflow sequence covering almost 100 years, including a number of droughts (as referred to above).

This inflow sequence is used to generate either historic or probabilistic inflow sequences for any period required. This is not a forecast of what will happen, but can provide a series of inflow scenarios for chosen return periods or actual historic events. For example we

might select a period of six months and typical inflows representing the following conditions:

- The average inflow equivalent to a 50% probability, a one in two year return period
- The inflow equivalent to a 5% probability or a one in 20 year return period
- The inflow equivalent to a 2% probability or a one in 50 year return period
- The inflow equivalent to the 1975/76 drought (historical rather than probabilistic)

The required reservoir inflow sequences are then substituted into a spreadsheet model of our supply/demand system. Additional information included in this model would be:

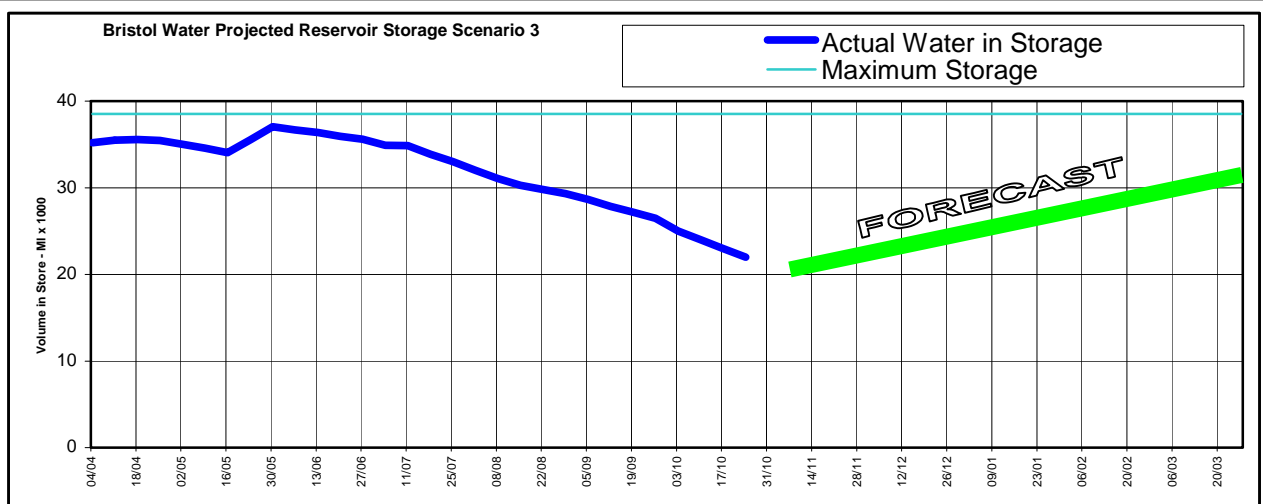
- Monthly dry weather groundwater yields and availability
- Monthly prediction of River Severn abstraction availability
- Monthly river compensation requirements
- Monthly prediction of required bulk transfers and contracted supplies
- Monthly prediction of customer water demand (with or without constraints)

This model is used to calculate the balance between supply and demand across our resource zone, with the surplus or deficit being added to, or subtracted from, the reservoir volume each month. This provides a simple way to run a number of scenarios. The results may then be expressed graphically in terms of a prediction of the reservoir volumes for any scenario.

An example of the end result of this approach is illustrated below, in a plot provided for the Environment Agency indicating the impact of a particular drought scenario for winter of 2005/06, together with the commentary provided at the time.

Scenario 3 - represents 60% of average winter rainfall

This would be quite a severe scenario, equivalent to the inflows observed during winter of 1990-91 or 1975-76 according to our records (approximately a 1 in 15 year return period). Inflow to reservoirs would be relatively low, resulting in stored volume of approximately 78% by April 2007 assuming current winter demand and dry weather groundwater outputs. Although this is not an optimum storage position, it is not exceptional. At this volume, the company would be monitoring events carefully (this would be a situation similar to the beginning of 1976). If dry conditions experienced over winter continued into the spring and early summer, there would be a strong probability that initial actions detailed in our drought plan would be considered during the summer.



