Veolia Water Projects

Water Resources Management Plan

Final Draft Plan 2019

VEOLIA WATER

DOCUMENT INITIAL REVIEW AND AUTHORISATION SHEET

Document

FINAL DRAFT PLAN 2019

Project or Subject:

Water Resources Management Plan

Job:

Preliminary Check

Originator: R Burd		Project Manager: John Bryan	
Signature	*Date: 30/11/17*	*signature*	*Date: 30/11/17*
Comments			

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FINAL DRAFT

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AUTHORISATION FOR ISSUE/USE

Project Manager	*John Bryan*	30/11/17	Issue to Use by Ext. Reporter	☐

Executive Summary

Veolia Water Projects [VWP] Tidworth is an Inset Appointment which supplies Regulated Water and Waste Water services to over 900 civilian properties and over 120 commercial properties in and around the Wiltshire town of Tidworth. In addition the overarching PFI agreement with the Ministry of Defence includes services to the Tidworth Military garrison where up to 6,000 personnel can be based on the site at any one time. The Contract also includes the provision of similar services to some 1300 Service Families accommodations [SFA's] in the town and surrounding community. The water supply comes from groundwater, drawn from a supply of robust unconfined chalk aquifer boreholes. These water sources provide sufficient water to meet all the needs of the customers as well as providing neighbouring company Wessex Water with a number of treated bulk supplies.

This document is an update of the original Water Resources Management Plan produced in 2014. The purpose of the Plan is to show how Veolia Water intend to maintain sufficient water supplies to meet the customers' needs until 2045. It is a statutory document which has been subject to public consultation. In order to compose this plan, studies were undertaken to understand how the supply and demand of water will change over the next 25 years, taking into account and making due allowance for any uncertainty associated with MoD developments. A principle driver for the review is the proposal for a number of large new housing developments on land recently sold by the MoD in and around the town together with the latest Army predictions around its basing requirements.

The outcome of the supply versus demand analysis considering issues such as climate change, environmental impact, outages and headroom assessments over the period. The original plan projected a deficit of 2.12 Ml/d resulting in the requirement to increase the capacity of the borehole pumps. Subsequent investigations of pumping capacity have indicated that the pumps are throttled to help control the rate of flow through the treatment process. As demand increases this throttle can be managed to increase output at boreholes BH2 and BH3. There is no need therefore to invest in larger pump sets.

Veolia Water Projects intends to continue working in a sustainable manner, promoting efficient water use and continuing to improve its own assets to reduce water waste. Demand will continue to grow as the new developments come on line as their additional use will more than offset the benefits of leakage reduction and efficiency of water use by existing and new customers.

As part of the options appraisal Veolia Water Projects will prioritise security of supply, conservation of stressed aquifers, protecting river flows and their ecology while considering the cost of capital which, due to the nature of the Inset Appointment Conditions, cannot be linked to customer bills through the Periodic Review mechanism in the usual way.

VWP aim to use BH2 and BH3 while restraining use at the CP source, thus participating in the protection of the Nine Mile River from abstraction effects. Environment Agency catchment modelling studies show that the Winter Bourne and Pilhill Brook are only marginally affected by abstraction at BH2 and BH3, potentially affecting their dry season length and reach. However this is offset by the sewage treatment works discharging treated effluent back into the same aquifer via soak away lagoons slightly further down the catchment (any leakage will also return the same way).

Abbreviations

ADSL	Aspire Defence Services Limited
AGA	Above Ground Asset
BGA	Below Ground Asset
CC	County Council
CCW	Consumer Council for Water
CoP	Code of Practice
DAPWL	Deepest Advisable Pumping Water Level
DI	Distribution Input
DMA	Demand Management Area
DEFRA	Department for Environment, Food and Rural Affairs
DMG	Drought Management Group
DMP	Drought Management Plan (Statutory Document)
DO	Deployable Output (from water sources)
DWI	Drinking Water Inspectorate
DZ	Drought Zone
EA	Environment Agency
EMP	Environmental Monitoring Plan
JRSLA	Junior Ranks Single Living Accommodation
LBA	Leckford Bridge Agreement (with Wessex Water)
LoS	Level of Service
LTA	Long Term Average
mAOD	Meters Above Ordnance Datum (Sea Level)
mBHP	Meters Below Head Plate
MoD	Ministry of Defence (Refers to Tidworth Garrison)
OBH	Observation Borehole
Ofwat	Office of Water Services, Industry Regulator
PFI	Private Finance Initiative
Serk	System for control and data capture of operating sites
SFA	Services Family Accommodation
SoS	Secretary of Sate (refers to the Minister for Environment)
SRO	Source Reliable Output
STW	Sewage Treatment Works
TWUL	Thames Water Utilities Limited
The 'wire'	Refers to MoD secure land boundary
UKWIR	Water Industry Research Group
VWP	Veolia Water Projects (Part of Veolia Water UK)
WAFU	Water Available for Use
WaSC	Water and Sewerage Companies
WIA	Water Industry Act, 1991
WR	Water Resources
WRMP	Water Resources Management Plan (Statutory Document)
WRZ	Water Resource Zone
WW	Wessex Water
9MR	Nine Mile River

NOTE.
For security purposes all abstraction locations are referred to by codes.
Namely; CP, BH1, BH2, BH3,
The geographic locations are known to the Environment Agency.

Table of Contents

1. Introduction

Thames Water Utilities Limited (TWUL) operated the water supply and sewerage function of this small water resource zone on the edge of Salisbury Plain in Southern England under an Inset Appointment since 1998. The Inset was acquired by Veolia Water in 2007, who are now responsible for the management of the water resource zone during the 25 year planning period. Veolia Water Projects (VWP) provides water services (clean and waste) for over 900 civilian properties and over 120 commercial properties in Tidworth and the surrounding areas in Wiltshire on the edge of the Salisbury Plain (see Figure 1). The PFI agreement with the Ministry of Defence (MoD) means VWP also services a large garrison that can house up to 6,000 personnel on the site at any one time together with some 1300 Service Families Accommodation [SFA's] properties in the town and community. All of the supply comes from groundwater, drawn from a supply of robust unconfined chalk aquifer boreholes. These water sources provide sufficient water to meet all the needs of the customers as well as providing neighbouring company Wessex Water (WW) with a number of bulk supplies (see section 2.3). The previous Water Resources Management Plan (WRMP) 2014, created by VWP showed the supply and water balance over the 25 year planning period until 2040 and this has been updated in 2017 to more accurately reflect the future situation up until 2045. The predicted supply demand balance has been compared with figures returned as part of the June return to ensure that the prediction is as accurate as possible (see Figure 3).

The updated supply demand calculations indicate no deficit exists for the zone on average based on the initial supply demand balance throughout the period from the year 2017 to 2045.

The original analysis indicated a deficit of 2.12 Ml/d resulting in the requirement to increase the capacity of the borehole pumps at BH2 and BH3. Subsequent investigations of pumping capacity have indicated that the pumps are in effect throttled prior to the treatment process. In future the treatment process may not be required, particularly as pesticide levels continue to improve. As demand increases this throttle can be managed to increase output at boreholes BH2 and BH3. There is no need therefore to invest in larger pump sets.

There are numerous new developments currently under construction totalling 1203 additional houses by 2021 (details included in section 3.2). The growth in demand will continue to be monitored to ensure that there is sufficient headroom to ensure a reliable supply of water to customers.

This document intends to demonstrate VWP has a sound and through understanding of its new demand and supply situation and will continue to assess the situation given that the network is rapidly evolving as military land is developed for local housing purposes.

Figure 1: Veolia Water Projects Service Area.

The Tidworth network consists of a single distribution system fed by the boreholes Chalkpit (CP) and Boreholes BH2 and BH3 via a service reservoir at Clarendon. The population and size of the network are such that it is classified as a single Water Resource Zone (WRZ) with major features shown in the map above.

Assessment of the borehole output against licence for 2016/2017 indicates significant spare licence capacity. Note that this output also supplies the export to Wessex via Leckford Bridge which average 1.62 Ml/d during 2016 / 2017.

Date	Tidworth No2 Daily Flow	Chalkpit Daily Flow	Tidworth No3 Daily Flow	Tidworth Group Daily Flow
Output				
Average	2.15	1.54	2.14	5.82
Peak Day	2.41	2.69	2.41	7.28
Licence				
Average	3.68	3.64	3.68	9.02
Peak Day	4.32	4.69	4.32	12

The report has been assembled under the regulatory framework shown below in Figure 2. All these activities require board approval and sign off.

PREVENTIVE December	REACTIVE October	MONITORING June
Water Resources Management Plan Supply over next 20 years Demand for next 20 years Supply / Demand Balance Works required to maintain the balance	**Drought Management Plan** Management Triggers and Scenarios Drought Action Plan Environmental Impacts Post Drought Actions	**Small business Return / July Return** Risk and Compliance statement Key Performance Indicators Customer experience Reliability and availability of supply Environmental impacts Finance **Supply / Demand Table** Production Import / exports Billing and leakage
INTERNAL REVIEW		
Annual commentary and review Forecast of growth v production Update on capital works required Resubmit to regulators every 5 years	Annual review of the plan Resubmit to regulators every 5 years	Submitted annually to the regulators
EXTERNAL REGULATORS AND REVIEW		
Department Environment Food Rural Affairs Drinking Water Inspectorate Water UK (working to deliver solutions) Market Operation Services Ltd (non-household) Environment Agency	Environment Agency Natural England	Environment Agency Natural England OFWAT (economic regulator)

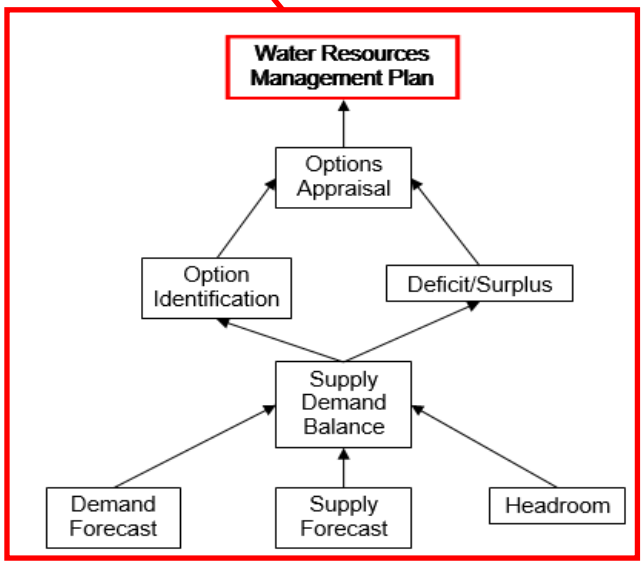


Figure 2: Key Components of a WRMP

The Water Resources Management Plan forms part of a larger VWP strategy aimed at prevention of supply issues by monitoring performance and minimising risk through the implementation of the wider regulatory framework.

