



**Thames Water**

**AMP6 Outcomes Reporting  
Policy**

**Annex 2 – Wholesale**

**Asset Health Control Limits & Failure  
Thresholds**

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# AMP6 OUTCOMES REPORTING POLICY

## ANNEX 2 – WHOLESALE

### ASSET HEALTH CONTROL LIMITS & FAILURE THRESHOLDS



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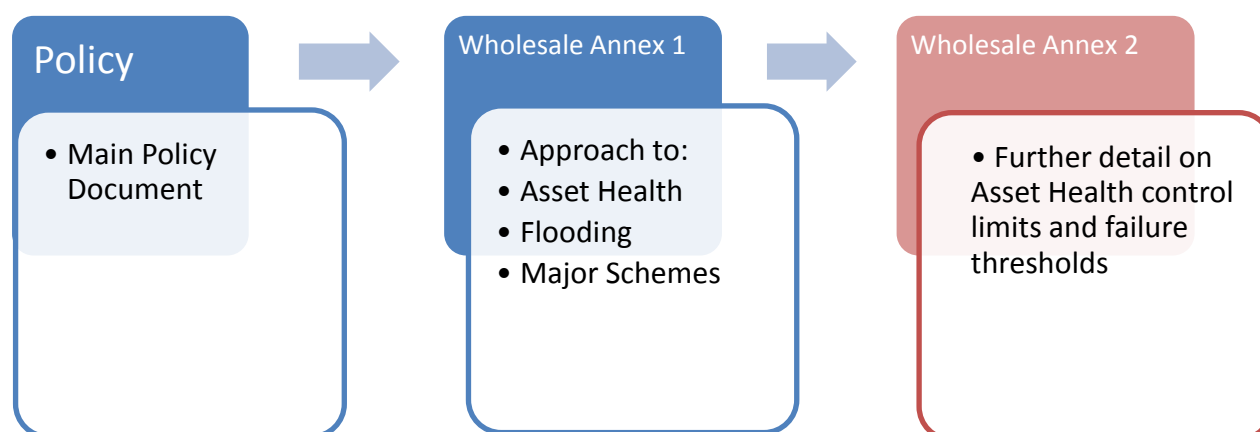
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# 1 Introduction

This document is Annex 2 and forms part of two wholesale technical annexes to the main AMP6 outcomes reporting policy document, as shown in Figure 1.

**Figure 1: Structure of main AMP6 Outcomes Reporting Policy document and Wholesale annexes**



Annex 1 provides more detail on the underlying principles that have informed the way we will measure our performance against our PR14 Final Determination for Performance Commitments (PCs) and Outcome Delivery Incentives (ODIs) relating to Asset Health, Flooding and Major Projects in the Wholesale Water and Wholesale Wastewater price controls.

Annex 2 provides further detail to support the assessments for the four Asset Health PCs. These are:

- SB1: Asset Health Wastewater Non-Infrastructure
- SB2: Asset Health Wastewater Infrastructure
- WB2: Asset Health Water Non-Infrastructure
- WB1: Asset Health Water Infrastructure

Each Asset Health PC has a number of sub-measures. This annex describes the following for each sub-measure:

- The control limit and how it was calculated
- The failure threshold and how it was calculated
- Impact of external factors on performance



## 2 Wastewater Non-Infrastructure

There are three sub-measures for this asset health composite indicator:

- Percentage of sewage treatment works (STWs) failing numeric discharge consents
- Total population equivalent (PE) served by STWs failing look-up table consents
- Number of unconsented pollution incidents (category 1, 2 and 3 water incidents) from STWs, storm tanks, pumping stations and other sewage-related premises

The control limits and failure thresholds for the sub-measures included in the Asset Health Wastewater Non-Infrastructure PC for AMP6 are shown in Table 1. Further detail on each sub-measure is included in Sections 2.1 to 2.3.

**Table 1: Asset Health sub-measures – Wastewater Non-Infrastructure**

Indicator	AMP6 Ref Level	AMP6 control limit	AMP6 failure threshold
STW discharges failing numeric consents (%)	0	2.01	2.61
Total population equivalent served by STW failing look up table consents (%)	0	0.68	0.94
Unconsented pollution incidents from STWs, storm tanks, pumping stations and other sewage-related premises (water incidents)	27	69	90

Source: Thames Water Calculations

### 2.1 STW discharges failing numeric consents

#### Calculation of the control limit

The data set used to derive the control limit is shown in Table 2.