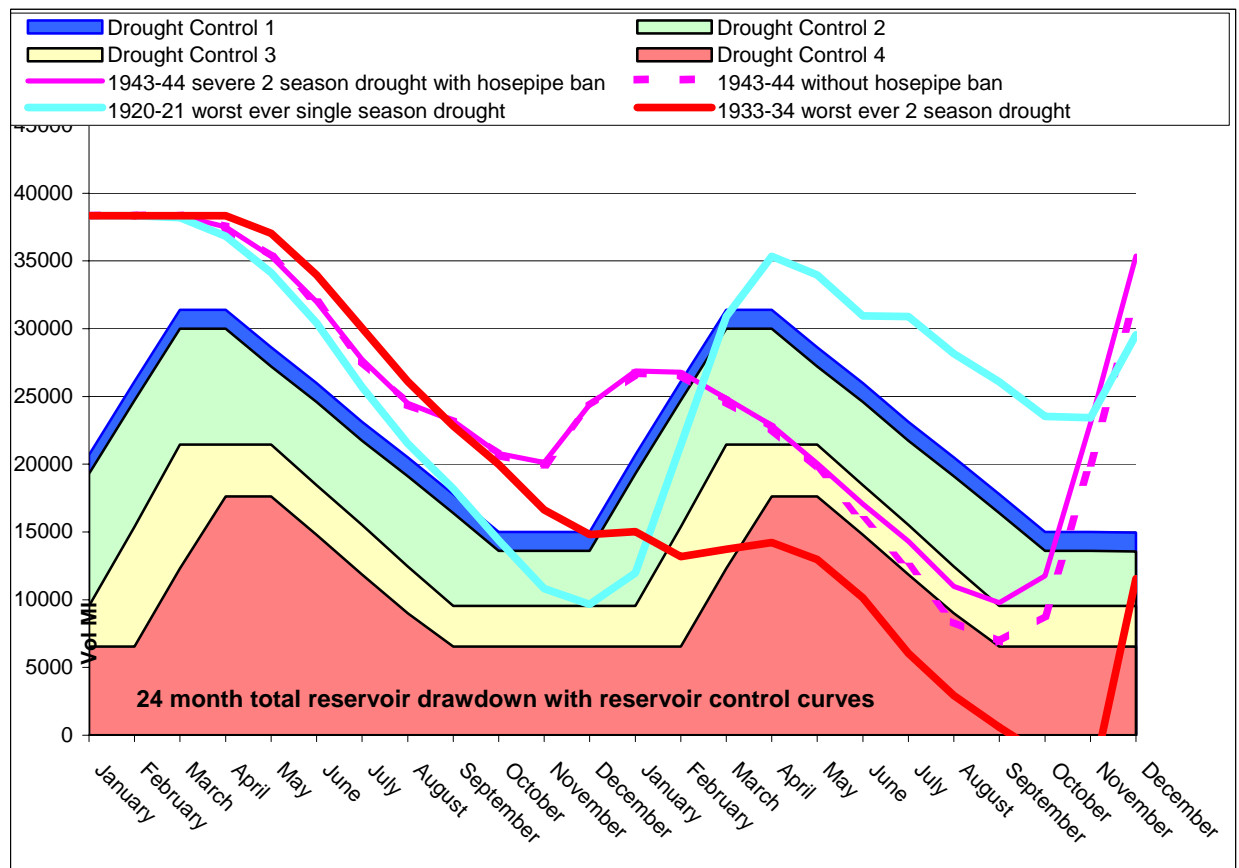
This technique is flexible and can be used to cover any period or scenario required. The technique does not make predictions of what will occur, it provides a range of possible outcomes based on previously observed weather patterns to inform management.

3.5 Triggers to Implement Drought Management Measures

The control curves used by the Company have been discussed in section 3.3. The volume of reservoir storage with respect to the control curve at any point in the year is used as a basis for decisions regarding system operations. The resources system is regarded as two-season critical and the drought control curves reflect this aspect of the system. However, the control curves also protect the system from severe single season droughts. The control curves would apply each year. However the drought control curves are not meant to be inflexible trigger points for action. Different decisions may be made for the same point on the control curve, as other issues have to be taken into account in addition to the volume of storage. These include:

- The time of year, whether considering the drawdown period or the recharge period
- The rate of change of reservoir volume
- Short term and long term weather forecasts
- Effectiveness of measures already in place
- Impact of restrictions on River Severn abstraction

In addition to the drought management actions listed above, the Company would also consider the management and communication strategy according to the particular circumstances.



The plot above illustrates reservoir levels in relation to control curves and how levels would fall in response to the types of severe drought observed in the past (if no actions to reduce demand, or increase supply were taken).

3.5.1 Trigger Points from Drought Control 1

Even if at the start of April, reservoir storage is at a high level (above 30,000 MI), a severe drought could cause a sharp drawdown in reservoir storage. When the total volume is above the Drought Control 1 line (DC1), the action would be to monitor the situation as normal. The system would be operated in order to minimise costs. The Company would provide the usual level of background publicity and PR activity regarding the sensible use of water

If the change of reservoir volume clearly had a trajectory that would take it close or below DC1, the following actions would be triggered.

- Resources Committee would be fully aware of the situation.
- Resources Committee would establish a greater frequency of meeting, as the situation required.
- Network operations would be called upon to reduce system pressures where possible, and maximise their efforts to reduce mains leakage, and customer leakage through 'LeakStop'.
- Consideration would be given to an increased level of publicity for the developing situation together with planning a media campaign if required.