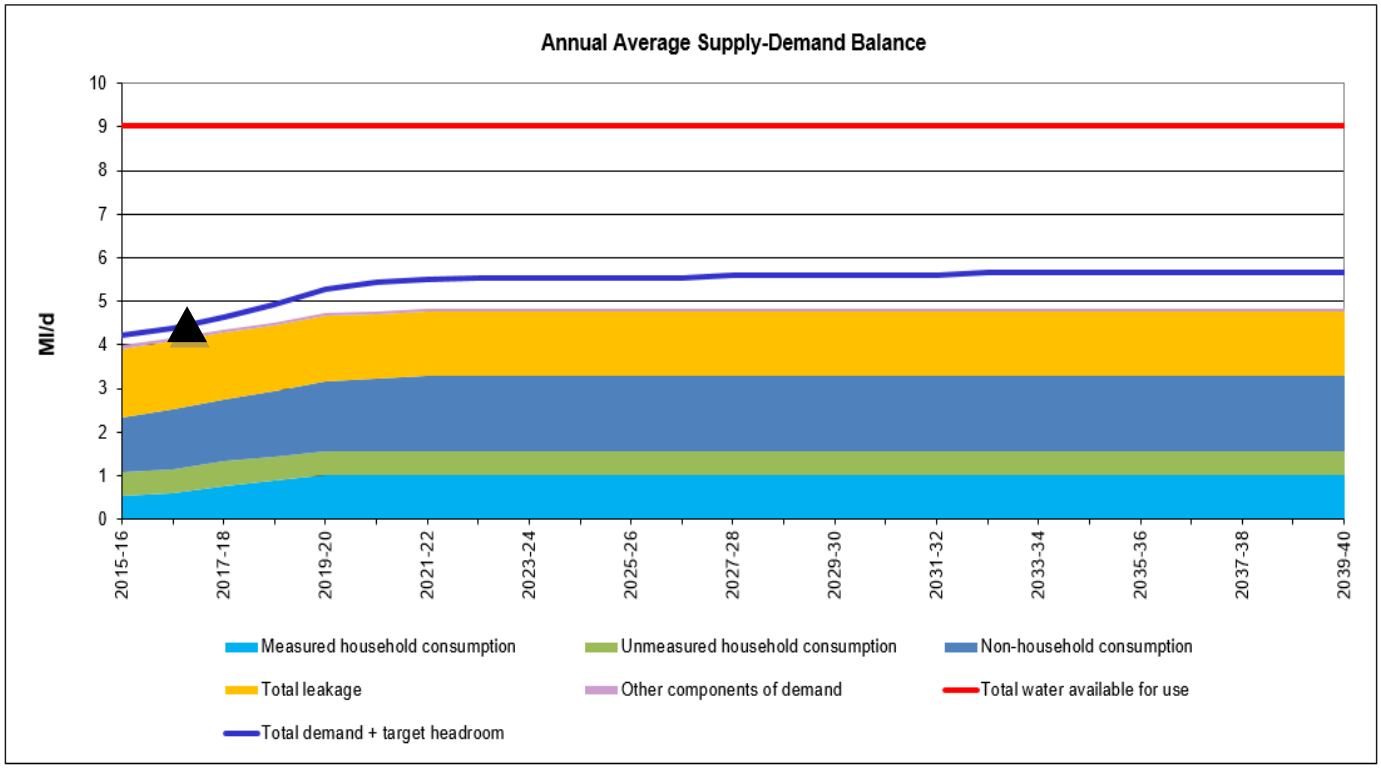


Figure 3: Annual average final planning supply demand balance

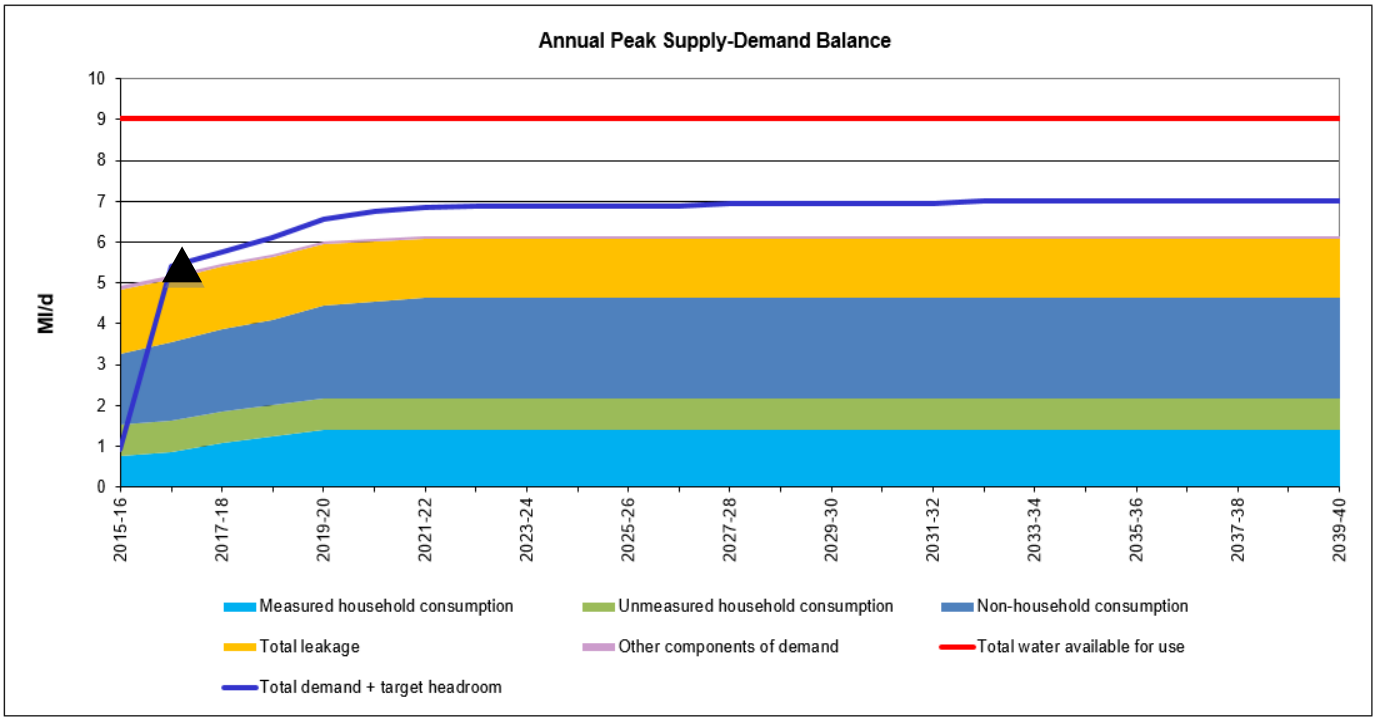


Figure 3A: Peak annual supply demand balance

▲ Indicates observed demands, this indicates that the prediction is accurate. Note that this does not include the export to Leckford Bridge (Wessex) that averaged 1.62 Ml/d during 2016 / 2017.

2. Supply

2.1 Current Water Supply Situation

VWP Tidworth extracts raw water from three separate sources according to licence conditions (see section 2.4 for details). These are treated on two sites (BH2 and BH3) via GAC filtration and at one site (CP) with marginal chlorination with an interposed contact tank/main at both sites. Both treated waters are pumped to one strategic reservoir (Clarendon Reservoir) and from one source to a small distribution reservoir under borehole pressure. From these positions the network is almost entirely gravity fed. One (BH1) source was abandoned (prior to VWP) due to water quality issues and additional treatment being required at that site. This source has now been removed from the licence and the volumes split between BH2 and 3. The table below shows a summary for all the source output totals for 2016 / 2017.

Source Volume Outputs for 2016-17 (YTD, all values average Ml/d)

Date	Tidworth No2 Daily Flow	Chalkpit Daily Flow	Tidworth No3 Daily Flow	Tidworth Group Daily Flow
Output				
Average	2.15	1.54	2.14	5.82
Peak Day	2.41	2.69	2.41	7.28
Licence				
Average	3.68	3.64	3.68	9.02
Peak Day	4.32	4.69	4.32	12

From this summary it can be seen that VWP sources operate at an average of 5.82Ml/d throughout the year, but can run at 7.28Ml/d as a peak volume. This is an increase of 25% from average to peak. Sources BH2 and BH3 combined provide 74% of the total distribution input (DI). As the raw water from these sources is treated at the same site and are located in a similar position in the aquifer, they should be considered as 'one source' from a water resource (WR) perspective. However in section 2.5 for outage assessments they are separated as operational issues are key. These sources are also assessed to be the most robust in terms of deployable output (DO), however CP cannot be overlooked. BH2 & BH3 essentially run at peak capacity on a yearly basis (the difference between average and peak is only 12%), whereas CP has an increase of 75% between its average and peak. Therefore this source is relied upon to meet periods of peak demand but otherwise adds minimally in a 'normal' day (for other WQ issues associated with this site and usage, see section 2.4).

Viewing the DI from all sources over the year as seen in Figure 4 shows an unusual trend. Unlike the major WASC's, VWP Tidworth does not have a 'traditional peak' during the summer months from the usual domestic activities (e.g. garden watering, paddling pools, hot weather etc). The MoD being such a large customer in relation to the overall Tidworth population means any change in activity will be reflected in the demand and hence DI. Examples being large exercises on Salisbury Plain or extra Military personnel in or out of the garrison e.g. Soldiers block leave, which will negate any increases in civilian increased summer water use.

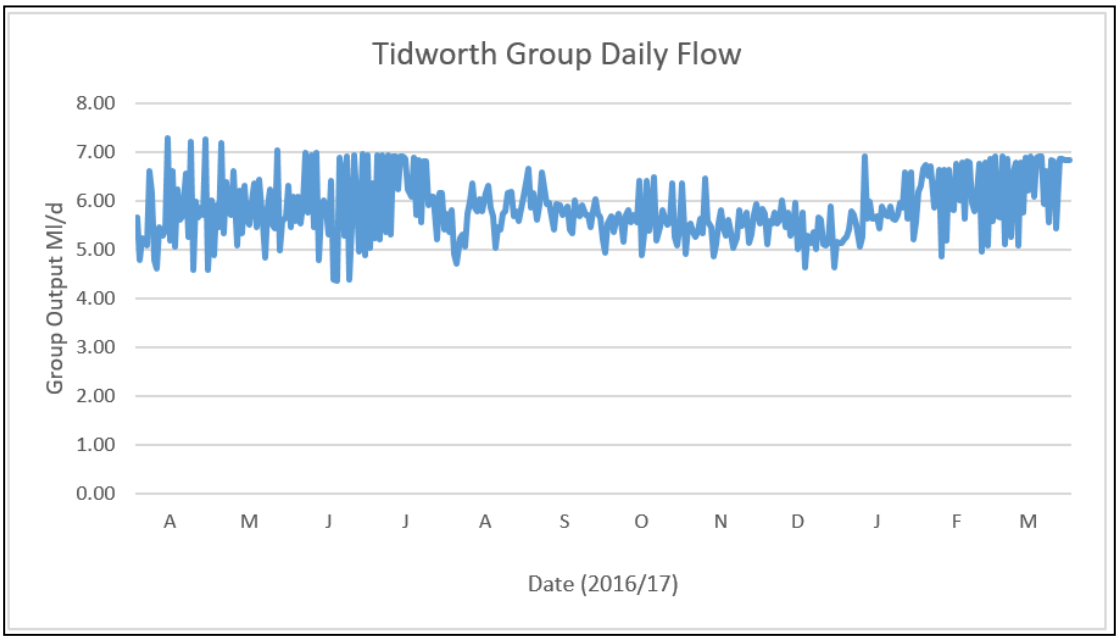


Figure 4: Source Output Volumes Tidworth (YTD 2016-17)

2.2 Water Resource Zone (WRZ)

A 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. The VWP supply network is highly integrated and the risk of supply failure is shared throughout the Service Area, Therefore all the supply area is one water resource zone (WRZ).

2.3 Imports & Exports

There are no imports into the VWP inset, the water balance showed a robust supply versus demand situation. However there is a significant export to Wessex Water at Leckford Bridge.

The Leckford Bridge Agreement (LBA) is an operating agreement dated 16th November 2006 between TWUL and WW endorsed by the MOD. It is a bulk supply agreement comprising a maximum volume of 3 Ml per day with a maximum instantaneous flow equivalent to 36.5 litres per second, with a maximum take of no more than 1,000Ml per year, giving an average value of 2.74Ml/d. Key to any changes in this agreement revolve around a 'critical figure' agreed to be 5.4Ml/d (as a daily peak) which VWP needs to be able to provide for its own customers. If the peak daily demand exceeds this figure VWP can reduce the volume of this bulk transfer on a litre by litre basis (the day after WW receives notice of this occurring). This also applies if VWP has its licence reduced to a value below the critical figure. To date, WW has not taken its full entitlement but this will be discussed in the demand section 3. For the purposes of the WRMP VWP should assume that the agreement was expected to terminate in 2022, but as the nitrates affecting the Wessex abstraction at this location are not reducing markedly the Plan will assume the LBA will continue throughout the period of the Plan.

