CALCULATING UNCERTAINTY IN THE SUPPLY DEMAND BALANCE

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ABSTRACT

Management of water resources requires prudent decision making in the face of both short and long term uncertainties.

Probabilistic outage and headroom methodologies have been developed by United Kingdom Water Industry Research to quantify short and long term uncertainties respectively. Outage represents an allowance for a reduction in source or treatment capacity. Headroom represents uncertainty of either the yield that sources can supply, or the demand that is forecast. These concepts therefore provide a framework for considering risk and uncertainty in the water supply-demand balance in a clear and transparent manner.

This paper summarises the application of outage and headroom methodologies the metropolitan Auckland water supply and a small town outside of the main network. The output of each of these assessments is a probability distribution, from which the water provider, Watercare, can select a value that reflects the exposure to uncertainty that it can accept and that is also acceptable to customers. One key benefit highlighted by this study is that the outcome can be a single value of a reasonable buffer, or uncertainty allowance, for each part of the planning period. This makes communication with non-technical stakeholders more straightforward.

KEYWORDS

Calculating uncertainty, outage, headroom, risk, water resources

1 INTRODUCTION

Management of water resources requires prudent decision making in the face of uncertainty (Hall et al., 2012). Inevitably supply planning and demand forecasting use information from the past to predict the future. However, many factors that influence available water supplies can be subject to change over the long term, with uncertainties including potential changes in climate, regulatory regimes or water quality. Similarly, socio-economic and land-use changes could result in changing patterns of demand, which are also uncertain. The allowance made for this uncertainty is referred to herein as the "headroom" between the forecast demand and the available supply.

Uncertainties in available supplies also exist on a day-to-day basis. At any given time it is unlikely that a water utility will have all of its sources and treatment works available to it at their specified capacity. Reductions in capacity can be due to planned and unplanned maintenance, power failures or changes in raw water quality – such as turbidity or pollution events.

Following an international literature review, Watercare concluded that structured methodologies published by UK Water Industry Research (UKWIR) provide the most robust probabilistic methodology for assessing these supply demand balance uncertainties. Watercare appointed CH2M Beca Ltd and Tonkin & Taylor Ltd to undertake these assessments on their behalf.

This paper summarises these methodologies and details how Watercare has applied them to the metropolitan Auckland supply demand balance and a small town outside of this main network.

2 UNCERTAINTY IN THE SUPPLY DEMAND BALANCE

2.1 POSSIBLE APPROACHES

A review of different methodologies that have been applied internationally to make allowances for risk and outage in water resource planning was completed. Watercare sought this review to enable them to apply an appropriate approach to consider uncertainty. The review found that:

- There are few published structured methodologies for calculating outage. UKWIR (1995) provides an appropriate probabilistic approach, although its application varies in detail.

- In broad terms, utilities and regulatory bodies recommend the use of probabilistic methodologies and / or scenario planning for consideration of long term uncertainties in the supply demand balance. Whilst Monte-Carlo approaches are mentioned and a number of possible frameworks are set out (NSW Office of Water (2010), Water Services Association of Australia, (2008), Gravens et.al, (2008)), the only detailed published probabilistic methodology is that of UKWIR (2002).

The US Army Corps of Engineers (Gravens et.al, 2008) recommends using Monte Carlo based planning to assess uncertainty as part of water resource planning. This is a similar approach to UKWIR (2002) whereby Monte Carlo analysis is used to assess uncertainty (i.e. headroom). The advantage of the UKWIR approach is that it is a proven methodology that brings together many of the different supply and demand uncertainties that apply to long term water resource planning.

The difference between scenario planning and a probabilistic approach is the output provided. One of the advantages of the UKWIR approach is that following completion of the modelling and the selection of the level of acceptable risk, a value of uncertainty is identified that can be planned for at different stages in the future. It is advantageous to group these uncertainties in this way and to be able to describe them as a single value (changing over time).

A scenario based approach would provide a wide range of uncertainties that are difficult to combine. However, if there are any very large uncertainties (and hence large risks), it may be better to explicitly address these using scenario analyses and address all the minor uncertainties with headroom.

Watercare concluded that applying the UKWIR outage and probabilistic headroom methodologies, possibly combined with scenario analysis where appropriate, would provide the most readily applicable and relevant systematic approaches for incorporating short term supply uncertainties and long term supply and demand uncertainties into its water resources planning framework. Both of these methodologies apply a stochastic approach to the assessment of risk.

2.2 SUPPLY DEMAND PLANNING FRAMEWORK

Outage and headroom are concepts that are included in the UK water industry's approach to water resource planning. This is one of a number of methodologies from the UK that have developed due to the (unique) regulated environment post privatisation and the risks faced by water companies. These began by the development of methodologies to assess the Deployable Output (the reliable yield) of sources and forecast future demand. It was then realised that there are 'threats' to the Deployable Output and uncertainties in the supply-demand balance. This led to the incorporation of outage to make an allowance for temporary reductions in Deployable Output, followed by the headroom methodologies which enable the quantification of uncertainty.

A simple diagram which illustrates the supply-demand balance is presented as Figure 2-1. The timing of water resource infrastructure investment is based on a comparison of the forecast demand for water and the reliable yield of the sources of supply. Allowances for uncertainty related to both supply and demand are included as outage and headroom. This shows the expected point in time when infrastructure investment is required as demand plus headroom exceeds the water available for use.