In most circumstances, if the volume in storage looked as if it was falling below DC1 we would:

- Implement the beginning of a media campaign, initially using the local press and radio
- Inform the Environment Agency Drought Co-ordinator of the developing situation
- Advise local stakeholder groups, Consumer Council for Water, City Council and provide further information on the situation and water efficiency through the Company Web site.
- Begin action to ensure that all groundwater sources can operate at capacity.
- Begin planning and purchases or hire of plant required in order to bring back into service any disused sources.

The Environment Agency manages flows on the River Severn, and would be likely to apply for reductions in abstraction from the Severn during a severe drought. The first stage reductions of 5% in demand have already been incorporated into the calculation of Deployable Output. Their revised analysis makes reference to further voluntary reductions from all River Severn abstractors. We would wish to accommodate the requirement of the Agency if we had sufficient storage in our reservoirs as defined by DC1. We propose:

- If reservoir volume is above DC1, we would assist the Agency if there were drought orders on the Severn that required second stage reductions in abstraction at Sharpness.
- If the reservoir storage fell below DC1 and the Severn was being operated under drought orders, we may consider the early implementation of a hosepipe ban to cover the loss of River Severn resource as a result of the drought orders.

3.5.2 Trigger Points from Drought Control 2

Drought control 2 (DC2) is the control curve that indicates decisions are required regarding the use of a ban on the use of hosepipes and sprinklers. There are other conditions that would inform any decision to apply such a ban. These are:

- If the reservoirs were at a relatively high level by April (above 30,000 MI)
- If the reservoirs were at a relatively low level by April (below 30,000MI)
- If the reservoirs were very low at the start of the recharge period (15,000 MI or below in December)
- Short and long-term weather forecasts

3.5.2.1 *Reservoirs above 30,000 MI in April*

If the reservoirs begin the year with a volume above 30,000 MI and all components of the water resources system are operating, a very severe single season drought could drive reservoir volume below this line late in the summer. In October, a hosepipe ban may have little impact, and it may be better to put out a stronger message to the public via the print and broadcast media, and concentrate on other activity. The following actions would be being taken if reservoir volume was below DC2:

- The actions triggered by DC1 would continue to be executed
- The Resources Committee will decide whether the timing is appropriate for a hosepipe ban, or whether a higher profile media campaign would achieve more.
- An extended advertising campaign in the local media, asking customers directly to save water and advice on how to use water wisely, or face the prospect of a hosepipe ban at a later date (if it was deemed to be too late for any ban to be effective).
- Purchase/installation of plant and equipment to begin to bring the disused sources back into operation.
- Regularly update the Environment Agency and other stakeholders of the developing situation and the activity taken in response.

3.5.2.2 *Reservoirs below 30,000 MI in April*

This situation is most likely to occur if reservoirs have been taken to a low level in the previous year, and/or there has been a relatively dry winter. If reservoir levels begin the year low, but were rising, the Actions would be the same as in 3.5.3.1 above.

If reservoirs continued to fall so that there is no probability that the storage will be greater than the control curve, then action will need to be taken rapidly in the expectation of the drought continuing. In addition to the actions already progressed, the following would take place:

- Advise the regulatory agencies the Company is about to impose a ban on hosepipe use.
- Progress to implementation of a full ban on the use of sprinklers and hosepipes within 14 days.
- An expansion of the media campaign to advise the public and other stakeholders of the legal force and penalties that support a hosepipe ban.
- Business care staff and Bye-laws officers will liaise with largest customers to determine if consumption can be reduced.
- All company staff to be alerted to report illegal use of hosepipes or other proscribed devices.
- Legal sections to prepare for prosecutions for illegal use of hosepipes etc. under section 76 of the Water Industry Act.

During a summer with a hosepipe ban in force we would continue to reinforce the messages that use of hosepipes would be an offence. The Company would encourage members of the public to report those seen using a hosepipe and would press for prosecutions in those cases.

3.5.2.3 Reservoirs below 15,000 Ml in December or January

Under these conditions, the resources system would have been subject to a summer drought followed by a winter drought with no recharge. The Company would need to prepare for the possibility of a second year of severe drought if reservoir levels were showing no sign of recovery. Under these circumstances, further actions are required relating to the seeking of drought permits or drought orders. In addition to activity outlined above we would:

- Ensure disused sources are returned to production and are operating at their optimum level.
- Impose a ban on use of hosepipes and sprinklers, with full media explanation that we are obliged to carry this out in order to seek additional measures.
- Seek drought orders under section 74 of the Water Resources Act for drought orders to limit the non-essential use of water as described in the Drought Direction 1991.
- Seek drought permits to allow the reduction of compensation discharges as described.
- Plan for the emergency engineering works to maintain treatment works output and abstraction from reservoirs.

We will seek the drought permits early in the year, as the time involved to process the applications is extensive. We would not expect them to be available for six to eight weeks.

If during the period the situation made the permits unnecessary, we would delay their use, but retain them for as long as they were valid.