Veolia will continue to provide the following transfer volumes to Wessex via Leckford Bridge:

DYAA demand transfer from Veolia to Wessex 2.74Ml/d
DYCP demand transfer from Veolia to Wessex 3Ml/d

Veolia Water Projects (VWP) states that it can reduce the export below 3 Ml/d peak demand if the demand within Veolia Water Projects (VWP) service area exceeds 5.4 Ml/d, on a litre by litre basis. For the following reasons it is unlikely that such reductions will occur during the peak period for Wessex Water:

- Wessex Water's critical period demand is forecast to occur during peak summer periods, as a dry weather related demand uplift. A significant proportion (50%) of VWP demand is from a military base, which does not have a typical domestic driven demand profile, and peak periods are unlikely to occur at the same time as peak demand from Wessex Water due to summer leave for military staff.
- VWP has internal reservoir storage in the system of 12Ml, which relative to total demand provides resilience to meet additional peak period demand for several consecutive days.
- VWP drought plan details demand reduction strategies – refer to the Drought Management Plan for more information.
- Additional borehole work to lift capacity from 9Ml/d to 12Ml/d would improve peak output capacity as well as improve resilience of supply during periods of future maintenance.

There are three separate 'enclaves' within the VWP supply boundary operated in accordance with their own Licence by Wessex Water and containing some 350 Wessex Water customers. This arrangement originated before TWUL gained the inset as the MoD were supplying these legacy estates, two of which are Social Housing from the 1950's, the other being a new build private development in the 1980's. Consequently this agreement was carried over to TWUL and then VWP. Unlike the LBA these supplies are deeply imbedded within VWP distribution network and no such 'critical figure' or mechanism for reduction of supply exists. The enclaves supply points are thought of as part of the Commercially Metered customer base [as 3 individual commercial accounts] in operating terms and will be treated as such from a water resources perspective.

2.4 Levels of Service (LoS)

VWP nor its predecessors have had occasion to resort to any form of restrictions [formal or informal] in over 15 years including through recent drought conditions in 2006/07 when many water companies' sources in Southern England were under extreme pressure. Thus the preferred LoS are supported by historical actual LoS as shown in the table below.

LoS offered by VWP to all Regulated Customers – Historical and Future.

Zone	Situation	Impact to Customers	Probability	Historic Events
1	High Demand	No restrictions	1 in 5 years (20%)	0
2	2 years of High Demand	Proactive approach to water efficiency	1 in 10 years (10%)	0
3	Temporary Ban	Hosepipe Ban	1 in 25 years (4%)	0
4	Drought Order	Possible rota-cuts in worst case scenario	1 in 100 years (1%)	0

There has been no evidence of water restrictions in the Tidworth area. The probability of future events has been based upon 100 years of rainfall data history which has then been used to predict likely impact on the ground water table. The water network has been sized in many cases to meet Crown Fire Fighting standards and so there is no obvious restriction in terms of capacity of the network to meet the needs of the customers. Refer to the drought management plan for further information.

There was an apparent high demand situation that occurred from 1st June to 19th June 2017 which corresponded with record breaking high temperatures. Clarendon reservoir level reduced as demand exceeded available supply. All customers received adequate supplies during the event with no need to implement the drought management plan.

A subsequent investigation revealed a number of reasons for this high demand event which are not attributed to normal peak demand conditions:

- Work had commenced on installing improved treatment facilities at Chalkpit and this impacted on the reliability of the output of the plant. This was resolved once the permanent treatment process was fully installed. Project work will not occur during periods of predicted high demand.

- Wessex Water took more water from the Leckford Bridge export than was being reported. Closer communications with Wessex Water have been organised to allow better management of the transfer of flow.

- A 6 inch wheel valve was subsequently discovered to be fully open allowing in excess of 1 Ml/d of water to escape in an uncontrolled fashion to a vehicle washing facility within the military complex. All such valves have been locked to prevent unauthorised and wasteful operation.

- Better monitoring of existing telemetry data will provide early warning of problems with reliability at Chalkpit, increased Leckford Bridge export and significant non-legitimate demand occurring within the military facility.

2.4.1 Customer Engagement

The annual return (June return) is published as part of the company business plan in the public domain.

Strategic documents such as the Water Resources Management Plan are also available for public consultation and VWP will respond positively to feedback from customers.

Customer service is regularly monitored including the performance of the existing customer contact number (DG9) and response to written complaints (DG7).

Customer service performance monitoring:

				TOTAL CONTACTS RECEIVED:					
DG standard	Description	Target	Penalty	Q1	Q2	Q3	Q4	TD Contact	DG FAILURES IN PERIOD
DG2	Low pressure	Nil	Claim £25						0
DG3	Unplanned interuption/Burst main	No.	Auto £20-50 failure + auto £10 - £25 per 24 hrs						0
DG5	Properties at Risk of sewer flooding	No.							0
DG5	Sewer flooding internal	Nil	Auto Annual W W charge						0
DG5	Sewer flooding external	Nil	Claim 50% Annual W W charge						0
DG6	Bill queries and resolutions	100% dealt with & compliant in 5 working days	Auto £20	126	133	74	87	420	0
DG7	Written/TP complaints	100% dealt with & compliant in 7 working days	Auto £20	0	0	0	0	**0**	0
DG8	Bills based on meter readings	%							
DG9	Incoming calls						28		

DG standard	Description	Penalty Payment		Q1	Q2	Q3	Q4	YTD	
GSS	Appointments	Auto £50		0	0	0	0	**0**	0
GSS	Billing and Charges	10 business days - Auto £10, £30 & £50			0	0	0		
GSS	Water / Wastewater written complaints	10 business days - Auto £30		0	0	0	0	**0**	0
GSS	Sewer flooding - Internal	Refund Wastewater bill - Auto		0	0	0	0		
GSS	Sewer flooding - External	Material affect <£75 - Claim							
GSS	Supply restoration, planned work failure	£20 - £50 - Auto							
GSS	As above, additional 24 hrs	£10 - £25 - Auto							
GSS	Unplanned restoration	£20 - £50 - Auto							
GSS	As above, additional 24 hrs	£10 - £25 Auto							
GSS	Low Pressure >7m hd x2 in 28 days.	£25 Auto or Claim							
GSS	Failure to make Auto payments	£10, £20, £50, Claim and Auto		0	0	0		**0**	0

Penalty payments are also monitored as a level of performance in terms of levels of service and resultant customer satisfaction.

Quarterly meetings are held with the MoD as they are the largest internal customer and a new key performance indicator report is being developed to monitor performance in relation to this contract.

Direct communications continue with Wessex and the volume of water exported via Leckford Bridge is monitored daily. Meetings have been held to ensure that both Veolia and Wessex Water Resources Management Plans align.

The remainder of the customer base consists of approximately 1000 regulated properties. Due to the small number of customers it is possible for customer services to provide a one to one service with direct contact with the customer if necessary.

Communication concerning water efficiency and leak spotter initiatives is delivered via the company web page, with a single page devoted to documents of interest, such as the Water Resources Management Plan and Drought Management Plan.

2.5 Reductions to Deployable Outputs

> *A key term used when discussing water supply is Deployable Output (DO). This is the sum of the amount of water each individual source (including both surface and groundwater) can yield which is available to the Company for putting into supply. This takes into account licensed volumes, pump capacity, treatment and distribution constraints. It is calculated for a stress period (drought) and for both average and peak demands during this period.*

Current Deployable outputs for all VWP Tidworth sources:

Date	Tidworth No2 Daily Flow	Chalkpit Daily Flow	Tidworth No3 Daily Flow	Tidworth Group Daily Flow
Output				
Average	2.15	1.54	2.14	5.82
Peak Day	2.41	2.69	2.41	7.28
Licence				
Average	3.68	3.64	3.68	9.02
Peak Day	4.32	4.69	4.32	12

Tidworth Borehole 1 (BH1)

Tidworth BH1 is abandoned and now removed from the licence due to pesticide contamination (Atrazine). It was not seen as cost effective to implement treatment on site or move raw water to another treatment site.

Tidworth Borehole 2 and 3 (BH2 and BH3)

The DO's for BH2 and BH3 are essentially linked as they share treatment process and licence restraints. Both boreholes are operated on a continuous basis to their maximum capability. As shown in the above table these sources are operating closer to their licensed volumes than CP.

Initially it was assumed that they could not deliver Licence / DO due to aging of the pumps and were only capable of running at 28-30l/s (2.4-2.6 Ml/d) maximum, with the lower flows at lower groundwater levels.

To perform at maximum licence the pumps would need to run at around 33 l/s (66.59l/s combined for 24 hours). Additional to pump performance the GAC filters limit flows to 62l/s (5.36Ml/d), however the contact tank can process up to 75l/s (6.48Ml/d).

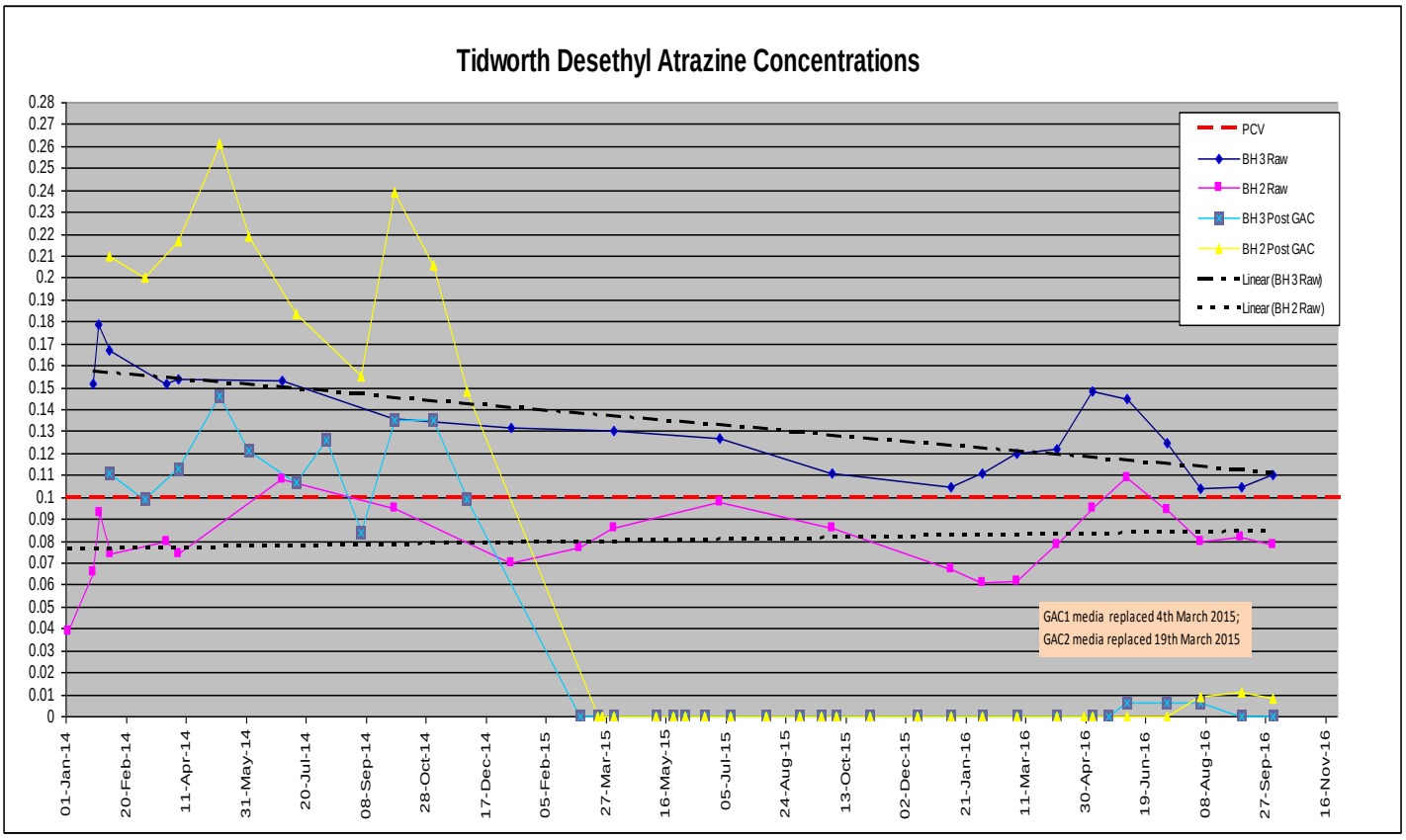
A subsequent investigation has revealed that the pumps themselves are adequate in terms of condition and performance. The main concern is the restriction caused by the GAC treatment process after the pumps.

