A SUBMISSION

BY

THE RIVER SHANNON PROTECTION ALLIANCE (RSPA)

TO

IRISH WATER

IN

THE MATTER OF POSSIBLE DIVERTING OF RIVER SHANNON WATER

TO

DUBLIN

APRIL 2015.

CONTENTS

INTRODUCTION

On March 9th, 2015 Irish Water published a 'Need Report' in which it claimed that Dublin would, in the near future, require a new and additional source of water to cater for the anticipated needs of the Greater Dublin Area (GDA). The report, and subsequent media announcements, indicated that it was seriously considering Diverting River Shannon Water via a lengthy pipeline, some 100 miles in length and at a cost well in excess of 500 million Euros , to Dublin for domestic, commercial, and industrial consumption.

This is the third attempt in the past nine years , to force through a Shannon Abstraction Proposal, each time producing high cost reportage, with each proposal less convincing than its predecessor. The first two proposals were produced by Dublin City Council (DCC) and its consulting engineers. The current proposal is the work of Irish Water which has taken over the task of promoting what can now be seen as the Irish Water/Dublin City Council Shannon water abstraction scheme.

None of the proposals to date differ greatly, except for minor tweaking and rewording, making it clear that the Shannon is viewed as the only game in town. They include extracting water at a rate of some 300 hundred million litres per day (MLD), a level of abstraction which will certainly increase exponentially year on year with the runaway growth of Dublin.

The River Shannon Protection Alliance (RSPA) considers these proposals to be:

UNNESSARY – There are ample supplies of raw water available to GDA, both now and well into the future, and a range of additional sources exist in close proximity to Dublin, should they become necessary in the future.

A LICENCE TO WASTE – Close to half of Dublin's water supply is currently lost due to leakage, and no serious commitment toward system repairs are included in the Irish Water proposal. The introduction of Shannon water would result in a disincentive to eliminate profligate waste of hundreds of millions of litres per day.

HIGH RISK - The Irish Water/DCC proposal poses many serious risks to the communities along the complete length of the Shannon from the Shannon Pot to the Shannon Estuary, economically, socially, and environmentally. The report fails to outline any form of pumping strategy or water level monitoring or water level control on the river Shannon and its lakes as a whole, the absence of which would place at risk the preservation of water quality; the ecology; the navigation; the angling industry; the boating industry; the hotel, B&B, and catering industry, along the complete length of the River Shannon catchment area. These adverse affects would be particularly acute during Summer / Dry periods when water availability is lowest and demand is highest.

BREACH OF EU WATER FRAMEWORK DIRECTIVE – Environmental Scientist, Jack O'Sullivan has stated that "taking huge volumes of water from the Shannon Catchment and discharging into the Irish Sea would be contrary to the principles of the EU Water Framework Directive".

DRIVEN BY VESTED INTERESTS – The scheme is promoted by vested political and commercial interests in Dublin City Council and its east coast satellite counties, so as to ensure a continued inflow of Foreign Direct Investment (FDI) to Dublin and the east coast, with scant regard for the economic development requirements of the regions outside the pale, and particularly the riparian communities (more than one million people) along the full length of the Shannon.

This document and accompanying appendices will deal in greater detail with each of these areas of concern, making it clear to the promoters of the proposed scheme, and parties in a position of influence, that the proposed diverting of the Shannon is based on flawed assertions and forecasting - is a travesty in the making - and represents Victorian Era Technology for a 21st. Century Problem.

CRITIQUE OF IRISH WATER NEED REPORT PUBLISHED ON 9th MARCH 2015

The Irish Water Need Report (IWNR) published on the 9th March 2015 has, like other previous published reports on this topic, started with an answer and strived to fill in a surrounding story to support that answer while ignoring a range of alternative answers. The preferred answer espoused by Irish Water is that the future water supply needs of the Greater Dublin Area (GDA) need to be met by pumping water from the River Shannon as the only alternative mentioned is desalination which is prohibitively expensive (i.e. a straw man). In this critique virtually all of the assumptions upon which this answer is based are questioned and alternative answers are provided which have the potential to save taxpayers/water customers somewhere in the region of €500m in the medium term. The opportunity cost of this proposed project is therefore extremely high.

The findings of the Irish Water Need Report (2015) are refuted under four main headings: (1) framing of debate; (2) demand projections; (3) alternative supply options; and (4) best practice with taxpayers/water customers money.

(1) Framing of debate

The impetus for the work carried out on this topic was a genuine concern around the turn of the millennium with future raw water supply for the Greater Dublin area as the Celtic Tiger period was showing a rapidly increasing demand curve. This growth was never sustainable, however, and should have been recognised as such by those tasked with predicting future trends. What came out of this work was a figure of around 300 MlD (megaliters per day) which was considered to be what a major new source should supply to meet demand. This includes peaking and contingency planning. In the last number years there have been constant links made in the media between disruption to water supplies in GDA and raw water supply shortage. These links are completely without basis as the reason for all those recent water shortages was a shortage of treated water and not raw water. The October 2013 water shortage that coincided with the Web Summit was a technical treatment issue that is apparently resolved. The debate needs to be clear about the difference between raw water supplies and treated water supplies. It should also be clear at this stage that imposing a figure of 300 MlD on potential new raw water supply options is a completely unnecessary artificial restriction based on flawed modelling. In the Irish Water Need Report (2015) the only references to alternative options were a handful of mentions of 'desalination' whereas, in reality, there are a wide range of options on the supply side as well as on the demand side for meeting requirements in the next 30 or more years.

The 'benefitting corridor' is an add-on feature that has little relevance to the primary objective which is the GDA water supply. The reason it has little relevance is that there is a plentiful supply of raw water available in the counties mentioned in this corridor and any current problems are due to poor investment in local treatment infrastructure which is a separate issue.

(2) Demand Projections

In order to reach the magical figure of an extra 300 MlD or so needed to justify the Shannon Scheme, Irish Water has been required to use 2050 as a planning horizon and to include a large part of the midlands where there is not a raw water supply restriction issue. It also involves a huge number of assumptions being made by the independent expert report writers (Indecon and AOS Planning) that are little more than guesses. An analysis of water demand forecasting by the relevant authorities in this area in recent times has shown it to be extremely poor. The original 2006 need report produced by RPS-Veolia for Dublin City Council produced an alarming picture of 'knife-edge' supplies with 2016 considered as a critical date for finding a large new raw water source. A further report in 2008

reinforced this view, although extending the critical deadline out somewhat and all intervening reports/statements in the following years have been along a similar vein. The reality in 2015 is that these early demand projections are already, after less than 10 years, some 75 MLD too high as demand has plateaued since 2007 at around 540 MLD. This forecasting error is extremely high and highlights the shortcomings in those tasked with assessing future water demand. As 2050 is now 35 years away, the figures in the Irish Water Need Report are essentially meaningless based on past forecasting experience. Planning a range of flexible and quicker solutions to meet estimated demand within the next 20 years would be a far more prudent use of money.

The historical reality is that population growth (which also does not necessarily correlate on a one-to-one basis with water demand) is closely linked to net migration and the past 35 years has seen a lot of variation in this. The original 2006 RPS-Veolia report did not factor in negative net migration while the CSO estimates for April 2013 and 2014 in Figure 1 show what actually occurrred with figures of -33,100 and -21,400, respectively.

CSO statistical release, 26 August 2014, 11am

Population and Migration Estimates

April 2014

	Year ending	
	April 2013	**April 2014**
Immigration	55,900	60,600
Emigration	89,000	81,900
Net migration	-33,100	-21,400
of which Irish nationals	*-35,200*	*-29,200*
Natural increase	40,800	37,900
Population change	7,700	16,500
Population	**4,593,100**	**4,609,600**

Figure 1

The fluctuating trend of positive and negative migration is reflected in longer historical records as shown in Table 1. The purpose of including this here is to show that accurate predictions of population growth are really not possible on the timescale of 35 years. Another factor is internal migration within the country from rural to metropolitan centres and vice versa. The continued high cost of accommodation in the GDA could be a very significant factor in turning people away from living there in the future and this could have a knock-on effect for businesses wishing to locate there.

Table A Average annual births, deaths, natural increase and estimated net migration for each inter-censal period, 1926 to 2006

Period	Total births	Total deaths	Natural increase	Change in population	Estimated net migration
			Thousands		
1926 - 1936	58	42	16	0	-17
1936 - 1946	60	43	17	-1	-19
1946 - 1951	66	40	26	1	-24
1951 - 1956	63	36	27	-12	-39
1956 - 1961	61	34	26	-16	-42
1961 - 1966	63	33	29	13	-16
1966 - 1971	63	33	30	19	-11
1971 - 1979	69	33	35	49	14
1979 - 1981	73	33	40	38	-3
1981 - 1986	67	33	34	19	-14
1986 - 1991	56	32	24	-3	-27
1991 - 1996	50	31	18	20	2
1996 - 2002	54	31	23	49	26
2002 - 2006	61	28	33	81	48

Table 1

The critical demand outline of the Irish Water Need Report (2015) is given in Table 5-1 of that document and this is reproduced below in Table 2. There are a number of interesting additions not least of which is an extra 100 MlD required under 'Strategic Industrial Allowance' by 2050. To put this in perspective, this equates to around 12 further full St. James Gate Guinness breweries which is either: (a) complete fiction; or (b) a very good reason for people in the Shannon Region to hold on to their water supplies and attract these large industries that would presumably employ lots of people in the area they choose to locate in.

Table 5-1 Water Demand Projection Summary (Shannon source option)

Component	Scenario 1(a)	Scenario 1(b)	Scenario 2
	2050 (Ml/d)	2050 (Ml/d)	2050 (Ml/d)
Domestic Demand	263.3	228.9	260.7
Non Domestic Demand	177.7	170.0	181.1
Strategic Industrial Allowance	100.0	75.0	100.0
CSL	23.9	22.9	29.6
UFW	130.0	130.0	130.0
Operational Water	4.6	4.2	4.7
Peaking Allowance (20%)	93.9	85.2	95.2
Headroom and Outage (15%)	70.4	63.9	71.4
Production Requirement	863.8	780.1	872.7
less Existing Sources	658.0	658.0	658.0
Demand / Supply Deficit	205.8	122.1	214.7
Benefiting Corridor	99.1	99.1	99.1
Total Potential Supply Requirement	304.9	221.2	313.8
Allowance for WTP usage (5%)	15.3	11.1	15.7
Abstraction Requirement from 'New Source'	320.2	232.3	329.5

Table 2

Treated water losses from both distribution and customer leakage, according to the Irish Water report, are currently at 33% in the GDA which is high by international standards with the best

countries achieving 5 – 6% losses under this category. The stated approach of Irish Water is to deal with leaks according to what they term the 'sustainable economic level of leakage' (SELL). That means: fix them until it is not economic to do so. This approach is wide open to manipulation as no outsider can be sure what the economics of a particular project are and leak repairs (which are internationally known to be a cost-effective solution to supply issues) could easily be cast aside in favour of investing in a large new source such as the Shannon Scheme which would account for a huge amount of the Irish Water infrastructure budget.

Another element in the figures listed in Table 2 is the large amount (c. 160 Mld) attributed to both 'Peaking Allowance' and 'Headroom and Outage'. It is not explained how this relates to both treated water and raw water supplies. While summer drought shortages would relate to raw water supplies, the classical shortage associated with running taps in freezing weather in winter will not be related to raw water shortage but rather treated water shortage. This figure requires further explanation as a result of this and other observations.