**Table 2: Data for STW numeric discharge consents**

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
% works	1.43%	2.01%	5.44%	4.58%	0.29%	0.57%	0.57%	0.00%	0.28%	0.87%	0.86%	1.15%

Source: Data 2000 to 2009: Annual Return Reporting Summarised in TJ051 AMP5 Serviceability Report v1.12.doc. Data 2010 to 2013: Annual Return Reporting, Table 2.1.2d Sewerage Non-Infrastructure reference levels, AMP5 outputs reports. Data 2014: Draft MD109, Copy of 2014\_TW\_260215\_Draft\_to\_TW\_260215.xlsx

Data for the years 2005 and 2006 have been excluded from our calculation as they are associated with a period of deteriorating performance. The mean and standard deviation of the remaining data are shown in Table 3 with the calculated control limit, and the existing AMP5 reference level and upper control limit.



**Table 3: Analysis for STW numeric discharge consents**

Mean	Standard deviation	Mean + 2 SD	AMP5 ref level	AMP5 control limit
0.8	0.6	2.0	1.12	2.01

Source: Thames Water calculations

The mean plus two standard deviations gives a value of 2.0%. As this is very close to the AMP5 upper control limit, we have maintained the AMP5 upper control limit as the AMP6 control limit.

#### Failure threshold

We have applied a failure threshold of 2.61%. This is one standard deviation beyond the control limit. We have tested this level and confirm that the one period of significant failure that occurred in 2005/06 would have breached this threshold.

#### Impact of external factors on performance

The Environment Agency (EA) has recently begun to take bi-partite samples when investigating pollution incidents reported by Thames Water. If the sample is above an upper tier consent value the works will now be reported as a failing works. Before self-reporting of pollution incidents, it is unlikely that a sample would have been taken. Reported compliance could be worse for exactly the same level of performance. Significant changes in the method of reporting will therefore be considered to be a mitigating factor before penalties are imposed.

It is possible that Thames Water will be asked to provide support in response to national or regional emergencies outside of the normal expected operation of our assets. This would be considered as a mitigating factor, if these events caused our performance to exceed our control limit. A recent example of this is our support following the Buncefield fire. In that instance, tanks at Maple Lodge sewage treatment works were used to store hazardous liquids which reduced the treatment capacity of the works and led to deterioration in performance. Consent failures during that period were excluded from analysis of failing samples by the EA.

#### Summary

- Control limit for AMP6 to be maintained at the AMP5 level of 2.01%.
- Failure threshold for AMP6 of 2.61%.
- External factors that may affect performance are a change in reporting procedure by the EA and the loss of treatment assets in response to a national or regional incident.



## 2.2 Total PE served by STWs failing look-up table consents

### Calculation of the control limit

The data set used to derive the control limit is shown in Table 4. The sub-measure is assessed using the metric of % population equivalent (PE) affected (PE failing/Total PE).

**Table 4: Data for STW look-up table failures**

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
% Pe	0.07%	0.09%	2.98%	3.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.84%	0.00%	0.00%

Source: Data 2000 to 2009, Annual Return Reporting Summarised in TJ051 AMP5 Serviceability Report v1.12.doc. Data 2010 to 2013: Annual Return Reporting, Table 2.1.2d Sewerage Non-Infrastructure reference levels, AMP5 outputs reports. Data 2014: Draft MD109, Copy of 2014\_TW\_260215\_Draft\_to\_TW\_260215.xlsx

Data for the years 2005 and 2006 have been excluded from the calculation as they are associated with a period of deteriorating performance. The mean and standard deviation of the remaining data are shown in Table 5, with the calculated control limit, and the existing AMP5 reference level and upper control limit.

**Table 5: Analysis for STW look-up table failures**

Mean	Standard deviation	Mean + 2 SD	AMP5 ref level	AMP5 control limit
0.10	0.26	0.62	0.17	0.68

Source: Thames Water calculations

The mean plus two standard deviations gives a value of 0.62%. As this is similar to the AMP5 control limit, we have maintained the AMP5 control limit of 0.68% in AMP6.

### Failure threshold

We have applied a failure threshold of 0.94. This is one standard deviation beyond the control limit. We have tested this level and confirm that the one period of significant failure that occurred in 2005/6 would have breached this failure threshold.

### Impact of external factors on performance

We expect loss of treatment capacity as a result of providing support to national or regional emergencies to be accepted as a mitigating factor if performance is then affected.





## Summary

- Control limit for AMP6 to be maintained at the AMP5 level of 0.68.
- Failure threshold for AMP6 to be at 0.94.
- External factors that may affect performance are the loss of treatment assets in response to a national or regional incident.

## 2.3 Unconsented pollution incidents (category 1, 2 and 3 water incidents)

This is a new indicator for AMP6 and therefore there is no existing control limit for comparison.

### Calculation of the control limit

The data for unconsented pollution incidents (category 1, 2 and 3 water incidents) from sewage treatment works, storm tanks, pumping stations and other sewage premises from 2008 is shown in Table 6.