The need for future investment in the GAC process has now been called into question due to observed reductions in Atrazine and Desethyl Atrazine concentrations. There are no plans to remove this treatment process. Most of the catchment area that supplies the boreholes consists of a target range with only one farm evident. The military historically used pesticides to keep border fencing clear but such activity has ceased.

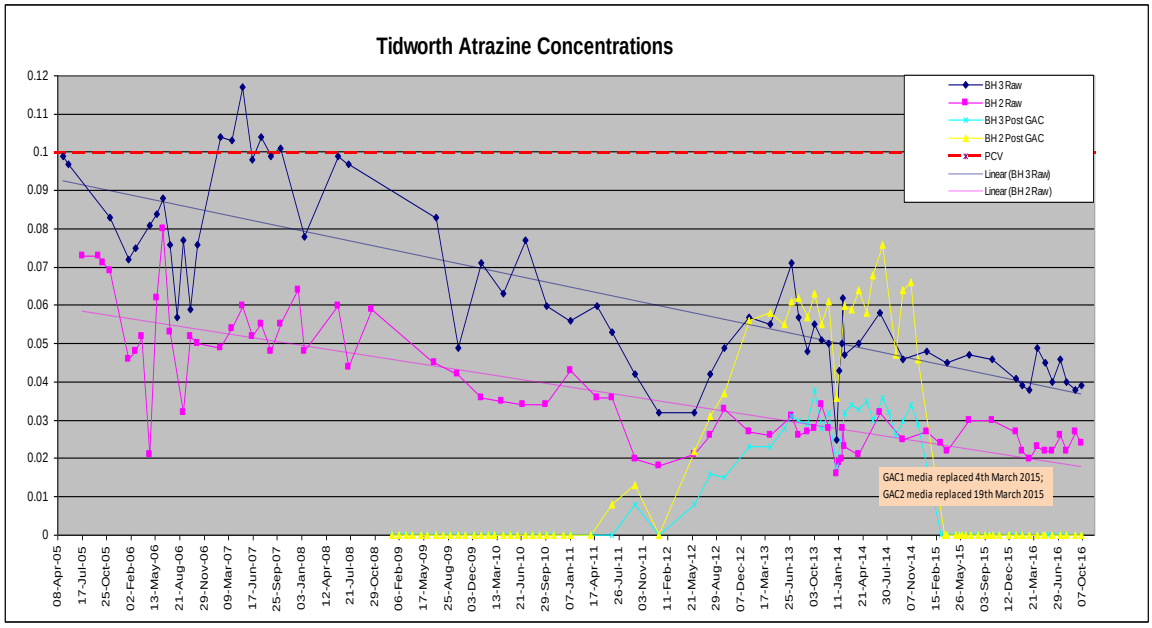
The quality of water at BH2 and BH3 will continue to monitored, with provision in place to open throttles after the pumps should a drought situation occur and the longer term option of abandoning the GAC process.

The sizing of the pumps at BH2 and BH3 can be determined when the pumps condition requires replacement in the future. Pump condition and performance will continue to be monitored with review to future eventual replacement.

Refer to the pesticide level monitoring graphs below showing gradual improvement in levels.



No pesticides have been used by the MoD to weed barbed wire perimeter since before 1998. No other customers use pesticides. GAC will always remain on-line because the process is relatively cheap whilst the benefit in terms of security of supply is significant. Levels are falling away as historic contamination is washed out of the water table and degrades.



Chalkpit (CP)

The treatment process at this site has been improved, including the complete replacement of the disinfection cabinet, gas fittings and associated equipment resulting in increased reliability.

CP site has a number of complex issues affecting its DO. The borehole arrangement has two pumps that individually can deliver flows of 38 (3.3Ml/d) and 35 l/s (3.02Ml/d), Combined, they can deliver peak Licence (4.75Ml/d). However, recent pumping tests have shown this figure cannot be achieved as turbidity spikes have occurred at these higher rates, shutting down the source. Assuming one pump running at full capacity (24 hours) the source would produce 3.0Ml/d DI. However, condition 9.4 of the Abstraction Licence states that the abstraction should routinely and preferentially be taken from BH2 and BH3, before any use is made of CP due to concerns over the Nine Mile River (9MR) as highlighted by an EA investigation, which indicates approximately 1% of the abstraction from CP impacts on the flows to this river.

Due to this restriction, and the quality constraint, the DO of this source can be considered to be lower than the Licence and has been set here as 2Ml/d average and 2.75Ml/d peak. Although in times of emergency or failure of one of the other boreholes it has the capability of producing its full licensed volumes.

2.6 Outage Assessments

Outage is also calculated as part of Water Supply, it is defined as a temporary loss (less than 3 months) of Deployable Output and it can be as a result of power loss, pollution events and other reasons.

The original analysis of outage assessment remains valid and has been retained as part of the update to the WRMP 2014.

Assessments were mainly based on interviews with operational staff and management experiences with each source and historical data was used as an aid to completing the analysis.

A Monte-Carlo based statistical model using excel (random number generator), which was created specifically for this outage assessment. A Monte-Carlo model was created for the single resource zone, with source outages and duration being summed to give a total outage value for the resource zone. The results are shown in the following two tables for the average and peak outages (same method adapted for section 4.1 headroom assessment).

Outputs of Monte-Carlo analysis on average DO figures

Average Outage					
Resource Zone	**Average DO**	**Average Outage Ml/d**			
		10%ile	**50%ile**	**90%ile**	**95%ile**
1	5.52	1.38	1.79	2.2	1.80
% of DO		23	30	38	31

Outputs of Monte-Carlo analysis on peak DO figures

Peak Outage					
Resource Zone	**Peak DO**	**Average Outage Ml/d**			
		10%ile	**50%ile**	**90%ile**	**95%ile**
1	7.05	1.7	2.09	2.48	2.03
% of DO		26	32	38	31

This Monte-Carlo analysis used on the Pro-forma data show a ‘worse case’ than expected as they included ‘one off’ events that have been mitigated against, e.g. surface water flooding at CP where a small barrier wall has been built to reduce the effect of similar SW flooding occurring in the future. Events such as an E.Coli spike that caused a voluntary outage have been included, even though the robust disinfection process treated the microbiological issue. Concerns over why it had occurred led to the borehole outage as more raw water samples were taken.

These factors added to the fact that VWP Tidworth does not have any ‘economies of scale’ as it is a small operation with only 3 raw water sources, any small outage will result in a significant percentage of the DI being affected. This will result in any outage assessment showing a less secure source reliable output (SRO) than that with which VWP actually operates.

The Average Outage table uses the average DO against outage events. The most likely situation shows that between 1 in 1 year, or 1 in 2 year outage events of under 2Ml/d will affect VWP. Although this is almost 30% of the companies DO for that day, the network can comfortably deal with this kind of outage as it has large reservoir storage in comparison to demand and only peak demand would see these significantly depleted. This value has been skewed by the turbidity issues (mainly due to minor surface run-off events) at CP. 1 in 10 and 1 in 20 year event show a similar level of outage as 1 in 1 year event, which again demonstrates VWP lack of economies of scale in source outputs. Clearly the less likely event will remove a more

secure source, but as there are only 3 in total it will not have a meaningful effect. The fact that a 1 in 20 year event indicates a lower outage than 1 in 10 year indicates the lack of operational data/knowledge at VWP Tidworth (more known events at a 1 in 10 year frequency).

As a result these figures are not reflective of the 'true' effect outage has on VWP. A more useful method of looking at outage is on an event basis as duration of outage events are key to impacts on VWP LoS. The table below shows the total event outage value in Ml, these would be amounts per year. They show the more likely events are very small volumes annually and they do not pose a threat. However the 1 in 10 and 1 in 20 year events do show a significant total outage.

These are again worse case and mainly revolve around pump failure and concerns over getting replacements ordered and delivered.

This situation has been addressed as part of VWP new Asset Management Plan (AMP) which will identify greater operational risks and help quantify asset life spans more effectively. Operational incidents are being recorded on a database and performance of assets are being closely monitored as part of the company key performance indicators.

Monte-Carlo assessment of outage per event (in 1 year)

Outage per event (Ml)				
	10%ile	**50%ile**	**90%ile**	**95%ile**
Average DO	2.3	4.6	10.78	13.92
Peak DO	2.8	5.6	11.6	15.9

2.7 Climate Change

The original analysis from the WRMP 2014 remains valid.

2.7.1 Overview

The climate of south-west England is classed as oceanic. Inland areas of higher altitude such as Tidworth (next to Salisbury Plain) which are over 100 m above sea level receive a much higher annual rainfall average than lowland areas. Current climate work predicts the southwest region to become the hottest in the UK. The wettest time of year tends to be early to mid-winter with the driest being early summer, with a total average yearly rainfall of 755mm (91yrs worth of data).

Changing rainfall patterns caused by climate change may reduce the recharge of underground sources and increase demand in the summer months at the same time. *UKCP09* findings showed that annual precipitation will remain relatively unchanged but will be more intensified during the winter meaning there will be drier period during summer (peak demand) months.

The frequency of these low rainfall events in the past is not necessarily a guide to how they will occur in the future, particularly when climate change is considered. The *UKCP09* projections do not show a long term historic decline in overall rainfall patterns, but they do predict more variability. Increased variability could result in more drought condition periods and more flood condition periods.

2.7.2 Vulnerability Assessment

VWP Tidworth is 100% reliant on groundwater sources for raw water supply. Vulnerability to climate change was considered by reviewing Source Reliability Output (SRO) diagrams for the 3 groundwater sources and historic work undertaken for the Drought Management Plan.

The Tidworth DMP shows VWP can cope with 2 poor recharge (below 100%LTA but above 80%LTA rainfall) years without altering its level of service. However climate change cannot be discounted as having an impact on the 25 year water resources planning horizon.

SRO diagrams were reviewed to assess how decreases in groundwater levels associated with climate change induced drought may result in decreases in deployable output. Under drought conditions at current peak deployable outputs of 3.24 Ml/day per borehole, there are 18 and 40 m between the pumping water level and the pump intake in boreholes 2 and 3 respectively. This suggests that boreholes 2 and 3 have a low vulnerability to climate change.

At the peak DO of 2 Ml/d at Chalkpit, there is 12 m between the pumping water level and pump intake under drought conditions. This suggests that Chalkpit has a low vulnerability to climate change.

