

Northumbrian Water

**PR09
Water Resources
Management Plan**

**Supplementary Report
to the
Statement of Response**

September 2009

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DOCUMENT CONTROL SHEET

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1. Introduction

The following report has been submitted as part of the Water Resource Management Plan process following a request from Defra for further information to enable the Secretary of State to reach a decision on directing the company to publish its Plan or to call for an Inquiry or Hearing into the Plan.

This report should be read in conjunction with the revised draft Plan (April 2009) available on the Company's website.

A meeting was held between the Company and the Regional Water Resource Team of the Environment Agency, prior to compiling this report, to gain a better understanding of what additional information was required. This resulted in a breakdown of Point 1 in Defra's letter into 5 specific questions which are repeated before our reply.

The request for additional information solely related to Environment Agency comments from their consultation response to our draft WRMP and our subsequent Statement of Consultation Response, although some of the additional information requirements in Defra's letter did not appear in any response from consultees. The request to provide additional information on Deployable Output contradicts the response from other consultees, such as Ofwat, who thought our work on DO was a good improvement in understanding on the equivalent work in the 2004 Water Resource Plan. We believe these diametrically opposing views came about by the different ways each organisation engaged with the Company during the construction of the draft WRMP.

Ofwat, through their Reporter, fully engaged with the company to understand, audit and suggest improvements to the Plan which both parties found constructive. The Environment Agency, probably because of their multiple roles in the WRMP process, maintained a distance from the company because of their interpretation of the statutory process. This created difficulties in producing a plan that their consultation response suggested they wanted to see. This non-involvement has also led to a lower understanding of the work the company has carried out, especially in the more detailed technical area which is difficult to incorporate into a document that is meant to appeal to a wide audience ranging from customers to technical experts, and must remain readable to all. A constant change of Environment Agency staff within the Regional Water Resource Team has also added to the problem of a better understanding of the NW system and history.

2. RESPONSE TO REQUEST FOR FURTHER INFORMATION

The company's response uses the same numbering as the Defra letter.

1. *A description of how infrastructure limitations (identified through headroom studies) impact on the operation of the Kielder resource zone in normal and dry year conditions.*

A meeting with the Environment Agency, after receipt of the Defra letter, was held and the following points of clarification were provided to the company to answer this point. Whilst willingly providing the further information to show that all customers within the Kielder zone receive the same level of service, we doubt that the EA have this level of information available to them from other companies to enable them to look so closely at distribution points within Water Resource Zones. As such we remain concerned that information to this level of detail is outside the Water Resource Management Plan process.

EA clarification

Tyne Area – Discrete Zones

The reports identify supply-demand issues at times of peak demand in eight small, discrete zones located in the Pennines. MW note that these are generally resolved by tankering water from Whittle Dene WTW. The reports suggest there is no long term proposal to connect these discrete systems to the main NWL network reported in the headroom assessments. We are concerned about the risks to supply for customers in these discrete zones.

The MWH report actually states that there are long term proposals to connect the discrete systems and in late 2006 NWL produced a Rural Supplies Strategy which considered the future viability of remote "stand alone" treatment sites and, where feasible, considered the options for their abandonment. The sites mentioned in the report were all covered in the Strategy. However, as stated in the MWH report, as all of the sites are capable of being replenished by tankering potable water to their service reservoirs, should demand exceed their DO or they dry up in hot summers, then the level of service these customers receive is no different to any other NW customer. Maintaining a constant supply of water is simply an economic decision in the case of these sources, not a Level of Service consideration. The situation at the 8 minor sources is as follows:

Allenheads

As part of NWL's Rural Supplies Strategy this area is to be connected to the distribution system supplied from Wear Valley TW. The work was identified in our Business Plan and is currently scheduled to be completed in the first 2 years of the next AMP period.

Birchtrees

The area supplied from Birchtrees springs is at the western end of the company's distribution system supplied from Gunnerton WTW. In recent years the distribution system has been reinforced by a new outlet main from Gunnerton to Hexham, a new Tyne river crossing and a new main from Wall to Haltwhistle. This now means that any additional demand from the Birchtrees area can be met when the work to connect the Birchtrees system to the main distribution system is completed during 2010.

Byrness

Due to the distances involved there are no proposals to connect this system to the nearest distribution system supplied from a major works during AMP5. However, feasibility studies will be carried out late in AMP5 for a scheme to be included in AMP6. Capital maintenance at the site ensures that the treatment is reliable and the raw water source, being Catcleugh Reservoir means there is not an issue with maintaining supply. Even if there were to be any unforeseen problems, with a demand of 35m³ per day tankering would ensure normal supplies. This would only require 2 tankers per day and procedures for tankering to the various sites are already in place.

Carrshields

The Carrshields area is included in the proposal for Allendale mentioned above and will be connected to the distribution system from the Wear Valley WTW as part of that scheme in the first 2 years of the next AMP period..

Otterburn

Similar to Byrness there are no proposals to abandon this source. It is also supplied from Catcleugh Reservoir, guaranteeing a supply of raw water. Tankering would be used should there be a supply failure and this did successfully happen recently when a burst main interrupted supply from Otterburn TW.

Rochester

This area lies between Byrness and Otterburn is supplied from Catcleugh Reservoir. There are no proposals to abandon the treatment works and, like Byrness, should it ever be required the small demand 30m³ per day can comfortably be supplied by tankering.

Slaggyford

Similar to Birchtrees, the Slaggyford area will be connected to the distribution system supplied from Gunnerton WTW enabling the spring source to be abandoned. This work will be completed in AMP5.

Stonehaugh

This borehole source is some distance from any main distribution system and there are no plans to connect. Investment is being made to improve the reliability of the membrane filters which treat the water. With a demand of only 40m³ per day tankering can be used to maintain supply.

EA Clarification

Tyne Area – Tyne Valley Sub-Zone

This sub-zone is supplied by Gunnerton WTW. The headroom reports note there have been some issues in maintaining supplies to service reservoirs at the extremities of the network. They suggest reservoir levels have been supported by tankering at times of peak demand. We are concerned about the risk this imposes to customers' security of supply.

As part of NWL's Section 19 undertaking between late 2005 and September 2008 extensive work was carried out on this system which has resulted in new pipes being laid from Gunnerton TW to Gilsland at the western extremity of the network. A distance of some 45km. These works have resulted in greater hydraulic capacity ensuring sufficient water reaches the service reservoirs on the network.

The MW report stated that significant mains rehabilitation and upsizing was taking place which would address the issue.

EA Clarification

Tyne Area – Tyneside Sub-Zone

This system consists of four interconnected system zones (Fontburn, Wansbeck, Tyneside and North Tyne). Water can be moved around the zone via a system of large trunk mains. The Headroom Reports suggest the full interconnectivity of the trunk mains network is not useable due to a risk of dirty water incidents. They refer to an ongoing programme of trunk mains cleaning to resolve this issue. You should confirm whether this programme has been completed and if the zone can now operate at full connectivity or whether this represents a 'real' risk.

Due to an unacceptable number of discoloured water complaints associated with this part of the distribution system, the company entered into an Undertaking with the Drinking Water Inspectorate (DWI) to :-

- Clean distribution system
- Investigate and clean the trunk main
- Construct, install and commission a new trunk main

This formed part of the company's PR04 Business Plan.

To comply with the undertaking NWL's developed its Acceptability of Water programme. This involves large sections of the strategic network being refurbished or replaced. In the Tyne area this involves work on around 157km of mains with a completion date of March 2011. To date some 17km of 900mm main has been laid and commissioned and 20km of cleaning has been completed. Through careful co-ordination planning NWL has maintained supplies and the potential to move water around the strategic network, if required, whilst the work is being carried out. Upon completion the strategic network will be fully flexible.

It should be noted that even prior to this work being carried out, the requirement to move water to ensure constant supply has never occurred, therefore any lack of flexibility is actually theoretical.

EA Clarification

Tyne Area – Tosson System

This area can theoretically be supported by Fontburn Reservoir via Stanton Mixing Tank. However this connection is currently closed due to the main being in poor condition causing water quality issues. Therefore MW consider this a discrete stand-alone system. You should clarify if the Tosson System is discrete zone and justify the level of service for this area.

Work has been undertaken to provide connections allowing for the installation of a temporary pump near Stanton which will allow water from Fontburn reservoir to supply the Tosson system. Whilst NWL are aware of the issue with the mains, procedures are in place to enable the implementation of the flow reversal with minimal disruption to customers and therefore do not consider Tosson to be a discrete zone.

EA Clarification

Central Area – Honey Hill (Wear Valley/Sunderland not Honey Hill)

There are water quality concerns and hydraulic constraints which prevent water being transferred from the Tyne area into Washington and Sunderland area (via the Derwent North Pipeline and Carr Pumping Station).

The issue over water quality concerns actually relates to fluoridation. The water supplied from the Carr Hill link main is fluoridated whereas water from Mosswood TW is not.

The terms of existing fluoridation agreements in NW (in relation to the Water Industry Act 2003) mean that water cannot be supplied outside the authority of

an agreement, unless specific circumstances apply. The supply of artificially fluoridated water into an area not covered by a fluoridation agreement is only permitted temporarily where it is considered necessary for:

- a) the purpose of dealing with any serious deficiency in supply; or
- b) in connection with the carrying out of any works (including cleaning and maintenance)

Serious deficiency in supply" is defined by the WIA as "any existing or threatened serious deficiency in the supply of water (whether in quantity or quality) caused by an exceptional lack of rain or by any accident or unforeseen circumstances."