**Table 6: Data for non-infrastructure pollution incidents**

Year	2008	2009	2010	2011	2012	2013	2014
No	17	23	15	18	64	178	152

Source: Thames Water Annual Return Data

The table shows there has been a step change in performance since 2011. This has not been related solely to the serviceability of the assets. We have produced a model for predicting the number of pollution incidents based on rainfall and soil moisture deficit which, given the modelling confidence levels, appears to be accurate until early 2012. From March 2012 onwards, the actual number of incidents is much greater than the predicted number due to weather changes, which suggests that some external factor has impacted the number of reported incidents.

The increase is believed to be partly due to a change in our level of self-reporting of incidents, meaning that previously unreported incidents are now captured in the EAs measurement of incidents.

It is also partly due to a change in the way that the EA records pollution incidents, which no longer depends on confirmatory visits by the EA following a third party notification. We accept that these changes are both in the interest of customers.

In addition there have been periods of exceptionally wet weather in the last three years. For example, performance in 2014 was affected by the very wet weather in January and February, with 72 (47%) of the 152 incidents occurring in those two months. During this time the sewers were inundated with water from overflowing watercourses which was transported to overflows in the network, to pumping stations and sewage works which were not designed for such high flows. The assets performed as designed and many of these pollution incidents were not a result of asset failure.



We have made a judgement on the period that should best be used to calculate the reference level and control limit. Whilst we could have used the data from these recent events, we, and our independent technical assurance experts, considered that this might appear to support unacceptably high control and failure thresholds. We note that the reference level we submitted in our PR14 Business Plan proposals has been calculated based on data from 2008 to 2012. Most of this data is from before the step change in reported incidents and are therefore likely to generate a mean, and reference level, that does not reflect current (and future) performance. In order to be consistent we have used the mean and standard deviation from this data series to calculate our control limits.

The reference level and standard deviation of the 2008 to 2012 data along with the calculated control limit and the AMP6 ref level are shown in Table 7.

**Table 7: Analysis for non-infrastructure pollution incidents**

	Reference Level	Standard deviation	AMP6 Control Limit (Ref Level +2SD)
Number of incidents	27	21	69

Source: Thames Water calculations

The reference level of 27 is stated in our Final Determination. Using the process set out in Annex 1, we have calculated a control limit of 69, which is two standard deviations above the reference level.

We note that the calculated control limit of 69 from this data is less than half of the performance in the last two years, and represents a significant challenge to achieve performance below this level.

### Failure threshold

As this is a new sub-measure, we have assessed the upper failure threshold based on one standard deviation from the control limit. This gives an upper failure threshold of 90. Our performance in 2012/13 and 2013/14 would have exceeded this threshold.

### Impact of external factors on performance

As in 2014, performance can be affected by extreme weather events – for example, when the sewerage network is inundated with overflow from rivers.

We plan to install event duration monitors in AMP6 to better understand the performance of our assets. Currently if a small loss of wastewater to the environment occurs – for example, from a pumping station overflow – it is unlikely to be reported as a pollution incident unless it is seen or there is obvious environmental impact on the watercourse.

Pollution incidents identified solely as a result of event duration monitoring will be identified separately and not included in the reported values for this indicator.

### Summary

- Control limit for AMP6 to be set at 69 incidents a year.
- The failure threshold is set at 90 incidents per year.

# AMP6 OUTCOMES REPORTING POLICY

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### ASSET HEALTH CONTROL LIMITS & FAILURE THRESHOLDS



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- External factors that may affect performance are changes in procedure by the EA, flooding due to extreme weather, and incidents detected by event duration monitors that would not otherwise have been identified.



### 3 Wastewater Infrastructure

There are four sub-measures for this asset health composite indicator:

- Properties internally flooded due to sewer flooding other causes (SFOC)
- Number of unconsented pollution incidents (category 1, 2 and 3 water incidents) from foul sewers, combined sewer overflows and rising mains
- Number of sewer collapses
- Number of sewer blockages

The control limits and failure thresholds for the sub-measures included in the Asset Health Wastewater Infrastructure PC for AMP6 are shown in Table 8. Further detail on each sub-measure is included in Sections 3.1 to 3.4.