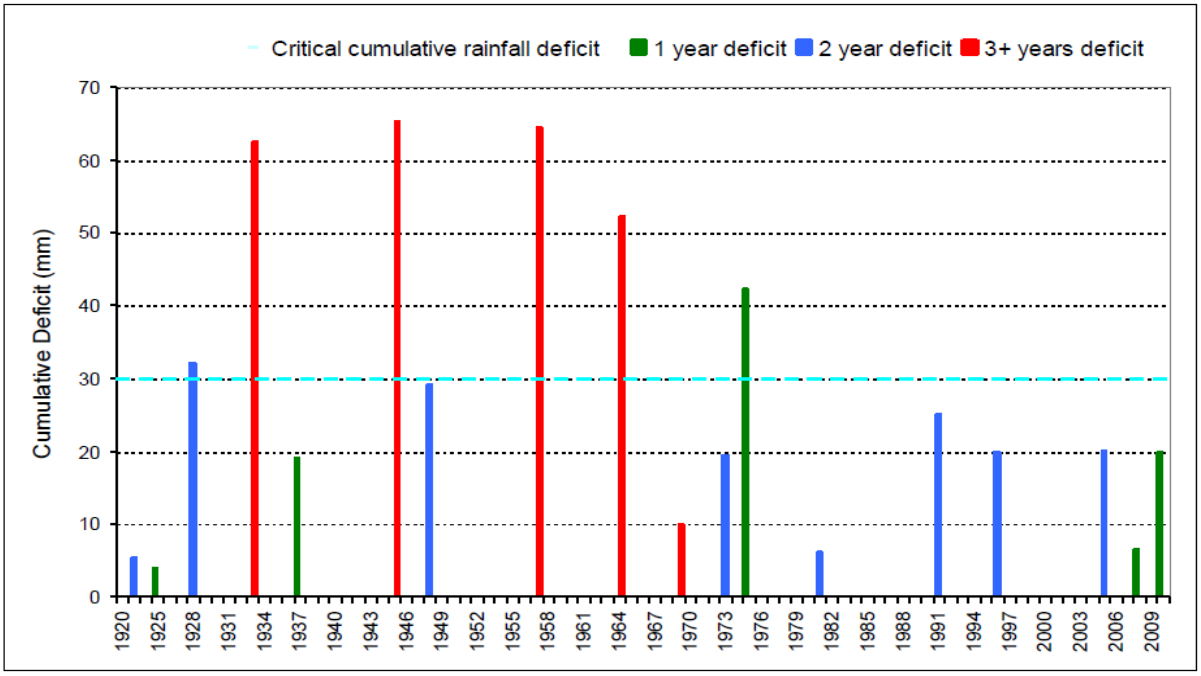
2.7.3 Impacts of climate change on deployable output of Veolia Water Projects Tidworth Sources

The impact of climate change on DO of BH2, BH3 and CP was assessed using Water Resources Planning Guidelines. This approach uses groundwater level change factors derived from the British Geological Survey's Future Flows and Groundwater Levels Project.

The nearest BGS Future Flows borehole is located at Clanville Gate, near Andover (14 km east of Tidworth). The borehole is cased into the chalk and is considered to be suitable for climate change impact predictions at Tidworth.

Future Flows predictions suggest a maximum decrease in groundwater levels of 1.5 metres at Clanville Gate in the 2050s. As previously discussed, boreholes 2, 3 and Chalkpit have large depths between drought peak DO pumping water levels and pump intakes. Consequently maximum decreases in groundwater levels of 1.5 m due to climate change are highly unlikely to affect Deployable Output.

The following graph indicates historic low rainfall events that impact on groundwater levels. This indicates a low risk of a drought sufficient to impact the suction (groundwater level) within the boreholes in such a way as to impact on borehole pump performance.



2.8 Flooding

According to the EA regional flood model maps produced for Tidworth, none of the clean water Above Ground Assets (AGA's) are at risk from a flooding event. All Below Ground Assets (BGA's) are resistant to the effects of flooding (all gravity fed network) with the exception of accessing them in the event of an extreme flood in the areas highlighted in
Figure 6.

Several waste water assets are at risk of flooding. Two pumping stations are very low risk due to their position in the 1 to 100 year (+) zone. Actions could be taken to minimise their use and make alternate arrangements such as tankering of sewage. The STW is a slightly greater risk as it sits in the 1 in 75 year zone (1.3% chance).

The probability of an impact of flooding is therefore low, but the impact could be high. Therefore these risks will be added to the company risk register allowing for criticality scoring against other company risks.

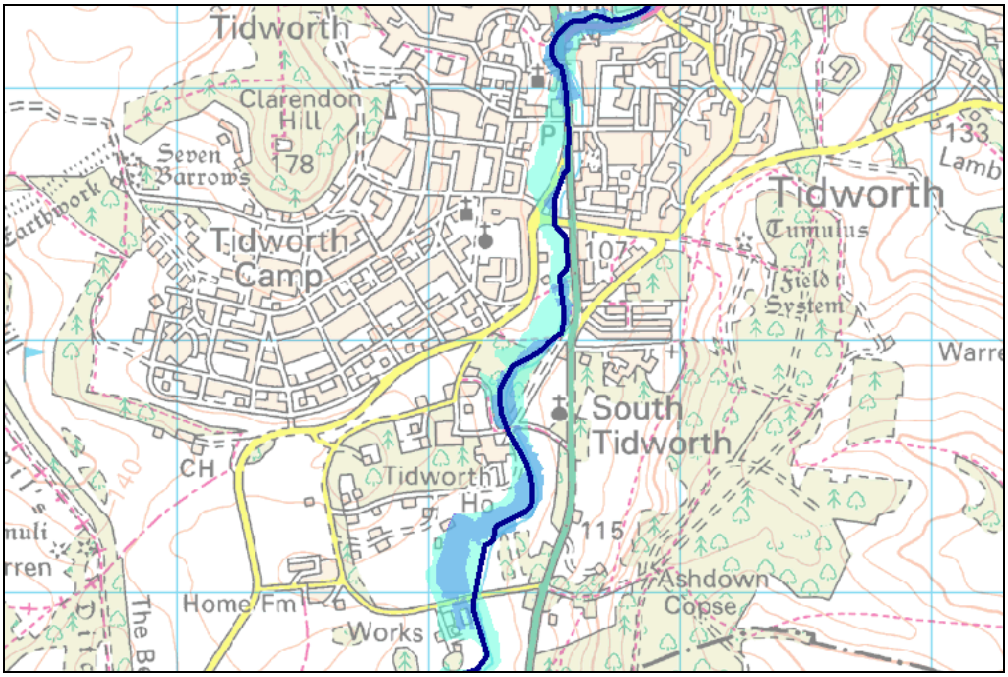


Figure 6: EA flood risk map for Tidworth area

2.9 The Environment

Biodiversity has been indicated as a concern by Natural England and the Environment Agency.

As part of general housekeeping a system has been put in place by VWP to constantly review health and safety aspects during site visits. This will be extended to include environmental observations. Environmental awareness training has been delivered to operational staff.

There are no DWI drinking water protected areas local to Tidworth.

2.10 Freeze / Thaw Risks

During March 2018 there was a significant drop in temperature and high localised snow fall. There was no observed increase in leakage or burst mains.

Many of the mains have been laid at significant depth due to the MoD background to the network. Because the mains have been laid at greater depth there appears to be little risk of a dramatic increase in demand due to sudden variation in temperatures.

The same holds true for prolonged dry spells resulting in hard ground conditions followed by ground movement due to sudden rainfall. No evidence exists of concerns in relation to these severe weather events.

Work is ongoing to monitor demand and weather conditions as part of a weekly operational report to back up these operational observations with hard data.

3. Demand

The predicted demand for water is developed using a sequence of elements as described in the section below. VWP has produced robust demand forecasts based on assumptions about how water demands will change over the next 25 years. A model was used to generate long-term forecasts of demand components in average conditions based on assumptions about changes in population, per capita consumption, leakage rates, meter penetration, savings on metering and non-household demand.

All demand forecasts used are based on a best estimate normal year, annual average daily demand, for a single set of population and properties..

3.1 Current Demand

There are 1049 dwellings that do not fall into the category of Tidworth Garrison. 736 of these are metered and it is intended to increase this number going forward as new buildings are constructed within the area of supply.

Total supply over the past year is shown in Figure 7. This peaks at 7 Ml/d which is well below the average group licence of 9 Ml/d.

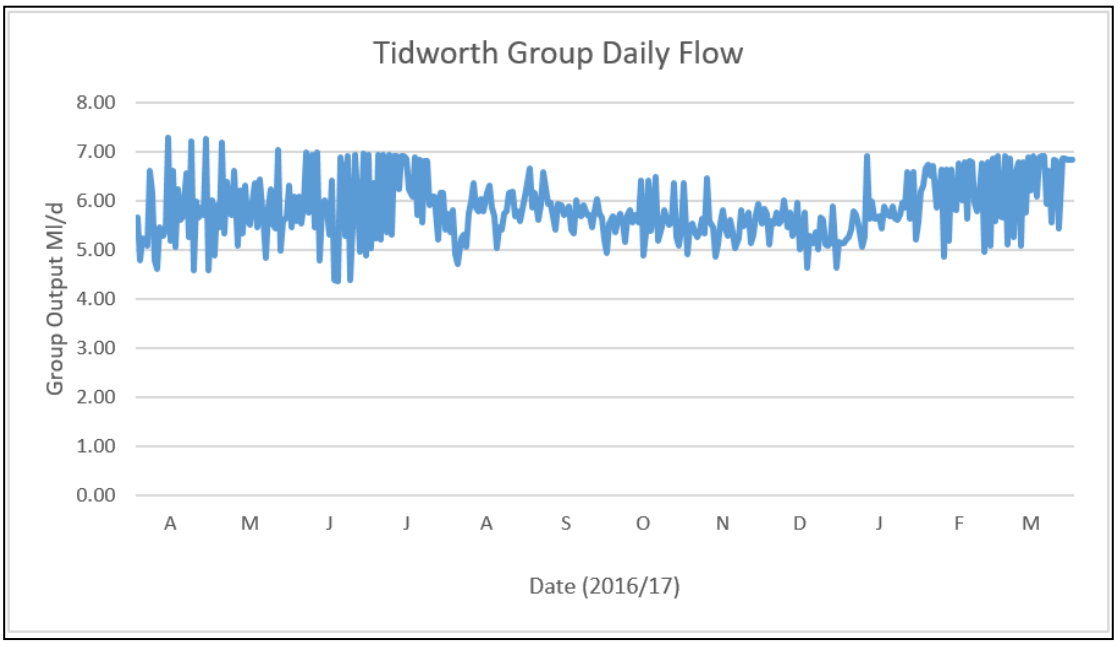


Figure 7: VWP abstraction including Wessex Water bulk supply (Leckford Bridge)

The average abstraction over 2016-17 was 5.94 Ml/d with 1.62 Ml/d on average being exported to Wessex Water via Leckford Bridge. The peak water abstracted was 7.4 Ml/d being over 1.4 Ml/d greater than the average abstracted.

Examining the source outputs shown in Figure 7, VWP does not experience a normal summer peak as explained due to MoD associated activity. Usually a low is seen in August and December, possibly due to large numbers of junior ranks and officers living both on site and in SFA's take holiday [aka Block Leave]. There are also occasions where large Military Exercises consisting of out of Garrison troops from elsewhere in the UK over write the usual customer consumption 'footprint'. Daily peak demand is therefore very difficult to predict or apportion to particular months,

hence VWP aims to meet any daily peak throughout the year. Historically VWP and its predecessors have always been able to meet demand and have generally been in a comfortable situation. However an estimate of future peak has been made as described below.

A demand forecast is developed by using the values of the various demand drivers; population and household forecast, commercial demand forecast, micro-component forecast (which gives the Per Capita Consumption), minor-components forecasts and leakage forecasts. A value for domestic demand is produced by multiplying the PCC by the population forecast. The total demand forecast is then the sum of the domestic demand, commercial forecast, MoD forecast, leakage forecast and minor component forecast. Minor components include water use associated with Water Taken Unbilled and Distribution Operational use.

Total Demand = Domestic + Commercial + MoD + Bulk Supply + Leakage + Minor Components

Forecasts

Equation 1: Simplistic bottom up approach to calculate demand (using *Netbase*)

A supply demand balance has been produced since 2015 and this has been used to compare with the demand forecast to ensure that the predictions are accurate.