The use of the Carr Hill link main would generally be implemented as part of a plan to supplement supply into the area, or where maintenance was required on the strategic network downstream of the works along the Sunderland trunk main. In such circumstances, these emergency conditions would be invoked in line with a clearly defined method statement, and only after consultation with the relevant Health Protection Agencies, Local Authorities and the Strategic Health Authority,

Regarding the hydraulic constraints these would be reduced to an insignificant level by careful control of the downstream pressure at the Link Main cross-connection together with other key control valves in the Sunderland area. When the main was commissioned in 1993 an operational procedure was put in place to facilitate the full use of this strategic link which would be implemented in the event of a transfer being required. However it should be noted that since its commissioning use of the link main has never been required to maintain supply to the area.

EA Clarification

Central Area – South Durham

This area is supplied by Mosswood WTW which has two outlets: the Derwent North and Derwent South pipelines. In order to deliver the peak demand flow to South Durham via the South Derwent pipeline all five pumps at Mosswood WTW must be running. This could affect the level of service experienced by customers in South Durham if one pump failed. MW recommended that the pumps are upgraded so that the required maximum flow can be delivered by just four pumps allowing a standby pump.

Whilst we acknowledge MWH's comments in the report they were determined without appropriate pump tests. As part of the ongoing maintenance regime pump number 5 was refurbished earlier this year. Tests were carried out on the pumps in June 2009 which showed the capacity of 5 pumps was 87 Ml/day and 4 pumps estimated to provide 70 Ml/day. Additional analysis

confirms that this 4 pump capability meets all demand scenarios when considered alongside the extensive storage in the system and the recent work at Honeyhill WTW to increase the DO to 45 MI/day. Further tests on pumps are due to take place in the coming months. For efficiency reasons NWL prefer to run 5 units as it enables each pump to be run at a lower rate, however this is only a consideration during normal operations.

2. *A description of the method that you have used to assess deployable output (including a clear description of how you use the i-think model to calculate deployable output and determine levels of service).*

Deployable Output has been determined in line with Section 6.1 of the Water Resources Planning Guideline. This defines Deployable Output (DO) as :-

The output of a commissioned source or group of sources or bulk supply as constrained by environment, licence if applicable, pumping plant and/or well/aquifer properties, raw water mains and/or aquifers, transfer and/or output mains, treatment, water quality.

All DO is declared downstream of the treatment works.

A full review of Deployable Output was completed using the following process:

- A review of the DO as stated in the 2004 Water Resource Management Plan
- A review of Resource availability.
- A review of licence constraints.
- A review of Works Capacities.
- A review of Raw and Potable Network Constraints.

Deployable Outputs were initially reviewed via a suit of Headroom Studies carried out in 2007. These studies were a snapshot of conditions existing in July 2006. This period was the selected as the highest demand level experienced in recent years.

These studies included:

- The principles of the Water Resources Planning Guideline; and
- Interviews with Operations staff in Resources, Production, Networks, Networks Control and Network Analysis to incorporate output from the “i-Think” Corporate Resource Models.

The following is an example of how this was applied to the Central sub-zone:

Water Resource Availability

Data Sources:

- JBA Report ‘Assessment of Surface Water Yield’
- NWL Water Resource Plan, NWL Drought Plan.

Verification:

- Examination of historical and predicted raw water reservoir level variations within the Central Area catchment.
- GWS Record sheets
- MIPS data records of GWS flows, Waskerley Air Shaft flow.

Assessment of Water Treatment Works Capacities.

Sustainable WTW Output

Data Source:

- WACS Historical records of Daily Works Output – DI Meter Data

Verification:

- Interviews held with WTW managers to establish current, historical and predicted future sustainable works output.

Assessment of Network Constraints.

Corporate Data on historic outputs and demands were abstracted from:

- SCADA (Telemetry data).
- MIPS (Management Information Presentation System)
- WACS (Water Accounting System).
- Netbase (Network Management Tool)

Updating

The studies were then updated to take into account:

- Completed Capital Projects
- Projects expected to be completed before the commencement of the Water Resources Management Plan.
- A review of the “i-Think” Corporate Resource Models.

An example of how the process was applied to each Water Treatment Works (Honey Hill WTW) is given below.

Examination of the historical DI output records for Honey Hill WTW shows that the output of the works has been reducing over the last 5 years, from approx. 45 Mld in 2001 to approx. 34 Mld in 2006. However, work is currently ongoing to re-furbish the works, with an expected completion date of late 2007. Therefore, the following figures can be taken as the sustainable treatment works capacity currently and in the near future:

Current Treatment Works Capacity = **34 Mld** (due to works process problems).

Predicted Treatment Works Capacity late 2007 = approximately **45 Mld** (following completion of refurbishment work).

NWL comment: this capacity has been achieved and exceeded during 2008/9.

The methodology outlined above was described and demonstrated as part of the Ofwat audit of the draft WRMP and the following are extracts from the results of the audit:

Excerpt from Auditors report SAF 'C-80288/JHH/NES.PR51' following on from the audits carried out on the 5th & 6th March 2008 states:

"The resource modelling would appear to include and illustrate resource and storage constraints within the system for forward planning purposes."

The revised draft WRMP contained the following 2 tables showing the changes to DO between the 2004 and 2009 WRP and WRMP. The DO in the 2004 WRP had been thoroughly audited and accepted by the Environment Agency.

Reproduced from Revised Draft WRMP:

Kielder Zone

As can be seen from Table 3.1 below the total Deployable Output for the zone has changed. These changes have come about as a result of better application of the methodology for calculating DO which had previously been applied to licences with little consideration given to other constraints. The table also reflects continued investment at treatment works for example Horsley where the DO has risen from 135 to 150 Ml/day and at Gunnerton where use of a pump enables the DO to be increased to 11 Ml/day.

NWL have a Rural Resource Strategy which will see the isolated springs abandoned and mains laid to supply the areas from larger treatment works. This is reflected in a reduction of DO during the course of the next AMP. The reduction is around 0.2 Ml/day.

SOURCE NAME	WRP04 Dry	WRMP09 Dry	WRP04 Normal	WRMP09 Normal
Whittle Dene	106.80	118.00	108.18	118.00
Gunnerton	7.00	11.00	7.00	11.00
Byrness/Roicester/Otterburn	1.2	0.33	1.2	0.33
Horsley	135.00	150.00	135.00	150.00
Fontburn	10.00	19.00	15.00	19.00
Warkworth	45.46	42.50	45.46	42.50
Swan Well	0.53	0	0.7	0
Tosson	3.20	2.62	4.00	2.62
Cambo	0.12	0	0.12	0
Stonehaugh	0.03	0.04	0.03	0.04
Slaggyford	0.06	0.10	0.06	0.10
Allenheads	0.02	0.03	0.02	0.03
Halton le Gate	0.03	0	0.03	0
Birchtrees	1.56	0.7	1.56	0.7
Carr Shield/Currick	0.01	0.06	0.01	0.06
Northern Supply Zone	311.02	344.39	318.37	344.39
Derwent (Mosswood WTW)	155.00	152.00	152.00	152.00
Wear Valley WTW	22.00	34.00	25.00	34.00
Honeyhill WTW	45.00	45.00	47.54	45.00
Sunderland GWS total	43.06	44.00	45.00	33.00
Lumley	40.00	42.00	40.00	42.00
Central Supply Zone	305.06	317.00	309.54	317.00
Lartington	121.00	128.00	121.00	128.00
Broken Scar total	180.00	180.00	180.00	180.00
Southern Supply Zone	301.00	308.00	301.00	308.00
KIELDER RESOURCE ZONE	917.08	969.39	928.91	969.39

Table 3.1: Kielder Zone Deployable Outputs.

SOURCE NAME	2004	2009	+/-	
Whittle Dean	108	118	10	Licensed and previously reported as group
Gunnerton	7	11	4	Licence 318.2Mld (WD 181.82 OV 136.38)
Byrness/Rochester/Otterburn	1	0.332	-1	DO is treatment capacity limited
Horsley	135	150	15	Improved Treatment capacity.
Tyne / Rede group (above)	251.38	279.33	28	
Fontburn	15.00	19	4	Minimum of 15 v Potential Deployable 19
Warkworth	45.46	42.5	-3	Reduction in WTW capacity following GAC.
Swan Well	0.70	0	-1	Abandoned source
Tosson	4.00	2.62	-1	WTW capacity reduction
Cambo	0.12	0	0	Abandoned source
Stonehaugh	0.03	0.041	0	
Slaggyford	0.06	0.1	0	
Allenheads	0.02	0.033	0	
Halton Lee Gate	0.03	0	0	Abandoned source
Birchtrees	1.56	0.7	-1	
Carr Shield / Currick	0.01	0.01	0	
Northern Supply Zone	318.37	344.33	26	Improved Treatment capacity.
Derwent (Mossswood WTW) TTT Tr	152.00	152	0	
Wear Valley WTW	25.00	34	9	New Wear Valley WTW (replaced WearHead)
Honeyhill WTW	45	45	0	
Sunderland Ground Water Stations Total	47.54	44.00	-4	WTW capacity reduction
Lumley	40	42	2	Improved Treatment capacity.
Central Supply Zone	309.54	317.00	7	Improved Treatment capacity.
Lartington	121.00	128	7	Improved Treatment capacity.
Broken Scar Total	180	180	0	