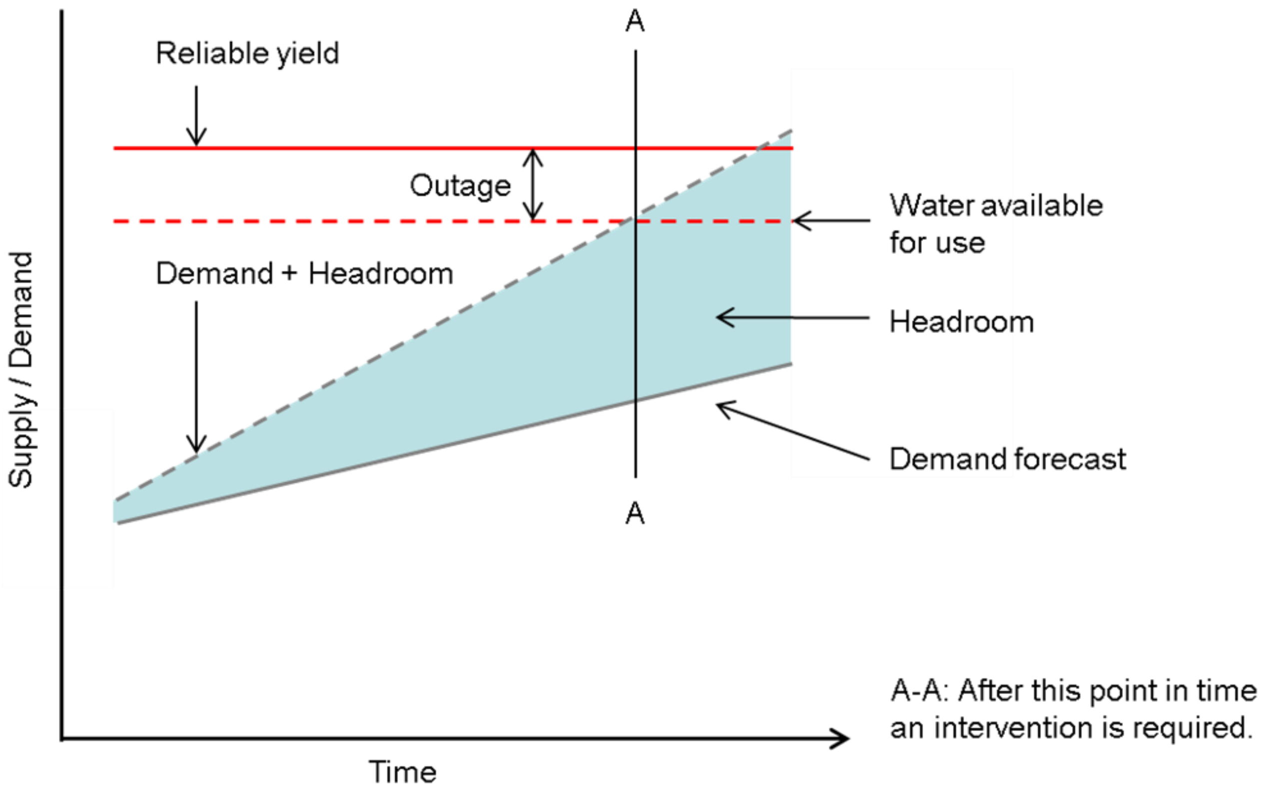

Figure 2-1: Illustration of the supply-demand balance

2.2.1 OUTAGE

The UKWIR (1995) outage method incorporates a frequency based approach that combines distributions for specified types of outage events. The data required to develop the methodology includes:

- The duration of the event (days); and
- The magnitude of the loss of output during the event (in ML/D).

A key point of this approach is that it is based on records of actual outage events. These data must be recorded to enable the methodology to be implemented. The methodology is accompanied by a user guide and spreadsheets to assist users to implement this methodology. Note that outage is more critical to small, stand-alone water resource zones that are fed by a small number of sources. Watercare's metropolitan area is an integrated system, where an outage event may not necessarily reduce its ability to meet supply targets due to system interconnectivity. Outage may therefore be more critical to Watercare outside of the metropolitan supply area, where small numbers (or single) sources are used.

Allowed outage events are prescribed by UKWIR (1995) and comprise:

- Pollution – e.g. chemical spill, tanker in river;
- Algae – e.g. cyanobacteria, toxic supply, odour, discolouration;
- Turbidity;
- Power failure; and
- System failure – e.g. pump failure, damaged valve/pipeline, blocked screens etc.

Nitrates and planned outage are the two other outage categories identified by UKWIR (1995). Nitrate effects on groundwater are identified as a particular issue in the UK. With regard to planned outages the Environment Agency (2012) note that planned maintenance impacting yield should be timed outside peak periods.

The concept of a "sourceworks" is important for the outage assessment but not straightforward. UKWIR loosely defines this as "all assets between and including the point of abstraction and the point where the water is first fit for purpose". A review of approaches taken by United Kingdom water companies was undertaken. This study has considered each water treatment plant (WTP), with its associated sources, as a sourceworks. Figure 2-2 shows the Ardmore sourceworks as defined for the purposes of the 2014 outage assessment as an example. This is consistent with approaches taken by United Kingdom water companies (ESW, 2008) and ensures that the assessment:

- Does not consider impacts on a water source that do not affect system output, as the WTP can treat the particular pollutant without a loss of yield; and
- Does not double count outage events.

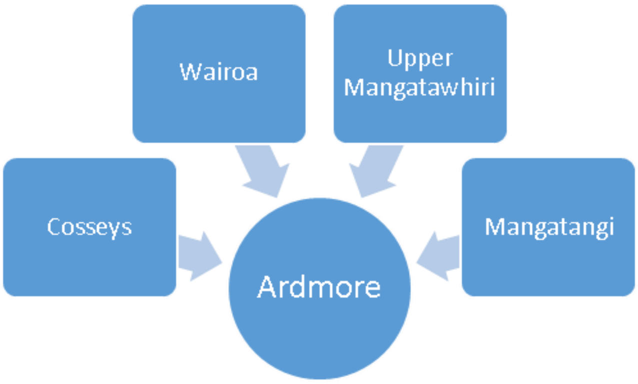

Figure 2-2: Ardmore sourceworks

The results of the assessment include a distribution of potential outage from which a value (usually the mean) can be selected for inclusion in the supply-demand balance. Making an appropriate allowance for outage is important for all water supply systems, but is particularly important for small, discrete supply systems where a loss of output could lead to the level of service not being met.

2.2.2 HEADROOM

As for outage, the UKWIR (2002) methodology sets out clearly the 'allowed' components of headroom and their composition as summarised in Figure 2-3. Uncertainties in the supply-demand balance may either increase, or reduce, the surplus between supply and demand. Headroom is calculated to enable a reasonable allowance for these uncertainties to be made.

Typically, a triangular distribution is used around a best estimate of the component of uncertainty, although other types of distributions can be adopted where there is sufficient data to describe them. It is important to consider how the uncertainties contribute to either 'negative' or 'positive' headroom for both supply and demand side components.

The headroom methodology (UKWIR, 2002) reviews this with respect to the different input parameters. Reductions in supply availability lead to positive headroom, i.e. reduced source output requires increased headroom (or risk allowance), and increases in supply availability lead to negative headroom. For demand side components the opposite is true. When there is increased demand this leads to positive headroom while reductions in demand lead to negative headroom.