**Table 8: Asset Health sub-measures – Wastewater Infrastructure**

Indicator	AMP6 Ref Level	AMP6 control limit	AMP6 failure threshold
Properties internally flooded due to SFOC (nr)	1,077	1,274	1,358
Unconsented pollution incidents from foul sewers, combined sewer overflows and rising mains (category 1 to 3 water incidents)	206	332	393
Number of sewer blockages (nr)	84,438	89,698	93,251
Number of sewer collapses (nr)	736	881	1,004

Source: Thames Water Calculations

The Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 resulted in an estimated 40,000km of sewers transferring to our ownership on 1 October 2011 (termed 'transferred network') in addition to our legacy network. We currently have only two full years of data on blockages, collapses, other causes flooding and pollution from transferred assets, which does not provide a robust baseline from which to calculate the impact of the transferred network. Our approach is therefore to base calculations of the control limit upon the data from the legacy network and to make a pro-rata adjustment on the basis of the accepted reference levels which include a component for the transferred assets. Significant movements in the performance demonstrably and solely due to the transferred assets could be considered as a mitigation event as explained in Annex 1.



### 3.1 Properties internally flooded due to SFOC

#### Calculation of the control limit

The reference level in AMP6 for the legacy assets has been increased from 667 to 848 to account for the transferred network. The data set used to calculate the control limit is shown in Table 9. Data from 2012/13, when performance was significantly above AMP5 control limits, has been excluded.

**Table 9: Data for SFOC properties**

Year	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
SFOC nr of properties	845	796	843	967	1,230	903

Source: Thames Water Annual Return Data

The mean and standard deviation are show in Table 10 along with the calculated control limit and the existing AMP6 reference level.

**Table 10: Analysis for SFOC properties**

Units (properties)	Mean	Standard deviation	Mean + 2 SD	Mean + 3 SD	AMP6 ref level
Legacy network	871	66	1,003	1,069	848
Transferred network	235	18	271	289	229
Total	1,106	84	1,274	1,358	1,077

Source: Thames Water calculations

The mean of this data is similar to the AMP6 reference level. The control limit is therefore based on 2 standard deviations above the mean, giving a value of 1,274 properties for the total network.

#### Failure threshold

The failure threshold is set using control limit plus one standard deviation, which gives a value of 1,358 properties.

#### Impact of external factors on performance

Performance can be affected by extreme weather events – for example, when the sewerage network is inundated with surface overflow from rivers and silt deposited in the sewers, leading to an increased number of blockages and hence other cause flooding. A suitable distinction would be the "extreme weather" condition for determining when GSS payments are not made.



## Summary

- Control limit for AMP6 is set at 1,274 properties a year.
- The failure threshold is set at 1,358 properties a year.
- An external factor that may affect performance is flooding due to extreme weather, leading to silt deposition in the sewer, infiltration and surface water inundation. Significant movements in the performance demonstrably and solely due to the transferred assets will be considered as an exceptional event.

## 3.2 Unconsented pollution incidents (category 1, 2 and 3 water incidents)

### Calculation of the control limit

During AMP5 the number of reported pollution incidents in the Thames Water area increased significantly. The data since 2005 is shown in Table 11 and the increase since 2011 is clear and we do not consider that the increase is solely due to deterioration in Asset Health. Since 2012 the introduction of self-reporting and a change in EA approach to categorisation has led to an increase in the number of reported incidents. To reflect this change, the AMP6 reference level for the legacy assets has been increased from 124 to 203.

**Table 11: Data for network pollution incidents**

Year	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
No	134	106	96	103	106	76	127	223	237	190

Source: Thames Water Annual Return Data

We have reviewed the pollution incidents per month and created a model that relates the number of incidents to rainfall, the response time and the degree of self-reporting per month. The model can then be used to predict how many incidents there were likely to have been if the level of self-reporting had been 60% at the time. The annual value is the sum of the 12 monthly values. This model is statistically robust and was used to calculate the reference level for the legacy assets based on data from 2008 to 2012.

The number of incidents predicted by the model for the years 2008 to 2012 is shown in Table 12. The number of incidents in 2013 and 2014 reflect actual performance, as they reflect new embedded and improve self-reporting processes.

**Table 12: Modelled prediction for network pollution incidents**

Year	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13	2013/14
No	174	164	156	196	329	237	190

Source: Thames Water calculations and Annual Return Data

This data can be used to derive a mean and standard deviation along with the calculated control limit. These and the proposed AMP6 reference level are shown in the Table 13.



**Table 13: Analysis for network pollution incidents**

Units (incidents)	Mean	Standard deviation	Mean + 2 SD	AMP6 ref level
Legacy network	207	60	327	203
Transferred network	3	1	5	3
Total	210	61	332	206

Source: Thames Water calculations

The calculated mean is very close to the AMP6 reference level. The control limit is therefore set at two standard deviations beyond the mean, giving a value of 332 incidents. We note that the performance of the legacy assets in 2012 almost exceeded this control limit.

### Failure threshold

As this is a new sub-measure, we have assessed the upper failure threshold based on one standard deviation above the control limit. This gives a failure threshold of 387 for the legacy assets and 393 when the transferred network is included.