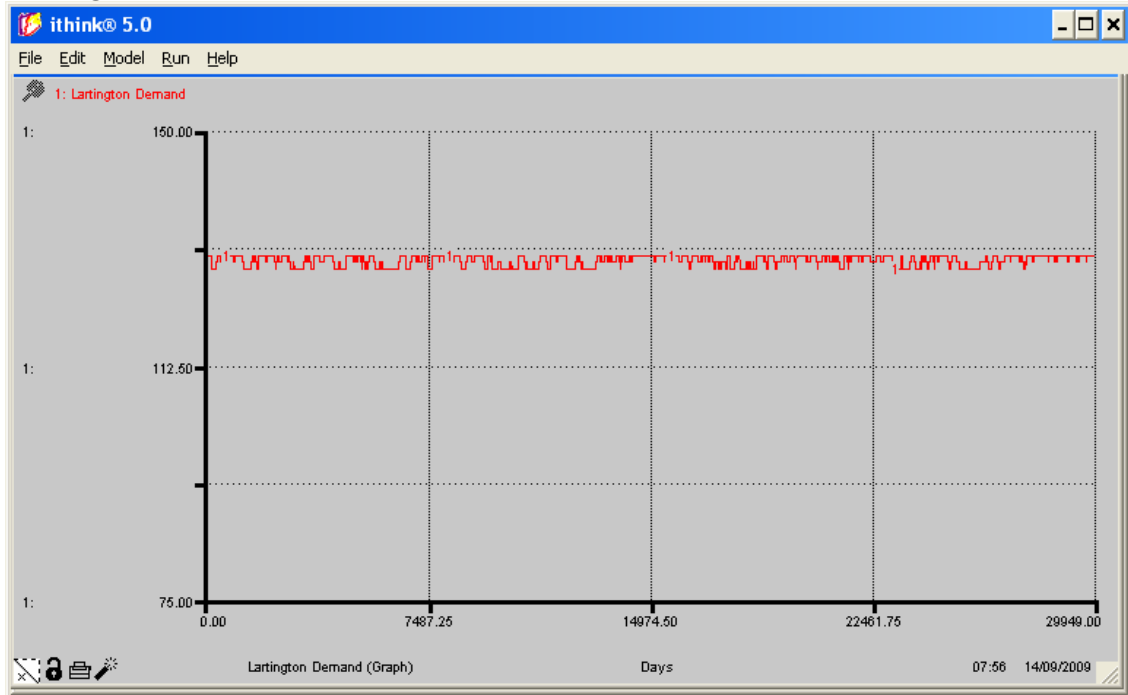
SOURCE NAME	2004	2009	+/-	
Southern Supply Zone	301.00	308.00	7	Improved Treatment capacity.
Berwick Total	11.42	8.64	-3	Interpretation of Conjunctive licence.
Fowberry Total	2.22	3.65	1	Average Annual v Maximum with new licence
Berwick/Fowberry Zone Total	13.64	12.29	-1	
Broken Scar	50.00	115.00	65	Interpretation of Conjunctive licence.
Blackwell	159.11	159.11	0	
Low Worsall	268.21	164.00	-104	Installed Pump Capacity v licence.
Industrial Zone Total	477.32	438.11	-39	

The changes to DO compared to the EA accepted 2004 DO are all explained in Table 3.1 (above) from the revised draft WRMP.

Once the DO had been determined using the methodology already described the values were input into the i-Think model which shows the effects of such abstractions on the reservoirs using a long record of resource conditions. Data going back to 1926 is used in the model which encompasses a sufficient variety of conditions and most of the known severe droughts in the last 100 years. Hydrological rainfall runoff models of catchments have been developed calibrated and used to cover the period 1926-1996 whilst inflow data obtained from corporate systems and Environment Agency information has been added to extend the period modelled to 2007.

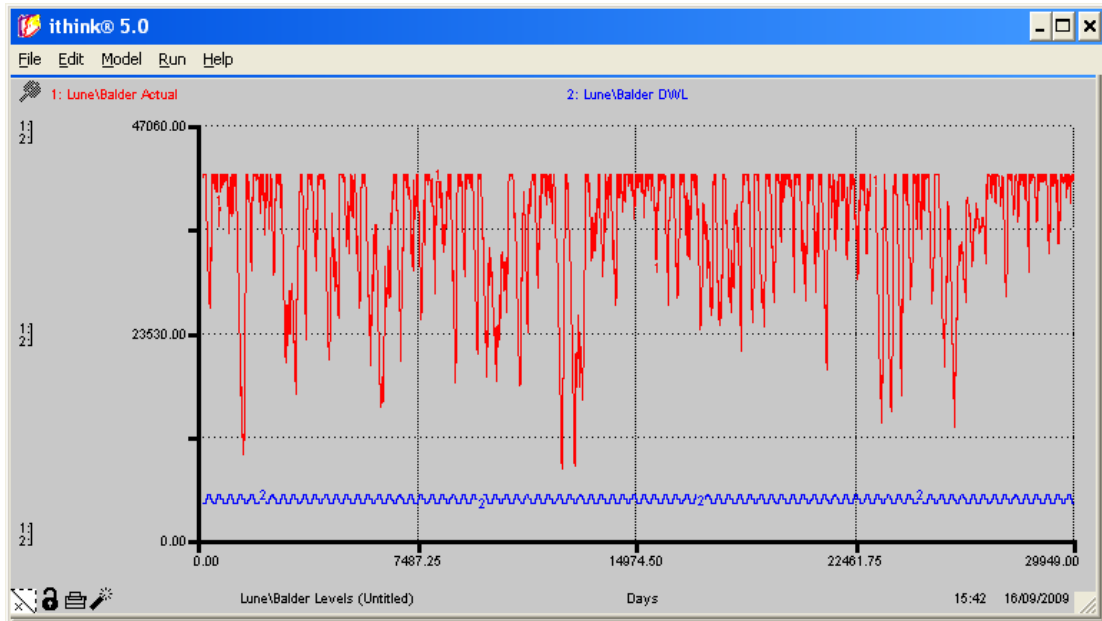
The overall purpose of the model is to show that taking the maximum DO's for the treatment works does not drop any of the reservoirs below their usable level thus meaning no further water could be taken. It is worth noting that this is an extreme scenario which exceeds any abstractions previously taken since NWL have never required maximum DO's from the works simultaneously. The graphs below are extracts from the results of the model. In all graphs the X axis represents days i.e. 29949 between 1926 and 2007.

Lartington DO



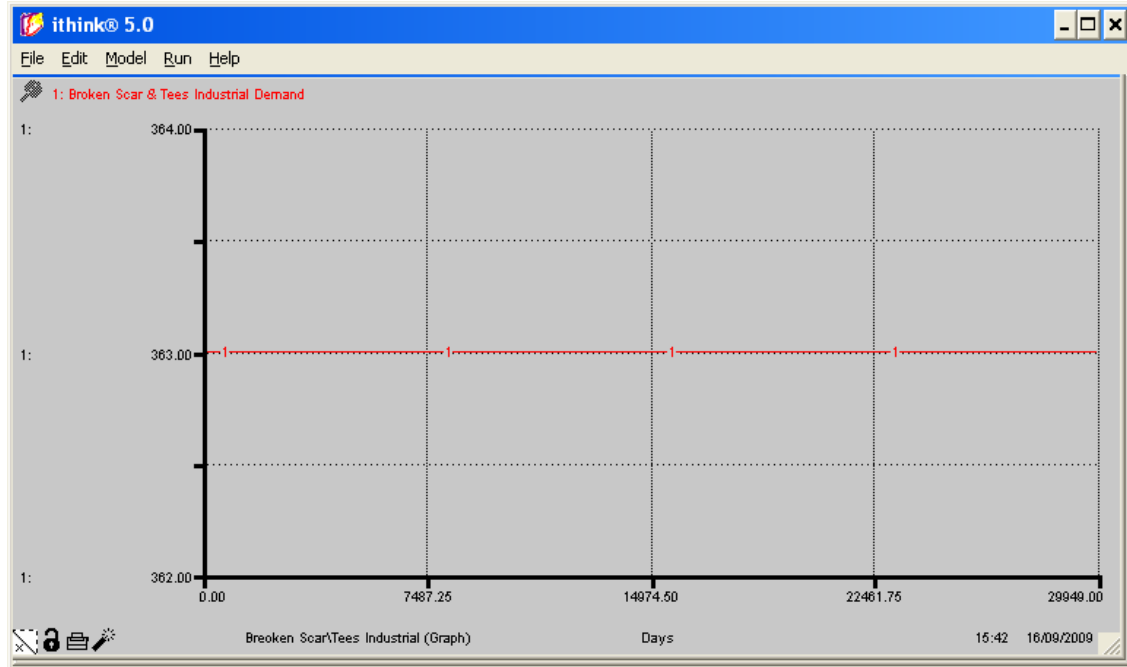
The above graph shows the modelled Deployable Output for Lartington TW. The lowest value equates to the stated DO of 128 Ml/day. This graph is based on the available storage from the Lune and Balder reservoirs. The modelled levels of the group of reservoirs can be seen in the graph below. The blue line on the graph represents the usable volume.