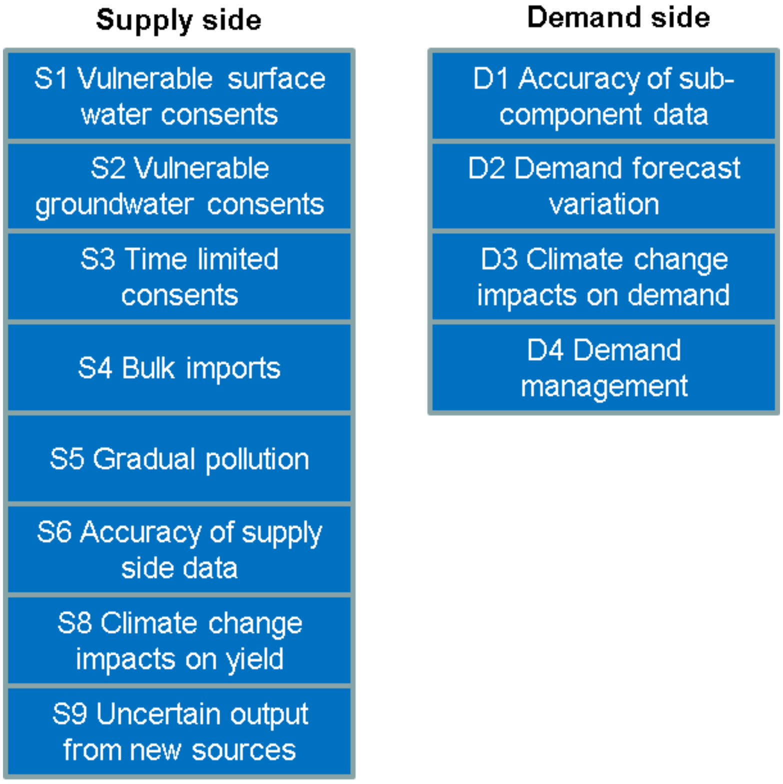

Figure 2-3: Supply and demand side headroom components (UKWIR 2002)

The headroom results show a distribution of uncertainty that can be added to the supply-demand balance. A graph of typical results is shown in the extract from the UKWIR guidance (2002) which is reproduced as Figure 2-4. The results therefore describe the headroom uncertainty and how this changes over time. At each point in the graph where the uncertainty has been assessed, the overall risk to supply can be represented as a curve, or distribution, as indicated by the lower part of the figure. These are combined across the planning period to set out the overall risk.

The results generally indicate increasing uncertainty with time. Many of the planning uncertainties increase with time, as the basis on which the assessments are made are less well understood. Watercare can therefore select the value of headroom that reflects the level of risk that they will take, on behalf of their customers. If this level of risk is low (for example the mean) this could lead to an increased risk of deficit as too many of the uncertainties are not accounted for. Where it is too high this could lead to the development of additional water resources in advance of when they are actually required.

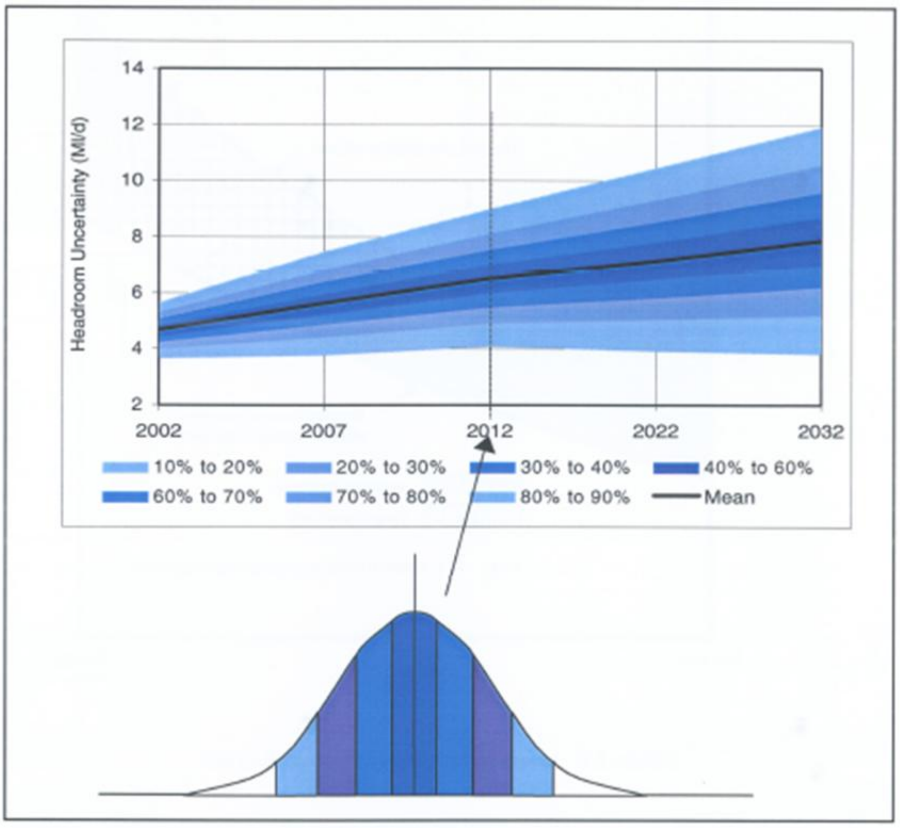

Figure 2-4: Typical results from headroom analysis (Reproduced from UKWIR (2002))

3 APPLICATION TO WATERCARE

3.1 METROPOLITAN AUCKLAND

Watercare provides water and wastewater services to around 1.4 million people in the Auckland region. The average daily supply is 326ML (Watercare Services Limited, 2014). Watercare operates two Levels of Service within its Metropolitan supply area. These are:

- To supply average demand during a drought with a severity of 1 in 100 years, with 15% capacity remaining within the reservoirs; and
- To meet peak demand during a 1 in 20 year drought without imposing hosepipe bans.

The supply-demand planning work carried out by Watercare is within the context of meeting these two levels of service. The supply system comprises the following main components, which are operated conjunctively:

- The Waitakere Dams (Upper and Lower Huia, Upper and Lower Nihotupu and Waitakere Dams) and the associated Huia and Waitakere WTP;
- The Hunua Dams (Cosseys, Wairoa, Managtawhiri, Mangatangi) and the associated Ardmore WTP;
- Onehunga groundwater supply and WTP;
- Waikato River supply and WTP.

3.1.1 OUTAGE

The authors carried out an assessment of outage for the peak month in 2014 (CH2M Beca/Tonkin & Taylor, 2014). This was carried out in accordance with the UKWIR methodology (UKWIR, 1995). Figure 3-1 provides an overview of the approach taken to this study. It commenced with two parallel workstreams; a literature review of available methodologies for developing estimates of headroom and outage, alongside a data gathering process. Following the completion of these two activities preferred methodologies were identified. Workshops were held with Watercare operations and planning staff to:

- Develop the methodology for collating outage data;
- Refine and sense check outage data; and
- Review the assumptions underlying the draft headroom distributions.