### Impact of external factors on performance

Performance can be affected by extreme weather events – for example, due to prolonged infiltration during periods with sustained high groundwater levels or when the sewerage network is inundated with surface overflow from rivers. A suitable distinction may be the "extreme weather" condition for determining when GSS payments need not be made.

We plan to install event duration monitors in AMP6 to better understand our asset performance. If a small loss of wastewater to the environment occurs at the moment – for example, from a combined sewer overflow – it is unlikely to be reported as a pollution incident unless it is seen or there is obvious environmental impact on the watercourse. Pollution incidents identified solely as a result of event duration monitoring will be identified separately and not included in the reported values for this indicator.

### Summary

- Control limit for AMP6 to be set at 332 incidents a year for the legacy and transferred network
- Failure threshold to be set at 393 incidents per year for the legacy and transferred network
- External factors that may affect performance are flooding due to extreme weather and incidents detected by event duration monitors that would not otherwise have been identified.



## 3.3 Number of sewer collapses

### Calculation of the control limit

The data used to set the control limit are taken from JR07 onwards, when performance improved following a period of deteriorating performance. The data are shown in Table 14.

**Table 14: Data for sewer collapses**

Year	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Nr	902	916	530	465	406	372	264	345	331	348

Source: Thames Water Annual Return Data

The mean and standard deviation are shown in Table 15, with the calculated control limit, and the existing AMP5 reference level and upper control limit.

**Table 15: Analysis for sewer collapses**

	Mean	Standard deviation	Mean + 2 STD	AMP5 ref level	AMP5 control limit	AMP6 ref level	AMP6 control limit
Legacy network	382	83	548	498	596	498	596
Transferred network	183	40	263	n/a	n/a	238	285
Total	565	123	810	n/a	n/a	736	881

Source: Thames Water calculations

The AMP6 control limit is identical to the AMP5 control limit for the legacy network. The transferred network has been taken into account by scaling up the current AMP5 upper control limit (596) by the ratio of the AMP6 reference level (736) to the AMP6 legacy network reference level (498), which is 881 collapses.

### Failure threshold

We have assessed the failure threshold at 1,004 collapses based on the addition of one standard deviation (123) to the AMP6 control limit.

### Impact of external factors on performance

We do not envisage external factors having a significant impact on the number of collapses.





## Summary

- Control limit for AMP6 to be set at 881 collapses a year.
- Failure threshold for AMP6 to be set at 1,004 collapses a year.
- We do not expect any external factors that will be used to mitigate performance.

## 3.4 Number of sewer blockages

### Calculation of the control limit

The data used to set the control limit could be taken from JR06 when performance was first reported and the confidence grade of B4 (+/- 25%) was assigned. However it is more appropriate to use data from JR08 when the confidence grade was improved to B2 (+/- 5%). The data are shown in Table 16.

**Table 16: Data for sewer blockages**

Year	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13	2013/14
No	66,700	62,466	60,264	54,867	52,908	54,373	56,104	55,801	53,637

Source: Thames Water Annual Return Data

The mean and standard deviation of the data since JR08 are shown in Table 17, with the calculated control limit, and the existing AMP5 reference level and upper control limit.

**Table 17: Analysis for sewer blockages**

	Mean	Standard deviation	Mean + 2 STD	AMP5 ref level	AMP5 control limit	AMP6 Ref level	AMP6 control limit
Legacy network	55,422	2,414	60,250	57,362	60,935	57,362	60,935
Transferred network	26,160	1,139	28,438	n/a	n/a	27,076	28,763
Total	81,582	3,553	88,688	n/a	n/a	84,438	89,698

Source: Thames Water calculations

The AMP6 control limit is identical to the AMP5 control limit for the legacy network. The transferred network has been taken into account by scaling up the current AMP5 upper control limit (60,935) by the ratio of the AMP6 reference level (84,438) to the AMP6 legacy reference level (57,362) and will be 89,698.

### Failure threshold

We have assessed the failure threshold of 93,251 blockages based on addition of one standard deviation (3,553) to the AMP6 control limit.



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#### Impact of external factors on performance

A possible external factor affecting performance could be when silt is deposited in sewers following fluvial inundation of the network. A suitable distinction may be the "extreme weather" condition for determining when GSS payments need not be made.

#### Summary

- Control limit for AMP6 to be set at 89,698 blockages a year.
- Failure threshold for AMP6 to be set at 93,251 blockages a year
- An external factor that may affect performance is flooding due to extreme weather leading to silt deposition in the sewer.