Lune/Balder Levels



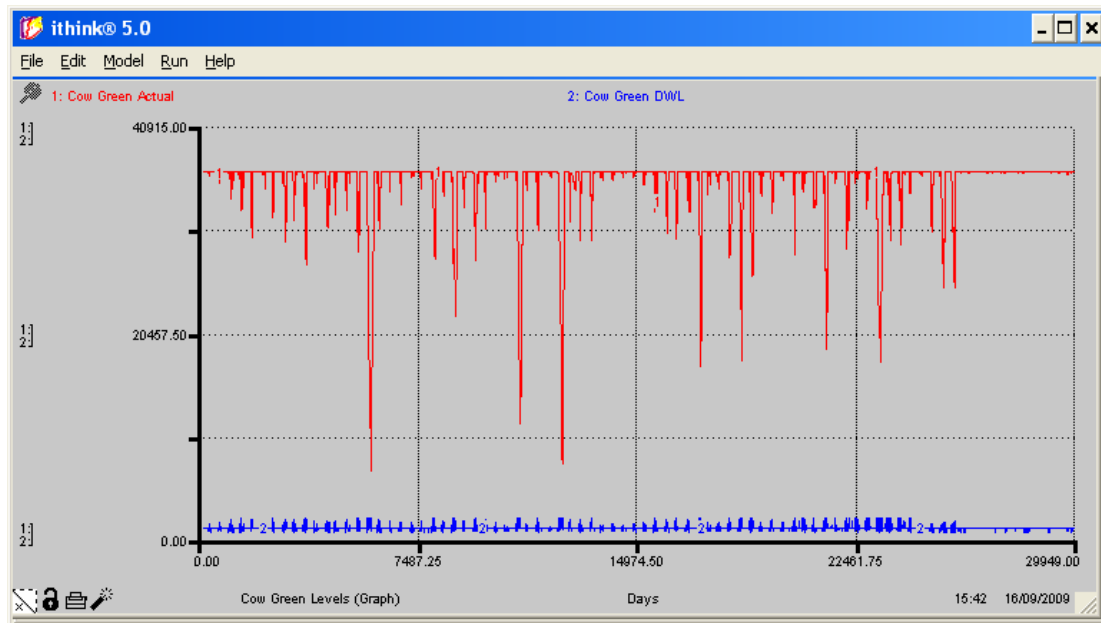
The Deployable Output for Broken Scar TW and the Industrial Water system taken from the River tees is shown in the graph below.

Broken Scar & Tees Industrial DO

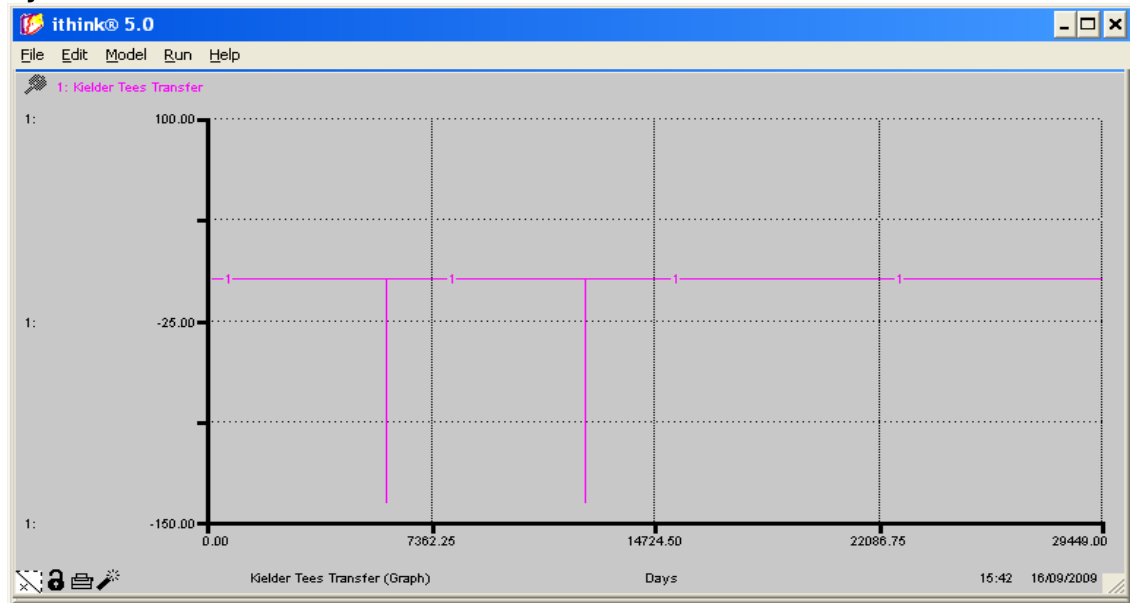


Again this is determined based on the effect such an abstraction has on the River Tees which is a regulated MMF river and on the levels in Cow Green Reservoir. In addition there is the potential to put water into the Tees using the Tyne Tess transfer. The following two graphs show firstly Cow Green reservoir levels and secondly the flow from the transfer.

Cow Green Levels

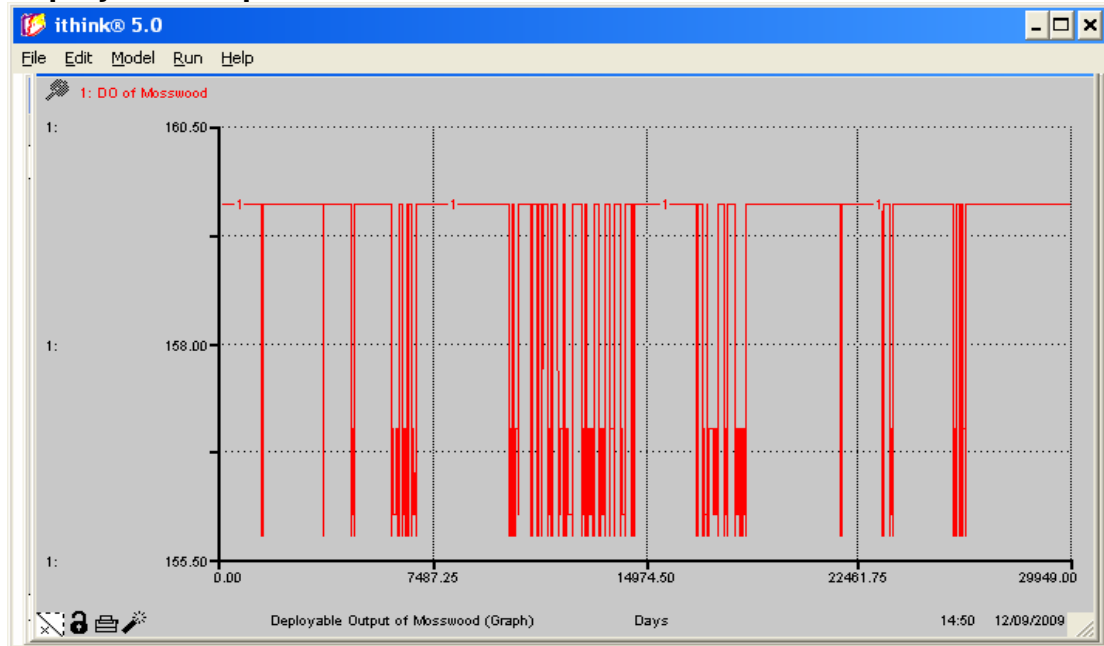


Tyne Tees Transfer



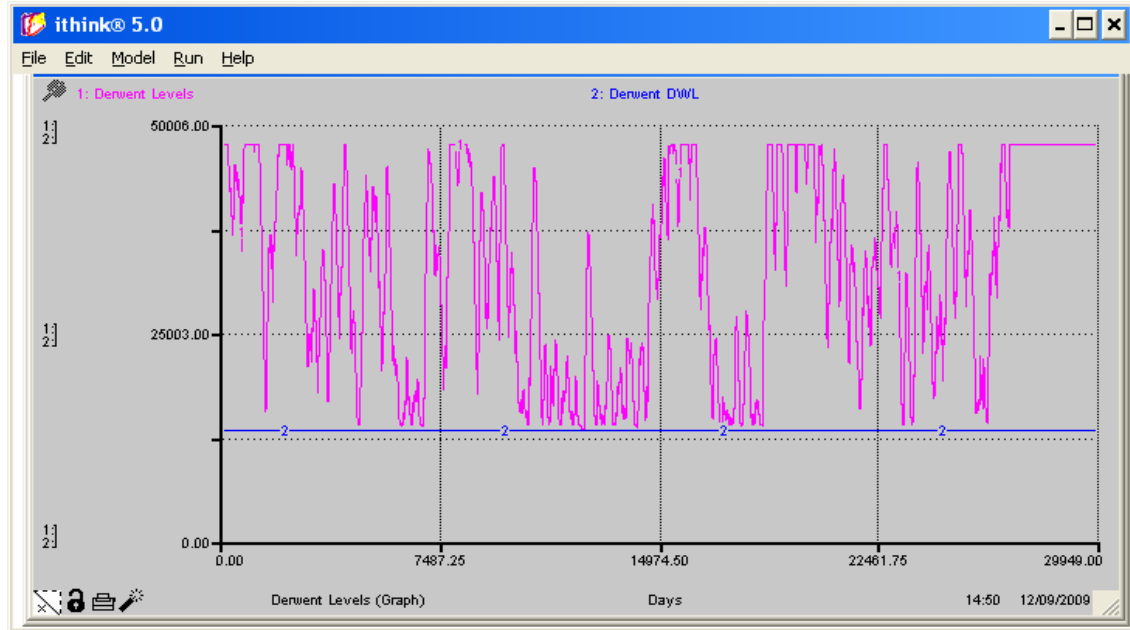
It can be seen from the Tyne Tees Transfer graph that the model suggests that it would only have been necessary to use Kielder water in to the Tees on 2 occasions in the previous 81 years. Moving on to the Central Area, the graph below shows the Deployable Output for Mosswood TW. The values are slightly higher to provide the model parameters on which to work but clearly show that 152 MI/day can be maintained.