The next item of note in the report is the chart reproduced in Figure 2 (Figure 5-A in the IWNR). This is a blatant misrepresentation of the current water supply situation as it omits the current water supply capacity within the so-called 'benefitting corridor'. This is an inexcusable omission and merely shows the diagram to be useless spin. The steep growth slope in the green curve at around 2021 is an arbitrary feature with no basis in fact. This chart can consequently be completely disregarded. As shown in Figure 3, the main items of note are that current raw water supply in the GDA is c. 623 MlD while average demand has plateaued at c. 540 MlD for about 8 years now. The argument being made here is not that new sources are not needed but that, in the context of the current situation, imposing a constraint of 300 MlD on potential new sources is ridiculous.

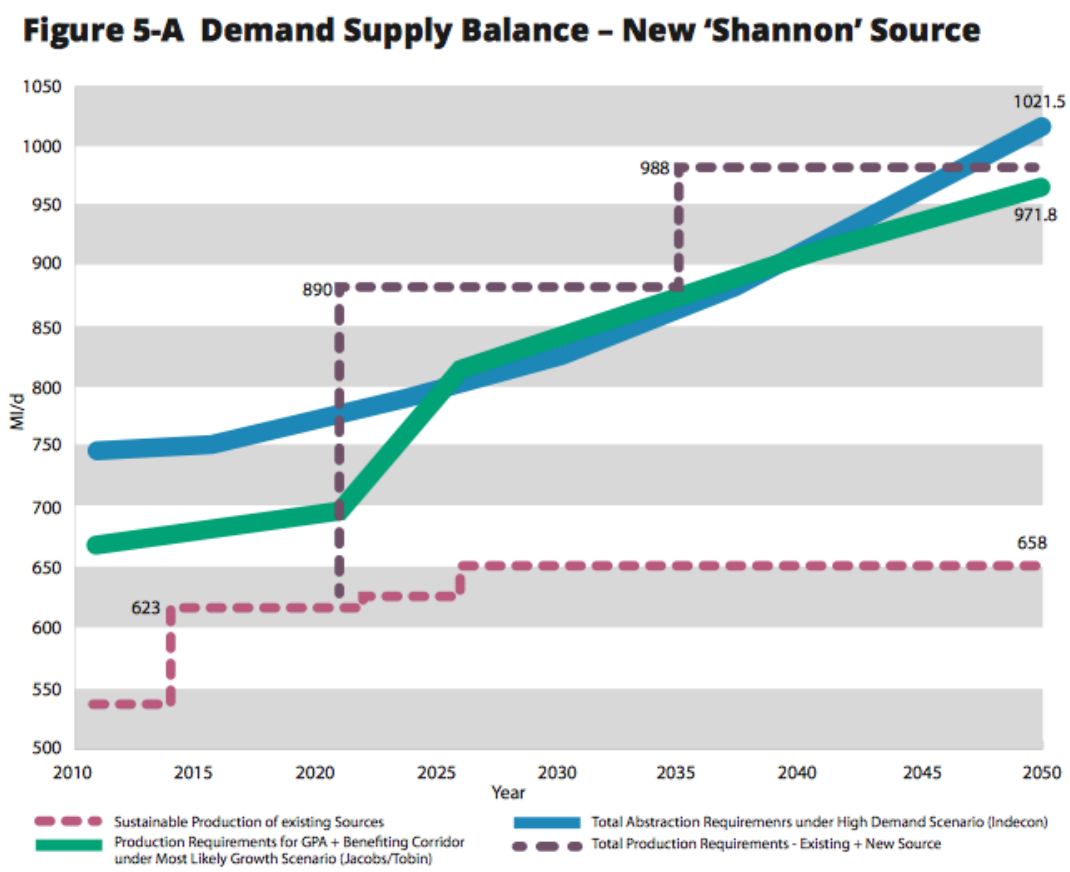


Figure 2

Table 6-1 Production Capacity / Deployable Output of the water treatment plants serving the Water Supply Area of Dublin

Water Treatment Plant	Production Capacity / Deployable Output (Ml/d)			
	2011	2015	2022	2026
Ballymore Eustace	310	310	310	310
Leixlip	148	215	215	215
Vartry	65	65	75	75
Ballyboden	12	12	12	12
Srowland	0	13	13	38
Bog of the Ring	3	3	3	3
Rathangan Wellfield	3	3	3	3
Monasterevin Wellfield	2	2	2	2
Total	543	623	633	658

Figure 3

(3) Supply Options

There are a broad range of options within this category that vary in terms of complexity of explanation and cost-effectiveness. As well as the obvious leak reduction process already referred to, two illustrative options are discussed in broad outline here as potential large new sources of water that are technically straightforward from an engineering perspective. These are groundwater resources and environmental flow replacement. The main differences between these and the Shannon Scheme are as follows:

1. Unlike the Shannon Scheme, they will not require the spending of at least €700m before one drop of water is delivered. The individual cost per project (several stages can be envisaged) range in scale from probably €10m up to €150m depending on what scale these would be carried out at. This would represent a flexible solution that can greatly reduce demand-side risk in the lifetime unit costs of water for new supply options.
2. They are likely to take between 3 to 7 years to deliver which is far better than the 10 years or more that a Shannon Scheme would require as it is already very clear that there is very determined local opposition to this project.
3. Unlike the Shannon Scheme which will account for a huge portion of the available capital budget and will therefore most likely be carried out as a single solution, the supply option approach advocated here allows for several different strands of new water supply development and water conservation to take place simultaneously which greatly reduces the economic risks involved.

3.1. Groundwater

As is evident from Figure 3, groundwater currently accounts for a very small amount of the water supply in the GDA, which is in stark contrast to the situation worldwide where it constitutes a major supply source. The potential of groundwater to serve the new water supply needs of the GDA was addressed by Eugene Daly and Associates in their 2008 report for Dublin City Council. The area under consideration in this study was within an 80km radius of Dublin. This conservative report whittled down the number of available MlD by applying stringent criteria for potential sources but even still managed to identify a potential sustainable availability of 125 MlD within the area studied. This was a token report, however, as it was made clear beforehand that a new source should be able to provide

300 MlD, which is considered to be nonsensical in light of the plateauing of demand in the GDA in the last 8 years. Several times in this report, the authors outlined the limitations of the available data and no comprehensive dedicated drilling exploration programme was carried out in conjunction with it. It should, therefore, be considered as no more than a useful guide and a proper well-funded study that includes drilling exploration should be undertaken in order to provide more concrete answers to the amount of groundwater resource available and the costs and hurdles in extraction.

In this critique it is not possible to go into any detail on the nature of the total groundwater resource but three illustrative observations are made in the following sections that suggest that supplies of at least 100 MlD should be potentially viable, if not considerably more.

Regional resource

The first observation is shown in Figure 4, which shows the level of annual groundwater recharge for the whole of County Kildare (top right in this case – the other counties shown are not relevant to the GDA). By way of example, the large sand and gravel aquifer that underlies the Curragh and surrounding area is evident as a purple cluster in the centre and this has been described as being around 180 square kilometers in size. The annual average groundwater recharge of this aquifer is around 400mm, which means that the total potential supply of this one feature alone is of the order of 200 MlD. Not all of this water is obviously available but even a 20% availability would be in the 40 MlD range. This would represent a very significant water supply resource and can be one component in an overall flexible new supply solution. It is worth noting that there is still considerable debate among hydrogeologists as to how to charactise yearly evapotranspiration within a given area including the amounts involved and how this varies by season. Potential evapotranspiration as calculated using the Penman method is not the same as actual evapotranspiration, which is a percentage of the former. This topic is very relevant to groundwater resource assessment and should be recognised as an area where there is incomplete knowledge in terms of characterising the productivity and sustainability of Irish aquifers.

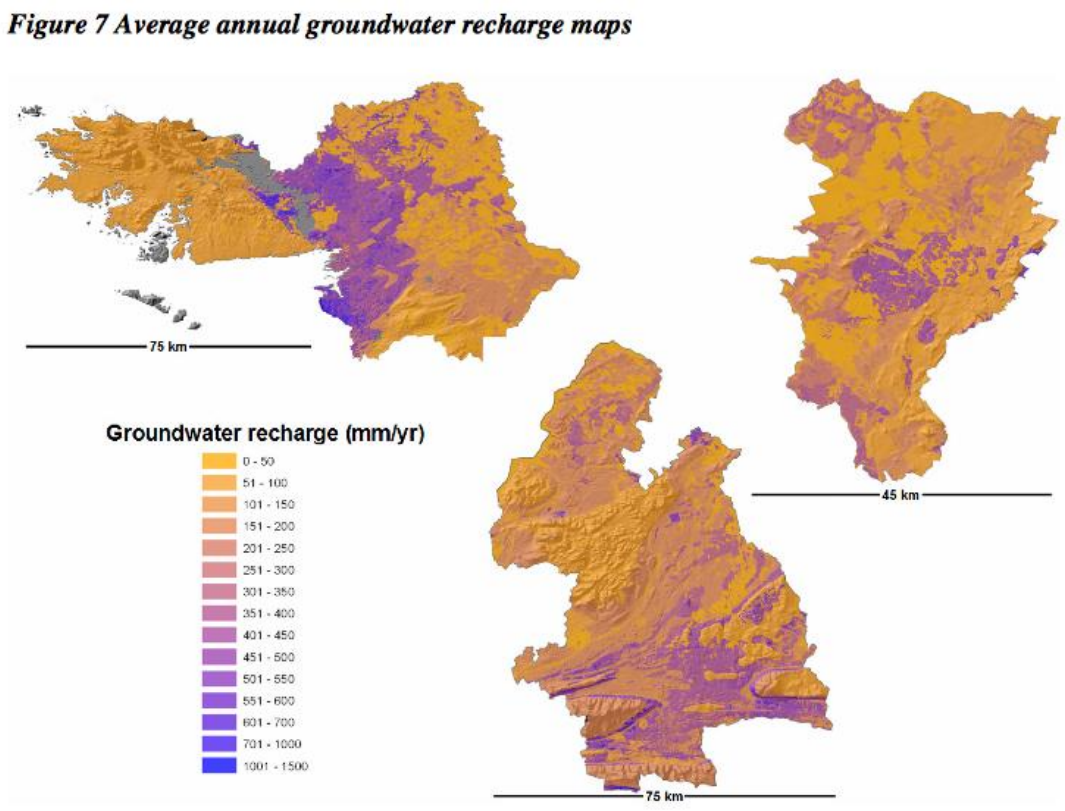


Figure 4. Source: OPW

http://www.opw.ie/hydrology/data/speeches/08%20-%20Hunter%20Williams%20-%20National%20Groundwater%20Recharge%20Map.pdf

Well yield example within the Curragh aquifer

To follow on from the sample given above, Table 3 shows the current yield from two exemplary groundwater wells in the Curragh. The well in the right column, Hare Park Deep Well, was drilled pre 1940, is 70m deep and has a diameter of 350mm. The yield of this one well alone is recorded as 2765 cubic meters of water per day (or 2.765 MlD) which is substantial. Approximately 15 such new wells, drilled at low cost in the Curragh aquifer, would provide around 40 MlD. The use of groundwater provides additional security of supply as surface water resources are the first to suffer in drought conditions while large aquifers can contain considerable buffer storage.

