Water Resources Management Plan 2012

Main Report

March 2012

ATKINS

Northern Ireland Water Limited
Water Resources Management Plan

Main report

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Notice

This document and its contents have been prepared and are intended solely for NI Water's information and use in relation to its Water Resources Management Plan.

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Plan Design Enable

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Glossary of acronyms

Term	Description
AIC	Average incremental cost
AIR AIR09	Annual information return Annual information return 2009
AISC	Average incremental social cost
ALC	Active leakage control
Aquator	Water resource modelling application
BAG	Benefits assessment guideline
BFI	Base flow index
Capex	Capital expenditure
CCDeW	Climate change and demand for water report
CCNI	Consumer Council for Northern Ireland
CoP	Code(s) of Practice
DAF	Dissolved air filtration
DC	Demand centre
DECC	Department of Energy and Climatic Change
DI	Distribution input
DMA	District Meter Area
DO	Deployable output
DOE	Department of the Environment
DRD	Department for Regional Development
DYAA	Dry year annual average
EA	Environment Agency (England and Wales)
EBSD	Economics of balancing supply and demand
ELL	Economic level of leakage
FDC	Flow duration curve
GAC	Granulated activated carbon
GHG	Greenhouse gases
GIS	Geographical information system
HH	Household
l/h/d	Litres per head per day – unit of per capita consumption
LFE	Low Flows Enterprise software
LGD	Local Government District

Term	Description
LoS	Levels of Service
LRMC	Long-run marginal cost
LTA	Long term average
MILP	Mixed integer linear program
Ml/d	Mega litres per day
MLE	Maximum likelihood estimation
NEP	National Environment Programme (England & Wales)
NIAUR	Northern Ireland Authority for Utility Regulation
NIEA	Northern Ireland Environment Agency
NISRA	Northern Ireland Statistics and Research Agency
Non-HH	Non-household
NPV	Net present value
NYAA	Normal year annual average
Opex	Operational expenditure
OSNI	Ordnance Survey Northern Ireland
PC10	Price Control 2010
PCC	Per capita consumption
PET	Potential evapotranspiration
Planning period	5-year regulatory planning periods, starting in 2013–18
PPP	Public Private Partnership
PR09	Periodic Review 2009 (England and Wales)
Q4	4th quarter of the Financial Year (January to March)
R&D	Research and development
RDS	Regional Development Strategy
ROI	Region of Influence
SBP	Strategic Business Plan
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SIC	Standard Industrial Classification
SPL	Supply pipe leakage
TMM	Trunk mains model
UKCIP02	UKCIP 2002 climate projections
UKCP09	UK Climate Programme 2009

Term	Description
UKTAG	UK Technical Advisory Group
UKWIR	UK Water Industry Research Ltd
WAFU	Water available for use
WDMS	Water Demand Management Strategy
WFD	Water Framework Directive
WG	Weather generator
WISKI	Water Information System (database) developed by Kisters AG
WRMP	Water Resources Management Plan
WRP Table	Water Resource Plan Table
WRPG	Water Resources Planning Guideline (England and Wales)
WRS 2002	Water Resources Strategy 2002–2030, published in January 2003
WRZ	Water resource zone
WTW	Water treatment works
WWTW	Wastewater treatment works

1. Overview

1.1 Introduction

This is Northern Ireland Water's Final Water Resources Management Plan (WRMP) for the period 2010–11 to 2034–35. NI Water is required by law to produce a WRMP and to consult consumers and other stakeholders on how it proposes to manage its water resources into the long-term future. This Final WRMP (WRMP 2012) meets the requirements of the Department for Regional Development (DRD) Guidelines. Current best practice from the UK water industry has been followed for the separate supply-side and demand-side elements of the supply demand balance and how uncertainty and risk should be built into the WRMP.

A glossary of technical terms is included in section 10.

As required by the DRD guidelines, the following Statutory Consultees were consulted during the preparation of the Draft WRMP:

- Department for Regional Development (DRD);
- Department of the Environment (DOE) – in this case Northern Ireland Environment Agency (NIEA);
- Northern Ireland Authority for Utility Regulation (NIAUR); and
- The Consumer Council for Northern Ireland (CCNI).

The content of the Draft WRMP was discussed with these Consultees; comments made during and following those discussions were considered prior to preparation of the Draft WRMP which was published for public consultation.

The Draft WRMP continued the main strategic themes from the 2002–2030 Water Resource Strategy (WRS 2002) and subsequent updates. It brought together the following:

1. Revised forecast of future demand that starts from a lower base year demand than WRS 2002, due in part to NI Water's progress in demand management and leakage reduction;
2. Assessment of climate change impacts on both supplies and demands using outputs from the UK Climate Programme 2009 (UKCP09);
3. Development of a new water resource model to assess deployable output (DO) using the most recent flow data combined with a new regional approach to hydrological analysis that ensures consistency across Northern Ireland;
4. Incorporation of uncertainties and risks using industry best practice; and
5. Comprehensive appraisal of options to maintain the supply demand balance, informed by the parallel Strategic Environmental Assessment (SEA).

On the basis of no changes to existing abstraction licences, the key features of the Draft WRMP were:

- Continuation of strategic transfers identified in WRS 2002;
- Further incremental reductions in leakage where economic to do so;
- No additional water treatment works capacity required until towards the end of the planning period (approximately 20 years); and

- The supply demand balance can be maintained at Water Resource Zone level up to the end of the planning period without any increase in the aggregate of the authorised abstraction licences.

The main uncertainty to the Draft WRMP came from the possibility that NIEA may seek to impose reductions (known as sustainability reductions) to the volume of abstraction authorised by existing abstraction licences in order to address the requirements of the Water Framework Directive (WFD) and other environmental drivers. Such sustainability reductions have the potential to reduce DO and increase the risks to maintaining security of supplies. If significant change occurs NI Water would need to revisit the WRMP.

This uncertainty has been highlighted in a number of the consultation responses. At the time of this Final WRMP the timetable for completion of the NIEA abstraction licence review is not yet known. This means that the analysis of water resource availability for the Final WRMP remains based on existing abstraction licence volumes and conditions.

1.2 Water supply planning in Northern Ireland

The topography of Northern Ireland and the well distributed rainfall has historically led to the development of upland reservoirs, lowland reservoirs and direct run-of-river abstractions to meet both urban and rural centres of demand. Groundwater sources have also played a part.

Increasing growth and more stringent environmental requirements, combined with the unfavourable economics of maintaining and operating small, isolated sources has led to the progressive rationalisation of sources of supply and the closure of small, mostly groundwater sources. Increasing emphasis has been given to providing connections between different sources of supply and demand centres, which can also increase the resilience of the supply system.

The climatic characteristics of Northern Ireland combined with the demographic characteristics of the customer base, means that the supply system does not experience large seasonal variations in demand. Planning for meeting peak demands has therefore not been a priority either for NI Water or its predecessors. NI Water does not specify any explicit levels of service relating to customer restrictions as part of its operational and management response to drought conditions.

NI Water’s policy is set out in the general statement under the heading “Interruptions to your water supply”:

> We aim to supply adequate, continuous supplies of safe drinking water to each customer connected to our distribution system.

The statement refers more to short-term interruptions to supplies, rather than to longer-term restrictions that might be imposed to conserve resources during times of drought.

For the purpose of this WRMP the whole area supplied by NI Water has been subdivided into 5 Water Resource Zones (WRZs). These WRZs are built up from the supply areas used for the regulatory Annual Information Returns (AIR) and the 15 zones used for the previous Water Resource Strategy 2002–2030 (WRS 2002). The boundaries of the 5 WRZs have been reviewed by NI Water’s leakage team and the Atkins Trunk Mains Modelling (TMM) team.

A WRMP takes supply and demand data for a base year and then forecasts each of these over a 25 year planning horizon. This WRMP uses 2008–09 as the base year; water balance data have been taken directly from the Annual Information Returns 2009 (AIR09) submitted to the regulator, NIAUR. The WRMP also takes as its starting point the existing infrastructure that is itself a legacy from planning and investment decisions informed by previous strategies.

A number of planning scenarios may be required for the development of a WRMP. The main planning scenario is the “dry” year annual average scenario. Such a scenario occurs when a period of low rainfall leads to elevated and unconstrained demand. Dry year demands are used because the primary objective of the WRMP is to ensure that even under drought conditions, when supplies may be stressed, the level of demands associated with hot dry conditions can be met in full.

Selection of the final planning solution is informed by the output of an investment model that has been developed for this WRMP following industry best practice and guidance. The investment model is used to identify the combination of demand-side and supply-side measures that are able to maintain the supply demand balance throughout the entire 25-year planning period (2010–11 to 2034–35) at the least cost. Prior to including options in the investment model, a screening process which includes non-monetary criteria such as environmental implications was applied to reduce the number of unconstrained options to be included in the list of constrained options (see section 1.3.5).

The overarching objective of the Water Resource Management Plan (WRMP) is to look ahead 25 years and describe how the company aims to secure a sustainable supply of water taking into account expected demands and the implications of climate change. The WRMP will be complemented by the company's Drought Management Plan which will set out the short-term operational steps that the company will take if a drought develops and the risk to security of supplies increases.

The WRMP is a stand-alone document that provides a strategic plan for managing water resources. It does not alone provide the case for strategic investment decisions; rather it sets the framework at the Water Resource Zone (WRZ) level within which such decisions should be taken. There may also be other drivers for investment which should be assessed – for instance, operational resilience. Investment at smaller spatial scales will still need to be justified through other more local studies, such as trunk main studies, detailed zonal studies and targeted leakage initiatives.

Publication of this Final WRMP coincides with the start of the next round of water resource planning elsewhere in the UK. Although the process itself and some of the technical methodologies are being reviewed, the basic principles remain the same:

- The WRMP provides the high-level framework for water resource planning;
- It main focus is on the first 5 to 10 years of the planning process; beyond that there is increasing uncertainty about environmental and other regulatory policy, economic drivers that might stimulate future demands for water and climate change;
- Prior to the approval of investment in major water resource infrastructure additional, more detailed investigations will be required to confirm the feasibility, outline & detailed design, costs and economic justification of the options indentified in the WRMP;
- The WRMP is a live document; it will be reviewed on an annual basis, and a new WRMP will be produced every 5 years or earlier if there is a "material change of circumstance", for example the introduction of environmental conditions on abstraction licences that reduces the deployable output of existing sources, or the introduction of charging domestic customers.

Recent operational experiences, both in Northern Ireland (for example the winter "freeze-thaw" conditions in 2009–10 and 2010–11) and in England (for example the 2007 summer floods) show that despite long-term strategies for balancing supplies and demands at the scale of a water resource zone (WRZ), extreme events can nevertheless cause local operational difficulties which may lead to short-term interruptions to supplies. Whilst such extreme events fall outside the locus of a WRMP, infrastructure schemes that contribute an appropriate operational and management response to short-term supply difficulties can also contribute to maintaining the supply demand balance. Such infrastructure may also provide alternative operational responses that allow environmentally sensitive sources to be rested during drought.

1.3 Summary of plan

1.3.1 Availability of water

NI Water's water resources infrastructure comprises the following assets:

- Total licensed volume of raw water sources – 1075 Ml/d
- Treatment capacity – 1080 Ml/d
- Average daily distribution input (2008–2009) 633 Ml/d

A comprehensive review of the deployable output of all NI Water's sources has been undertaken in accordance with best industry practice. In comparison with the previous analysis of source yield for WRS 2002, consistent sets of flow timeseries covering the same period of time (1975–2009) have been developed for all of NI Water's sources. This consistency has been achieved using a new approach to regional hydrological analysis developed for Northern Ireland Environment Agency (NIEA). Assessments of deployable output (DO) have been undertaken using water resource systems models developed specifically for this WRMP. These models can also be used for operational and management purposes. Two different measures of DO have been derived: the unconstrained DO, which is calculated on the basis that there are no constraints to transfers within a WRZ and that the total demands in the WRZ can be represented as a single demand centre; and models for constrained DO that are based on separate demand centres within each WRZ and take account of known capacity constraints between the demand centres.

The WRMP Guidelines require that estimates of available supplies (DO) are made at the WRZ scale. This requires a high-level representation of the water resource system, which takes into account strategic transfer links between sources and demand centres. The characteristics and capacities of such links represented in the water resource model used to calculate Deployable Output were informed using the Trunk Mains Model (TMM) that was developed in parallel with the WRMP. This high level representation for the WRMP comprised a small number of demand centres so does not take into account distribution or operational constraints at the smaller spatial scales such as District Meter Areas (DMA). Distribution system investment requirements would be addressed using the TMM, carrying out trunk main capacity studies and/or some other distribution system model such as those used in detailed zonal studies.

Water treatment works (WTW) such as the Derg WTW fed by run-of-river abstractions are particularly sensitive to periods of low flow. Analysis undertaken for this WRMP, taking account of the current understanding of hydrological conditions and agreement reached between NI Water and NIEA regarding the drought contingency management plan included in the terms of the abstraction licences, shows that for the dry year annual scenarios that must be considered for a WRMP sufficient raw water would be available to allow the WTW to operate at its full capacity. However under more extreme drought conditions that would need to be assessed under a drought plan, supplies from the WTW might be at greater risk. The construction of new infrastructure links (such as the Carmoney to Strabane link main JL 715)) between neighbouring WRZs would provide additional resilience to such conditions, and also provide operational flexibility to other extreme weather events such as the "freeze-thaw" events of recent winters.

Comparison of the results for existing DO from the WRMP 2012 analysis with WRS 2002 shows that there is little change in the 2008–09 total DO for Northern Ireland. The WRMP 2012 DO is 773.6 Ml/d, marginally greater than the WRS 2002 DO of 771 Ml/d.

The estimates of DO used for the WRMP are derived using the current abstraction licences; however it is understood that as part of obligations to meet the requirements of the Water Framework Directive (WFD), NIEA will undertake to carry out a review of all abstraction licences over the coming years. This may in future lead to introduction of additional conditions to existing abstraction licences that could have an impact on DO and hence trigger the need for further options to maintain security of supplies.

In West WRZ, the Strule/Derg scheme to provide the Derg Water Treatment Works (WTW) with an alternative supply of raw water requires a new abstraction licence. Strict application of the abstraction licence conditions once the licence becomes active would mean that there could be some very dry, but rare circumstances when no water would be available to feed the WTW. Recent discussions between NI Water and NIEA have led to an agreement to develop an interim drought contingency plan for this WTW, which together with considered planning will mean this issue can be properly resolved and regulated. The analysis for the WRMP has been based on the design output available from the Derg WTW. This means that, although it is not strictly required to maintain the supply demand balance, the new strategic transfer from the North WRZ to the West WRZ (Carmoney to Strabane (JL715) proposed for the business planning period 2013 to 2018 would provide additional operational flexibility so that any reduction in output from the Derg WTW would not increase the risk of supply shortfalls (see Annex A for further details). It is recommended that a feasibility study should be progressed to address security of supplies in the context of the planning and operational conditions included in the new Derg/Strule abstraction licence.

Since publication of WRS 2002 there has been a major change in the financing and operation of sources to provide treated water into NI Water's distribution network in the transfer of 4 major WTWs (Castor Bay, Dunore Point, Moyola, and Ballinrees) to Public Private Partnership (PPP) arrangements. Whilst this change does not have any impact on the quantity aspects of the supply demand balance, there may be consequences for the future options to increase the availability of supplies.

1.3.2 Demand forecasts

In line with DRD guidance, this WRMP is based on the Annual Average Demand (AAD) scenario. The base year for the WRMP forecast is 2008–09 with a reported distribution input (DI) of 633 Ml/d; while the estimated dry year demand is 677 Ml/d. For comparison, the reported DI for 1999–00 (the base year for WRS 2002) was 704 Ml/d and the dry year demand was 721 Ml/d. This shows that the WRMP forecast is starting from a lower base than the WRS 2002 forecast.

Population and property forecasts have been taken from the Northern Ireland Statistics and Research Agency (NISRA) website. The University of Ulster was commissioned to conduct an economic outlook assessment for Northern Ireland as part of the recent PC10 process. That assessment included a section in which NI-level population and property forecasts from NISRA, based on 2006 estimates, were modified to take account of the economic downturn. The University of Ulster adjusted figures are provided for the period 2007–2017. These adjusted population and property forecasts have been applied in the WRMP, and it has been assumed that after 2017 the projections will return to the policy-based projection over a five year period.

By 2029–30 (the final planning year for WRS 2002) the WRMP dry year forecast is 720 Ml/d compared with 793 Ml/d forecast at WRS 2002. Five years later, at the end of the WRMP planning period in 2034–35 the dry year forecast is 731 Ml/d, some 60 Ml/d lower than the final WRS 2002 forecast.

The baseline demand forecast includes the current target level of leakage of 165.4 Ml/d to be reached by 2014–15 as discussed between NI Water and NIAUR. For the remainder of the baseline forecast, leakage is assumed to remain constant, although options for further reductions in leakage are considered as part of the options appraisal process.

For the purposes of the WRMP the leakage targets set at company level are broken down into targets averaged across each WRZ. It is important that the planning process for leakage reduction works within each WRZ consider distribution constraints within each zone so that the supply demand balance is maintained in each District Meter Area (DMA). This is because local supply demand balance deficits resulting from proportionally higher levels of leakage and the inability of the distribution system to cope with locally high leakage levels could be exacerbated if leakage work within a WRZ were to be focused on the wrong areas. The phasing of leakage reduction activities within each WRZ therefore needs to consider these constraints through the use of zonal distribution models and field testing as appropriate. This level of detailed planning is outside the scope of the WRMP.

Where there is a legislative requirement for the metering of all new connections to the water network since April 2007, the introduction of domestic charging has been deferred by the Executive. The costs of water and sewerage services for this sector are met by subsidy from the Department for Regional Development. There are no plans to introduce domestic charging during the current Executive mandate.

1.3.3 Uncertainties and risk

Uncertainties in the supply demand balance are taken into account through outage and headroom. Outage is an allowance to account for the fact that at any given time a source may not be able to produce its full DO due to unplanned events (for example power or system failures, or turbidity issues), or because of planned maintenance and refurbishment activity. Target headroom is an allowance to account for the inherent uncertainties involved in forecasting supply and demand, including climate change, and has been calculated using industry best practice.

Some of the consultation responses referred to uncertainties such as climate change that had already been included in the analysis (such as the potential impacts of climate change on both supplies and demands) and others (such as: uncertainty in the output of PPP schemes; the potential reductions in DO that might arise from the introduction of environmental conditions on existing abstraction licences; and the potential impact on customer demand arising from the introduction of water charging) that have been incorporated into the Final WRMP. Where it has been possible to quantify the impacts on the supply/demand balance – for example uncertainty in the output of PPP schemes – an allowance has been included in the headroom analysis. The other types of uncertainty cannot be quantified at present and will need to be incorporated in future WRMPs.

1.3.3.1 Outage

For the purposes of this WRMP it has been assumed that all existing infrastructure will continue to be maintained at a level that ensures that the existing output and performance is not compromised. The level of outage included reflects current operational practice.

1.3.3.2 Headroom

Uncertainties in the supply demand balance can be grouped under the following headings: accuracy of data, natural variations in climate and hydrology (including potential impacts of climate change), assumed outputs from new schemes, and changes in regulation. The largest source of uncertainty and hence the risk to the long-term strategy set out in this WRMP comes from regulatory uncertainty relating to abstraction licences and to the possible introduction of water charging at some time in the future.

At the time of this Final WRMP there has been no advice from NIEA on the possible location, magnitude and timing of any sustainability reductions associated with its review of abstraction licences under the WFD; it has not therefore been possible to allow for these uncertainties in the calculation of target headroom.

1.3.4 Baseline supply demand balance

The baseline supply demand balance provides an indication of the level of surplus or deficit in each WRZ in dry year annual average conditions, assuming continuation of current policies and practices and allowing for target headroom. If a deficit is identified in a given WRZ then some combination of demand-side and supply-side options will be needed in order to satisfy the deficits and thus ensure security of supplies under the specified design conditions. These supply demand balances do not represent conditions that might be expected under “normal” years, when demands are lower than the “dry” year demands and when there are ample water resources (so sources would be capable of operating up to the volumetric limits set out in the abstraction licences). Instead, as discussed in section 1.2, these supply demand balances represent a particular planning case; namely the dry year annual average.

There are three WRZs showing a deficit in the baseline supply demand balance under the dry year annual average scenario during the planning period:

- East WRZ – from 2021–22 onwards, reaching 18 Ml/d by the end of the planning period;
- South WRZ – from 2016–17 onwards, reaching 20 Ml/d; and
- Central WRZ – from 2013–14 onwards, reaching 4 Ml/d.

The surpluses in the other WRZ at the end of the planning period are:

- West WRZ (assuming no restrictions on the Derg/Strule abstraction licence) – 6 Ml/d; and
- North WRZ – 9 Ml/d.

The corresponding values for NI Water’s total supply area are:

- Deficit first arises in 2025–26; and
- Deficit reaches 27 Ml/d by the end of the planning period 2034–35.

1.3.5 Options appraisal

A summary of the elements that make up the preferred strategy for this WRMP is given in Table 1.1 and in Table 9.1. The options appraisal process comprised the following three steps:

- Unconstrained list of options developed for discussion at an initial NI Water workshop;
- Confirmation of constrained options set comprising those options that are considered to be feasible in technological, environmental and/or financial cost terms, at a second NI Water workshop; and
- Development of costs of each option to be used to derive a least cost solution to meet any deficits.

The Strategic Environmental Assessment (SEA) was undertaken in parallel with the options appraisal; the two processes informed each other. The aim of the SEA is set out below under section 1.3.7.

Industry best practice for the calculation of the cost of different options requires the costs of environmental and social impacts, as well as carbon emissions, to be taken into account. Capital and operating costs are quoted to Q4 2009–10 (final quarter) prices. Capital cost estimates have been informed by out-turn costs of recent schemes in Northern Ireland, and Atkins’ cost database of actual out-turn water schemes within England and Wales as used in preparation of water company business plan submissions for the 2009 Periodic Review (PR09). The costs of embedded carbon as well as the operational costs of carbon have been taken into account; since the Draft WRMP, DECC has issued additional guidance which has been incorporated into the analysis for this Final WRMP.

The constrained options were then taken forward for detailed appraisal and costing to derive average incremental and social costs (AISCs) in order to rank the options in term of the cost per volume of water supplied/saved (p/m^3), including an assessment of the environmental and carbon costs associated with each option. The costs and volumetric savings of additional leakage control were provided by NI Water's leakage consultants.

The constrained options were categorised under the following headings:

- Increase abstraction from existing sources;
- Refurbish existing sources;
- Leakage control;
- Domestic metering;
- Water efficiency;
- Planning period 2013–18 strategic transfers; and
- Other transfers.

1.3.6 Investment model

A spreadsheet model has been developed to undertake least cost optimisation of investment options for use in the development of strategic water resource plans. The model selects the combination of supply, demand and transfer options that delivers the overall least cost strategy for meeting the dry year annual average supply demand balance deficits in each WRZ in each year of the planning period.

1.3.7 Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment

NI Water is deemed to be the 'Responsible Authority' in relation to the development of a Water Resources Management Plan. It was the judgement of NI Water that the following tests set out in SEA guidance apply:

- The plan is to be prepared for the purposes of water management;
- The plan may set a framework for future development consents that could require Environmental Impact Assessment; and
- Its implementation could have significant environmental effects.

NI Water concluded that a Strategic Environmental Assessment of the Water Resources Management Plan was therefore required.

In accordance with best practice the Environmental Report was prepared by a different Atkins team from the Water Resources Management Plan team. However, there has been iterative communication between the two teams to ensure that the processes involved in developing the Environmental Report and the WRMP inform each other.

The SEA Environmental Report was made available in the public domain at the same time as the Draft WRMP.

Some of the organisations that submitted consultation responses to the draft WRMP queried whether the WRMP should be subject to a Habitats Regulation Assessment (HRA). An HRA (also known variously as an Article 6 Assessment or Appropriate Assessment) of Options proposed in the WRMP has been carried out. The requirement for an HRA applies if the development of an Option proposed in the WRMP is located within, adjacent to, or likely to affect a Special Area of Conservation (SAC) or Special Protection Area (SPA); sites commonly known as Natura 2000 sites. A review of the list of constrained options considered for the WRMP (see section 8.3) suggested that some of the options had the potential to effect Natura 2000 sites. An HRA test of Likely Significance (Stage 1 Screening) was completed and is reported in section 3 of the Strategic Environmental Assessment (SEA) Statement that accompanies this Final WRMP.

1.3.8 Plan summary

A summary of the elements that make up the preferred strategy for this WRMP is given in Table 1.1. In order to maintain the supply demand balance, the strategy includes a combination of further leakage reduction and construction of strategic transfers. Providing that the investments planned for the period up to 2014–15 are implemented in full (leakage reductions to meet the WRZ leakage targets and Phase 2A of the Castor Bay to Newry strategic main (JG035)) and that there are no changes to existing abstraction licences, then new water resources would not be required until after the end of the planning period. However the analysis has also shown that the selection and timing of options to address any supply demand balance deficits are sensitive to DO changes that might be triggered as a result of the introduction of new conditions on existing abstraction licences. The West WRZ provides a good illustration of the possible impact of changes in abstraction licences. Here NIEA has recently issued a new abstraction licence including flow constraints for the Derg WTW; the new licence is needed for the Strule/Derg scheme. Whilst the assumption of full output from the WTW is justified for the supply demand balance on which this WRMP has been based, very dry conditions could lead to a significant deficit in the Derg supply area. It is therefore appropriate for NI Water to consider measures to mitigate such risks. Whilst the Carmoney to Strabane strategic link main (JL715) planned for implementation during the business planning period 2013 to 2018) is not strictly required to meet supply demand balance deficits, it would substantially reduce the risk of short-term operational deficits. It would also provide operational flexibility to meet the new licence conditions and respond to extreme events, such as the winter “freeze-thaw” events experienced in 2009–10 and 2010–11 (see Annex A for more details).

Sensitivity analyses have been undertaken to assess the robustness of the plan, including sensitivity to changes in the cost of options. This analysis has shown that there are alternative timings for the implementation of strategic transfers and leakage reduction, which overall have little difference in total cost terms over the planning period.

The analysis shows that the various options for metering domestic customers do not form part of the least cost solution. Moreover the introduction of water charging for domestic customers would be required before widespread metering of existing domestic customers would contribute to managing demand and maintaining the supply demand balance. There may however be other reasons for introducing charging for domestic customers.

The analysis also shows the importance of strategic transfers within WRZs and between WRZs. The development of a trunk mains model (TMM) has allowed these transfers to be investigated more fully for this Final WRMP.

Year	Planning Period	Planned investments	Interventons selected by investment model for Least Cost Plan assuming planned interventions have been implemented
2008-09	SBP	Leakage reduction 1.9 Ml/d	
2009-10		Leakage reduction 4 Ml/d	
2010-11	PC10	Leakage reduction 4 Ml/d	
2011-12		Leakage reduction 4 Ml/d	
2012-13		Leakage reduction 4 Ml/d	
		Castor Bay to Newry Phase 2A (JG035)	
2013-14	2013-18	Leakage reduction 1.3 Ml/d	
2014-15		Leakage reduction 1.3 Ml/d to reach target of 165.4 Ml/d	Leakage reduction 0.5 Ml/d (Central WRZ)
2015-16			TR3: 2 Ml/d transfer South WRZ to Central WRZ
2016-17			
2017-18			
2018-19	2018-23		
2019-20			
2020-21			
2021-22			Leakage reduction 1 Ml/d (East WRZ)
2022-23			Leakage reduction 1 Ml/d (East WRZ)
			Leakage reduction 2 Ml/d (South WRZ)
2023-24	2023-28		Leakage reduction 2 Ml/d (East WRZ)
			Leakage reduction 1 Ml/d (South WRZ)
2024-25			Leakage reduction 1 Ml/d (East WRZ)
			TR2: 2 Ml/d transfer North WRZ to Central WRZ
2025-26			Leakage reduction 1 Ml/d (East)
2026-27			Leakage reduction 2 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2027-28			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2028-29	2028-33		Leakage reduction 2 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2029-30			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2030-31			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2031-32			Leakage reduction 0.5 Ml/d (Central WRZ)
			Leakage reduction 2 Ml/d (East WRZ)
2032-33			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2033-34	2033-38		Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2034-35			Leakage reduction 0.5 Ml/d (Central WRZ)
			Leakage reduction 1 Ml/d (East WRZ)
WRMP NPV (£m)			**£ 10.65m**
Total leakage reduction		**15.5 Ml/d**	**29.5 Ml/d**

Key:		
	ST	**Stategic transfer**
	TR	**Transfer**
	LR	**Leakage reduction**

Table 1.1 – WRMP Final planning strategy 2008–09 to 2034–35

1.4 Consultation

The Draft WRMP was issued for consultation at the end of October 2010 with a consultation period of 16 weeks closing on 24th February 2011. The Draft WRMP was published for consultation on the NIW website for both technical review/comment and also for wider public consultation. The Draft WRMP was published as:

- The main consultation document, which comprised the Main Report available from NI Water's website as a PDF document;
- The Technical Appendices available from NI Water's website as a PDF document; and
- The Non Technical Summary, giving an overview of the Draft WRMP available from NI Water's website.

An Environmental Report that described the outcomes from a Strategic Environmental Assessment (SEA) of the Draft WRMP was also published for public consultation at the same time as the Draft WRMP.

Interested parties were invited to send their observations and comments to DRD Water Policy Division.

During the consultation process an audit of the Draft WRMP was undertaken by the Reporter on behalf of NIAUR, and that audit informed the Regulator's response on the Draft WRMP to DRD. DRD circulated all the consultation responses it received to NI Water and asked the company to review all responses and to advise the Department on the need to respond to the issues raised on the Draft WRMP. DRD had received responses on both the Draft WRMP and the SEA; a list of the respondents to the consultation is given in Appendix F.

NI Water's review suggested that the issues fell into one of the three following categories:

- Issues to be addressed prior to publishing the Final WRMP (see section 1.5);
- Issues to be deferred until the next water resource planning round; and
- Substantive policy and regulatory issues for debate and agreement outside the scope of the water resource planning process.

The Draft WRMP recognised the substantial risk to abstraction licences that could arise from the implementation of sustainability reductions to meet the requirements of the Water Framework Directive (WFD). In line with UK best practice for water resource planning, it is expected that the environmental regulator (NIEA) will advise licence holders of the location and magnitude of sustainability reductions so that these can be taken into account in long-term water resource planning and appraisal of options to mitigate any consequential losses in deployable output. This will require close liaison between NI Water, the Department, and both the Environmental and Utility regulators. It is worth noting that in England & Wales this process has been addressed through the National Environment Programme (NEP) agreed between Ofwat and the Environment Agency, in which the work is undertaken by the water utility affected and funded through price limits. The process generally takes two five-year planning cycles between identification of a potential issue and identification of a preferred option(s) for implementation. No further information of the possible locations and magnitude of sustainability reductions has been made available for the Final WRMP.

Guidance emphasises that the SEA is an iterative process and an SEA Statement has also been published alongside this Final WRMP, indicating how the information and results in the Final WRMP and the SEA have been influenced and informed by each other.

1.5 Overview of key changes in Final WRMP

All responses on the Draft WRMP and the SEA Environmental Report have been reviewed (Appendix F). Amendments and updates to the Draft WRMP have been informed by the responses received. The response from the Northern Ireland Authority for Utility Regulation (NIAUR) was informed by the Reporter's audit of the Draft WRMP and SEA which was conducted in December 2010.

The main changes since the draft WRMP have been in response to:

- A review and update of deployable output (DO) calculations, taking account of more detailed information made available through the Trunk Mains Model (TMM) programme;
- Revised WRZ leakage targets, leakage reductions and associated costs;
- A revised draft policy on customer supply-pipe repairs;
- Updated headroom calculations taking account of new baseline demand forecast with revised leakage targets and headroom uncertainty of PPP schemes;
- A review of the current status of PC10 and planning period 2013–18 strategic transfer schemes;
- A review and update of the costs of options;
- A review of previous decisions that particular sources (for example Camlough) should be abandoned; and
- The inclusion of DECC prices for carbon in the investment model.

In parallel with this Final WRMP, the Strategic Environmental Assessment (SEA) Statement has been written.

1.6 Future Water Resource Management Plans

Future plans will also take account of any changes in best practice methodologies for water resource planning developed by the UK water industry, changes in Government policy on water charging, customer behaviour, and the introduction of sustainability reductions to meet the requirements of the Water Framework Directive (WFD).

The main changes to future WRMPs are therefore likely to include:

- Recalculation of deployable output (DO) taking into account any environmental constraints on existing abstraction licences that may be introduced by NIEA;
- Recalculation of DO with longer hydrological records;
- Possible introduction of water charging;
- Progressive introduction of NI Water's Water Demand Management Strategy (WDMS) (see section 4.3.5);
- Changes in technology that may lead to more cost effective delivery of leakage reduction;
- Changes to UK water industry best practice methodologies for water resource planning and regulatory guidance which is likely to cover, the definition of Water Resource Zones (WRZ), the treatment of uncertainty and risk in the supply demand balance and investment decisions, environmental and customer levels of service, consideration of extreme events, and the treatment of climate change on both supplies and demands;

- Changes to the cost of carbon; and
- Changes in customer behaviour that is reflected in observed water consumption as reported in the Annual Information Returns (AIR).

The Water Resource Management Plan process requires the plan to be reviewed annually and updated at least every 5 years or earlier if there should be a material change of circumstances. This is the first WRMP to be produced since NI Water has been regulated. The regulatory process has stimulated a process of continual improvement in the collection, analysis and interpretation of operational and customer data, leading to increased confidence in the reliability and quality of the data.

2. Water resources management plan

2.1 General information on plan content and development

NI Water is the appointed statutory undertaker for the supply of water and sewerage services to the population of Northern Ireland in accordance with the Water and Sewerage Services Order (Northern Ireland) 2006 (the 2006 Order). As an appointed undertaker, NI Water has a duty to produce and maintain a Water Resource Management Plan (WRMP) as set by Article 70 of the 2006 Order. The WRMP is then used to manage and develop water resources to ensure that NI Water continues to be able to meet its statutory duties under the 2006 Order.

In accordance with statute this WRMP formally documents:

- NI Water's estimate of the quantities of water needed to meet its obligations in accordance with the 2006 Order;
- The measures which NI Water intends, or will continue, to take to meet its obligations under the 2006 order; and
- The likely schedule of activities that will need to be taken to implement the measures required to comply with the WRMP and the 2006 Order.

This WRMP follows on from two previous water resource strategies: Water Resource Strategy 1992, for the Department of the Environment Water Executive, May 1994; Water Resource Strategy 2002–2030 for the Department for Regional Development Water Service, January 2003. In addition to the new requirement under the 2006 Order, this WRMP also seeks to address gaps identified in the previous strategy and to follow UK water industry best practice methodologies.

Preparation of this WRMP has followed UK water industry best practice which draws on research and development (R&D) projects, many of which were funded by UKWIR (UK Water Industry Research). Best practice requires the use of standard definitions which are consistent with those used for regulatory reporting (for example the Annual Information Returns (AIR)) to the Northern Ireland Authority for Utility Regulation (NIAUR). UK water industry best practice also requires certain technical methodologies to be followed for specific elements of the analysis.

DRD has produced its own guidelines[1] for the preparation of the WRMP. The DRD guidelines take into account the differences between the water resource, supply systems and customer base in Northern Ireland, and the relative maturity of the regulatory systems. The quality and robustness of the data that underpin the regulatory returns to NIAUR is expected to improve over time. This will help to reduce uncertainties in the components of the base year water balance and to align more closely with best practice in England & Wales which has been achieved after more than 20 years of regulation.

This WRMP is consistent with the DRD guidelines. The WRMP has been compiled from separate technical studies each of which has been described in Technical Notes that explain the approach and results. The Technical Notes have been circulated to NI Water staff and the Project Steering Group; comment and feedback has been taken into account in the preparation of the values used for this WRMP. The Technical Notes have been recompiled as Appendices to this WRMP.

[1] Guidelines for Preparing a Water Resources Management Plan, DRD Water Policy Division, September 2010

The least-cost combination of both supply-side and demand-side options to maintain the supply demand balance under dry year annual average conditions over the whole of the planning period has been identified. The analysis of cost considered capex, opex, and social & environmental costs including carbon.

During the preparation of this WRMP, NI Water has consulted with DRD Water Policy Division, NIAUR, NIEA and the Consumer Council for NI (CCNI). The Draft WRMP was also made available for public consultation.

In parallel with the preparation of this WRMP, a trunk mains model (TMM) has been developed. The TMM has been used to provide a more complete understanding of transfer within and between Water Resource Zones (WRZ) and hence the security of supplies across NI Water's operational region.

The following sections cover:

- Section 3 Water supply
- Section 4 Water demand
- Section 5 Climate change
- Section 6 Target headroom
- Section 7 Baseline supply demand balance
- Section 8 Options appraisal
- Section 9 Final water resources strategy
- Section 10 Glossary of terms used in the WRMP

The Appendices provide more detail of the work described in the previous sections.

- Appendix A Deployable output
- Appendix B Outage
- Appendix C Demand forecast
- Appendix D Headroom
- Appendix E Investment model
- Appendix F Consultation

A stand-alone document (Annex A) provides additional information on supply considerations in the West WRZ.

2.2 Planning period

The first, or base, year for the Draft WRMP was 2008–09. At the time of the Draft WRMP this was the last year for which full data existed, and for which a water balance was submitted to the regulator NIAUR. The response to DRD on how NI Water intended to reflect in the Final WRMP the responses to consultation on the Draft WRMP, NI Water asked specifically whether the base year should be changed from 2008–09. In accordance with DRD's reply the base year has not been updated for the Final WRMP

The planning horizon covers a 25 year period from the start of Price Control period PC10 (2010–11) and thus runs until 2034–35.

The objective of the WRMP is to identify a strategy to ensure that there is sufficient water available to meet projected demands under dry year annual average conditions over the whole of the planning period, taking account of uncertainties in the various elements of the supply demand balance and the level of risk to continuity of supplies that NI Water is prepared to take. A WRMP is not intended to include possible operational and/or distribution system investment in response to extreme events that might lead to localised distribution issues at spatial scales smaller than the WRZs. However, in response to consultation representations, this WRMP does include a discussion of the recent freeze-thaw events in section 4.1.3 and Appendix C.2.

2.3 Water resources zones (WRZ)

The UK Water Industry definition of a WRZ is "the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall". Note that although this definition has been in widespread use since 1997, recent extreme events (for example the 2007 summer floods on the River Severn) have stimulated a review of the WRZ definition; that work is still on-going.

The following criteria have been used to inform the identification of WRZ boundaries for the purposes of this WRMP:

- The largest area in which all resources can be shared effectively;
- It represents a group of customers who receive the same overall level of service;
- Each WRZ is essentially self-contained – defined by limits on infrastructure connectivity and/or geographic or physical boundaries. Each WRZ is defined by natural cleavage lines;
- There will be limited opportunity to transfer water across the zone boundary under normal operating conditions;
- Each WRZ is built up from smaller water balance units (such as District Meter Areas (DMA), leakage zones, etc.) which define supply management and zones for AIR reporting;
- Integrity: clear connectivity of infrastructure within each WRZ providing secure supplies to meet demand and defined levels of service;
- WRZ resilience: no pockets of population served within the zone which will be at a higher risk of supply-demand failure;
- The definition envisages that water can be supplied throughout each WRZ so is based on the assumption that there are no network constraints, although it is recognised that these exist to some degree in all supply networks; and
- Risk of supply failure or ability to maintain acceptable levels of service is generally measured by the frequency of imposition of restrictions on water use. Vulnerability to low pressure and unplanned interruptions to supply (which are a function of the condition and performance of local infrastructure) are not used as a basis for defining WRZ boundaries.

WRZs will vary in size depending on the configuration of the supply network and the way in which it functions. Separate supply demand balances are constructed at WRZ level. Surpluses in one or more WRZs may then be available for transfer across WRZ boundaries to meet deficits. If such transfers are identified as part of the least cost plan, then there may be an argument for amalgamating neighbouring WRZs together in future.

The WRZ boundaries have been identified following discussion between NI Water's leakage team and the Atkins WRMP and TMM project teams. The WRZ boundaries agreed with NI Water for use in the WRMP are shown in Figure 2.1.

Note that Rathlin Island is separated from the mainland by about 5 km. The island has a completely separate groundwater-based supply system. This system is not included in the regulatory reporting to NIAUR and therefore does not form part of this WRMP.

Figure 2.1 shows that the south-eastern part of the supply area is divided into two separate WRZs; between them these two WRZs contain 73% of Northern Ireland's population (East 50% and South 23%) and 74% of distribution input (East 46% and South 28%). There could be an argument for these two WRZs to be amalgamated into a single WRZ. This possibility would need to be considered in any future review of WRZ boundaries using new guidance on WRZ integrity that is expected to be issued in 2012 as part of updated water resource planning guidance.

Some consultation responses queried whether the WRZ boundaries should take account of the River Basin District Boundaries (RBD) identified in the WFD River Basin Management Plans. One of the main factors that identify the boundary of a WRZ is the configuration, density and capacity of the distribution network which are themselves determined by the properties that are served. This means that WRZ boundaries are often similar to but would not be expected to be the same as topographic catchment boundaries.

Updates to the UK water industry guidelines for the definition of WRZ boundaries are being developed, so it is expected that the next WRMP will take these into account. Any changes to the definition of WRZ boundaries would also have a knock-on effect on the data collection, analysis and reporting for the AIR to NIAUR. It is also expected that any NIEA review of abstraction licences would be based on analysis at the scale of the RBD.

No changes to WRZ boundaries have therefore been made since the Draft WRMP.

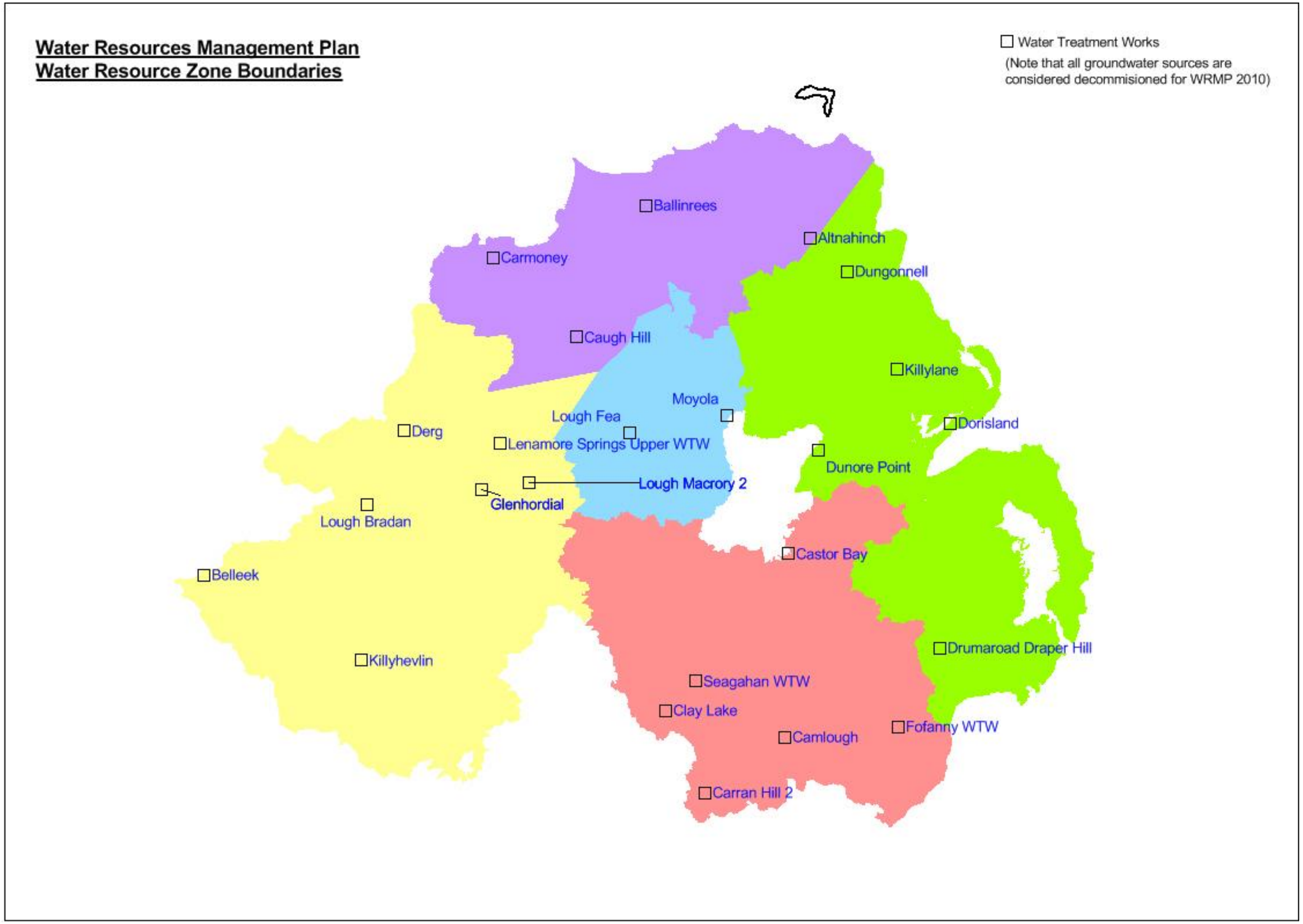

Figure 2.1 – Schematic of Water Resource Zone Boundaries

2.4 Scenarios

In accordance with best practice guidance for water resource planning, companies generally consider their supply demand balances under different planning scenarios. For each planning scenario a baseline forecast of supply and demand is produced. Where a deficit in the supply demand balance is identified, a final planning forecast is also produced to demonstrate the impact of the options used to overcome the deficit. These options may include new resources, demand management measures to reduce water consumption, or a combination of the two.

The primary planning scenario for the WRMP is the **dry year annual average scenario (DYAA)**, which is defined by a period of low rainfall and unconstrained demand. This forms the basis of the WRMP, because the overall objective of the WRMP is to ensure that even under drought conditions, when supplies may be stressed, the level of demands associated with hot dry conditions can be met in full.

The dry year demand forecast is developed from normal year annual average data (NYAA) – i.e. base year data that has been normalised to represent demands under “average” or typical climatic conditions. A normal year annual average demand forecast is thus produced in addition to the dry year annual average scenario, for comparative purposes.

Some companies might also need to derive critical period scenarios, where their supply demand balance is sensitive to these because there are sustained periods when demands are significantly higher than average; this is a peak demand condition. Supply-side characteristics may also influence whether or not critical period analysis is required, for instance, where WRZs are supplied predominantly by groundwater, or by run of river abstractions with limited storage.

The supplies available to NI Water are dominated by abstractions from Lough Neagh. Here, abstraction represents a very small proportion of the total storage, so the impact of abstraction on total storage, and hence water levels is small. This means that the deployable output from the Lough Neagh sources is controlled by licensed quantities and not hydrology. In addition, recent demand data does not suggest that there is a strong peak demand driver in Northern Ireland. For these reasons, it is not appropriate or necessary to consider the critical period scenario for Northern Ireland, because this is not the primary driver for investment to maintain the supply demand balance.

However, a number of consultation responses made reference to the freeze-thaw events over winter in both 2009–10 and 2010–11. These represent an extreme weather event causing operational issues for the company. They are not usually considered as part of the WRMP, which would tend to look at peak demand drivers during summer, when hot weather might be most expected to increase customers’ water use. Section 4 provides a more detailed analysis of the freeze-thaw events. However, for the Final WRMP, there has not been a critical winter period scenario run, because it is not appropriate under a supply demand balance driver to plan and justify investment to meet short-term operational issues from extreme events.

2.5 Reconciliation of data

The base year data (2008–09) for the water balance is taken directly from the Annual Information Return for 2009 (AIR09). The AIR09 data included in the regulatory returns to NIAUR have been reconciled using the maximum likelihood estimation (MLE) method to allocate uncertainties in the values of the water balance components in the base year.

The MLE method is the accepted method of reconciling the individual components of the water balance to ensure that the sum of the estimated components (“bottom-up” approach) equates to the measured distribution input[2] (“top-down” approach).

2.6 Sensitivity testing

Sensitivity analysis is used to assess the robustness and flexibility of the company-preferred strategy to meet a baseline supply demand balance deficit. This is achieved by varying input values to establish whether the strategy, and timing of that strategy, would change significantly. Sensitivity testing is necessary because many assumptions are required to derive the WRMP.