The approach adopted incorporated a return period which was linked to each type of event, with the maximum event included being a return period of 1 in 20 years. Therefore, events which were perceived to have a return period of greater than 1 in 20 years were not included in the analysis. The results of the outage assessment are therefore an estimate of the mean outage that would be expected to occur during the peak month.

Once the model inputs were finalised the @RISK models were developed, model outputs produced and sensitivity tests performed. Model results, interpretation and the overall conclusions followed.

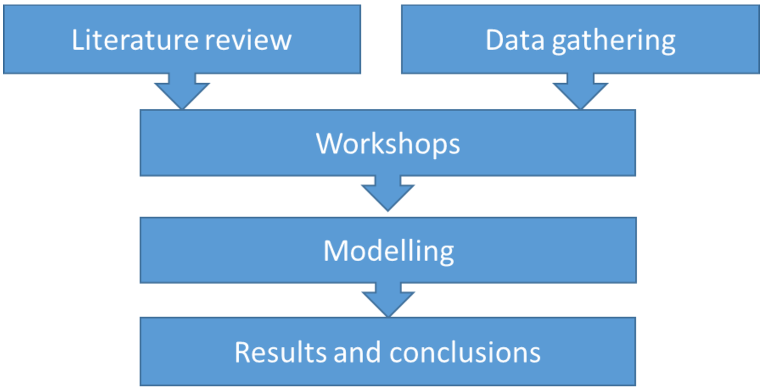

Figure 3-1: Process followed to develop the outage and headroom assessment

INPUT DATA

A detailed review of historical outage data for the period 2010 to 2013 was undertaken for this study by Watercare. The methodology involved reviewing weekly operations team meeting minutes to identify possible outage events. For each possible event Watercare's SCADA system was then interrogated to identify the outage:

- Start date, time and flow;
- Restart date, time and flow;
- End date, time and flow;
- UKWIR outage category; and
- Any other information.

This information was recorded in a standardised spreadsheet. Staff identified a ‘restart’ period as the time over which the Waikato WTP (water treatment plant) ramps up to the pre-outage flow as schematically shown in Figure 3-2.

Subsequent discussions with operations staff refined this approach, with the restart period for all sites other than the Waikato WTP being included in the estimated outage figures. The outage volume for the Waikato works has been treated separately and includes an allowance for a restart of 10ML/hour.

A workshop was held with Watercare planning and operations staff to sense check the data collated and to discuss potential legitimate outages at each ‘sourceworks’. The study then proceeded to consider the characteristics of the events and sourceworks, the underlying uncertainties and the most appropriate means of representing these within the outage analysis.

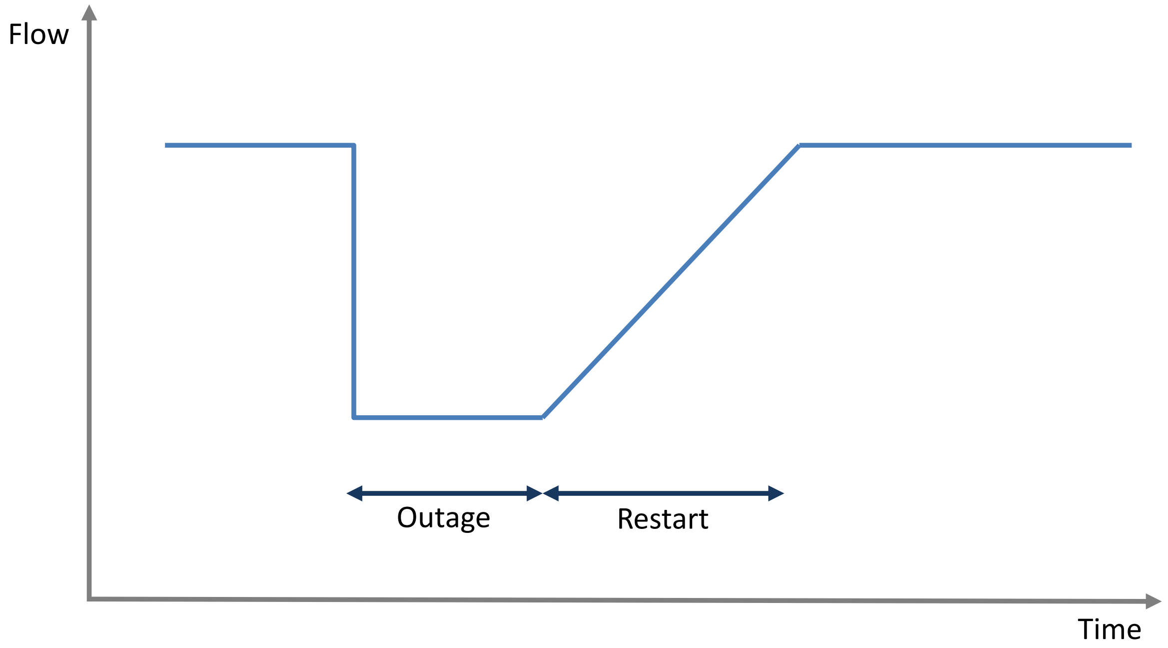

Figure 3-2: Schematic outage event including restart period

The model inputs were developed from known historical outage events where possible, with input from Operations staff through workshops. This methodology enables perceived risks to be identified, as allowed by UKWIR. This is a pragmatic approach that recognises that few, if any, water utilities will hold an accurate long term record of system outages in a format that is ideal for the purposes of this form of assessment. The literature review carried out for this study identified that UK companies to not hold comprehensive outage databases, despite the regulatory requirement to carry out this assessment.

Historical outage events have enabled the development of probability distributions for key events with certainty, notably turbidity events at Ardmore and pollution events on the Waikato River. The data collated have also enabled the distributions for smaller and more frequent outage events, such as power outages, to be developed with more confidence.

Consideration was given to including possible outages linked to cyanobacteria. However, a decision was made that there has been no record of such outages previously and including this type of event would be overly conservative in the current assessment.

Following the workshop phase of the outage assessment a decision was made to incorporate a return period assessment into the outage analysis. This enables the model to reflect the fact that not all possible outage events can reasonably be expected in each year. For example, a significant cyclone causing turbidity related outages at Ardmore would not be expected every year.

The return period was included in the model as a discrete distribution with an output value of either ‘0’ or ‘1’, with the frequency of occurrence linked to the return period. Hence if the return period is 1 in 10 years, a result of 0 would be expected nine times and a result of 1 only once. This binary output is then multiplied by the randomly selected output from the duration and magnitude functions.