3.5.3 Trigger Points from Drought Control 3

Drought Control 3 (DC3) defines trigger points for actions when the reservoir storage is between 25% and 50% full. If reservoir volumes are about to approach or cross this control line, the resources system will usually be in the second year of drought. Depending on the time of year, the transition from a hosepipe ban to the need for a ban on non-essential use and implementation of drought permits would be between six and 12 weeks. In addition to all measures outlined above we would:

- Advise the regulatory agencies and stakeholder groups that the Company is about to implement drought orders, and drought permits as described.
- Implement the ban on non-essential use by drought order previously applied for.
- Implement any reduction in compensation flows granted under drought permit if the timing is appropriate.
- Begin the implementation of schemes to maintain treatment works output, and access low reservoir storage as appropriate for the conditions or time of year or reservoir volumes.
- Seek drought permits to allow the emergency abstraction of water from the Floating Harbour, together with detailed scheme planning, agreements and permissions from the Harbour operators and City Council.
- Where the volume of water remaining in reservoirs begins to give treatment problems, establish the required remedial actions (this may at any time when the total volume in storage is 10,000MI or less).

During the recharge period, the urgency of this activity will be much greater when the reservoir volume is not recovering. However, it is much more difficult to predict the behaviour of the system in the recharge period. This may mean that actions started, may prove to be unnecessary and would be terminated if the system showed sufficient recovery. During the summer period drought, the system is much more predictable. As the reservoir volumes are falling coincidentally with the control curves, there is more time to consider the actions at each of the trigger points.

These considerations would be borne in mind when the Resources Committee considers any actions arising at the trigger points.

3.5.4 Trigger Points from Drought Control 4

Drought Control 4 (DC4) will define a trigger point for the implementation of the emergency scheme to abstract water from the Floating Harbour. It is expected that this scheme would take a maximum of six months to implement, although we would reasonably expect to complete it in less time if plant and materials were readily available. If storage volume was to approach this control curve, the measures detailed above would all have

been implemented. The severity of the drought would be beyond the one in one hundred year event, or be an unprecedented third year of drought.

In order to continue to maintain supplies we would.

- Begin the construction of the Floating Harbour abstraction scheme.
- Seek a drought order for the abstraction, if a permit has not already been granted.
- Begin the abstraction at the highest rate possible as soon as the conditions, or infrastructure permits.

3.5.5 Drought De-Escalation

There is no consistent pattern observed to the way droughts come to an end. In some cases this can be a rapid re-fill of reservoirs as a result of torrential rain. In other cases, there is a gradual return to average rainfall with months of slow reservoir recovery as the groundwater system becomes recharged.

Under such circumstances, the control curves provide a reasonable basis for determining at which point to terminate actions put in place to manage drought. It would be imprudent to cease activity the moment that the reservoir volume crossed a particular control curve in all cases. Such action might be premature, and months of work may be abandoned, only to have to be reinstated if reservoir inflow diminished again. In most cases, storage should be allowed to recover some way above the control curve to provide a reasonable security buffer.

3.5.5.1 Drought Control 4

Once reservoir volume had recovered to be above this control curve, there would be less pressure to complete the Floating Harbour abstraction scheme. Further active work on the scheme would cease once the reservoir volume had recovered to 3,000 MI above the control curve (or DC3 was crossed). Any work completed so far would be documented and made secure for future use.

If the scheme had been completed and abstraction was in progress, we would maintain abstraction until reservoir volume was 5,000 MI above the control curve. If required we would apply for an extension of the drought permit to allow this volume to be obtained. Once above this storage volume, works would take place to return to service the treated water mains by pigging, swabbing and chlorination. Some sections of main would need to be re-lined.

In both of the cases above, there would be no formal revocation of the drought permit. It would be held until it ceased to be valid.

3.5.5.2 Drought Control 3

As reservoirs show further recovery, we would look to minimise the impact of reductions in compensation releases.

As soon as the reservoir volume had recovered to 500 MI above DC3, we would reinstate the statutory compensation discharge at all sites. We would retain the drought permits for the three sites until they ceased to be valid, in case re-charge was not maintained.

If conditions increased the volume of water in store to 2,000 MI above DC3, and good recovery was in prospect we would revoke the drought order proscribing the non-essential use of water. We would advertise this fact in the appropriate literature, and media. However, we would make it clear that the resources situation still required the ban on hosepipe use to remain in force, and customers should do their utmost to continue to avoid the non-essential use of water where possible.

Once reservoir levels looked likely to increase above 10,000 MI, we would begin the removal of any temporary overland mains within reservoirs, together with any bank-side pumping plant or generators not required.

Water quality would be likely to remain poor during the early part of the recharge, so measures to improve operations at treatment works would remain in place for as long as quality problems persisted.

3.5.5.3 Drought Control 1 and 2

Reservoir storage would be allowed to increase to DC1 before we made any announcement that the ban on hosepipe use was to end. The accompanying media statements would make it clear that if careful use of water was not maintained, the restrictions may have to be re-imposed.