10.2 Summary of Borehole Details

	McDonagh Deep Well	Hare Park Deep Well
GSI no.	2621SEW436	2621SEW208
Grid ref. (1:25,000)	278829 216604	277130 211600
Townland	Curragh	Curragh
Source type	Borehole	Borehole
Drilled date	Pre 1940	Pre 1940
Owner	Dept. of Defence	Dept. of Defence
Elevation (ground level)	~110 m O.D.	~110 m O.D.
Depth	Approximately 70 m	Approximately 70 m
Depth of casing	Assumed to be screened to full depth	Assumed to be screened to full depth
Diameter	300 mm (12")	350 mm (14")
Depth to rock	Approximately 70 m	Approximately 70 m
Water level	15.92 m below ground 30/10/02 (not pumping at the time of measurement)	18.45 m below ground 30/10/02 (not pumping at the time of measurement)
Maximum drawdown	Not available	0.66 m (Ball, 1995)
Consumption (Water Works Personnel)	800 $m^3 d^{-1}$	1100 $m^3 d^{-1}$
Yield:	1010 $m^3 d^{-1}$	2765 $m^3 d^{-1}$ (Ball, 1995)

Table 3. Source: GSI

http://www.gsi.ie/NR/rdonlyres/67DA292A-A163-4926-A4AD-5A5F182FBFDE/0/CURRAGH_001.pdf

Rec*ent wellfield yield example from Co. Waterford*

As an illustrative example of what is being carried out in other water supply regions, the following information relates to the Ring Helvick Area in Waterford. The first part is a summary email written to local Labour Councillor Fiachra Ó Céilleachair by John O'Flynn, Deputy County Manager, in July 2008, that outlines the water supply development that is being considered with the most relevant section highlighted. This is reproduced here from the following source: http://www.labour.ie/fiachra/news/1217539399478332.html

Date: Wed, 30 Jul 2008 10:02:28 +0100

From: dmoore@waterfordcoco.ie

Subject: FW: RE: Ring Helcick Water Supply Scheme

To: fiachraoc@hotmail.com

RE: Ring Helvick Water Supply Scheme

Cllr. O'Ceilleachair,

Further to your email dated 29 July 2008 regarding the commencement of the construction phase of the aforementioned project. RPS Consultant Engineers Ltd. were appointed to assess the strategic supply options for the Ring Helvick Area and to subsequently prepare a Strategic Review Report for the Area, the initial draft of this report was issued in December 2007. The report also reviewed the findings of the Ardmore Water Supply Scheme Preliminary Report and the results of the groundwater investigations carried out in Dungarvan in May 2007. Following our detailed technical appraisal and assessment of the Strategic Review Report and the recommendations contained therein, it has been necessary to revise some aspects of the report. The latest revision of which was received on 28 July 2008. The report rules out the option of supplying water to the Ring Helvick Area from Ardmore, mainly on economic grounds. The report also identifies a number of groundwater sources with potential to supply quality water with the largest yielding borehole located in Mapestown, Dungarvan.

The recommended solution proposes to develop a Wellfield in Mapestown and to utilise this groundwater supply to provide water to the Ring Helvick Area at an estimated all-in cost of EUR5.3 million. The existing water sources will be decommissioned and considerable improvements (i.e. mains upsizing and pressure increases) will be made to the existing network in the area including the provision of 24-hour storage in the form of two new storage reservoirs. It is regrettable that the approval of the report could not be completed earlier but as you will appreciate, it is imperative that Waterford County Council selects the best option for the area in terms of security of supply and value for money. *In order to guarantee this, it was important to conduct a comprehensive evaluation and assessment of the recommendations contained in the Strategic Review Report. The necessary documentation required for submission to the Department is currently under preparation. Waterford County Council will request the Departments approval of the recommended supply option and the aforementioned construction stage budget. This documentation should be complete for submission in September 2008. It is unlikely that the construction stage of this project will commence in 2008.*

Regards,

John O'Flynn,

Deputy County Manager

The next bit of information is publicly available on the website of Patrick Briody & Sons Ltd who are one of the leading drillers of water wells in Ireland and relates to more recent (2013) drilling results for the same project as described above. This is shown in Table 4.

PATRICK BRIODY & SONS LTD

Contact	Employer	Engineer	Location	Brief Description Of Work	Date
John Leonard Waterford Co.Co. (058) 22000	Waterford Co.Co.	RPS, Cork Criona Doyle (021) 4465900	Mapestown, Dungarvan, Co. Waterford.	Drilling of 2 no test wells and 6 No production wells to varying depths up to 70 meters with uPVC screen/casing string, gravel pack & grout seal. Drilling comprising deep cavernous formation with large rounded stones. Average borehole yield excess 17,500 gph. Comprehensive well development of 6 no production wells by dual airlift /eductor method. In addition, S. Kelly & Sons, (Nominated Subcontractors) completed step test @ each well and simultaneous multi well test. Full water analysis and site preparations & reinstatement undertaken by PB & Sons Ltd.	Jan-June 2013

Table 4. Source: Patrick Briody & Sons Ltd

Six production wells that averaged 17,500 gph (presumably US gallons per hour) were drilled to depths up to 70m. This is equivalent to approximately 1.6 MlD per well and so the total of the six wells is a little short of 10 MlD. In the Water Services Investment Programme literature for 2010 – 2012 (http://www.environ.ie/en/Environment/Water/PublicationsDocuments/FileDownLoad,22735,en.pdf), €5.877m is allocated to the Ring Helvick Water Supply Scheme under the heading: Source, Reservoir & Network Contract.

As a result of the above information, it can be calculated that the cost of the Ring Helvick project appears to be in the region of €0.6m per MlD delivered. This is substantially cheaper than what is being proposed for the Shannon Scheme even before the massive savings from reducing demand risk by having a highly flexible supply solution are even considered.

3.2. Environmental flow replacement

A current limitation on the available capacity at the Leixlip water treatment plant (WTP) is that there is a statutory obligation that at least 2 cumecs of reservoir water is being released to the Lower Liffey, below Leixlip Dam, at all times[1]. This is calculated from the minimal environmental flow allowed in the river to ensure a healthy ecosystem. This equates to a level of a little over 170 MlD of raw water that would otherwise be available for treatment and water supply. If raw fresh water can be recirculated from a location adjacent to where it meets salt water (Islandbridge area in the case of the Liffey) then a significant portion of the 170 MlD could become available for treatment at Leixlip WTP. It should also be noted that a number of substantial tributaries (and groundwater flow) including the River Ryewater join the Liffey below Leixlip dam adding a considerable volume to the amount of raw water present at Islandbridge. It seems feasible, therefore, that an environmental flow replacement scheme could end up providing an additional 100 MlD raw water supply that would allow for expansion of the existing Leixlip WTP.

The pipeline distance between Islandbridge and Leixlip would be in the region of 16km, far lower than any of the different Shannon options, and the pumping head would also be considerably lower. Some additional treatment and storage facilities would be required, over and above the standard requirements for an expansion of Leixlip WTP, but these should be technically feasible and relatively inexpensive to deliver. Such an engineering-based approach would be in line with current worldwide trends where 'replacement of dam releases' is being recognised as a cost-effective water supply

[1] Dublin City Council: *Dublin Water New Sources Development,* McCarthy Hyder Consultants Report no: NE02171/D16/3, 2003

solution. For example, Figure 5 shows how Sydney in Australia intends to use around 50 MlD of recycled water to free up a similar amount for treated water supply by reducing the need for dam releases. This figure is sure to grow as time goes on.

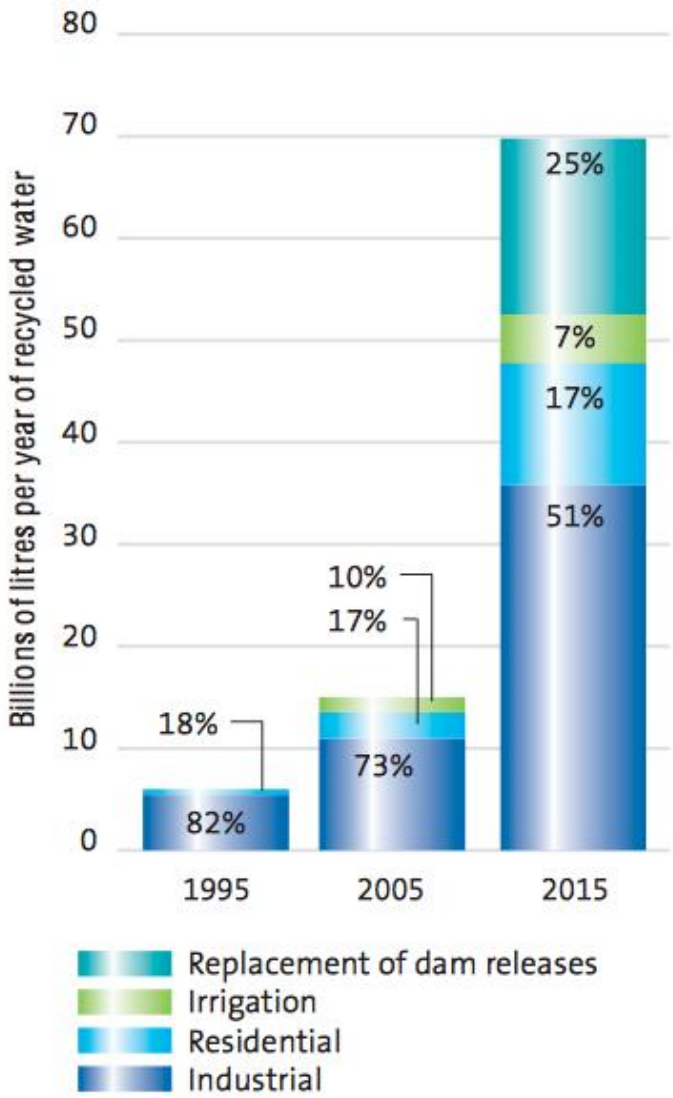


Figure 5. Source: Sydney Water

http://curieskitten.com/moodle/pluginfile.php/1043/mod_resource/content/0/water%20recycling%20greater%20Syd.pdf

(4) Best practice with taxpayers'/water customers' money

The onus is on Irish Water to provide timely and secure supplies of treated water to the GDA on the most cost-effective basis. Ploughing ahead with the Shannon Scheme in the full knowledge that it is (a) not capable of meeting any supply shortages in a timely manner, (b) multiple times as expensive as other options and (c) wide open to huge demand-side economic risk, constitutes reckless use of taxpayers'/water customers' money. The sensible thing to do, in light of 8 years of plateauing in GDA water demand, is to go back to square one and reassess all potential options without 300 MlD restrictions. Two illustrative supply options, each potentially capable of delivering at least 100 MlD (i.e 200 MlD in total) have been briefly described here and a comprehensive study is needed to show the most cost-effective combination of solutions to future water shortages. While it is not possible at present to put a value on the exact savings that could be realised in the medium term (planning for 2040 for example) by following these other options, it is considered likely that a figure in the region of €500m is reasonable based on inference from published water project costs. In the heavily-indebted Ireland of 2015 (both public and private) this represents a huge opportunity cost for one project.

RISKS AND CONSEQUENCES

ECONOMICAL

If in spite of the complete lack of need for Shannon water in Dublin, the promoters foolishly ignore the many sources of supply currently at Dublin's disposal, and yet persist with this mega project, what then are the likely risks and implications for the regions and communities, outside of Dublin and the east coast, for the Shannon River, and indeed for Dublin itself? As already stated, this is a high stakes game where many hundreds of millions of taxpayers Euros will be spent to construct a pipeline, the benefits of which are, at best uncertain, and at worst seriously questionable.