This analysis would generally consider two areas of sensitivity[3], as follows:

- Data uncertainty in the supply demand balance: data uncertainty is allowed for in target headroom (see description in section 6). The headroom analysis provides the basis for understanding the impact of data uncertainty on the supply demand balance; and
- Sensitivity of the proposed strategy to assumptions or changes in the supply demand balance.

This second element of sensitivity analysis is required to assess the robustness of the plan or strategy. This is to ensure that a small change in one of the components does not lead to a completely different strategy.

2.7 Company policies

The NI Water website lists its policies and procedures under the following headings:

- Charging regimes;
- NI Water’s Codes of Practice (CoP); and
- Environmental policies.

The policies of direct relevance to the WRMP are:

- CoP – Water supply services for domestic customers; and
- Environmental Policies:
  - Environmental Policy;
  - Energy Policy;
  - Leakage Levels; and
  - Climate Change.

In contrast with water undertakers in England & Wales, NI Water has no stated policy on customer Levels of Service (LoS). In England and Wales there are two Target Levels of Service directly related to a WRMP. The first, customer Target Levels of Service, relates to the frequency and nature of restrictions on water use that customers may experience, in the form of “hosepipe bans” and bans on “non-essential uses” under drought conditions. The second group is environmental

[2] Environment Agency (England & Wales) (Nov 2008), *Water resources planning guideline*, Section 5.7
[3] Environment Agency (England & Wales) (Nov 2008), *Water resources planning guideline*, Section 5.8

Target Levels of Service, which relates to the frequency of relaxations to conditions of abstraction licences.

NI Water's policy is set out in the general statement under the heading "Interruptions to your water supply":

> *We aim to supply adequate, continuous supplies of safe drinking water to each customer connected to our distribution system.*

The statement refers more to short-term interruptions to supplies, rather than to longer-term restrictions that might be imposed to conserve resources during times of drought.

As discussed in section 4.1.2 there have been no restrictions on water use in recent years. This, combined with relatively low peak demand experienced during summer months, means that the concept of customer-side restrictions on discretionary use such as garden watering is not considered by NI Water and its customers to be relevant. It is worth noting however that for some of NI Water's reservoir sources the operational drought plan does include rule curves that show where customer restrictions might need to be introduced.

The Environmental Policies listed above, with emphasis on environmental protection, minimising energy use and taking account of climate change have informed the development of this WRMP.

2.8 Details of competitors for each resource zone

There are no other water undertakers in Northern Ireland, and so there are no direct competitors. In all except the West WRZs NI Water's customers are supplied from a mixture of NI Water's own sources and from PPP sources.

3. Water supply

3.1 Deployable output

The fundamental supply-side building block for the supply demand balance is the estimation of deployable output (DO). The value of DO represents the output of a source (or group of sources) that can be achieved under specific design conditions. For surface water sources, the calculation of DO is based on behavioural analysis using flow time series that are as long as possible. The calculation of DO can be either for a single source, or for the combined output of all the sources in a given WRZ; this conjunctive use DO is very unlikely to be the arithmetic total of the individual source DOs. Calculation of the conjunctive use DO is considered best practice in the UK.

The DO of a source is a measure of what the source can produce under the hydrological conditions of the worst drought on record. Under more favourable hydrological conditions, a given source may be able to deliver more than the DO, up to limits determined by the capacity of the treatment works and/or abstraction licence conditions. The approach taken here follows that set out in guidelines that are based on a programme of R&D projects to develop practical methodologies for water resources planning funded by UKWIR and the Environment Agency (England & Wales). The methodologies have been reviewed and where necessary updated over time to take account of new techniques and analytical tools, greater computing power, and more data. As noted in section 2.1, best practice requires the use of standard terms with very specific definitions; for example the term “safe yield” is no longer used but has been replaced by the term deployable output.

None of the models or input data sets used for WRS 2002 was available for this WRMP (WRMP 2012). New water resource models have therefore been constructed using the Aquator water resource modelling application. The models have been configured to represent the current supply system. Model construction has used information and data collated from a variety of sources and through collaboration with both NI Water staff and the Atkins trunk main model (TMM) team. In addition to assessing the current supply system, the models have been used to test scenarios related to climate change (section 5.1) and to assist the optioneering process. The flexibility of Aquator has ensured that any model updates required have been quickly and easily absorbed into the build.

Appendix A provides further detail on the reasons for opting to use a water resources model, the decision to use Aquator, the model build process and the model setup and execution of DO and scenario model runs.

A number of the consultation responses queried the use of a relatively short period of hydrological data for the supply-side analysis (1976–2009); this issue is addressed in section 3.1.1. A potentially larger source of uncertainty in the supply-side analysis is the possible magnitude of the reduction in DO that would follow from the introduction of environmental constraints on existing abstraction licences – see section 3.3 for further discussion.

Some consultation responses also queried previous decisions to decommission sources. Since WRS 2002 a number of small and typically groundwater sources have been decommissioned and the abstraction licences surrendered to NIEA. Since the Draft WRMP further work to review the previous decision to decommission the Camlough source has been undertaken; the baseline supply demand balance still assumes that Camlough is decommissioned from 2015 onwards; however retaining Camlough is now included in the list of constrained options available for selection by the investment model (see section 8.3)

3.1.1 Hydrological analysis

The DO modelling for the supply forecast was undertaken over the period of 29/12/1975 to 11/07/2009 as this represented the full period of gauging station flow data available from the Rivers Agency (the method for the generation of input flow sequences is outlined in section A.4.3 of Appendix A).

UK water industry best practice requires the use of long time series of river flows to determine DO. The length of observed flow records available in Northern Ireland is relatively short, and a longer record should make it more likely that critical drought conditions are included within the design period, and a more drought resilient analysis should result. To undertake DO analysis using longer flow time series it would be necessary to infer river flow from rainfall records which are likely to go back further than 1975. The best method for this is to construct rainfall-runoff models which would be calibrated against post-1975 river flow records. This would require an extensive programme of hydrological work to obtain and ensure the quality of the basic hydrometric data, and to develop, calibrate and validate appropriate rainfall-runoff models. However, the benefits in terms of a more representative analysis and a greater statistical credibility are also clear. Such a programme of work is beyond the scope of this WRMP.

To consider the context of the 1975–2009 hydrological period against a longer historical record a number of analyses have been undertaken. The basis for all of this work is the Armagh metrological record which stretches back to 1853 in terms of rainfall measurements. This is the longest continuous rainfall record for Northern Ireland and it has been used to assess the dry periods which are of interest when determining DO (having first examined that there is a reasonable relationship between rainfall and flow). There are four parts to the investigation (with further details included in section A.4.3 of Appendix A):

- Historical drought length and severity;
- Rainfall frequency distribution;
- Aridity index[4]; and
- Aquator failures.

The first part of the analysis, in which rainfall was compared to the long term average, showed that the WRMP hydrological period included 2003–2004, which is the second longest dry period in the 1853–2009 Armagh record, but based on deficits against the long-term average this was not one of the most severe droughts (although no formal frequency analysis was completed). However, the period 1975–2009 does contain at least one of the most severe droughts in the Armagh record; 1995.

In the second part of the analysis (Figure 3.1), where rainfall was totalled over different periods (3 months of summer, 6 months of summer, 12 months, 24 months and 36 months), 1995 was confirmed as being a very severe year – the driest in the whole record for a 3 and 6 month duration. However, it didn't feature in the top 20 ranked years for the 12, 24 and 36 month totals. Both 2003 and 2004 (identified at the second longest dry period in the first featured in the first part of the analysis) feature in the top 20 driest years but not prominently – 2003 is only in the top 20 for the 12 month totals (15th) and 2004 only for the 24 month totals (20th).

[4] Environment Agency, 2006, SC040068/SR1, The impact of climate change on severe droughts: Major droughts in England and Wales from 1800 and evidence of impact

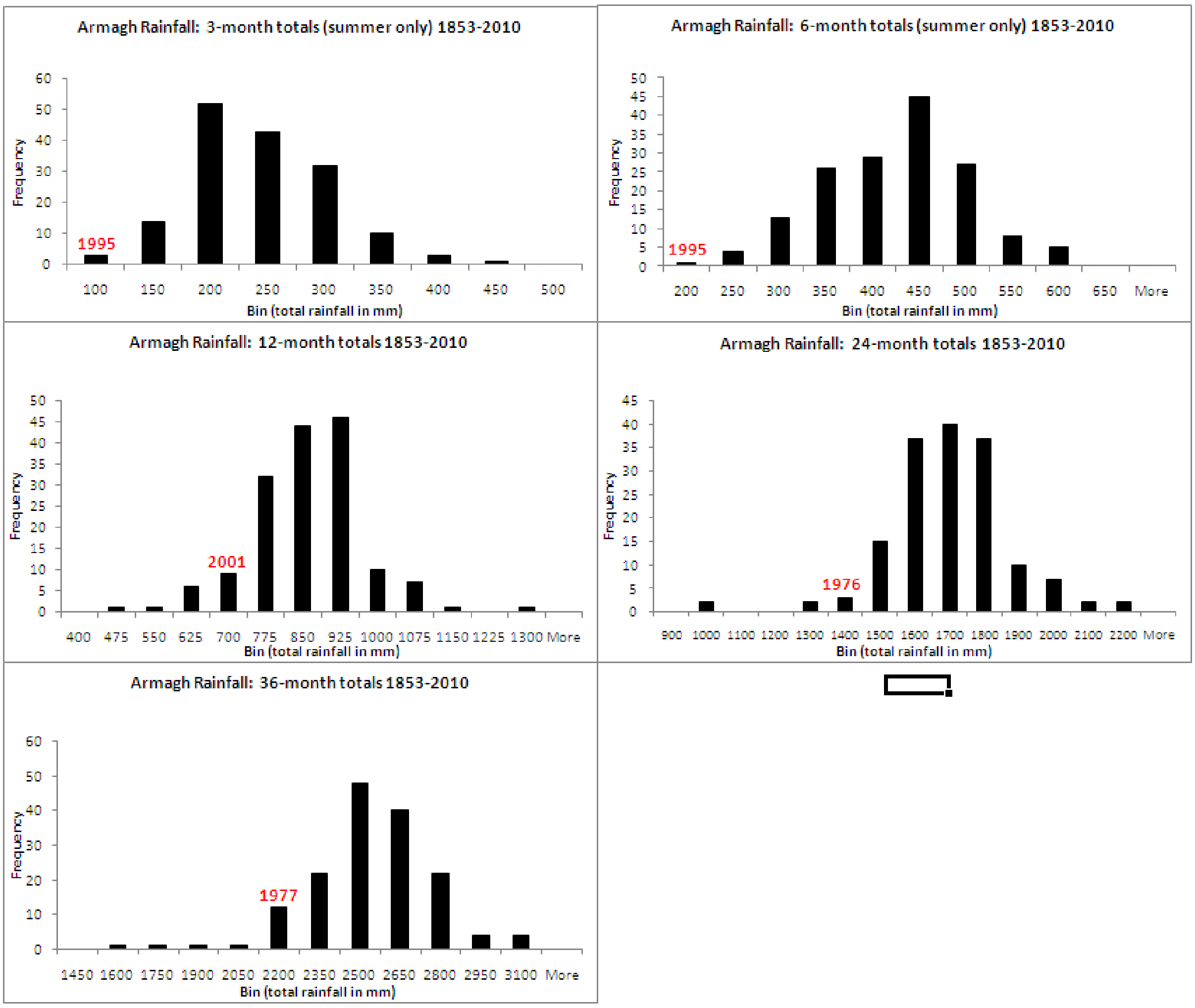

Figure 3.1 – Total 1853–2010 rainfall distributions for each of the defined periods: summer 3 month, summer 6 month, annual, 24 months and 36 months.

The placement of red years corresponds to the bin into which the driest years from the WRMP hydrological period fall

In the third part of the analysis temperature (and hence to some extent evaporative) influences are introduced by using the Environment Agency's aridity index methodology (Figure 3.2). The results show that the WRMP hydrological period includes relatively more dry periods than the overall record. It also clearly indicated 1995 as the driest year. As this method sums rainfall on the same 6 month basis as in the second part of the analysis it is unsurprising that there is good correlation between the two methods.

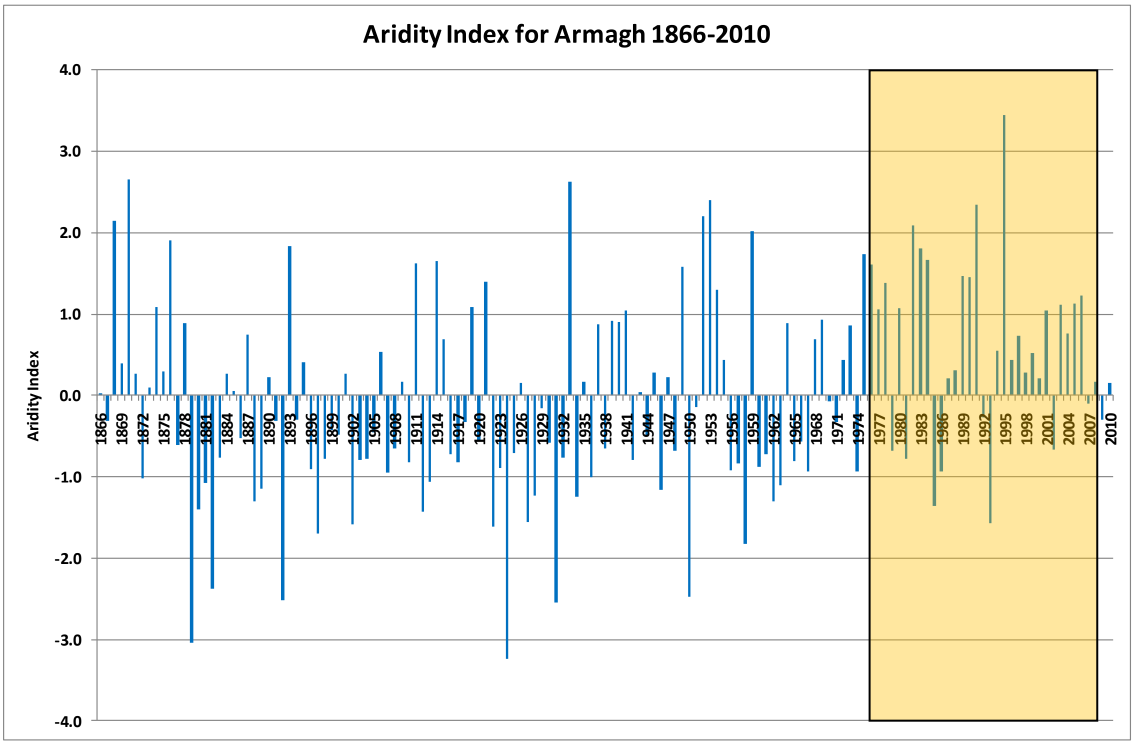

Figure 3.2 – Aridity indices for the Armagh record.

The beige shaded area corresponds to the 1976–2009 WRMP hydrological period.

In terms of the sources present in Northern Ireland many are either direct river abstractions or smaller reservoirs and there are no groundwater sources in the WRMP, suggesting that shorter dry periods are likely to be most critical. Therefore, this would indicate a high degree of confidence in using the period 1975–2009 to determine DO. However, in terms of volume alone sources such as Lough Neagh, Lough Erne and Silent Valley are critically important in Northern Ireland and are likely to be more impacted by longer dry periods which, according to this analysis, are less well represented by the period used for the WRMP. This limitation is not of immediate concern because these large sources are proportionally less hydrologically impacted by the abstractions taken from them. Therefore, even if they experience very long and severe dry periods there is unlikely to be any affect on abstractions and hence any impact on DO. However some sources, e.g. Silent Valley and Ben Crom could be affected as they are relatively large and abstraction is not so insignificant when compared with the local hydrology. Any attempts to extend records for future plans would be advised to start there.

Therefore, these analyses have shown that the WRMP 1975–2009 hydrological period is appropriate for the purposes of determining DO. Beyond the completion of the WRMP it might be beneficial to extend the hydrological record further back to determine the potential impacts of earlier longer duration dry periods on the larger sources. However, it is unlikely that further investigations would of themselves lead to a redefinition of DO in most of the WRZs, with the most significant impact likely to arise from the introduction of sustainability reductions. The WRZ most likely to benefit from additional analysis would be the East WRZ (Figure 2.1) where DO is defined by hydrological constraints at larger sources.

It is critically important if records are extended backwards that a high degree of confidence in the hydrological sequence is maintained. This is especially true for rainfall runoff modelling which relies on long high quality rainfall records with good spatial variability and appropriate river flow records for calibration. Evapotranspiration and plant/soil processes can also be critical in the conversion of rainfall to runoff particularly at lower flows. Even if it is deemed that sufficient data are available for these purposes then, a significant amount of effort would need to be expended to generate extended flow records.

3.1.2 Water resource modelling

A number of Aquator models have been built to represent the five WRZs[5] of Northern Ireland (section 2.3). The structure of each model was initially based on the WRS 2002 and updated using the expertise of key NI Water personnel and the Atkins TMM team. The input data required for the model were assembled from data requests to NI Water and further clarification and discussions with staff from NI Water and the Atkins TMM team. Where data was not available, assumptions have been made.

Timeseries of daily river flows for the period December 1975 to July 2009 at all the relevant points of interest were developed using the Low-Flows Enterprise (LFE) software and a bespoke tool to transpose daily flow records. Further details of the hydrological analysis and generation of consistent timeseries of river flows at all points of interest are given in Appendix A. This approach makes use of all relevant flow data that are available for the longest period of record.

Aquator has been chosen as the software platform most suitable for this WRMP. It has been used for a number of years by various water companies in the UK as a high level strategic water resources planning tool. It provides an intuitive and flexible platform for simulating all elements of a WRZ and, importantly, allows future supply system modifications to be incorporated into the model environment with ease. As is the case for all high level strategic tools, deciding on an appropriate level of simplification of the real system on the ground is a critical step in the model build. In this supply forecast the decisions are mainly based on:

- Professional judgement of what is suitable for a DO assessment;
- Review of how DO has been determined in Northern Ireland in other studies; and
- Ensuring that the work is consistent with the amount and quality of data that it was possible to assemble in the data collation phase of this WRMP.

3.1.2.1 Water Resource Zone Components

In the initial stages of the model build four schematics were produced based on information in the WRS 2002 that reflected the Divisional structure in place at that time. Each component was checked against available maps of the water supply network and then issued to a number of key NI Water personnel for review and comment. These original schematics were then updated to take account of this new information and rearranged into the five new WRZs (section 2.3) and reissued for final checks. Finally, each schematic was verified with the Atkins TMM team to ensure that the distribution network set out in Aquator was an appropriate representation of the real one.

The WRMP Guidelines require that estimates of available supplies (DO) are made at the WRZ scale. This requires a high-level representation of the water resource system, which takes into account strategic transfer links between sources and demand centres. The characteristics and capacities of such links represented in the water resource model used to calculate DO were informed using the Trunk Mains Model (TMM) that was developed in parallel with the WRMP. This high level representation for the WRMP comprised a small number of demand centres so does not take into account distribution or operational constraints at the smaller spatial scales such as

[5] A Water Resource Zone is the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.

District Meter Areas (DMA). Distribution system investment requirements would be addressed using the TMM, carrying out trunk main capacity studies and/or some other distribution system model such as those used in detailed zonal studies.

All existing and PC10 funded schemes are included in the models, but in accordance with WRS 2002 and current NI Water policy, all groundwater sources are assumed to be out of service for the WRMP 2012 baseline. Any assets which have been identified as being 'out of service' or abandoned have not been removed from the schematics, but have been disabled in the model and are represented with a line through the component name so that their status is clear. Assets transferred to and operated under the PPP have 'PPP' inserted into the component name. Under the PPP scheme Dalriada (Kelda Water Services) has since December 2008 operated the following facilities on behalf of NI Water; Dunore Point (Antrim), Ballinrees (Coleraine), Castor Bay (Craigavon), Moyola (Magherafelt). Aquator demand centre components (yellow circles in the schematics shown in Figure 3.4 to Figure 3.8) are included based on the WRS 2002 resource zone names because they remain the most appropriate means of apportioning demand across each WRZ (see Appendix A). It is important to stress that the links (black arrows) in the models do not necessarily represent an individual pipeline – it is more convenient to think of them as a general movement of water between areas across the supply network

In addition to the models just described, a further set of models was constructed to give estimates of the unconstrained DO of the WRZ. Under this condition all sources are linked to one central demand centre. In this approach DO results are not limited by capacity constraints of pipelines within the WRZ and so provide a useful indication of the total supply potential in the WRZ. These four model schematics (the Central WRZ is already connected in this respect) and further explanation of the approach are included in Appendix A.

NI Water staff provided feedback on the preliminary DO results which led to some minor revisions of the representation of water resource system.

Schematics

Figure 3.3 provides a guide to the component symbols used in the schematics for each WRZ model; Figure 3.4 to Figure 3.8 have been exported directly from Aquator, and show the schematics for each WRZ model.

Abstraction
An Abstraction allows water to be taken from a river to supply

Bulk supply
This component allows transfer of water to supply from outside the model

Catchment
A Catchment marks the start of one branch of the river network and adds water on daily basis to the river network at that point

Demand Centre
A Demand Centre acts as a source of demand such as city, town or region

Groundwater
This component is a simple representation of a groundwater source

Link
A Link connects joins together supply type connector. It represents pipelines, aqueducts and channels used in the supply distribution network

Reach
This component is a simple representation of a river reach that allows flow to be subject to a time delay along the reach and losses to be applied

Reservoir
A Reservoir provides storage for water either in the river network or in the supply system

Termination
A Termination component is required as the last component at the downstream end of a river reach to account for water leaving the system in the water balance calculations

Water Treatment Works
A Water Treatment Works is located in the supply system and supports Process Water losses and Clear Water Returns

Figure 3.3 – Key to Aquator model component symbols

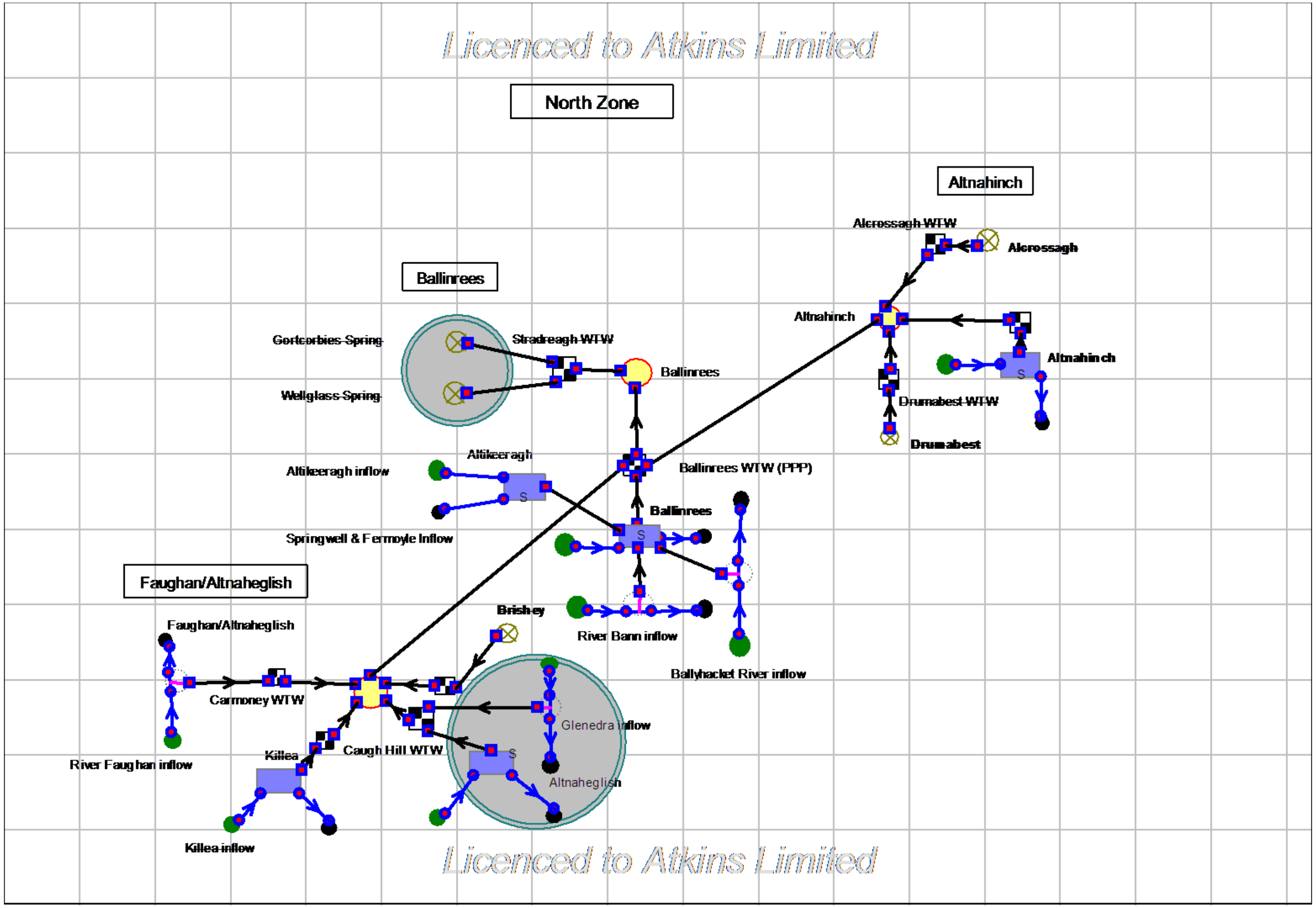

Figure 3.4 – North WRZ model schematic

Note that the links (black arrows) do not necessarily represent individual pipelines, rather a general movement of water

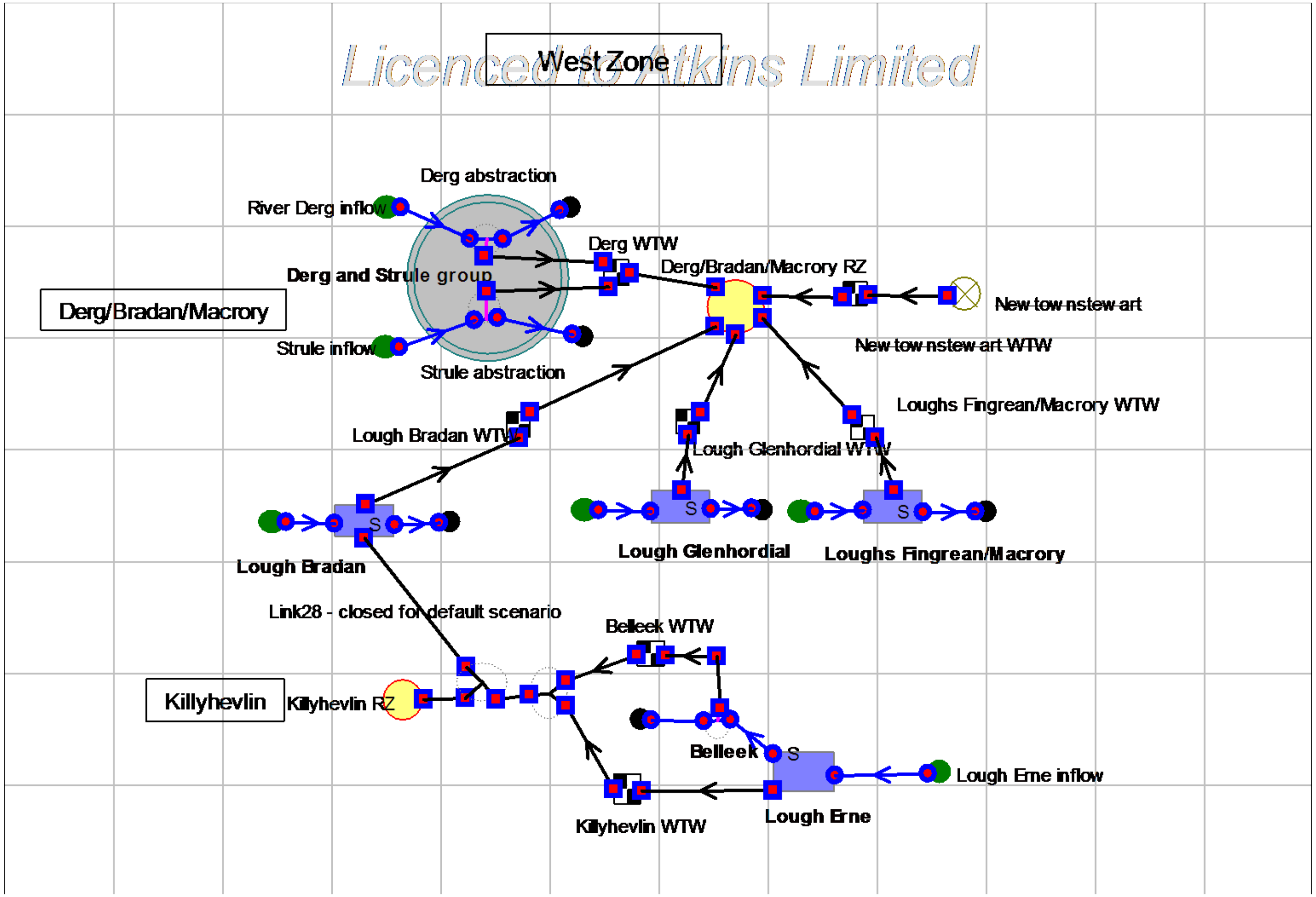

Figure 3.5 – West WRZ model schematic

Note that the links (black arrows) do not necessarily represent individual pipelines, rather a general movement of water

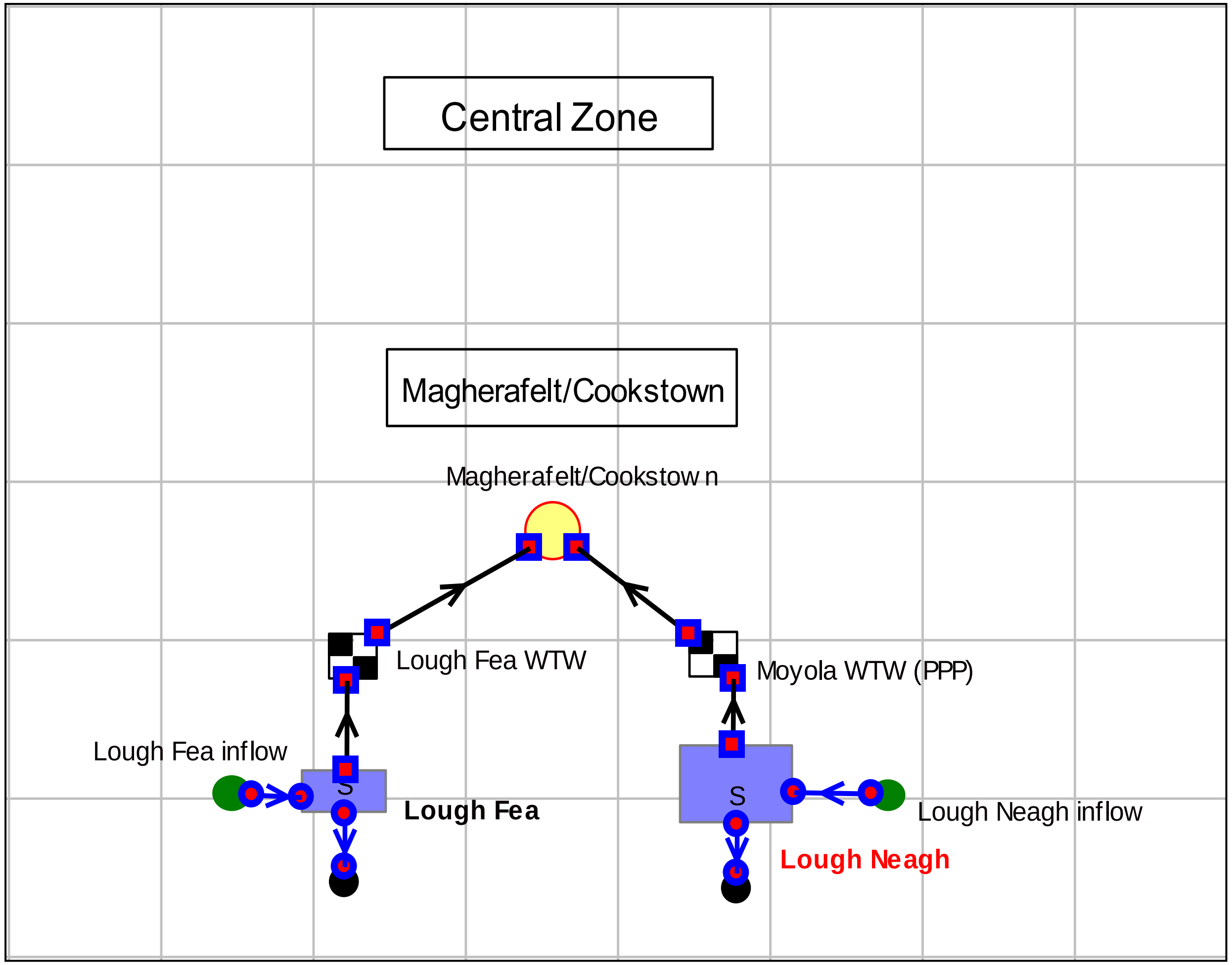

Figure 3.6 – Central WRZ model schematic

Note that the links (black arrows) do not necessarily represent individual pipelines, rather a general movement of water

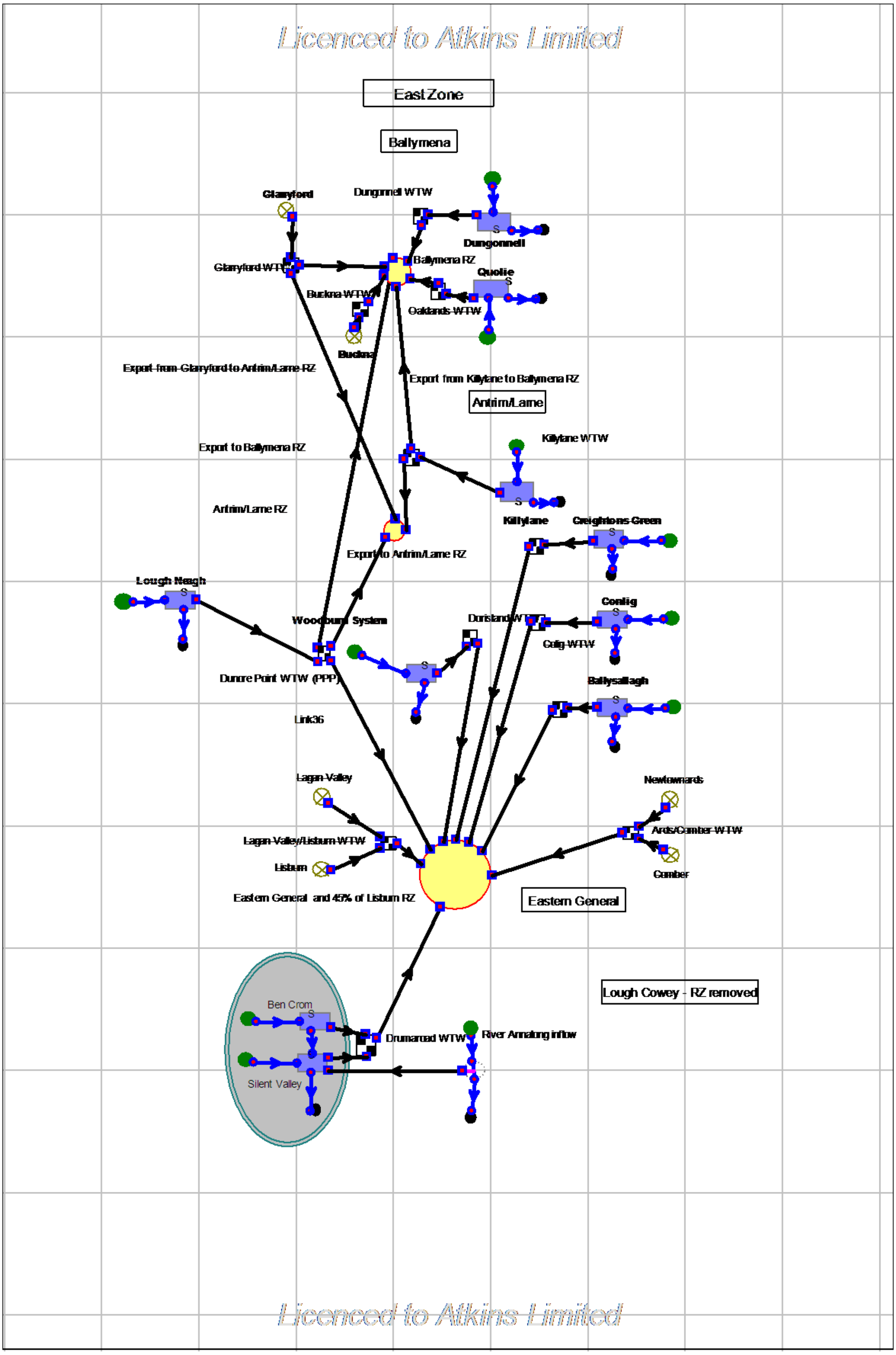

Figure 3.7 – East WRZ model schematic

Note that the links (black arrows) do not necessarily represent individual pipelines, rather a general movement of water

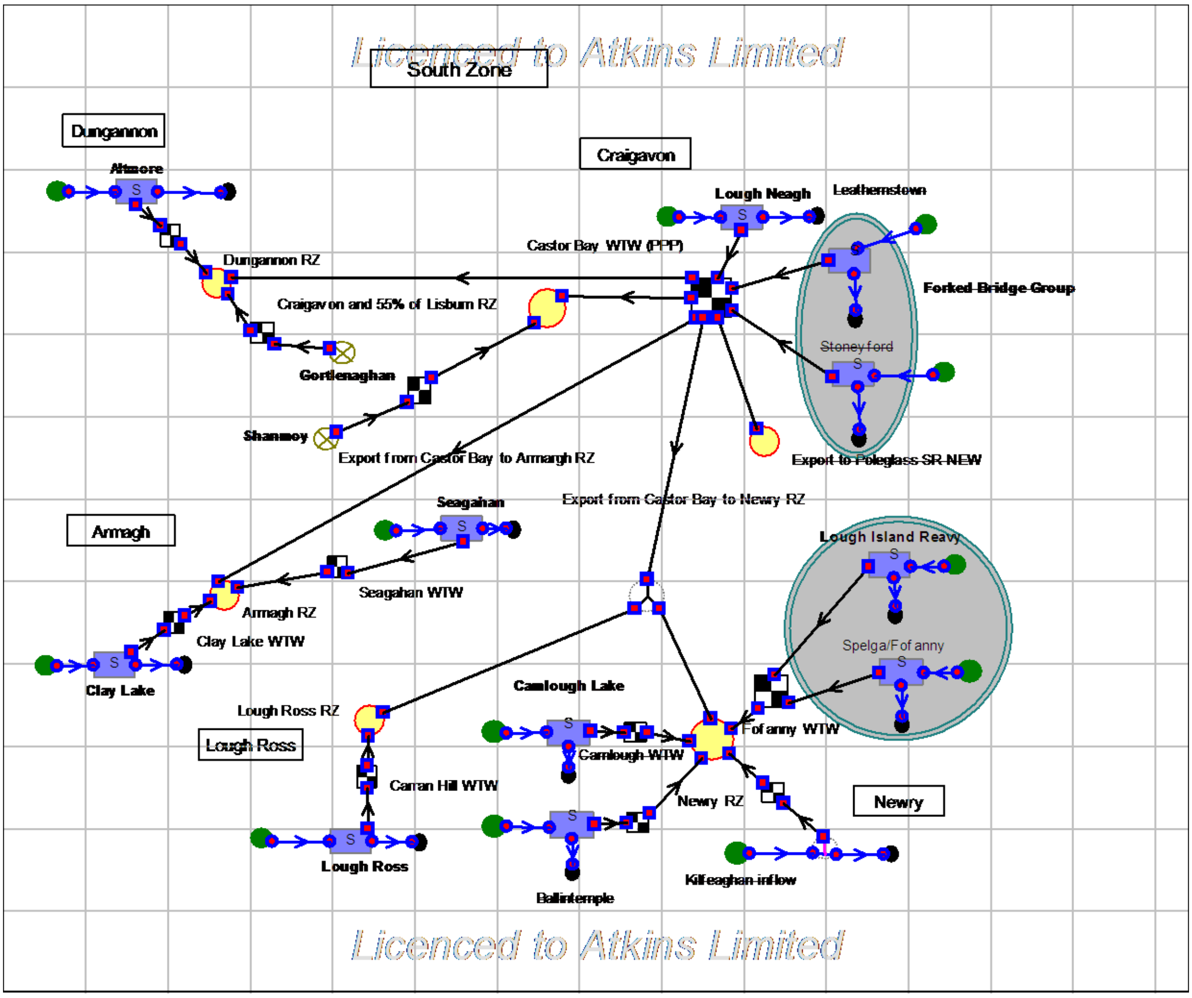

Figure 3.8 – South WRZ model schematic

Note that the links (black arrows) do not necessarily represent individual pipelines, rather a general movement of water

3.1.2.2 Model component data

The Aquator model is able to incorporate a very wide range of data and information relating to the operation of each component in the models. This type of data includes physical & operational data, and licence information. Directly measured or recorded data were not always available, but alternative sources were found or were derived as part of this work (in italics) or based on appropriate assumptions. Further details are included in Appendix A. The following data were used for the development of the Aquator models:

- **Impounding reservoirs**
  - Storage capacity;
  - Inflow record – *determined using the Low Flows Enterprise software*,
- **Boreholes**
  - Confirmation of whether borehole source still in service;
  - Yields.

- **Abstraction licences**
  - Daily and annual quantities;
  - Minimum and environmental flow conditions.
- **Infrastructure (link mains and WTW)**
  - Critical capacities constraints (e.g. between the source (impounding reservoir, river, borehole etc.) and the water treatment works); i.e. whether there a critical capacity limitation relating to the intake structure, pumping station or link (pipe, channel etc.) that will constrain the volume of water that is able to reach the works in addition to any licence constraints;
  - In addition to links in current operation, all new links which have approved funding under PC10 have also been included in the baseline;
  - Water Treatment Works (WTW) capacities and losses – a number of sources of information regarding physical capacities of WTW were used relating to maximum and any minimum flow capacities. Works operated under the PPP are included in the models, but then separated out in the reporting tables as bulk supplies at their contracted rates.
- **River and stream flows upstream of each intake** (flows into impoundments covered under impounding reservoirs)
  - Mean daily flow time series obtained from Rivers Agency for all 106 gauges *and also determined using the Low Flows Enterprise software*.
- **Demand Centres**
  - Daily demand quantities – where multiple demand centres sit within one WRZ, demand is distributed in proportion to post MLE distribution input average values from the 2008–09 Water Balance[6].

3.1.3 Baseline deployable output estimates

The overall DO for Northern Ireland was determined as 773.6 Ml/d until 2015 and 759.5 Ml/d after the decommissioning of the Camlough source in the South WRZ. The individual WRZ results are as follows:

- North WRZ – 106.2 Ml/d (115.6 Ml/d if transfers are unconstrained within the WRZ);
- West WRZ – 88.2 Ml/d (89.1 Ml/d if unconstrained), and assuming that the output from the Derg WTW is at the design capacity and that there is no change in output from the Belleek WTW;
- Central WRZ – 31.1 Ml/d (no different if unconstrained);
- East WRZ – 329.5 Ml/d (329.7 Ml/d if unconstrained); and
- South WRZ – 218.6 Ml/d and 204.5 Ml/d once Camlough is decommissioned beyond 2015 (223.7 and 218.9 Ml/d if unconstrained).

The results from the unconstrained models (all sources linked to one central demand centre) suggest that there is most scope for increasing DO by increasing connectivity of the distribution system in the North WRZ.

[6] As this was based on a total of 21 resource zones/demand centres it was necessary to combine some areas to produce values for the 15 demand centres included in the Aquator models. It was also necessary to split the Lisburn area across the East and South WRZs (Eastern General and Craigavon demand centres)

Appendix A includes tables that summarise the results of the DO calculations for each WRZ. A summary of the main features of the DO calculations for each WRZ is given below. The summary includes an estimate of the output from all sources within each WRZ that would be available under more favourable hydrological conditions. In such circumstances DO would be limited by existing authorised quantities and other licence conditions, and infrastructure constraints, not by hydrology. A comparison of the current DO assessment and previous estimates is shown in Table 3.1.

North WRZ

The DO for the North WRZ is 106.2 Ml/d which is equivalent to 1.4 times the 2008–09 post MLE Distribution Input (i.e. the DO is 1.4 times higher than the average demand met in those years). The condition under which DO is determined arises when Altnahinch reservoir empties in September 1984. If there were no hydrological constraints, i.e. DO was only constrained by abstraction licences and assets in place across the WRZ, then the output available would rise to 113.2 Ml/d.

With the unconstrained model, where all sources are connected to one central demand centre, DO increases to 115.6 Ml/d which again is determined by Altnahinch reservoir emptying in September 1984. Removing the hydrological constraints to leave only the asset and licence constraints increases the output available to 116.9 Ml/d.

With the current model setup based on existing infrastructure constraints a continuous 10 Ml/d is supplied from the Ballinrees PPP scheme to Altnahinch. Increasing the capacity of this link would appear to be the key to increasing the WRZ DO.

West WRZ

With the assumption that the output from the Derg WTW is not constrained by flow conditions in the abstraction licence, the DO for the West WRZ is 88.2 Ml/d which is equivalent to about 1.4 times the 2008–09 post MLE Distribution Input. The DO is determined by Lough Bradan emptying in September 1984. If there were no hydrological constraints (leaving only the asset and licence constraints) then the result would be increased to 90.6 Ml/d.

With the unconstrained model, DO is increased to 89.1 Ml/d which again is determined by Lough Bradan emptying in September 1984. Removing the hydrological constraints to leave only the asset and licence constraints would further increase DO to 92.3 Ml/d.

This DO is achieved with all other sources being used in preference to Lough Bradan over the full run. In terms of inter-WRZ connectivity, the Killyhevlin demand centre is receiving 36 Ml/d out of a possible 37 Ml/d so there is not much scope for moving inter-zonal transfers to Derg/ Bradan/ Macrory demand centre in improving overall DO. This is highlighted in the unconstrained DO run.

Central WRZ

The DO for the Central WRZ is 31.1 Ml/d which is equivalent to about 1.2 times the 2008–09 post MLE Distribution Input. At present there are no hydrological constraints and the result for this WRZ with a single demand centre is determined only by asset constraints (not hydrology).

East WRZ

The DO for the East WRZ is 329.5 Ml/d, which is equivalent to about 1.1 times the 2008–09 post MLE Distribution Input. The DO is determined in the Eastern General area by Silent Valley and Ben Crom reservoirs emptying in November 1978. However, the model is optimised to balance storage between Silent Valley/Ben Crom and the Woodburn system so with only a slightly different optimisation Woodburn could cause the failure. Removing the hydrological constraints to leave only the asset and licence constraints increases the output available to 342.3 Ml/d.

With the unconstrained model, where all sources are connected to one central demand centre, DO is increased very slightly to 329.7 Ml/d which this time is determined by the Woodburn system emptying in November 1978 (again this could easily have been Silent Valley and Ben Crom). Removing the hydrological constraints to leave only the asset constraints would raise the output available to 358.6 Ml/d.

South WRZ

The DO for the South WRZ is 218.6 Ml/d which is equivalent to about 1.3 times the 2008–09 post MLE Distribution Input. In 2015 the Camlough source is planned to be decommissioned which leads to a decrease in DO to 204.5 Ml/d. This DO reduction of 14.1 Ml/d is larger than the supply capacity of Camlough which is 5 Ml/d. This is due to the conjunctive nature of the model. The capacity of the link between Castor Bay and Newry is 18 Ml/d and means that additional water from Castor Bay cannot be moved towards the Newry demand centre to compensate for the loss of the Camlough supply to the Newry demand centre.

Both before and after the loss of Camlough in 2015, DO is determined by asset constraints at Newry. However, the model is optimised to share water from Castor Bay between the Newry and Lough Ross demand centres. With slightly different optimisation, Lough Ross could easily cause the failure. Using the unconstrained model, DO is increased slightly to 223.7 Ml/d which is determined by Clay Lake emptying in October 1991. After 2015, with the loss of Camlough, DO in the unconstrained model is 218.9 Ml/d.