We would cease operating the formerly disused sources when reservoir volume was approximately 2,000 MI above DC1 if there was to be no increased risk to health from doing so. This would take the resources position within the range of normal operating volumes.

With reservoir volume firmly established at DC2 +5000MI, the system would have substantially recovered from the effects of the drought. As a result, a normal pattern of operation would resume with respect to restoring system pressures, leakage control, and the optimisation of operating cost.

3.5.5.4 Drought Review

Within one year of the end of any drought requiring as a minimum the imposition of restrictions on customer water use, we expect to:

- Review the demand for water, and the effect of restrictions on demand during the drought to improve the planning assessment for the demand components and discretionary use.
- Review how effectively the sources treatment works had been managed and what outputs had been maintained in respect of the assessments of yield and Deployable Output.
- Review by market research how effectively the company message had been transmitted to the customers, and assess customer opinion on restrictions
- Assess any environmental data collected.

The company will then compile a brief report indicating if we believe there needs to be any material or significant changes to components of either the Water Resource Plan, or Drought Contingency Plan, or other operational plans.

3.6 Management and Communications

The Company recognises that the key to achieving a successful outcome during a drought will depend as much on effective communication with customers and stakeholder groups as upon any engineering activity. We have in place the systems that will:

- Recognise the change from normal to drought conditions
- Maintain high level management control of the system
- Alert the regulatory agencies to the developing problem.
- Advise and inform our customers and other stakeholders as the situation develops.

3.6.1 Internal Management

The Company has a permanent structure in place to monitor the volume of water in storage, the daily demand for water and general climatic factors. During the normal operation of the system, a number of daily reports inform other sections of the organisation of the resources status. A high level monthly Resources Committee meeting takes place in order to review the position regarding stored water and customer demand, together with major operational or planned outage, both at the time of the meeting and the prognosis for the future. Once a drought has been recognised meetings will be more frequent and monitoring of internal actions more intense. The full Board would also be kept fully informed and monitor the actions of the Resources Committee. The internal structure of the management team is indicated below.

3.6.2 Regulatory Communications

The Drought Contingency Plan will be available through the company web site, together with regular briefings explaining the water resource situation and future prospects. As during normal periods of operation, the Company would continue to meet all the usual information requirements of the regulatory authorities (within practical constraints).

In addition, we will notify the statutory consultees and others listed in our plan, including the Consumer Council for Water, in writing in regard of the developing situation, and the actions the company is planning or implementing, and where further information can be obtained.

The company would advise the Environment Agency through the Area and Regional Drought Controllers directly by e-mail or letter. This would happen as the first trigger points are being approached. At that time, a method of information exchange and frequency of contact, and information requirements will be agreed. This will be commensurate with the situation as it develops at the time. We will alert the Environment Agency and statutory consultees if there appears to be a reasonable probability that drought orders or drought permits are to be applied for.

- We will make arrangements to establish monthly meetings with the EA area Drought Coordinator if the resources situation is likely to require significant actions to reduce demand or increase water availability.

- It will be the discretion of the EA Drought Coordinator to invite other stakeholders to this meeting. However, we would expect the key statutory consultants such as Consumer Council for Water, Natural England and Ofwat to contribute to these meetings.
- We will publish the minutes of these meetings on our web site, or make them available as paper records to stakeholders that require them.
- We will notify other stakeholders of the developing situation, and refer them to the corporate web site for further information when it appears likely that we will make appeals for restraint, or impose restrictions on use.

When drought permits or drought orders are applied for, the Company will comply with the requirements to set notice with the relevant authorities and advertise the Company intentions in the local press and the London Gazette.

3.6.3 Communication with British Waterways

Approximately half of the water supply to the Bristol Water area is provided by a transfer of water from the River Severn at Gloucester to Purton, via the Sharpness Canal. This transfer is operated by British Waterways and is the subject of a detailed operational contract. This contract provides a guarantee that a minimum emergency supply would be made available within 24 hours of any operational emergency (excluding impacts of drought restrictions on the River Severn and force majeure, etc.). This contract allows for a minimum abstraction of 210 Mld under normal operating conditions. A reduction of abstraction of 15 Mld may be required during periods of high tide when the River Severn is in a regulation period (as detailed for licence 18/54/20/138/C). These volumetric reductions have been fully taken into account in the Water Resources Plan and the assessment of the level of service