The pipeline creates a dependence on what is virtually a single source of water. In the event of an adverse occurrence on the Shannon, e.g. algal bloom, system failure, etc. Dublin customers would have a crisis on their hands. On the other hand, depending on which version of the pipeline would be installed, consumers could find themselves drinking bog water. As well as that, the cost of completing this mega project, estimated to be anywhere between 500 hundred million and 1 billion Euros, plus the annual operating costs of some 150 million Euros, will force the consumer price for water usage upwards, and all to pay for an Engineer's Dream. High water charges will not affect Dublin alone; all customers of Irish Water will pay exorbitant fees.

Outside of Dublin, the adverse affect of a compromised river Shannon will be both local and regional, and it will be severe. The river, as a living organism, is vital to the survival of towns, cities, industries, commercial enterprises, navigation, tourism, heritage, and a vast range of flora and fauna, along its complete 250 mile length. Without a healthy river where historical levels and flow rates are not interfered with, all of these would go into decline. It is difficult if not impossible to estimate the economic value all of these entities in a document of this length. However we do know that we are talking of hundreds of commercial enterprises , and the communities that are depending on them for their viability, employment, and survival.

The mid to upper reaches of the Shannon are vital to the interests of the tourism, boating, angling, sport and social, and heritage industries. The lower reaches likewise, and there are also threats to larger populations and heavy industries. Both Limerick City Council and Clare County Council have recognised this and have passed formal resolutions of objection to Shannon abstraction. Other local authorities will follow. In the Shannon Estuary alone, there are serious concerns that large scale navigation would be compromised (see harbour master's letter in Appendix). It should be noted also that Shannon Airport receives its oil supplies via bulk carrier on the Shannon.

The livelihoods of more than one million people are directly or indirectly supported by the Shannon. This has come about as a result of many years of financial investment and painstaking work on the part individuals, and organisations , building up viable commercial enterprises for the benefit of their communities, family futures, and the general economy. No one has a right to 'arrive in' and take all of this away from them at the stroke of a pen. Yes, perhaps another community will gain, but at whose loss? This is a classic case of 'Robbing Peter to Pay Paul', and it simply will not be tolerated.

ENVIRONMENTAL

The ecosystem of the Shannon and its hinterland is a fragile one. It plays host to and supports countless forms of aquatic and non aquatic forms of life, migratory birds of major importance, and contains a number of vulnerable and important National Heritage Areas (NHAs), Special areas of Conservation (SACs), and Special Protection Areas (SPAs) for wildlife, and these areas are extremely sensitive to fluctuations in water levels and rates of flow.

HERITAGE

There is an abundance of heritage areas of national and international importance along the Shannon. Two of the more significant examples are Clonmacnoise – an ancient monastic settlement, dating to 544 A.D., one of the jewels in the crown, historically speaking. Lough Derg has many such sites, and the whole of the lake has been declared a heritage area. Access to these and many others is via landing craft, and any interference with the integrity of these revered sites would be met with a massive outcry.

BALANCED REGIONAL DEVELOPMENT

The promoters of the scheme are mainly Dublin and east coast political and commercial interests. Beyond these, there is no appetite for such an undertaking, anywhere in Ireland. The expressed 'need' for a new water source is driven by vested interests whose sole objective is the attraction of more and more foreign direct investment (FDI) and economic development to Dublin and the east coast. To achieve this, they are prepared to divert the Shannon to Dublin. This is tantamount to bringing the water to industry, rather than bringing the industry to the water, where it already exists. Doing so, further copper fastens the imbalance in regional economic opportunity that prevails in Ireland, to an extreme degree. The regions require the full use of all their resources in order to advantageously build their economies. Taking these resources away from them is contrary to the stated policies of balanced regional development, when what is really needed is 'positive discrimination' in favour of the regions.

Beyond the 'Pale', all areas, particularly those west of the Shannon are in need of economic improvement, and diverting the Shannon will be seen as a further emphasis and increase of the all too real East/West divide, economically and politically. Government's role on the issue, and that of all public representatives will be called into question, and held to account by their constituents. To commandeer the Shannon or Not, could well become a 'defining issue' of whether powerful political engineering can prevail over an issue of national importance which should be above politics.

In the coming general election, all candidates, regardless of party affiliation, will be called upon to remember who is voting them into office, and what the voters want from them.

CONCLUSION

As previously stated, the current study embarked upon by Irish Water is the third such exercise aimed at diverting the Shannon. All of these studies incur major consultancy and other fees, amounting to the best of our knowledge, to millions of Euros of tax payer's money. Should the current study proceed to the next levels, additional fees, of the same order or higher will be required to carry out the mandatory Environmental Impact Assessment (EIA), and a detailed Planning Application.

The first two studies were carried out by Dublin City Council (DCC), and produced nothing more than expensive glossy proposal documents, concluding of course with Shannon Abstraction. It is obvious that the current study is reaching the same conclusion, i.e. to no one's surprise, Shannon Diversion. One has to question the need to carry out three studies of the same subject and reaching the same result each time. Why the need to go over the same ground again and again? What can be different this time around? Who is paying for all of this?

The first two studies went no further than the production of proposal documents which presumably are now gathering dust. Is this a case third time lucky or wishful thinking? Or do the promoters think that they can ram it through in bully like fashion?

We call upon Irish Water to provide answers to these questions, and to explain how they can possibly justify such costs, and their insistence on 'Shannon or nothing else'.

<u>The risks of Privatisation.</u>

The RSPA has consistently called for the establishment of a national body for the purpose of sustainably managing all of the fresh water resources of Ireland (rivers, lakes and subterranean), so as to safeguard them in trust for the Irish people. Irish Water is not such an organisation. It is in fact a billing and revenue generating organisation. Despite assurances currently in place that it will remain a public body, as a private company it can at any time in the future be sold in whole or in part to private investors. At that point, Ireland would cease to own its own water, and would be subject to the whims and demands of shareholders and the vagaries of market conditions.

The negative consequences of privatisation around the world are well known. In most cases it has led to mismanagement, high consumer prices, neglected leakage repair (suppliers are paid by volume sold regardless of leaks), i.e. greater water loss, and reduction of conservation. In most cases, through mismanagement and over abstraction, rivers have been irreversibly damaged. The stranglehold of the corporate operators has resulted in many countries attempting to buy back their water rights.

Already, the possibilities of attracting private capital are being put forward, probably to help keep Irish Water off the national balance sheet. If the company is being established in a manner which would make it attractive to the private sector, and there are serious signs that this might be the case, then we need to worry more for the integrity of the Shannon.

The 'Shannon or Nothing' policy is as previously stated, deeply flawed and completely unjustifiable. It should be abandoned immediately in favour of the viable supply options available to Dublin's needs, beginning with aggressive leakage repair. Monies spent already would have made a considerable dent on leaks, and increased the potable supply somewhat.

The RSPA in conjunction with its affiliates, stakeholders, and general membership, will continue to actively oppose any incursion into the Shannon. The organisation is 'in it' for the long haul, and will pursue it at every level necessary to remove the threat to this renowned river.

Should a Shannon based proposal be proceeded with, we will make a strong case against at planning application time. We would be surprised if planning is granted, however if it is, we will appeal, and pursue the matter even further through the courts if necessary, and not excluding European representation where the matter is already receiving attention.

It would be much more preferable of course if the promoters of what is being described as a ‘daft scheme’ come to their senses and stop wasting vast sums and valuable time on a quick fix soft option solution for a problem that may never exist.

APPENDIX

- RSPA Press Release, issued on World Water Day – March 22, 2015-04-28.
- RSPA Press Release/Open Letter issued to candidates in local and European elections.
- Email/letter from Shannon Estuary Harbour Master to RSPA.
- Rethinking Big Water
- The Kielder Water Scheme: the last of its kind.

How to create a white elephant – a lesson for the Shannon.

PRESS RELEASE
THE RIVER SHANNON PROTECTION ALLIANCE
MARCH 22, 2015

Given the recent announcement by Irish Water that it is considering diverting the River Shannon to Dublin to cater for anticipated water shortages, the River Shannon Protection Alliance (RSPA) wishes to make it clear that any such proposal will face the strongest opposition to such needless, high risk, and outmoded infrastructural planning. This Irish Water/Dublin City Council proposal (the third attempt in recent years) would extract water at a rate of hundreds of millions of litres per day (MLD), and there can be no doubt that rates of abstraction will increase exponentially year on year, with disastrous consequences economically, environmentally, and socially for all of the communities along the full length of the Shannon.

Dublin does not now have a shortage of water, and it need not do so in the future. Current supplies are more than adequate for current demand, however Dublin City Council (DCC) has been throwing half of it away through years of leak ridden supply pipes and creaking treatment facilities, all of which have suffered from decades of neglect and under investment. Injecting Shannon water into such a system would result in wastage of most of this new supply, while delivering only marginal improvement. On the other hand, reducing leakage rates to international standards would double existing supplies.

If the day ever comes when Dublin needs additional supplies of water, there will never be a need to come to the Shannon. There are abundant supplies closer to home which can be availed of more easily and at a fraction of the cost of the current proposal. Shannon abstraction would require a pipeline in excess of one hundred miles in length, at a cost to taxpayers in the region of one billion Euros. At the same time a range of supply options exist on Dublin's doorstep waiting to be tapped. An estimated 100 million litres per day of high quality ground water is available sustainably from the Fingal/Meath/Kildare aquifer. Additional reservoirs can be built closer to Dublin. Desalination can provide unlimited supplies indefinitely, and it is becoming more and more cost effective with the introduction of new technologies e.g. reverse osmosis. Additionally, there is massive potential for water savings in Ireland through conservation measures. Just one example alone was a dramatic drop in consumption in the Dublin area recently, when it appeared that usage-based bills were about to issue from Irish Water in April.

Irish Water www.water.ie are currently calling for submissions regarding these proposals, and the RSPA will be responding robustly, questioning all of the assumptions and forecasting on which a new Dublin supply and Shannon abstraction are based. We call on all public representatives to consider their constituencies, and also on members of the public, to submit their views on this critical issue.

Finally, on this WORLD WATER DAY (March 22nd.) it is worth reminding ourselves that:
70% of Earth's surface is covered by water.
97.5% of that, is sea water, leaving 2.5% as fresh water.
70% of fresh water is locked up in the ice caps of Antarctica and Greenland, and underground aquifers which are too deep to be accessible.
Only 1% of the world's fresh water is accessible for human use. Found in rivers, lakes, and reservoirs.

"WASTE NOT WANT NOT"

Press Release

An Open Letter to Electoral Candidates
From
The River Shannon Protection Alliance

We are contacting all candidates in the forthcoming local and European elections.

The River Shannon Protection Alliance (RSPA) is the lead organisation opposing the Dublin City Council/Irish Water proposal to abstract water at high volumes (upwards of 500 millions of litres per day), for piping to Dublin for domestic, commercial, and industrial consumption in Dublin and its east coast satellite counties.

The RSPA has three branches, Athlone, Dromineer (Lough Derg), and Limerick, covering the full length of the Shannon, represented by 18 local authorities, with a population of some one million people.

Voters in these constituencies will be supporting candidates who demonstrably and openly oppose such dangerous, risk-laden, and completely needless assault on Ireland's greatest water course.

There is no shortage of water in the Greater Dublin Area (GDA), and there needn't be in the future (see accompanying article). There are numerous alternative water supply options available closer to Dublin which can supply the GDA with more than adequate supplies well into the future. These include fixing a leakage rate of 40%, implementing conservation/recycling measures, access to the Fingal/Meath/Kildare aquifer(yielding 100 MLDs), and desalination on Dublin's doorstep.