## 4 Water Non-Infrastructure

There are six sub-measures for this asset health composite indicator:

- Disinfection index (DWI) %
- Service reservoir coliform non-compliance %
- DWQ compliance measures – turbidity (number of sites).
- Process control index %
- DWQ compliance measures – enforcement actions (number)
- Water quality complaints for chlorine (number per 1,000 population)

The control limits and failure thresholds for the sub-measures included in the Asset Health Water Non-Infrastructure PC for AMP6 are shown in Table 18. Further detail on each sub-measure is included in Sections 4.1 to 4.6.

**Table 18: Asset Health sub-measures – Water Non-Infrastructure**

Indicator	AMP6 ref level	AMP6 control limit	AMP6 failure threshold
Disinfection index (DWI) (%)	99.97	99.96	99.95
Service reservoir coliform non-compliance (%)	0.27	0.54	0.81
DWQ compliance measures – turbidity (nr of sites)	1	2	3
Process control index (%)	99.99	99.98	99.97
DWQ compliance measures – Enforcement actions (nr)	0	1	2
Water quality complaints for chlorine (nr per 1,000 population)	0.07	0.124	0.151

Source: Thames Water Calculations

The asset health sub-measures are a sub-set of those used by Ofwat and the Drinking Water Inspectorate (DWI). Many of the sub-measures are close to 100% compliance (although sometimes they are expressed as the percentage of non-compliance). The reference levels have not changed from that used for AMP5 where applicable. For turbidity the upper control limit is as per AMP5. For the other sub-measures, where none existed for AMP5, they have been derived from the AMP5 dataset, either based on expert judgement (for Enforcement Actions and Disinfection supported by analysis of the AMP5 data) or using the reference level plus two standard deviations of the values reported for AMP5.

For the avoidance of doubt, nothing in this section overrides or takes precedence over our responsibility to provide water in accordance with the Drinking Water Quality Regulations.



## 4.1 Disinfection index

### Calculation of the control limit

This is a DWI indicator with a history of assured values that is derived from Thames Water systems (water sampling) using the DWI methodology. The data set used to derive the control limit is shown in Table 19.

**Table 19: Data for disinfection index**

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Performance	N/A	N/A	N/A	N/A	99.96	99.95	99.98	99.95	99.96

Source: Thames Water Annual Return data

The AMP6 reference level is unchanged from AMP5. The standard deviation is 0.01

The mean and standard deviation of the data are shown in Table 20 along with the calculated AMP5 and AMP6 reference levels.

**Table 20: Analysis for disinfection index**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level -1 SD
99.96	0.01	99.97	99.97	99.96

Source: Thames Water Calculations

Setting the control limit one standard deviation below the reference level, this gives a control limit of 99.96%.

### Failure threshold

We have set the failure threshold one standard deviation below the control limit, which gives a failure threshold 99.95%

### Impact of external factors on performance

Under some limited circumstances regulatory failures may be excluded from the total.

It is possible that Thames Water will be asked to provide support to national/regional events which inhibits its ability to maintain performance. It is also possible that there could be a change in reporting requirements or Thames Water could face external direction to undertake a different approach. Thames Water would expect these factors to be taken into account when assessing the performance of this indicator.



## Summary

- The control limit for AMP6 has been set as 99.96% compliance.
- The failure threshold is 99.95% compliance.
- External factors that may affect performance are a change in reporting requirements or a response to a national/regional event/incident or external direction.

## 4.2 Service reservoir coliform non-compliance

### Calculation of the control limit

This is an Ofwat indicator with a history of assured values that is derived from Thames Water systems (water sampling) using the DWI methodology.

The reference level is a maximum of one service reservoir failure within the year, which equates to 0.27% (for 1 out of 370 service reservoirs). The AMP6 reference level is unchanged from AMP5. In AMP5, the control limit was set at 0.81% equivalent to three service failures. In AMP5 we have invested to improve our performance in this area, and are resetting the control limit for AMP6 at two reservoir failures, or 0.54%

### Failure threshold

Due to the discrete nature of the dataset we have set the failure threshold at three service reservoir failures, which gives a value of 0.81%. This is equivalent to the AMP5 upper control limit.

### Impact of external factors on performance

Under some limited circumstances regulatory failures may be excluded from the total. It is possible that Thames Water could be asked to provide support to national/regional events which inhibits its ability to maintain performance. It is also possible that there could be a change in reporting requirements or Thames Water could face external direction to undertake a different approach. Thames Water would expect these factors to be taken into account when assessing the performance of this indicator.

## Summary

- Control limit for AMP6 is set at two service reservoir failures (0.54%).
- Failure threshold is set at three service reservoir failures (0.81%).
- External factors that may affect performance are a change in reporting requirements or a response to national/regional event/incident or external direction.