The assignment of a return period needs careful consideration for the peak period analysis. The probability should reflect the likelihood of the event occurring in the peak month. For example, a cyclone event like Cyclone Wilma has a return period of 1 in 10 years. It is most likely to occur in the late summer, so a return period of 1 in 10 Februaries is considered reasonable. However, a pollution event at the Ardmore sourceworks arising from a forestry truck falling into a lake may have an overall likelihood of 1 in 20 years, but a lower chance of impacting the month of February. A sensitivity analysis has been carried out to consider the impact of these assumptions on the outage assessment.

RESULTS

The results of the peak month outage assessment are shown as Figure 3-3 and Figure 3-4. Figure 3-3 shows the overall results of the 50,000 iterations of the Monte Carlo analysis. The outage values are shown on the x-axis and the percentage of recurrence on the y-axis. Figure 3-3 plots the frequency that the results from the 50,000 iterations fall into each of the bars of the histogram. As an example, around 5% of results were in the band 22 to 27ML/D. The key statistics describing the distribution are also shown, including the mean. This shows that the mean outage over the month of February was calculated as 39 ML/D, ranging from a 5th percentile of 21.6 ML/D to a 95th percentile of 88.8 ML/D.

The influences on the outage calculation are shown in the 'tornado plot' in Figure 3-4. This shows (from top to bottom) which elements of the outage calculation are most significant, centred around the mean. Therefore, in this baseline case, the most significant influence is the extended turbidity event at the Ardmore sourceworks, with the effect of the other elements reducing in scale.

It is reasonable to expect that the Ardmore sourceworks has the largest impact on the overall outage figure as this contributes the largest proportion of Deployable Output. Five of the top ten outage influences are at this site. The tornado plot further shows that the return period assumptions are significant, with the top 5 influencing outcomes linked to whether the events listed occur.

Whilst the Environment Agency (2012) notes that the outage value should link to the water utility's level of service, it is normal practice to use the mean value of the outage analysis in the supply-demand balance. The reason for this is that the stochastic analysis required to link outage with level of service is very complicated and data intensive. A 1 in 20 year demand will occur due to a specific set of characteristics, usually linked to weather, but also resulting from a degree of randomness. The outage figure with a 5% change of occurring in any year is likely to be the result of a different set of characteristics and randomness, which may or may not be linked to those resulting in high demand. To correlate the two analyses a time series analysis of each supply, demand and outage component would need to be developed and modelled. No known analysis of this level of complexity has been identified during the course of this review.

It is useful to consider the mode and median values for the outage distribution. The mode is 25.5 ML/D and the median 31.6 ML/D. This shows that the larger outage events have a significant impact on the overall mean.

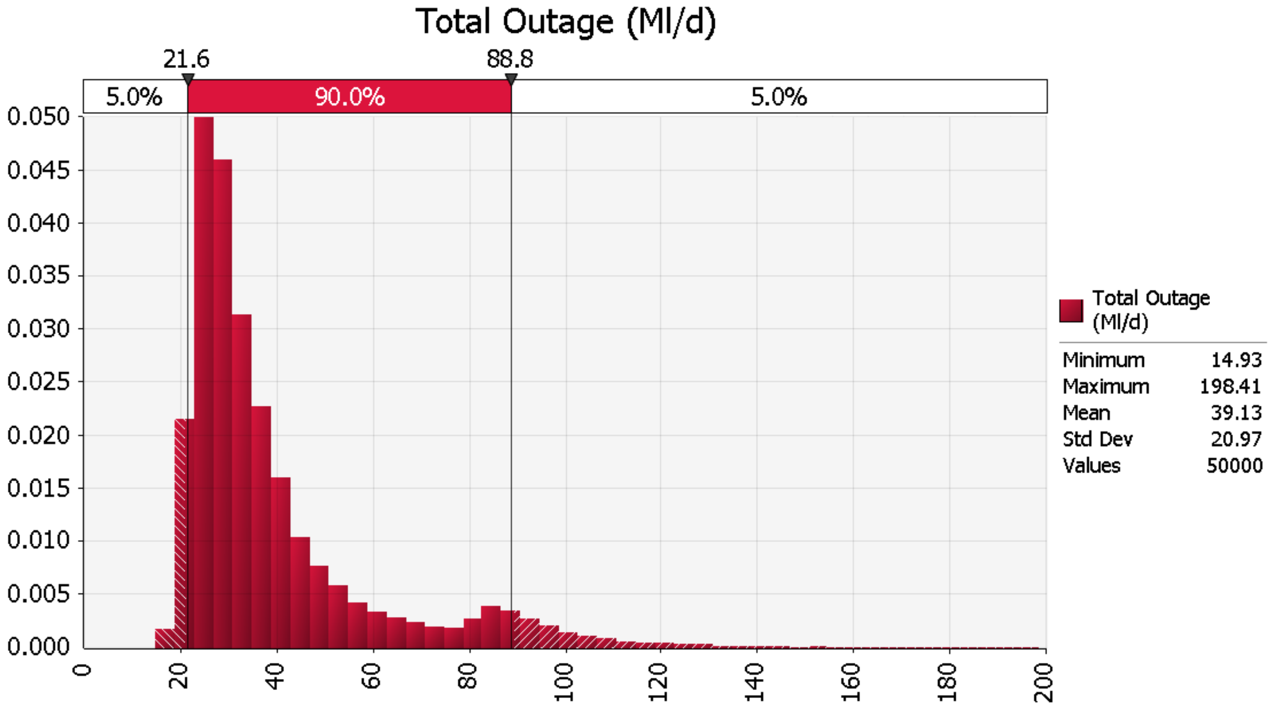

Figure 3-3: Outage results (peak month)