Deployable Output of Mosswood



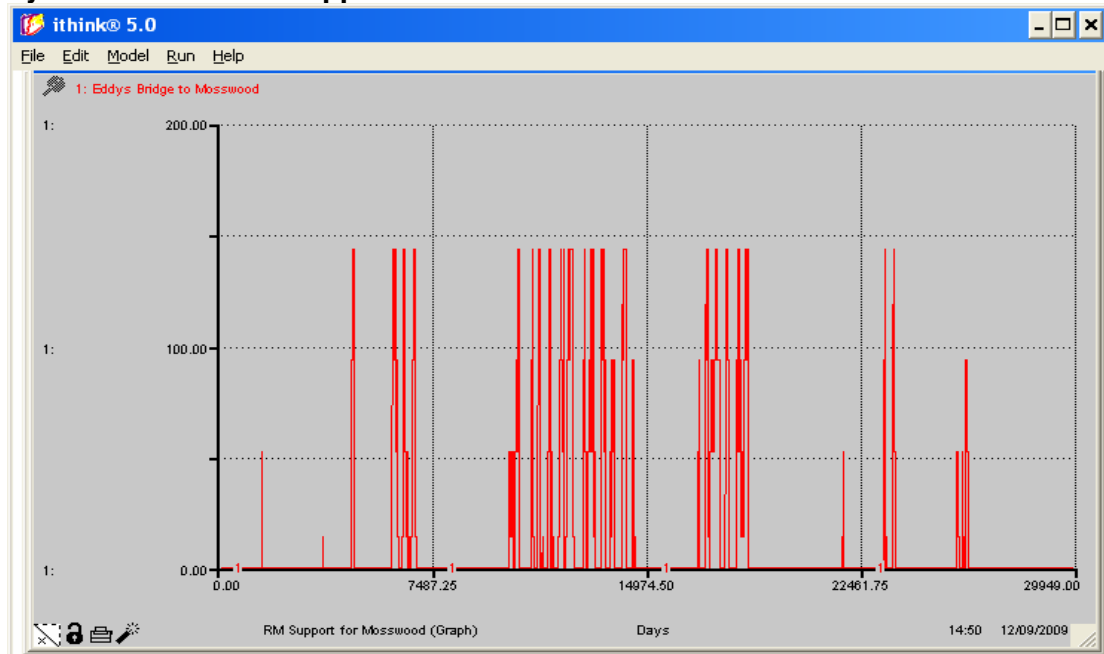
Derwent Reservoir is one of the supplies to Mosswood TW and the graph below shows the effect the abstraction has on the reservoir.

Derwent Levels



In addition to Derwent reservoir Mosswood can also receive water from the Tyne Tees transfer. The graph below show the additional requirement from the transfer to maintain the DO at Mosswood.

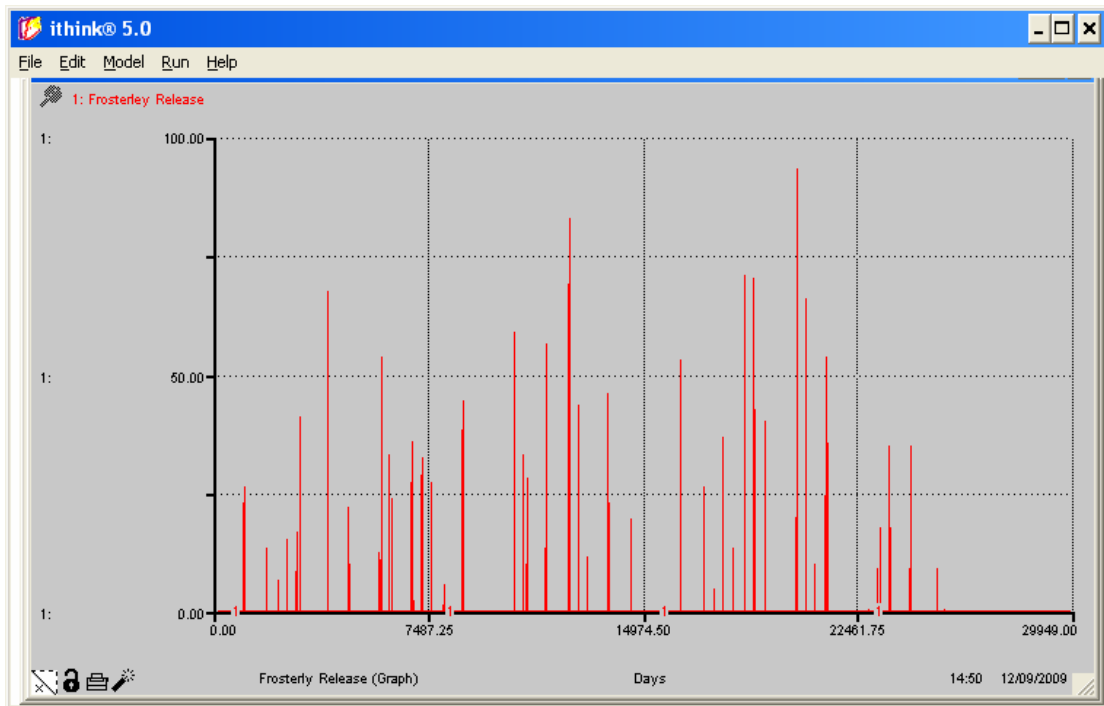
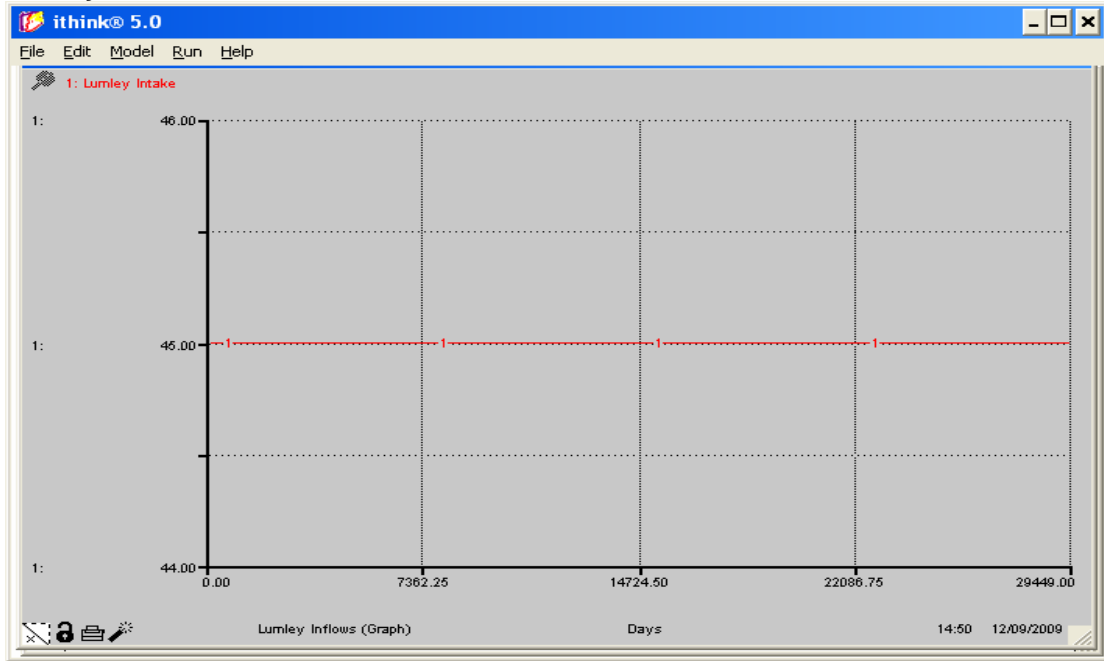
Tyne Tees Transfer Support for Mosswood



Another example of how the model confirms DO can be seen in the following 2 graphs the first of which shows the DO at Lumley TW which takes water from the River Wear. The River Wear is a regulated river and the Lumley abstraction can only be taken if a MMF is in the river. Water can be put into the Wear from Burnhope or

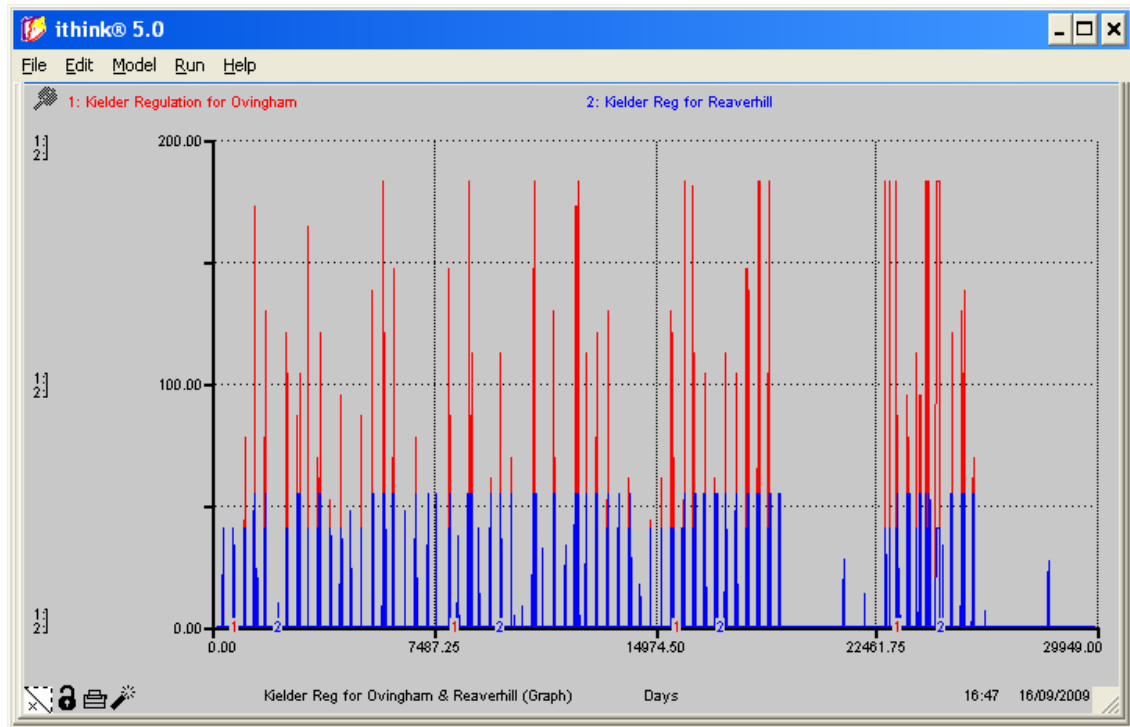
Tunstall reservoirs but in the event of these reservoirs falling below certain levels additional water can be put into the river from the Tyne Tees Transfer at Frosterley. The second graph below shows the modelled extent to which releases would be required.