3.1.4 Recommendations

The work described here (and in more detail in Appendix A) provides a robust basis for the DO values to be used in the supply demand balance elements of the WRMP. The approach makes best use of available data and techniques, and can be readily updated as and when improved data and information becomes available, for example using longer (pre-1975) flow time series or incorporating new elements to any WRZ.

As already noted, the UK water industry best practice requires the use of long time series of river flows to determine DO. The length of observed record available in Northern Ireland for the determination of DO is relatively short (from late 1975 to 2009). With a longer record there is a greater chance of encompassing drought conditions within the design period, and a more drought resilient analysis should result.

Analyses on the available flow data and a long rainfall record (back to 1853) at Armagh have shown that the 1975–2009 hydrological period used in this WRMP is appropriate for the purposes of determining DO. Beyond the completion of this WRMP it would be beneficial to extend the hydrological record further back to determine the potential impacts of earlier longer duration dry periods on the larger sources. However, it is unlikely that further investigations would lead to a redefinition of DO in most of the WRZs. The WRZ most likely to benefit from additional analysis would be the East WRZ because the Aquator failures analysis shows that Silent Valley and Ben Crom could be susceptible to longer drought periods than most of the sources (which are more vulnerable to short but severe drought events) while the largest sources are not significantly utilised in comparison with the natural hydrology Even if it is deemed that sufficient data are available for these purposes then, a significant amount of effort would need to be expended to generate extended flow records and that is beyond the scope of this WRMP.

At the outset of this WRMP programme there was an expectation that NIEA would have been able to advise NI Water on the scope and timetable of its programme of work to review existing abstraction licences and hence the possible location and magnitude of sustainability reductions. However, at the time of writing the WRMP, that process is still ongoing. Therefore the Aquator model includes current licence conditions only; there are no constraints built into the model to prevent abstractions from removing all flow up to the licence limit. Once any proposals for changes to existing licence conditions are provided by NIEA any changes can be incorporated into the Aquator models and any affect on DO assessed. Similarly, the river system in the models could be expanded to allow a more comprehensive simulation of hydrology across each WRZ thus allowing the potential impact on flows downstream of river abstractions to be examined. Sustainability reductions could lead to changes in DO with consequential impacts on the supply demand balance and hence the WRMP.

3.2 Comparison with previous deployable output

Table 3.1 compares the WRMP DO results with the WRS 2002 DO assessment and shows that there is little change in the total DO for Northern Ireland. The WRMP unconstrained DO of 789.2 Ml/d is about 18 Ml/d higher than the WRS 2002 DO of 771 Ml/d; while the WRMP constrained DO of 773.6 Ml/d is about 3 Ml/d higher than the WRS 2002 DO of 771 Ml/d. From 2015, with the decommissioning of Camlough, overall DO would be reduced to 759.5 Ml/d (unconstrained 784.4 Ml/d); i.e. below the WRS 2002 total.

WRMP 2012 WRZ	Sub-Zone Demand Centre (based on WRS 2002 WRZs)	WRS 2002 DO (Ml/d)		WRMP 2012 WRZ DO (Ml/d)	WRMP 2012 Unconstrained WRZ DO (Ml/d)	Comments
North	Altnahinch	17.0	101.2	106.2	115.6	A number of groundwater sources have been decommissioned since the WRS 2002
	Ballinrees	25.0				
	Faughan/ Altnaheglish	59.2				
West	Derg/ Bradan/ Macrory	32.0	68.9	88.2	89.1	This WRMP incorporates the planned River Strule abstraction but all groundwater sources have been decommissioned
	Killyhevlin	36.9				
Central	Magherafelt/ Cookstown	29.3	29.3	31.1	31.1	
East	Antrim/ Larne	33.9	418.9	329.5	329.7	The boundary between the WRMP 2012 South and East WRZs has divided some of the WRS 2002 WRZs, with Lough Island Reavy and a portion (55%) of Lisburn area demand moving into the South WRZ. The current model setup does not include transfers from Lough Island Reavy to Drumaroad WTW (16 Ml/d safe yield – calculated prior to WRMP 2012, 10 Ml/d normal summer use), or from Castor Bay to the East WRZ (no information provided by NI Water but could be around 20 Ml/d into the Eastern General demand centre). The Lough Island Reavy link is included as a transfer in the supply demand tables. A number of sources have been decommissioned since the WRS 2002, as well as Forked Bridge WTW.
	Ballymena	26.2				
	Lough Cowey	3.8				
	Eastern General	355.0				

WRMP 2012 WRZ	Sub-Zone Demand Centre (based on WRS 2002 WRZs)	WRS 2002 DO (Ml/d)		WRMP 2012 WRZ DO (Ml/d)	WRMP 2012 Unconstrained WRZ DO (Ml/d)	Comments
South	Newry	53.0	152.4	218.6 (204.5 beyond 2015)	223.7 (218.9 beyond 2015)	The Craigavon demand centre now incorporates 55% of the Lisburn area demand (100% in Eastern General for WRS 2002)
	Craigavon	67.6				
	Lough Ross	6.8				
	Armagh	21.0				
	Dungannon	4.0				
Total DO (Ml/d)		**770.7**		**773.6 (759.5 beyond 2015)**	**789.2 (784.4 beyond 2015)**	

Table 3.1 – Comparison of WRMP 2012 DO results with the WRS 2002 DO assessment

In accordance with the boundaries of the WRZs agreed with NI Water for the purposes of the WRMP, the current setup of the Aquator model does not include transfers from Lough Island Reavy to Drumaroad WTW, or from Castor Bay to the East WRZ. The Lough Island Reavy link is included as a transfer option in the supply demand balance tables; however no information was available to quantify the Castor Bay transfer into the East WRZ.

On an individual WRZ level, the major differences between WRS 2002 and this Final WRMP are due to the repositioning of WRZ boundaries, decommissioning of older sources and inclusion of all PC10 schemes. There is the opportunity to transfer water between the South and East WRZs; this has been considered for the overall strategy (section 9).

3.3 Reductions in deployable output

Temporary short-term losses in deployable output (DO) are included in outage (section 3.4). Changes in deployable output that might arise from climate change impacts on river flows (section 1) are taken into account in the calculation of headroom uncertainty (section 6).

Reductions in deployable output could also arise from changes in the authorised volumes and any environmental conditions to the existing abstraction licences. Such changes are generally referred to as sustainability reductions. However there is no reference to sustainability reductions in the DRD guidelines. Consultation with NIEA at the start of the WRMP process in July 2009 indicated that there will be a programme of abstraction licence reviews undertaken to meet the requirements of the Water Framework Directive (WFD). The programme may identify some rivers where sustainability reductions might be required. At the time of this Draft WRMP, however, the timing of the programme for undertaking such work is not known.

The UK best practice process used for determining how changes in abstraction licences to protect the environment whilst at the same time safeguarding security of public water supplies has developed over a number of five-year regulatory planning cycles. The process involves detailed environmental and economic investigations to determine whether or not abstractions are having an adverse impact on the water environment, and if so an options appraisal exercise is conducted to identify the costs of mitigation. Such work is often undertaken and funded under a National Environment Programme (NEP).

At the time of this WRMP, NIEA has not advised NI Water of any sustainability reductions. This means that no change in DO as a result of sustainability reductions have been allowed for in this WRMP.

3.4 Outage

Companies generally follow the principles set out in the operating methodology section of the report *Outage allowances for water resources planning* (UKWIR 1995) to determine their outage allowance. However, the degree to which a company explores outage will vary according to need and circumstance. Outage is defined as[7]:

> *A temporary loss of deployable output. (Note that an outage is temporary in the sense that it is retrievable, and therefore deployable output can be recovered. The period of time for recovery is subject to audit and agreement. If an outage lasts longer than 3 months, analysis of the cause of the problem would be required in order to satisfy the regulating authority of the legitimacy of the outage)*.

Outages may occur from either planned or unplanned events. Unplanned outages are caused by an unforeseen or unavoidable events affecting any part of the source works and occurring with sufficient regularity that the probability of occurrence and severity of effect may be predicted from previous events or perceived risk. The methodology[8] provides a definitive list of events that could be considered as unplanned outages:

- Pollution of sources;
- Turbidity;
- Nitrates;
- Algae;
- Power failures; and
- System failures.

Planned outages arise from maintenance, inspection, refurbishment, and repair of source works. These outage events would not generally be considered where the loss of deployable output (DO) resulting from such regular maintenance issues was already taken into account in the calculation of DO for the source works in question. The company would not generally undertake major planned maintenance during periods or prolonged dry weather when reservoir storage has been drawn down and rivers are experiencing low flows.

Further details of the approach to outage are given in Appendix B.

3.4.1 Derivation of outage allowance

The assessment of outage for WRS 2002 was based on discussions with each of the four Water Service Divisions in existence at the time, but no historic outage data was available. A nominal outage allowance of 3% of distribution input was assumed.

For this WRMP a structured interview was held with key NI Water staff to develop an understanding of outage, identify sources most at risk from outage events, and where possible to quantify these risks. The meeting was also used to gather available data.

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[7] Environment Agency (England & Wales) (Nov 2008), *Water resources planning guideline*
[8] UKWIR (1995), *Outage allowances for water resources planning*

The production capacity estimates of source works are based on the "20 hours rule" – i.e. if the works is shut for 4 hours, it can be run at a higher rate for 20 hours to catch up any lost capacity. Thus, allowances for most planned outages (maintenance, inspection, refurbishment, and repair of source works) are already considered in the estimates of water treatment works (WTW) capacity. If these were to be included as an allowance for planned outages, it would result in double counting. Therefore planned outage is assumed to be zero.

For unplanned outages, there was a lack of suitable historic data; hence the assessment was based on expert judgement. However, NI Water recognises the need for improved data collection for the future assessment of outage events.

For the purposes of the supply demand balances required for the WRMP, the Private Public Partnership (PPP) source works are assumed to act as bulk supplies into distribution at the contracted volumes. Therefore, no allowance has been made for potential outages at these source works because it is considered that outage has already been allowed for by the PPP contractor; note that treatment losses are allowed for in the Aquator model (Section 3.5) and uncertainty other uncertainties in headroom (Section 6.1).

Overall, the supply system is run with minimal outage as there is insufficient security in the system, so any outage event must out of necessity be dealt with immediately. Consequently the overall unplanned outage would be expected to be low.

Therefore, the outage allowance used for this WRMP is 2% of deployable output, based on expert judgement. Benchmark comparisons with other parts of the UK suggest that this is relatively low but it is felt to be a reasonable estimate for the ranges of sources available to NI Water and the characteristics of the distribution system. The 2% allowance for outage equates to approximately 7.54 Ml/d across the whole of NI Water's supply area. The outage allowances for each WRZ are presented in Appendix B.

3.4.2 Recommendations

NI Water recognises that the accurate estimation of outage is constrained by data availability at present. Currently, the outage allowance is relatively low, although is considered appropriate given the infrastructure and operating conditions experienced in Northern Ireland – i.e. NI Water must currently ensure that outages are minimised and any events resolved in a short period of time, as there is insufficient security and resilience within the supply system. However, as steps are taken to improve the resilience of the system, the issue of outage may become more critical to the planning process. Therefore it will be necessary to base future outage allowances on reliable data sets.

Improved data collection will also facilitate a move towards a probabilistic determination of outage, so that an allowance may be chosen at which the company understands the risk that it may be exceeded in any given year. For instance, if the outage value is taken from the 95th percentile of cumulative probability, then there would be a 5% chance that the level of outage that actually occurs would be greater than this value.

3.5 Raw and potable water transfers and bulk supplies

There are a number of cross-WRZ transfers currently in operation in Northern Ireland. These transfers are not included in the current model structures because they have been developed for determining DO of an individual WRZ. However, it would be relatively simple to model these transfers, either by merging separate WRZ models together and adding in new links between sources and the relevant demand centres, or by incorporating transfers as bulk imports into the WRZ with an assumption of some normal level of use.

As noted in section 2.1, in addition to the preparation of the WRMP and SEA, the programme of work included the preparation of a trunk mains model (TMM) of NI Water's network to allow a better understanding of the hydraulic capacity of the system and hence the potential for transfers between areas of surplus and areas of deficit.

For the purposes of the DO calculations, WTWs operated under the PPP contract supply water into the distribution system of each WRZ at the contracted rate. For the purposes of the supply demand balance analysis the DO of NI Water's sources in each WRZ is calculated from the WRZ DO minus the PPP contracted volume; see Table 3.2. However, the Aquator models must also allow for typical works losses and distribution system constraints (see section 3.6 and section A.4.3 in Appendix A) and this means that in the model some of the PPP supplies to demand centres are slightly less than is assumed in Table 3.2. Nonetheless, the simple representation in the supply demand balance analysis is retained for clarity in the planning tables.

Description	WRZ				
	North	East	South	Central	West
WRZ DO (Ml/d)	106.2	329.5	218.6	31.1	88.2
PPP name	Ballinrees	Dunore Point	Castor Bay	Moyola	N/A
PPP bulk import (Ml/d)	50.0	180.0	147.0	19.0	0.0
DO excl. PPP (Ml/d)	**56.2**	**149.5**	**71.6**	**12.1**	**88.2**

Table 3.2 – Bulk supplies into each WRZ

In addition to the PPP works, the current model setup does not include transfers from Lough Island Reavy (South WRZ) to Drumaroad WTW (East WRZ) or from Castor Bay (South WRZ) to the East WRZ. The Lough Island Reavy link is included in the supply demand balance tables (it has no diminishing effect on the South WRZ DO) as a transfer of 7 Ml/d into the East WRZ, but no information was available to quantify the Castor Bay transfer into the East WRZ.

3.6 Distribution operational use and treatment works losses

As noted in section 3.1.2, the distribution network in Aquator is a simplification of the real network. The level of detail in the current model setup has been reviewed by key NI Water operational staff and also the Atkins TMM team. The model is considered to be appropriate for water resource planning, but because it is based on a high-level physical representation of the system it is less detailed than the TMM.

Using 2009 estimated abstraction and measured delivery volume data provided by Dalriada (delivered through NI Water) it was possible to calculate typical losses for the PPP scheme WTWs. Therefore, a loss value of 5% was applied to each of these WTWs within the models (and so allowing for direct control within the model in relation to licensed quantities). Data were also provided for this plan which indicated that a loss value of 10% would be more appropriately applied to Drumaroad WTW. All other NI Water WTWs were given a default loss value of 5% based on Atkins' experience of works in England. These losses were applied directly in the model rather than in the supply demand balance tables so that the combined effect with the licence constraints could be simulated. As an example of the justification for doing so, where abstraction licence capacities are identical to WTW delivery capacities (e.g. at Ballinrees WTW), then supply of potable water to meet demand is below the capacity of the works since the licence would not allow for the abstraction of 5% additional water to compensate for losses.

4. Water demand

Total water demand is represented by distribution input (DI), which is the amount of water entering the distribution system from NI Water's own WTW and bulk supplies from the PPP schemes. DI is a measured component of the water balance.

Total water demand is comprised of a number of different components, some of which are measured directly and some of which are unmeasured. The main components are:

- Household, or domestic, customers;
- Non-domestic customers – e.g. commercial, industry, agriculture, etc.;
- Leakage from the supply system:
    - Distribution losses – i.e. leakage from the distribution mains;
    - Supply pipe leakage – i.e. leakage from customers' own supply pipes.
- Unbilled water and water used for operational purposes within the distribution system.

The purpose of this section of the WRMP is to set out how water demands for each of the above categories are derived in the base year (2008–09) and are then forecast over the planning horizon (to 2034–35). These are used to generate the normal year annual average (NYAA) demand forecast.

However, the planning scenario on which the WRMP is based considers dry year annual average (DYAA) demand – i.e. demand during a period of low rainfall (hence higher demand than in a "normal" year) but without any demand restrictions in place (known as unconstrained demand). The derivation of this dry year annual average demand scenario is addressed in the following section, before proceeding onto the calculation of base year and forecast demands for each of the categories of the water balance (uplifted from the normal year forecast), which are used to generate the dry year annual average demand forecast used in the WRMP.

Further details of the demand forecast are given in Appendix C.

4.1 Planning scenarios

4.1.1 Normal year analysis

Rainfall and temperature can have a strong influence on customer demand, and in particular domestic consumption. In general, during the summer months, periods of wet weather mean that there is less need for domestic customers to use water outside the home, so demands may be similar to winter levels. In contrast, drought conditions accompanied by sustained periods of high temperature can typically increase customer consumption through discretionary water use such as garden watering and other outside use.

Data from the Meteorological Office website for the Armagh weather station was used to conduct climate analysis of the last 20 years and to compare this period to Long Term Averages (LTA) (1961–1990 and 1971–2000). The objective of this climate analysis was to assess whether the base year (2008–09) was representative of reasonably normal climatic conditions, and hence customer demands.

Figure 4.1 shows average temperature and total rainfall over the "summer" months of April to September, a period over which climate is generally considered to influence customer demand.

Figure 4.2 shows the average temperature and total rainfall over the year (note that this is the financial year, to correspond with AIR data).

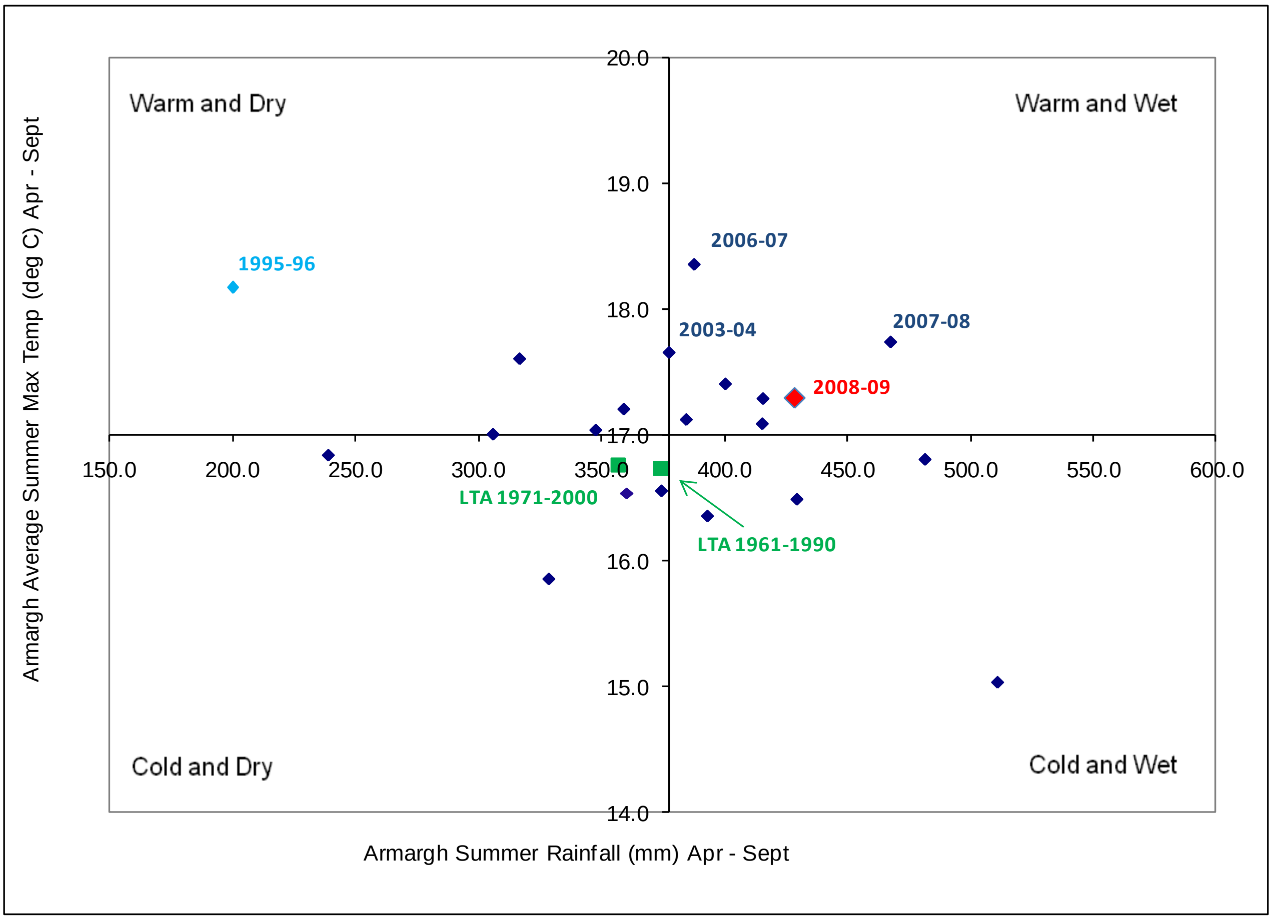

Figure 4.1 – Average temperature and total rainfall in summer months (Apr–Sep) (1988–89 to 2008–09)

Figure 4.1 shows that the summer of 1995 was very dry, and also warmer than most other years. The summer of 2006 was very warm on average, although fairly typical in terms of rainfall. 2008–09 was unexceptional in terms of the average temperature experienced, but was slightly wetter than usual.

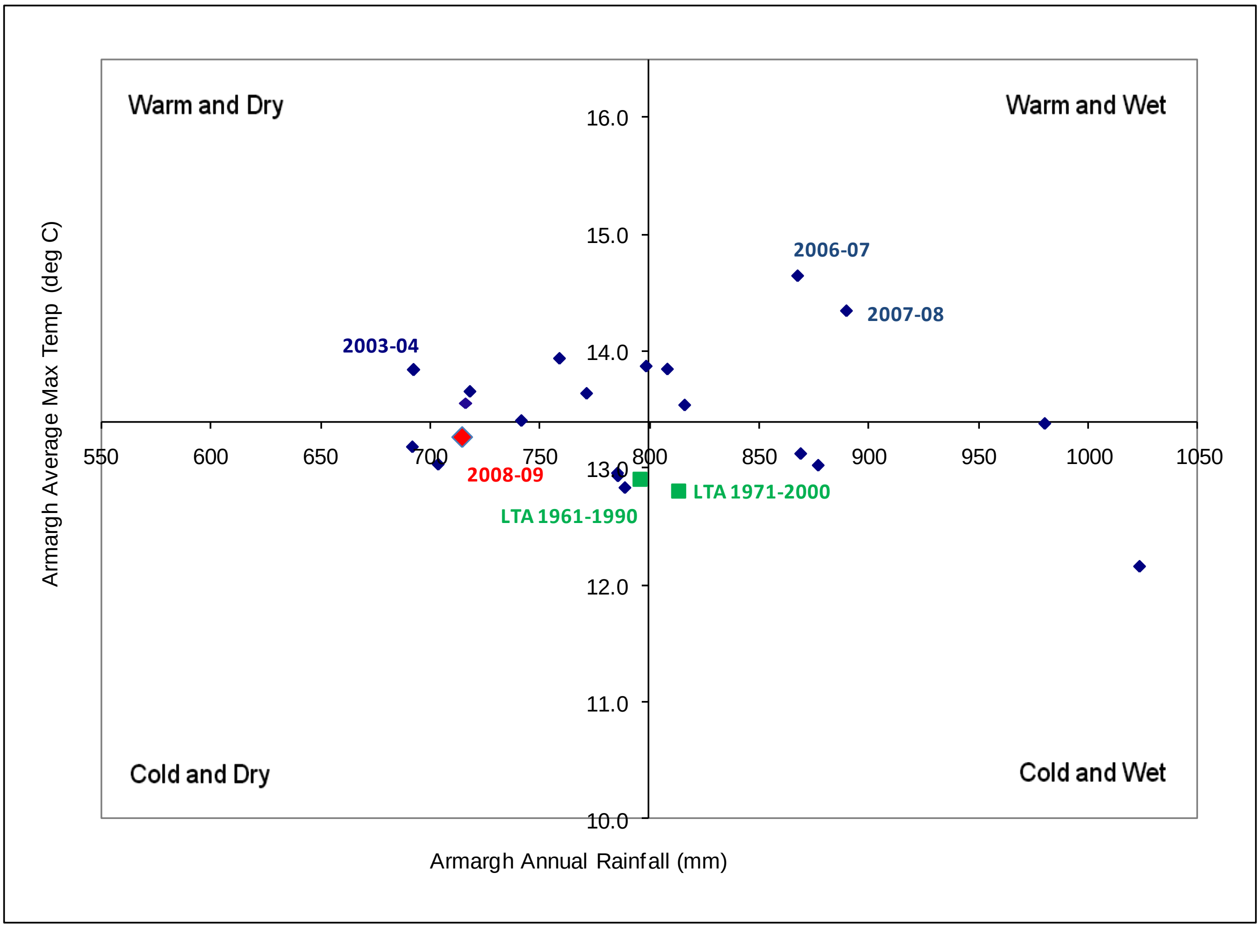

Figure 4.2 – Annual average temperature and total rainfall over the year (1988–89 to 2008–09)

The scatter plot presented in Figure 4.2 suggests that the total rainfall over the year 2008–09 was lower than usual (despite a relatively wet "long summer" period), though the average temperature was fairly typical. This compares to both 2006–07 and 2007–08 which were both warm and wet years. Both had relatively low annual average DI values, suggesting that the wet weather on average over the year resulted in reduced DI. 2003–04 was on average both warm and dry over the year.

The analysis of climate data shows that 2008–09 was not particularly out of the ordinary; although it had a wet July and August, it also had relatively dry spring and winter. In terms of average monthly temperature, 2008–09 was very similar to the monthly LTAs.

Overall, the analysis demonstrates that the base year (2008–09) can be considered relatively "normal". Therefore, it is assumed that no normalisation of the base year demand is required.

4.1.2 Dry year analysis

The planning scenario used in the WRMP is the dry year annual average demand (DYAA), which is defined as[9]:

> *The level of demand, which is just equal to the maximum annual average, which can be met at any time during the year without the introduction of demand restrictions. This should be based on a continuation of current demand management policies. The dry year demand should be expressed as the total demand in the year divided by the number of days in the year.*

The normal year annual average (NYAA) demands must be adjusted so that they represent those demands that might be expected in dry years.

There have not been any restrictions on demand imposed in recent years, so the base year and dry year analysis does not need to be adjusted to account for the impact of restrictions. Even in the dry conditions of 1995–96, whilst a publicity campaign was adopted to encourage customers to conserve water, there were no restrictions imposed. A recent survey of NI Water customers[10], found that in terms of water services, water supply restrictions such as hosepipe bans were given the lowest priority by customers. This was “for two reasons – most struggled to remember the last restriction and restrictions should not be in place when high levels of leakage exist”.

Initial analysis of demand and climate data suggested that:

- Distribution input (DI) does not correlate particularly well with the years that have been identified as dry years from climate analysis;
- Annual average household demand also does not correlate well with climate analysis, and the trend over the period 2002–03 to 2008–09 of increasing household demand (due to an increasing population) may mask any variations in annual average demand due to dry years; and
- Annual average non-household demand shows a very strong downward trend over the period 2002–03 to 2008–09, which significantly masks any correlation with climate data.

It was thus difficult to establish dry year factors for household and non-household demands directly. Instead, a simplified approach was used, which was to derive an overall dry year demand (distribution input) which is at the upper limit of what the Company feels could reasonably be met before demand restrictions might need to be considered.

An upper bound could have been based on the DIs experienced in the 1990s; however the customer base and other components of demand (such as leakage) have changed significantly since the 1990s, so this approach was not considered robust or appropriate. Instead, based on a combination of the climate analysis and the DI data, the 2003–04 DI was considered as the basis for estimating dry year demands. Thus the total company dry year annual average demand in the base year has been taken as 676.66 Ml/d. This seems reasonable given the observation that recent years do not show particularly high summer demands, and hence support the conclusion that in NI, the demand experienced in dry years may not be significantly high compared to “normal” years.

This does however mean that the dry year demand for the WRMP is significantly less than the dry year demand derived for the previous strategy (WRS 2002), which was based on the higher 1990s demands. These issues are illustrated in Figure 4.3, which demonstrates the trend of DI decreasing through time in recent years. It also presents some of the components of demand from 2002–03 onwards, in which non-household demand and leakage have a clear decreasing trend,

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[9] Environment Agency (England & Wales) (2009), *Water resource planning guidelines, Section 24*
[10] CCNI (Mar 2009), *Tapping into consumer views on water*

while there is a trend of gentle increase in unmeasured household demand (due mainly to population increases).

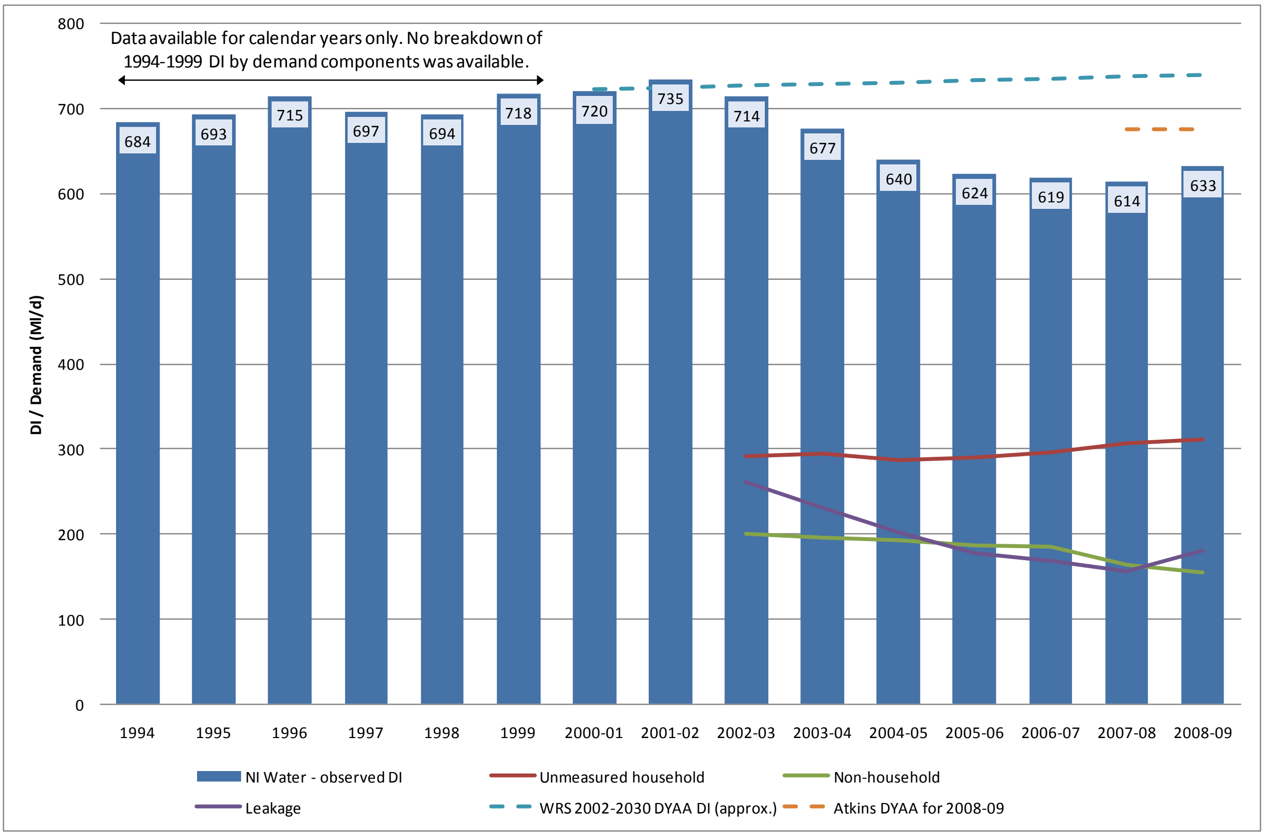

Figure 4.3 – Historic Distribution Input (DI) and recent trend in demand components

The 2003–04 dry year DI was apportioned between the WRZs on the basis of the percentage contribution of DI from each WRZ to the overall company DI in the most recent Annual Information Returns (AIR09). The results are presented in Table 4.1.

Component	East	North	Central	West	South	Company
NYAA demand – base year:						
2008–09 DI	291.31	76.38	26.47	62.24	176.31	632.71
% of company DI in 2008–09	46.0%	12.1%	4.2%	9.8%	27.9%	100.0%
DYAA estimates – base year:						
Estimated 2003–04 dry year annual average DI	**311.55**	**81.69**	**28.30**	**66.57**	**188.55**	**676.66**
Calculated household dry year factor	1.12	1.12	1.15	1.16	1.15	
Assumed non-household dry year factor	1.05	1.05	1.05	1.05	1.05	
Uplift factor for total DI (for information only)	1.07	1.07	1.07	1.07	1.07	1.07

Table 4.1 – Summary of dry year demand and dry year factors for each WRZ

The household and non-household components of demand were then adjusted so that the calculated overall DYAA demand for each WRZ is reached in the base year (2008–09). All other components of demand were assumed to be unaffected by dry years.

The calculated values for the 2003–04 based dry year demand are also shown in Table 4.1.

Note that it has been assumed that non-household demand is influenced to a lesser extent by dry year conditions, and hence an assumed dry year factor of 1.05 has been applied to non-household demand in each WRZ. This is based on general experience which suggests that on the whole dry years have either no effect or very little effect on non-household demand. The dry year household factors have been calculated so that the total DI reaches the target DYAA value considered appropriate to NI Water.

Potential uncertainties with this approach to deriving dry year demands, and estimating dry year factors, were included within headroom allowances, as discussed in section 6.

4.1.3 Winter peak periods – freeze-thaw events

During the consultation process on the Draft WRMP, a number of responses received made reference to the freeze-thaw events over both the 2009–10 and 2010–11 winters. These were extreme weather events that caused operational issues for the company. Such events are not usually considered as part of the WRMP, which consider dry year demand drivers when dry weather might be most expected to increase customers' water use. However in response to consultation responses on the Draft WRMP, this section provides a description and brief analysis of those freeze-thaw events.

The NIAUR report (March 2011) Utility Regulator's report of the investigation into the Freeze/Thaw incident 2010/11 states that: "Temperatures in December 2010 in Northern Ireland were the coldest for 100 years. Indeed, the two most recent winters have been exceptionally cold".

Figure 4.4 presents monthly average minimum temperatures for the years 2006–07 to 2010–11 compared to long term averages (LTAs). This demonstrates the very cold conditions experienced in winter 2010–11 (particularly December 2010), and winter 2009–10 (particularly January and February 2010) compared to other recent years and to the long term averages for 1961–1990 and 1971–2000.

However, one critical factor in the effects observed in the winter 2010–11 event was reportedly the speed of the thaw, as the NIAUR report (March 2011) recognises: "The low temperatures were unprecedented, the most severe in the past 100 years. But what was even more unexpected was the very rapid thaw, which started on 26 December".

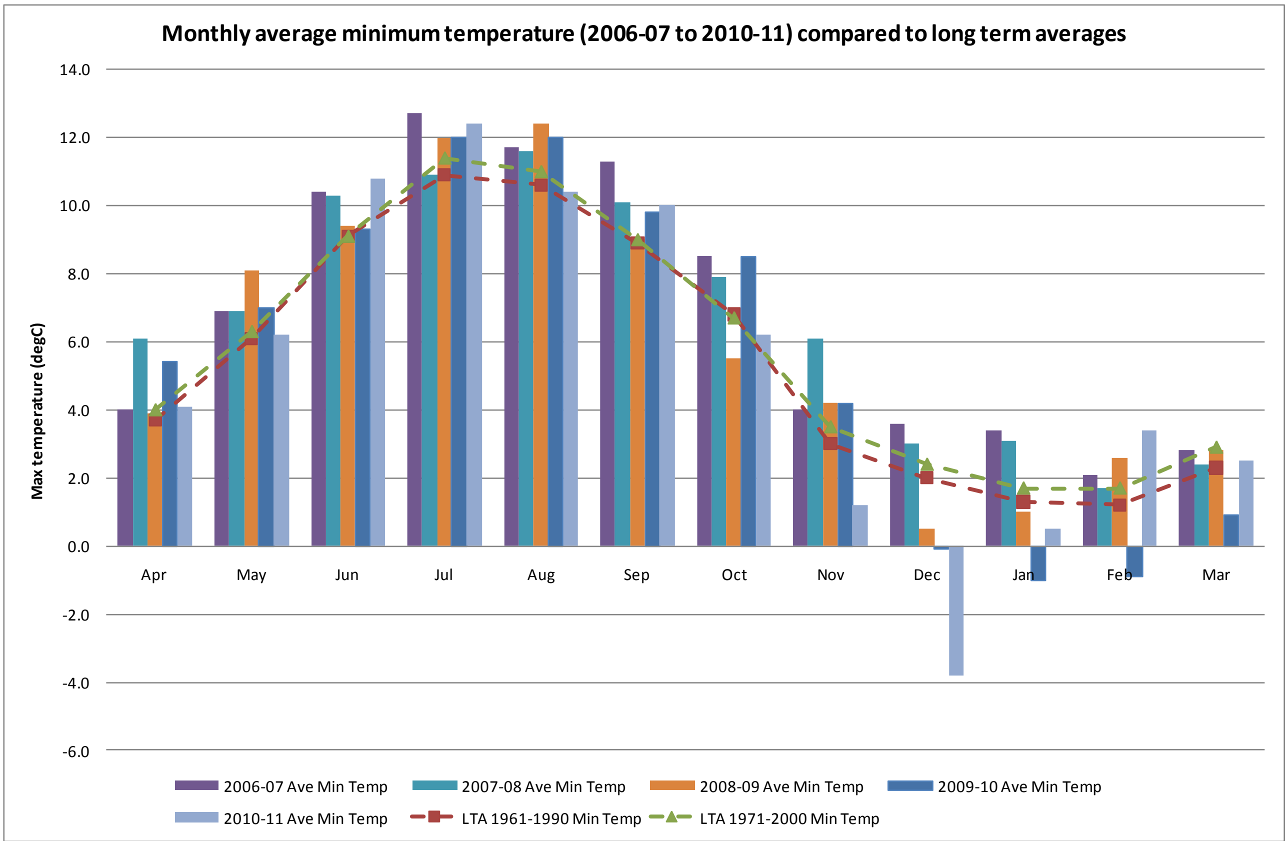

Figure 4.4 – Comparison of monthly average minimum temperatures 2006–07 to 2010–11 and LTAs

Figure 4.5 clearly shows the extreme nature of the recent 2009–10 and 2010–11 winter events. The average day peak week (ADPW) distribution input during winter in the last two years far exceeds the maximum in the preceding three years – 684 Ml/d in the middle of July 2006. In the winter of 2009–10, the maximum ADPW was 785 Ml/d, while in 2010–11 it reached 847 Ml/d. Peaking factors, calculated as the ADPW divided by the annual average, are 1.25 and 1.35 respectively – far higher than that 1.10 peaking factor experienced due to summer demand in the hot and dry conditions of July 2006.

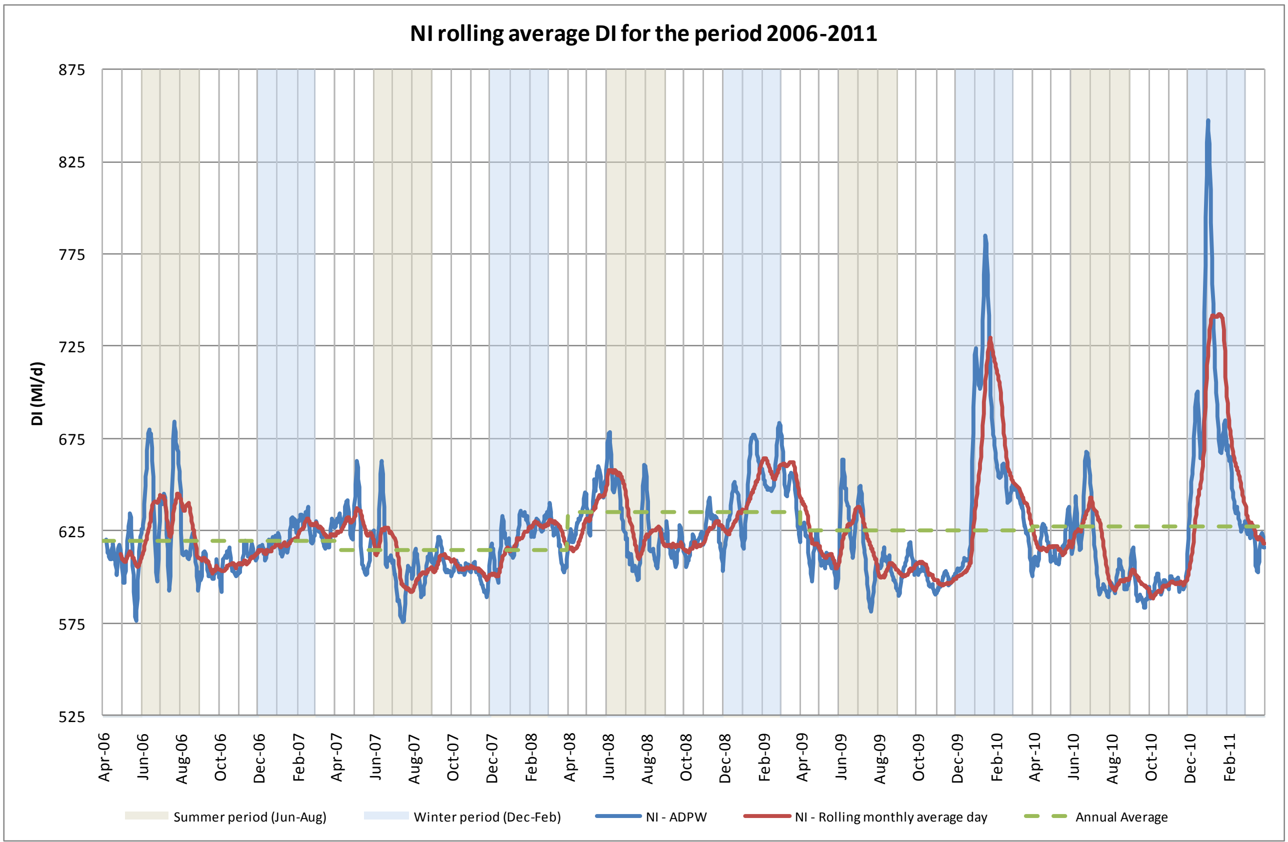

Figure 4.5 – Rolling average DI in NI for the period 2006–07 to 2010–11

Recent operational experience, both in Northern Ireland (for example the winter "freeze-thaw" conditions in 2009–10 and 2010–11) and in England (for example the 2007 summer floods) show that despite long-term strategies for balancing supplies and demands at the scale of a water resource zone (WRZ), extreme events can nevertheless cause local operational difficulties which may lead to short-term interruptions to supplies. Such extreme events are generally considered to fall outside the locus of a WRMP, which looks at the conditions likely to be experienced under dry drought conditions.

The above analysis clearly demonstrates that the recent winter peak periods were exceptional. NIAUR commented in their *Utility Regulator's report of the investigation into the Freeze/Thaw incident 2010/11* report (March 2011) that "80% of the additional water demand caused by the freeze thaw leaked from domestic and business water pipes. The remainder was lost from NI Water's network."

Clearly, infrastructure schemes that contribute an appropriate operational and management response to short-term supply difficulties can also contribute to maintaining the supply demand balance in the longer term. Such infrastructure may also provide alternative operational responses that allow environmentally sensitive sources to be rested during drought.

For the Final WRMP, a critical winter period scenario has not been investigated or run through the investment model. This is because the focus on the WRMP is on ensuring that there are sufficient supplies available over the long term planning horizon to meet demands likely to be experienced in dry year annual average conditions, because it is not considered appropriate to plan and justify investment on short-term operational grounds in response to extreme events

It is worth noting that during 2011–12, a UK Water Industry Research (UKWIR) project will be commissioned, which aims to investigate the effect of weather on leakage and bursts (research project WM08). It is anticipated that the project will recognise that climatic events such as recent harsh winters as well as hot weather and prolonged wet or dry spells can affect leakage and bursts, and that this could become more common place due to climate change impacts. The objective of the work is therefore expected to be to forecast the effects of weather factors (such as temperature, rainfall and soil moisture deficit) on leakage or bursts. It is not clear at present when this work will be completed, but the study should be available for future WRMPs.

4.2 Base year components of demand

Base year data from the Annual Information Return 2009 (AIR09) had been reconciled using the maximum likelihood estimation (MLE) method so that the sum of all estimated demand components is equal to the distribution input. The base year AIR09 data can be used to derive each component of demand (including for both measured and unmeasured customers) experienced across the company. This data must then be disaggregated to derive WRZ-level estimates.

The contribution of each component of the 2008–09 water balance is shown in Figure 4.6.

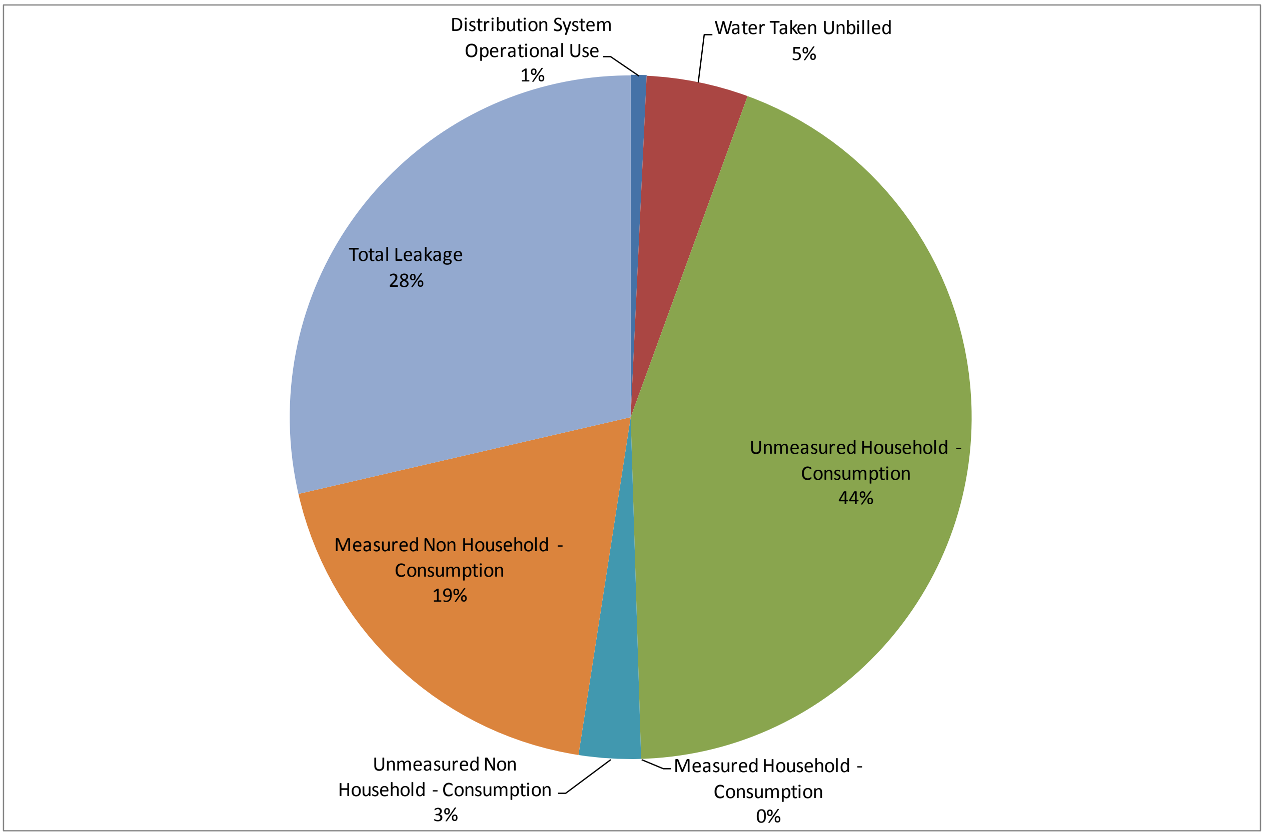

Figure 4.6 – Base year (2008–09) water balance components

4.2.1 Base year population and properties

4.2.1.1 Base year population

As explained in section 2.2, the base year of 2008–09 has not been updated for the Final WRMP. The total population of Northern Ireland has increased from the early 2000s to the base year (2008–09) level of approximately 1,775,000 people. Population estimates for households and non-households are taken directly from AIR09 Table 7 data for the base year. A summary of the base year data disaggregated into the 5 WRZs is presented in Table 4.2.