Demand prediction calculations were updated in 2016 and this is used to show how demands will change in a dry year assuming existing management and water efficiency policies are implemented.

Given that the network includes a large secure military base some demand is unmeasured, but is calculated by Netbase using the following equation.

Unmeasured Consumption = Distribution Input – Measured Consumption – Leakage

Equation 2: Unmeasured components calculated using *Netbase* data

Below are extracts from the Annual return – Water balance components table. Values are based on VWP billing system *Navision*, post office records, council records and community surveys carried out by VWP. Consumption data is based on meter reads and *Netbase*. (For details of *Netbase* see section 3.4)

Table 1: Known properties in Tidworth, 2016 / 2017

Billing (No of Properties)	
Households billed unmeasured water	313
Households billed measured water	608
Households billed water	921
Non-households billed unmeasured water	0
Non-households billed measured water	128
Non-households billed water	128
SFA properties	1,300
Garrison Properties (behind the wire)	200
Void Properties (civilian household)	14

Table 2: Water Balance 2016 / 2017

	Veolia Water Projects Ltd	Annual Return	2016/17		1.00	
ANNUAL RETURN - WATER BALANCE COMPONENTS						
Environment Agency/Natural Resources Wales Data - annual average out-turns						
Row numbe	**DESCRIPTION**	**UNITS**	**DP**		**TIDWORTH Zone 1 of 1**	**Total**
	SUPPLY					
A	**Resources**					
1_{AR}	Raw water abstracted	Ml/d	2dp		5.94	5.94
2_{AR}	Raw water imported	Ml/d	2dp		0.00	0.00
3_{AR}	Potable water imported	Ml/d	2dp		0.00	0.00
4_{AR}	Raw Water Losses and Operational Use	Ml/d	2dp		0.00	0.00
5_{AR}	Raw water exported	Ml/d	2dp		0.00	0.00
5.1_{AR}	Non potable water supplied	Ml/d	2dp		0.00	0.00
6_{AR}	Potable water exported	Ml/d	2dp		1.62	1.62
7_{AR}	Deployable output (submit data by exception)	Ml/d	2dp		0.00	0.00
B	**Process Losses**					
9_{AR}	Treatment works losses and operational use (submit data by exception)	Ml/d	2dp		0.00	0.00
10_{AR}	Outage experienced	Ml/d	2dp		0.00	0.00
	DEMAND					
11_{AR}	Distribution input	Ml/d	2dp		4.32	4.32
C	**Consumption**					
19_{AR}	Measured non household water delivered	Ml/d	2dp		0.50	0.50
20_{AR}	Unmeasured non household water delivered (optional)	Ml/d	2dp		2.27	2.27
21_{AR}	Measured household water delivered	Ml/d	2dp		0.15	0.15
22_{AR}	Unmeasured household water delivered	Ml/d	2dp		0.12	0.12
23_{AR}	Measured non household - consumption	Ml/d	2dp		0.50	0.50
24_{AR}	Unmeasured non household - consumption	Ml/d	2dp		2.27	2.27
25_{AR}	Measured household - consumption	Ml/d	2dp		0.15	0.15
26_{AR}	Unmeasured household - consumption	Ml/d	2dp		0.12	0.12
29_{AR}	Measured household - pcc	l/h/d	0dp		102	102
30_{AR}	Unmeasured household - pcc	l/h/d	0dp		160	160
31_{AR}	Average household - pcc	l/h/d	0dp		122	122
32_{AR}	Water taken unbilled	Ml/d	2dp		0.00	0.00
33_{AR}	Distribution system operational use	Ml/d	2dp		0.00	0.00
D	**Leakage**					
34_{AR}	Measured non household - uspl	Ml/d	2dp		0.00	0.00
35_{AR}	Unmeasured non-household - uspl	Ml/d	2dp		0.00	0.00
36_{AR}	Measured household - uspl	Ml/d	2dp		0.00	0.00
37_{AR}	Unmeasured household - uspl	Ml/d	2dp		0.00	0.00
38_{AR}	Void properties - uspl	Ml/d	2dp		0.00	0.00
39_{AR}	Total mains and trunk mains leakage (Distribution Losses)	Ml/d	2dp		1.28	1.28
40_{AR}	Total leakage	Ml/d	2dp		1.28	1.28
41_{AR}	Total leakage	l/prop/d	2dp		501.11	501.11

	CUSTOMERS					
E	**Properties**					
43_{AR}	Unmeasured household - properties	000's	3dp		0.313	0.313
42_{AR}	Measured household - properties	000's	3dp		0.608	0.608
46_{AR}	Unmeasured non household - properties	000's	3dp		1.500	1.500
45_{AR}	Measured non household - properties	000's	3dp		0.128	0.128
44_{AR}	Void household - properties	000's	3dp		0.014	0.014
47_{AR}	Void non households - properties	000's	3dp		0.000	0.000
48_{AR}	Total properties	000's	3dp		2.563	2.563
F	**Population**					
50_{AR}	Unmeasured household - population	000's	3dp		0.751	0.751
49_{AR}	Measured household - population	000's	3dp		1.459	1.459
52_{AR}	Unmeasured non household population	000's	3dp		3.600	3.600
51_{AR}	Measured non household - population	000's	3dp		0.307	0.307
53_{AR}	Total population	000's	3dp		6.118	6.118
G	**Occupancy**					
55AR	Unmeasured household - occupancy rate	h/pr	2dp		2.40	2.40
54AR	Measured household - occupancy rate	h/pr	2dp		2.40	2.40
H	**Metering**					
56AR	Total Household Metering penetration (excl. voids)	%	2dp		66.02%	66.02%
57AR	Total Household Metering penetration (incl. voids)	%	2dp		65.03%	65.03%

To allow accurate calculations of leakage per connection the military buildings (1,300 SFA and 200 additional structures) have been included as unmeasured non-household properties.

3.2 Demand Forecast

It is anticipated that new housing developments will impact the demand going forward. These will alter the demand outlook over the current planning period by a significant amount compared to any annual population increase associated with existing properties.

At the time of preparing this WRMP there are three new developments that are outlined in the table below.

Future development planned build rates

	2017/18	2018/19	2019/20	2020/21	2021/22
Persimmon	360	460	560	634	634
Area 19	30	200	322	322	322
Corunna	0	0	80	247	247
Total	390	660	962	1203	1203

The total expected domestic housing increase after all three developments have been completed stands at 1,203 properties.

The number of new connections added to the network is being carefully monitored on a monthly basis to ensure that the growth in demand is in line with that predicted in the Water Resources Management Plan.

Due to the level of uncertainly due to the MoD development the supply / demand planning tables provided with this WRMP are worst case in nature in that they include high levels of leakage (not currently apparent) as well as no benefits in terms of water efficient devices and associated demand side control. The actual supply / demand situation will be compared with these worst case scenarios to ensure that sufficient headroom is maintained.

The MoD as the largest single user of water in the Service Area will have the potential to impact the above assumptions with its future plans / development needs over and above the SFA requirements. Recently upgraded accommodation across all sites in the Garrison for Junior Ranks and Officers has resulted in a net increase in soldiers on the base but their consumption has been mitigated to a great extent by the refurbishment and installation of contemporary water efficient plumbing fittings which replace early 20th Century fittings.

Future demand growth for the military part of the network needs to be monitored with some care. The original WRMP prediction was for a demand of 1.79 Ml/d, however the demand analysis for 2016 / 2017 indicates that this demand currently stands at 2.27 Ml/d.

The following assumption has been used regarding likely increase in military personnel and is based upon local knowledge rather than definite figures.

	2017/18	2018/19	2019/20	2020/21	2021/22
Military Personnel	0	260	520	780	1040

The uncertain nature of the MoD planning focus, the Political dimension and the general commitments of the UK Armed Forces overseas all serve to demonstrate the difficulties in assessing the overall water consumption increases in a predominantly garrison town.

This means that attempts to determine the per capita consumption figures for the planning tables has also been difficult. Major efforts have been made to more accurately calculate the total population within the area of supply and these figures have been used in the annual Water Resources Management Plan supply / demand table. The PCC and leakage per connection figures appear to be realistic when the military personnel and military infrastructure embedded within the regulated network is considered.

3.3 Metering and Water Efficiency

Metering currently sits at; 66% penetration of domestic homes, this is expected to increase to 86% by 2020 / 2021 after the completion of the new developments.

Wessex Water trials showed that metered customers used on average 17% less water than unmetered. Using the water balance and known consumption values, metered customers in Tidworth use over 5% less water than unmetered. This shows water efficiency should slightly improve with the new developments and population increase as all new properties will be metered.

There are some 900 dwellings that do not fall into the category of the Military portion of Tidworth Garrison. Of these some 608 are currently metered and it is intended to increase this number within the legacy housing stock going forward. All new properties are metered. It is hoped that a further 100 legacy accounts will opt to convert to metered status by 2020. Compulsory metering is not being considered at this time.

There are only 300 unmeasured properties and as a percentage the number of unmetered will reduce as new metered properties are constructed. Company literature and processes are in place to offer metering options but so far there have been zero applications. Metering options have not been considered in the supply / demand planning tables due to the small numbers of properties and minimum impact that would result from such an activity.

A major refurbishment programme behind the wire of all accommodation blocks has given VWP the opportunity to advise the MoD on the available water saving devices and applications. Through their Prime Contractor responsible for this re-development water efficient fittings have been installed throughout including the widespread use of Rainwater Harvesting for groups of Junior Ranks barracks. The outcomes, benefits and potential pitfalls of this technology are being closely monitored by VWP as well as the Prime Contractor.

Due to the active development within the military areas some metered connections have been abandoned and other new connections added. Some of the new connections have yet to have their meters connected via Automatic Meter Reading (AMR) systems to the Netbase software. This makes accurate assessment of demand difficult during the transitionary period of the redevelopment within the military areas.

3.4 Leakage

Leakage is primarily calculated using a “bottom up” and “top down” approach employed widely in the Water Industry through a software system known as *Netbase* which is operated by VWP leakage contractor. This conforms to best practice and a procedure has been added to the Veolia local management system that explains the process involved in calculating the leakage.

Netbase uses DMAs and several key meter locations to correct the bottom up estimations from each property / DMA. Whilst many Regulated customers are measured and the water volumes used by the remainder are easy to assess using Industry Standard consumptions, the bulk of the more recent work has been conducted in an attempt to quantify the varying MoD garrison uses.

The MoD Prime Contractor for the garrison has metered all significant buildings for water use and this information has been shared with contractor who use this data as

part of their demand and leakage assessment. This initially improved confidence in the demand analysis, however ongoing redevelopment of the military complex means that some metered connections have been abandoned. Some new connections, although fitted with meters, have yet to be connected via AMR to the Netbase system. In these instances historic demand data for the period when accurate metering was in place has been used to estimate the demand.

The current leakage figure is 1.28 Ml/d. This is in effect an unaccounted for water measure as this figure likely includes volumes of water used for operational use:

- Hydrants are tested regularly within the military areas to ensure that stringent Crown fire-fighting standards are maintained. The testing of the hydrants uses water and due to the nature of the network the volume used in this way will be higher than for normal networks. A method of improved hydrant testing has been proposed that reduces volumes of water used and provides an improved assessment of fire-fighting capacity. This process will be documented and considered for implementation.

- The ongoing redevelopment of the military depot and the 3 ongoing housing developments within the network will result in new mains being laid and in some cases old mains being abandoned. New mains are flushed through at 3 times their volume prior to introduction to supply, again unmetered operational use of water. Supply pipe leakage has not been separated as the network consists of a small number of connections, complicated by larger connections to military barracks.