Lumley Intake



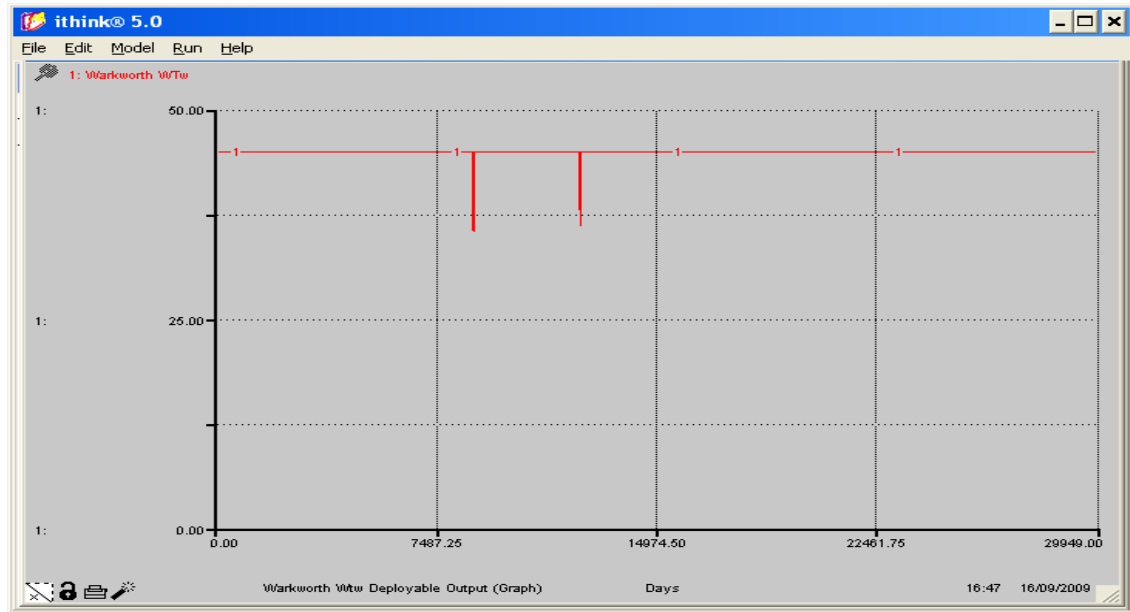
Frosterley Release

In the North Area Ovingham pumps extract water from the Tyne at Ovingham and supply Horsley TW and Barrasford pumps provide water for Hallington reservoirs. To ensure sufficient water is available to maintain these abstractions the river can be regulated by making releases from Kielder. The graph below shows the modelled requirement for such releases.



Reaverhill & Ovingham Regulation

Also in the North Area, Warkworth abstracts water from The River Coquet. This river is not regulated and NWL are only allowed to abstract to the higher licensed quantity when flow in the river is at or above a certain level. Using inflow data to determine the river level the model shows that on all but 2 occasions in the last 81 years 45 MI/day can be abstracted to provide the DO from the works of 42.5 MI/day. The graph below shows these results. The levels in the river are now monitored daily and in the event of ever reaching the lower level the works would be supplemented with water from Horsley using the strategic network to transfer water.

Warkworth TW River Abstraction

3. *Evidence that you have taken account of your review of the impact of siltation on your reservoir capacities when modelling deployable output.*

In 2003 NWL received a report looking at the effects of siltation on the capacity of Burnhope reservoir in the Wear Valley. The study had concluded that, over time, levels of siltation had reduced the storage capacity of the reservoir and an estimated figure for the reduced capacity was calculated. A further desktop exercise within NWL used this report and other sources of data to estimate the potential levels of siltation at other reservoirs based on such parameters as age of reservoir, land use within catchment, soil type etc. The extrapolation of the Burnhope study to other reservoirs, to determine the level of siltation, was deemed to be the best methodology to give the company an estimate of the effects of siltation on raw water storage capacity. It should be noted that this method is likely to overestimate the effects of siltation.

For the purposes of the draft WRMP, the i-Think model was populated with these new estimates of the capacities of the reservoirs. The table below shows the capacity differences between the previous and current (WRMP 08) model.

Reservoir	Previous Modelled Capacity (No Siltation)	Current Modelled Capacity (with Siltation)
Catcleugh	10477	8615
Colt crag	5010	5010
Fontburn	3280	2791
Hallington	6495	6426
Whittle Dene	2470	2335
Burnhope	6168	4853
Derwent	50006	47715
Tunstall	2364	2000
Waskerley & Smiddyshaw	3872	3469
Cow Green	40915	36514
Lune and Balder total	47060	41567
Kielder	198200	195950

4. *Evidence to show how you integrate the three separate models for the Kielder Resource Zone and how the Kielder transfer operates under normal and historic drought years.*

The Kielder Transfer Scheme is a system which enables water to be transferred from Kielder reservoir at the head of the North Tyne to the River Wear and down to the River Tees. It begins with Kielder reservoir which has a storage capacity of 200,000 Million litres. Varying rates of water can be released into the River North Tyne which subsequently joins the River South Tyne to form the River Tyne.

The River Tyne is a Regulated river with a Minimum Maintained Flow (MMF). This requires NWL to ensure that, regardless of how much water we abstract within our licence constraints, a minimum flow of 227 Ml/day remains in the river after our final point of abstraction at Ovingham. As the natural flow in the river drops NWL make releases from Kielder to ensure this MMF is maintained – a process called River Regulation.

This enables NWL to ensure sufficient water is available in the river to allow Barrasford to abstract its fully licensed volume, ensuring Gunnerton WTW can maintain its DO, and to also supplement the Hallington Reservoirs which supply Whittle Dene WTW. This also allows for the maximum licensed volume at Ovingham to be abstracted which, with a small supplement from Whittle Dene, ensures sufficient raw water for Horsley WTW to achieve its DO.

To enable water to be transferred from Kielder into the other rivers there is a pumping station at Riding Mill which takes water from The River Tyne and pumps it, via pipe and tunnel, as far south as the River Tees. The River Tees is also a regulated river on which NWL has to ensure an MMF after its abstraction at Blackwell. Normally this is done by making additional releases from Cow Green reservoir at the head of the Tees, but it is also possible to provide additional water, from the Tyne – Tees tunnel, into the river at Eggleston. This regulation ensures raw water resources at Broken Scar TW are sufficient to reach its DO.

The River Wear is also a regulated river with an MMF required after NWL's abstraction for Lumley WTW. If required, regulatory releases are made from impounding reservoirs at Burnhope and Tunstall but if these reservoirs are at a low level, or water needs to be retained in Burnhope reservoir to ensure supply to Wear Valley WTW, then releases can be made from the Tyne-Tees Tunnel into the Wear at Frosterley. This regulation ensures that sufficient water is available in the Wear to enable Lumley WTW to maintain its DO.

In addition to regulating the rivers to ensure a raw water supply, Kielder can also be used to provide support to the other major treatment works in the Central area. Derwent reservoir provides raw water for Mosswood TW and a

constant compensation flow into the River Derwent. In the event of the reservoir level dropping, this compensation flow can be provided from the Tyne-Tees tunnel thereby conserving water in Derwent reservoir. The total raw water supply for Mosswood WTW can also be provided from the tunnel in the event of a major issue at the reservoir. Both of these options enable sufficient raw water to ensure the DO from Mosswood WTW. Honeyhill WTW takes water from a system of 3 reservoirs Hisehope, Smiddyshaw and Waskerely. As the overall storage in the 3 reservoirs falls water can be pumped from the Tyne-Tees tunnel into Waskerley reservoir to reduce the rate of decline. Although the amount pumped is not sufficient on its own to maintain the DO of the works, careful monitoring of reservoirs levels and supplementary feeds in the distribution network ensures the DO from Honeyhill WTW is available when required.