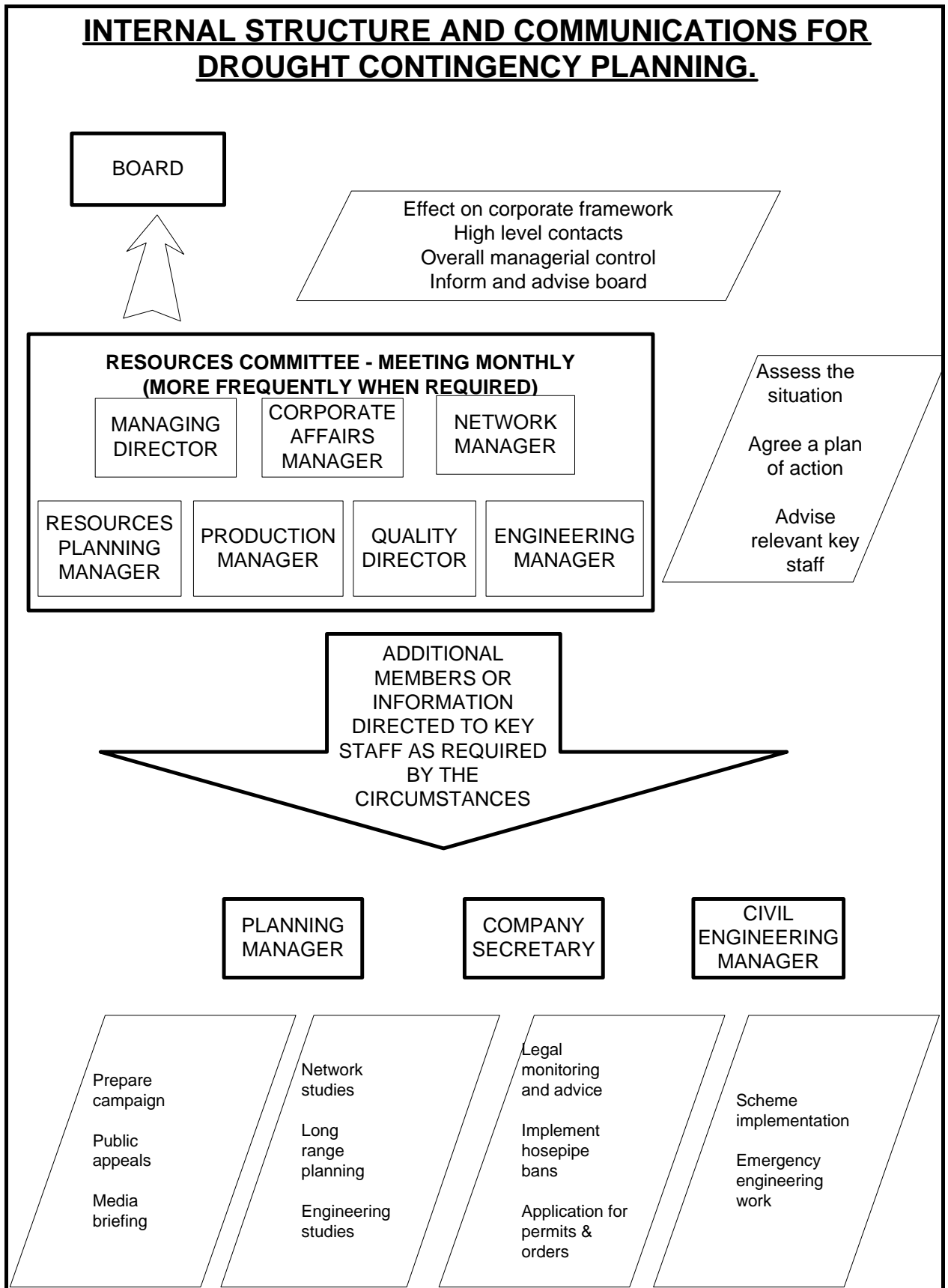
British Waterways are the owners of the abstraction licence that permits the taking of water from the Severn. As a consequence, the operating agreement takes full account of the conditions stipulated by the Environment Agency for this licence. As part of the general management of the Sharpness abstraction, we consult with British Waterways if a drought condition appeared imminent to ensure there are no issues relating to security of supply from the pumping system and canal due to maintenance or exceptional operations (although our contract already addresses many of these details). Our contract with British Waterways includes agreements on the following issues:

- Security and maintenance of the canal and pumping system
- Agreed level of service for canal outage periods
- Agreed minimum transfers following engineering emergency
- Abstraction reductions required under tidal and river flow conditions

During a potential drought that affected the River Severn, both British Waterways and Bristol Water would be in regular contact with the Midlands Division of the Environment Agency (following the communication protocol set out in the Drought Contingency Plan for the River Severn). We would also be closely monitoring flows on the Severn in order to ensure our abstraction does not further reduce flow in the lower Severn and comply with the terms of the abstraction licence. This is done as a matter of routine during all summers when the River Severn is under regulation. In the past we have also agreed operating arrangements to review the following issues when necessary:

- The schedule of spring and neap tides at Sharpness Dock
- Actual flow conditions at Bewdley and Deerhurst gauges on the River Severn
- The forecasts of possible low flow conditions at Deerhurst gauge
- Likely abstraction volume at Sharpness
- Potential water quality issues and effects on canal operation
- Impact of Environment Agency operations or alerts on the River Severn
- Any need to maximize efficiency of locking on the canal if required
- Security and maintenance matters

During any prolonged dry period when we are taking large volumes of water from the Sharpness Canal, we discuss issues with the British Waterways Hydrologist every two weeks as spring tides occur or more regularly, depending on the severity of the situation. During a drought, we will increase contact with British Waterways and formalise any exchange of relevant information by using e-mail. We will include British Waterways in our list of consultees in respect of drought management activity outlined in the sections above.