## 4.3 DWQ compliance measures – turbidity

### Calculation of the control limit

This is an Ofwat indicator with a history of assured values that is derived from Thames Water systems (water sampling) using the Ofwat/DWI methodology. The data set used to derive the control limit is shown in Table 21.

**Table 21: Data for turbidity**

Year	2010	2011	2012	2013	2014
Performance	0	2	1	1	0

Source: Thames Annual Return Data

The AMP6 reference level is unchanged from AMP5 and is the mean performance since 2010.

The control limit has been set on a pragmatic basis, allowing two failures – this is broadly consistent with an approach using reference level plus 1 standard deviation.

The mean and standard deviation of the data are shown in Table 22 along with the AMP5 and AMP6 reference levels.

**Table 22: Analysis for turbidity**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level + 1SD
1	1	1	1	2

Source: Thames Water Calculations

The AMP6 control limit is therefore set at two sites. This is the same as the upper control limit in AMP5.

### Failure threshold

Using the same basis as for control limits and recognising the discrete nature of the data, the failure threshold is set at three sites.

### Impact of external factors on performance

Under some limited circumstances regulatory failures may be excluded. We note that the operation of the desalination sites is a specific exclusion from this sub-measure.

It is possible that Thames Water will be asked to provide support to national/regional events which inhibits its ability to maintain performance. It is also possible that there could be a change in reporting requirements or Thames Water could face external direction to undertake a different approach. Thames Water would expect these factors to be taken into account when assessing the performance of this indicator.



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## Summary

- The control limit for AMP6 is set at two site failures.
- The failure threshold is set at three site failures.
- External factors that may affect performance are a change in reporting requirements or a response to national/regional event/incident or external direction.
- Operation of the desalination sites is a specific exclusion from this sub-measure.

## 4.4 Process control index

### Calculation of the control limit

This is a DWI indicator with a history of assured values that is derived from Thames Water systems (water sampling) using the DWI methodology.

The AMP6 reference level is unchanged from AMP5. The control limit has been set on a pragmatic basis that aligns with AMP5, accepting that performance above 99.99% is unlikely to be achievable. No control limits were set in AMP5, but we consider that performance below 99.98% is likely to reflect an underlying asset health issue. The control limit is therefore set at 99.98%.

### Failure threshold

The failure threshold is set at 99.97%.

### Impact of external factors on performance

It is possible that Thames Water could be asked to provide support to national/regional events which inhibits its ability to maintain performance. It is also possible that there could be a change in reporting requirements or Thames Water could face external direction to undertake a different approach. We would expect these factors to be taken into account when assessing the performance of this indicator.

## Summary

- Control limit for AMP6 is set at 99.98%.
- The failure threshold is set at 99.97%.
- External factors that may affect performance are a change in regulatory reporting or a response to a national/regional event/incident or external direction.



## 4.5 DWQ compliance measures – Enforcement actions

### Calculation of the control limit

This is a DWI indicator with a history of assured values that is derived from our systems using the DWI methodology. The data set used to derive the control limit is shown in Table 23.

**Table 23: Data for enforcement actions**

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Performance	N/A	N/A	N/A	N/A	0	0	0	0	0

Source: Thames Water Annual Return Data

The AMP6 reference level is zero, which is unchanged from AMP5. It is also the mean performance since 2010. The control limit has been set at one enforcement action on a pragmatic basis, as an approach using standard deviations is not appropriate in this case.

### Failure threshold

The failure threshold is set on a pragmatic basis as two enforcement actions.

### Impact of external factors on performance and mitigation

We note that the definition of enforcement actions are still being finalised with the DWI. The definition of the term enforcement action may affect what mitigating factors should be taken into account.

External actions would be considered by DWI before issuing an enforcement action.

### Summary

- Control limit for AMP6 has been set at one (1) enforcement action.
- The failure threshold is set at two (2) enforcement actions.





## 4.6 Water quality complaints for chlorine

### Calculation of the control limit

This is a DWI indicator with a history of assured values that is derived from Thames Water systems (customer contacts) using the Ofwat/DWI methodology. The data set used to derive the control limit is shown Table 24.

**Table 24: Data for water quality complaints for chlorine**

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Performance	N/A	N/A	N/A	N/A	0.055	0.050	0.080	0.110	0.104

Source: Thames Water Annual Return Data

The AMP6 reference level is unchanged from AMP5. Data from all years has been included in the analysis. The mean and standard deviation of the data are shown in Table 25 with the calculated control limit, and the AMP5 and AMP6 reference levels.

**Table 25: Analysis for water quality complaints for chlorine**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level + 2 SD
0.08	0.027	0.07	0.07	0.124

Source: Thames Water Calculated Data

The control limit is set at 0.124 complaints per 1,000 population.