The promoters of this *adventure* toward the Shannon are mainly Dublin City and east coast interests. Theirs is a vested interest in attracting more and more FDI and economic development to the east coast, with scant regard for the existing and future vital needs of those beyond the pale, and indeed in total disregard for the resulting damage to the economies and social fabric of the many communities

who depend on the integrity and health of the Shannon. Such commandeering of the Shannon flies in the face of national policy of balanced regional development.

With the Midwest Region on the *cusp of an economic renaissance* there must be no risk to its prime assets and drivers of economic development. Future development will be driven by key regional assets, chief of which are, a dynamic urban area (Limerick City) with appropriate critical mass, skilled labour pool, and first class third level institutions. Connectivity in the region is now second to none, enjoying air, sea, rail, and road networks compatible with 21st. century infrastructure standards, encompassing **Independent Shannon international Airport** in County Clare, the Shannon Estuary (capacity of major maritime industry), rail network to all parts of the country, and similar advanced road systems.

Underpinning all of these factors is volume and flow of the River Shannon which must be must be protected and preserved. It has been shown that the DCC/Irish Water abstraction proposal, if allowed to proceed, will seriously compromise the ability of the Midwest to advance the economic development of the region.

Similarly, all of the towns, villages, and communities along the Shannon are poised and waiting for economic revival to support the many enterprises in commerce tourism, angling, sports activities, hospitality, etc. All of which will not thrive if the Shannon is compromised.

Sadly, this issue has all the hallmarks of a developing east/west divide, which if allowed to grow will leave the west of the country disadvantaged yet again, sacrificed on the altar of powerful political

engineering. **If ever there was a time for elected representatives to stand up for their constituencies, regardless of political affiliation, this must be a clarion call.**

Limerick City and Clare county councils have passed formal statements of objection to the DCC/ Irish Water abstraction proposal, and other local authorities are expected to do so also.
We are asking all candidates to do the right thing by the Shannon and its citizens, and to state their position in advance. Positions can be notified at info@shannonprotectionalliance.ie , all of which will be made known to our members, and to the media. **The best of luck to all of you at the polls.**

Gerard Siney

From: "Damien" <bddelaney@eircom.net>
To: "Sanders Joc" <joc_sanders@iol.ie>; "Gerry Siney" <gsiney@eircom.net>
Sent: 08 August 2011 09:57
Subject: Fw: Shannon Water Extraction

----- Original Message -----
From: "Alan Coghlan" <acoghlan2009@gmail.com>
To: <info@shannonprotectionalliance.ie>
Sent: Monday, July 25, 2011 5:24 PM
Subject: Shannon Water Extraction

Sirs,

I contact you as the Harbour Master of the Shannon Estuary. I have the responsibility for the safety of navigation from Shannon Bridge at Limerick to a line joining Loop Head and Kerry Head.

I have followed the argument about water extraction at a remove but following the figures on the daily amount of water to be extracted I have become concerned.

At Limerick we rely heavily on the current during ebb tides to scour out the river thereby making it easier to maintain and accessible for deeper drafted ships.

If this scheme goes ahead the net result will be more siltation at Limerick resulting in the reduction of ship size using the Dock and consequently a loss of income to both the city and the Port Company.

I intend to contact RPS who I believe wrote some reports on the proposal. I shall also be in contact with Jack O'Sullivan , who we know, for more detail.

Following those contacts I will revert with the Port Company's official stance on the proposal.

Best Regards
Alan Coghlan (Capt)
Harbour Master Shannon Estuary
President International Harbour Master's Association
acoghlan2009@gmail.com

08/08/2011

Rethinking Big Water -- Is It Time for a New Approach to Municipal Water Infrastructure?

By: Erica Gies

Courtesy of **Ceres**, 99 Chauncy Street, 6th Floor, Boston, Massachusetts 02111, USA

Las Vegas has long served as a stereotype of human excess: gambling, drinking, sex, all-you-can-eat buffets. But the latest chapter is playing out away from the Strip, in the part of the valley where two decades of booming development have swelled the population to 2 million residents who rely on a dwindling water supply.

Ninety percent of the southwestern U.S. city's drinking water comes from the Colorado River, impounded behind Hoover Dam in Lake Mead. An extended drought has sucked the lake's water levels down more than 100 feet since 2000, and the pipes that convey the lake's water to the city may soon protrude into open air.

If Las Vegas' excess in trying to support the water needs of millions in a sere valley marks an extreme, its proposed solution — boosting supply through megaprojects — is all too common. To ensure continued water delivery, the Southern Nevada Water Authority, which manages Las Vegas' water supply, has spent the past five years boring a lower feed pipe through rock at a cost of $817 million. And to diversify supply, the SNWA also plans to spend another $3 billion to $15 billion (depending upon who's counting) to build a 263-mile-long pipeline to bring in groundwater from rural northeastern Nevada.

Other massive water supply projects are being planned elsewhere in the U.S. Seventeen desalination plants have been proposed in California alone, according to the Pacific Institute, a non-governmental organization that conducts research and policy analysis. And Dallas–Fort Worth water authorities recently proposed a series of supply-boosting infrastructure projects that could cost $53 billion by 2060, according to **Sharlene Leurig**, senior manager of the water program at Ceres, an NGO that advocates for sustainable business.

The irony is that all this expense and financial risk may not even be necessary. "It's mythology that population growth means increase in water use." — Sharlene Leurig

Water analysts such as Leurig say the persistent impulse to boost supply is an anachronism. Many utilities' water supply managers believe they need to build new water supply infrastructure because they are using demand forecasts based upon historic use or tied to population growth, or don't forecast demand at all.

Yet in some places, including southern California, Seattle, Dallas–Fort Worth, and even, yes, Las Vegas, water demand has either plateaued or declined even as population has expanded. “It’s mythology that population growth means increase in water use,” says Leurig. In fact, per capita demand has been decreasing throughout the United States since the 1980s.

Megaproject Mania

Historically humans tended to settle near fresh water; civilizations that relied instead upon extensive engineering to supply water usually faded away or moved on when they used up their supply or a changing environment made their precarious system unstable. Such examples are legion: The Khmer’s Angkor Wat in Cambodia. The Anasazi in New Mexico. The Maya in Central America.

In many cases, megaprojects aren’t sustainable from an environmental perspective. And they can quickly become financially unsustainable.

Yet extensively engineered megaprojects such as the Los Angeles Aqueduct and the immense federal dams that clog rivers across the American West have built the contours of the country we know today. Thanks to water megaprojects, U.S. populations are booming in the driest areas, whereas water-rich communities such as Milwaukee, Wis., on the shores of Lake Michigan are losing people. Without Hoover Dam, Las Vegas would still be a tiny desert oasis. Without the LA Aqueduct, the City of Angels would remain a dusty outpost overshadowed by San Francisco. Millions of people live and thrive in places that are naturally inhospitable to humans.

In many cases, megaprojects aren’t sustainable from an environmental perspective. And they can quickly become financially unsustainable. Utilities that pursue water supply megaprojects do so at some risk because they can have unintended consequences, says Leurig. For one thing, even if a city genuinely needs new supply, megaprojects can stimulate new population growth and further exacerbate supply tensions — much as new highways beget more traffic.

The Las Vegas water utility has already run into trouble with its new pipe from Lake Mead — known locally as “the third straw.'

Ironically, megaprojects can also reduce demand and thereby undermine the fiscal integrity of the utilities building them. This occurs when the rate hikes required to pay off the project become an economic driver that encourages water consumers to conserve.

The Las Vegas water utility has already run into trouble with its new pipe from Lake Mead — known locally as “the third straw.” Ratings agencies downgraded nearly $2 billion of debt in 2011 amid declining water sales, according to a December 2012 report from Ceres. Similarly, Moody’s put Colorado Springs’ water utility on watch for a possible downgrade for awhile in 2012, thanks in part to a nearly $1.5 billion capital program to funnel water from the Arkansas River, a tributary of the Mississippi.

Desalination plants are at risk of fueling this cycle because they produce particularly expensive water. A $158 million plant in Tampa Bay, Fla., completed in 2008 at $40 million over budget, is being undermined by lower-than-projected demand and cheaper alternative water sources, according to a November 2012 Pacific Institute report on desalination plant financing. As a result the plant often operates below capacity, yet water customers must still pay for it on their bills.

So, what are those less expensive alternatives? Chief among them are conservation and reuse.

Cheapest by Far

Conservation is actually a source of water — and it's the cheapest by far. An analysis in San Diego County found water conservation and efficiency cost from $150 to $1,000 per acre-foot, whereas desalination costs $1,800 to $2,800 per acre-foot. And there's plenty of water available in the conservation bucket: The average American uses more than twice as much water as the average Frenchman, Austrian, Dane or German, according to a 2006 U.N. report.

More efficient technologies and policies that require their use are already causing demand to decline. For example, plumbing codes throughout the U.S. now require 1.6-gallon or dual-flush toilets rather than the old 6-gallon standard. Front-loading washing machines use less water than their predecessors. The economic shift from manufacturing toward services is also cutting water use across the country.

By adopting xeriscaping and other water conservation strategies, Tucson, Ariz., residents have reduced their daily water draw from 200 gallons per person in the 1980s to 130 gallons today. Photo courtesy of Sonoran Gardens, Inc.

Many utilities are pushing consumption further downward with maintenance and conservation programs. The U.S. General Accounting Office found that U.S. cities lose one-fifth of their water to leaks, so utilities can gain a lot of water — and reduce the need for megaprojects — just by repairing infrastructure and replacing leaking pipes and faulty meters. These projects are doubly smart

because the longer infrastructure repair is deferred, the more it will ultimately cost.
On the consumer side, enticements or regulations can stop people from cleaning their sidewalks with a hose, limit car washing or nudge them to swap out lawns for drought-tolerant plants.

The paradox facing water districts is how to create a rate structure that continues to incentivize conservation but also covers costs.

More utilities are also using tiered pricing to encourage conservation, charging customers increasingly more per unit of water as their water use increases. The first, say, 5,000 gallons are inexpensive. But the next 5,000 gallons will cost more, and so on.

The paradox facing water districts is how to create a rate structure that continues to incentivize conservation but also covers costs. A typical water bill addresses both fixed costs, for infrastructure investments, and variable costs, which depend upon the amount of water used. One way to increase revenue security is to hike the percentage of the bill that goes to fixed costs. Tilt too far toward fixed costs, however, and utilities lose their power to influence demand. Finding that elusive balance is critical.

Utilities that plan longer term will understand that conservation ultimately benefits their balance sheets, says Mary Ann Dickinson, president and CEO of the Chicago-based Alliance for Water Efficiency.

The San Antonio Water System operates with this understanding. Conservation rises to the top of project choices because “our models presume that water conservation is a supply,” says Karen Guz, SAWS’ director of conservation. The utility compares costs for water conservation programs with new supply costs, which illustrates the fiscal advantage of conservation programs. San Antonio’s per capita consumption was 143 gallons last year; SAWS’ goal is to decrease per capita by 2 gallons per year between now and 2020.

Las Vegas, too, is seeing the wisdom in conservation. Residents currently use 219 gallons per capita per day; Las Vegas Valley Water District’s goal is to reduce that figure to 199 by 2035.

Recycled Water

A second alternative to new supply is reuse. Wastewater from one use may be clean enough to use for another purpose. Or water may be treated to less than drinking water standards and then put to another purpose, reducing the need to bring new water into the system.