Population component	NI Water	North WRZ	East WRZ	South WRZ	West WRZ	Central WRZ
Measured household	0	0	0	0	0	0
Unmeasured household	1,672,510	230,070	844,524	382,976	149,388	65,553
Measured non-household	95,930	13,196	48,439	21,966	8,568	3,760
Unmeasured non-household	6,670	918	3,368	1,527	596	261
Total population	1,775,110	244,184	896,331	406,469	158,552	69,574

Table 4.2 – Summary of base year (2008–09) AIR09 population data

4.2.1.2 Base year properties

Similarly, the estimates of household and non-household properties in the base year are also taken from the AIR09 submission. A summary of the split of property data by component for each WRZ in the base year is presented in Table 4.3.

Property component	NI Water	North WRZ	East WRZ	South WRZ	West WRZ	Central WRZ
Measured household	0	0	0	0	0	0
Unmeasured household	646,099	88,877	326,244	147,946	57,709	25,323
Void households	42,528	5,850	21,474	9,738	3,799	1,667
Measured non-household	78,416	10,787	39,596	17,956	7,004	3,073
Unmeasured non-household	30,519	4,198	15,410	6,988	2,726	1,196
Void non-households	7,170	986	3,621	1,642	640	281

Table 4.3 – Summary of base year (2008–09) AIR09 property data

Note that the total void properties in NI Water were reported in AIR09 as 49,698. For the purposes of the WRMP, these have been split into void households and void non-households according to the ratio of total households to non-households excluding voids.

4.2.2 Base year household demand

The unmeasured domestic consumption figures reported in AIR09 were derived using a small area consumption monitor to derive per capita consumption (PCC). A major survey of customers within the consumption monitor was completed in spring 2008, providing a count of property types and any vacant properties within each area.[11]

Data from the AIR09 submission was used to derive the base year household demand. The post-MLE unmeasured household demand for the company was disaggregated between the five WRZs used in this WRMP.

There were differences in the calculated PCC in each WRZ, as presented in Table 4.4. These differences may be attributable to some extent to differences in the socio-economic characteristics of customers in different areas. For example, the proportion of each property type (and associated garden size) is likely to vary between urban and rural areas with urban areas being more likely to have more flats and rural areas more detached houses with larger gardens; affluence of the customer base may vary in different parts of Northern Ireland; the population demographic and therefore water-using behaviours may vary; and local climate characteristics may also induce a change in consumption.

WRZ	Normal year annual average PCC in base year, 2008–09 (l/h/d)
North	148.1
East	166.9
Central	157.9
West	149.6
South	183.4
Company	166.2

Table 4.4 – Estimates of base year PCC in each WRZ derived from values in AIR09

4.2.3 Base year non-household demand

Base year data from AIR09 was used to derive the non-household demand experienced across the company for both measured and unmeasured customers. The post-MLE non-household demands for the company were then disaggregated between the five WRZs.

It should also be possible to report the non-domestic customer demands by industrial sector from the customer database, using classifications based broadly on the Standard Industrial Classification (SIC) codes. The main purpose for doing this would be to try to derive more accurate and robust non-domestic demand forecasts for specific sectors. A breakdown of base year demands by SIC code was not available for this WRMP, but this approach could be used in future should the relevant data become available.

[11] Crowder Consulting, June 2009, *Per capita consumption report*

4.3 Baseline demand forecast

The base year data outlined in section 4.2 was used as the start point for the normal year annual average forecast over the planning horizon to 2034–35.

4.3.1 Population and property projections

Household demand forecasts use population projections, combined with per capita consumption estimates to calculate household demand through time. Population and property forecasts are available from the Northern Ireland Statistics and Research Agency (NISRA) website.

The NISRA data provide a combination of 2006 and 2008-based projections. The most recent forecasts for which estimates were available at sub-Northern Ireland level (i.e. Local Government District, or LGD level) are 2006-based. The overall 2008-based population projection did not have a LGD level breakdown at the time of producing the WRMP.

This information was only available for calendar years, whereas the components of the demand forecast and base year (AIR09) data are all based on financial years. It has been assumed that the calendar year can approximate the financial year – e.g. the population or property projection for the year 2010 could be used to approximate the figure for 2010–11.

In addition to the published NISRA data set, the University of Ulster was commissioned by NI Water to conduct an economic outlook assessment for Northern Ireland as part of the recent Price Control (PC10) process. The University of Ulster assessment includes a section in which NI-level population and property forecasts from NISRA, based on 2006 estimates, were modified to take account of the current economic downturn[12]. The University of Ulster adjusted figures were available for the period 2007–2017. After 2017, it has been assumed that the projections will return to the policy-based 2006 projection over a five year period.

The Regional Development Strategy (RDS) for Northern Ireland, *Shaping our future*, was published in 2001. An update, *Adjustments to the regional development strategy – 2025*, was published in June 2008. The main change was that the number of additional residential units estimated to be required by 2015 was increased from 160,000 in the original RDS to 208,000 in the adjusted RDS. The adjusted RDS provides a breakdown of these additional units by LGDs. The base year from which additional residential units were estimated was 1998. However, 1998-based information was not available from NISRA, so it was not possible to determine what proportion of “additional residential units” may have already been built and hence included in the 2006-based NISRA figures from which their forecasts are based.

Therefore a policy-based approach has not been adopted for this WRMP. Instead, potential uncertainties associated with population and household forecasts and other components of the demand forecast have been included within headroom (section 6).

4.3.1.1 Population forecast

The overall population forecast was derived for each WRZ, by using the LGD population forecasts from 2006–2021, and the relative area of each LGD in each of the 5 WRZs, combined with the University of Ulster adjusted NI population projection (2007–2017) to account for the potential effects of the current economic downturn. From 2022 onwards, the population forecast was available at the NI level only, but the forecast was apportioned on the basis of the percentage

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[12] University of Ulster (May 2009), *Northern Ireland economic outlook as pertaining to Price Control 2010*, section 2

contribution of the WRZ population to total NI population in the final year for which detailed information was available (2021).

The annual growth in total population for each WRZ from the hybrid forecast described above was used in the demand forecast. Note that the Ulster University adjustment actually results in a decrease in population in the East and North WRZs (and for NI Water) in moving from the base year to the second year of the forecast.

The overall population for each WRZ must also be disaggregated into measured/unmeasured households/non-households.

It is assumed that the population of non-households, which is due to people living on farms and in communal establishments (such as hospitals, prisons, educational establishments, etc.), is unlikely to change significantly through time, so the base year non-household population was assumed to remain constant through the planning period to 2034–35.

Therefore, the growth in total population over the planning period was assumed to contribute entirely to household population growth. At present domestic customers are not charged directly for water services and there are no plans to introduce a charging scheme and any associated metering. The growth in total WRZ population has therefore been assigned entirely to the unmeasured household category in the baseline (representing a continuation of existing policy). For the purposes of the baseline forecast, the measured household population remains at zero through the planning period. The impacts of potential domestic metering policies have been considered as part of the options appraisal (see section 8).

The supply demand balance over the whole of the 25 year planning period is described in section 7. This shows that with current assumptions on population growth, and based on existing abstraction licences and hence estimates of deployable output, that for Northern Ireland as a whole, the capacity of the existing infrastructure has the capacity to meet forecast demands. Some constraints have however been identified at the WRZ scales and would need to be addressed by the options identified in section 9.

4.3.1.2 Property forecast

The overall property forecast was derived for each WRZ, by using the LGD projections from 2006–2021, and the relative area of each LGD in each of the 5 WRZs, combined with the University of Ulster adjusted NI property projection (2007–2017) to account for the potential effects of the current economic downturn. From 2022 onwards, the property forecast was available at the NI level only, but the forecast was apportioned on the basis of the percentage contribution of WRZ properties to total NI properties in the final year for which detailed information was available (2021). This forecast was only available until 2031. After which point, it was assumed that annual growth from 2030 to 2031 would continue until the end of the planning period.

The annual growth in total domestic properties for each WRZ from the NISRA projections was used in the demand forecast. Note that the Ulster University adjustment actually results in a decrease in properties in the East WRZ in moving from the base year to the second year of the forecast.

Non-household occupied properties comprise farms and institutions. It was assumed that the total number of occupied non-households is unlikely to change significantly through time, so the growth in properties forecast by NISRA for each WRZ will be solely attributable to households. It was also assumed that non-household properties in general (i.e. including commercial and industrial properties) are unlikely to change significantly over the planning period, so they have been kept constant.

For the baseline forecast, it is assumed that there will be no metering of domestic customers over the planning period in NI, because there is currently no charging of domestic customers and no plans to do so. Therefore, for the baseline forecast the growth in total WRZ occupied properties has been assigned to the unmeasured household category, with measured households remaining at zero through the planning period. As stated above the impact of potential domestic metering policies have been considered as part of the options appraisal (in section 8).

4.3.2 Forecast household demand

The baseline forecast shows how demands are expected to change through time. It is often informative to assess historic trends in PCC and in unmeasured demand (in Ml/d terms); in this case from the AIR data series. However, changes in the customer base over the period of analysis, especially in terms of increasing population, will affect the trend of household demand over time. Climatic effects will also normally influence the household demand seen in any given year.

In view of these issues concerning historic data a micro-component approach was developed to forecast growth in PCC. Micro-component analysis can be a useful means of building up an impact assessment profile of likely or known regulatory, behavioural and technological changes that influence household water consumption. For example, trends have been identified in the past suggesting a move towards increased frequency of personal washing, reflecting rapid growth in shower ownership but declining use of baths. Micro-component analysis allows such trends to be incorporated into a demand forecast in a quantifiable way. This helps to develop plausible estimates of how per capita consumption may change through time, as an alternative to historical trend analysis.

The following list of household demand components has been incorporated in the micro-component analysis:

- Toilet flushing;
- Bath use;
- Shower use;
- Clothes washing;
- Dish washing;
- Garden use;
- Car washing; and
- Miscellaneous use.

Micro-component consumption has been analysed for the WRMP based on assumptions relating to a normal year annual average scenario.

There is currently no information available for NI Water's customers regarding micro-component demand for domestic customers in the base year. The derivation of the base year micro-component values has therefore been based on available published data. The micro-component analysis was conducted at the Northern Ireland level, but was assumed to apply equally to all WRZs across Northern Ireland.

Assumptions regarding future changes to micro-components have been based on the report *A scenario approach to water demand forecasting*[13].

The micro-component analysis has been used to derive estimates for change in PCC throughout the planning period. The rate of change in total micro-component consumption, as calculated using the micro-component model, excluding 'miscellaneous use', has been used as the basis for the forecast of PCC over time within the demand forecast.

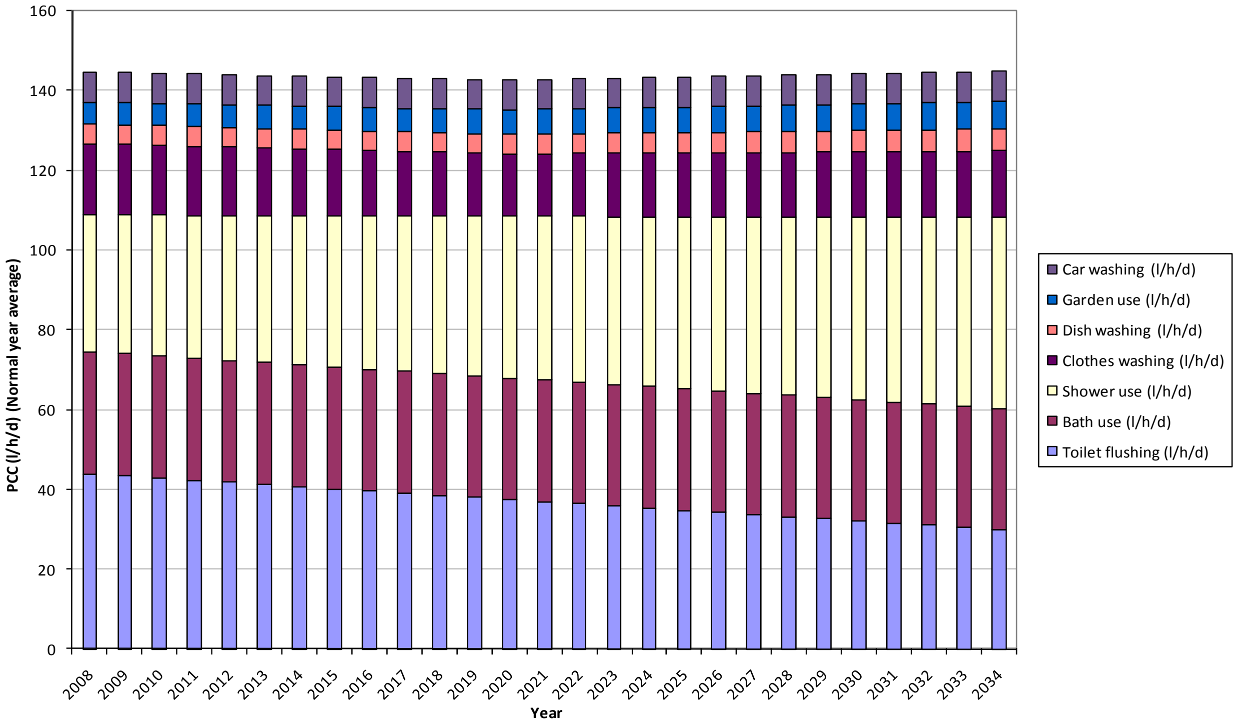

Figure 4.7 – Variation in PCC and associated micro-components through time in "normal" years

The results of the micro-component analysis suggest there is an underlying stability in total PCC although there are differences in some of the components; for example the modelled reduction in toilet flushing associated with more water efficient WC cisterns is offset by higher water use generated by more frequent showering. There is an overall increase in normal year consumption of just 0.2 l/h/d over the planning period in the component of total PCC that is made up from those micro-components for which reasonably robust estimates can be derived (i.e. excluding miscellaneous use). This corresponds to a 0.15% increase in consumption over the planning period, or approximately 0.006% growth per annum. This minimal percentage increase in PCC derived from micro-component analysis supports the use of a flat profile of PCC in the demand forecast (i.e. PCC remains constant through the planning period).

Such a profile seems logical, given that no metering of household customers has been allowed in the baseline case (as there is currently no charging of domestic customers, and there are no plans to do so), and thus there is no financial incentive for customers to conserve water. Note that current NI Water activity to promote water efficiency is incorporated in the base year estimates of household demand and PCC, and is thus implicitly included in the baseline forecast – the

[13] Environment Agency (August 2001) *A scenario approach to water demand forecasting*, National Water Demand Management Centre, Environment Agency

assumption is that a similar level of water efficiency promotion is expected to continue throughout the planning period.

This baseline forecast, which has been assumed to approximate “normal” year conditions must then be scaled up to derive a household demand in “dry” year conditions, as discussed in section 4.1.2.

The derived dry year PCC values for the base year (2008–09) are presented in Table 4.5. The values represent unmeasured household customers only, as there are no metered household customers in the baseline.

WRZ	Dry year annual average PCC in base year, 2008–09 (l/h/d)
North	166.3
East	187.6
Central	181.1
West	173.1
South	210.5

Table 4.5 – Assumed base year PCC in each WRZ for DYAA

For the reasons discussed previously, a flat PCC profile was applied in the demand forecast, so these dry year PCC values for each WRZ are assumed to remain constant throughout the baseline planning period. The estimated impacts of climate change on demand are also included in the baseline dry year annual average demand forecast, as discussed in more detail in section 5.2.

4.3.3 Forecast non-household demand

As discussed in section 4.3.1, the University of Ulster was commissioned as part of the PC10 submission to conduct an economic outlook assessment over the short term for each of the main sectors of the economy of Northern Ireland. This analysis included an assessment of future economic impacts on non-domestic demand[14].

On the basis of their economic assessment, the report sets out a non-household demand forecast for the period 2009–2013, in terms of change in consumption compared to 2008. They also provide a longer term forecast of 0.5–1% growth per annum, and they compare this to Scottish Water’s assumed annual growth in consumption of 0.3%.

The economic summary in the University of Ulster report states that there were almost 25 years of continuous growth and rising employment before the Northern Ireland economy fell into recession during the second half of 2008. Yet the trend in non-household water demand (from AIR submissions) shows a decline over the entire period 2002–03 to 2008–09. Overall this suggests that the relationship between economic activity and water consumption by non-household customers may be weak. It may also reflect the implementation of water efficiency and waste reduction measures to reduce water utility bills.

[14] University of Ulster (May 2009), *Northern Ireland economic outlook as pertaining to Price Control 2010*, section 3

Given these findings, the long term forecast of non-household water consumption growth of up to 1% per annum seems high and potentially unrealistic.

Therefore, the lower bound of the University of Ulster forecast of annual growth in non-household water consumption, 0.5%, was applied to the demand forecast from 2014 onwards. The growth rate from 2009–10 to 2013–14 was based on the University of Ulster forecast of the impact of the recession, suggesting a reduction of –4.1% in 2009–10, followed by growth in subsequent years so that by 2013 non-household demand returns to the base year 2008–09 level of demand.

The forecasts developed for non-household demand in a “normal” year must be uplifted by a dry year factor to derive non-household demands for the dry year annual average scenario, as discussed in section 4.1.2. There is little direct evidence of climate-related impacts on non-household demand; however, it is generally assumed that some non-household sectors will be affected by climatic factors, for instance agriculture. For the purposes of this WRMP, a dry year factor of 1.05 has been applied to non-household demand in each WRZ in line with the dry year analysis discussed in section 4.1.2.

4.3.4 Baseline leakage strategy

The baseline leakage strategy included in the WRMP is to move to the ‘economic’ level of leakage as soon as possible. The economic level of leakage is the point at which the cost of the work required to reduce leakage becomes greater than the cost of the water lost, taking account of social and environmental costs. Targets are generally set for total leakage, which comprises distribution losses (from the undertaker’s trunk mains and distribution system) and supply-pipe leakage (from customers’ supply-pipes) and are subject to review and agreement by the regulator NIAUR.

These target levels of leakage were based on an assessment of the short-run economic level of leakage (SRELL), which was originally conducted by Crowder Consulting in 2008–09. Since 2008–09 NI Water has made significant steps to improve the quality of data used in leakage assessments and to adopt industry best practice methodologies and systems. This ongoing work is helping to continually improve the accuracy and robustness of the leakage calculations, such as those used in the assessment of SRELL. NI Water has recently acquired new best practice leakage software (Netbase), which is to replace the existing legacy ‘TDMS’ system from 1 April 2013. Use of the more accurate Netbase system is likely to result in an increase in the estimated levels of leakage compared to that calculated by TDMS. This change is currently being assessed and should be complete by March 2013.

The reported level of leakage for NI Water in 2008–09 (from the AIR09 submission) was 180.92 Ml/d (following reconciliation of data using MLE). The analysis using the Netbase system concluded in October 2011 identified the SRELL as 165.4 Ml/d; this value of SRELL was the basis for the leakage target provided for this WRMP. For the baseline forecast it has been assumed that NI Water will reduce leakage, as measured using the new Netbase software, to the current estimate for the economic level of leakage of 165.4 Ml/d by 2014–15. The use of Netbase to estimate leakage levels will influence the rate at which leakage must be driven down to achieve the SRELL figure of 165.4 Ml/d. NI Water will review historical and recent leakage reduction performance and the potential scale of the Netbase assessment to confirm leakage targets and determine resources through the PC13 process.

The WRZ leakage targets included in the baseline demand forecast in this WRMP are presented in Table 4.6 and Figure 4.8. It has been assumed that leakage effort from 2008–09 to 2014–15 will target those WRZs with higher initial leakage levels in order to obtain the least cost leakage programme over the period. As can be seen from Table 4.6, this means that the majority of leakage reduction to achieve the 165.4 Ml/d leakage target should be concentrated in the South

WRZ, with smaller reductions in the East and Central WRZs. The approach adopted is described in greater detail in section 8.

WRZ	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015 onwards [1]
NI Water	**180.92**	**179.00**	**175.00**	**171.00**	**168.00**	**166.70**	**165.40**	**165.40**
East	76.39	75.62	74.03	72.43	71.24	70.72	70.20	70.20
North	15.50	15.50	15.50	15.50	15.50	15.50	15.50	15.50
Central	8.43	8.42	8.41	8.39	8.38	8.38	8.37	8.37
West	20.13	20.13	20.13	20.13	20.13	20.13	20.13	20.13
South	60.47	59.32	56.93	54.54	52.75	51.98	51.20	51.20

Table 4.6 – Summary of leakage targets used in baseline demand forecast

Notes:
[1] Assumption that leakage level will remain constant in baseline forecast from 2015–16 to 2034–35.

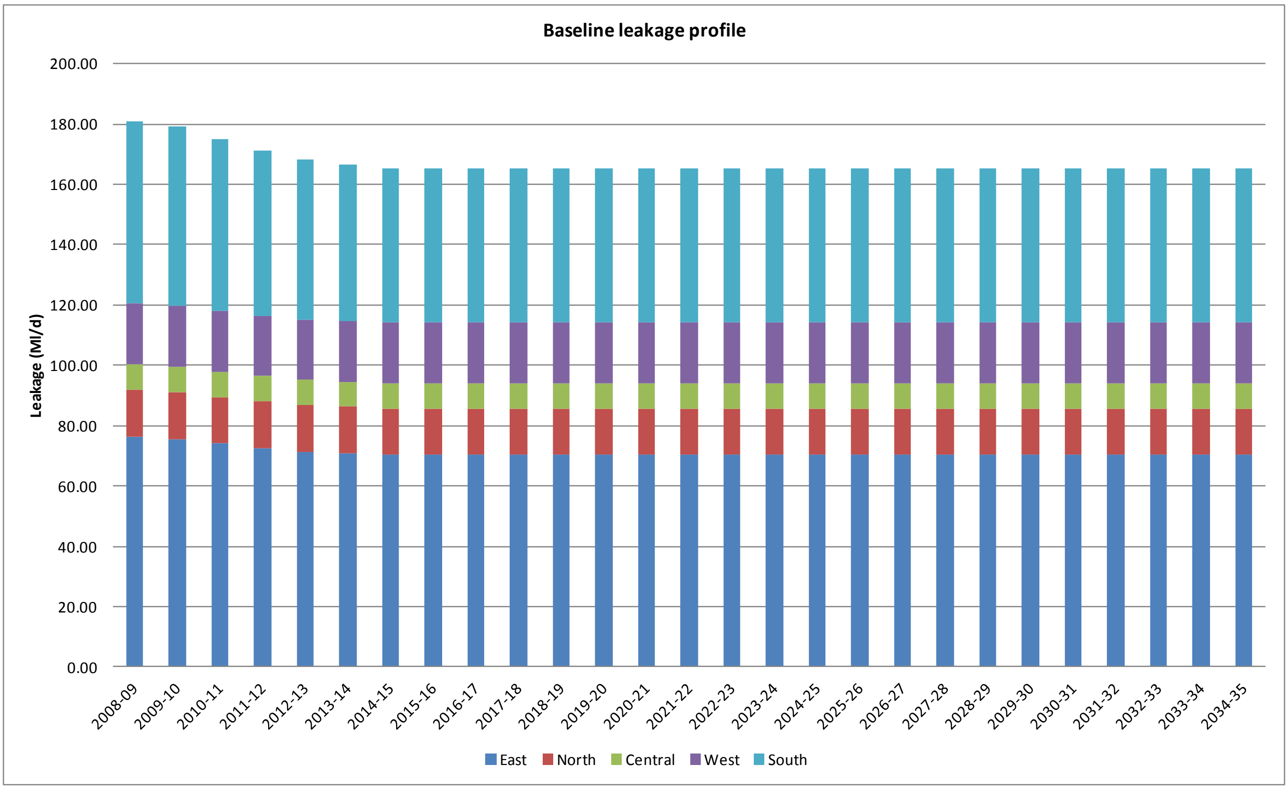

Figure 4.8 – Baseline leakage profile for each WRZ

The baseline leakage forecast for the normal year annual average demand scenario is assumed to be the same as for the dry year annual average. No allowance has been made for annual variations in leakage due to climatic conditions.

Additional leakage reduction options are considered as part of a final planning approach. Leakage reduction options (see section 8.4.2) beyond the current company target of 165.4 Ml/d by 2014–

15 have been included in the options appraisal in order to derive the least cost solution to ensuring the supply demand balance over the planning period, as set out in section 9.

For the purposes of the WRMP the company level leakage targets are broken down into targets averaged across each WRZ. It is important that the planning process for leakage reduction works within each WRZ consider distribution constraints within each zone so that the supply demand balance is maintained in each District Meter Area (DMA). This is because local supply demand balance deficits resulting from proportionally higher levels of leakage and the inability of the distribution system to cope with locally high leakage levels could be exacerbated if leakage work within a WRZ were to be focused on the wrong areas. The phasing of leakage reduction activities within each WRZ therefore needs to consider these constraints through the use of zonal distribution models and field testing as appropriate. This level of detailed planning is outside the scope of the WRMP.

4.3.5 Baseline water efficiency and metering

No allowance has been made in the baseline planning forecast for the introduction of domestic metering, because NI Water does not at present have any legislative powers to install meters. NI Water’s existing water efficiency policy encourages the efficient use of water amongst household and non-household customers, through information leaflets, the Company’s website, and at various events. NI Water places particular focus on educating at all levels including school children through school visits. Children are encouraged to involve their parents in carrying out home water audits.

NI Water has undertaken a number of other water efficiency initiatives, including work with IKEA to encourage customers to carry out home water audits. NI Water’s home water audit and water efficiency information packs were also provided during household visits by the Energy Savings Trust. Free water saving devices including cistern displacement devices (e.g. Hippo’s, Save a Flush), trigger guns and shower timers are available to customers on request and are also distributed at all NI Water events.

NI Water is currently carrying out a pilot study to ascertain the cost/benefits of various domestic water efficiency tools. The findings from this will be used to inform the ‘Water Demand Management Strategy‘ which is planned to be implemented in the planning period starting in 2015. The expected outcomes of the WDMS will be included as inputs into the next round of water resource management planning.

Current water efficiency activity amongst household and non-household customers is implicitly included in the base year (AIR09) demand data. Separating and quantifying the exact saving in demand from this baseline water efficiency activity requires estimation and is subject to high levels of uncertainty. The forecast incorporates inherent water efficiency savings actually seen in the household and non-household demand components of the base year. So for the baseline forecast, which assumes that water efficiency activity will remain the same as in the current year, no additional assumptions of water efficiency savings are required.

Demand management measures will need to be considered for future WRMP to help meet potential deficits in the supply demand balance as part of a “twin track” approach in response to possible sustainability reductions which in turn could increased the magnitude of climate change impacts. Demand management options include:

- Leakage reduction activity (considered as part of demand management in this context);
- Water efficiency initiatives; and
- Metering of domestic customers.

The demand management options assessed for inclusion in the Final WRMP are discussed in more detail in section 8.4.2 to section 8.4.4.

4.3.6 Summary of demand forecast

The baseline demand forecast for each WRZ, and for NI as a whole, is presented in Table 4.7 for selected years, and in Figure 4.9 throughout the planning period.

WRZ	2008–09: base year	2017–18: end of 5 year planning period	2022–23: end of 5 year planning period	2034–35: end of total planning period
NI Water	**676.66**	**683.85**	**702.17**	**730.55**
East	311.55	308.95	314.12	326.69
North	81.69	83.27	84.85	88.56
Central	28.30	29.98	31.15	32.46
West	66.57	69.94	72.27	75.24
South	188.55	191.71	199.77	207.60

Table 4.7 – Summary of baseline demand forecast in selected years

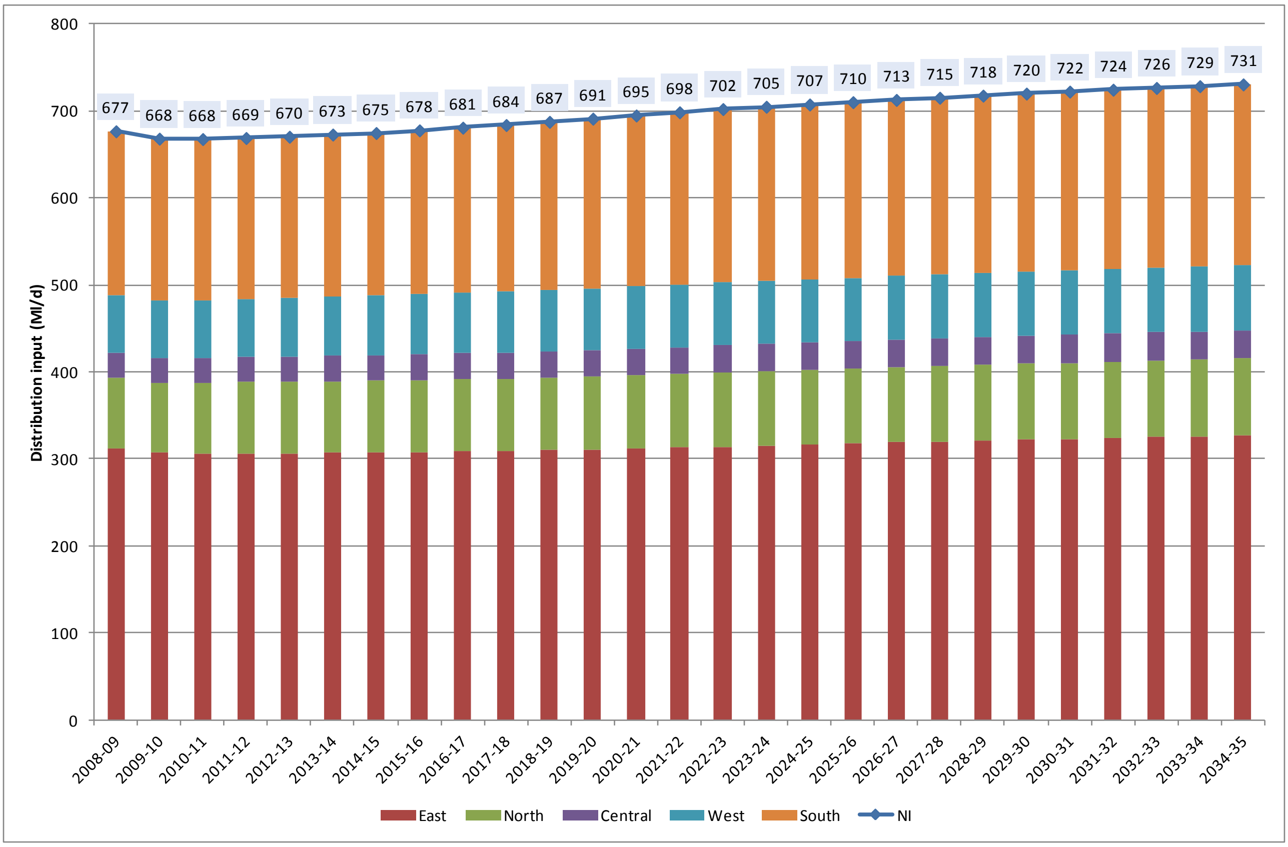

Figure 4.9 – Baseline demand forecast by WRZ

Table 4.8 shows the demand forecast broken down into the main components of household and non household demand, leakage and minor component.

WRZ	2008–09: base year	2017–18: end of 5 year planning period	2022–23: end of 5 year planning period	2034–35: end of total planning period
Total	**676.66**	**683.85**	**702.17**	**730.55**
Household	315.00	332.97	347.22	364.89
Non-household	145.44	150.17	154.24	164.96
Leakage	180.92	165.40	165.40	165.40
Minor	35.30	35.30	35.30	35.30

Table 4.8 – Major components of baseline demand forecast in selected years

5. Climate change

5.1 Supply

Two approaches have been taken to account for potential climate change impacts on water resources in Northern Ireland. The first makes predictions of future river flow and thence on water supply impacts; the second provides a more qualitative assessment, based on expert judgement of the potential impacts of climate change.

The first approach examines all of the water supply catchments in Northern Ireland and incorporates the latest UK Water Industry Research (UKWIR) flow factors, known as the UKWIR UKCP09 Rapid Assessment. The second approach makes use of the UKCP09 weather generator to make a preliminary example assessment of how climate change may influence the seasonal and inter-annual rainfall totals, and how these compare with historical droughts. The output from the second approach could also be used to assess climate change impacts directly on flow (and thence supply) if suitable rainfall-runoff models are developed for a future plan.

The publication of the UK climate impact projections in 2009 (UKCP09) provides a more detailed set of climate change projections for the UK. The UKCP09 projections are derived using a complex methodology that incorporates several of the key uncertainties in climate modelling. The outcome is a set of probabilistic projections that quantify the strength of evidence for a particular change at a given location, future timeslice and emission scenario. This gives more comprehensive information than the deterministic approach of the 2002 projections (UKCIP02) or the multi-model approach of UKWIR06 (described in section 5.1.2).

The update of previous flow meteorological and flow factors for UKCP09 – referred to as the 'UKWIR UKCP09 Rapid Assessment' – provides a revised set of monthly and seasonal flow factors based on the updated projections. The factors are produced for 183 catchments in the UK, and for the 2020s. In addition, the UKCP09 weather generator (WG) provides a tool for generating plausible future time series of various climate variables (on daily or hourly timescales). This is particularly useful where substantial historical data are not available. The WG is used here to compare historical droughts in Northern Ireland with future scenarios of climate change, and also to provide an assessment of the impact of climate change on potential evapotranspiration[15] (PET), which is not included in the standard UKCP09 projections.

5.1.1 Approach 1: Flow Factors

The more complex approach within the UKWIR methodology would require rainfall-runoff models to convert perturbed precipitation and PET time series into associated flow perturbations. Without these models for Northern Ireland (section 3.1.1), it is necessary to use the more simple method, perturbing river flow series instead.

[15] The amount of evaporation and transpiration that would occur if a sufficient water source were available

UKWIR flow factors[16] are provided for five catchments in Northern Ireland:

- Six Mile Water at Antrim;
- Claudy at Glenone Bridge;
- Burn Dennet at Burndennet;
- Camowen at Camowen Terrace; and
- Fairywater at Dudgeon Bridge[17].

Because these catchments do not cover all of the required area of Northern Ireland, it was necessary to examine key meteorological, geographical and hydrological characteristics of the catchments draining to these gauging stations, with each of the supply catchments; thus enabling the flow factors to be transferred (i.e. applied) to other catchments. This is a way of estimating the flow factors in the absence of hydrological models and without detailed examination of the UKCP09 projections (in a similar manner to the UKWIR Rapid Assessment).

The data comparison uses the following four factors:

- Region of Influence (ROI) stations (top 5);
- Hydrometric Area (location);
- Rainfall; and
- Base Flow Index (BFI).

The ROI data was derived from the LFE software (Low Flows Enterprise model of Northern Ireland[18]), which provides a variety of information on each catchment, from which a gauged catchment can be selected for use as a proxy. This software is the same as has been used already to generate daily time series for Aquator catchment inflows. Each catchment of interest was scored, based on the four factors, in its similarity to the catchments for which flow factors were available. The outcome of this and the factors applied are presented in section A 6.2 of Appendix A, but an example for Six Mile Water is included here. The perturbations to the baseline flow series for each supply catchment provide a quantified estimate of the impact of climate change on river flows for the 2020s timeslice.

[16] Von Christierson, B., Wade, S. and Rance, J. 2009. Assessment of the significance to water resource management plans of the UK Climate Projections 2009, UKWIR, London.
[17] Fairywater was not included in the assessment as it is mislabelled as ‘Scotland’ in the UKWIR Rapid Assessment spreadsheets and was thus overlooked. This fifth catchment could be included in any subsequent assessment.
[18] Provided by the Northern Ireland Environment Agency for use on this project.

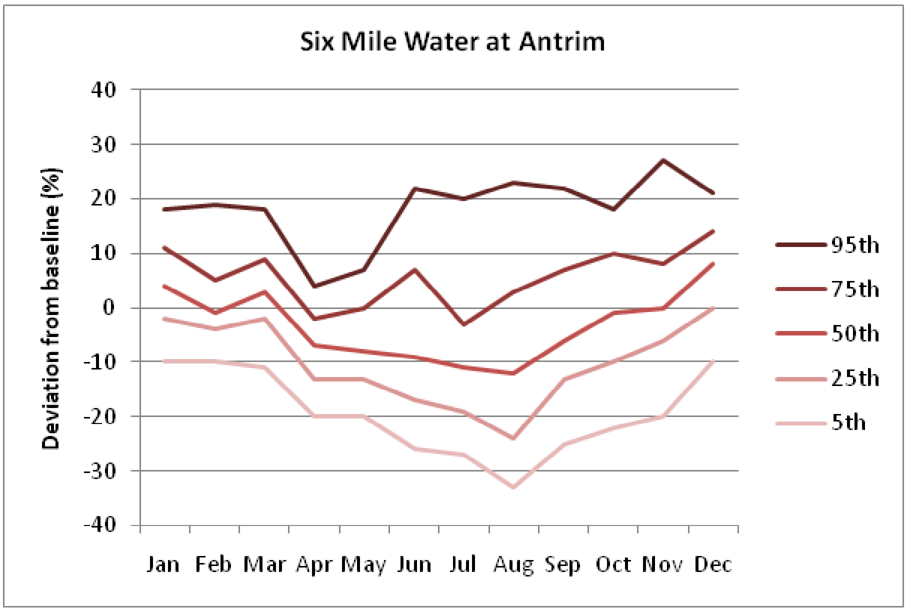

Figure 5.1 – Flow factors for Six-Mile Water at Antrim

5.1.1.1 Climate perturbed deployable output estimates

The Aquator water resource models were reconfigured to investigate the potential impacts of anticipated changes that could be brought about in Northern Ireland due to climate change using the perturbed flow series generated (see section A.6 of Appendix A)

The absolute changes to DO are shown in Table 5.1 for the three climate changes scenarios investigated with the Aquator models (5th, 50th and 95th percentile) and Table 5.2 gives the results in percentage terms. The 50th percentile projection is used to define the potential impact of climate change on supply, while the 5th and 95th percentile projections are used to estimate the uncertainty in that assessment and so are included in the headroom model. For the South WRZ, DO has been assessed both before and after the decommissioning of the Camlough source in 2015.

Looking across the whole of Northern Ireland, the 50th percentile scenario showed virtually no change from the baseline. Under the 5th percentile perturbations there was a DO reduction of just below 27 Ml/d (3.5%) simulated. Under the 95th perturbations simulated DO was increased by 23 Ml/d (3.0%).

In percentage terms the biggest individual WRZ reduction in DO seen under the 50th percentile projections was a 0.9% decrease in DO simulated in the North WRZ. For the 5th percentile projection there was a 5.8% reduction in the North WRZ, and at the 95th percentile, the largest increase in DO simulated was a 5% increase in the East WRZ.

Thus, the potential of climate change on supply is estimated to be relatively small and the effect of uncertainty in this estimate on headroom is also relatively small. However, some caution is needed. As described in section 3.1.4, NIEA has not been able to advise NI Water on the scope and timetable of its programme of work to review existing abstraction licences and hence the possible location and magnitude of sustainability reductions. As a result the Aquator models do not include any constraints based on abstraction conditions based on flow and/or water level to prevent abstractions from removing all flow up to the licence limit. It is expected that the inclusion of any environmental flow conditions in existing abstraction licences may lead to a greater impact of climate change on DO and hence have an impact on the supply demand balance when these are assessed in future reviews and/or updates to this WRMP.

WRZ	Deployable Output (DO) (Ml/d)	Climate Change Scenario DO Results (Ml/d)			Notes
		5th Percentile	50th Percentile	95th Percentile	
North	106.2	100.0	105.2	111.3	Altnahinch reservoir is always critical with supplies running out at the same time in each scenario.
West	88.2	86.8	88.0	89.5	Lough Bradan is always critical with supplies running out at the same time in each scenario.
Central	31.1	31.1	31.1	31.1	Hydrological conditions do not become limiting under any of the climate change scenarios.
East	329.5	314.4	328.1	346.1	DO responds to changing hydrological conditions across the WRZ under the climate change scenarios.
South	218.6 (204.5 after 2015)	215.1 (200.4 after 2015)	218.6 (204.5 after 2015)	218.6 (204.5 after 2015)	Under the 5th percentile climate change scenario DO is determined by hydrological conditions at Spelga/Fofanny reservoir both before and after the decommissioning of the Camlough source in 2015. However, as hydrological conditions become more favourable under the 50th and 95th percentile climate change scenarios, DO is determined by asset constants in the Newry and Lough Ross areas and the results are identical to the baseline DO.
NI Total	**773.6 (759.5 after 2015)**	**747.4 (732.7 after 2015)**	**771.0 (756.9 after 2015)**	**796.6 (782.5 after 2015)**	

Table 5.1 – Climate change run results showing revised DO values under the 5th, 50th and 95th percentile climate change scenarios

Note: South WRZ DO is calculated before and after the decommissioning of the Camlough source in 2015

WRZ	Climate Change Scenario DO Results (Ml/d)			Range (%)
	5th Percentile	50th Percentile	95th Percentile	
North	94.2%	99.1%	104.8%	10.6%
West	98.4%	99.8%	101.5%	3.1%
Central	100.0%	100.0%	100.0%	0.0%
East	95.4%	99.6%	105.0%	9.6%
South	98.4% (98.0% after 2015)	100.0% (before and after 2015)	100.0% (before and after 2015)	1.6% (2.0% after 2015)
NI Total	**96.6% (96.5% after 2015)**	**99.7% (before and after 2015)**	**103.0% (before and after 2015)**	**6.4% (6.6% after 2015)**

Table 5.2 – Climate change impact on baseline DO

Note: South WRZ DO is calculated before and after the decommissioning of the Camlough source in 2015

5.1.2 Approach 2: Weather generator

For the second approach, the UKCP09 weather generator[19] (WG) was used to make a preliminary assessment of how climate change may influence seasonal and inter-annual rainfall totals, and how these compare with historical droughts. This approach provides an estimate of the impact on future flow in droughts and dry periods beyond that possible with the flow factors and a limited flow record. By analysing the observed record, it is possible to establish the key meteorological conditions that are present in a drought or critical period and possible changes thereon.

The assessment has been undertaken as an example, for the 2020s, based on Armagh. Armagh has a long observed rainfall series, with monthly totals used here from 1853 to 2009 inclusive. Historical droughts in Northern Ireland had been identified as occurring in 1855–56, 1887–88, 1933–34, 1952–56, 1983 and 1995, and these events are compared with output from three runs of the UKCP09 WG, with the following conditions set:

- ‘Wet’: 2020s; ‘High’ emissions[20]; conditioned on the 90th percentile of winter and the 90th percentile of summer;
- ‘Medium’: 2020s; ‘High’ emissions; conditioned on the 50th percentile of winter and the 50th percentile of summer; and
- ‘Dry’: 2020s; ‘High’ emissions; conditioned on the 10th percentile of winter and the 10th percentile of summer.

[19] Note that the WG ‘seed’ was unchecked, thus the runs contain differences due to the WG variability, as well as the differences in percentiles. A more detailed assessment was beyond the scope of this WRMP but could examine this variability more systematically.
[20] The ‘High’ emissions scenario was used for all three runs, because this is the current emissions path that is being followed, although in practise there is little difference between scenarios in the short-term (more pronounced changes are noticeable towards the middle of the century and beyond).

To assess the impact of climate change on effective rainfall, the equivalent PET WG data were also analysed. The WG 'control' data and the three scenario runs are used for comparison.

A validation exercise was completed to verify the WG baseline; mean monthly rainfall was generated for the 'control' (i.e. a baseline of 1961–90) WG run and compared with the 1961–90 average for Armagh. The resulting graph (Figure 5.2) shows that the WG approximates the Armagh historical data well. It can be seen that the seasonal totals are similar, although the WG gives a higher winter total.

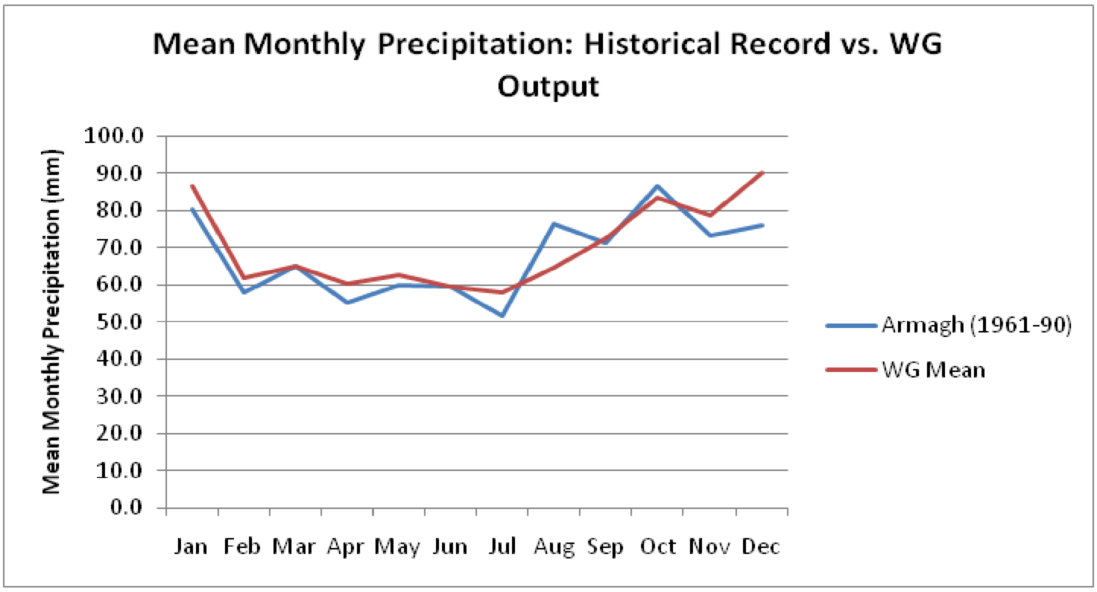

Figure 5.2 – Armagh – Mean Monthly Precipitation; Historic vs Weather Generator

5.1.2.1 Results

In summary the WG produces 100 runs of 30-year daily rainfall time series for each of the three WG runs. These daily data were summed and then combined to form a single 300-year series of seasonal rainfall totals. From these series, 6-month (summer only), 24-month (summer-winter-summer-winter) and 36-month (summer-winter-summer-winter-summer-winter) rolling totals were calculated, and subsequently plotted on histograms. The equivalent 'bin' for each historical drought (from the Armagh station record) is also plotted as the baseline for comparison.

As shown in the 6-month totals example (Figure 5.3), this histogram shows a typical pattern with a shift towards the drier (left-hand) 'bins' for dry WG run (green), and a shift to the wet end (right) for the wet WG run (blue). The medium WG run (red) shows a fairly similar pattern to the baseline, but with a greater number of seasons falling in the more extreme 'bins', and a reduced number in the central bins.

Histograms for the 24-month and 36-month rolling totals are included in Appendix A. The shorter historical droughts are equivalent to the drier 'bins' in the 6-month totals histogram, while the longer droughts, particularly 1952–56, are more evident in the 24- and 36-month histograms. The implication of these results is that historical droughts are infrequent in the context of the baseline WG run, but may become more frequent in future, especially in the case of longer-term events.

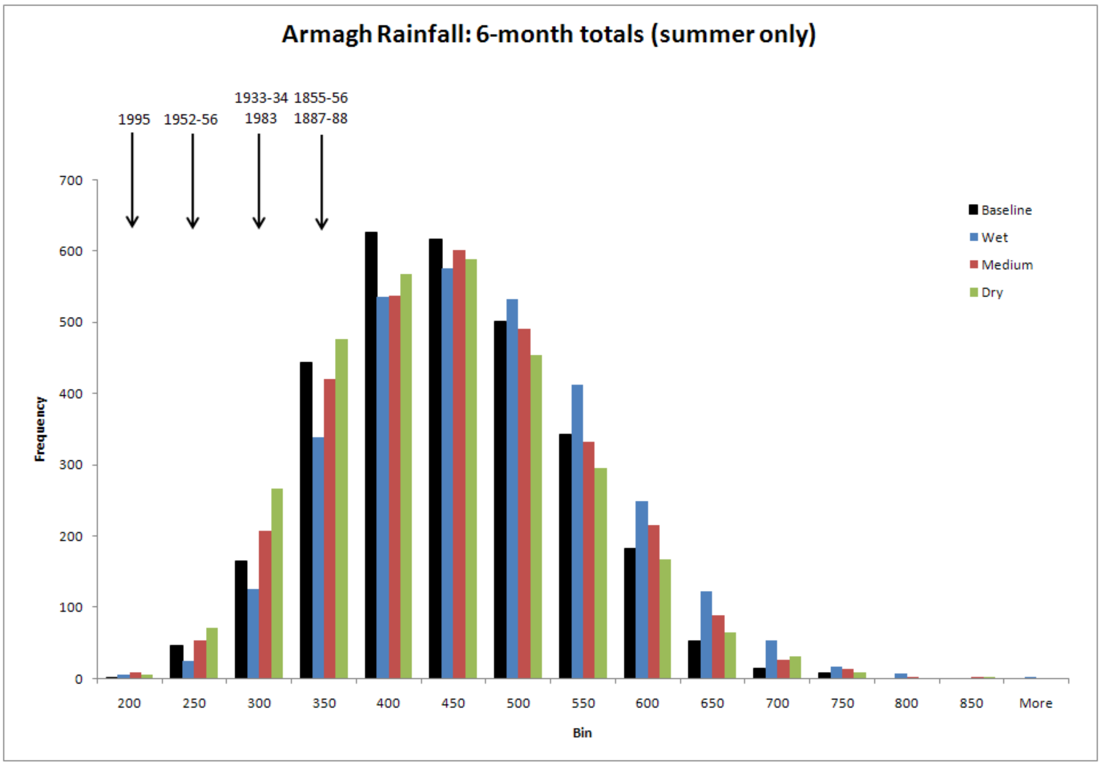

Figure 5.3 – Histogram of baseline and projected Armagh rainfall (6 month totals)

Since river flow will be affected by PET as well as rainfall, a similar analysis was undertaken with PET data. Any increase in PET throughout the year will reduce the amount of rainfall that can be classed as ‘effective’ and contribute to catchment runoff and river flow. Absolute PET figures were plotted for both control (1961–90) and the three climate change runs (Figure 5.4). It can be seen that as expected PET increases through spring, peaking in midsummer, and declining to winter; this is evident in all three climate change runs and those runs show increases in PET throughout the year.