3.6.4 Communication with Customers and Other Stakeholders

The majority of the visible output of the Company will be targeted at this group, as it is this group that we wish to influence and change attitude to water use by measures proposed in the Drought Contingency Plan.

Bristol Water has a structured plan for communicating all company policies to a wider audience. This process begins in 'good' summers with promotion of messages on the wise use of water and other water efficiency initiatives. These include:

- The 'Have you got the Bottle?' campaign to install water saving cistern devices
- Information and advice on conserving water around the home
- Gardening tips to save water
- 'Are You a Water Wizard' –auditing method for household water use

In addition to those messages, there is usually a significant output of Company driven editorial in the local press and radio. This activity can be accelerated as required by the situation to include key messages communicated through news interviews a web site, leaflets, posters, media advertising, plus editorial briefings. As a result of previous experience, there is a stock of standard briefings and advertisements already available for this level of communication.

As the drought intensifies, and the first control curve is approached or reached, a pre-planned media campaign would be instigated. This campaign would aim to:

- Create sharp increase in customer awareness of the need to save water.
- Suppress demand for water.
- Prepare customers for the possibility of water use restrictions.

This press and media campaign will carry targeted information and advice to all customers. As part of this media campaign we will alert customers to other information and weekly resource situation updates to be provided on our Internet web site.

We would implement a four to six week campaign based on the following style

- High-impact choice of media.
- 'Save water now' style graphic photos of low/empty reservoirs; strangled hosepipes etc.
- Radio - short, sharp memorable messages and practical advice.

The media initially chosen for the campaign would be:

- '48 sheet' billboard posters at strategic sites around supply areas.
- Bus sides and backs throughout area.
- Extensive radio advertising.
- Mobile add-vans at shopping centres.

This would all be backed by a continuing free editorial campaign in regional and local print media, providing a steady stream of water-wise tips/practical suggestions.

At the point at which a hosepipe ban is imposed, we would need to re-run the media campaign. This would probably take the same format, but concentrate much more on the following:

- The need for the hosepipe ban to reduce demand and avoid further restrictions.
- The legal force and penalties associated with a hosepipe ban.
- To advise customers that the Company intends to prosecute those that do not comply.
- The severity and impact that further restrictions would have on homes and businesses.

Through our Business Care team, we will advise large industrial customers of the water resources position, and what the future prospects are likely to be. Through this route we will also be asking the large water users if there is any scope for reducing water consumption through efficiency activity.

We will send a letter to non-household customers that have an annual consumption of 3MI or greater to advise them of the need to ensure that they are using water as efficiently as possible, and provide them with additional sources of water efficiency information.

As previously stated, we will make regular formal contacts with Wessex Water regarding their likely pattern use of the water available through the Bath transfer. We would expect that they will want to transfer water at their fully contracted rate but will explore any opportunities for temporary reductions that may occur.

3.7 Environmental Status and Monitoring

The map of the Company area in the appendices illustrates the extent of our water resource zone and also any European habitat sites that may be impacted by a drought. We have only three sites within this definition. These are the artificial water bodies created for public water supply at:

Chew Valley reservoir	SSSI & SPA
Blagdon reservoir	SSSI
Cheddar reservoir	SSSI

These reservoirs will not be the subject of any activity under drought permits or orders. Over the course of a normal year, the variation in reservoir level at these sites can be in excess of 60%, and no adverse effects have been observed in the past on the existing flora and fauna of the lake, or the fish populations. Droughts in 1976 and 1991, the volume of reservoirs fell to below 10,000 MI without any obvious long-term detriment to the local environment.

We would need to maintain the rate of abstraction from reservoirs as the water level falls. This may cause the water level in reservoirs to fall to lower than normal levels. At these low water levels, we will require temporary enhancements to the existing infrastructure. These will be limited and confined to improvements to treatment or temporary mains and boosters, not requiring special powers or permissions under the Water Act. However we would have regard to the Habitats Directive and the Natural England list of proscribed activities for any temporary work, or plant location. We would consult fully with the Environment Agency and others in advance of any activity to minimise impacts.