Industry, businesses and homes can also capture and reuse their own water.

San Antonio has perhaps the largest such direct-use water recycling program in the United States. Treated wastewater is discharged into the San Antonio River that wends through downtown along the famous Riverwalk. It’s then used to water golf courses and a local park and to supply local manufacturers.

Industry, businesses and homes can also capture and reuse their own water. Such "distributed water" supply became possible as technological improvements shrank the physical footprint of water treatment plants as well as their energy consumption and cost, says David Henderson, a founding partner of XPV Capital, a Toronto-based venture capital firm that invests exclusively in water projects.

"We can now build wastewater plants in a manufacturing facility and then ship them," says Henderson, who says that such plants can serve off-grid users. Some distributed users still draw water from utilities but get more than one use before sending it into the wastewater stream. For example, office buildings that use water cooling towers for climate control are starting to recycle the cooling water on site, says Henderson, periodically cleaning it so it can be run through further cycles.

Purple pipes at Titusville, Fla.'s Blue Heron Water Reclamation Facility carry wastewater that's clean enough to use for irrigation and cooling systems. Photo by Rusty Clark (Flickr/Creative Commons).

San Francisco residents are installing simple "gray water" systems to route waste streams from, say, dishwasher drainage to gardens, where they can be used to water plants. A training program for residents sponsored by the San Francisco Public Utilities Commission teaches people how to install these systems. New construction in San Francisco; Irvine, Calif.; and other cities is beginning to use "purple pipes," essentially a second plumbing system that transports non-potable water from, say, shower drainage to the toilet for flushes.

Cultural Shift

Specific usage innovations and efficient technologies are important in increasing conservation and reuse and reducing the need for megaprojects. But more critical is the cultural shift currently underway among water utilities, away from heavy engineering and toward soft path management.

Water utilities are an engineering-dominated world, points out Juliet Christian-Smith, a senior research associate with the Pacific Institute. "They know how to build pipelines, canals and water treatment plants." However, a huge

generational turnover is on the cusp, she says. “It’s a great opportunity because we have a whole different series of knowledge areas coming in. Most people who are recent college graduates will have some kind of environmental science or ecology exposure and maybe even some sustainable management training,” she says.

Also critical to the culture shift is more accurate demand management and more effective utility rate structures. The Alliance for Water Efficiency is writing a handbook, due out in June 2014, about how to design a conservation-oriented rate structure and stabilize revenue at the same time. Ceres and Pacific Institute are also working on this problem.

“If they’re panicked about declining sales and feel they’re not meeting their operational costs, they’ll cut conservation out of fear that they can’t afford it,” says Dickinson, “but it’s the most affordable solution.”

The alliance is already working with 300 utilities and plans an extensive outreach campaign after the publication of the new handbook.

Dickinson points to Australia as an example of a western country that, in response to major drought, dramatically improved the sustainability of its water management. “There’s a lot more we can do to free up water supply from waste,” she said.

The Kielder Water Scheme: the last of its kind?

CS MCCULLOCH, University of Oxford, UK

SYNOPSIS. The peculiar history of the Kielder Water Scheme provides insights into the operation of democracy, the politics of promotion of mega-projects and the problems of their subsequent assessment and accountability. Two public inquiries were held before the Scheme was approved but the industry it was planned to supply was already reducing its water requirements before construction started. Opposition to the reservoir, particularly from those whose homes it would displace, was strong and divided Conservative political allegiances. The controversies, which led the Director of the Water Resources Board to claim that schemes like Kielder would never be repeated, continue even today. The history of the Scheme has been explored by examination of the records of the public Inquiry and by interviews with some of the principal actors involved in the drama.

INTRODUCTION

The Kielder Water Scheme was conceived in the mid 1960s at a time when the power and autonomy of water engineers in England and Wales had risen to levels never before, nor since, attained. Unfortunately, engineering accomplishments were often marred by economic miscalculation. The resulting mismatch between vastly increased water supply at a time of diminishing rise in demand, together with huge debts incurred at a time of rapid inflation and high interest rates, had lasting effects on the state's management of water resources. Political intrigue and the overbearing ambition exhibited by the Northumbrian River Authority may have contributed to the replacement of river authorities by water authorities in preparation for privatisation of water supply in 1989.

A regional-scale scheme such as a water transfer network on the scale of Kielder, involving a large storage reservoir and inter-river transport of water through a tunnel, requires support politically and financially at more than the local scale. Big schemes require big finance and state backing to proceed with schemes in the face of strong local opposition. The political setting which encouraged engineers to think of major schemes such as the

Improvements in reservoir construction, operation and maintenance. Thomas Telford, London, 2006

Kielder Water Scheme will be described before its history and implications for water governance.

WATER RESOURCES BOARD

In England and Wales in the 1960s, post- War belief in national planning of resources was undiminished. As late as 1965, the idea of public ownership of all water supplies still appeared in the Labour Party's manifesto but successive governments failed to nationalise water because of fear of antagonising municipal and local authority water undertakings as well as private owners (Hassan, 1994). However, Members of Parliament (MPs) dealing with Private Bills for many reservoir schemes during the 1950s and early 1960s called for a national strategy for water resource development against which individual projects could be assessed. Reservoir construction in England was growing exponentially and many feared the associated damage to amenity and loss of farmland if this upward trend should continue unabated. Parliament wanted professional advice.

Following the 1963 Water Act, a national planning body dedicated to water resources was set up to strengthen the slow-moving Ministry of Housing and Local Government (MHLG) with its multiple responsibilities. This newly-formed body, the Water Resources Board (WRB), was an unique experiment in self governance of water engineers by water engineers and, remarkably, it survived for nearly a decade. Emerging from their customary position in the background, water engineers were allowed centre stage to proclaim their ideas of rational planning at regional and national scales. In typical British fashion, though, their power was limited to the giving of advice and was hampered by being confined to considerations of water quantity, crucially omitting quality.

The WRB's first Annual Report (WRB 1965) announced its role as "the master planner of the water resources of England and Wales", although implementation of its plans was not straightforward. In England and Wales, supplied by many rivers, the case for national planning was not obvious. River catchments appeared to be more suited for management purposes because of the interrelationship between water flowing from the tributaries into the principal rivers, on the way to the sea. Even Barry Rydz, Director of WRB planning, conceded that large areas of England and Wales were best served by local planning of water resources (Rydz 1971). Yet, many of the questions raised by reservoir construction impinged on national policies for industrial growth or for support for agriculture. The WRB was faced with a challenge to reconcile local issues with national policies, based on persuasion rather than authority.

The WRB built up to a staff of around a hundred and had a modest research budget but its influence conceptually was far greater than its size or budget might suggest. The Third Annual Report of the WRB stated:

> 'The Water Resources Act 1963 with its emphasis on collection of data provides the incentive to apply scientific and engineering principles to achieve logical development, so that water can be made available in the quantities required where and when it is needed (WRB, 1967,29).'

Supply "where and when it is needed" was the objective rather than adaptation of human developments to water availability.

With this objective, the WRB privileged quantifiable information. Their confidence in "logical development" allowed the rubbishing of opposing arguments, which were not proved by hard data. Adverse reaction "to the exploitation of the water resources of an area for the benefit of water consumers far away" was deemed "irrational" (WRB, 1967, para 49). The Director of the WRB, Norman Rowntree, believed "maintenance of our standards of life depends on expanding industrial, commercial and agricultural activity" and the "maximum development of natural resources". "The solution of water supply problems…will require the construction and operation of large works and highly-developed technical control". He believed that his opponents should not have a monopoly on emotion, "Enthusiasm and fervour" should be added to the water engineers' "cold calculations of safety, yield and cost" (Rowntree, 1962, 267).

Large-scale schemes such as interbasin transfers of water or even establishment of water grids on the model of the electricity grid certainly aroused enthusiasm and fervour and recognition for regional planning by the WRB. Without the WRB, and the financial arrangements endorsed by the 1963 Water Act, water resource development in the North East would have been very different.

NORTHUMBRIAN RIVER AUTHORITY

Another important player, this time with executive powers, was the Northumbrian River Authority (NRA), set up with 28 others, by the same Water Act 1963 which established the WRB. The ambitions of the NRA and the WRB reinforced each other. Both favoured large schemes to increase industrial water supply, mainly to Teesside. Like WRB, the NRA lasted only a decade and approval of their Kielder Water Scheme, achieved in 1973, was shortly followed by the taking over of their responsibilities and debts by the Northumbrian Water Authority (NWA), which became operational in 1974.

The Kielder Water Scheme involved construction of a large, remote storage reservoir and use of innovative tunnelling machines to link regulated rivers. Pipelines were not unusual but Kielder was revolutionary because it was "a very big tunnel and regulating" (Jackson Interview). In the words of the WRB, "The scheme is a bold and imaginative one: the largest single water conservation scheme yet undertaken in this country" (WRB, 1973, Appendix 2, 23).

In contrast, Pearce calls Kielder Water the "Cunningham reservoir" as a journalistic device to denigrate the whole Scheme as "an embarrassing and expensive monument to the follies of water planners in the 1970s" (Pearce, 1982, 8). Andrew Cunningham was jailed in 1974 for accepting bribes from John Poulson the notorious architect in return for a commission to design a grandiose headquarters for the NRA when he was its Chairman. Cunningham was influential in encouraging the ambition of the Kielder Scheme and dogged in its defence but it is wrong to attribute the vision to him. Credit should go to Urban Burston, Chief Engineer of the NRA[1], whose former colleague and successor, Nigel Ruffle, developed the plans soon after the formation of the NWA in 1974 (Rennison, 1979).

HISTORY OF THE SCHEME

In September 1965, the WRB set up a Northern Working Party of water engineers from River Authorities and water undertakers. Andrew McLennan[2], formerly Director of the Sunderland and South Shields Water Company was the Chairman and Burston was a member. Its role was to consider the possibilities of regional-scale cooperation in the development of water resources. The enthusiasm of Burston for planning water resources on a regional scale influenced the Working Party and his ambition was welcomed by WRB officials, who needed new ideas reaching beyond local water undertakings to justify their national planning role.

At first, the reservoir planned on the North Tyne was called Otterstone, rather than Kielder, and it was endorsed in the Interim Report of the Northern Working Party in 1967. To estimate water demand up to 2000, the Working Party used population projections of a 25% rise from the Office of National Statistics (in fact population declined!), per capita water consumption figures from the USA (despite differences in lifestyles and climate) and assumptions that water demand from industry would continue to grow rapidly. In the Interim Report, the use of aqueduct(s) linking the

[1] Two others, in addition to Burston, were attributed responsibility at the opening of Kielder in 1982, Ted Wrangham, farmer, and Andrew McClennan, Vice Chairman of WRB.
[2] McClennan was later succeeded as Chairman by J.F.Glennie and B. Rydz

principal rivers (the Tyne, Wear and Tees) in the North East, offered satisfaction to immediate deficiencies on Teesside but further reflection suggested that such aqueducts could not be built before completion of the newly-approved Cow Green reservoir in 1971 (NRA, 1973). The idea of linking the rivers was shelved only temporarily. If demand continued to rise as rapidly as predicted, even Cow Green would not assuage industry.