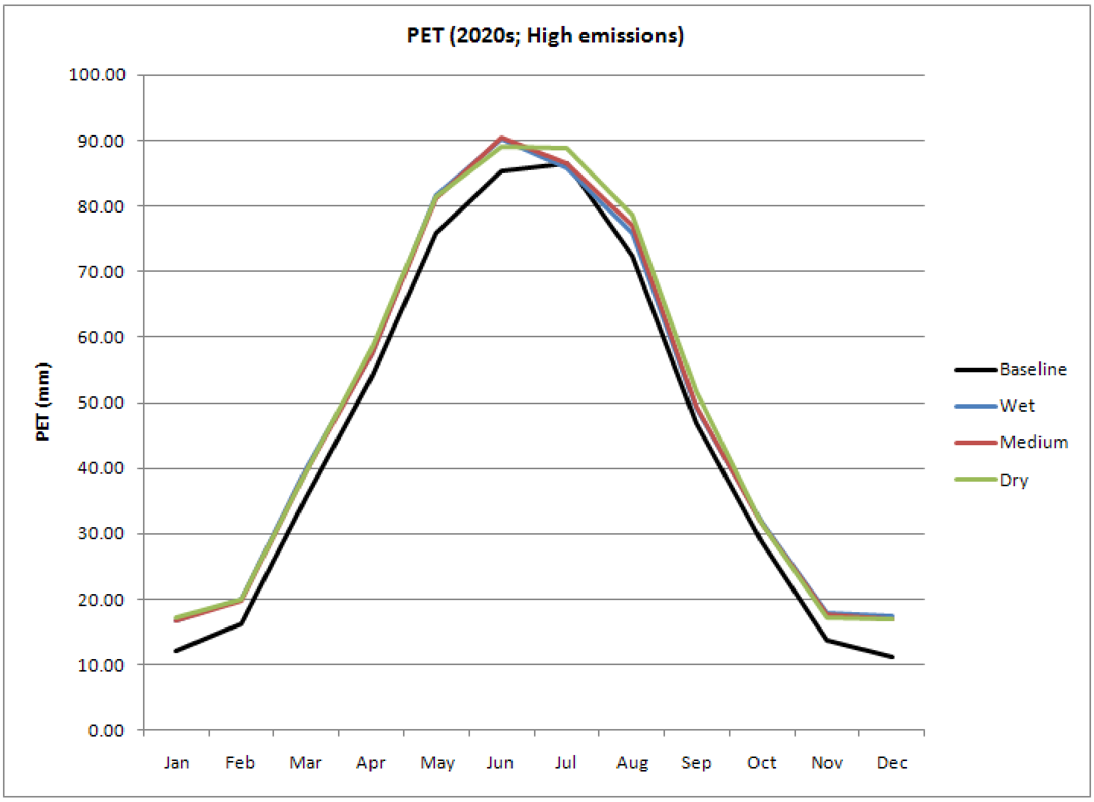

Figure 5.4 – Monthly baseline and projected potential evapotranspiration for the 2020s

To show how the climate change run deviates from the baseline run for each month of the year, this is plotted as percentage change values in Figure 5.5. The plot shows that in percentage terms, the increases in the winter months are substantially more pronounced than in summer. Therefore, where there are increases in rainfall – particularly in winter – this will not necessarily translate into as substantial gains in recharge as might be expected since an increasing amount of this will be lost to evaporation.

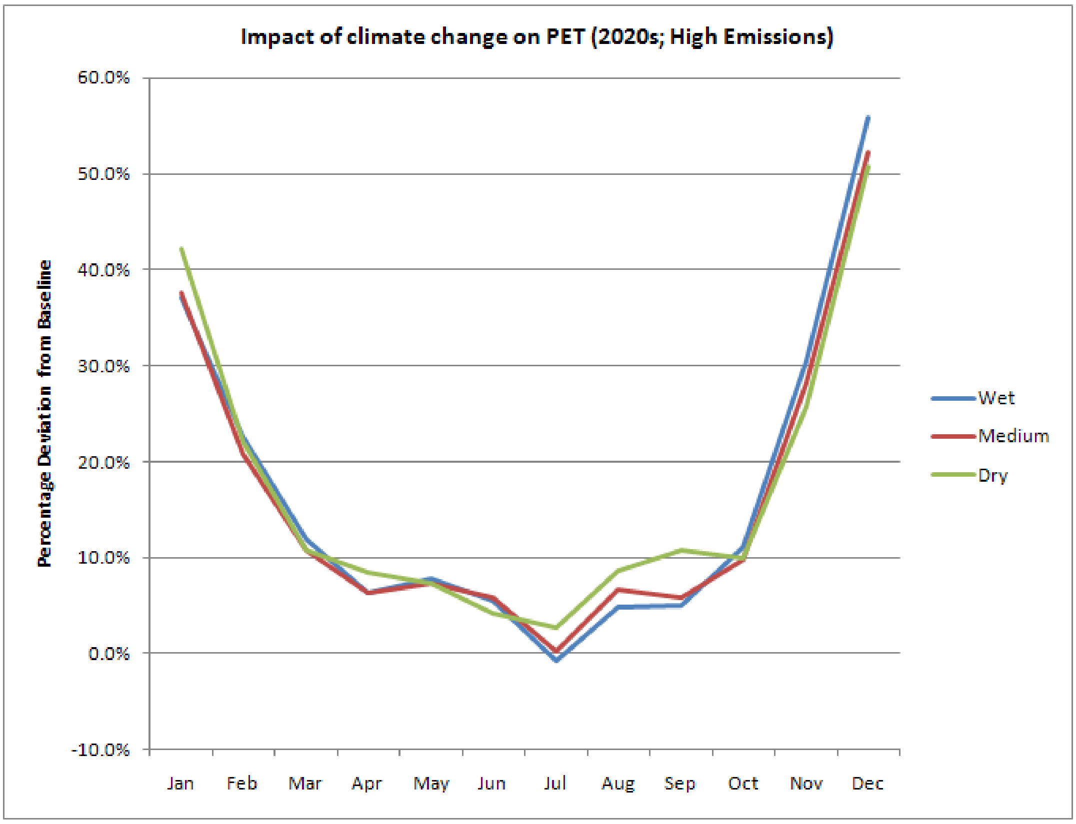

Figure 5.5 – Percentage deviation of climate change potential evapotranspiration predictions from the baseline for the 2020s

5.2 Demand

The assessment of the impact of climate change on demand is derived from analysis presented in the *Climate change and demand for water (CCDeW)* report[21]. This provides a set of factors describing the impact of climate and socio-economic change on household and non-household demand.

The study area for CCDeW was limited to England and Wales, with results condensed into eight regions for the purpose of assigning climate change scenario values. Thus, an immediate limitation of CCDeW is that it does not include Northern Ireland. To address this, average climatic data, typical per capita consumption and regional climate change projections were assessed to identify a suitable proxy region to represent Northern Ireland. It was concluded that the north west of England provided the most appropriate proxy. However, it should be noted that because climate change projections for the north west show bigger changes in temperature and precipitation compared to Northern Ireland, the demand effects may be greater in the north west than would be seen in Northern Ireland.

[21] Downing, T.E, Butterfield, R.E., Edmonds, B., Knox, J.W., Moss, S., Piper, B.S. and Weatherhead, E.K. (2003), *Climate change and demand for water*, Research report, Stockholm Environment Institute, Oxford

5.2.1 CCDeW factors

CCDeW provides demand factors for different climate change and socio-economic scenarios. Climate scenarios were based on UKCIP02, and provide low (L), medium-high (MH) and high (H). These are combined with four potential socio-economic scenarios, which were created as plausible and consistent descriptions of possible futures. These are: alpha (α) (representing provincial enterprise); beta (β) (representing world markets); gamma (γ) (representing global sustainability); and delta (δ) (representing local stewardship).

For a scenario that is most similar to conventional development, the beta 'world markets' socio-economic scenario can be used. There is little difference between the climate change scenarios for the 2020s, and so the medium-high emissions scenario was adopted primarily because most information is provided on this within CCDeW.

Note that the mean impact on demand is applied to the demand forecast, while headroom is based on the differences between the maximum and the mean, and the mean and the minimum, to inform the upper and lower boundaries respectively. Headroom allowances are discussed further in section 6.

For domestic demand, this gives a 1.43% mean increase in per capita consumption in the 2020s. For headroom allowances, the WRZ-level minimum (1.15%) and maximum (1.67%) were used with a normal distribution. These results are presented in Table 5.3, along with other the regions covered by CCDeW for comparative purposes.

Scenario	Percentage change in demand, 2020s (β)			Percentage change in demand, 2050s (β)		
	Min	Mean	Max	Min	Mean	Max
North West [1]	**1.15**	**1.43**	**1.67**	**2.39**	**2.97**	**3.40**
Anglian	1.25	1.83	2.43	2.54	3.04	3.35
Midlands	1.25	1.83	2.43	2.42	3.68	4.95
North East	1.27	1.48	1.61	2.54	3.04	3.35
Southern	0.94	1.45	2.19	1.74	2.92	5.03
South West	0.96	1.39	1.70	1.81	2.81	3.48
Thames	1.00	1.37	1.88	2.01	2.67	3.59
Wales	1.08	1.45	1.97	2.05	2.79	3.90

[1] Proxy for Northern Ireland

Table 5.3 – Climate change factors for household demand

For non-domestic demand, there are no WRZ-level figures provided in CCDeW and so it is difficult to derive a measure of uncertainty for target headroom. However, a lower band of zero was used, with an upper band of approximately 2.7% to reflect the spread of uncertainty in sectors (from 0.0% to 5.2% (CCDeW, p.89) whilst recognising the potential for over-estimating the climate change impact. The best estimates of climate change impacts on industrial and commercial demand are summarised in Table 5.4. For comparison, figures for all CCDeW regions are also given.

Region	Percentage change in demand, 2020s MH (β)	Percentage change in demand, 2050s MH (β)
North West [1]	**1.8**	**3.8**
Anglian	2.6	5.7
Midlands	1.8	3.9
North East	1.8	3.6
Southern	2.7	5.7
South West	3.0	6.1
Thames	2.5	5.4
Wales	2.4	5.2

[1] Proxy for Northern Ireland

Table 5.4 – Climate change factors for non-household demand

5.2.2 Application of demand factors

UK water industry best practice recommends that the CCDeW factors for the 2020s should be scaled back to the base year to give an annual percentage increase. With a base year of 2008–09, this would give an annual mean increment of 0.089% for domestic demand (i.e. the 1.43% mean increase divided by the 16 years between the base year and 2025, the mid-point of the 2020s). This could then be scaled back and forward from 2025, and applied cumulatively.

However, this is not the only possible approach that could be used for scaling demand factors, and is further complicated because it is not clear from CCDeW which year should be used to scale back the change factor to get an annual increment. If the 1961–90 period is used as the base period (after which it is commonly assumed that climate change would have an impact on the baseline), then 1975, as the mid-point in this 30-year period, would be appropriate. By not scaling from 1975, there is a risk of over-estimating the impact of climate change after 2025 as the annual increments are too large. Also, there is an assumption that the base year, and therefore the forecast based on this, is unaffected by climate change; if the base year already includes an element of climate change, the future impact of climate change will then be overestimated.

By scaling back to 1975, this would result in a linearly-average increment of 0.029% for domestic demand accumulating from 1975 to 2025 (i.e. starting at 0 in 1975 and increasing in annual 0.029% increments to 1.43% in 2025). This compares with an annual increment of 0.089% for the WRP guidance approach. Figure 5.6 shows an indicative graph that provides a comparison of the WRP approach (green line) with the approach that scales back to 1975 (blue line).

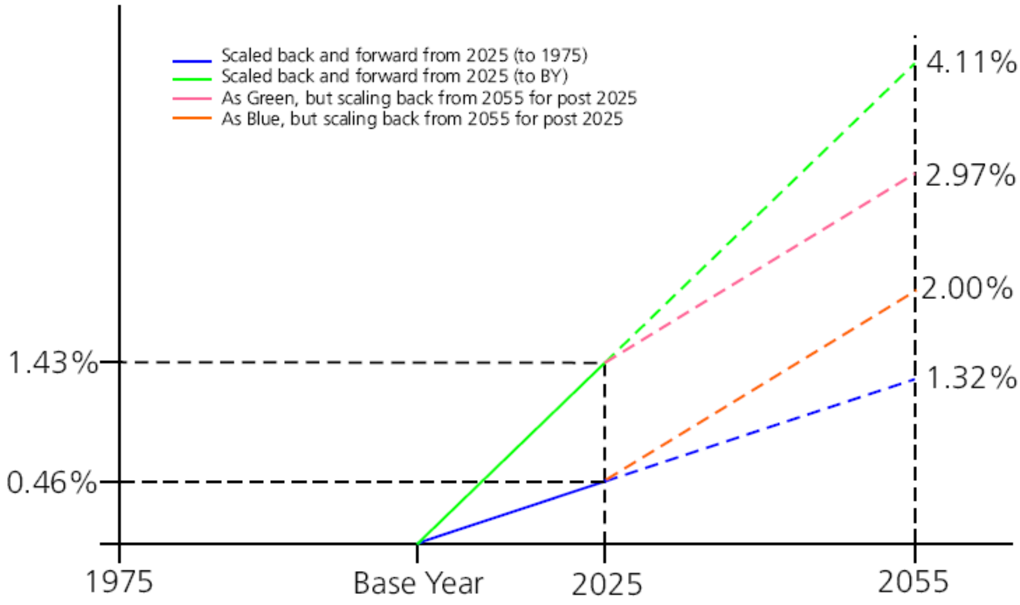

Figure 5.6 – Indicative graph of four methods of CCDeW scaling

One way of avoiding potential over-estimation after 2025 is to use the factors for the 2050s and scale back to 2025. This approach is logical, as the annual climate change impact would generally be expected to be greater for the 2050s than the 2020s. When the 2050s factors are used after 2025, the WRP guidance approach changes from the green to the pink line; while the scaling back to 1975 approach changes from the blue to the orange line, as also shown in Figure 5.6. Note that the pink method actually shows a decrease in the rate of climate change impact from 2025, which is counter-intuitive.

The most logical approach, which has been adopted for this WRMP, is to use the Orange method. It provides a profile of annual climate change factors for demand that most accurately portray the likely profile of climate change over the first half of the 21st century and avoids potential issues of double-counting.

5.3 Impact on the supply demand balance

The combination of climate change impacts on both supplies and water demand is allowed for within the supply demand balance. The supply-side effects are reported explicitly as a component of the supply demand balance. Whereas the effects on demand are included within the household and non-household components of the demand forecast.

An allowance is also made for the uncertainty in estimating the impact of climate change on supplies and on water demand. This included in target headroom, and is discussed further in section 6.

Figure 5.7 presents the impact of climate change on the baseline supply demand balance for the whole of Northern Ireland, broken down into supply-side and demand-side impacts. This represents the best estimate of the likely impact of climate change over the planning horizon.

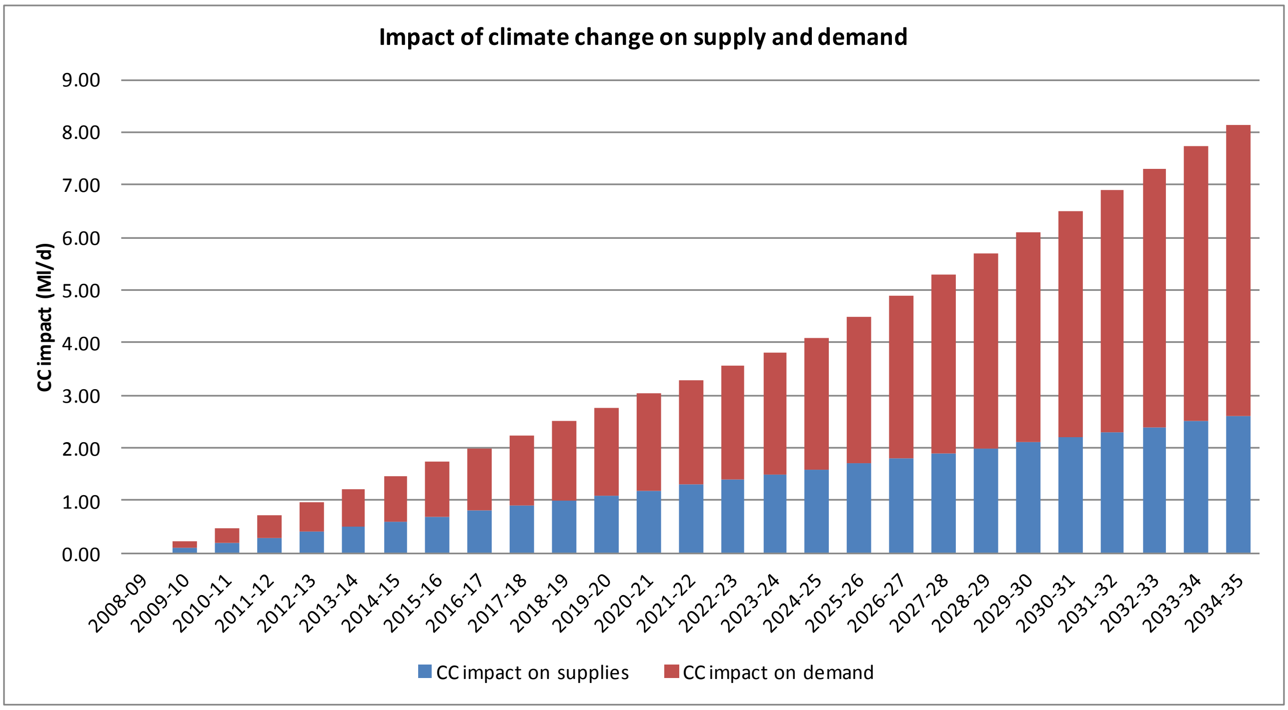

Figure 5.7 – Climate change impacts on supply and demand for NI

Methodologies for how the potential impacts of climate change should be allowed for in water resources planning continue to evolve, for example the UKWIR/Environment Agency project "Impact of climate change on resource yield" and UKWIR project CL04B "Impact of Climate Change on Water Demand". The results from project such as these, and any subsequent changes to water resource planning guidelines will need to be taken into account in future WRMPs.

6. Target Headroom

6.1 Method

The following section outlines the systematic approach, based on the UKWIR Improved Methodology[22], which has been used to assess the level of uncertainty in the supply demand balance. There are many sources of uncertainty involved in the forecasting of water supply and demand and hence the resulting supply demand balance. These uncertainties can be summarised under the following categories,

- Accuracy of data. All forecasts are to some extent based on historic records, and therefore inaccuracies in observed data can have implications for forecasts. The scope of this uncertainty is wide and may cover inaccuracies from rainfall records that are used to drive hydrological models to water meters used to measure distribution input;
- Natural variations. Forecast models are typically based around a set of assumptions about future trends and changes. Whether these assumptions relate to rainfall patterns, population growth or general behaviour there is an inherent uncertainty about forecasts and the extent to which past records are likely to be a good representation of the future;
- New schemes. Implementation of new schemes, whether water resources or demand management, is also uncertain. Predicted yields may or may not be realised, or estimated demand savings may not be achieved or maintained throughout the planning period; and
- Political uncertainty. Renewal of abstraction licences or future changes to regulatory frameworks can also be sources of uncertainty. Clarity with appropriate authorities is usually sought to eliminate as far as possible these uncertainties, but they may still exist under particular circumstances.

The effect of the uncertainty is to make the water resource planning process, as with any future decision making, an exercise in risk management. In water resource planning, target headroom is used as a margin to take account of the risk that might arise from deviations from the most likely forecast. Uncertainties for each of the named components in the UKWIR methodology relevant to the NI Water supply system have been quantified as far as possible. The process of quantification brings together past experience and records, expert judgement and industry guidance. The components of headroom defined in the UKWIR methodology are split between supply and demand, and are listed below, though not all of these are relevant to NI Water's supply system:

Supply Related – components S1 to S9

- S1 Vulnerable surface water licences;
- S2 Vulnerable groundwater licences;
- S3 Time-limited licences;
- S4 Bulk imports;
- S5 Gradual pollution of sources causing a reduction in abstraction;
- S6 Accuracy of supply-side data;
    - S6–1 Infrastructure uncertainty;
    - S6–2 Meter uncertainty;

[22] UKWIR (2002), *An Improved methodology for assessing Headroom*. Report 02/WR/13/2

- S6–3 Uncertainty for aquifer constrained sources;
- S6–4 Uncertainty for hydrology constrained sources;

- S8 Uncertainty of impact of climate change on source yields; and
- S9 Uncertain output from new resource developments.

Demand Related – components D1 to D4

- D1 Accuracy of sub-component data;
- D2 Demand forecast variation;
- D3 Uncertainty of impact of climate change on demand; and
- D4 Uncertain outcome from demand management measures.

Each of the headroom components is assessed for any known uncertainties that fall under its heading. These uncertainties are quantified to give probability distributions of the risk to the supply demand balance. These distributions provide the basis for building a model of the overall risk for any given WRZ. Such a model sums together all the distributions and uses Monte Carlo analysis to produce a final probability distribution of headroom uncertainty for each WRZ. This process is completed at 5 yearly intervals throughout the planning period so that estimated future changes in uncertainty can be incorporated. Such changes include the potential uncertainty in the impact of climate change and/or the decommissioning of a particular source.

The final stage in producing target headroom is to select a value from the output of the analysis which is expressed as a probability distribution for the headroom uncertainty of each WRZ. For example choosing the 90th percentile from the probability distribution of headroom uncertainty means that there is a 10% risk that available supplies will be unable to meet forecast demands plus Target Headroom. As headroom is produced for each year in the planning period a so called ‘glidepath’ of headroom uncertainty can be adopted if different levels of risk are chosen for future years. For this WRMP a constant glidepath of 90% has been chosen throughout the planning period.

6.2 Target headroom

A Monte Carlo risk model has been used to simulate 15,000 iterations from which probability distributions of headroom uncertainty have been generated. The results from this model for the 90th percentile are presented in Table 6.1 and Figure 6.1.

The East WRZ and South WRZ have the largest absolute values of target headroom and exhibit a general upward trend toward the end of the planning period. In contrast the Central WRZ has the smallest absolute values and remains at a roughly constant level throughout the planning period.

WRZ	2008	2012	2017	2022	2027	2032
East	20.30	19.47	19.67	20.38	21.19	22.96
North	4.76	4.73	4.89	5.22	5.55	6.08
Central	2.01	1.98	2.02	2.06	2.12	2.20
West	4.91	4.89	4.90	4.97	5.09	5.34
South	13.47	13.00	13.32	13.90	14.54	15.30
Total	45.45	44.07	44.80	46.52	48.49	51.88

Table 6.1 – Target headroom

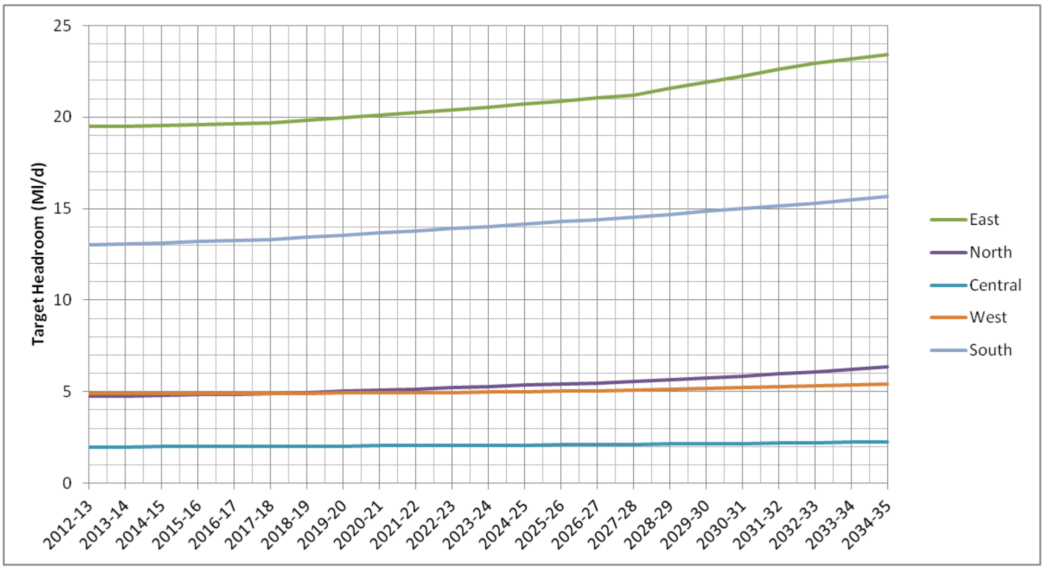

Figure 6.1 – Profiles of target headroom for each WRZ

Absolute values of headroom are often misleading as they are skewed toward the larger WRZs. A more useful indication of relative changes in headroom is shown in Figure 6.2 and Table 6.2 by expressing headroom as a percentage of DI. The Figure shows that North WRZ begins with relatively low target headroom but this increases quite rapidly in the later part of the planning period. In contrast the Central WRZ does not exhibit the same increases as the other zones and ends the planning period with the lowest relative target headroom.

WRZ	2008	2012	2017	2022	2027	2032
East	6.5%	6.4%	6.4%	6.5%	6.6%	7.1%
North	5.8%	5.8%	5.9%	6.2%	6.4%	6.9%
Central	7.1%	6.9%	6.7%	6.6%	6.7%	6.8%
West	7.4%	7.2%	7.0%	6.9%	6.9%	7.1%
South	7.1%	7.0%	6.9%	7.0%	7.2%	7.4%
Total	6.7%	6.6%	6.6%	6.6%	6.8%	7.1%

Table 6.2 – Target headroom as percentage of DI

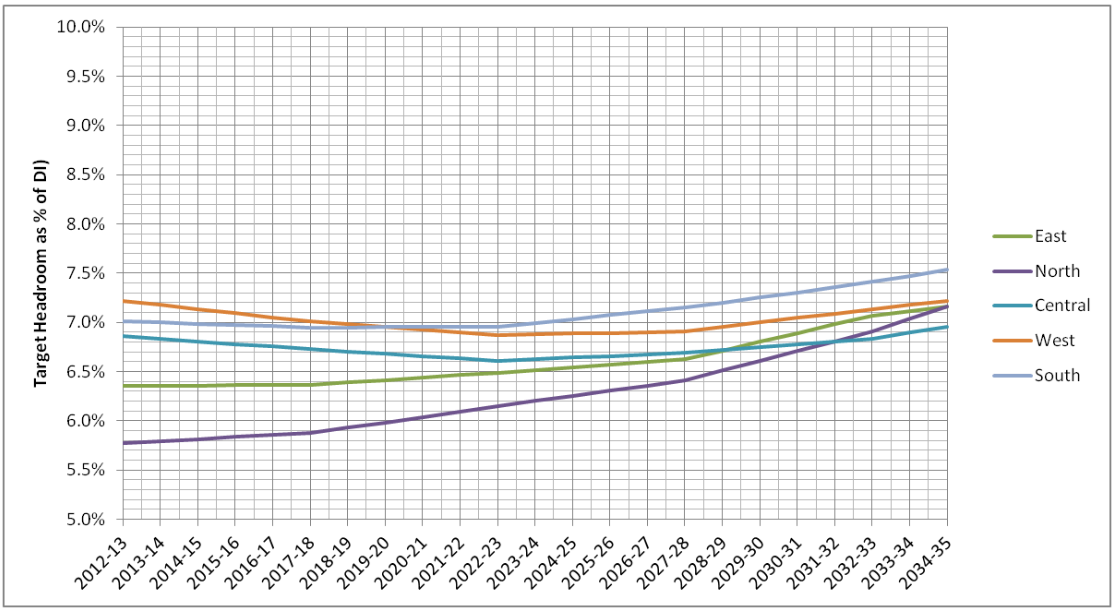

Figure 6.2 – Target headroom as a percentage of DI

In order to manage risk appropriately it is important to understand the sources of uncertainty and their relative magnitudes. Figure 6.3 shows the relative contributions of each of the component categories to overall NI Water target headroom. The main contributors to headroom are on the demand side and relate to the uncertainty around future growth (D2) and implementation of demand management measures (e.g. leakage reduction) (D4).

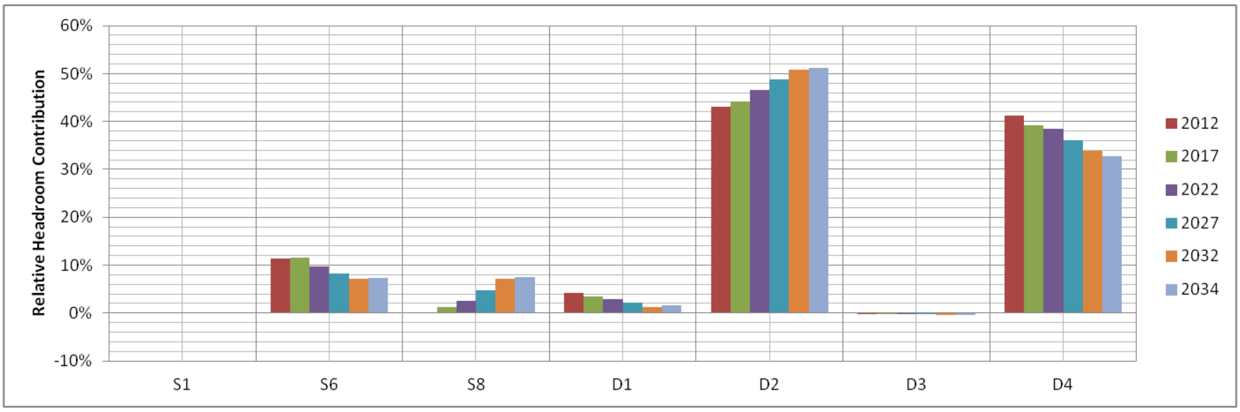

Figure 6.3 – Relative component contributions to total headroom

7. Baseline supply demand balance

The elements discussed in the preceding sections 3 to 6 are combined together to produce the baseline supply demand balance. This provides an indication of the level of surplus or deficit in each WRZ in dry year annual average conditions, assuming continuation of current policies and practices.

If a deficit is identified in a given WRZ then some combination of demand-side and supply-side options will be needed in order to satisfy the deficits and thus ensure security of supplies under the specified design conditions. Either additional supplies will be needed and/or efforts must be made to conserve water through the introduction of demand management options and policies. The optimum solution may actually involve a combination of supply and demand options – known as the “twin track” approach. Another possibility is that water could be imported from a neighbouring WRZ which is in surplus. The options available are discussed in detail in section 8, while the final planning solution is presented in section 9.

It is important to appreciate that these supply demand balances do not represent conditions that might be expected under “normal” years, when demands are lower than the “dry” year demands and when there are ample water resources (so sources would be capable of operating at the limits set out in the abstraction licences). Instead, these supply demand balances represent a particular planning case: the dry year annual average.

Planning for dry years is a prudent, industry-standard approach to ensure security of supplies to customers in relatively unusual, though not extreme, climatic conditions. But the planning condition is for dry years and unconstrained demand (i.e. without any demand restrictions in place), not for the more extreme conditions that would be experienced under drought conditions. Clearly it would not be economic to plan to ensure a surplus in all possible drought conditions – this would result in an excessive and expensive supply system. In a drought, which by its definition is an extreme event, it would be reasonable and prudent for a water undertaker to introduce some form of demand restriction to conserve water. The purpose of the WRMP is to maintain security of supplies in with unconstrained dry year annual average demands.

The baseline supply demand balances presented in Figure 7.1 to Figure 7.5 show the forecast supplies and demands for each WRZ assuming continuation of current policies, with allowances for climate change. The plots show the supplies available as “water available for use” (or WAFU), which is the conjunctive use deployable output of the WRZ minus an allowance for outages and taking into account any bulk imports or exports.

Where demand plus headroom (the planning allowance to account for uncertainty in forecasting) exceeds the projected supplies available, the WRZ is in deficit. Conversely, where projected supplies exceed demand plus headroom there is a surplus.

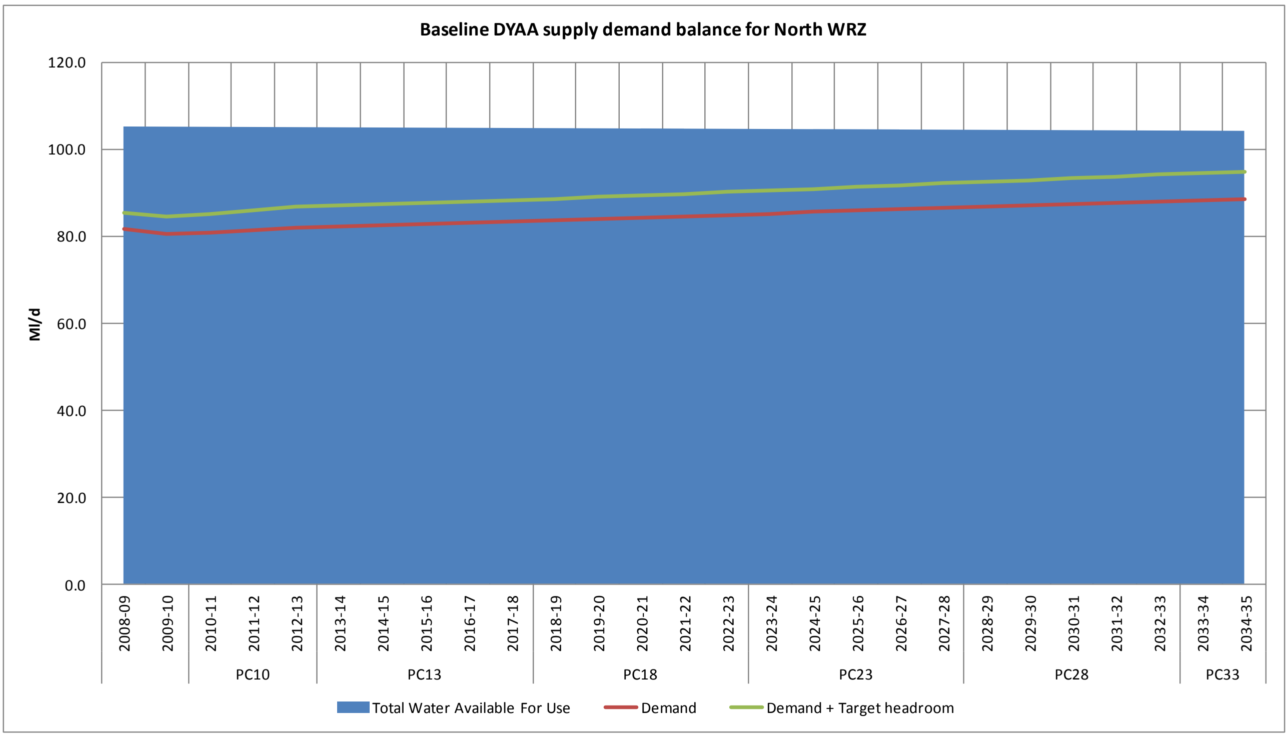

Figure 7.1 – Baseline supply demand balance in the North WRZ

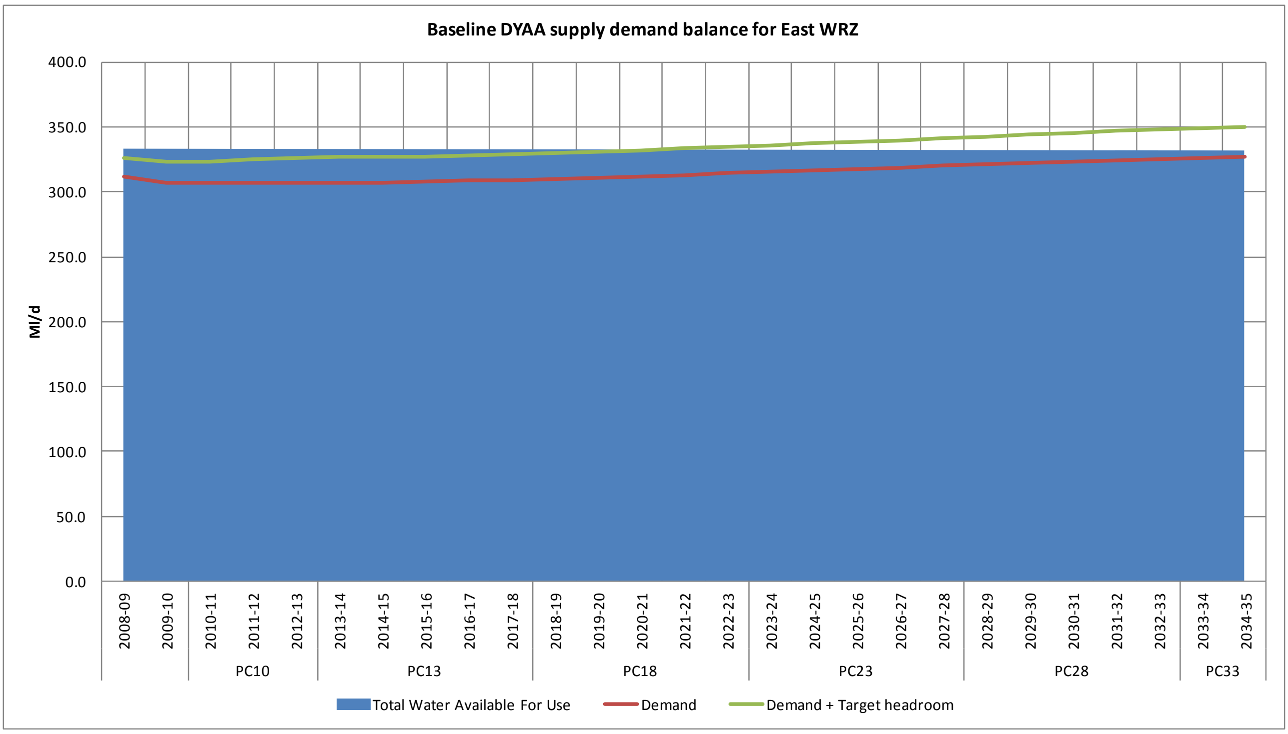

Figure 7.2 – Baseline supply demand balance in the East WRZ

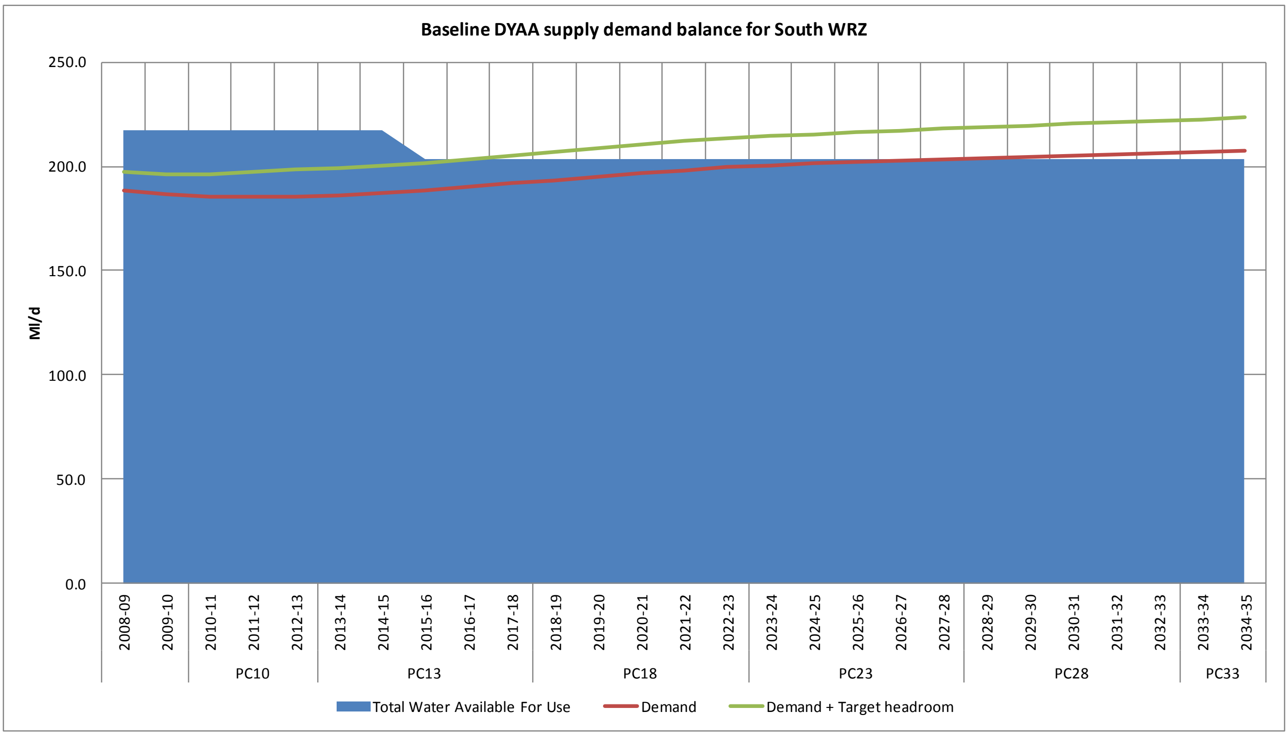

Figure 7.3 – Baseline supply demand balance in the South WRZ

Note that Figure 7.3 shows the impact on WAFU of the decommissioning of Camlough WTW from 2015–16.

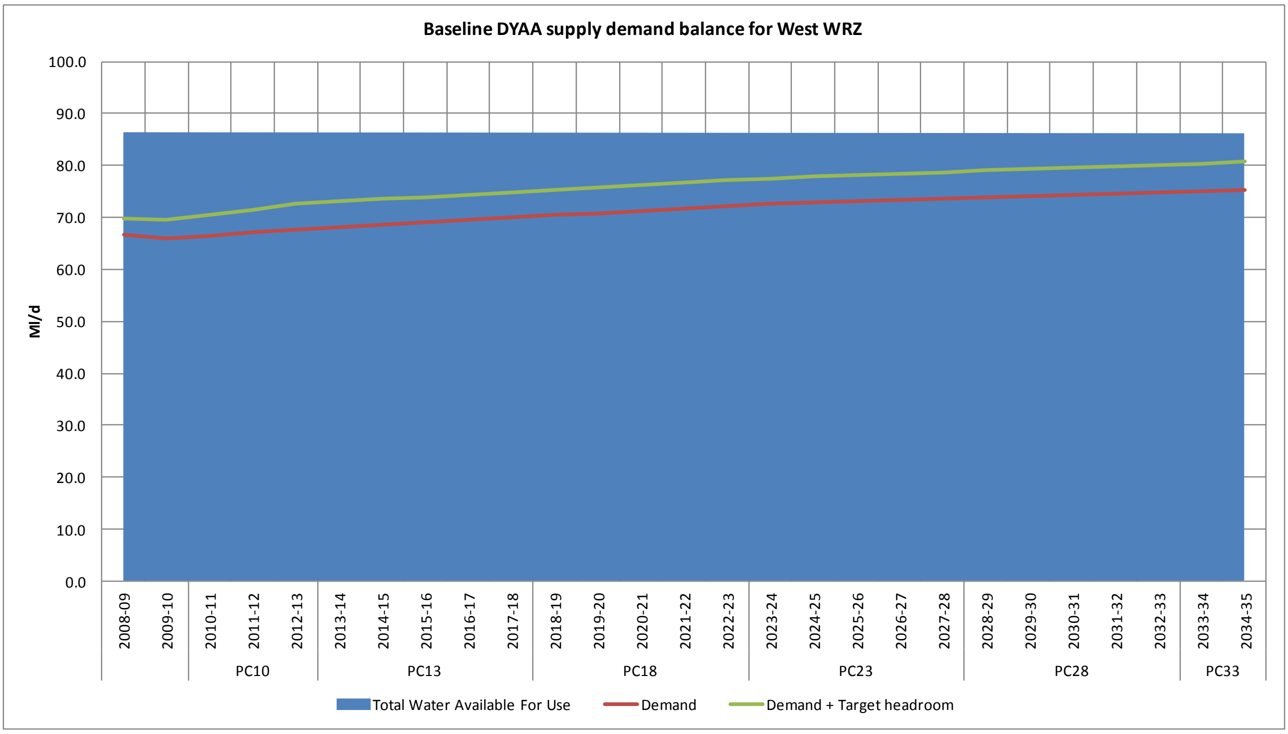

Figure 7.4 – Baseline supply demand balance in the West WRZ

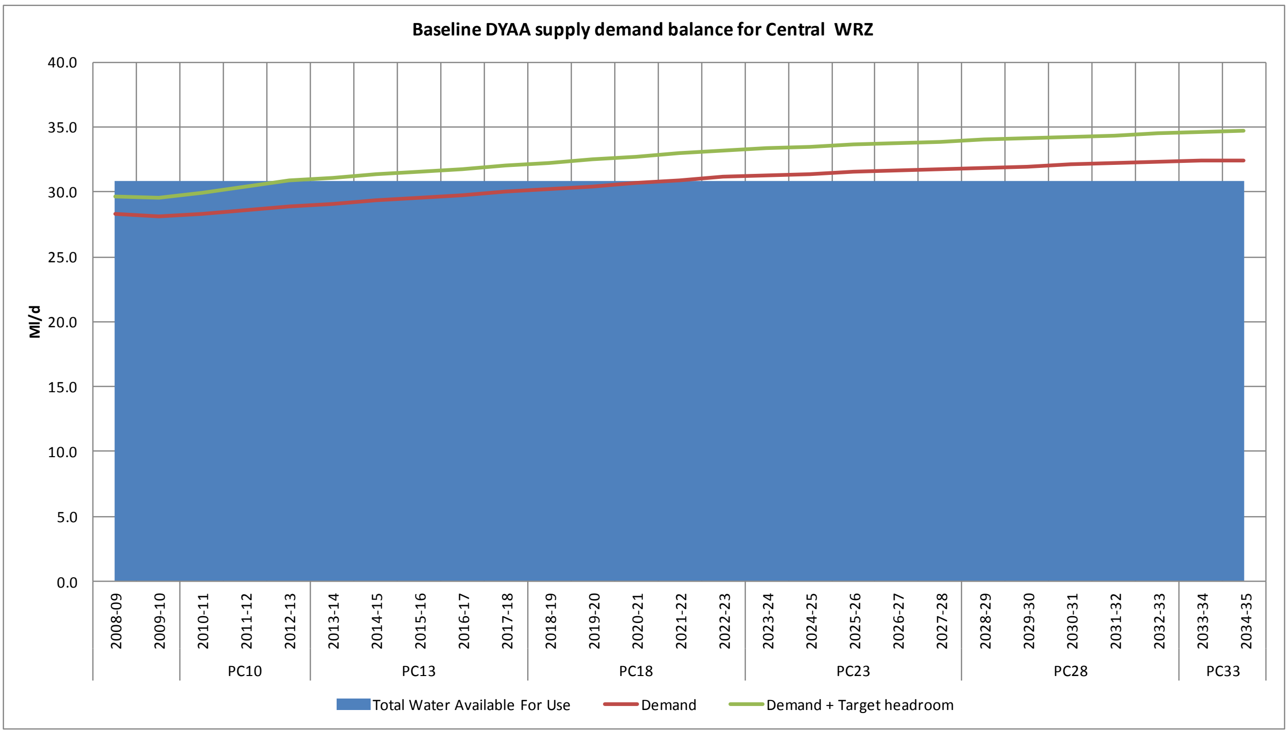

Figure 7.5 – Baseline supply demand balance in the Central WRZ

The step change in water available for use in the South WRZ is due to the decommissioning of Camlough WTW, which was discussed in section 3.