VWP report leakage as both Ml/d and loss per connection as per the Annual return – Water balance components table and at the moment distribution operational use is reported as zero. The impact on the demand balance of more accurately assessing operational use will not change overall demand, merely adjust the components of the demand. Using the Sustainable Economic Levels of Leakage [SELL] principle suits the Tidworth PFI Inset model as within the Inset regime there is no mechanism to recover extra leakage costs from the customer base. Instead there is a more direct correlation between the water assessed as lost by leakage, the cost of treatment etc and the cost of finding and repairing leaks. The aspirational leakage figure of 1.2 Ml/d is the current estimate of an SELL value which may vary downwards once other factors discussed below are known in more detail.

One hidden leak can significantly increase leakage rates as the network is relatively small when compared to other water companies. Leakage can therefore vary significantly from year to year. Due to this a worst case scenario has been assumed in future planning tables: leakage remains above the SELL. This helps ensure that in future supply exceeds demand even should leakage rates exceed SELL.

VWP are conscious of the environmental imperatives to limit abstraction rates. One method of achieving this is to reduce background leakage by installation of network pressure management systems. Some pressure management has been implemented, but widespread pressure management is limited by the need to maintain minimum pressures in line with the Crown Fire Standards for the military installations that are embedded within the network.

VWP continue to investigate effective methods for reducing leakage with the aim of achieving the 15% reduction in long term leakage set out by OFWAT, such as:

- More rapid response to leakage outbreaks by the implementation of smart metering systems.

- Implementation of advanced pressure control valves that respond to increases in flow by opening to provide an unrestricted supply in the case of a fire-flow.

3.5 Climate Change

Studies predict that demand across VWP region in 25 years will be higher than it is today. We expect a minimum of 1,208 new houses will be built in the next 5 years. We expect overall demand to increase by 20% from the current 4.32 Ml/d to 5.66 Ml/d in the future.

Demand is likely to increase as a direct result of climate change. *UKCP09* predictions for VWP region predict a net increase in temperature across the year. As historical data shows, temperature increases have a direct relation to demand due to changes in water usage.

Climate change, potentially leading to longer and hotter summer periods, will also drive more frequent and higher peak seasonal demands. This is confirmed by the key findings of *UKCP09* projections, which have indicated that warming will be likely and more intensified in the summer months. Increases in temperature are directly linked with increases in demand with all water companies experiencing higher demand peaks in the summer months. Although the MoD usage does not show an overall peak in summer demand, the additional civilian customers from new developments and the effects of climate change means VWP will have to plan for higher summer peaks going forward.

Approximately 100 years of rainfall data has been used to determine the likelihood of low water table due to consecutive years of rainfall deficit. Strangely there is evidence to support the view that occurrence of consecutive dry years has decreased in the vicinity of Tidworth which would seem to be against climate change.

A worst case assessment has been made that averages the number of such events over the last 100 years, even though the last occurrence was more than 40 years ago. Further work will proceed referencing additional borehole data and rainfall data to assist in improving prediction of future exceptional weather events due to climate change.

From the UKWIR report on 'impact of climate change on demand' it is predicted that domestic demand will increase by 0.6% up until 2045. As domestic demand makes up the minority of demand within the Tidworth supply area then this will not have a significant impact on the long term demand forecast.

The current conclusion is that given that MoD usage dies not show an overall peak in summer demand, climate change is unlikely to have a significant impact on future peak demand within the Tidworth area, however occurrence of extreme weather events will become more common (and this has been incorporated in the assessment of likelihood of drought conditions).

3.6 Greenhouse Gas Emissions

The energy required to produce and distribute water through the Tidworth network is approximately 170,000 kWh per year. Using a conversion of 0.527 kg CO2 / KWh the total CO2 emissions appear to be approximately 90,000 kg of CO2.

Energy use going forward will be monitored and will form part of future WRMP commentaries.

4. Supply/Demand Balance

4.1 Target Headroom

Target headroom has been defined as:

> *"the minimum buffer that a prudent water company should allow between supply (including raw-water imports and excluding raw-water exports) and demand to cater for specified uncertainties (except those due to outages) in the overall supply-demand resource balance".*

Target headroom is defined as the minimum buffer introduced into the annual supply-demand balance to ensure that the chosen level of service can be achieved. Available headroom is the actual difference between Water Available For Use (WAFU) and demand at any given point in time. Where available headroom falls below target headroom a supply-demand balance deficit is introduced and as a result the level of service for WR cannot be met.

The complicating factor affecting the assessment of Supply versus Demand in this PFI Inset Appointment is best described as the" Military Uncertainty Factor". As discussed in Section 3.2, increases in consumption are highly uncertain due to the transient nature of MoD planning. The original WRMP prediction was for a military demand of 1.79 Ml/d, however the demand analysis for 2016 / 2017 indicates that this demand currently stands at 2.27 Ml/d.

Estimates of additional personnel (based on local knowledge) indicate 1,040 additional troops based on the site (as personnel return from Germany). Assuming a Per Capita Consumption of 130 l/h/d then this would result in an additional demand of 0.135 Ml/d (a small increase given the existing demand of 2.27 Ml/d).

A peaking factor of 1.4 x average demand has been applied to all demands with the exception of leakage which remains the same as for average demand conditions. The actual peak demands will be compared to predicted demands to ensure accuracy.

The deployment of troops on Operations and Exercise also produces some more nebulous consumption assessments of actual consumption throughout the year. There is no reliable advanced warning of these activities for obvious reasons of security and their effect may be to reduce military occupancy to a very small percentage of the total established levels for several months at a time. The corollary of this situation maybe that an influx of Units consisting many hundreds of troops deploy to Tidworth and its environs on Salisbury Plain thus inflating consumption of services. This scenario often occurs several times per annum and can last for 2-3 weeks at any one time.

The Headroom components that are included in the methodology are:

Supply Related;
S5 Gradual pollution of sources causing a reduction in abstraction
S8 Uncertainty of climate change on yield
S9 Uncertain output from new resource developments
Demand Related;
D1 Accuracy of sub-component data
D2 Demand forecast variation
D3 Uncertainty of impact of climate change on demand

The six headroom components shown above have been considered within the target headroom assessment.

S5 – Gradual pollution of sources

VWP concern is over nitrate levels within the aquifer that its two main sources draw from. Nitrate concentrations appear to be stabilising, however there still remains a level of risk associated with high nitrate levels.

S8 – Climate Change on supply

Climate change and potential reduction of groundwater levels by significant amounts is seen as a risk to one abstraction site in particular. However, due to the lower outputs required from CP, this does not impact on DO. Impacts of climate change on CP could also be mitigated against by increasing abstraction at BH2 and 3 to their licence capacities as required, however this will require significant investment.

S9 – Uncertainty of new sources

This refers to VWP need to increase deployable outputs to meet future demand (see section 4.2 and 5). This is currently at the options appraisal stage and a risk of uprated existing sources not delivering predicted capacity has been included into the headroom calculations.

D1 – Accuracy of sub-component data

As the VWP bottom up approach uses Netbase there are assumptions highlighted that this method uses which can decrease confidence. However current operation figures show we are meeting demand at an accurate known output level from sources.

D2 – Demand forecast variation

The largest risk is under predicting future use from the new developments, together with the aspirations of the Military, the headroom calculation will attempt to consider this risk as described above.

D3 – Climate change on demand

This is not considered to have as much impact as it would have on supply, factor in the significant change in civilian population over the next planning period and any climate change increased demand will not be relevant. This can be discounted from headroom calculations as a result.

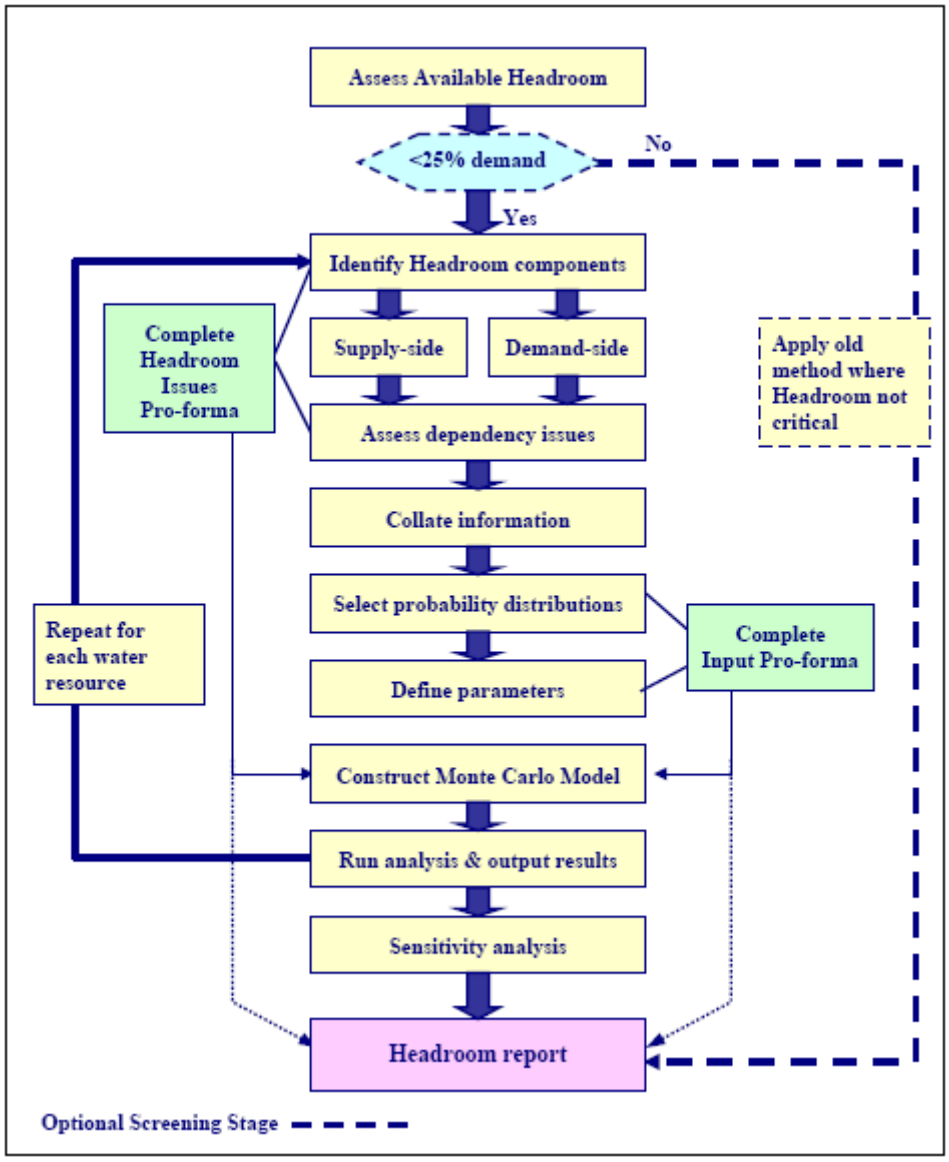


Figure 8: Overview of Headroom methodology has been retained for this WRMP

The following table shows the outputs from the headroom analysis at 5 year intervals. The original WRMP 2014 analysis remains valid.

Results from headroom analysis

Target Headroom		2012	2017	2022	2027	2032	2040	2045
Company Average Baseline	%	4	5	6	7	8	9.5	9.5
	Ml/d	0.220	0.275	0.330	0.385	0.440	0.5225	0.5225

The headroom figures range between 4 and 9.5%. Considering the size of VWP, the military uncertainty and the level of DI combined with the flexible distribution network, a headroom of 9.5% is a reasonable figure. 9.5% has been retained as a long term target for 2045.