In 1969, the Scottish consulting engineering firm of Babtie, Shaw and Morton was appointed to prepare feasibility reports. The team's experience in building hydroelectric dams and tunnels in Scotland was pertinent to the new task. After the WRB's Interim Report, the Babtie consulting engineers made a desk study on alternative sources to meet the predicted rise in demand. The challenge of transferring water between rivers proved very attractive to the engineers involved. David Coats, the consulting engineer who had overall charge of the project, admired Urban Burston's big ideas: "he was very good in thinking forward and he was very keen that something be done". Coats himself was enthusiastic both about tunnelling and about thinking big. His previous work on the large and ambitious Loch Katrine tunnel and reservoir scheme had initially provided an embarrassing surplus of water for Glasgow but, eventually, it had proved to be valuable. Coats believed that "to think small and to assume that things are not going to change is wrong" (Coats interview).

In February 1970, the WRB's Final Report on "Water Resources in the North" recommended that the Tyne-Tees Link should be completed as soon as possible, "to be in operation by 1975"; two sites should be investigated as potential storage reservoirs Otterstone (Kielder) and Irthing. The report favoured Kielder, which could provide a yield of about 200mgd (910,000 m^3/d) and could meet all the projected water demands in the area until after 2001 or, alternatively, could meet the needs of both Northumbria and Yorkshire "for about 20 years". One very large new reservoir in Kielder Forest would solve other problems. The Forestry Commission had underestimated the rapid decline in labour requirements which had followed introduction of machinery; they had housing surplus to requirements in this remote area and construction of a reservoir would offer some alternative employment. WRB stated that 'A reservoir here would cause a minimum of disturbance and could be attractive in appearance, offering opportunities for a tourist centre (WRB, 1970a, 29).'

The WRB presented two alternative strategies. Plans for six new reservoirs in the West-East strategy (see Fig.1) looked more challenging politically and less engineeringly-exciting than a very large one at Otterstone (Kielder), with the possible addition of Irthing, with a tunnel linking three rivers as shown in the North-South strategy (see Fig.2) . NRA's Water Resources

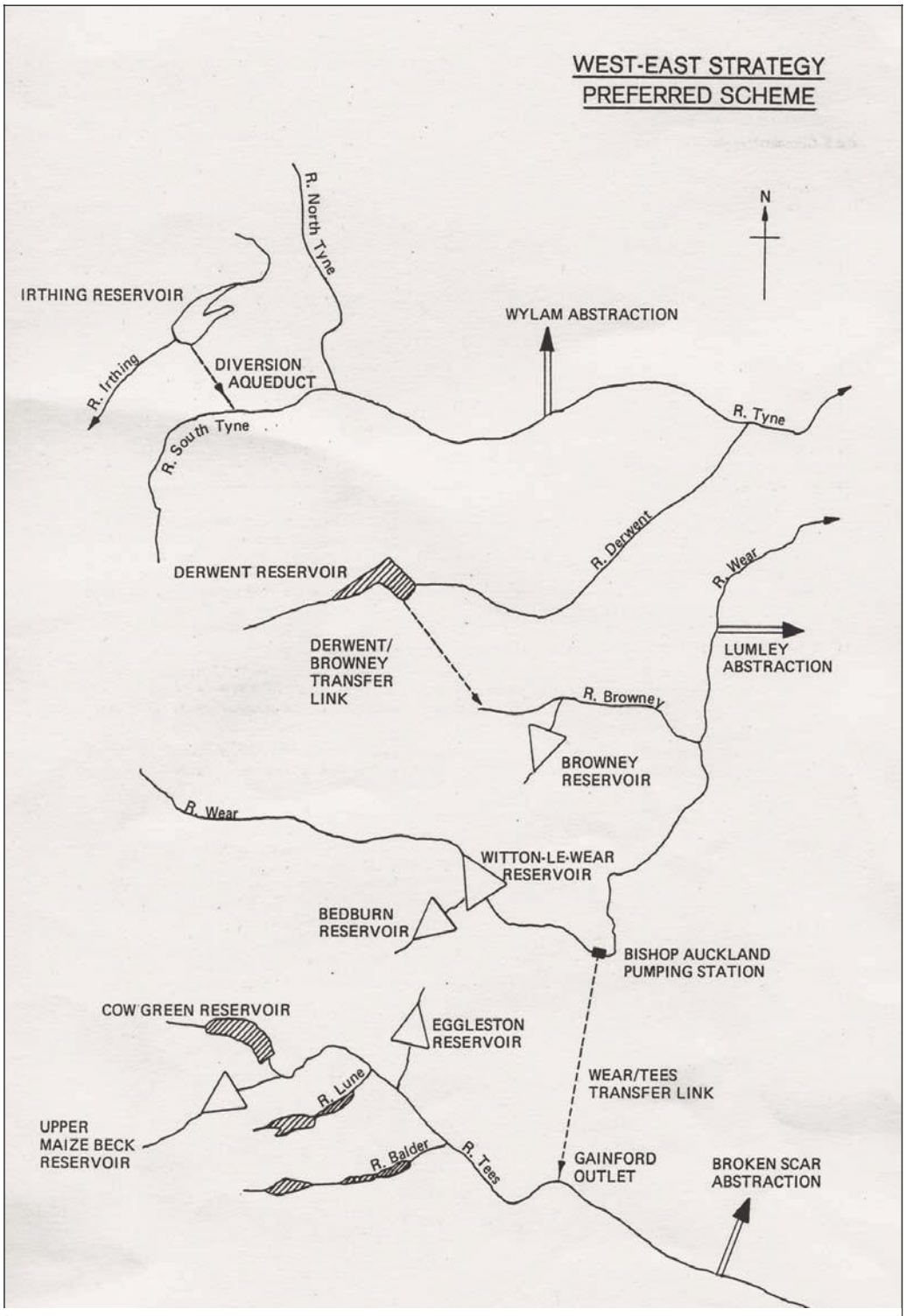
Committee considered the two strategies with a report on comparative financial costs in July 1970. A recommendation "that powers be sought to develop the Otterstone Reservoir site and to construct an aqueduct tunnel linking the Rivers Tyne, Wear and Tees" was confirmed by NRA in September 1970 (NRA, 1973).

WRB suggested that the water grid proposed for the NRA should extend beyond its boundaries into Yorkshire but the political barrier of establishing co-operation between two neighbouring River Authorities proved insuperable. Recent experience of building reservoirs in the North East in rapid succession: Selset (1960), Balderhead (1965) and Cow Green (1971) for TVCWB, and Derwent Reservoir (1966) for the South Shields Water Company, suggested that fewer, larger reservoirs would avoid several long and expensive battles to gain permission as well as, more doubtfully, economies of scale. The prospect of raising regional finance and external funding following the 1963 Water Resources Act gave hope that the undertakers would not have to await last minute decisions by the main industrial beneficiaries for capital provision.

Enthusiasm for the Scheme was not just espoused in the local NRA and in the WRB but also within the MHLG. Senior civil servants were convinced that such schemes were the way forward. The Under Secretary, Jack Beddoe, wrote a memo to a colleague:

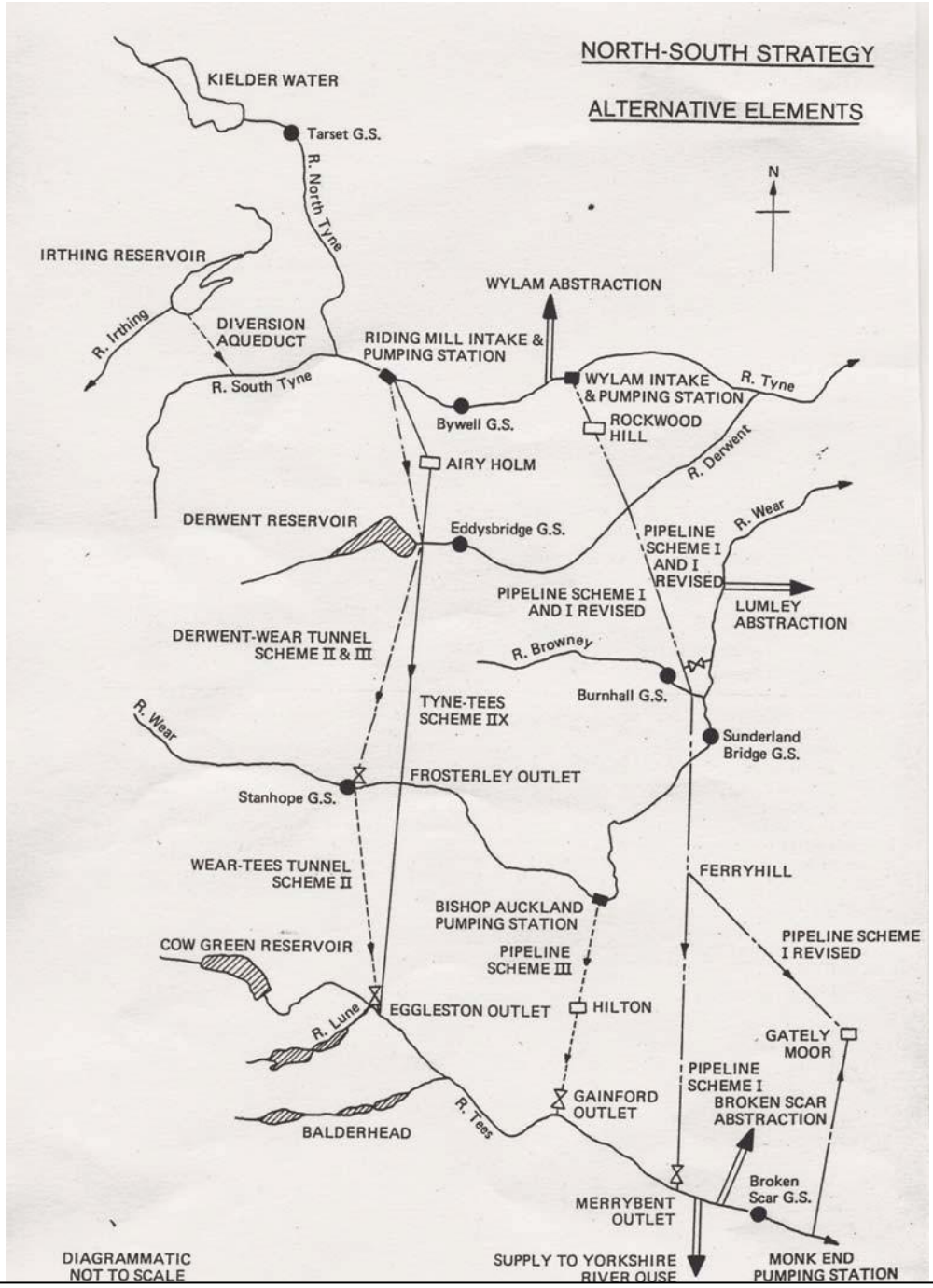
> 'within the next few years the most economic organisation of water conservation will require substantial transfer of water between the areas of the present River Authorities, the switching of sources between different distribution networks at different times, changing water undertaking sources to river regulation and the building of large-scale transmission links to supplement the transfer of water in rivers (HLG, 1970).'

The concept of large-scale water planning had come of age but Beddoe foresaw "major financial and administrative problems" (ibid, 1970). The limit to the extension of grids of water supply would be political more than technological.



Source: WRB Water Resources in the North. Northern Technical Working Party Report 1970. Not to scale.

Figure 1: WRB's West-East strategy. This strategy would have involved construction of 6 new reservoirs and 3 tunnels.



Source: WRB Water Resources in the North. Northern Technical Working Party Report 1970. Not to scale.

Figure 2 WRB's North-South Strategy: only 2 new reservoirs, Kielder and Irthing were needed to augment the Tees via the Tyne-Tees tunnel.

DECISIONS ON THE PROMOTION OF THE SCHEME.