The figures show that there are three WRZs showing a deficit in the baseline supply demand balance during the planning period:

- East WRZ – from 2021–22 onwards;
- South WRZ – from 2016–17 onwards; and
- Central WRZ – from 2013–14 onwards.

Note that the West WRZ supply demand balance had been based on the assumption that the Derg WTW is able to operate at its design capacity even under drought conditions. The wording of the recently issued abstraction licence allows for the implementation of operational arrangements to ensure this assumption is valid. However in order to make additional supplies available within the West WRZ and to provide other operational benefits strategic transfers from neighbouring WRZs should be considered. Recent operational experience has identified the need for additional capacity and operational flexibility in the distribution system of the West WRZ. It is recommended that a feasibility study should be progressed to address security of supplies in the context of the planning and operational conditions included in the new Derg/Strule abstraction licence.

The next stage in the WRMP process is to assess the options available for balancing supply and demand in these WRZs. This may include bulk supplies from the WRZs which are in surplus through the planning period. This is discussed in section 8, before the final planning solution is presented in section 9.

8. Options appraisal

8.1 Approach for options appraisal

The following section of the WRMP sets out the process for identification and appraisal of demand management and supply side options that has been used to derive the final planning solution for NI Water over the planning period from 2010–11 to 2034–35. The options process has followed the Economics of Balancing Supply and Demand (EBSD)[23] approach as required by the DRD planning guidance.

The first stage involved an initial workshop held in October 2009 to identify an unconstrained list of options, attended by key representatives from NI Water and members of the Atkins WRMP, TMM and SEA teams. All potential options were identified for maintaining the supply demand balance, without consideration of cost or environmental constraints, to establish a comprehensive list of unconstrained options.

Following the initial workshop the unconstrained list was circulated to key staff within NI Water for further review and comment, prior to a second workshop held in December 2009. The objective of the second workshop was to identify a feasible list of constrained options to take forward for further consideration, ruling out those options with excessive capital or operating cost and/or environmental impact.

The constrained options were then taken forward for detailed appraisal to derive average incremental and social costs (AISCs) in order to rank the options in term of p/m^3 of water supplied/saved, including an assessment of the environmental and carbon costs associated with each option.

The constrained options were then incorporated into a least cost optimisation investment model to determine the final water resources planning strategy for NI Water over the planning period from 2010–11 to 2034–35. Details of the investment modelling approach and identification of the final strategy are set out in section 9 of this WRMP.

Since the Draft WRMP and the comments on that document received from respondents to the public consultation additional work has been undertaken to refine the components and costs of the various options available to address deficits in the supply demand balance and to refine policy and other assumptions used for the investment model.

This additional work included:

- Characteristics (such as the length and diameter) of strategic transfers were informed by use of the Trunk Mains Model (TMM);
- Leakage reductions and associated costs were provided by NI Water's leakage consultants;
- Leakage targets and dates of implementation have been revised;
- The status of implementation of strategic transfer schemes originally planned for implementation during Planning Period 2013 to 2018 has been updated;
- The status of the decision to decommission Camlough has been reviewed; and
- Revised carbon costs have been published by DECC.

[23] Nera (2002), *The Economics of Balancing Supply and Demand (EBSD)*, UKWIR

8.2 Unconstrained list of options

The unconstrained options established from the initial workshop are listed in Table 8.1. The options not taken forward into detailed appraisal on grounds of excessive cost or environmental impact are shaded. Note that since the Draft WRMP, retaining Camlough has been included as an option for the Final WRMP.

The rationale for ruling out the discounted options is discussed in section 8.2.1.

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Water Resource Zone	Option taken forward to detailed appraisal?
Increase abstraction from existing sources	LN1	***Increase output of Castor Bay WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	South	Yes
	LN2	***Increase output of Castor Bay WTW.*** Abstract additional water from Lough Neagh above the existing licence limit.	30.0	South	No
	LN3	***Increase output from Dunore WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	East	Yes
	LN4	***Increase output from Moyola WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	Central	Yes
	LE1	***Increase output from Killyhevlin WTW.*** Abstract additional water from Lough Erne.	10.0	West	Yes
	FB1	***Increase output from Fofanny WTW.*** Abstract additional water from Lough Island Reavy.	10.0	South	Yes
Refurbish existing sources	CL	***Refurbish Camlough WTW.*** Refurbish Camlough WTW to maintain the existing output capacity of 5 Ml/d. *Note Retaining Camlough was considered for the Final WRMP*	5.0	South	No
New reservoir development	NR	***Construction of new impounding reservoirs for potable water supply.***	10.0	All	No

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Water Resource Zone	Option taken forward to detailed appraisal?
Other supply side options	DS	***Desalination plant for potable supply.***	10.0	East	No
	ER	***Indirect Effluent Reuse***	10.0	East	No
	NA	***New abstraction from lakes or rivers***	10.0	All	No
	AS	***Reinstatement of abandoned sources***	10.0	All	No
Leakage Control (note values updated since Draft WRMP)	LR	***Leakage Reduction***. Further incremental leakage reduction below the revised leakage target of 165.4 Ml/d though active leakage control and pressure management from 2014/15.	Maximum WRZ reduction East: 23 North: 5 Central: 2.5 West: 5.7 South:15		Yes
	SPL1	***Supply pipe repair policy.*** Leakage savings shown as additional reductions from 2014/15 leakage target based on NI Water draft SPL policy November 2011	Maximum of 3.2	All	Yes
Domestic Metering	M1	***Metering Scenario 1.*** Metering of new households and meter optants for pensioners from 2013–14.	7.7	All	Yes
	M2	***Metering Scenario 2***. Metering of new households and meter optants for all domestic customers from 2013–14.	11.2	All	Yes
	M3	***Metering Scenario 3.*** Metering of new households and meter optants for all domestic customers from 2013–14 and metering on change of occupancy.	32.6	All	Yes
	M4	***Metering Scenario 4.*** Metering of new households and meter optants for all domestic customers from 2013–14 and metering on change of occupancy to 2025–26. Compulsory metering from 2025–26 to achieve 90% meter	37.7	All	Yes

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Water Resource Zone	Option taken forward to detailed appraisal?
		penetration by 2034–35.			
Water Efficiency	WE1	***Households water audits***	0.2	All	Yes
	WE2	***Targeted non household water audits***	0.5	All	Yes
	WE3	***Additional education talks at schools***	0.4	All	Yes
Planning period 2013–18 Strategic transfers	ST1 (JR 342)	***Castor Bay to Belfast Phase 3***	Strategic transfer	South to East	Yes
	ST2 (JG035)	***Castor Bay to Newry*** ***Phase 2A – Ballydougan to Carnbane*** ***Phase 2B – Carnbane to Camlough & Crieve***	Strategic transfer	South	Yes
	ST3 (JL715)	***Carmoney to Strabane***	Strategic transfer	North to West	Yes
	ST4 (JL713)	***Killyhevlin to Lough Bradan***	Strategic transfer	West	Yes
	ST5 (JF017)	***Glencuil to Cabragh***	Strategic transfer	West to South	Yes
Other transfers	TR	***Other transfers identified by the TMM team that could maintain the supply demand balance***	Strategic transfer	all	Yes

Table 8.1 – List of Unconstrained Options

8.2.1 Discounted Options

8.2.1.1 Increase in output from Castor Bay above the existing Lough Neagh licensed quantity (LN2)

The existing abstraction licence for Lough Neagh authorises NI Water to abstract up to a total of 392 Ml/d from three locations around the lough; Castor Bay, Dunore and Moyola. The licence also specifies the division of abstraction between the three locations in terms of the maximum volumes that can be abstracted at each of the three locations. The arithmetic total of the three authorised abstractions is 363 Ml/d. After allowing for treatment works losses, this gives an aggregate maximum output of 346 Ml/d from the three WTW, which are operated under the PPP scheme.

The total abstraction limit of 392 Ml/d is 29 Ml/d greater than the arithmetic total of 363 Ml/d of the individual abstraction limits for each of the three WTWs. Discussions between NI Water and NIEA suggest that any increase in the authorised volumes for abstraction at one or more of the three individual locations, even if the aggregate total remained less than the current licence limit of 392 Ml/d, would require NI Water to submit a formal request with appropriate supporting information for the licence to be reviewed. NIEA would then undertake a full determination of the application for up to an additional 29 Ml/d to be abstracted from either Moyola, or Castor Bay or Dunore Point, or split between these three locations.

When identifying the initial list of options, an option was included for an additional 30 Ml/d output from Castor Bay WTW (Option LN2), which would require abstraction above the total Lough Neagh licensed quantity of 392 Ml/d. On development of the supply demand balance, it became apparent that such a large incremental increase in capacity would not be required before 2034–35 at the earliest. Option LN2 was therefore discounted and was not taken forward into detailed appraisal. The 10 Ml/d enhancement scheme for Castor Bay was however retained together with 10 Ml/d enhancement schemes for Dunore and Moyola WTW.

8.2.1.2 Retention of Camlough WTW (CL)

As a result of the consultation process, the option of retaining the Camlough WTW has been considered as an option for maintaining the supply demand balance in South WRZ; see section 8.4.1.6.

8.2.1.3 New Impounding Reservoirs (NR)

The viability of constructing new impounding reservoirs at potential sites such as at Glendergan and Glenedra as options to maintain the supply demand balance was discussed at the option workshops held on October 2009 and December 2009.

New reservoir schemes would involve the flooding of existing valleys with associated high impacts on the environment and local communities. Construction of new reservoirs would generally be more expensive than abstracting additional water from existing NI Water sources, principally due to the construction of the new reservoir embankment and additional distribution costs to the point of supply.

In view of the high environmental impact and high construction cost of impounding reservoirs, and the current availability of water from other lower cost options to maintain the supply demand balance, including additional abstraction from existing sources, a decision was taken by NI Water to rule out impounding reservoirs and not to take forward this option into the detailed options appraisal. This approach was also supported by the SEA team on grounds of potential high environmental impact of reservoir construction.

8.2.1.4 Desalination (DS)

Desalination to remove dissolved salt concentrations from brackish water or seawater is commonly used in many countries around the world for potable water supply, particularly in arid areas where other supply options are limited. Whilst there have been advances in desalination technology in recent years, including the development of the reverse osmosis process where water is passed through membranes under high pressure to remove dissolved salt, desalination still requires large amounts of energy and expensive infrastructure, making it very costly compared to the use of fresh water from rivers or lakes.

Desalination may be a longer term option for NI Water but after other available sources have been fully utilised. Desalination is not considered to be an economically viable option for consideration over the planning period from 2010–11 to 2034–35. It is likely that any desalination plant in Northern Ireland would be sited on the coast and close to an existing power station such as Kilroot or Ballylumford in order to minimise power supply costs. The power demand for a 10 Ml/d seawater plant would be in the order of 5MW of energy, with associated high running costs and high carbon impact. Treated water from the desalination plant would be pumped inland to areas of high demand, through the installation of new treated water transfer mains. Concentrated brine resulting from the desalination treatment process would also need to be returned to the sea through a new discharge pipeline. Such discharges can lead to localised environmental impacts unless adequate brine dispersal capacity is provided.

The viability of desalination for inclusion within the NI Water Draft WRMP was discussed at the option workshops held on October 2009 and December 2009. Based on the high capital and operating cost and high environmental impact of this process, and the current availability of water from other lower cost options in Northern Ireland including additional abstraction from existing sources, a decision was taken by NI Water to rule out desalination before 2034–35 and not to take this option forward to the detailed options appraisal. This approach was also supported by the SEA team on grounds of the potential high environmental impacts associated with desalination.

8.2.1.5 Effluent Reuse (ER)

Effluent reuse has been considered by many water companies in England as part of their PR09 WRMP submissions and particularly by companies in water stressed areas of South East England. Such options typically comprise the transfer of treated wastewater effluent to augment river flows and to allow additional abstraction for potable water supply. Typically, options consider the transfer of effluent from coastal Wastewater Treatment Works (WWTWs), where effluent discharge is not already required to support inland water flows.

The infrastructure required for effluent reuse schemes can include tertiary treatment of the WWTW effluent in order to meet water quality requirements of the receiving watercourse, effluent transfer pipelines and pumping stations, additional potable water treatment capacity and new potable water distribution works. For Northern Ireland it would be feasible to transfer treated water effluent from existing WWTWs located on Belfast Lough to augment water available for abstraction within Lough Neagh.

The viability of effluent reuse for inclusion within the NI Water Draft WRMP was discussed at the optioneering workshops held on October 2009 and December 2009. In view of the high cost of effluent reuse schemes, the potential environmental impact on water quality and the current availability of water from other lower cost options to maintain the supply demand balance, including additional abstraction from existing sources, a decision was taken by NI Water to rule out effluent reuse before 2034–35 and not to take this option forward to the detailed options appraisal. In addition NI Water also considers that the concept of effluent reuse would not be acceptable to its customers when other alternative options are available. This approach was also supported by the SEA team on grounds of the potential environmental impact of effluent reuse, in terms of water quality impacts on the receiving watercourse and additional pumping costs associated with the transfer of treated effluent over long distances.

8.2.1.6 New River/Lough abstractions (NA)

Construction of new abstraction works from either inland river or lough sources has been ruled out on cost grounds and not taken forward into the detailed appraisal stage. New abstraction locations would be more expensive than enhancing output from existing NI Water sources due to the requirement for additional land purchase and distribution works. This approach was also supported by the SEA team on grounds of additional environmental impact of new abstraction locations compared to development of existing sites.

8.2.1.7 Reinstatement of abandoned small sources (AS)

As part of the Water Resources Strategy 2002 NI Water identified a number of existing small water sources and associated WTWs for closure on cost efficiency grounds. The viability of reinstating these sources as part of the updated WRMP to 2034–35 was discussed at the option workshops held on October 2009 and December 2009. It was concluded that reinstatement of such sources is not viable, as NI Water has already demonstrated as part of the WRS 2002 that maintaining these sources is uneconomic compared to other options. NI Water also has a policy of surrendering abstraction licences for abandoned sources.

Reinstatement of small abandoned sources is therefore not considered as a viable option for consideration within the WRMP. Consequently this option has been ruled out by NI Water and the option has not been taken forward to the detailed appraisal stage.

8.3 Constrained list of options

The constrained options as identified at the second options workshop in December 2009 are set out in Table 8.2. Descriptions of each constrained option are provided under section 8.4.

It should be noted that the constrained option list includes a number of additional water transfer schemes including mains reinforcement between Ballinrees and Altnahinch, and transfers to support the Central WRZ (Options TR1 to TR4). These schemes were identified after the second options workshop, based on information provided from the TMM team, and have been added to the constrained options list as shown in Table 8.2.

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Resource Zone
Increase abstraction from existing sources	LN1	***Increase output of Castor Bay WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	South
	LN3	***Increase output from Dunore WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	East
	LN4	***Increase output from Moyola WTW.*** Abstract additional water from Lough Neagh within the existing licence limit.	10.0	Central
	LE1	***Increase output from Killyhevlin WTW***. Abstract additional water from Lough Erne.	10.0	West
	FB1	***Increase output from Fofanny WTW.*** Abstract additional water from Lough Island Reavy.	10.0	South
Refurbish existing sources	CL	***Refurbish Camlough WTW.*** Refurbish Camlough WTW to maintain the existing output capacity of 5 Ml/d.	Magnitude depends on implementation of Castor Bay to Newry Phase 2A (JG035)	South

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Resource Zone
Leakage Control (note values updated since Draft WRMP)	LR	***Leakage Reduction***. Further incremental leakage reduction below the revised leakage target of 165.4 Ml/d though active leakage control and pressure management from 2014/15.	Maximum WRZ reduction East: 23 North: 5 Central: 2.5 West: 5.7 South:15	
	SPL1	***Supply pipe repair policy.*** Leakage savings shown as additional reductions from 2014/15 leakage target based on NI Water draft SPL policy November 2011	Maximum of 3.2	All
Domestic Metering (note that under current powers domestic metering is a theoretical option only)	M1	***Metering Scenario 1.*** Metering of new households and meter optants for pensioners from 2013–14.	7.7	All
	M2	***Metering Scenario 2***. Metering of new households and meter optants for all domestic customers from 2013–14.	11.2	All
	M3	***Metering Scenario 3.*** Metering of new households and meter optants for all domestic customers from 2013–14 and metering on change of occupancy.	32.6	All
	M4	***Metering Scenario 4.*** Metering of new households and meter optants for all domestic customers from 2013–14 and metering on change of occupancy to 2025–26. Compulsory metering from 2025–26 to achieve 90% meter penetration by 2034–35.	37.7	All
Water Efficiency	WE1	***Households water audits***	0.2	All
	WE2	***Targeted non household water audits***	0.5	All
	WE3	***Additional education talks at schools***	0.4	All
Planning period **2013–18 Strategic transfers**	ST1 (JR 342)	***Castor Bay to Belfast Phase 3***	Strategic transfer	South to East
	ST2 (JG035)	***Castor Bay to Newry*** ***Phase 2A – Ballydougan to Carnbane*** ***Phase 2B – Carnbane to Camlough & Crieve***	Strategic transfer	South
	ST3 (JL715)	***Carmoney to Strabane***	Strategic transfer	North to West
	ST4 (JL713)	***Killyhevlin to Lough Bradan***	Strategic transfer	West

Option Category	Option Reference	Description	Additional Yield/ saving (Ml/d)	Resource Zone
Other transfers	TR1	***Mains reinforcement between Ballinrees and Altnahinch*** Note this scheme has been implemented as a Single Source Scheme under the Major Incident Mitigation Project	Strategic Transfer	North
	TR2	***2 Ml/d transfer from North to Central WRZ***	Strategic Transfer	North to Central
	TR3	***2 Ml/d transfer from South to Central WRZ***	Strategic Transfer	South to Central
	TR4	***2 Ml/d transfer from East to Central WRZ***	Strategic Transfer	East to Central

Table 8.2 – List of Constrained Options

Note: the domestic metering options (M1 to M4) are shown as shaded cells because under current powers these are theoretical options only

8.4 Constrained option description and assessment

8.4.1 Increase abstraction from existing sources

Based on the preliminary supply demand balances derived for each WRZ in December 2009, forecast deficits of 5–10 Ml/d were identified at WRZ level at the end of the planning period in 2034–35. In view of the magnitude of the supply demand balance deficits, incremental increases of 10 Ml/d were considered for the identified enhancement options at Castor Bay, Moyola, Dunore, Fofanny and Killyhevlin.

8.4.1.1 Option LN1: Increase output from Castor Bay WTW

Option LN1 comprises the expansion of the existing Castor Bay WTW to provide an additional 10 Ml/d of treated water capacity to meet demand growth within the South and East WRZs. The existing works was upgraded in 2007 as part of the PPP scheme (Project Alpha) and has a maximum delivery capacity of 147 Ml/d. The enhancement option would increase the delivery capacity of the works from 147 Ml/d to 157 Ml/d. The works is located on the south east shore of Lough Neagh about 2 km north of Liscorran. There is land available within the existing WTW site boundary and no additional land purchase would be required for the works expansion.

For the proposed 10 Ml/d upgrade to Castor Bay WTW, new treatment works infrastructure would be required to provide the increased capacity. In deriving the capital cost estimate for this option it has been assumed that a new 10 Ml/d treatment stream would be provided using the same treatment processes of the existing works including: coagulation and flocculation; DAF (dissolved air filtration) units; manganese contactors; GAC (granulated activated carbon) absorbers; disinfection works; and washwater and sludge disposal plant.

It has been assumed that the existing inlet works for Castor Bay WTW would have sufficient existing capacity to transfer an additional 10 Ml/d of raw water to the works. Further information regarding any potentially increased use of Lough Neagh is included in section 8.5.1, the SEA Environmental Report and SEA statement.

Through discussion with the TMM team it has been assumed that the existing Castor Bay works has sufficient distribution capacity to deliver an additional 10 Ml/d of water into supply after 2013, following completion of the PC10 transfer schemes for Castor Bay to Newry Phase 1, Castor Bay to Dungannon and Castor Bay to Belfast (Ph2).

8.4.1.2 Option LN3: Increase output from Dunore WTW

Option LN3 comprises the expansion of the existing Dunore WTW to provide an additional 10 Ml/d of treated water capacity to meet demand growth within the East WRZ. The existing works was upgraded in 2007 as part of the PPP scheme (Project Alpha) and has a maximum delivery capacity of 180 Ml/d. The enhancement option would increase the delivery capacity of the works from 180 Ml/d to 190 Ml/d. The works is located on the north east shore of Lough Neagh some 5 km south of Antrim. There is land available within the existing WTW site boundary and no additional land purchase would be required for the works expansion.

For the proposed 10 Ml/d upgrade to Dunore WTW, new treatment works infrastructure would be required to provide the increased capacity. In deriving the capital cost estimate for this option it has been assumed that a new 10 Ml/d treatment stream would be provided using the same treatment processes of the existing works including: coagulation and flocculation; DAF units; manganese contactors; GAC absorbers; disinfection works; and washwater and sludge disposal plant.

It has been assumed that the existing inlet works for Dunore WTW would have sufficient existing capacity to transfer an additional 10 Ml/d of raw water to the works.

Through discussion with the TMM team it has been assumed that the existing Dunore works has sufficient distribution capacity to deliver an additional 10 Ml/d of water into supply.

8.4.1.3 Option LN4: Increase output from Moyola WTW

Option LN4 comprises the expansion of the existing Moyola WTW to provide an additional 10 Ml/d of treated water capacity to meet demand growth within the Central WRZ. The existing works was upgraded in 2007 as part of the PPP scheme (Project Alpha) and has a maximum delivery capacity of 19 Ml/d. The enhancement option would increase the delivery capacity of the works from 19 Ml/d to 29 Ml/d. The works is located at the NNW corner of Lough Neagh between Ballyronan and Toome. There is no spare land available within the existing WTWs boundary and new land would need to be purchased adjacent to the western or southern boundary of the existing site, approximately 100 m x 100 m in plan area.

For the proposed 10 Ml/d upgrade to Moyola WTW, new treatment works infrastructure would be required to provide the increased capacity. In deriving the capital cost estimate for this option it has been assumed that a new 10 Ml/d treatment stream would be provided using the same treatment processes of the existing works including: coagulation and flocculation; DAF units; manganese contactors; GAC absorbers; disinfection works; and washwater and sludge disposal plant.

It has been assumed that the existing inlet works at Moyola would need to be upgraded to allow an additional 10 Ml/d abstraction from Lough Neagh. Through discussion with the trunk main modelling team it has also been assumed that additional distribution works would also be required to allow transfer of an additional 10 Ml/d of treated water into supply. It has been assumed that the existing high lift pumping station would require upgrading to provide the additional increase in flow capacity and that the existing delivery main between Moyola WTW and Mullaghboy SR would require replacement with a new 500 mm diameter 7.5 km pipeline to deliver 29 Ml/d.

8.4.1.4 Option LE1: Increase output from Killyhevlin WTW

Option LE1 comprises the expansion of the existing Killyhevlin WTW to provide an additional 10 Ml/d of treated water capacity to meet demand growth within the West WRZ. The existing works was upgraded in 1997, which involved the installation of new clarifiers and sand/GAC rapid gravity filters which increased the maximum works capacity to 35 Ml/d. The works is located on the banks of the Upper Lough Erne. There is no spare land available within the existing WTWs boundary and new land would need to be purchased adjacent to the boundary of the existing site, approximately 100 m x 100 m in plan area.

For the proposed 10 Ml/d upgrade to Killyhevlin WTW, new treatment works infrastructure would be required to provide the increased capacity. In deriving the capital cost estimate for this option it has been assumed that a new 10 Ml/d treatment stream would be provided including: coagulation and flocculation; DAF units; manganese contactors; GAC absorbers; disinfection works; and washwater and sludge disposal plant.

It has been assumed that the existing inlet works at Killyhevlin would need to be upgraded to allow an additional 10 Ml/d abstraction from Lough Erne. Through discussion with the trunk main modelling team it has also been assumed that additional distribution works would be required to allow transfer of an additional 10 Ml/d of treated water into supply. For the purposes of the options appraisal it has been assumed that the existing high lift pumping station would require upgrading to provide the additional increase in flow capacity. An allowance for 7.5 km of 500 mm diameter trunk main has also been included in the cost estimate.

8.4.1.5 Option FB1: Increase output from Fofanny WTW

Option FB1 comprises additional raw water abstraction from Lough Island Reavy for transfer and treatment at Fofanny WTW. The option would provide an additional 10 Ml/d of treated water to meet demand growth within the South and East WRZs. The existing abstraction licence at Lough Island Reavy is currently under-utilised due to transfer constraints between Lough Island Reavy and the Drumaroad and Fofanny WTWs.

The existing licence quantity at Lough Island Reavy is 40 Ml/d. Currently a maximum of approximately 20 Ml/d can be pumped to Fofanny WTW, which lies approximately 5 km to the south west of the lough, and around 7 Ml/d to Drumaroad (about 15 km to the north east). Hence only around 27 Ml/d of the full licence quantity can be abstracted from the lough, leaving an additional 13 Ml/d that could be taken within the existing licence limit.

For this option it has been assumed that an additional 10 Ml/d could be abstracted from the lough. The additional water would be transferred through a new pipeline to Fofanny WTW increasing the Fofanny transfer from 20 Ml/d to 30 Ml/d. Total abstraction assuming 7 Ml/d to Drumaroad would be around 37 Ml/d, which is within the existing licence quantity.

It has been assumed for the purposes of the options appraisal that a new inlet works would be required at Lough Island Reavy to abstract an additional 10 Ml/d, comprising a new inlet structure, raw water pumping station and 400 mm diameter transfer main to Fofanny WTW. It has also been assumed that the option would require a new 10 Ml/d treatment stream at Fofanny WTW, including: coagulation and flocculation; DAF units; manganese contactors; GAC absorbers; disinfection works; and washwater and sludge disposal plant.

Fofanny WTW is located within an area of outstanding natural beauty and all treatment buildings completed as part of a recent upgrade to the works were partly buried to reduce visual impact. An allowance for additional landscaping works has therefore been included in the cost estimate. Through discussion with the TMM team it has been assumed that additional water provided by this option would be supplied within the Newry area. Allowance for a 4 km 400 mm distribution main has been included in the cost estimate.

8.4.1.6 Option CL: Reverse decision to decommission Camlough

Camlough WTW is located just off the A25 Newry to Camlough road on the outskirts of Newry. The works treats raw water abstracted from the Camlough Lough, which lies some 4 km to the south west of the WTW. The WTW supplies Camlough, Bessbrook and the western side of Newry. The configuration of the present works is the result of a series of refurbishments which culminated in a major refurbishment carried out in 1995. The WTW has a maximum output capacity of 5 Ml/d.

Although the WTW currently meets EC water quality standards, the WRS 2002 recommended that the works should be decommissioned on grounds of cost efficiency. NI Water currently plans to decommission the WTW in 2015.

In addition to the deteriorating condition of the works and high operating costs, NI Water also has concerns over the long term maintenance of the Camlough embankment which is not owned by NI Water. The Company is concerned that the supply of raw water from this source could be put at risk if the embankment is not properly maintained. In view of the risk of interruptions to the raw water supply on the reliability of the future operation of Camlough WTW, and the significant expenditure that would be required to modernise the existing works, NI Water did not consider that retention of Camlough WTW was an appropriate option to provide sufficient security of supply to maintain the supply demand balance over the planning period. Additional work has been undertaken since the Draft WRMP to estimates the costs that would be required to maintain the WTW and to undertake the remedial and maintenance works required at the embankment.

Within the baseline supply demand balance it has been assumed that Camlough WTW will be taken out of service during planning period 2013–18.

8.4.2 Leakage Control

8.4.2.1 Option LR: Leakage Reduction

For the Draft WRMP the baseline supply demand balance assumed that NI Water would achieve the then PC10 WRZ leakage target of 166 Ml/d by 2012–13. Since the Draft WRMP, additional work on leakage reductions and the associated costs has been undertaken, and a revised WRZ leakage target of 165.4 Ml/d to be met by 2014–15 has been discussed with NIAUR. The forecast reduction in leakage in each of the five WRZs from 2008–09 to 2014–15 has been based on updated leakage cost curves developed for NI Water by Crowder Consulting[24]. The leakage curves were derived in Crowder's short run economic level of leakage (ELL) modelling work carried out for NI Water in 2011 and have been prepared for each of the five WRZs.

It has been assumed that leakage effort will target those zones with higher initial leakage levels in order to obtain the least cost leakage programme over the PC10 period. As can be seen from Table 8.3 this analysis has shown that the majority of leakage reduction during PC10 and the start of planning period 2013–18 to achieve the 165.4 Ml/d leakage target should be concentrated in the South and East WRZs, with smaller reductions in the Central WRZ. Any reductions in leakage below the 165.4 Ml/d target will provide additional actual headroom in the supply-demand balance.

[24] Crowder Consulting (Oct 2009), *Economic level of leakage report and 2011 update*

Water Resource Zone	Total leakage AIR09 (2008/9) (Ml/d)	Target Total leakage (2014/15) (Ml/d)	Reduction in leakage to meet target (Ml/d)
East	76.39	70.20	6.19
North	15.50	15.50	-
Central	8.43	8.37	0.06
West	20.13	20.13	-
South	60.47	51.20	9.27
Company	180.92	165.40	15.52

Table 8.3 – Total leakage

The preliminary forecasts and target leakage used for the Draft WRMP have been updated for the Final WRMP following discussion with NIAUR.

For the purposes of the options appraisal, further incremental reductions in total leakage below the 165.40 Ml/d target for 2014–15 have been considered in order that longer term leakage reductions can be evaluated against other options for maintaining the supply demand balance. Further reductions in leakage have been assumed to be available from the start of 2015–16, in increments of 0.25 Ml/d, 0.5 Ml/d, 1 Ml/d, and then further additional steps of 1 Ml/d. Cost estimates for these increments in leakage reduction have been based on the leakage cost curves (Including carbon costs) for active leakage control and pressure management as provided by Crowder Consulting in October 2011.

8.4.2.2 Option SPL1: Free Supply Pipe Repair Policy

In England and Wales, where water undertakers are commercially funded, facilities (with variations between companies) for free supply pipe repairs or subsidised replacement of supply pipes have been available to customers for a number of years. There may be potential for achieving savings in supply pipe leakage through the implementation in Northern Ireland of similar repair policies; supply pipe leakage has therefore been considered as an option for this WRMP.

NI Water is majority funded by the NI Executive and is not currently funded to provide a free repair or a subsidised replacement service of customer supply pipes. In order to tackle supply pipe leakage the Company operates a Leakage Notice Procedure. Under this procedure customers at a property where a supply pipe leak has been identified receive a 28 day notice. The notice informs the customer that there is a leak and that it is the customer's responsibility to arrange for its repair. If after 28 days the leak has not been repaired customers are issued with a letter informing them that NI Water will repair the leak at the customer's expense.

Crowder Consulting has undertaken a review for NI Water to investigate the possible impact of introducing a free and/or subsidised supply pipe repair policy. Initial work has assessed the potential reductions in supply pipe leakage that could be achieved from current levels together with the associated costs. Estimates of the magnitude of leakage reductions are based on a number of (often generic) assumptions, supported by local data where available. Over time it is expected improved local data will mean that uncertainties in the magnitude of the potential reductions will fall and hence a better assessment of associated costs can be determined.

The most recent work shows that previous estimates had been too optimistic; the supply pipe leakage repair options used for the Final WRMP now have higher cost and deliver even more modest reductions in leakage. Supply pipe leakage repair options were not selected for the Draft WRMP, so it is not surprising that they have not been selected for the Final WRMP. The practical implementation of such a scheme would also require changes to the funding and regulatory regime.

8.4.3 Domestic Metering

Domestic customers in Northern Ireland are not charged directly for their water use.

For the purposes of the Draft WRMP a number of domestic metering scenarios were developed to investigate the impact of metering on the supply demand balance and whether metering could form part of NI Water's least cost development plan to 2034–35. It is important to note that NI Water currently does not have the necessary powers to implement domestic metering, so these cases must be regarded as potential scenarios only.

8.4.3.1 M1: Metering Scenario 1

Scenario M1 assumes that all new domestic properties will be metered and charged at a volumetric rate from 2013–14 onwards, and that all pensioners can opt for a measured supply. These powers would be available to NI Water under the draft charging scheme should this be introduced in future. Assumptions regarding the take up rate and water savings for this scenario are as follows:

- Meters installed on all new households from 2013–14 onwards;
- Pensioners have the right to opt for a measured supply from 2013–14 onwards. Approximately 15% of the NI Water population is estimated to be aged 65 or over according to NISRA data. Based on meter optant rates in England and Wales, it has been assumed that 1% of pensioners would opt for a new meter in each year of the planning period; and
- Metering provides a 10% saving in average consumption.

These assumptions result in a forecast meter penetration rate by 2034–35 of approximately 24% of all households.

8.4.3.2 M2: Metering Scenario 2

Scenario M2 assumes that all new domestic properties will be metered and charged at a volumetric rate from 2013–14 onwards, and that all domestic customers can opt for a measured supply (not just pensioners). This scenario would require additional legislative changes to the draft charging scheme. Assumptions regarding the take up rate and water savings for this scenario are as follows:

- Meters installed on all new households from 2013–14 onwards;
- Pensioners have the right to opt for a measured supply from 2013–14 onwards. Approximately 15% of the NI Water population is estimated to be aged 65 or over according to NISRA data. Based on meter optant rates in England and Wales, it has been assumed that 1% of pensioners would opt for a new meter in each year of the planning period;

- All domestic customers can opt for a measured supply from 2018–19 onwards. Based on meter optant rates in England and Wales, it has been assumed that 1% of customers would opt for a new meter in each year of the planning period; and
- Metering provides a 10% saving in average consumption.

These assumptions result in a forecast meter penetration rate by 2034–35 of approximately 48% of all households.

8.4.3.3 Option M3: Metering Scenario 3

Scenario M3 assumes all new domestic properties will be metered and charged at a volumetric rate from 2013–14 onwards, all domestic customers can opt for a measured supply (not just pensioners), plus an element of selective metering on change of occupancy. This scenario would require additional legislative changes to the draft charging scheme. Assumptions regarding the take up rate and water savings for this scenario are as follows:

- Meters installed on all new households from 2013–14 onwards;
- Pensioners have the right to opt for a measured supply from 2013–14 onwards. Approximately 15% of the NI Water population is estimated to be aged 65 or over based on NISRA data. Based on meter optant rates in England and Wales, it has been assumed that 1% of pensioners would opt for a new meter in each year of the planning period;
- All other domestic customers can opt for a measured supply from 2018–19 onwards. Based on meter optant rates in England and Wales, it has been assumed that 1% of customers would opt for a new meter in each year of the planning period;
- NI Water may meter properties on change of occupancy from 2018–19 onwards. It is assumed that customers move house once every 12 years on average and that 80% of available properties would be metered; and
- Metering provides a 10% saving in average consumption.

These assumptions result in a forecast meter penetration rate by 2034–35 of approximately 70% of all households.

8.4.3.4 Option M4: Metering Scenario 4

Scenario M4 assumes all new domestic properties will be metered and charged at a volumetric rate from 2013–14 onwards, all domestic customers can opt for a measured supply (not just pensioners), selective metering on change of occupancy and compulsory metering to achieve 90% meter penetration by 2034–35. This scenario would require additional legislative changes to the draft charging scheme. Assumptions regarding the take up rate and water savings for this scenario are as follows:

- Meters installed on all new households from 2013–14 onwards;
- Pensioners have the right to opt for a measured supply from 2013–14 to 2025–26. Approximately 15% of the NI Water population is estimated to be aged 65 or over according to NISRA data. Based on meter optant rates in England and Wales, it has been assumed that 1% of pensioners would opt for a new meter in each year of the planning period;
- All other domestic customers can opt for a measured supply from 2018–19 to 2025–26. Based on meter optant rates in England and Wales, it has been assumed that 1% of customers would opt for a new meter in each year of the planning period;

- NI Water may meter properties on change of occupancy from 2018–19 to 2025–26. It is assumed that customers on average move house once every 12 years and that 80% of available properties would be metered;
- Compulsory metering programme from 2025–26 to 2034–35, replacing meter optant and change of occupancy policies;
- Metering provides a 10% saving in average consumption;

These assumptions result in a forecast meter penetration rate by 2034–35 of approximately 90% of all households.

8.4.4 Water Efficiency

NI Water's existing water efficiency policy encourages the efficient use of water amongst its household and non-household customers, through information leaflets, the Company's website, and at all Company events. NI Water places particular focus on educating its customers at all levels including school children through school visits.

NI Water has undertaken a number of water efficiency initiatives, including work with IKEA to encourage customers to carry out home water audits. NI Water's home water audit and water efficiency information packs have also been distributed during household visits by the Energy Savings Trust. Free water saving devices including cistern displacement devices, trigger guns and shower timers are also available to customers on request and are also distributed at all NI Water events.

For the Draft WRMP three water efficiency options were developed to further promote water efficiency as described below. Since the Draft WRMP, NI Water has developed its Water Demand Management Strategy (WDMS); estimates of reductions in consumption and the associated costs associated with implementation of the WDMS will be available for consideration in future WRMPs.

8.4.4.1 Option WE1: Household water audits

Under this option it is assumed that NI Water would carry out water audits during water quality sampling visits to raise water efficiency awareness. Customers would also be offered a water efficiency kit at the same time as the audit, including a cistern displacement device, shower timers, and water saving leaflets. Water savings and costs associated with the household water audits have been estimated based on information provided by the Market Transformation Programme, the Waterwise Evidence Base 2008 and the Ofwat Good Practice register 2007. It has been assumed that 250 household water audits would be carried out each year during the planning period from 2010–11 to 2034–35.

8.4.4.2 Option WE2: Targeted non-household water audits

Under this option it is assumed that NI Water would carry out targeted non-household water audits options to raise awareness of water efficiency focussing on large users. The audits would be carried out by trained NI Water personnel to provide guidance to customers on how water consumption could be reduced. The audits would focus on domestic demand components including WCs, urinals and shower use. Based on information published by the Ofwat Good Practice Register 2007, the average water saving per day for non-household water audits carried out by companies in England and Wales is approximately 78 l/prop/day. It has been assumed that 250 non-household water audits would be carried out each year during the planning period from 2010 to 2034–35.

8.4.4.3 Option WE3: Additional educational talks at schools

This option builds on the current school educational programme implemented by NI Water. Additional school visits would be carried out by trained personnel, over and above existing levels, to raise school children's awareness of water efficiency and how their actions at school and home can play an important role in reducing consumption and protecting the environment. It has been assumed that 250 additional school visits would be carried out each year across Northern Ireland. Water savings for this option have been estimated based on micro-component analysis derived from published data from Waterwise.

8.4.5 Planning period 2013–18 Strategic Transfers

All proposed planning period 2013–18 strategic transfer schemes were originally considered as options for maintaining the supply demand balance to 2034–35. The options were:

- Castor Bay to Belfast Phase 3 (JR342);
- Castor Bay to Newry Phase 2 (JG035) – note that construction of Phase 2A of the Castor Bay to Newry main is due to start in early 2012;
- Carmoney to Strabane (JL715);
- Killyhevlin to Lough Bradan (JL713); and
- Glenchuil to Cabragh (JF017).

The costs and capacities of the link mains have been included within the investment modelling to determine the least cost resource development plan for NI Water to 2034–35, as discussed in section 9.

8.4.6 Other Transfers

During development of the constrained options list, additional strategic transfer options that could help to maintain the supply demand balance during the planning period were identified through discussion with the TMM team, as detailed below. The costs and capacities of these potential transfers have also been included within the investment modelling discussed in section 9.

8.4.6.1 Option TR1: Ballinrees to Altnahinch

In the North WRZ there was an existing distribution constraint between Ballinrees WTW and the Altnahinch supply area which is constraining zonal deployable output by approximately 10 Ml/d. This scheme has already been implemented as a Single Source Scheme under the Major Incident Mitigation Project.

8.4.6.2 Transfers to support the Central WRZ (TR2, TR3 and TR4)

Through discussion with the TMM team three transfer options to meet the forecast deficit in supplies in the Central WRZ were identified for the Draft WRMP. The required capacities and corresponding lengths and diameters have been refined through use of the TMM between the Draft and Final WRMPs.

- Option TR2: 2 Ml/d capacity transfer from the North WRZ (Caugh Hill WTW) to the Central WRZ (Moydamlaght SR). 12 km pipeline and new pumping station; and
- Option TR3: 2 Ml/d capacity transfer from the South WRZ (Carland SR) to Central WRZ (Cookstown southern DMAs). 2.2 km pipeline and booster stations.

The TMM modelling work showed that Option TR4 (East WRZ to Central WRZ) was not viable, so it was not included in the analysis for the Final WRMP.

8.5 Economic Analysis

The Average Incremental Social Cost (AISC) of each proposed scheme was calculated according to the 'Economics of Balancing Supply and Demand' (EA and UKWIR, 2002) methodology, in accordance with the water resources planning guideline. This approach recognises the need to take account of environmental and social impacts, as well as carbon emissions, when evaluating costs of different options. The AISC for the constrained options are included in Table 8.4 ranked in least cost order.

Capital and operating costs used in the assessment are at Q4 2009–10 prices. For the resource enhancement options the capital cost estimates have been based on the provision of a new 10 Ml/d treatment stream. Capital cost estimates have been benchmarked against Atkins cost database of actual out turn water schemes within England and Wales as used in preparation of water company business plan submissions for the 2009 periodic review (PR09).

Option ref:	Option Name	AISC (£/m^3)
LR1	1 Ml/d in leakage below 2014–15 target	0.08
LR2	2 Ml/d reduction in leakage below 2014–15 target	0.08
LR3	5 Ml/d reduction in leakage below 2014–15 target	0.09
LR4	10 Ml/d reduction in leakage below 2014–15 target	0.10
SPL1	Free supply pipe repair policy – indicative costs	0.19*
LN3	Increase output from Dunore WTW (10 Ml/d)	0.28
LN1	Increase output from Castor Bay WTW (10 Ml/d)	0.28
LN4	Increase output from Moyola WTW (10 Ml/d)	0.38
LE1	Increase output from Killyhevlin WTW (10 Ml/d)	0.39
FB1	Increase output from Fofanny WTW (10 Ml/d)	0.40
SPLA	Subsidised supply pipe repair policy – Option A	0.44
SPLB	Subsidised supply pipe repair policy – Option B	0.44
SPL1	Free supply pipe repair policy	1.03
CL	Retain and refurbish Camlough WTW	1.03
WE2	Targeted non household water audits	1.29
M3	Metering Scenario 3	1.85
M4	Metering Scenario 4	1.93
WE1	Household water audits	2.08

Option ref:	Option Name	AISC (£/m^3)
M1	Metering Scenario 1	2.09
M2	Metering Scenario 2	2.21
WE3	Additional educational talks at schools	2.54

Notes: Carbon costs are included within the stated AISC figures.
AISC calculated using UK water industry best practice incorporating estimates of opex and capex
Camlough WTW AISC calculated using incremental DO once Castor Bay to Newry Phase 2A (JG035) has been implemented.

Table 8.4 – Ranking of options by AISC

8.5.1 Environmental and Social Costs

The Environment Agency's Benefits Assessment Guidance (BAG)[25] provides an approach for estimating social and environmental costs of water resource options. The methodology applies a 'benefits transfer', whereby the value of social/environmental benefits is transferred from a 'study site' to the 'policy site'. The benefits value for a change in the environmental characteristics of a range of British study sites has been derived from the public's 'willingness to pay' or 'willingness to accept' through historical primary valuation studies published in the EA guidance document. A value can therefore be transferred to the 'policy site' following some adjustments to reflect the extent of the change in the environmental and social characteristics.

The only elements of the BAG method that are relevant to the water resource options within the options appraisal are the Rivers and Groundwater section (Part 2) and the Reservoirs, Lakes and Broads section (Part 3). For Lough Neagh, a previous environmental assessment carried out by NI Water Service in 2005[26] to support the current abstraction licence for Lough Neagh concluded that the Company's total authorised abstraction from Lough Neagh (392 Ml/d) would have negligible impact on water levels. It follows that a 10 Ml/d increase in abstraction within the 392 Ml/d abstraction limit, as proposed for the options under consideration for the Draft WRMP (Moyola, Castor Bay and Dunore), would similarly have negligible impact on water levels within Lough Neagh. There is therefore no justification for the inclusion of environmental or social costs within the options appraisal for the three Lough Neagh schemes, other than carbon costs as detailed below under section 8.5.2. Similarly, for the option for additional abstraction from Lough Erne (LE1) the additional abstraction of 10 Ml/d is considered to be negligible compared to the volume of Lough Erne and hence no allowance for environmental and social costs have been included in the options appraisal, other than for the cost of carbon.

For the purposes of the Draft WRMP it was also assumed that an additional 10 Ml/d abstraction from Lough Island Reavy (Option FB1) would have no adverse effect on water levels within the Lough. However it was recognised that Lough Island Reavy is a much smaller body of water at around 9000 Ml and should this option have been selected as part of the least cost plan, then further assessment of the potential environmental impact would need to be carried out for the Final WRMP.

[25] Environment Agency (England and Wales) (July 2003) *Guidance Assessment of Benefits for WQ and WR schemes in the PR04 Environment Programme*
[26] Mott McDonald/DRD Water Service (2005) *Environmental Statement for Increased Public Water Supply Abstraction from Lough Neagh 2005-2015*

8.5.2 Carbon Costs

The Draft WRMP used the approach to the valuation of carbon set out in 'The UK Low Carbon Transition Plan' (July 2009)[27]. In that report the Department of Energy and Climatic Change (DECC) announced that the shadow price of carbon has been replaced with the non-traded price of carbon. Further guidance has been issued since the Draft WRMP[28].[29]; the carbon costs for the Final WRMP have been updated with the June 2010 data.

8.5.2.1 Operational cost of carbon

The operational cost of carbon has been calculated for each option within the AISC analysis and investment modelling in accordance with current Government guidance. Operation of new water supply schemes will result in carbon emissions due to the on-site use of electricity for pumping and water treatment processes. Energy is also consumed for heating, lighting etc within water Company buildings.

The energy required to operate the proposed resource schemes was calculated based on the actual measured annual energy consumption for NI Water's existing treatment works. These were then converted to carbon emissions using Defra's emissions conversion factor for national grid electricity (Defra, 2008) of 0.537 kg CO_2 per kWh of electricity consumed. The environmental cost of carbon emissions was then monetised by applying the current non-traded price of carbon of £52 per tonne CO_2 emissions (2010 prices). Carbon costs were also calculated for the demand management schemes including leakage reduction, metering and water efficiency to account for additional vehicle movements associated with each option.

8.5.2.2 Embedded costs of carbon

In addition to the operating cost of carbon, greenhouse gas emissions associated with the construction of new resource schemes have been included in the AISC analysis and investment modelling. For the purposes of the Final WRMP a carbon calculator tool has been applied to assess the amount of embodied carbon for the construction of each resource option associated with the quantity of material and transportation of material and labour. As for the operating cost of carbon, the carbon emissions associated with the construction of each option were monetised using the non-traded price of carbon. Embedded carbon costs were also included for each of the metering scenarios.

8.5.2.3 Carbon emissions

NI Water's carbon emissions are now included in the Annual Information Returns (AIR) to NIAUR. Table 45 *Energy consumption and greenhouse gas accounting* includes separate lines for the total tonnes of CO_2 equivalent (tCO_2e) produced in the reporting period for water supply and waste water services.

NI Water continues to develop its strategy for managing and accounting for its carbon emissions. Over time it is expected that not only will the quality of the information improve, data will be collected to allow a more detailed breakdown than reported at present for the two main sectors

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[27] Department of Energy and Climatic Change (DECC) (July 2009), *The UK Low Carbon Transition Plan*
[28] Department of Energy and Climate Change (DECC) (June 2010), *Updated short term traded carbon values for UK public policy appraisal*
[29] Department of Energy and Climate Change (DECC) (October 2011), *Update short term traded carbon values for UK public policy appraisal*

under the heading of operational greenhouse gas (GHG) emissions per Ml of treated water and per Ml of sewage treated. At present these values are available at the company level only, rather than for the individual WRZs; in time it may be possible to break these down from total emissions into abstraction, treatment and distribution.