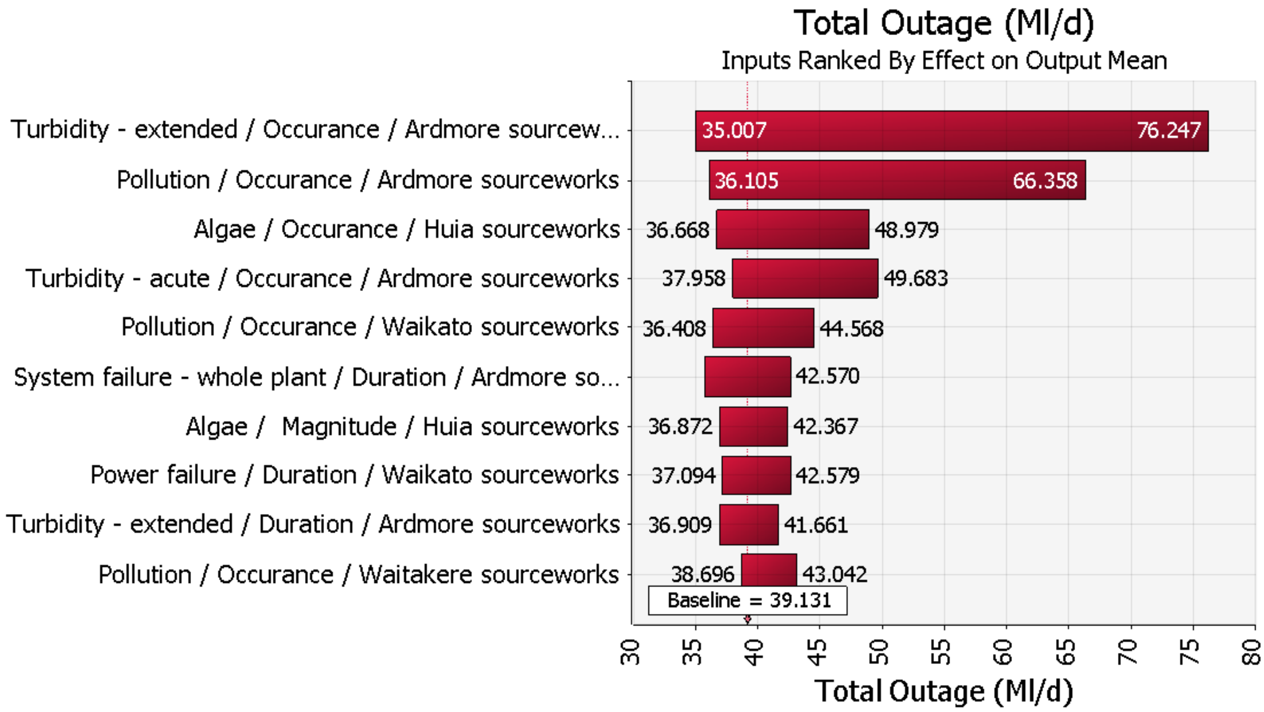

Figure 3-4: Tornado plot of outage results (peak month)

3.1.2 HEADROOM

The analysis of data has been mindful that the headroom analysis has been carried out for both the peak day and average planning scenarios. An inherent assumption of the proposed analysis is that the headroom components are independent. Dependence of components has not been considered in detail for this study. A summary of how each of the components, which were shown in Figure 2.3, has been considered in the analysis is summarised below.

S1 TO S3 – CONSENT UNCERTAINTY

These components relate to situations where a water utility expects that its consents may be revoked or reduced in the future, for example due to environmental flow releases or the introduction or amendment of minimum residual flows. Watercare confirmed that it does not consider that any of its current consents risk amendments or revocation that would result in a reduction in yield. Components S1 to S3 have therefore been excluded from this analysis.

S4 – BULK IMPORTS

Some water utilities rely on bulk transfers from other organisations. Specific arrangements between utilities may mean that it is not always possible to rely on these transfers, particularly during dry periods. Watercare does not rely on bulk imports from other utilities therefore component S4 is excluded from this analysis.

S5 – GRADUAL POLLUTION

This component identifies water supply sources, such as aquifers, rivers and lakes that are at risk from pollution resulting in a change in deployable output or the abandonment of the source if it is no longer economically viable to maintain. The types of pollution that may affect headroom uncertainty are:

- A gradual increase in concentration of a contaminant that can result in more onerous treatment requirements or abandonment of the source;
- A sudden pollution event resulting in abandonment of the source; and
- Reservoir sedimentation which cannot be controlled or removed.

To assess the risk of gradual pollution, reviews of recent trends in water quality data at many of the sources were considered. Discussions were also held with Operations staff about where reductions in water quality could potentially reduce deployable output. This information was used to develop distributions for this component within the headroom model. Care was taken not to double count risks already accounted for as part of the outage assessment.

S6 – ACCURACY OF SUPPLY SIDE DATA

The estimates of deployable output, often referred to as yield, include underlying inaccuracies or uncertainties due to the data and methods used to derive them. The underlying factors constraining yield will impact the type and scale of uncertainty. The four typical source constraints are:

- Climate and catchment characteristics for surface waters;
- Aquifer characteristics for groundwater sources;
- Abstraction consent limits; and
- Infrastructure capacity.

The accuracy of these data were determined with reference to groundwater yield assessments during the dry period of 2010-11 and expert judgement regarding the error band for the rainfall – runoff modelling for surface water source yield assessments. At the time of the assessment Watercare had not carried out detailed modelling to determine the impact of the Waikato Regional Plan Variation 6 (RPV6) restrictions on its yield, when referenced to the level of service. An assessment of the likely range of values was used to determine the headroom values. For those sites where infrastructure constrains the source yield possible meter inaccuracy is typically used to reflect the overall uncertainty. Appropriately installed modern meters can have accuracies as high as±2%. However, Auckland Council typically requires a meter accuracy of ±5% in its resource consent criteria and this general uncertainty was applied.

S8 – CLIMATE CHANGE IMPACTS ON YIELD

Watercare does not currently include any possible future impacts of climate change in its yield estimates. Limited work has been undertaken to understand the possible impact of climate change on Auckland’s water supply.

In general terms, the Waitakere and Hunua lakes rely upon winter rainfall to refill and meet demand over the following spring and summer. A simple estimate of the impact of climate change on Watercare’s storage system was derived by directly applying the percentage change in winter rainfall (by 2040) to the relevant yield, resulting in a triangular distribution with a minimum value of -10%, mid value of -1% and upper bound value of +5% yield. In the absence of better information this was be applied at both average and at peak. A similarly basic approach was taken for the Onehunga aquifer and the Waikato River abstraction.

S9 – UNCERTAINTY OF FUTURE SOURCE YIELDS

A study was recently carried out on behalf of Watercare by Beca to review options to provide a strategic water source (or sources) for Auckland (CH2M Beca, 2013). This report was prepared to assess options for strategic water sources to meet the increased demand for water over the next 35 years

Almost 100 different options were considered and a shortlist of nine options prepared on the basis of yield, water quality and practicability. These shortlisted options were then reviewed in more detail to focus on a wider range of criteria. Fatal flaws that would prevent successful implementation of five of these options resulted in a shortlist of four. The preferred option from that study was an additional abstraction and treatment works on the Waikato River. An assessment of the uncertainty of the future yield was made based on an understanding of the existing treatment plant.