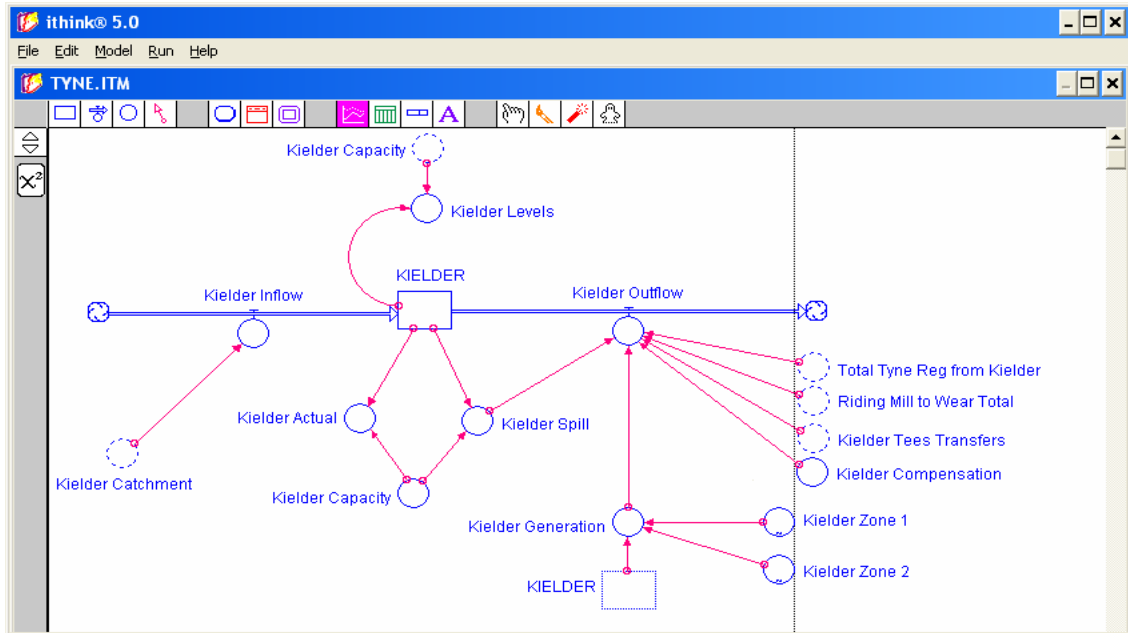
Under normal conditions regulation of the River Tyne is not required as there is sufficient natural flow to achieve the required abstractions and MMF. Under these conditions regulation of The River Wear is not normally required but would be provided from Tunstall reservoir initially rather than the Tyne-Tees transfer. No support is required from Kielder for The River Tees.

Support is required at Waskerely for around 12 weeks in the summer as the yield from the catchment of the reservoirs reduces and compensation to The River Derwent may also be transferred on to the Tyne-Tees tunnel.

Kielder remains a truly significant water resource underpinning the Level of Service of the Kielder Water Resource Zone. To gain an understanding of its potential to enable the company to endure any type of severe drought, it is worth considering the following. If we consider the hypothetical scenario where the transfer scheme was required to simultaneously provide the entire licensed abstraction rates at all the points mentioned in the above passages, and Kielder reservoir was only at 80% full at the start of the period, then the abstractions could still be maintained for a period in excess of 300 days without any inflow into Kielder.

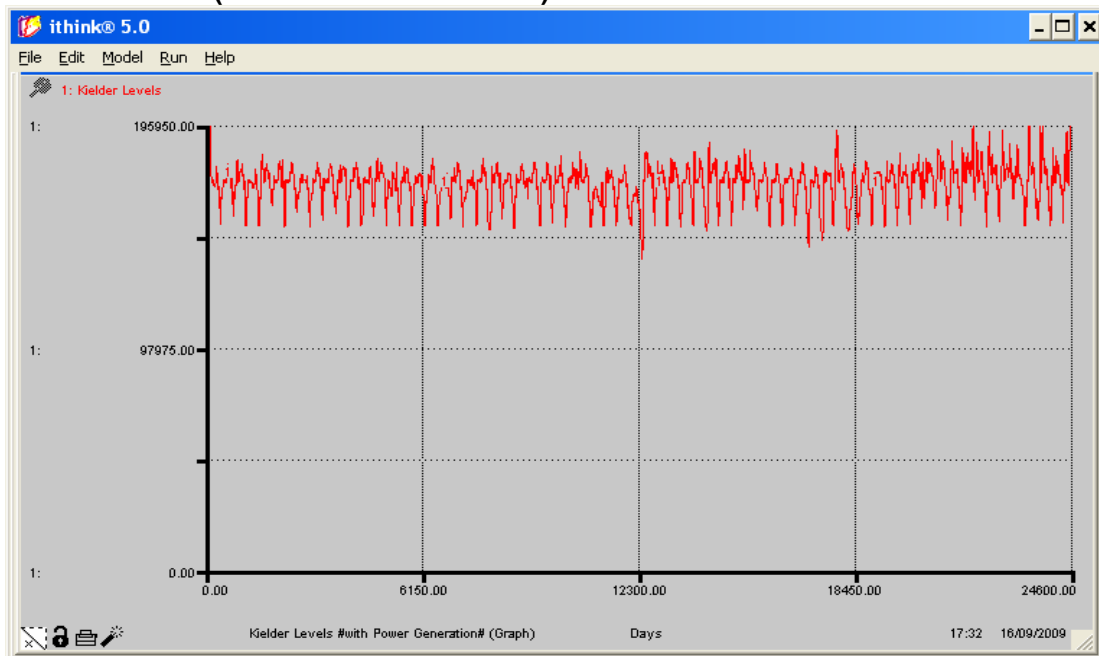
It can be seen that modelling the Kielder transfer scheme as well as the other reservoir systems would be a complex task. To make this more manageable, and to remain within the capabilities of the i-Think application, the whole system was split into three areas. The models for each area were then run individually to determine the area's input from the transfer scheme. The 3 resultant inputs from the transfer scheme were then analysed to ensure they could be achieved in total. The results showed that all required inputs could be met.

To improve the method the results from the 3 area models are now transferred into a further model reflecting the impact on Kielder Reservoir. This is shown in the diagram below.



Based on all the elements shown contributing to Kielder Outflow in the above model, the level in Kielder based on the estimated reduced capacity due to siltation, would vary as shown in the graph below.

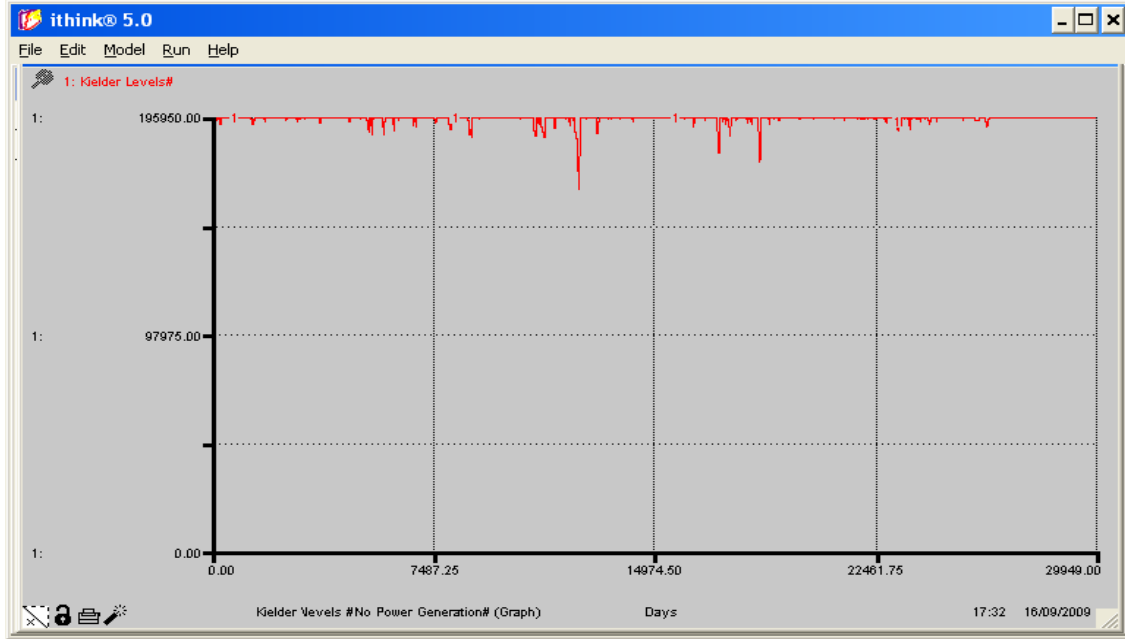
Kielder Levels (with Power Generation)



Modelling shows that the capacity would fall to around 70% of its overall capacity. The generation releases which are included in the above model could be reduced if there were the potential for a long term drought, although the record shows this would never be necessary. The graph below shows the level in Kielder if no

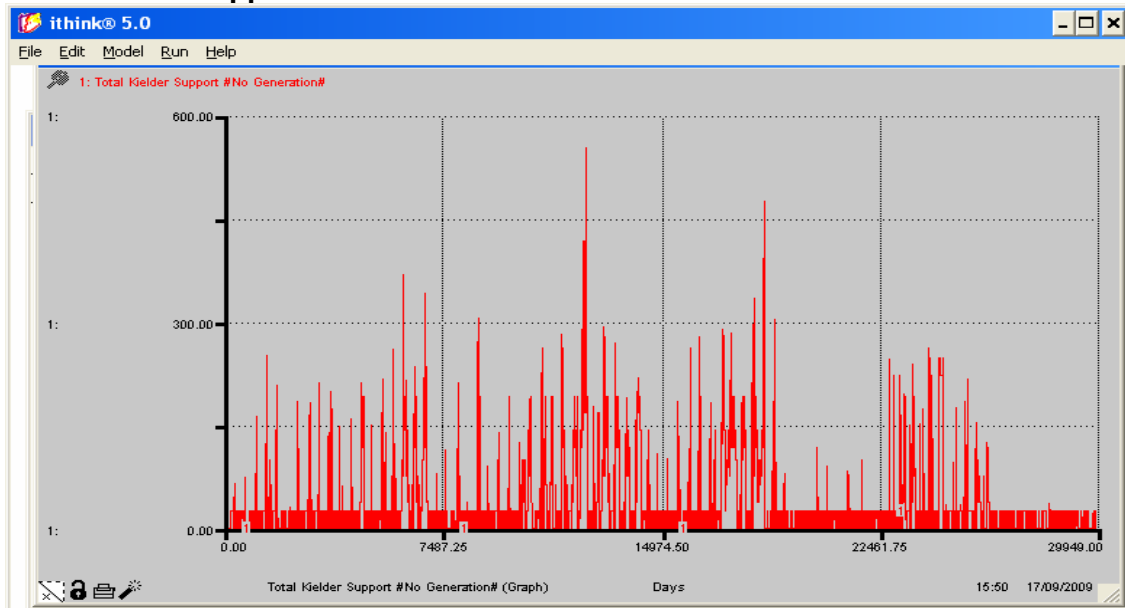
generation releases were made. Under these circumstances the reservoir would fall to around 82.5% of its overall capacity.