WAFU = DO - Outage

Available Headroom = WAFU - Demand

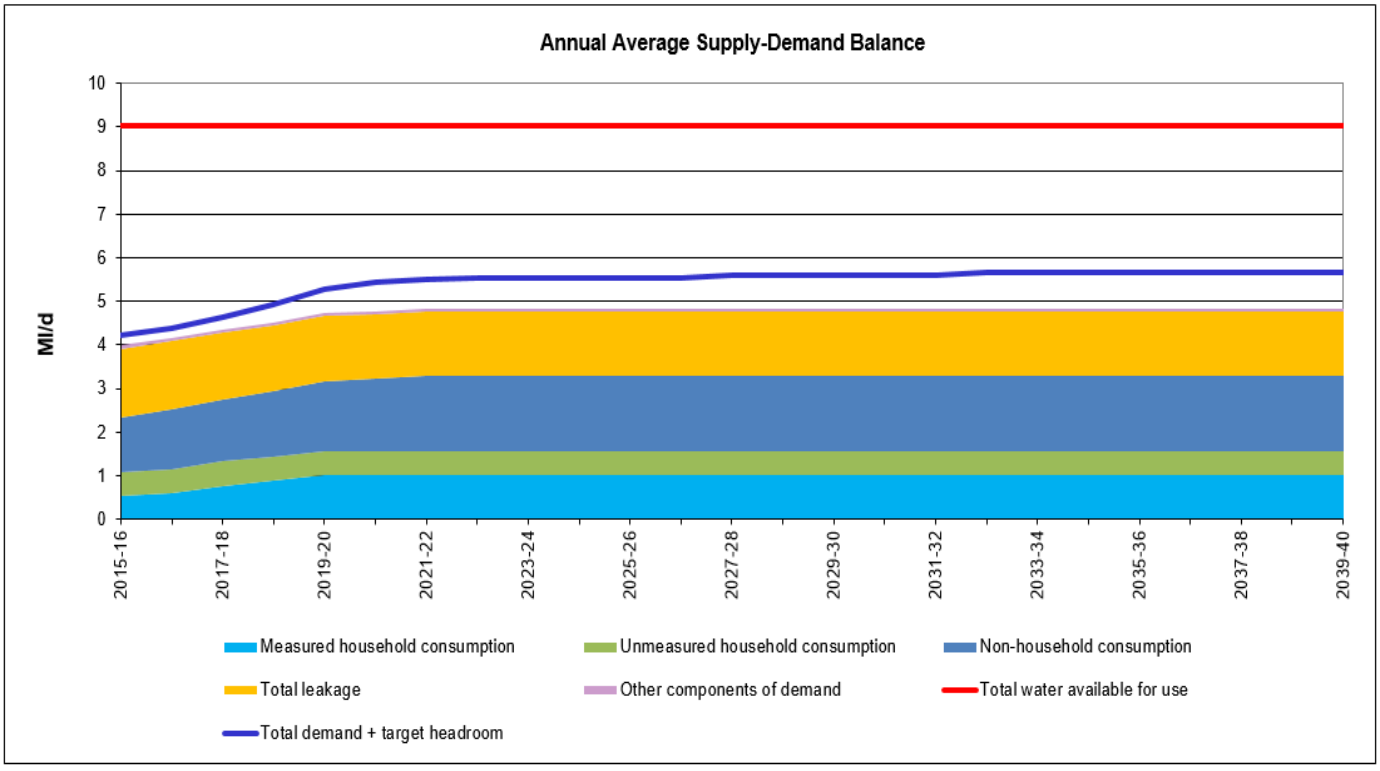
Available Headroom ≮ Target Headroom

The equations listed above were used in the headroom calculations as well as the supply demand balance in section 4.2.

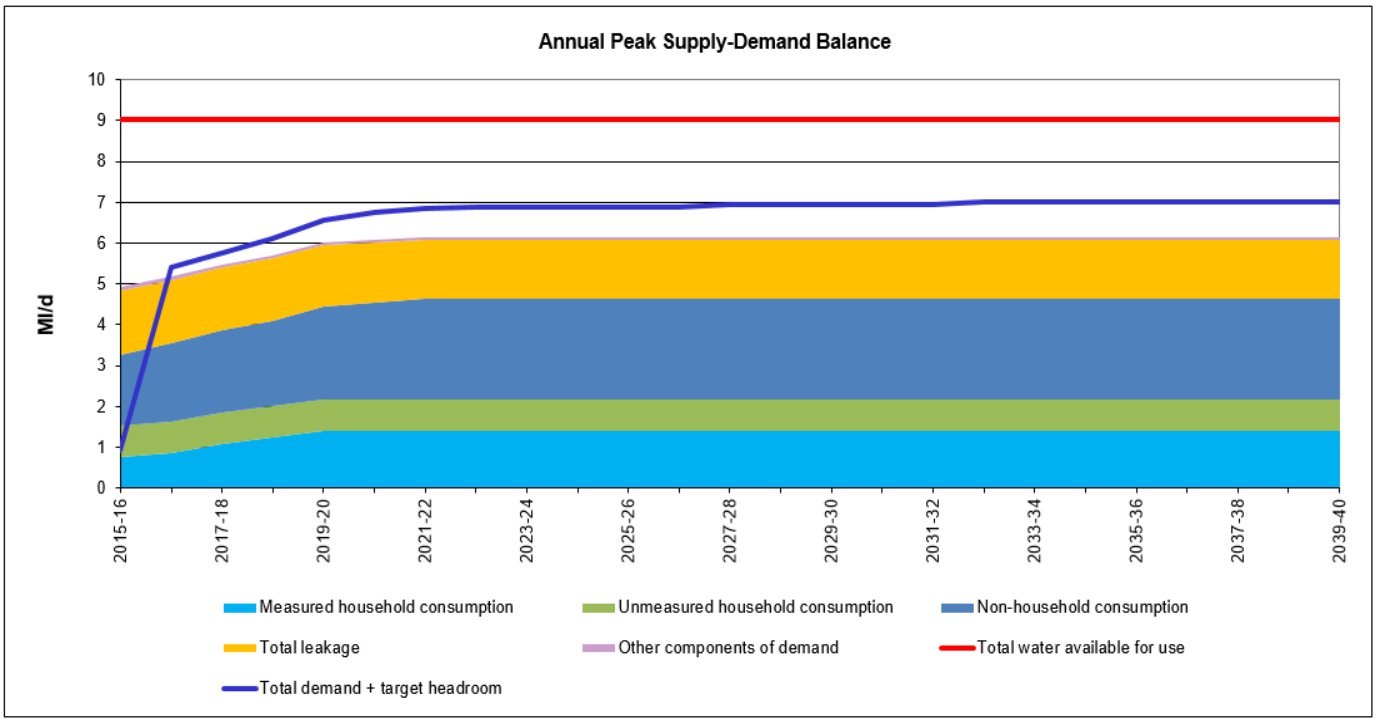
4.2 Baseline Supply/demand Balance

The analysis indicates that demand will increase to approximately 5 Ml/d (from the existing 4.32 Ml/d) whilst total demand plus target headroom will be approximately 5.7 Ml/d.

Improvements in the treatment at Chalkpit and assessments of condition and performance at BH2 and BH3 indicate that it is possible to pump to the licensed output of 9 Ml/d. To ensure that this remains the case it is necessary to continue to assess the health of the assets at the three boreholes.



The analysis indicates that future peak demand will exceed 6 Ml/d and including headroom the figure will approach 7 Ml/d. Again this is below the group license of 9 Ml/d (believed now achievable by operational activities such as removing the GAC throttled after the pumps at BH2 and BH3.



Given the high degree of development within the network it is prudent that the supply / demand situation is regularly reviewed as new information becomes available.

Although the situation currently looks stable in terms of available supply exceeding predicted growth in demand care should be taken when one considers:

- Military infrastructure redevelopment
- Domestic developments
- Leakage levels

Given the relatively small size of the Tidworth resource zone small changes in these volumes can dramatically impact on the supply / demand balance calculations.

4.3 Resilience

The Tidworth network consists of a single water supply zone fed by 3 boreholes via one major reservoir. As there is no neighbouring zone from which Tidworth can be supported should a failure occur it is necessary that the company place emphasis on resilience of supply.

To this end the company has developed:

- Computerised Maintenance Management System (CMMS) to ensure that supply assets are adequately maintained. This includes planning maintenance to occur outside of peak demand periods.

- Implementation of Security Emergency Measures Directive (SEMD) techniques even though the population supplied is less than 25,000 (a trigger at which SEMD becomes applicable).

- Asset Management reporting, including Asset Health so that the performance of supply infrastructure and non-infrastructure assets can be monitored.

5. Supply / Demand Options

5.1 Option Identification

The following sets out the key strategic parameters to which VWP options need to adhere;

I. Worse case planning scenario's to ensure security of supply
II. Cost of capital (one must consider the inability for VWP to pass through to customers' bills these costs due to the Inset Conditions.) considered along with good environmental practice
III. Protecting river flows and their supported ecology
IV. Conservation of water abstracted to stressed aquifers

The primary strategy of VWP is to ensure that BH2 and BH3 are capable of pumping sufficient volumes to meet future growth in demand with CP acting in a supporting role.

Additional activities are included in the table below which aim to improve the overall supply demand balance. This table indicates a reference number, option description, the benefit that could result in Ml/d and a measure of the complexity of the solution (high, medium, low).

Each option will be investigated and the WRMP will be updated annually incorporating the outcome of the investigations.

Reference	Description	Benefit	Complexity
WRMP1	BH2 and BH3 continued assessment of asset health, performance and condition to ensure that the output is sufficient to meet future growth in demand as indicated within the WRMP. Most recent assessment was positive, but need to monitor the situation going forward.	3 Ml/d	Medium
	Add the solution of temporary bypassing GAC restrictions as an operational activity under the Drought Management Plan	Drought management plan	Low
WRMP2	Assessment of the reliability of Chalkpit source given that new treatment equipment has been installed and is operational	2 Ml/d	Medium
WRMP3	Leckford Bridge agreement is due to expire on 2022. Need to agree with WW on future use of this transfer	Better communication	Low
	It is possible to invest in additional capacity at BH2, BH3 and CP and allow increased transfer at peak demand periods / drought conditions	3 Ml/d	High

	pumping to peak licence and exporting to WW		
WRMP4	Investigate improved use of existing telemetry system to provide live view of network performance and more effective alarm generation	1 Ml/d over a period of 1 week when gate valve left open	Medium
WRMP5	Environmental monitoring at sites. To be achieved by combining observations with basic house-keeping of sites.	Lower environmental impact	Low
WRMP6	Add 1 in 75 year risk of flooding of Tidworth STW's to the risk register	Improved resilience	Low
WRMP7	Regular assessments of supply / demand balance due to ongoing development within the network	Improved resilience of supply	Medium
WRMP8	Investigate Netbase methodology in more detail to determine level of estimates used to determine leakage and unmetered usage within the military areas	Improved resilience of supply	Medium
WRMP9	Consider future options for reducing leakage such as more advanced pressure control using flow modulation to auto-detect fire-flow requirements	Reduction in leakage – estimate 0.1 Ml/d, main benefit is reduced burst mains and improved resilience of supply	High
	Operational usage: Number of hydrants tested x water used per hydrant, volume of main installed x 3 (for flushing) will reduce unaccounted for water	Reduction in leakage but increase in operational use	Medium

6. Conclusion

Investigatory work completed at BH2 and BH3 plus the improvement of treatment at Chalkpit indicates that the sources are now capable of meeting growth in demand.

The current strategy of running BH2 and BH3 at higher volumes and minimizing the use of Chalkpit continues to minimize the impact on Nine Mile River.

The Leckford Bridge agreement is approaching renewal (in 2022) and consideration regarding options to abandon the agreement, maintain the agreement or increase the transfer (given major capital investment required to allow CP, BH2 and BH3 to pump to peak license flow rates).

Environment Agency catchment modelling studies show that the Winter Bourne and Pilhill Brook are only marginally affected by abstraction at BH2 and BH3, potentially affecting its dry season length and reach. The requirement of a more detailed study needs to be assessed during the next 5 year investment plan.

A series of improvements have been proposed. These will be investigated with decisions and improvements added to the Water Resources Management Plan as the situation develops.