D1 – ACCURACY OF SUB-COMPONENT DATA IN THE DEMAND FORECAST

The demand forecast for Auckland is primarily based on current estimated gross per capita consumption, multiplied by the forecast population, provided by Auckland Council. The sub-component data therefore comprise;

- Water into supply volumes;
- Estimates of current population; and

- Estimates of future population

Watercare's water into supply volumes are accurate to +/-2%. Statistics New Zealand estimates of current population for the year of the assessment were compared with published Usually Resident Population data for the same year, and the difference of 5% was used as the uncertainty. Forecast population uncertainty is incorporated into D2.

D2 – DEMAND FORECAST VARIATION

Watercare produces three separate Auckland Metropolitan Demand forecasts for high, medium and low future population growth as provided by Auckland Council. This provides a lower, mid and upper bound value for the headroom distribution.

D3 – CLIMATE CHANGE IMPACTS ON DEMAND

Watercare has not carried out any specific local analysis of the possible impact of climate change on demand. Work modelling the impact of climate change on water demand elsewhere in New Zealand (NIWA et al (2012), Ibbit et al (2010) and Ruth et al (2007)) has assumed that annual average demands could increase by between 0% and 3%, but that seasonal variations could be much larger.

Peak demand could be more variable, if the work carried out by NIWA et al (2012) is representative of the situation across New Zealand. However, in the absence of an Auckland-specific assessment, the values used for average demand were also applied at peak.

D4 – UNCERTAINTY OF DEMAND MANAGEMENT SAVINGS

The demand forecasts include an assumption that a 15% target reduction in in per capita consumption will be achieved by 2025. Watercare considers that achieving the 15% demand management target is the most likely outcome of its demand management programme to 2025. The uncertainty regarding this figure was estimated using expert judgement in conjunction with Watercare.

RESULTS

The average results show mean headroom for the average supply demand balance increasing from -2.98 ML/D in 2015 to 15.74 ML/D in 2040 (Figure 3.4) and the mean headroom at peak increasing from -11.55 ML/D to 15.37 ML/D over the same period (Figure 3.6). Overall the mean values are reasonably close to zero throughout the planning period. This is as many of the identified uncertainties are centred around a mean of zero. Mean values are negative early in the planning period largely due to the effect of S6, supply side uncertainty. For catchment limited sources, this is skewed between a 5% maximum loss and a 10% maximum gain.

Incorporation of the calculated mean value of headroom in the supply-demand balance would potentially understate the risks that Watercare face in the future. It was therefore recommended that Watercare adopt the 75th percentile value of headroom. This reflects the level of uncertainty that Watercare could reasonably expect to occur and plan for, i.e. it was recommended that a combination of 75% of potential uncertainties should be included as part of the supply-demand balance. Clearly, where events or uncertainties occur that are currently excluded from headroom (and the supply-demand balance), these should be adopted as part of future updates.

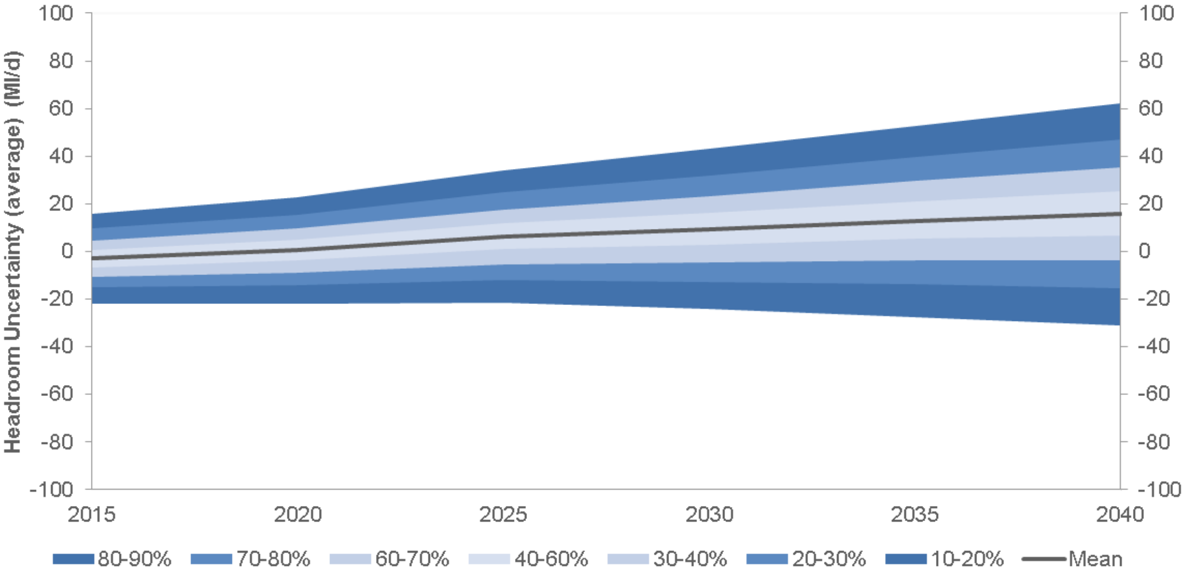

Figure 3-5: Headroom – Average Demand (baseline)

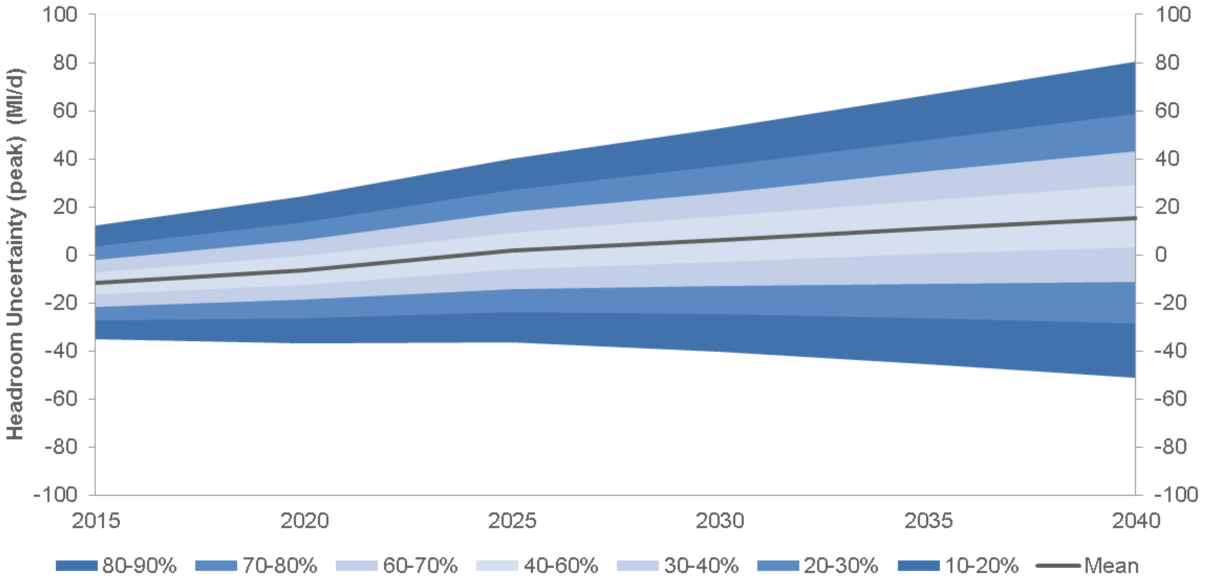

Figure 3-6: Headroom – Peak Demand (baseline)