We also propose to carry out activity that may slightly reduce the flow released to rivers that are supplied by compensation water from the reservoirs at certain times of year. This will only be done in an extreme situation when there is a risk of a supply failure during a severe drought. This represents a change in policy compared to previous Drought Contingency Plans. There is now an expectation that any contingency plan should include the use of drought permits to modify abstraction regimes. The river reaches affected are:

Chew	Chew Stoke to Compton Dando
Congresbury Yeo	Blagdon to Iwood
Cheddar Yeo	Cheddar Ponds to main River Axe

None of these stretches of river have a statutory or European designation. We have collected most of the baseline data regarding the river stretches. We expect to work with the Environment Agency to continue to maintain and update this data in future. We have agreed the scope of requirements with the Environment Agency to cover the following:

- The monitoring parameters and criteria in order to define the environmental quality.
- The provision of data to maintain the record of baseline conditions.
- Establishing the sites that best represent the general river ecology.
- Establishing the baseline environmental condition during periods of low flow generally.
- Monitoring requirements during the period when flow reductions are in place.

The proposed emergency abstraction from the Avon at the Floating Harbour has been considered to have a minimal environmental impact. The water will be taken from the system at the point where it would normally be discharged to the tidal section of the Avon. On average, discharges of fresh water from the floating harbour are estimated to be in excess of 200 Mld (excluding volume released for navigation). The proposed abstraction is only a very small fraction of the total volume of water released from the harbour, which in turn is insignificant in terms of the tidal flow of saline water in that section of the Avon.

The primary monitoring consideration for the Company would be whether the water quality is suitable for treatment to a potable standard at all times throughout the year.

3.7.1 Monitoring Plan for Reservoirs

The company already conducts regular weekly testing of the reservoir waters for a range of physical, chemical and biological parameters. This testing programme is usually increased in frequency in response to any particular water quality issues (in the case of large algal blooms for example). Air diffusers are routinely in operation from April to October at Chew and Blagdon. These help to mitigate the effects of stratification and stagnation at the lower levels in the reservoirs. Water levels are monitored as part of the general resources management. On the reservoirs that are game fisheries, the health and quality of the fish population are also carefully monitored. All such data is maintained within a corporate database for future reference.

This general data collection provides a good baseline of monitoring with which to assess any temporary changes due to drought conditions. Monitoring would increase during a drought, as changes to water quality began to impact the operation of treatment works.

3.7.2 Monitoring Plan for Rivers Affected by Drought Plan Actions

Details of the baseline information available on the three river reaches affected by our plan are contained within the appendices (we recognise the assistance of the Environment Agency in providing the data). We regard these details as substantially complete, although some further work may need to be carried out to visually and physically survey some reaches during a dry period. These three river reaches are not designated sites, and are not considered particularly sensitive to variations in river flow at the periods selected. The monitoring plans contain a range of mitigation actions that could be carried out if drought conditions are so extreme that monitoring during the period of reduced compensation indicates adverse effects.

All of this work was carried out in consultation with the Environment Agency and Natural England. An agreed scoping document defined the extent of the information and monitoring required. This scoping document is a part of the final report prepared by Cascade Consulting and is included in the appendices of the Drought Contingency Plan.

The proposed actions, subject to a drought permit for each of the sites, are as described below.

- **River Chew** Reduce compensation flow released to stream at Chew reservoir from 14.4 to 7 Mld for the months of May, June and July and from 6.8 Mld to 3.4 Mld in winter, (annual total 1170 MI). The section of river affected is from Chew Stoke to Compton Dando, and is not a designated site under EU legislation.

- **Cheddar Yeo** Reduce compensation flow released to stream at Cheddar gorge collecting ponds from 6.8 Mld to 3.8 Mld during winter (annual total 540 MI, subject to River Axe statutory conditions being met). Reach affected is from the Cheddar Ponds compensation discharge to the confluence with the Axe. This section of river is not a designated site under EU legislation.
- **Congresbury Yeo** Reduce compensation flow released to stream at Blagdon reservoir from 8.6 Mld to 4.6 Mld summer (annual total 720 MI). Reach affected is from Blagdon compensation discharge to Iwood. This section of river is not a designated site under EU legislation

Cascade Consulting have reviewed the baseline data available to date together with the hydrology and environmental sensitivity of the sites and the wider ecological context of the affected areas. From this work they have produced an analysis of the current baseline condition and the probable impact of the proposals (subject to some further investigation).

They have proposed an environmental monitoring plan for each of the sites that include identification of additional baseline data to be collected, and the suggested level of monitoring during operations carried out under a drought permit. These monitoring plans are contained within the appendices relating to the drought permit application details for each of the three river sites listed above.

Some minor data still requires collection in order to fully establish the baseline position. This relates mainly to a visual record of identified river reaches, together with a morphological survey of the indicative assessment points. We would expect to collect this data during the earliest warm and dry summer, when a pattern of lower than average river flow has been established for a reasonable period.

The data collected under these conditions will provide the best representative indication of the typical dry period ecological and morphological features. The impact of any further flow reduction caused by the application of a drought permit can then be reliably assessed against this benchmark.