9. Final water resources strategy

This section brings together material from previous sections into the preferred strategy. This strategy is consistent with the main themes of strategic transfers and leakage reductions set out in WRS 2002. There are however changes in the required timing for implementation of individual schemes and some strategic transfers have already been implemented. There are also changes in some WRZs that have been triggered by various factors including a new base year supply demand balance, revisions to future demand forecasts, more refined analytical methodologies, and issues concerning the abstraction licence for the Derg WTW (see section 9.4.2 and Annex A). Some of the differences in strategy arise from the more comprehensive approach to modelling conjunctive use deployable output that is consistent with UK water industry best practice.

The choice of options for the preferred strategy has also been informed by the Strategic Environmental Assessment (SEA) process. The SEA Environmental Report was published for consultation as a separate document; the SEA Statement will be published with this Final WRMP.

It has been assumed that the strategic transfer schemes and other supply demand balance schemes planned for implementation during PC10 form part of the baseline condition; this includes the Strule to Derg pipeline within the West WRZ. With the exception of Castor Bay to Newry Phase 2A (JG035) the schemes identified for implementation during planning period 2013–18 are included in the option set used by the investment model.

The Draft WRMP used the water balance for 2008–09 reported in AIR09 Table 10 and supporting documents as the base year for the analysis. Following consultation, DRD confirmed that the base year did not need to be updated to 2009–10 for the Final WRMP.

9.1 The investment modelling process

Following completion of the options appraisal described in section 8, the capital and operating costs for all options in the constrained list were used as input data for the least cost optimisation model. This model has been developed following the methodology set out in the UKWIR report Economics of Supply and Demand (EBSD). The objective of the model is to identify the least cost water resources management strategy to meet forecast supply demand balance deficits in each year of the planning period from the base year up to 2034–35.

For each of the five WRZs the investment model takes as its starting point the baseline supply demand balance as reported in section 8. Using the estimated capital and operating costs for each option, and any specified constraints on the earliest year in which an option could be commissioned, the model solves a mixed integer linear programme (MILP) for each WRZ. The objective of the model is to minimise the cost, in net present value (NPV) terms, of options required to satisfy any forecast supply demand deficit over the whole of the planning period.

9.2 Overall water resources strategy

The least cost final planning solution for each of the five WRZs that make up the NI Water supply area, as derived from the investment modelling, is shown in Table 9.1. The strategy includes a combination of strategic transfers (section 9.2.1), WRZ leakage reduction (section 9.2.2) and further resource development (section 9.2.3) to maintain the supply demand balance. The total NPV for the final planning solution is £10.65m; excluding all PC10 and Castor Bay to Newry Phase 2A (JG035) costs for strategic transfers and costs for reducing leakage to the current target of 165.4 Ml/d by 2014–15.

The analysis completed for this WRMP has shown that other options including domestic metering and water efficiency are not economic options for maintaining the supply demand balance, so these options do not form part of the least cost solution.

It should be noted that the required leakage reductions to meet the revised leakage target of 165.4 Ml/d in 2014–15 are included in the baseline water demand forecast. These reductions and the Castor Bay to Newry Phase 2A main are shown in the left–hand column of Table 9.1.

9.2.1 Strategic transfers

9.2.1.1 Planned schemes

For the investment modelling it has been assumed that all PC10 strategic transfers will be completed by the end of 2012–13. This means that all PC10 transfers have been included in the baseline supply demand balance and are not treated as possible options to meet any future supply demand balance deficits. With the exception of Castor Bay to Newry Phase 2A (JG035) all planned strategic transfers for the next planning period from 2013–18 have been considered as options within the investment model.

The planned strategic transfers for PC10 and the 2013–18 planning period are shown schematically in Figure 9.1.

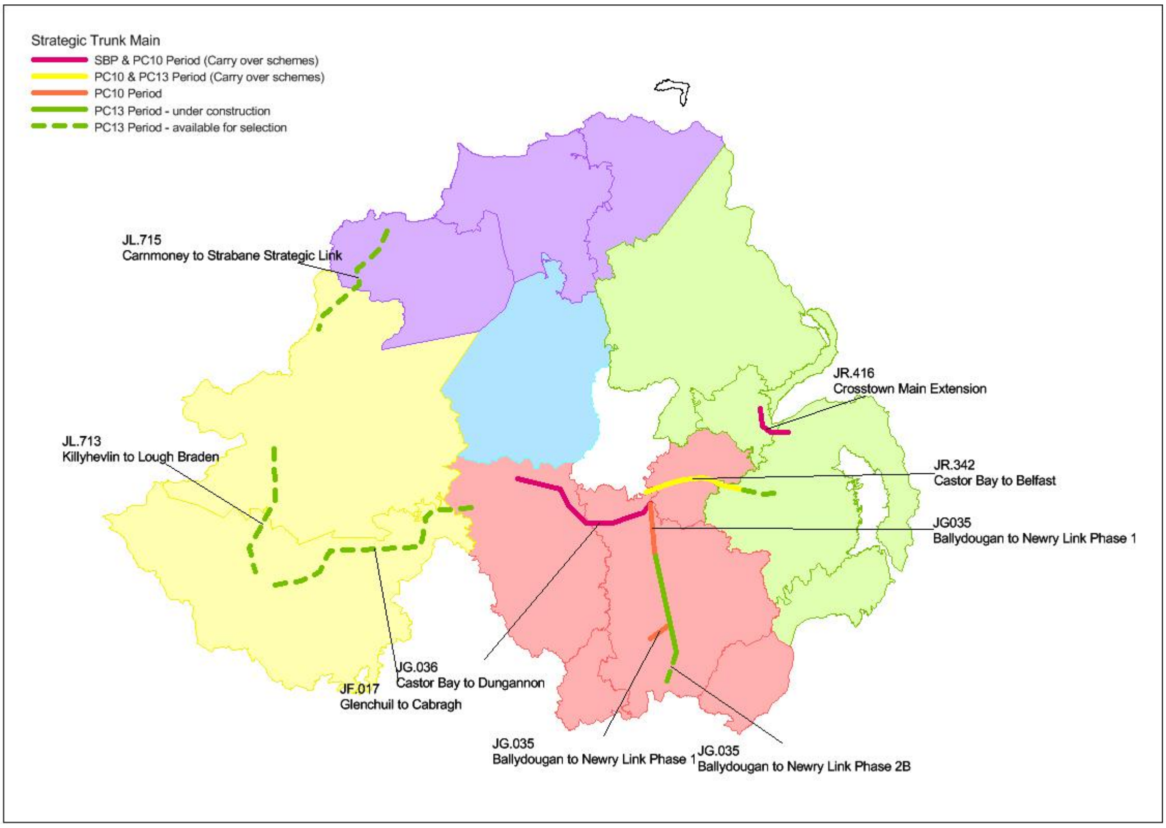

Figure 9.1 – Schematic of strategic transfers for PC10 and planning period 2013–18

Killyhevlin to Lough Bradan (JL713 – ST4) and Carmoney to Strabane (JL715 – ST3)

Although the Killyhevlin to Lough Bradan (JL713) scheme within the West WRZ is not selected by the investment model there are however other drivers for this scheme in order to improve the interconnectivity of the distribution system and robustness of supply, particularly in view of the identified risk of abstraction constraints from the River Strule during drought periods. There is also a strong case to fast track the construction of the Carmoney to Strabane strategic link main (JL715) for completion within planning period 2013–18, to increase security of supply within the West WRZ during drought periods. These issues are discussed in further detail in section 9.4.2 and in Annex A.

Castor Bay to Newry Phase 2 (JG035 – ST2)

As discussed section 8, decommissioning of Camlough WTW has been included in the baseline supply demand balance. The investment modelling now assumes that Phase 2A of the Castor Bay to Newry scheme (JG035) will be implemented. In addition to providing operational and distribution benefits, the scheme also provides supply demand balance benefits for meeting the dry year annual demand within the South WRZ.

9.2.1.2 Transfer schemes to Central WRZ

Two strategic transfers to the Central WRZ also form part of the least cost solution to maintain the supply demand balance as follows:

- TR3 to provide a 2 Ml/d bulk supply from the South WRZ to Central WRZ by 2015–16; and
- TR2 to provide a 2 Ml/d transfer from the North WRZ to Central WRZ by 2023–24.

These transfer schemes have been selected in preference to further leakage reduction within the Central WRZ or expansion of the Moyola WTW.

9.2.2 Leakage Reduction

Further leakage reduction below the WRZ leakage target of 165.4 Ml/d by 2014–15 forms part of the final planning strategy to 2034–35.

Further total leakage reduction of 10 Ml/d within the South WRZ and 18 Ml/d within the East WRZ are selected by the investment model during the period 2017–18 to 2034–35. This results in an additional leakage reduction of 29.5 Ml/d at Company level below the current target for 2014–15 of 15.4 Ml/d. This reduction in leakage should be considered in the context of the main components of demand shown in Table 4.8. A 10% reduction in the 2034–35 household demand of 365 Ml/d could be achieved if water efficiency and other demand management measures were to lead to a 10% reduction in PCC.

A plot of recent leakage, the glidepath to the 2014–15 target and the leakage profiles selected by the investment model for the Draft (dashed) and Final (full) WRMP are shown in Figure 9.2. The plots shows that leakage reductions in East WRZ and South WRZ only start to increase from 2021–22 onwards.

It is important that the planning process for leakage reduction works within each WRZ consider distribution constraints within each zone so that the supply demand balance is maintained in each District Meter Area (DMA). This is because local supply demand balance deficits resulting from proportionally higher levels of leakage and the inability of the distribution system to cope with locally high leakage levels could be exacerbated if leakage work within a WRZ were to be focused on the wrong areas. The phasing of leakage reduction activities within each WRZ therefore needs to consider these constraints through the use of zonal distribution models and field testing as appropriate. This level of detailed planning is outside the scope of the WRMP.

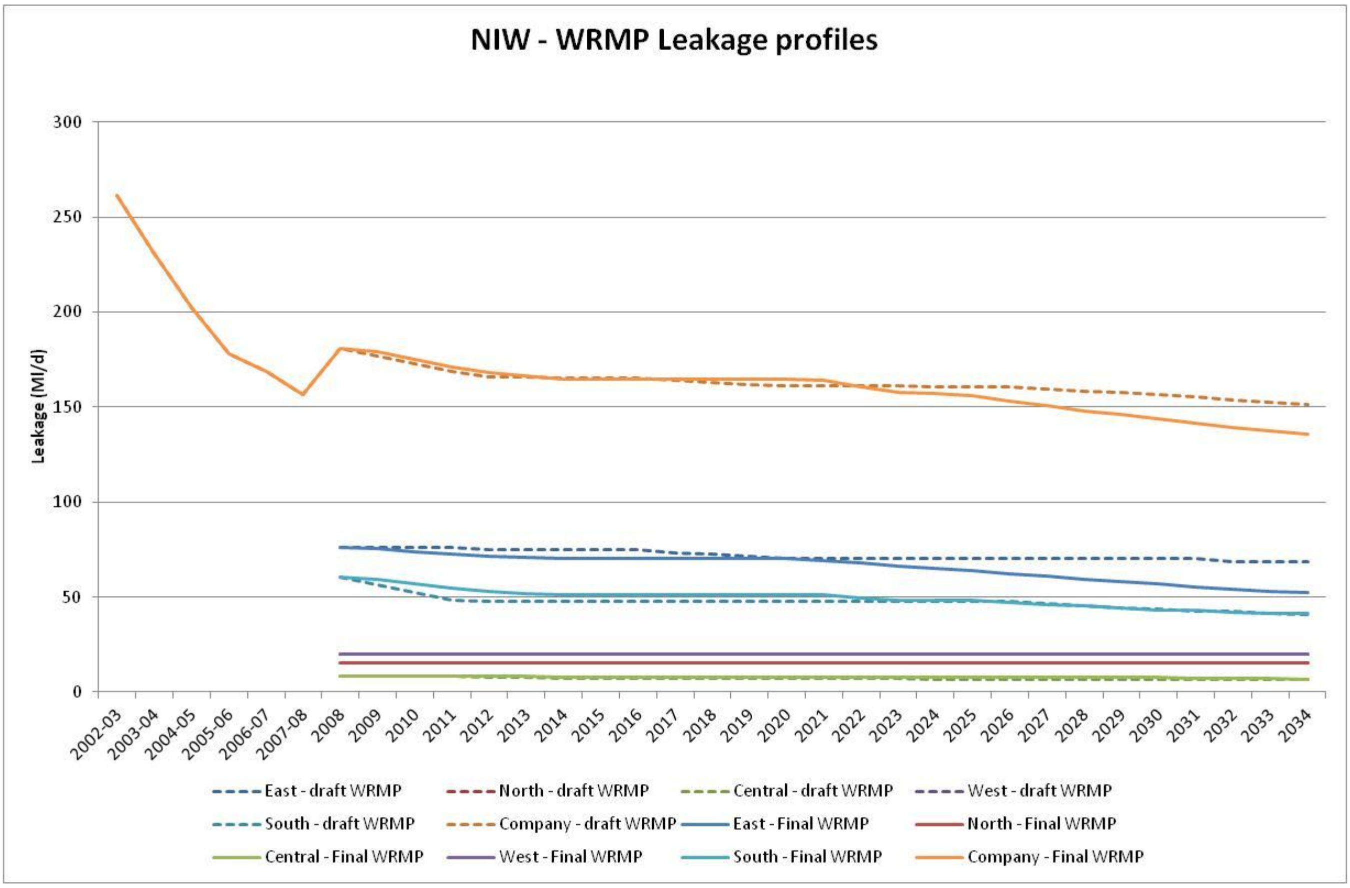

Figure 9.2 WRMP leakage profiles for Draft and Final WRMP

9.2.3 Resource developments

Provided that the 2014–15 WRZ leakage targets are met, that the strategic transfers identified are implemented and that there are no changes to abstraction licences, then no new water resource schemes would be required to meet forecast annual average dry year demands.

9.2.4 Least Cost Plan at WRZ level.

Runs of the investment model have identified a combination of leakage reductions and strategic transfers that comprise a least-cost investment strategy to maintain target headroom in all WRZs throughout the planning period. The values of target headroom are based on current understanding of the uncertainties in the various elements of the supply demand balance, and hence the risk to security of supplies.

The components of the least cost development plan for each WRZ, shown in Table 9.1, are described below:

North WRZ – assuming full output from the Derg WTW

- No over WRZ leakage reductions are required within the North WRZ from 2014–15 to 2034–35, however additional localised leakage reductions may also be required;
- A 2 Ml/d transfer is required from the North WRZ to the Central Zone in 2024–25 (Option TR2); and

- The Carmoney to Strabane strategic transfer (JL715) from the North WRZ to West WRZ is not required, assuming the full 26.6 Ml/d yield from the Derg WTW is available during the planning period, without any abstraction constraints during low flow periods.

East WRZ

- Once the 2014–15 WRZ leakage target is met then zero Ml/d leakage reduction during planning period 2013–18, 2 Ml/d leakage reduction during 2018–23, 7 Ml/d leakage reduction during 2023–2028, 7 Ml/d leakage reduction during 2028–33, and 2 Ml/d leakage reduction from 2032–33. Additional localised leakage reductions may also be required.

South WRZ – assuming that Castor Bay to Newry Phase 2A (JG035) is implemented

- 2 Ml/d transfer is required from the South WRZ to the Central Zone in 2015–16 (Option TR3); and
- Once the 2014–15 WRZ leakage target is met then zero Ml/d leakage reduction during planning period 2013–18, 2 Ml/d leakage reduction during 2018–23, 3 Ml/d leakage reduction during 2023–2028, 4 Ml/d leakage reduction during 2028–33, and 1 Ml/d leakage reduction from 2032–33. Additional localised leakage reductions may also be required.

West WRZ – assuming full output from the Derg WTW

- No WRZ leakage reductions are required within the West WRZ from 2013–14 to 2034–35. Additional localised leakage reductions may however be required.; and
- The Carmoney to Strabane strategic transfer from to the West WRZ to from North WRZ (JL715) is not required during the planning period, assuming the full 25 Ml/d output from the Derg WTW is available during the planning period, without any abstraction constraints during low flow periods. Earlier implementation of this strategic transfer would increase the operational flexibility in the WRZ and thus provide greater resilience to extreme events such as winter “freeze-thaw” events. In addition this strategic transfer would allow operational flexibility to be formally included as a drought management measure to supplement flows in the West WRZ if there is a period of constrained abstraction from the River Strule.

Central WRZ

- Once the 2014–15 WRZ leakage target is met then 0.5 Ml/d leakage reduction during planning period 2013–18, zero leakage reduction during 2018–23, zero leakage reduction during 2023–2028, 0.5 Ml/d leakage reduction during 2028–33, and 0.5 Ml/d leakage reduction from 2032–33. Additional localised leakage reductions may also be required.
- 2 Ml/d transfer is required from the South WRZ to the Central Zone in 2015–16 (Option TR3); and
- 2 Ml/d transfer is required from the North WRZ to the Central Zone in 2024–25 (Option TR2).

Year	Planning Period	Planned investments	Interventons selected by investment model for Least Cost Plan assuming planned interventions have been implemented
2008-09	SBP	Leakage reduction 1.9 Ml/d	
2009-10		Leakage reduction 4 Ml/d	
2010-11	PC10	Leakage reduction 4 Ml/d	
2011-12		Leakage reduction 4 Ml/d	
2012-13		Leakage reduction 4 Ml/d	
		Castor Bay to Newry Phase 2A (JG035)	
2013-14	2013-18	Leakage reduction 1.3 Ml/d	
2014-15		Leakage reduction 1.3 Ml/d to reach target of 165.4 Ml/d	Leakage reduction 0.5 Ml/d (Central WRZ)
2015-16			TR3: 2 Ml/d transfer South WRZ to Central WRZ
2016-17			
2017-18			
2018-19	2018-23		
2019-20			
2020-21			
2021-22			Leakage reduction 1 Ml/d (East WRZ)
2022-23			Leakage reduction 1 Ml/d (East WRZ)
			Leakage reduction 2 Ml/d (South WRZ)
2023-24	2023-28		Leakage reduction 2 Ml/d (East WRZ)
			Leakage reduction 1 Ml/d (South WRZ)
2024-25			Leakage reduction 1 Ml/d (East WRZ)
			TR2: 2 Ml/d transfer North WRZ to Central WRZ
2025-26			Leakage reduction 1 Ml/d (East)
2026-27			Leakage reduction 2 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2027-28			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2028-29	2028-33		Leakage reduction 2 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2029-30			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2030-31			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2031-32			Leakage reduction 0.5 Ml/d (Central WRZ)
			Leakage reduction 2 Ml/d (East WRZ)
2032-33			Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2033-34	2033-38		Leakage reduction 1 Ml/d (East)
			Leakage reduction 1 Ml/d (South)
2034-35			Leakage reduction 0.5 Ml/d (Central WRZ)
			Leakage reduction 1 Ml/d (East WRZ)
WRMP NPV (£m)			**£ 10.65m**
Total leakage reduction		**15.5 Ml/d**	**29.5 Ml/d**

Key:		
	ST	**Stategic transfer**
	TR	**Transfer**
	LR	**Leakage reduction**

Table 9.1 – Final Planning strategy 2008–09 to 2034–35

9.3 Metering

As described under section 8 a range of domestic metering scenarios were considered as part of the option appraisal for the Draft WRMP. Each of the metering scenarios was incorporated within the least cost modelling to derive an overall NPV for each scenario The NPV results showed that metering would not be cost effective in maintaining the supply demand balance, due to the high cost of meter installation and operation. The NPV of each of the scenarios is substantially higher than the final planning solution, which assumes a continuation of the current policy of no domestic metering for new or existing households. No further modelling of possible metering options has been undertaken for the Final WRMP.

9.4 Sensitivity Analysis

9.4.1 Capital costs sensitivity

To test the sensitivity of the least cost plan, the capital cost estimates for the resource development options and strategic transfer schemes have been varied by +/−25%

The sensitivity tests showed that the investment model is not sensitive to the capital cost estimates.

9.4.2 Sensitivity relating to the abstraction licence for Derg WTW

NI Water had an abstraction licence (AIL/2007/0037) that authorised abstraction of up to 15 Ml/d from the River Derg to supply the Derg WTW in the West WRZ. This maximum abstraction rate was below the treatment capacity of the Derg WTW which is 26.6 Ml/d.

Utilisation of the full Derg WTW capacity was identified in WRS 2002 as an essential component of that strategy. NI Water has subsequently applied to NIEA for and been granted a licence (AIL/2008/0178[30]) that authorises abstraction up to the capacity of the Derg WTW (26.6 Ml/d) using water either from the River Derg or from the River Strule or from a combination of both. A planning application for an intake on the River Strule above its confluence with the River Derg and for a new pipeline to carry water to the Derg WTW has also been submitted.

Hands-off flow profiles have been developed with NIEA to provide a pragmatic approach to operating the abstraction regime for the Derg WTW; acknowledging the protected status of the river (e.g. it is a Special Area of Conservation for Atlantic salmon). The minimum flow conditions ensure compliance with UK Technical Advisory Group (UKTAG) guidelines for supporting good ecological status under the WFD at all times. This approach is flexible, appropriate, and allows a full take of 26.6 Ml/d for most but not all of the time.

The conditions of the new licence (AIL/2008/0178) are such that under certain, albeit rare occasions, abstraction at the full rate of 26.6 Ml/d will not be possible. Modelling of the water resource situation in the West WRZ for the Draft WRMP shows that the licence conditions would result in a significant reduction in DO. In practice it is expected that the licence limits could result in a worst-case reduction in the yield of the Derg WTW from 26.6 Ml/d to 8 Ml/d during the lowest flow conditions predicted. 8 Ml/d represents the maximum abstraction level from the Strule that would meet the UKTAG requirements at all times of the flow record.

[30] Note that this licence replaces the existing licence for the Derg abstraction (AIL/2007/0037) because it covers both intakes

A lack of interconnectivity in the WRZ means that at times of very low flow, when no water can be abstracted from either the River Derg or the River Strule due to licence constraints, there are no alternative sources of supply to make up any short term deficits. The available flow record suggests that low flow conditions that could severely restrict abstraction only arise about 1% of the time, but these events could last for up to 3 weeks. Discussions between NI Water and NIEA regarding the licence reached an agreement whereby in the event of such water scarce periods arising, the output from the Derg WTW could be maintained by following normal drought planning procedures under Article 4.6 of the WFD.

Under this arrangement, NI Water will implement a drought contingency management plan in order to maintain public water supplies during times of exceptionally dry weather. The details of the contingency plan are still to be agreed with NIEA, but will require monitoring additional to that otherwise required to satisfy the licence conditions. It is anticipated that whenever very low flows start to develop, NI Water will apply for a temporary variation to the licence to permit abstraction below the normal minimum flow conditions for the River Strule, provided demand management measures and other agreed action plans are in place. It is expected that baseline monitoring would lead to enhanced monitoring (of flow, water quality, and ecology) during low flow events with appropriate triggers set to minimise the risk to the protected features (e.g. salmon); i.e. supply side restrictions would be brought in before any significant environmental impact was caused.

In view of the agreement between NIEA and NI Water written into the new licence, the full 26.6 Ml/d DO resulting from the new abstraction licence has been included in the baseline DO for the West WRZ for the purposes of the WRMP. The full DO value has been included on the basis that any reduction in abstraction would only occur alongside drought management measures.

Options to mitigate impact of low flows

Whilst the full 26.6 Ml/d output from the Derg WTW was justified for inclusion in the Draft WRMP, it was recognised that there remains a risk that very low flows within the River Strule could result in significant short term deficits in the Derg supply area. It is therefore appropriate for NI Water to consider mitigating the risks to public water supply within the Derg area during drought periods, although such measures are outside the scope of the Water Resources Management Plan process.

Water resources modelling has shown that bringing forward the proposed planning period 2013–18 strategic link main between Carmoney and Strabane (JL715) would substantially increase the robustness of supply within the West WRZ during periods of low flow in the River Strule. During low flow periods a reduction in abstraction to 8 Ml/d (the maximum abstraction rate permitted under the UKTAG guidelines at the lowest flows), would result in an immediate deficit in resources in the West WRZ in planning period 2013–18. The construction of the Carmoney to Strabane strategic transfer in planning period 2013–18 would provide a 10 Ml/d transfer capacity between the North and West WRZ, which would significantly reduce the risk of supply failure during low flows.

In addition to the Carmoney to Strabane transfer the proposed Killyhevlin to Lough Bradan transfer (JL713) may also increase the robustness of supply during drought conditions in the West WRZ, assuming a bi-directional transfer scheme between the two sources of supply.

Recent operational experience has identified the need for additional capacity and operational flexibility in the distribution system of the West WRZ. It is recommended that a feasibility study should be progressed to address security of supplies in the context of the planning and operational conditions included in the new Derg/Strule abstraction licence.

9.4.3 Sensitivity related to Belleek WTW

Belleek WTW located to the west of Lough Erne within the West WRZ, has a reliable output capacity of 2 Ml/d. Analysis using the TMM for the Final WRMP suggests that a trunk main of over 20 km would be required to maintain supplies to customers if Belleek WTW were to be decommissioned. This suggests that the washwater discharge facilities from the WTW need to be upgraded to meet required discharge consent standards rather than replace the current output from the WTW with treated water transfers from Killyhevlin WTW.

9.4.4 Sensitivity to assumptions on per capita consumption

The Draft and Final WRMP were based the assumption that per capita consumption (PCC) would remain constant over the whole of the planning period. It is estimated that a reduction in PCC of 10% by the end of the planning period would reduce domestic water consumption by just under 32 Ml/d, which is the same order of magnitude of the required leakage savings from 2014–15.

9.4.5 CO_2 emissions

Annual Information Return (AIR) Table 45 *Energy consumption and greenhouse gas accounting* gives a total tonnes of CO_2 equivalent (tCO_2e) produced for NI Water's water supply services. Estimates of carbon emissions for each year of the planning period are shown in Figure 9.3 for both the baseline and the final planning scenario.

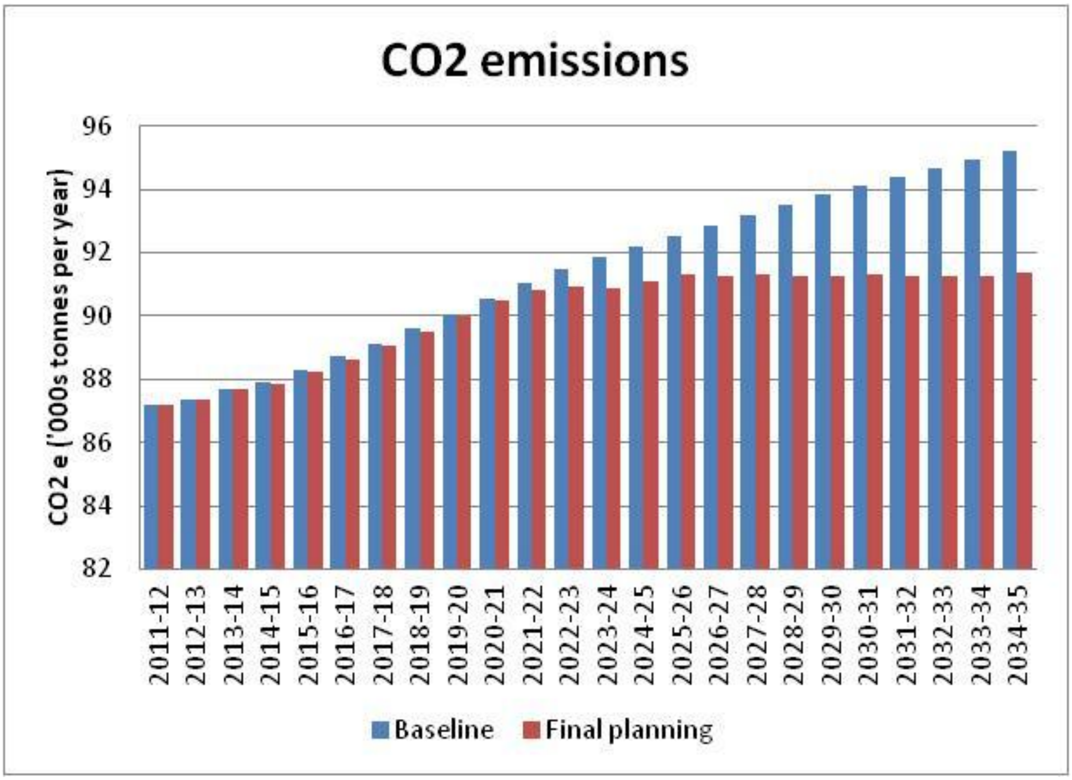

Figure 9.3 Estimated carbon emissions over the course of the plan

9.5 Conclusions

The analysis undertaken for this Final WRMP endorses the strategy set out in WRS 2002 and in the Draft WRMP, namely that in the short-term with the existing abstraction licence, current charging policies and historic hydrological conditions, and provided that the WRZ leakage targets are met, then NI Water has sufficient sources of treated water from its own WTW and from the PPP schemes to meet forecast demands at the company level. However in order to transfer water from areas of surplus to areas of deficit, some strategic transfer mains are required. In addition to providing supply demand balance benefits some of the transfers also have operational benefits such as providing additional security of supply during extreme weather conditions such as the winter “freeze-thaw” events which led to significant, but relatively short-term increases in distribution input.

This WRMP continues to make full use of existing infrastructure, and in particular the very large contribution from the Lough Neagh and Ballinrees PPP WTWs, that together provide about 50% of the treated water supplies available to NI Water.

Many of the uncertainties and risks to this WRMP are similar to those experienced by water undertakers in England & Wales, for example: population and housing growth; fluctuations in economic activity; climate change. These uncertainties have been taken into account in target headroom. There are however two other major uncertainties that will need to be taken into account in future reviews of this WRMP, namely sustainability reductions and any changes to water charging policy.

Until such time as NIEA advises the possible locations and magnitudes of sustainability reductions and/or the introduction of environmental conditions to existing abstraction licences it is difficult to judge the potential impact on the supply demand balance of individual WRZs. It seems unlikely that there are any new sources of raw water, apart from Lough Neagh, that would not have very serious environmental impacts. Any implementation of sustainability reductions is therefore likely to trigger additional strategic transfers and demand-side measures. The main source of additional raw water would appear to be Lough Neagh. So in order to substitute for lost deployable output, the construction of increased capacity at the PPP sources on Lough Neagh and additional strategic transfer capacity will be required. The additional carbon emissions associated with additional transfers will need to be considered when balancing the environmental benefits of sustainability reductions with any additional carbon emissions associated with maintaining security of supplies.

The WRMP does not include increases in the total level of abstraction authorised under existing abstraction licences, nor does it require any new abstraction licences. Therefore there are unlikely to be any impacts of the plan on the ecological status of water bodies beyond those that have been assessed under existing licence permissions. Any changes to licence conditions to meet Water Framework Directive and/or other environmental requirements could have a major impact on future revisions to the plan.

The main components of the plan are continuations of existing programmes of strategic trunk mains infrastructure and leakage control. The risks to implementation of the option set are therefore similar to those already being experienced in the planning and implementation of existing programmes.

As discussed in section 8, metering of domestic customers would not be a cost-effective option for this WRMP. Furthermore, NI Water’s distribution input does not exhibit a peak demand profile so the driver for investment is average rather than peak demand conditions. Peak water demands are generally caused by discretionary water use which is usually associated with outdoor summer uses. This means that the introduction of domestic metering in Northern Ireland does not have the potential to reduce demands significantly. Direct charging for domestic water services combined with metering may however be justified on other sustainability grounds, but in addition to uncertainty about the savings in consumption that might be achieved, the introduction of metering would primarily be a political decision and would trigger changes to existing statutory and regulatory powers.

Given the relatively young regulatory system, these issues are not likely to evolve quickly. The risk to this WRMP is therefore not one of needing additional resources to meet rising demands (provided leakage targets are met), but rather the need for options to mitigate the potential impact from sustainability reductions on the continued availability and magnitude of supplies from local sources. A WRMP that depends on the implementation of options that require fundamental changes to charging and regulatory policy would be extremely risky.

This WRMP shows that there are no additional supply demand options that need to be considered under a supply demand balance driver, unless there are sustainability reductions that reduce the deployable output available from existing sources. Modelling using the TMM has informed the configuration and capacity of strategic transfers both between and within WRZs that could improve security of supplies and provide supply demand balance as well as other benefits.

The WRMP does not alone provide the case for strategic investment decisions; rather it sets the framework at the Water Resource Zone (WRZ) level within which such decisions should be taken. There may also be other drivers for investment which should be assessed – for instance, operational resilience. Investment at smaller spatial scales will still need to be justified through other more local studies, such as trunk main studies, detailed zonal studies and targeted leakage initiatives.

10. Glossary

This glossary has been compiled for the NI WRMP using UKWIR definitions as updated in draft versions of the draft documentation for UKWIR project WR27 Water Resource Planning Tools 2012.

Abstraction

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

Abstraction licence

The authorisation granted by NI Environment Agency to allow the removal of water from a source.

Allowable outage

The *outage* (calculated from legitimate *Unplanned outage* and *Planned outage* events) which affect the "water available for use" to the extent that it contributes to a supply shortfall, for example, during annual average, peak or other critical resource planning period. Outage events are always temporary (up to three months). An *Outage allowance* may be made for such outages. Also see *Supply* and *Supply Demand Balance (SDB) equation.*

Annual average demand

The total *Demand* in a year divided by the number of days in the year.

Aquifer

A geological formation, group of formations or part of a formation that can store and transmit water in significant quantities. An aquifer is confined where its piezometric surface (sometimes referred to as the head and equivalent to the water table in unconfined aquifers) lies in or above the overlying confining layer. An aquifer is unconfined where the water table is not covered by a confining layer.

Available headroom

The difference (in Ml/d or percent) between the total amount of water available for use and the *Demand* at any given point in time. Also see *Supply* and *Supply Demand Balance (SDB) equation.*

Average day demand in peak week (ADPW)

One seventh of the total demand in a peak week from any 12 month accounting period (ADPW). Note that *Demand* here is measured as *Distribution Input.*

Average incremental costs (AIC)

The Average Incremental Cost (AIC) is calculated by dividing the *net present value* of all the costs by the *net present value* of the volume of water provided by an option or scheme.

Average incremental social costs (AISC)

The Average Incremental Social Cost extends the *AIC* calculation to include any external costs arising from “externalities” i.e. wider cost impacts for society and environment.

Base year

The first year of the *Planning period/horizon*, forming the basis for the *Demand* and *Supply* forecasting of subsequent years.

Baseline demand forecast

A demand forecast in which water efficiency assumptions reflect the base service targets set in the autumn of the most recent reporting year, leakage levels are maintained at the targets discussed with the regulators for the most recent reporting year, and metering programmes beyond the base year only include a forecast of the uptake of optional meters. The *Demand* forecast assumes the implementation of the company’s water efficiency plan and excludes yield gains from customer side and distribution side management options, irrespective of any supply surplus.

Baseline supply forecast

A forecast which reflects a water company’s *Deployable output*, excluding yield gains from production side and resource management options, including agreed reductions planned as *Sustainability reduction*(s), including an allowance for *Outage*, process losses, balance of imports and exports and non-potable supplies, irrespective of any *Supply* surplus.

Baseline supply demand deficit

Forecast gap between projections of *Baseline supply forecast* and *Water demand* (plus the *Risk (target headroom allowance) profile*), over a *Planning period/horizon* from base year to final year, derived using the *Supply Demand Balance (SDB) equation* of the Water Resources Planning Guideline Tables.

Behavioural analysis

The analysis of data, typically over a long time series, which is used to describe or derive a model of changes in the data, often with the intention of predicting the future behaviour of the variable being analysed.

Bulk supply

Transfers of either raw or treated water into or out of a water company’s supply area or within the company area.

Catchment

The area from which precipitation (rainfall) and groundwater would naturally collect and contribute to the flow of a river.

Conjunctive use

The operation of paired or mixed sources in combination such that the *Deployable output (DO)* of the combined sources is greater than the sum of the yields of individual sources alone.

Conjunctive use system

The integrated use of water resources from, for example, surface storage, groundwater storage, run-of-river and desalination plant within a *Water system*.

Critical drought event

A severe drought event which occurred within the period of historical records used in *Deployable output (DO)* calculations, and upon which the magnitude of DO depends.

Demand or Water demand

The demand for; i.e. consumption (or waste) of water typically measured as the *Distribution input.* In UK water resources planning, demand generally refers to *Dry year annual average unrestricted daily demand* and/or peak demand expressed as the average unrestricted daily demand in the peak week.

Demand management

The implementation of policies or measures (including metering/tariff structures, leakage reduction and "household" (domestic) and non-household water efficiency) which serve to control or influence the consumption or waste of water (this definition can be applied at any point along the chain of *Supply*).

Deployable output (DO)

The output of a commissioned source or group of sources or *Bulk supply* as constrained by:

- licence, if applicable
- pumping plant and/or well/aquifer properties
- raw water mains and/or aqueducts
- transfer and/or output main
- treatment
- water quality

for specified conditions and appropriate demand profiles to capture variations in demand over the year. Also see *Hydrological yield* and *Potential yield.*

Distribution input

The amount of water entering a water supply distribution system at the point of production.

Dry year annual average

The dry year annual average represents a period of low rainfall and *Unrestricted demand* and is used as the basis of a water company's Water Resources Management Plan.

Dry year annual average unrestricted daily demand

The level of *Water demand*, which is just equal to the maximum annual average, which can be met at any time during the year without the introduction of demand restrictions. This should be based on a continuation of current demand management policies. The dry year demand should be expressed as the total demand in the year divided by the number of days in the year.

Economics of Balancing Supply & Demand (EBSD)

A methodology developed for the water industry to assess the Economics of Balancing Supply and Demand. It sets out the stages to be followed by a water resources planner in order to develop a supply-demand balance plan.

Feasible options

Supply-demand balance options that satisfy the *EBSD* method's screening criteria and are further analysed for capability to address the water resources planning problem.

Forecast/plan horizon

The end date of supply and demand forecasts contained within a Water Resources Management Plan.

Gauged flow

The measured flow of a river which reflects natural runoff from a *Catchment* and artificial influences such as *Abstraction* and discharges that occur upstream of the measurement point.

Hands-off flow

A condition included in an *Abstraction licence* that requires the licence holder to stop or cut back their abstraction when the river flow falls below the predetermined flow rate stated in the licence.

Headroom uncertainty

A probability distribution that represents a likely range of values for *Headroom* for selected years within the Water Resources Management Plan *Planning period*. Also see R*isk (target headroom allowance) profile.*

Household consumption

The water delivered that is assumed to be within the control of the customer; i.e. excluding supply pipe losses. Household consumption = use + plumbing losses. Note that *Demand* incorporates household and non-household consumption and leakage

Hydrograph

A graph showing the flow or level in a channel or well plotted against time. Time is normally plotted on the horizontal x-axis, with the flow or level on the vertical y-axis.

Hydrological yield

The unconstrained output of a source that can be sustained by the *Catchment* or *Aquifer* feeding the *Source*.

Levels of service for water resource planning

The planned average frequency of drought-driven customer demand *Restrictions*. For example, a water company may plan to offer a *Level of service* of one temporary use restriction (e.g. hose pipe ban) in 10 years on average, and further restricts demand by way of rota cuts or standpipes with a longer frequency of one in 100 years on average.

Modelling

The representation of a *Water system*, for example, surface water *Catchment* or groundwater regime (or both) by a conceptual set of assumptions expressed physically (in a physical model), deterministically (in a deterministic model), as objective function/constraints (in an optimisation model) or by means of statistical relationships (in a stochastic model).

Monte Carlo Simulation

Monte Carlo simulation is a mathematical technique that uses repeated random samplings based on the input variable uncertainties to deliver a distribution for the output variable.

Net present value

The difference between the discounted sum of all of the financial benefits arising from a *Supply-demand balance* option (or scheme) and the discounted sum of all the costs arising from the option or scheme.

Network constraints

Network constraints occur where existing infrastructure is not capable of distributing all the water a treatment works can produce. Often constraints are associated with small rural sources on the edge of the supply network, feeding areas of local demand.

Normal year annual average

A *Supply-Demand balance scenario* considering a year with normal or average weather patterns

Normal year annual average demand

The total water demand in a year with normal or average weather patterns, divided by the number of days in the year.

Outage

A temporary loss of *Deployable output*. (Note that an outage is temporary in the sense that it is retrievable, and therefore deployable output can be recovered. The period of time for recovery is subject to audit and agreement. If an outage lasts longer than 3 months, analysis of the cause of the problem would be required in order to satisfy the regulating authority of the legitimacy of the outage i.e. it is being written off as a contributor to water available for use. Also see *Supply* and *Supply Demand Balance (SDB) equation.*

Outage allowance

The value of *Allowable outage* expressed in Ml/d. Outage allowances are a subset of planning allowances. The value of the allowance is based on the most critical resource planning period.

It combines with the supply element of the supply demand balance.

Planned outage

A foreseen pre-planned *Outage* resulting from a requirement to maintain source works asset serviceability. Planned outages must result directly from programmes declared by water companies under the general headings of maintenance, capital or revenue in accordance with the water company’s policy.

Planning period/horizon

An agreed look ahead period for which the Water Resources Management Plan is prepared.

Planning Scenario

The planning scenario for which a forecast is being derived.

Potential yield

The volume of water which can be withdrawn from a *Reservoir* or *Aquifer* in specified conditions, without depleting the storage so that withdrawal is no longer possible.

Preferred options

A supply-demand balance option or combination of options that have been selected as the option(s) best able to address the water resources planning problem.

Probability

A measure of the likelihood of an event. In practice, this can be estimated with the relative frequency of events such as the ratio of the number of times the event actually occurs to the number of times the event could occur.

Reservoir

An impoundment with natural or pumped inflows.

Reservoir storage

Freshwater (live storage and treatable dead storage) holding capacity of a reservoir which is part of a water system.

Resilience

The ability of a *Water system* to recover and return to full performance rapidly after being exposed to an extreme event. In the Water Resources Management Plan context, this reflects how the plan can cope with circumstances other than those planned for.

Restrictions

Enforceable restrictions on *Water demand* – for example temporary water use restrictions.

Risk

A measure of the *Probability* (or likelihood) of an event (or set of events) of a specified magnitude and the consequences of its occurrence.

Risk (target headroom allowance) profile

A specific level of *Headroom uncertainty* (known as target headroom allowance profile across the planning period) as a planning allowance to provide a buffer against uncertainty that is commensurate with an acceptable or tolerable level of risk within a Water Resources Management Plan.

Robustness

The ability of a water system to perform well across a range of possible future conditions.

Security of supply for water resources planning

The level of confidence (assurance) that a *Water system* can maintain a supply of water to meet *water demand* in an environmentally sustainable manner and at an appropriate price level.

Sensitivity analysis

A process whereby the components of the different parameters of the *Supply Demand Balance (SDB) equation* can be tested one at a time, to determine their influence on SDB risk and cost.

Sensitivity testing

A process that establishes the level of dependence of a given *Supply Demand Balance (SDB) scenario* on changes in a specific parameter, linked to the components of the *Supply Demand Balance (SDB) equation*. For example, per capita consumption estimates or occupancy rate for *Demand* forecasts and raw water or treatment works losses that are included in the *Supply* forecasts.

Simulation model

A representation of a *Water system* using a computer software package, in order to determine its behaviour over a wide range of conditions

Source

A named *Supply* input to a *Water resource zone*. For example, a multiple well/spring source, linked to a productive *Aquifer*, is a named place where water is abstracted from more than one operational well/spring.

Source works

All assets between and including the point of abstraction and the point at which it is first fit for purpose.

Supply (also referred to as water available for use or WAFU)

This is the total water available for use (WAFU), as defined through equations (1) and (2) below.

WAFU (own sources) = 1 − (2 + 3 + 4) ……………………………………………(1)

where:

- 1 is DO that incorporates yield gain from production side & resource management options
- 2 is reduction in DO
- 3 is outage allowance
- 4 is process losses

Total WAFU = 5 + (8 + 13) − (7 + 12) − 10 ……………………………………………(2)

where:

- 5 is WAFU (own sources)
- 8 is raw water imported
- 13 is potable water imported
- 7 is raw water exported
- 12 is potable water exported
- 10 is non potable supplies

Supply Demand Balance (SDB) equation

The development of the SDB equation is best illustrated with the expressions that describe the principal components of the final planning SDB.

WAFU (own sources) = 1 − (2 + 3 + 4) ……………………………………….(1)

where:

1 is DO that incorporates yield gain from production side & resource management options
2 is reduction in DO
3 is outage allowance
4 is process losses

Total WAFU = 5 + (8 + 13) − (7 + 12) − 10 ……………………………...……….(2)

where:

5 is WAFU (own sources)
8 is raw water imported
13 is potable water imported
7 is raw water exported
12 is potable water exported
10 is non potable supplies

Available Headroom = 50 − 14 …………………………….…………(3)

where:

50 is Total WAFU – see equation (2))
14 is Distribution Input (Demand) that incorporates yield gain from customer side & distribution side management options

Available Headroom = ≤ Target Headroom ……………………………………(4)

And

Available Headroom = ≥ Target Headroom needed to provide an appropriate level of assurance …………………(5)

The SDB Equation is:

SDB = Available Headroom - Target Headroom ……………………………………(6)

Supply-demand balance

The difference between total water available for use (as *Supply*) and forecast *Distribution input* (as *Water demand*) at any given point in time over the Water Resource Management Plan's *Planning period/horizon.*

Supply-demand deficit

An identified deficit between baseline total water available for use (as *Supply*) and forecast *Distribution input* plus the target *Headroom uncertainty* allowance profile across the *Planning period/horizon*.

Sustainability reduction

Reductions in *Deployable output* required by the environmental regulator to meet statutory and/or environmental requirements.

Sustainable economic level of leakage (SELL) and economic level of leakage (ELL)

The economic level of leakage is the level of leakage at which it would cost more to make further reductions than to produce the water from another source. The sustainable economic level of leakage (SELL) is based on the same concept, but SELL takes more explicit account of social and environmental costs and benefits.

Time series

A set of ordered observations on a quantitative characteristic of an individual or collective phenomenon taken at different points in time.

UKCP09 projections

The UK climate projections 2009 published in June 2009. The projections are “probabilistic” in the sense that they reflect a range of changes in climate based on observations, a large number of models and expert judgement

Unconstrained options

The complete and exhaustive list of all technically feasible options that could be used to address the *Water resources planning problem*.

Unplanned outage

An *Outage* caused by an unforeseen or unavoidable legitimate outage event affecting any part of the *Source works* and which occurs with sufficient regularity that the *Probability* of occurrence and severity of effect may be predicted from previous events or perceived risk. The definitive list of legitimate unplanned outage events is:

- Pollution of source
- Turbidity
- Nitrate
- Algae
- Power failure
- System failure

Unrestricted demand

The *Demand* for water when there are no enforceable *Restrictions* on customers' use in place (this definition can be applied at any point along the chain of supply, within a *Water resource zone*).

Water resource planning period

Currently, a regulatory 25 year time horizon from a base year identified by the water industry regulators.

Water resource zone

The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same *Risk* of supply failure from a resource shortfall.

Water resources planning problem

The water resources planning problem arises from a potential imbalance between supply and demand within a water system over the Water Resource Management Plan *Planning period/horizon*. The imbalance can be identified from an analysis of *Supply* and *Demand* forecasts which may reveal a baseline supply-demand deficit or an erosion of *Security of supply*. Resolution of the planning problem requires a supply-demand balance economic appraisal (*EBSD*) process for investment planning decisions.

Water system

A subset of, or an aggregate of, *Water resource zone*(s) with geographical boundaries covering different water resource features (e.g. reservoirs, groundwater sources, *Bulk supplies* and run-of-river schemes) and *Demand* centres and for which a "*Water system*" *Deployable output* can be estimated, and for which an evaluation of the *Supply-demand balance* can be carried out.

What-if scenario

A way of sampling from a range of future conditions e.g. demographics, climate, and environmental regulation, that affects *Demand* and available *Supply*, and the use of this information to define a *Planning scenario* for assessment and examination – i.e. it informs scenario planning in water resources management.

WRP tables

Water resource management plan tables, prescribed by the Water Resources Planning Guideline (WRPG), and used for the presentation of key quantitative data associated with a Water resource management plan.