3.2 APPLICATION OF THE OUTAGE AND HEADROOM ASSESSMENT OUTSIDE OF THE METROPOLITAN SUPPLY

This approach to outage and headroom was also carried out for one of the non-metropolitan supplies. The supply is by a number of groundwater bores, which provide potable water to over 8,000 residents. Population growth is expected over the next 25 years which could result in demand exceeding the available supply.

3.2.1 OUTAGE

Outage is particularly relevant for a small supply where demand is approaching the system capacity. This is the case here, where there is limited redundancy in the system should an outage event occur.

Actual historical unplanned outage events, including acute turbidity, power failure and system failure, were used to establish an outage allowance for the peak month. Expert judgement and experience were used to determine the return periods, duration and magnitude of each event included in the assessment. The results of the outage assessment followed a normal distribution with a mean value of 0.25ML/d.

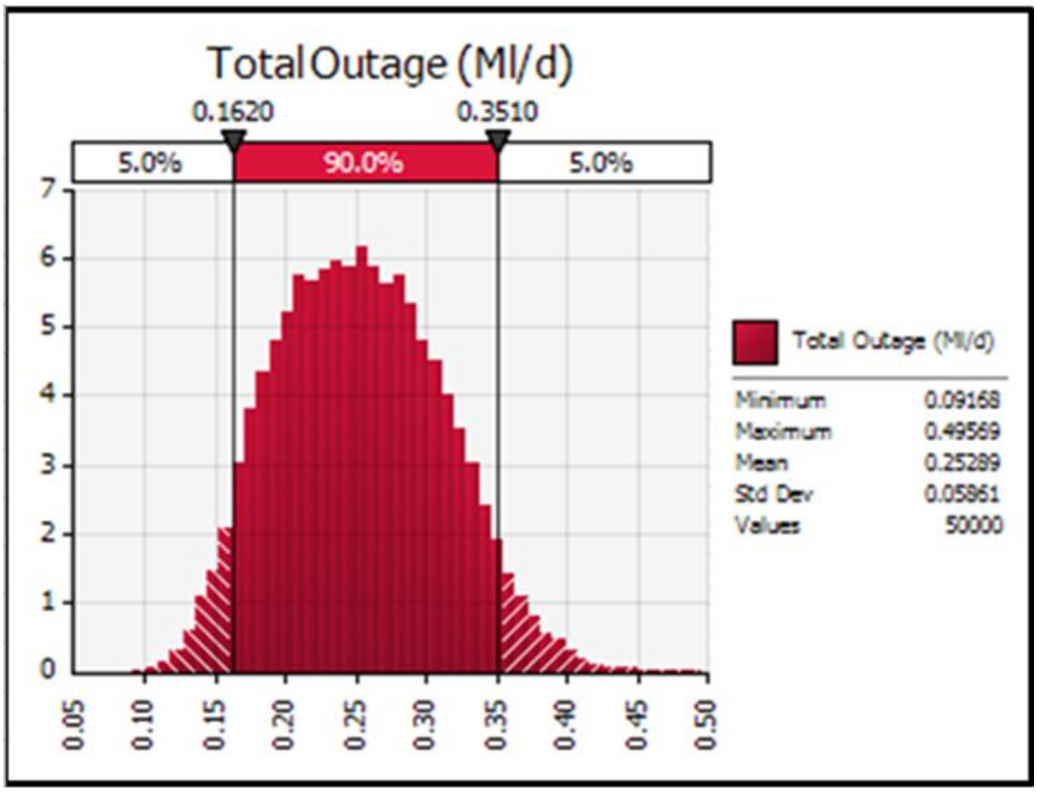

Figure 3-7: Outage results, peak month

3.2.2 HEADROOM

The components included in the headroom assessment were:

- Climate change impacts on both supply and demand;
- Meter over/under-registration;
- Current and future population estimates (which drive domestic demand in the demand forecast);
- Non-domestic demand variation; and
- Non-revenue water.

The main sources of uncertainty in the demand forecast are population growth and the peak factor. The other factors included in the assessment have a much lower impact on uncertainty. One benefit of the UKWIR headroom assessment is that the user can see from the results which components have the most impact by viewing the tornado plot outputs, similar to those shown in Figure 3-4for outage.

The headroom assessment allowed Watercare to prepare a demand forecast that could account for the considerable uncertainties in the demand forecast in a manner that was easy to understand and communicate. In order to make the headroom assessment even more transparent, demand scenarios based on specific assumptions were overlaid with the results of the headroom assessment. The advantage of this was that the user could easily see the level of confidence associated with those specific demand scenarios.

4 CONCLUSIONS

This study has found that it is possible to apply the UKWIR probabilistic methodologies for considering outage and headroom uncertainties in the supply demand balance in a New Zealand context. The methods have been applied to both a large, complex supply network – the Auckland metropolitan area – and a smaller, discrete supply outside of this network.

The benefits of quantifying uncertainties in this structured and transparent manner are numerous. The methods enable the development of single figure or ‘answer’ for inclusion in the supply demand balance. This simplicity is often sought by non-technical decision makers, regulators and members of the public but can provide discomfort to technical planners and operators. By using the probabilistic and structured techniques, the selected figures can be demonstrated to have a sound basis, with more underpinning data available if required. They also make it possible to communicate the level of risk associated with different choices and help informed decision making.

This study also found that one of the benefits in applying the methods was that they required the structured capture of data. Both operators and water supply planners can go through a considered process within a sound framework to think about uncertainties and how they can be addressed. This enables the largest uncertainties to be identified and steps developed to reduce them.

There are a number of possible refinements to the method applied for the completed study. One approach that could be considered in the future would be to develop scenarios around any significant changes to the supply-demand balance. In Watercare’s case the major issue is the uncertainty associated with population growth and this approach may enable Watercare to plan for this uncertainty in the future. Certainly, some form of scenario analysis should be considered as part of updates to the supply-demand balance.

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Waikato Regional Plan Variation 6

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