As soon as the Water Resources Act 1971 allowed powers to be sought without a Private Bill, the Kielder Water (draft) order was published in June 1971. In December 1971, the Secretary of State for the Environment, Rt. Hon. Geoffrey Rippon MP called for a public Inquiry and this was held 3 February to 15 March 1972 under an Inspector, Mr. A.R. Chaun, who was not a water engineer but a qualified town and country planner. The engineering case was strengthened by appointment of an "Engineering Assessor", Mr J. Keith Jackson, a former Superintending Engineer in the MHLG. The Engineering Assessor was allowed to submit a report in parallel with the Inspector's report.

The context of the public Inquiry was a time of great political tension with the Conservative Government, led by Prime Minister Edward Heath, being faced with strikes by the miners, railwaymen and other public sector workers, violence in Northern Ireland and rising inflation. In the drama of the opening meeting on a dark February day, Keith Jackson remembered trying to read documents by torch and candlelight because of a power cut (Jackson interview).

The political complications for the Environment Minister, Geoffrey Rippon, did not end with pressure to quell restive miners in the North East, to support manufacturing industry and to increase employment. The Conservative Party, at the time, was perceived as a defender of the rural way of life and the Hexham constituency, in which Kielder lay, was Geoffrey Rippon's seat. Yet, when he was called upon to adjudicate over Kielder, he confronted by his retired predecessor as Conservative MP for Hexham, Sir Rupert Spier, who was leading local opposition to Kielder reservoir as Chairman of the North Tyne Preservation Society. The NRA was led by strong Labour politicians.

Faced with such conflicts, retreat into compromise had its attractions for Rippon. The Inquiry heard pleas from people who would be displaced by the reservoir; fears that the Scheme's high cost would result in expensive water and that there might be an industrial depression. Despite this, the Inspector recommended the Scheme in its entirety and the Engineering Assessor was also enthusiastic. In January 1973, the Minister made a ruling: he agreed to the tunnel and the North-South strategy, but asked for a reconsideration of the Kielder reservoir site, which would drown 58 homes, displacing 130 people; he called for an investigation of the remote Irthing

site, affecting 'two families at most', as an alternative. The Secretary of State's letter stated:

> '...the degree of hardship, particularly for those who would have to leave their homes and the damage to the environment which would result from flooding the site ought not to be accepted without first testing more fully the case for and against constructing a reservoir on the River Irthing…(NRO, 1973)'

His response was a shock for the engineers promoting this pioneering attempt to provide the first regional water grid: technological progress threatened to be impeded by social considerations for a small minority of affected locals. However, by being persuaded that the tunnel was a necessity, the Minister eventually lost any argument against the Kielder reservoir because only the huge quantity of water that Kielder could yield would justify the large tunnel. His verdict was only a temporary delay.

The NRA was not to be thwarted. Not only would Irthing produce less water than Kielder, it was in the region of the Cumberland River Authority and would not be fully under NRA control. The financial and administrative barriers foreseen by Beddoe were formidable. Jackson (Personal communication) reports that the NRA sent a sharp response on 2 February 1973 to the Secretary of State saying that they had no intention of considering the Irthing site for the main reservoir. The need for the water, they said, was too urgent for any delays. This reassertion of the power of the NRA proved effective in getting the Inquiry reopened. The power of the petitioners against the Scheme was diminishing.

Almost simultaneously in February 1973, a White Paper was published: "Steel-British Steel Corporation: 10-year Development strategy" (Cmd. 5226). This promised that Teesside would have one of the largest and most modern steel complexes in Europe. Large quantities of water would be needed. The recommendation of Spens' report (Spens, 1947, 7) that "the North East Development Area is not an area into which really large water using industries should be encouraged to develop" was ignored.

Faced with these pressures, in April 1973, the Minister ruled that the Inquiry be reopened. The second Inquiry, 19/06/73 to 09/07/73, had a different Inspector, this time a barrister, Sir Robert Scott, but the same Engineering Assessor. Scott tried to avoid going over old ground and at the end refused to make a recommendation. He wrote, "There was no new Application before the inquiry and therefore no occasion for formal recommendations." One of the intended main beneficiaries, ICI, did not bother to send a representative. The spokesman who forecast a huge increase in water for

British Steel Corporation " did not stay to be cross-questioned, perhaps because the plans on which he based his estimates had not been, and never were, approved " (Charlton, 1982, p.16). Scott stated in the final paragraph of his report.

> 'With Kielder the centre of interest, lukewarm support for alternatives except as lesser evils than Kielder, and the need for further site investigations, the reopened inquiry cannot be considered a satisfactory test of the case for an alternative scheme (Scott, 1973, para. 90).'

Despite this equivocal ending, Scott reflected that the North-South strategy already had the stated preference of the Minister based on the first Inquiry and that the weight of evidence was in favour of a tunnel in the light of WRB figures suggesting that the tunnel would cost £26m (£193m)[3] set against pipelines at £39m (£289m).

The Minister approved the Scheme in October 1973 and the Kielder Water Order was made in April 1974. The newly-formed Northumbrian Water Authority, with wider responsibilities, crucially including sewage and water quality, took over the Scheme. Perhaps in response to the behaviour of the River Authorities, the Water Authorities were set up with fewer local politicians and a majority of Ministerial appointees. The Kielder case threw question marks against the Ministerial Order procedure, which replaced the previous adjudication by Select Committees.

TUNNEL TEMPTATION

Throughout the discussions, the Tyne-Tees tunnel was key. Once the 32 km long, 2.9 metre diameter tunnel was approved, then a massive water discharge was needed to justify its huge size. The tunnel was tempting both technically and politically.

An attraction for ambitious engineers was the innovation of powerful tunnelling machines which performed "full face penetration" and which could be imported from Germany and the U.S. (Brown, 1975). The long and large tunnel would allow the three rivers to be used conjunctively.

Politically it was also attractive. Whereas a conventional pipeline would require way-leave permissions and construction disruption along the A68 main road, a tunnel would be bored underground and cause little visual upset on the surface, requiring few negotiations with landowners. In a depressed region, with declining coal mines and shipbuilding industries, infrastructure investment would provide some employment, and gave a little

[3] Figures in brackets indicate conversions to 2002 prices http://www.eh.net

hope that new industries might be attracted, or at least not deterred by lack of water.

Financially, the proposition was less appealing. The NRA was suspected of having a gung ho attitude towards costs, knowing that the Water Authority would soon supplant it. At the time of the Inquiry in 1973, the costs quoted were £26m (£193m) for the tunnel and £13m (£97m) for Kielder reservoir. By 1978, the cost estimates had risen to £70m (£391m) (Lambert, 1978, p.32). Later, the tunnel costs rose further because an unexpected outcrop of extremely hard dolerite of the Little Whin Sill was encountered (Coats, Berry and Banks, 1982) and a new £1m (£2.2m) boring machine had to be brought in, setting back completion by a year (Newcastle Journal, 1982). High capital costs were only part of the problem. Running costs would be high also because water abstracted from the Tyne 56km downstream of the Kielder dam at Riding Mill, Britain's largest pumping station, had to be pumped up 200 metres over a distance of 6.2km to the highest point of the aqueduct near Airy Holm whence the water could flow without further assistance as far as Teesside (NWL, 1993). Before the Scheme was built but only after the decision to go ahead had been made, doubts were expressed about the likely high operating costs, which would dwarf even the high capital costs (Ray discussion of Burston and Coats, 1975, p.149). When industrial water demands fell and the hoped for expansion of the steel industry in the North East did not materialise, local residents were faced with large increases in their domestic water bills.

IMPLICATIONS AND RECRIMINATIONS

The Scheme is described on a bronze plaque at the reservoir site as one of the biggest water projects ever undertaken in Europe and Kielder Water as the largest man-made lake in Europe. Today, the reservoir rests mostly idle. The water is rarely needed for supply and then mainly for transfer to the Wear rather than the Tees. The hydroelectricity, generated as an afterthought to the original plans, is a small contribution to the National Grid and the reservoir's claims as a tourist attraction are hampered by its remoteness, rainy climate and monotonous coniferous plantations with associated populations of vicious midges.

Teesside continues to be supplied from the Teesdale reservoirs without supplementation from Kielder because the cost of pumping water from the Tyne to the highest point of the Tyne-Tees tunnel is greater than the cost of supply by gravity flow from Upper Teesdale dams. Only twice in its history has the Tyne-Tees transfer tunnel been used to transfer water to the Tees, first in 1983 and then in 1989, (FOE, 2003) although water has been transferred as far as the Wear to supplement the underperformance of the

Derwent reservoir (Soulsby *et al.*, 1999). David Archer, a former employee of Northumbrian Water and the Environment Agency, asserts that Kielder has "saved the North East from serious water restrictions during the droughts of 1989 and 1990s", although he concedes that a smaller reservoir would have sufficed (Archer 2003 155).

Such over-investment was enabled by separation of the industrial consumers from funding of water supply infrastructure. Rather than continued iteration with the industrial consumers to judge its effectiveness in promotion of economic development, the dedicated focus on water supply made it an end in itself and safeguards against overinvestment were weak. Uncritical extrapolation of water demands at the outset was not corrected at later stages when British Steel failed to expand on Teesside. Unlike the financial arrangements in Teesdale, reformed regional funding meant that those industries which demanded more water at the Kielder Inquiry made little or no contribution to the capital costs of the Scheme (McCulloch 2004 59-60). Brady concluded that major industries should have a direct financial stake in such resource developments and "pay the cost of the works whether or not their share of the increased demand is taken up, provided that the industries remain solvent" (Brady, 1985, p.140).

Instead, the Government in the 1980s decided that the "consumers of the NWA should meet the charges incurred by Kielder and that the costs should be borne regionally" other than "Temporary assistance given one year by way of a repayable grant"(Sir Peter Harrop's evidence to the House of Commons Committee of Public Accounts 1984-1985 para1166). The suffering of the regional domestic consumers was somewhat lessened by the writing off of some of the debts in preparation for the privatisation of water supply in 1989 and continuing subsidies from the Environment Agency (NSL Group 2003).

CONCLUSION

At the opening ceremony in 1982, banners decried the reservoir as a White Elephant but the Chairman of the NWA, Sir Ralph Carr-Ellison gave reassurance:

> 'Beyond any shadow of doubt, it was correct to go ahead with this scheme. Not only have we got a reservoir to serve the needs of the region for the 1980s but we have a reservoir that will serve its needs until 2050…The price we have paid will turn out to be cheap (Newcastle Journal 26/05/82).'

Yet, even in the engineering press, there was scepticism:

> 'It is possible that no water from Kielder will be required for consumption within the next decade with the scheme not being fully utilised until the second half of the next century (Hayward, 1982, 27).'

The controversies over the Kielder Water Scheme led the Director of the WRB, Norman Rowntree to doubt whether such ambitious water schemes would ever be repeated (Wolf interview). The cost of the Scheme, both its capital cost and the running cost, threw doubts on the sufficiency of checks and balances on infrastructure expenditure by public bodies, once the main industrial beneficiaries were not obliged to fund the construction. Privatisation post-1989 has been accompanied by re-regulation of the water supply industry. Now the plans of engineers are overseen by economists, accountants and others in the Office of Water Services (OFWAT) and by biologists and engineers within the Environment Agency. Political and financial barriers to the exercise of engineering technology remain strong today. Sir Norman Rowntree may well have been prescient in his belief that the Kielder Water Scheme was likely to be the last of its kind in England and Wales.

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