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NI Water – Water Resource Planning

Annex A

Supply Options in West Water Resource Zone

March 2012

Notice

This document and its contents have been prepared and are intended solely for NI Water's information and use in relation to the interpretation of the Water Resource Management Plan and its relationship to infrastructure investment decisions identified by other studies.

Document History

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4.0	Revised draft for possible inclusion in Final WRMP	WRMP Team	BSP	AS	BSP	Dec 2011
3.0	Final draft for possible inclusion in Draft WRMP	WRMP Team	BSP	AS	BSP	July 2010
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1.0	Working draft for client contribution	WRMP Team	BSP	AS	BSP	July 2010
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1. Purpose of report

The Water Resource Management Plan (WRMP) has been prepared according to UK water industry best practice and DRD guidelines. The WRMP is based on a number of technical analyses that use data and information from a number of different sources within NI Water and also from external bodies.

The separate studies that underpin the WRMP have been reported in a series of Technical Reports many of which are now part of the WRMP Appendices. The Technical Reports were circulated to the Project Steering Group as individual elements of the work were completed.

The starting point of the WRMP process is to produce a supply demand balance; this under baseline conditions that represent the existing status and capacities of water sources and treatment works. The baseline condition was simulated based on an assumption that all water resource related infrastructure identified for completion during the PC10 period has been completed and is operational.

During review of the Draft WRMP, it was noted that the scheme relating to the River Strule to Derg WTW pipeline and associated abstraction was still outstanding for the West WRZ. Due to significant delays experienced in the issuing of a new abstraction licence and associated planning permission this scheme had not commenced prior to the PC10 period as originally planned.

During discussions with the NI Authority for Utility Regulation (NIAUR), to discuss the level of audit appropriate for the Draft WRMP, questions were raised about the continuing validity of the drivers for the Strule to Derg pipeline given delays in the issue of the required abstraction licence by NI Environment Agency (NIEA) and the granting of planning permission. The Draft WRMP also recognised that although the Carmoney to Strabane strategic link (JL 715 previously scheduled for completion during PC13) was not strictly required to maintain the supply demand balance in West Water Resource Zone (WRZ), completion of the scheme would provide operational flexibility and provide additional resilience to the WRZ.

The purpose of this report is to examine the drivers for the two schemes and to assess their continued validity. **The report is not part of the WRMP documentation because it does not fall within the strict scope as set out in the water resource planning guidelines.**

2. Water Resource Management Plan

The objective of the WRMP is to identify a strategy that ensures there is sufficient water available under specified design conditions to meet projected demands over the whole of the 25-year planning period, taking account of uncertainties in the various elements of the supply demand balance and the level of risk to security of supplies that NI Water is prepared to accept. The preparation of the WRMP follows specific technical guidance that has evolved over the past 20 years and that represents UK water industry best practice.

The output of the WRMP is an investment strategy that maintains the supply demand balance in each year of the 25-year planning period. The investment strategy is identified using a least-cost optimisation model which also takes account of environmental and technical issues.

The work undertaken for the Draft WRMP showed that the overall strategic aims of previous strategies were still valid, namely the continuation of a programme of new and/or upgraded strategic transfers from areas where supplies of treated water exceed demand combined with progressive reductions in average WRZ leakage levels.

On the basis of the following assumptions, the Draft WRMP concluded that at the company level NI Water had sufficient sources from its water treatment works (WTW) and PPP schemes to meet forecast demands;

- No change to existing abstraction licences;
- The time series of hydrological conditions from the historic record are considered to be representative of possible future conditions (without climate change);
- NI Water's WTW's continue to operate at the design capacity;
- Infrastructure schemes identified for completion during the PC10 period have been commissioned and are included in the baseline conditions;
- Leakage targets agreed with NIAUR are met by 2010–2013; and
- No change to current charging policies.

However in order to transfer water from areas of surplus to areas of deficit then some new or upgraded strategic transfer mains would still be required.

3. Derg Water Treatment Works (WTW)

3.1 Background

Raw water for the Derg Water Treatment Works (WTW) has been abstracted from the River Derg at Tievenny for a number of decades. The Derg WTW is the second largest WTW (after Killyhevlin) in the West Water Resource Zone (WRZ) and contributes 27% of the total treatment capacity in the zone. A schematic of the main features of the WRZ is shown in Figure 3.1.

By the end of the 1990s the Derg WTW had reached the end of its useful life so a new works was needed to ensure that treated water met the prevailing drinking water standards. The new WTW is located on the left bank of the River Derg at Tievenny about 500 m downstream of the old works, but the location of the intake structure on the River Derg has not changed. At the same time as a state-of-the-art water treatment plant was constructed, a decision was taken to increase the capacity of the works in line with demand forecasts and the recommendations of the Water Resource Strategy 2002–2030 (WRS 2002).

The new Derg WTW began operation in spring 2002 and has a stated design capacity (after allowing for process losses) of 25 Ml/d. The capacity of the new WTW therefore exceeded the volume authorised in the abstraction licence in force at that time; see section 3.4.

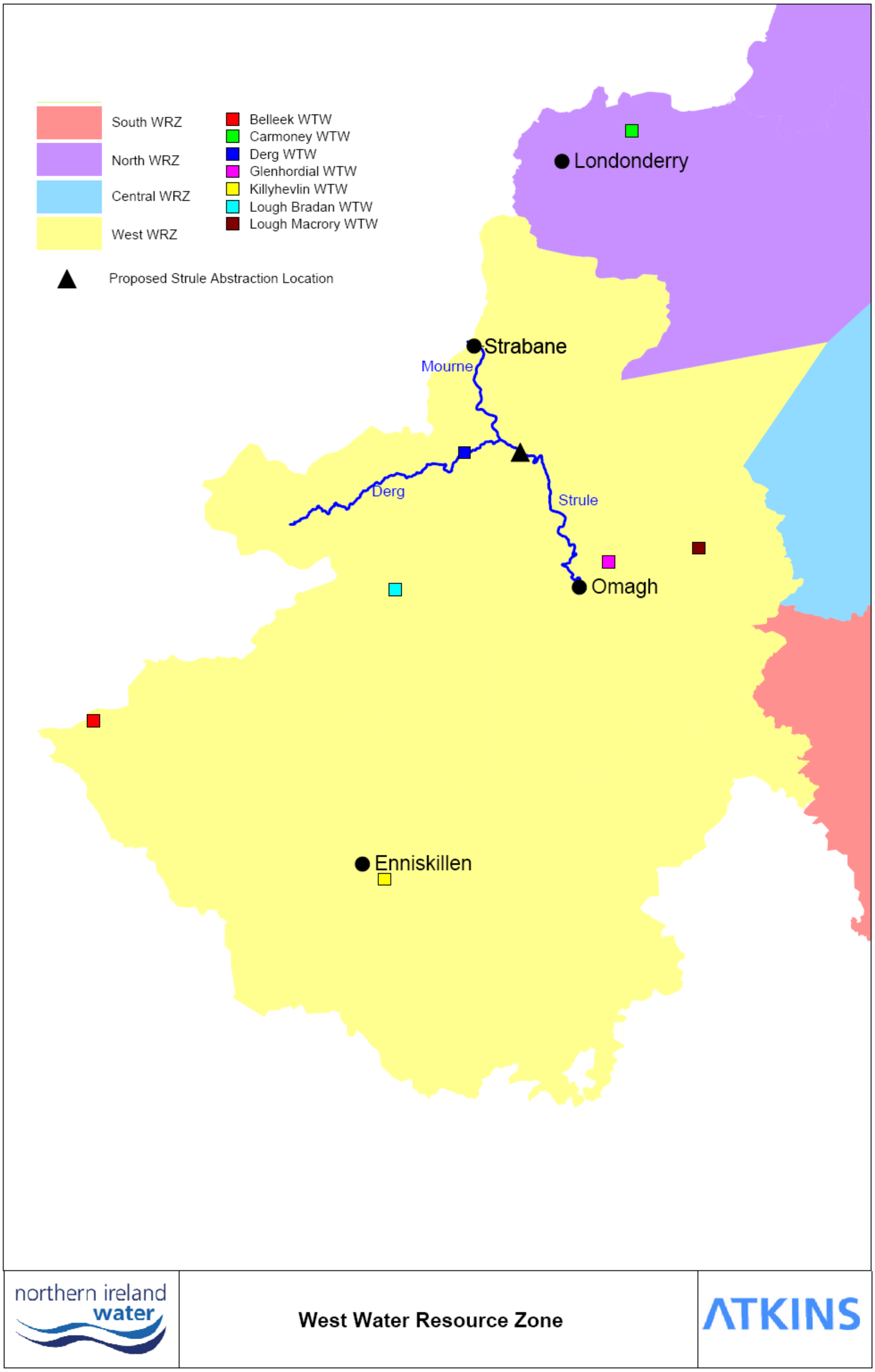

Figure 3.1 – Schematic of West Water Resource Zone

3.2 Alternative sources of raw water

A number of options for increasing supply to the new and expanded WTW were considered in the WRS 2002 and it recommended the acquisition of additional water rights. WRS 2002 concluded that there would be substantial environmental and cost implications associated with transfers of raw water from outside the immediate catchment which would involve construction activity and pipelines far in excess of that required for more local schemes. WRS 2002 therefore recommended a pumping station on the River Strule and a raw water pumping main from the River Strule to the Derg WTW, and ultimately the construction of a regulating reservoir on one of the headwater tributaries of the Derg at Glendergan. Each of these options would require detailed environmental studies to support applications for the required abstraction licences (see section 3.4) and planning permissions. Such studies were commissioned by DRD Water Service under the Derg Supply Area Augmentation project.

3.3 Environmental issues

The proposed sites for the Strule abstraction and the Glendergan reservoir lie within the River Foyle and Tributaries Special Area of Conservation (SAC). An SAC is an area that has been designated under European Legislation (The ‘Habitats Directive’). The Habitats Directive gives a higher level of environmental protection than the Water Framework Directive (WFD). The Habitats Directive is transposed into Northern Ireland law through The Conservation (Natural Habitats etc) Regulations (Northern Ireland) 1995.

The Glendergan River is also designated as an Area of Special Scientific Interest (ASSI), and forms part of the catchment that includes the Lough Foyle Special Protection Area (SPA) and the Lough Foyle Ramsar site. Therefore the European designation covering the river, in combination with its actual ecological position in the landscape and the presence of protected and Local Biodiversity Action Plan (LBAP) fauna confirm that this river is of national and international importance.

A series of environmental studies and other associated technical investigations were carried out in the period after publication of WRS 2002 in relation to the two infrastructure proposals: for a run-of-river abstraction from the River Strule; and to develop a dam and associated impounding reservoir on the Glendergan River. Note that the required output from the Derg WTW was defined within the WRS 2002.

Each of the two schemes (Strule abstraction & pipeline and the Glendergan Reservoir) would have environmental impacts on the Foyle and Tributaries SAC. The studies undertaken showed that the proposed Glendergan Dam would pose considerable environmental implications and likely raise significant opposition on environmental grounds. There are significant technical issues to resolve and a significant risk that the required permissions might not be granted for the scheme.

Balanced against this is the fact that at present, a practical resolution to the environmental issues regarding abstraction from the River Strule/Derg has been resolved to the extent that a new abstraction licence was issued in 2010 (see Appendix A). The new abstraction licence includes a number of controls and conditions some of which are new, for example the requirement for NI Water to develop and agree with NIEA a drought contingency management plan. The 2010 licence does not become live until the monitoring plan has been agreed.

3.4 Abstraction licence issues

3.4.1 General

When the new abstraction licensing regime was introduced by NI Environment and Heritage Service (EHS) in early 2007, DRD Water Service submitted licence applications for all its sources. New abstraction licences were issued by EHS in March and April 2007, with authorised licensed quantities based on the previous abstraction orders or in some cases the historical level of abstraction. The pre-2007 Abstraction Order for the Derg was 13.6 Ml/d, but the new licence was issued for 15 Ml/d from March 2007 to reflect the level of recent historic abstraction at that time.

It is important to note that at that time no environmental studies were required to be undertaken to support the licence applications.

The 2007 licence shares common features with all the other abstraction licences issued to NI Water at that time:

- To measure abstracted volumes at the works and make records available for inspection at each site. To record flows each week and make annual returns to NIEA;
- To undertake a monitoring programme with a plan submitted for approval by NIEA (by 31st March 2008 or other date agreed in writing) to cover locations, equipment and data recording procedures; and
- To submit a sediment management plan for approval by the same date as the monitoring plan including work details, methods, timing of activities, and disposal options.

3.4.2 Derg/Strule

A series of hydrological and other studies has been undertaken to support initiatives by NI Water to secure a new abstraction licence for the required volume of raw water to feed the Derg WTW. In April 2008 NI Water applied for a new licence to abstract up to 26.6 Ml/d from either the River Derg or from the River Strule or a mixture abstracted from both rivers. The licence application for the Derg/Strule was the first to be undertaken to meet new requirements for environmental statements and for supporting information to meet the requirements of the Water Framework Directive (WFD). EHS and then NIEA were at that time developing this approach to abstraction licensing to meet WFD requirements.

After protracted discussion between NI Water and Northern Ireland Environment Agency (NIEA) to retain the maximum flexibility for NI Water, the new licence with environmental flow conditions was issued at the end of April 2010. The new abstraction licence authorises abstraction from either the River Derg or the River Strule or both, up to a combined maximum of 26.6 Ml/d but with flow constraints on both rivers. The wording of the licence includes some of the conditions of the 2007 licence.

A copy of the licence (with key sections highlighted) is included as Appendix A to this Report. The licence refers to two types of flow constraint based on;

- UKTAG (UK Technical Advisory Group) guidance; and
- Hands-off flows (HoFs).

Note that the third bullet of Schedule 1.1 states:

> “the licence shall come into effect only upon submission and approval of sediment and flow monitoring plans (as listed in condition 9)”

Also, the last paragraph of Condition 9 states:

> “NB The operation shall not commence until the Department has given written approval to the said plans.”

Strict adherence to the conditions of the licence would mean that under certain, albeit very rare conditions, no water could be abstracted from either the Derg or the Strule which means that under the strict terms of the definition the yield from Derg WTW would be zero; severely affecting deployable output (DO).

Discussions with NIEA during the licence application process mean that a more flexible wording has been included in the licence, which gives NI Water the potential for abstraction at all times, provided that the measures of an agreed drought contingency management plan are implemented to reduce demand, mobilise alternative sources, and monitor environmental impacts during very low flows.

The discussions with NIEA have included reference to the proposed Carmoney to Strabane strategic link main in the West WRZ. There is a potential alternative source of treated water in the West WRZ, which is from Killyhevlin WTW. However, this option was assessed in the WRMP, and was not selected on economic grounds, particularly due to the need for a substantial upgrade of the WTW and installation of a pipeline between Enniskillen and Omagh. It is therefore to be assumed that NIEA would expect the Carmoney to Strabane strategic link main to be a constituent part of the drought contingency management plan.

3.4.3 Abstraction licence review

At the start of the WRMP work programme NI Water and Atkins representatives met on 7th July 2009 with NIEA to explain the context of the plan, to consult with NIEA, and to clarify what role NIEA would expect to take in the formulation of the plan. Copies of the agreed minutes of that meeting are included as Appendix B.

Key points from the minutes are:

- NIEA noted that licences issued in March 2007 were based largely on historical abstraction and were considered “to be generous”;
- NIEA will need to review all licences under Water Framework Directive (WFD) but no work programme or timetable has yet been developed, although a start has been made;
- NIEA anticipated that reductions in licences (Sustainability Reductions) will be agreed through joint NIEA/NI Water discussions without prejudice to the “Statement of Regulatory Principles Intent”; and
- NIEA noted that to date more attention has been given to scientific assessment of discharge consents rather than abstraction licences.

At the time of the Draft WRMP, NIEA had not advised NI Water of its proposed programme of abstraction licence review, nor given any indication of the abstraction licences that it considers to be particularly vulnerable to Sustainability Reductions in order to meet WFD and other environmental requirements.

The inference to be drawn from the July 2009 meeting and the protracted discussions on the Derg/Strule licence is that it is likely that NIEA will seek to impose additional licence conditions on other abstraction licences. Such Sustainability Reductions would be expected to lead to a loss in

DO in many cases and hence the need for additional schemes to maintain the supply demand balance. However, until such time as NIEA advises NI Water of the timetable for the abstraction licence review and the process through which options to replace the Sustainability Reductions would be funded, these considerable uncertainties cannot be included in the WRMP.

No further information has become available in time for consideration in the Final WRMP.

4. Supply demand balance

4.1 Demand

The base year demand has been based on the breakdown of the individual demand components reported in the 2008–2009 AIR Tables. This base year data was used as the start point for the normal year annual average forecast over the planning horizon to 2034–35. The planning scenario on which the WRMP is based considers dry year annual average (DYAA) demand – i.e. demand during a period of low rainfall (hence higher demand than in a “normal” year) but without any demand restrictions in place (unconstrained demand). Planning for “dry” years is a prudent, industry-standard approach to ensure security of supplies to customers in relatively unusual, though not extreme, climatic conditions. Hence the normal year demand forecast is factored up to represent demands that are likely to be experienced in dry years.

A summary of the key points to note is as follows:

- In the West WRZ, the base year DYAA demand was estimated to be 66.57 Ml/d;
- Population and property forecasts for Northern Ireland have been based on projections by the Northern Ireland Statistics and Research Agency (NISRA);
- In the West WRZ, the DYAA per capita consumption (PCC) was estimated to be 173 l/h/d in the base year. Forecasts of PCC were derived from a micro-component analysis which can be a useful means of building up an impact assessment profile of likely or known regulatory, behavioural and technological changes that influence household water consumption. The results of the micro-component analysis suggest there is an underlying stability in total PCC, so the PCC was assumed to remain constant throughout the planning period;
- Non-household demands were based on an economic outlook assessment over the short term for each of the main sectors of the economy of Northern Ireland conducted by the University of Ulster; and
- The baseline leakage strategy was informed by target levels of leakage agreed between NI Water and the regulator NIAUR. These target levels of leakage were based on work by Crowder Consulting and culminated with new levels of leakage reduction provided in October 2011. The target level of leakage for the West WRZ is assumed to remain at 20.13 Ml/d throughout the planning period.

The baseline forecast for each WRZ and for Northern Ireland as a whole is presented in Table 4.1 below. This baseline forecast is used to develop an initial supply demand balance for each WRZ. This provides an indication of the level of surplus or deficit in each WRZ in dry year conditions, assuming continuation of current policies and practices. If a deficit is identified in a given WRZ then a combination of demand-side and supply-side option will be needed in order to satisfy the deficits and thus ensure security of supplies under the specified design conditions.

WRZ	2008–09: base year	2017–18: end of PC13	2022–23: end of planning period 2013–2018	2034–35: end of planning period
NI water	**676.66**	**683.85**	**702.17**	**730.55**
East	311.55	308.95	314.12	326.69
North	81.69	83.27	84.85	88.56
Central	28.30	29.98	31.15	32.46
West	66.57	69.94	72.27	75.24
South	188.55	191.71	199.77	207.60

Table 4.1 – Summary of baseline demand forecast in selected years

4.2 Supply (Deployable output)

4.2.1 General

In accordance with UK water industry best practice deployable output (DO) has been calculated for the WRZ as a whole rather than for each source independently. The DO of the WRZ represents the total volume of treated water that is available in the WRZ as a whole under conditions of the worst drought on record, given the existing licence conditions and infrastructure capacity and configuration.

The approach is described in detail in Appendix A of the WRMP. For surface water sources, the calculation of DO is based on behavioural analysis using flow time series that are as long as possible. The calculation of DO as the combined output of all the sources in a given WRZ means this conjunctive use DO is very unlikely to be the arithmetic total of the individual source DOs.

Calculation of the conjunctive use DO is considered best practice in the UK, and the approach taken here follows that set out in guidelines that are based on a programme of R&D projects to develop practical methodologies for water resources planning funded by UKWIR and the Environment Agency (England & Wales).

None of the models or input data sets used for WRS 2002 was available for this WRMP. New water resource models have therefore been constructed using the Aquator water resource modelling application. The models have been configured to represent the current supply system. Model construction has used information and data collated from a variety of sources and through collaboration with both NI Water staff and the Atkins trunk mains model (TMM) team.

4.2.2 West WRZ

Under the previous licence of 15.0 Ml/d from the River Derg (section 3.4) the DO for West WRZ would be 68.2 Ml/d. This is equivalent to about 1.08 times the 2008–09 post MLE Distribution Input but delivers a deficit when compared with a demand forecast (plus target headroom) of 70.0–80.7 Ml/d over the planning period (see section 4.1). Furthermore, there are no environmental flow conditions on that licence and the new licence application has shown what would be expected by NIEA. Imposing UKTAG conditions on the Derg licence would reduce DO to 51.2 Ml/d.

The Strule pipeline offers a means to meet the forecast demand by supplying raw water from the larger River Strule to the Derg WTW. If one assumes that any drought contingency management plan is effective whenever needed (i.e. the output from the Derg WTW is not constrained by the flow conditions in the abstraction licence), then the DO for the West WRZ is 88.2 Ml/d which is equivalent to about 1.4 times the 2008–09 post MLE Distribution Input and delivers a surplus over the 25 year planning period (see section 4.1). This is the view taken by the WRMP.

When modelling to estimate DO there is always a critical ‘event’ that determines the DO. For the West WRZ the Derg/Strule licence DO is determined by Lough Bradan emptying in September 1984 under the combination of high demand and low flow conditions. This situation is managed in the model through optimisation to ensure that all other sources are used in preference to Lough Bradan in the run-up to the critical event. In terms of within-WRZ connectivity, the Killyhevlin demand centre in the south of the WRZ is receiving 36 Ml/d out of a possible 37 Ml/d at this point so there is not much scope for moving water within the zone. However, if hydrological constraints could be overcome the DO for the West WRZ would be increased to 90.6 Ml/d based on infrastructure limits.

In contrast, a strict application of the new licence conditions without effective drought contingency planning would reduce the DO to 64.7 Ml/d, which would still leave the WRZ in immediate deficit in terms of water resource planning despite the new Strule pipeline. Since there is no prospect for significant transfers within the zone under existing infrastructure constraints, additional supplies of water are needed if the forecast demands are to meet the security of supply desired by NI Water. Based on water resource planning guidelines, this additional supply of water is needed immediately.

The option of new storage in the zone has not been considered feasible for the WRMP and section 3.3 of this document explains that there remain considerable environmental, technical and planning issues around such a solution. There are also options which utilise treated water; however, as noted in section 3.4.2, the Carmoney to Strabane strategic link main (JL 715) is a significant scheme in the West WRZ currently planned for the period 2013–2018 and it would also be expected by NIEA to be a constituent part of the drought contingency management plan. This scheme would bring water from the North WRZ where there is a predicted surplus of 11.3 Ml/d through the planning period (see section 4.2.3 below). A transfer of 10 Ml/d treated water into the Derg/Bradan/Macrory supply area would increase the DO in West WRZ to 81.6 Ml/d even if an effective drought contingency management plan could not otherwise be implemented. This would be sufficient to meet the forecast demands for the whole WRZ and is discussed in sections 9.2 and 9.4 and of the WRMP.

To offer an explanation it should be noted that the nature of WRZ-scale (conjunctive-use) DO assessment is such that water is often locked-up in a zone when water is available but cannot reach an area of demand even within a single WRZ. When the West WRZ DO is restricted to 64.7 Ml/d, Killyhevlin is only outputting 26.5 Ml/d despite a capacity of 37 Ml/d. Thus, a 10 Ml/d supply of treated water into the Derg/Bradan/Macrory supply area can deliver a marginal yield (DO increase) of 16.9 Ml/d once some of the water locked-up at Killyhevlin is also made available.

4.2.3 North WRZ

Since the option considered for improving Security of Supply in the West WRZ is to import treated water from the North WRZ, it is crucial that the Aquator models are also used to assess what affect on DO comes from the use of a forecast surplus in this way from the North WRZ. The predicted DO for the North WRZ is 106.2 Ml/d which is equivalent to about 1.4 times the 2008–09 post MLE Distribution Input and delivers a surplus when compared with a demand forecast (plus target headroom) of 85.3–94.9 Ml/d over the planning period (see section 4.1). The DO is determined by Altnahinch reservoir emptying in September 1984. The largest source in the North

WRZ is the PPP works at Ballinrees, and in the Aquator model a link between Ballinrees and Altnahinch is critical to determining the DO for the WRZ.

Again, Ballinrees is critical, and there is a link between Ballinrees WTW and Moys service reservoir (SR), which has a 15 Ml/day capacity. Moys SR currently has a demand of about 6.5 Ml/day, but the CIP report for the “Ballinrees to Limavady/Londonderry Augmentation” is to allow the remaining capacity of this link main to be utilised in the Faughan/Altnaheglish supply area (i.e. Caugh Hill/Carmoney Zone). In the model it is assumed that the full 15 Ml/d can be transferred when needed.

Exporting 10 Ml/d of the predicted surplus as clean water from Carmoney to the West WRZ only reduces the predicted surplus to 10Ml/d; i.e. it stays in surplus. The reason that the change is slight is because Altnahinch normally controls the DO rather than Carmoney and so most of the export to Strabane is of water that was otherwise ‘locked-away’ in terms of DO calculations for the North WRZ.

4.2.4 Summary

It is apparent from the Aquator water resource modelling work that the Strule licence is critical for meeting predicted demands in the West WRZ. The modelling work also shows the potential of the Carmoney to Strabane link main scheme (JL 715) to deliver water to the West WRZ at critical times of need (periods of very low flows and drought) so that the supply demand balance is met with the security of supply desired by NI Water. There are a number of caveats that relate to this option and these are discussed in section 6.2.

5. Operational issues

5.1 Winter freeze-thaw

Freeze-thaw event occurred over the winters of 2009–10 and 2010–11. The freeze-thaw highlighted a number of key issues previously outlined in the 2002 Water Resource Strategy (WRS 2002) Summary Report that need to be addressed quickly to improve the robustness and resilience of the water network. Key recommendations from WRS 2002 included:

- Increased abstraction from River Strule: increase the output of the Derg WTW to 25 Ml/d by additional abstraction from the River Strule. This was initially recommended to be undertaken by 2005. Fast tracking needs to be considered on two fronts; the acquisition of the licence and the construction of the transfer main;
- Strategic Links: the freeze-thaw incident has highlighted the importance of delivering the strategic links set down in WRS 2002. Particular priority must be given to:
  - The Castor Bay to Newry link main (JG035) – Phase 1 scheme completed, Phase 2A construction due to start in January 2012, timing of Phase 2B to be determined;
  - The Carmoney to Strabane link main (JL715);
  - Castor Bay and Dungannon link main (JG036) – scheme completed;
  - Increased storage at Glenlough Service Reservoir, Ballymoney (JB648) – scheme completed.

The early delivery of these schemes will augment supplies to Newry/South Down, Strabane and effectively Omagh.

5.2 Drought management

As noted above a crucial element of the new Derg/Strule licence is the requirements for a drought contingency management plan to be developed by NI Water and agreed with NIEA. This has been specifically included in the licence to allow for flexible management of water resources in the West WRZ even under very low flow and drought conditions.

It is expected that the plan would include both demand-side and supply-side elements. However, the potential magnitude of demand-side savings is small. Given the relatively low peak to average ratio, discretionary use is already small. Some additional small savings in leakage might be possible, but the main opportunity would come from customer appeals to save water.

The main element of the drought contingency management plan would in theory be to mobilise new sources of water. However there are no unused raw water sources of sufficient size in the WRZ to be suitable options; the only practical options are thus to develop new storage or import water from a neighbouring WRZ where a surplus treated water is available. Until such a time as that is possible, the drought contingency management plan also allows for abstraction to continue as long as the monitoring of environmental impacts shows that abstractions are not having a deleterious effect on the ecology and function of the rivers.

6. Discussion of Options

6.1 Demand-side

There are three groups of potential demand-side options: metering, water efficiency schemes, and leakage control.

Domestic customers in Northern Ireland are not charged directly for their water use. Although a draft charging scheme has been developed by DRD, the Northern Ireland Executive has yet to conclude its position on water charging for domestic customers and has deferred domestic water charges until at least 2011. In line with this, there can be no universal domestic metering until a decision is made by the Executive.

NI Water's existing water efficiency policy encourages the efficient use of water amongst its household and non-household customers, through information leaflets, the Company's website, and at all Company events. NI Water places particular focus on educating its customers at all levels including school children through school visits. For the Draft WRMP three water efficiency options were considered to further promote water efficiency, but these were not selected for the least-cost plan. Since the Draft WRMP NI Water has begin to roll out its Water Demand Management Strategy (WDMS) which is expected to deliver further reductions in consumption through water efficiency measures.

Further incremental reductions in total leakage below the 166 Ml/d company-wide PC10 target level of leakage were considered for the Draft WRMP in order that longer term leakage reduction could be evaluated against other options for maintaining the supply demand balance. A revised leakage target of 165.4 Ml/d to be achieved by 2014/15 has been agreed with NIAUR. Further reductions in leakage were assumed to be available from 2015–16, in small increments with cost estimates for these increments were based on the leakage cost curves for active leakage control and pressure management and incorporating carbon costs as provided by Crowder Consulting in October 2010.

The main opportunity for demand management in the West WRZ is leakage reduction. However, based on the leakage control costs provided by Crowder Consulting and the supply demand balance, the modelling solution was to reduce leakage below the target level in the South and East WRZ only (with a small reduction in Central WRZ), where it made most economic sense to do so, whereas the West WRZ remained with a constant leakage target through the planning period.

6.2 Supply-side

On the supply-side there are two groups of potential options: raw water and treated water sources.

6.2.1 Raw water

Most of the rivers and loughs in West WRZ have been designated under some environmental scheme or other. The designations range from the Habitats Directive which gives the highest level of protection at an international level, through to national to local designations. The process of applying for new abstraction licence or for an increase in existing licensed quantity is likely to be an extremely lengthy process requiring detailed environmental work and a high burden of proof. A successful outcome is also not guaranteed.

Two raw water options have been considered: Glendergan and the Strule pipeline. Both are discussed earlier in the document and key issues are summarised below:

Glendergan

- A reservoir could be sited of sufficient size to deliver the water needed, but technical investigations did not proceed far enough to provide full confidence that the suggested sites are geo-technically feasible;
- There remains a considerable risk that environmental and planning issues cannot be overcome;
- The time needed to address environmental and planning issues is predicted to be extensive given examples from elsewhere in the UK; and
- A considerable programme of additional environmental work required.

Strule/Derg

- DO modelling shows that the previous licence was not sufficient to ensure the supply demand balance could be met;
- A new abstraction licence has been issued, but environmental flow conditions limit its reliability at very low flows;
- The licence contains reference to a drought contingency management plan that can be used to ensure abstraction continues at all times if environmentally acceptable. This would need to include activities to: reduce demand, mobilise alternative sources, and monitor environmental impacts during very low flows;
- Planning permission has been granted;
- Construction is due to start in 2012.

6.2.2 Treated water

Carmoney to Strabane (JL 715)

- This is the only scheme identified for the planning period 2013–2018 that can supply additional treated water to the West WRZ;
- Discussions with NIEA have included reference to this scheme and it can be assumed that NIEA would expect the Carmoney to Strabane strategic link main to be a constituent part of the drought contingency management plan (together with demand management and the monitoring of environmental impacts);
- The drought contingency management plan must ensure that the Carmoney-to-Strabane link is not used more than strictly necessary; i.e. only to preserve reservoir stores in case of DO conditions developing and during exceptional weather conditions such as those experienced during the 2009–2010 winter freeze-thaw (see section 5.1);
- DO modelling shows that transfer of 10Ml/d treated water is both available from the North WRZ and sufficient to meet the supply-demand balance in the West Zone;
- The CIP report for the “Ballinrees to Limavady/Londonderry Augmentation” allows for the full capacity of the Carmoney-to-Strabane link main to be utilised. This is the modelled situation, but is not yet possible until completion of the scheme;
- The export of water from the North WRZ requires (a slightly) increased abstraction from the River Faughan. This is within the existing licence, but there is a risk this may not be permissible after a sustainability reductions review;
  - Modelled abstractions (even without the export) breach UKTAG guidance with an estimated maximum abstraction impact of 56% (60% with the export) on river flows;
  - Putting it into a simple context; our minimum flow estimate for the River Faughan is 61Ml/d, while the licence allows an abstraction up to 55 Ml/d (although the works is limited to 35Ml/d output after losses) this is not sustainable and is likely to be reviewed.

Killyhevlin (JL 713)

- This option comprises the expansion of the existing Killyhevlin WTW to provide an additional 10 Ml/d of treated water capacity;
- New treatment works infrastructure would be required to provide the increased capacity at Killyhevlin WTW;
- There is no spare land available within the existing WTWs boundary and new land would need to be purchased adjacent to the boundary of the existing site;
- Additional distribution works would be required to allow transfer of treated water into supply from Enniskillen to Omagh;
- The option was not selected in the preferred strategy following investment modelling.

7. Conclusions

It is apparent from the Aquator water resource modelling work that the Strule licence is critical for meeting predicted demands in the West WRZ. The modelling work also shows the potential of the Carmoney to Strabane link main scheme to deliver water to the West WRZ at critical times of need (periods of very low flows and drought) so that the supply demand balance is met with the security of supply desired by NI Water. The construction of new storage in the West WRZ (e.g. a dam at Glendergan) would also have the potential to deliver this security of supply, but this would pose considerable environmental implications and likely raise significant opposition on environmental and planning grounds. In summary:

- The Strule pipeline is an essential requirement for maintaining the supply demand balance in the West WRZ;
- There is a risk that this scheme would not be effective to deliver the supplies needed under very low flow and drought conditions;
- The Carmoney to Strabane strategic link main is a scheme already identified for operational reasons to be implemented in the planning period 2013 – 2018 and which has also been raised as forming part of the drought contingency management plan required by NIEA as part of the abstraction licence;
- Water is available at Carmoney for the link at proposed capacity of 10 Ml/d, and this volume of water is sufficient to ensure that forecast demands (and headroom) can be met in the West WRZ.

No other alternative sources of raw water in the West WRZ are considered to be feasible options, except development of a dam at Glendergan which has been ruled out primarily on environmental and planning grounds. The option to utilise treated water from Killyhevlin was also assessed as part of the WRMP options appraisal process; however, this option was not preferred due to the need for a substantial upgrade of the WTW and installation of a pipeline between Enniskillen and Omagh.

Recent operational experience has identified the need for additional capacity and operational flexibility in the distribution system of the West WRZ. It is recommended that a feasibility study should be progressed to address security of supplies in the context of the planning and operational conditions included in the new Derg/Strule abstraction licence.

This annexe to the WRMP has been written to assess the continued validity of assumptions made in the WRMP. It does not form a part of the WRMP documentation as it does not fall within the strict scope set out in the water resource planning guidelines. It has considered the drivers, operational issues and preliminary indications of the trunk main capacity. Appendices to this document include the minutes of a meeting with NIEA and the abstraction licence.

Appendix A – Derg/Strule abstraction licence

LICENCE TO ABSTRACT AND IMPOUND WATER

Northern Ireland Water

Site Address: Public water supply abstractions/impoundment at Irish Grid References (IGRs) H3247286176 and H3897886465 from the Rivers Derg and Strule.

The Department of Environment (the Department), in accordance with the Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006 ("the Regulations") hereby grants this licence to Angela Halpenny (Head of Environmental Regulation), Northern Ireland Water (NIW), Northland House, 3 Frederick Street, Belfast, BT12NR for "the licence holder" to carry on, at or in connection with the site address set out above, the controlled activities described in the Schedule of Conditions to this licence, subject to the requirements of the Regulations and the conditions set out in the licence schedule.

Signed ....

Date of Issue ....

Authorising Officer on behalf of the
The Department of Environment
Environment and Heritage Service
17 Antrim Road
Lisburn
BT28 3AL

Date effective ....

The licence should be kept safe and available for inspection at all times.

Note: References to "the map" are to the map, which is attached to this licence.

Note: References to "the Department" are to the Department of Environment.

Water (NI) Order 1999
Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006

Schedule of conditions

1. Location of abstraction point, impoundment and discharge point

1.1. This licence authorises:

- The abstraction of surface water from the River Derg at IGR H3247286176. This is marked as 'Derg abstraction' on the attached map.
- The abstraction and impoundment of water on the River Strule at IGR H3897886465. This is marked as 'Strule abstraction and impoundment' on the attached map.
- The licence shall come into effect only upon submission and approval of sediment and flow monitoring plans (as listed in condition 9). If approved, this licence will replace the existing licence authorising the current NIW abstraction on the River Derg (Licence Ref AIL/2007/0037).

2. Purpose of abstraction

2.1. The primary purpose of this activity is for the public supply of drinking water.

3. Means of abstraction

3.1. The means of abstraction is by diversion and pumping of river water.

4. Period of abstraction

4.1. All Year.

5. Impoundment

5.1. The impoundment (as listed in condition 1) is a natural stone weir that may be refurbished during the construction phase. Full details of the work to be carried out must be provided as part of the monitoring plan (as listed in condition 9.1).

6. Abstraction volumes/rates

6.1. **This licence authorises:**

- The abstraction of water from the River Derg (as listed in condition 1) which shall not exceed 26.6 megalitres per calendar day (Ml/d); **or**

- The abstraction of water from the River Strule (as listed in condition 1) which shall not exceed 26.6 Ml/d; **or**
- The combined volume abstracted from both rivers shall not exceed 26.6 Ml/d

6.2. The maximum rate of abstraction at either intake point shall not exceed 0.308 cubic metres per second (cumecs)

6.3. Definitions of time periods:

- A calendar day = Midnight to midnight 24 hour period

7. UKTAG Water Resource Standards

7.1. The operator must ensure at all times the activity meets the proposed UK Technical Advisory Group (UKTAG) water resource standards for rivers at good status, as detailed in Table 1. Qn values represent the percentile of natural river flow that is normally exceeded e.g. Qn95 is the flow expected to be exceeded 95% of the time within a long-term record

Table 1

	Season	**Flow >Qn60**	**Flow >Qn70**	**Flow >Qn95**	**Flow <Qn95**
River Type	% change allowed from natural flow				
Salmonid spawning and nursery areas	Apr – Oct	25	20	15	10
	Nov – Mar	20	15	***Flow > Qn80*** 10	***Flow < Qn80*** 7.5

* The percentage values are the maximum permitted amount of change from the natural flow

7.2. Tables 2 and 3 apply these standards to the rivers Derg and Strule respectively, based on river flow data for the period 1983 to 2007. The maximum abstracted flows must remain within the % change from natural flow listed within these tables.

Table 2

	Season	**Flow >508,704 m3/d**	**Flow >347,166 m3/d**	**Flow >86,545 m3/d**	**Flow <86,545 m3/d**
River Type	% change allowed from natural flow				
Salmonid spawning and nursery areas	Apr – Oct	25	20	15	10
	Nov – Mar	20	15	***Flow >228,087 m3/d*** 10	***Flow <228,087 m3/d*** 7.5

River Derg based on river flow data for the period 1983 to 2007

Table 3

	Season	Flow >1,491,328 m3/d	Flow >1,091,165 m3/d	Flow >401,390 m3/d	Flow <401,390 m3/d
River Type	% change allowed from natural flow				
Salmonid spawning and nursery areas*	Apr – Oct	25	20	15	10
	Nov – Mar	20	15	*Flow >769,801 m3/d* 10	*Flow <769,801 m3/d* 7.5

River Strule based on river flow data for the period 1983 to 2007

8. Hands-off Flows

8.1. In order to meet the UKTAG water resource standards and to ensure adequate flow downstream of the abstraction points, the following hands-off flows must be maintained:

Table 4

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
River Derg HoF (Ml/d)	240	240	240	155	155	155	155	155	155	155	240	240
River Strule HoF (Ml/d)	340	340	340	340	340	240	240	240	240	340	340	340

9. Sediment and Monitoring Plans

9.1. At least 2 months prior to the commencement of this scheme a plan for monitoring the operation must be submitted to the Department for approval. The plan shall contain management, operational and monitoring details relevant to the following issues:

- River flow monitoring and the management of abstraction volumes
- The management of hands-off flows
- A pollution prevention plan for the construction phase of this scheme.
- Details of all monitoring and measurement devices and control systems
- Details of the design and operation of intake structures and refurbishment work that may be carried out on the weir
- Sediment management (or evidence that none is required)
- Maintenance activities; particularly with respect to the intake screens
- Record keeping and data return to NIEA

- Protocols for the reporting of any period when any abstraction does not meet the UKTAG water resource standards or hands-off flow as listed in conditions 7 and 8

9.2. The approved sediment and monitoring plans will constitute a detailed programme of activities and a reporting regime (for information/data) which must be provided to the Department as detailed in condition 9.1.

9.3. The said plans will also become a condition of the licence (as an annex) and may be reviewed periodically by the Department, the licence holder or in response to the reported monitoring results.

NB The operation shall not commence until the Department has given written approval to the said plans.

10. Inspection

10.1. Authorised Officers from the Department shall be allowed to safely inspect the operation of the scheme (including measurement devices) at all times.

10.2. Any change in the operation of the scheme which results in abstraction or impoundments of water not specified in the original application shall be notified immediately to the Department.

11. Record keeping.

11.1. A record must be kept of the daily abstraction volumes from both rivers. This abstraction record must be made available if requested by the Department and the operator must also submit an annual return of this information to the Department during the month of February in forthcoming years – see Appendix 1.

12. Drought Contingency Management Plans

12.1. This licence limits NIW's abstractions from the River Derg and River Strule (conditions 6.1, 6.2, 7.2 and 8.1). This water resource is used to supply the Derg Water Treatment Works.

12.2. In order to maintain public water supplies during times of exceptionally dry weather NIW will have drought contingency management plans in place.

Informatives

1. The licence

1.1. The licence may be reviewed, either upon request from the licence holder or if deemed necessary by the Department.

2. Fish pass/cumulative impact of abstractions

2.1. The cumulative impact of this proposed scheme and the existing abstraction to Rocks Lodge Fish Farm (Application No. AIL/2008/0152) will be assessed by NIEA, DCAL and Loughs Agency in order to determine whether a fish pass will be required.

3. Design and construction of structures

3.1. The design and construction of all structures including intakes, returns, and weirs must comply with current fisheries legislation. If any further alteration is made to the impoundment (as listed in condition 1) the licence holder shall immediately notify the Department, Department of Culture Arts and Leisure and Rivers Agency (Northern Ireland).

4. Environmental Effects

4.1. The operation of this scheme shall not have a detrimental effect on the environment in terms of water quality class or ecological status upstream or downstream of the abstraction point.

5. Water and Access Rights

5.1. Operation of an Abstraction Licence does not confer a legal right to abstract water or a legal right to access land at any location in Northern Ireland. Any authorisation granted in accordance with the regulations requires the applicant to have established "water rights" and "access rights" either through ownership or by agreement with any relevant third parties.

Appendix B – Minutes of NI Water/NIEA meeting on 7th July 2009

Project:	NI – Water Resource Management Plan		
Subject:	Kick-off meeting with NIEA		
Date & Time:	Tuesday 7th July 2009, 14:45 to 16:15	**Meeting No:**	1
Meeting Place:	NIEA, Lisburn	**Minutes By:**	BSP
Present:	Dave Foster Mark Livingstone Tom Adamson	**Representing:**	NIEA
	Dave McCrum Alison McMullan		NI Water
	Ben Piper		Atkins

<table>
<tr><th>Item</th><th></th><th>ACTION</th></tr>
<tr><td></td><td>Purpose of meeting
• BSP explained the background to the WRMP and the requirement in the Brief for Atkins to consult with NIEA on a number of issues.
• The main purpose of the meeting was a high-level introductory meeting; more detailed technical meetings will then take place as required between the Atkins team and appropriate NIEA staff.
• BSP also explained that discussion at the meeting should help NIEA identify WRMP related issues on which it might seek to be involved.
• BSP explained that the draft WRMP is due to be completed by April 2010. The draft WRMP is seen by NI Water as the 1st stage in an iterative process, with successive plans based on more robust and reliable information.
• BSP explained that WRMP project also includes the development of a Trunk Mains Model (TMM).</td><td></td></tr>
<tr><td></td><td>Introductions with Roles and Responsibilities
NIEA
Dave Foster; Head Water Management Unit (comprising 8 Technical Groups)
Mark Livingstone; Head Uniform Licensing Group
Tom Adamson; Water Utility Regulation Team
NI Water
Dave McCrum Head of Environmental Regulation (Waste Water & Waste, Drinking Water and LIMS sections)
Alison McMullan Environmental Regulation, Drinking Water Regulation, including WTW discharges and abstractions
Atkins
Ben Piper; Project Manager
Brian Cox; Technical Lead, supplies
James Duggin; Technical Lead, demands
Andrew Mahon; Technical Lead, SEA</td><td></td></tr>
<tr><td></td><td>Overview of WRMP process
• BSP gave a high-level overview of the WRMP process.
• Dave Foster advised that in contrast to Environment Agency in England & Wales, NIEA at present has no statutory Water Resource Planning function.
• After discussion, DF agreed that NIEA would review its statutory and non-statutory role in the WRMP process and advise NIW/Atkins. DF was not able to give a timetable for this, but noted that it would be useful to include material that describes NIEA role in the draft WRMP.</td><td>NIEA</td></tr>
</table>

Item		ACTION
	Elements of WRMP requiring further dialogue between NIW/Atkins and NIEA **Possible Reduced Abstraction Sites** • NIEA noted that licences issued in March 2007 were based largely on historical abstraction and were considered “to be generous”. • NIEA will need to review all licences under Water Framework Directive (WFD) but no work programme or timetable has yet been developed, although a start has been made through a pilot Monitoring Plan. • NIEA anticipates that reductions in licences will be agreed through joint NIEA/NI Water discussions without prejudice to the “Statement of Regulatory Principles Intent”. DMcC to send Atkins copy of SORPI. • NIEA noted that to date more attention has been given to scientific assessment of discharge consents rather than abstraction licences. • NIEA asked whether Atkins would take account of ecological requirements when calculating deployable outputs (DO). • BSP advised that DO calculations have to be based on current licence conditions. If future changes to licences are envisaged then these will need to be advised to NIW/Atkins so that they can be taken into account in future revisions of DO. • DF noted that such information was unlikely to be available for the draft WRMP. • BSP advised that DO assessments for the draft WRMP would be made using current licence conditions. If NIEA is able to identify well in advance of the draft WRMP catchments where it considers abstraction licences to be at risk, then these can be referred to in the draft WRMP as possible risks to the future supply/demand balance. • NI Water advised that most groundwater sources were in the process of being decommissioned or mothballed. Groundwater sources are unlikely to be a major component of the WRMP	DMcC NIEA
	Strategic Environmental Assessment (SEA) • DF advised that NIEA would review the requirement for SEA internally. • TA to advise Atkins of the NIEA contact (likely to be from the Agency’s Strategy Unit) for Atkins to approach for discussion of SEA.	NIEA TA
	Water Framework Directive (WFD) • See comments above referring to abstraction licence review. • NIEA noted that under current programme it seemed unlikely that abstraction issues would be dealt with under 1st round of River Basin Management Plans (RBMP) but with more action expected for 2nd round.	
	Use of common data and models • BSP explained that Atkins was in the process of developing Aquator models of the water resource system. • The Aquator models may have wider water resource planning uses of interest to NIEA. The models will need to be populated with flow time series. Where observed records are not available, use of the LowFlows application would facilitate the generation of flows at	

Item		ACTION
	ungauged catchments. • All agreed the principle that data and models should be shared wherever possible. Atkins supply-side work to continue on assumption that outputs from LowFlows will be available. TA/Brian Cox to review in context of LowFlows training/handover to be undertaken at end of July 2009. • TA expressed concern at the reduction in rainfall observations at NI Water sites; BSP advised that this was not within the scope of the WRMP.	Atkins
	WRMP Process • DF noted that NIEA would review its approach to the WRMP and would advise NI Water in due course. • BSP noted that WRMP process has been adapted by SEPA (Hilary Smithers) for use in Scotland. There may be useful parallels for NI which Atkins is exploring	BSP
	Climate Change • DF noted that NIEA has a small climate change team • NIEA is keeping a watching brief on climate change and is developing its approach. • DF mentioned recent SNIFFER research, and that climate change is not as embedded in NIEA as within Environment Agency	
	Requirements for future high-level meetings • General agreement that NIEA (as well as NI Water and NIAUR) is at an early stage in developing its approach to WRMP process. The process will need to take time to bed-down and evolve • It was agreed that it might be appropriate for NIEA to attend a Project Steering Group meeting at some stage	

Final Water Resources Management Plan 2012
Main Report

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