Kielder Levels (No Power Generation)



The overall Kielder support for the elements consisting of maintaining the DO's of the works abstracting from the Tyne and from the Tyne Tees transfer (i.e. Tyne regulation and Riding Mill pumps) is shown in the graph below with the modelled maximum in the order of 550 MI/day.

Total Kielder Support



5. *Evidence of the need for the interlinking of the Berwick and Fowberry infrastructure including an assessment of the alternative options considered.*

The Berwick/Fowberry WRZ is a small zone in the far North of the company's supply system. The zone is relatively sparsely populated (2008/09 population 18,900) with most of the population centred in the towns of Berwick and Wooler. Most of the zone is highly rural and includes Holy Island. It is classed as a separate zone to the main Kielder WRZ as there is no hydraulic link between the 2 zones and there is no direct means of Berwick being supported by transfers from Kielder Reservoir.

All water supplies within the zone are derived from groundwater, with 2 distinct clusters of boreholes at Fowberry, in the South of the zone, and Felkington/Thornton in the North, generally known as the Berwick or Murton group. The Southern supplies are treated at Fowberry and predominantly supply Wooler, whilst the Northern supplies are treated at Murton and predominantly supply Berwick. Although it is one WRZ there is currently no significant hydraulic link between the northern and southern supplies.

The WRZ, in addition to having an average day dry year demand forecast, has a critical period which is the average day peak week demand. This critical period arises from the tourist nature of the area. The Berwick/Fowberry area used to have a large influx of tourists, mainly from Glasgow, that coincided with the industrial shut down week in July. This resulted in a peak demand in July 1997 some 40% above the annual average daily demand. However, knowledge of, and measurement in, the zone at this time was much less than today and there remains some doubt if the peak was as high above the average day as was recorded. Regardless of this the tourist nature of the area has changed considerably over the last decade. Loss of heavy industry in Glasgow has meant that the shut down week for industry in the summer now affects very few workers. This in turn has meant there is no longer a large influx of tourists into the zone for 1 week of the year. In fact in 2007/08, the peak week occurred between 26th July and 1st August 2007 with an average day demand of 9.63 MI/d, compared to the annual daily average demand of 8.95 MI/d (a 7.5% increase). In 2008/09 no summer peak week could be found, with the week 12 – 18th May 2008 being the peak, which did not align with any holiday period, having an average day demand of 9.25 MI/d compared to the average daily demand of 8.46 MI/d. With 2009 predicted to be a warmer summer than 2008, and the recession forecast to result in more people holidaying at home, we will see if a peak week, in the true sense, is re-established. If no significant peak week is detected during AMP5, this zone will be removed from having a critical period.

Having examined this area to understand the changes since 1997, it has obviously developed as a much longer season holiday resort and has also seen a large increase in 2nd home ownership, often as a result of conversion

of previously derelict homes or agricultural buildings. Two very large, and growing, caravan sites have been built up around Haggerston (Berwick supply) and Wooler (Fowberry supply).

The overall, permanent, population in the WRZ is set to increase over the next 25 years but only at about 0.5% p.a.

Year	08/09	14/15	24/25	34/35
Population (000)	18.9	19.34	20.46	21.63

From council tax receipts the Berwick area, at over 10% second/holiday home ownership, is amongst the top 10 areas in the UK for second homes.

The total WRZ has a forecast dry year daily average demand of 8.48MI/d in 2008/09 gradually increasing to 8.91MI/d in 2034/35. The licensed volumes for abstraction are:

	Berwick and Fowberry	Berwick	Fowberry
Daily Licence			
To 31/03/2015	20.94	17.3	3.64
Post 31/03/2015	20.42	17.3	3.12
Annual Licence			
To 31/03/2015	14.6	11.42	3.18
Post 31/03/2015	13.64	11.42	2.22

The lower available resource post 31/03/2015 assumes the temporary licence variation in the Fowberry area expires on this date and is not re-granted. This increase to licence was obtained in January 2008 and increased the Fowberry annual volume from 950MI/annum to 1,160MI/annum and the daily maximum from 3.12MI/d to 3.64MI/d. The licence variation was granted following the existing Fowberry licence being exceeded the previous year. In addition to the granting of the variation the company also agreed to investigate getting further resources into the Fowberry area.

The demand forecast, broken down for the 2 areas is:

Annual average dry year demand with growth pattern from revised DWRMP

Year	Berwick and Fowberry	Berwick	Fowberry
2006/07	8.91	6.19	2.72
2009/10	8.48	5.93	2.55
2014/15	8.57	5.93	2.64
2024/25	8.61	5.91	2.70
2034/35	8.91	6.08	2.83

Whilst the total WRZ comfortably has sufficient headroom to meet the expected growth (including target headroom), the Fowberry area will be in deficit when the licence variation expires in 2015. Because of the relative resources in each area, one new home in the Fowberry area effectively has 5 times the effect on the areas supply demand balance to one new home in the Berwick area. The target headroom estimate for the Fowberry area ranges from 0.04MI/d in 2008/09 to 0.12MI/d in 2034/35. On expiry of the temporary variation the area falls back into supply demand deficit.

To address the deficit the company has explored a number of options:

Increased Leakage Control

Since the full introduction of Netbase over the last few years leakage within the whole zone has been operated at, or below the ELL target. There is no opportunity, in such a rural area, to introduce leakage schemes that are economic and would reduce leakage from its current level.

Metering

This area has a meter penetration level similar to that for the whole company and this is generally expected to grow in line with the company levels. We could consider a selective (change of occupier) metering strategy for just this, relatively, small area but increased metering would not remove the forecast deficit and because of the tourist influence metering is not likely to have the same water saving effects that are seen in non-tourist areas. Second homes that are only occupied by the owner as a holiday home are likely to have opted for a meter as the RV charges for water services are likely to be higher than a measured charge. In addition converted buildings will not have a rateable value and will automatically be metered. Second homes rented out as holiday homes may choose not to be metered but having a meter or not does not alter the water using behaviour of the holidaying occupants as they do not pay for the water used during their stay, it simply forms some overall part of the weekly rent. The largest growth area in Wooler is probably the caravan/campsites in the area. These are already metered but again holiday makers are not influenced in their water use by a meter as they simply pay an overall weekly rent that is not influenced by the water they use.

Transfer in water from the Kielder zone

This option was considered as the Kielder zone has a significant surplus of potable water and is supported by Kielder Reservoir. The nearest surface water treatment works to the Fowberry area Warkworth WTW. The headroom available from Warkworth is considered sufficient to supply the increased water requirement to Fowberry, especially as the current supply area of Warkworth can be supplemented by water from Horsley WTW via the Southern trunk main.

A link to the Warkworth WTW Northern Trunk Main network via Hedgeley reservoir was considered but rejected for the following reasons:-

- The Northern Trunk Main pumps can run up to a maximum instantaneous flow of approximately 15½ MLD and peak summer demand in 2006 was 14 MLD, giving only approximately 1½ MLD of headroom.
- The existing 12" diameter Northern Trunk Main between Alnwick and Bolton pumps would be undersized to provide a supplement and a length of approximately 8 km would require upsizing.
- Bolton pumps lift water into Hedgeley reservoir. The pump currently runs for 24 hours per day in the summer, so would not have additional capacity. It would require an upgrade.
- The nearest mains on the Warkworth system with any additional spare capacity of the magnitude required to supplement the Fowberry system is the 9" main at Dean House on the A697 road near Glanton some 17 km to the south of Wooler.

In summary 2 pumping station upgrades and 25 km of new main would be required.

Whilst this option has not been specifically priced because of the quantity of the work required to make the link it was ruled out as an option, it would be in excess of £5m.

Linking Berwick to Fowberry

The linking of the Berwick / Felkington supplies to the Wooler / Fowberry supplies is the favoured option on grounds of building more resilience into the Berwick WRZ and has the least cost. As has been shown earlier, the Berwick zone as a whole has sufficient licensed resources to satisfy the supply demand balance over the planning horizon with an available headroom in 2034/35 of 3MI/d (20%). Berwick has a DO far in excess of forecast demands and Fowberry has a DO below forecast demands. We intend to utilise the Felkington borehole output (1.4MI/d) and transfer the potable water to Watchlaw Service Reservoir that feeds the Wooler/Fowberry system. This involves the laying of 6km of 225mm mains. The cost for this work is £0.716k.

This option has been included in our Business Plan to Ofwat and will be instigated in AMP5.