### Failure threshold

The failure threshold is set at one standard deviation from the control limit giving a value of 0.151 complaints per 1,000 population.

### Impact of external factors on performance

Under limited circumstances failure of the measure or associated sample may be excluded in line with current processes. It is also possible that there could be changes to reporting requirements or Thames Water could face external direction to undertake a different approach. Thames Water would expect these factors to be taken into account when assessing the performance of this indicator.

### Summary

- The control limit for AMP6 has been set at 0.124 complaints per 1,000 population.
- The failure threshold is set at 0.151 complaints per 1,000 population.
- External factors that may affect performance are changes to reporting requirements, national/regional event/incident or external direction.



## 5 Water Infrastructure

There are six sub-measures for this asset health composite indicator:

- Total bursts (number)
- Unplanned interruptions to customer greater than 12 hours (properties)
- Iron mean zonal non-compliance (%)
- Inadequate pressure (DG2) (properties)
- Planned network rehabilitation (km)
- Customer complaints for discolouration or white water (number per 1,000 population)

The control limits and failure thresholds for the sub-measures included in the Asset Health Water Infrastructure PC for AMP6 are shown in Table 26. Further detail on each sub-measure is included in Sections 5.1 to 5.6.

**Table 26: Asset Health sub-measures – Water Infrastructure**

Indicator	AMP6 ref level	AMP6 control limit	AMP6 failure threshold
Total Bursts (nr)	8,840	11,206	13,572
Unplanned interruptions to customer >12hrs (DG3) (properties)	1,354	3,055	4,756
Iron mean zonal non-compliance (%)	0.16	0.23	0.30
Inadequate Pressure (DG2) (properties)	34	46	52
Planned Network Rehab (km)	650	650	650
Customer Complaints discolouration/white water (nr per 1,000 pop)	0.38	0.49	0.55

Source: Thames Water Calculations

### 5.1 Total bursts

#### Calculation of the control limit

This is an Ofwat indicator with a history of assured values that is derived from Thames Water systems (burst records) using the Ofwat methodology. The target has been tightened from AMP5 with a lower reference level. The data set used to derive the control limit is shown in Table 27.



**Table 27: Data for bursts**

Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Performance	13,278	10,928	10,729	14,240	9,825	9,268	7,447	7,253	9,247

Source: Thames Water Annual Return Data

Data from all years has been included in the analysis. The mean and standard deviation of the data are shown in Table 28 along with the calculated control limit, and the AMP5 and AMP6 reference levels. The AMP5 control limit is set at 13,340, but based on a higher reference level of 11,000.

**Table 28: Analysis for bursts**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 Reference level + 1SD
10,246	2,366	11,000	8,840	11,206

Source: Thames Water calculated data

The control limit has been set at one standard deviation above the reference level, which gives a value of 11,206 bursts.

### Failure threshold

The failure threshold is set at one standard deviation above the control limit, which gives a value of 13,572 bursts.

### Impact of external factors on performance

The number of bursts will be influenced by the year-on-year variability in the weather. Although severe weather has been used to set the control limits the number of bursts could exceed the control limit if more extreme weather is experienced. Extreme weather, beyond that experienced since 2006, could cause excessive ground movement.

Third party damage to the assets is excluded on a consistent basis with past performance.

### Summary

- The control limit for AMP6 has been set at 11,206 bursts.
- The failure threshold is 13,572 bursts.
- External factors that may affect performance are third party impacts. Extreme weather may also be taken into account if it is demonstrably worse than any year since the dataset was established.



## 5.2 Unplanned interruptions to customer >12hr (properties)

### Calculation of the control limit

This is an Ofwat indicator (historically referred to as DG3) with a history of assured values derived using modelling and interrogation of pressure logging records. Reporting uses the Ofwat methodology.

The data set used to compare performance for the control limit is shown in Table 29.

**Table 29: Data for unplanned interruptions to customer**

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Reported Performance	2,955	3,091	905	1,381	1,209	1,052	1,706	2,465	1,563
Interruptions removed (see below)						5,482			4,395
Total Performance	2,955	3,091	905	1,381	1,209	6,534	1,706	2,465	5,958

Source: Thames Water Annual Return data and Thames Water calculations

The reference level for AMP6 has been reduced. The same uncertainties and risks apply, so we have therefore applied the AMP5 control limit methodology to the AMP6 reference level.

The raw data from 2010/11 and 2013/14 is excluded from any comparison as they contain data associated with either deteriorating performance or external third party impacts. The values for these years were reduced as described below:

- The peak in 2010/11 was reduced due to anomalies in performance; there was a single incident that totalled 5,482 properties.
- The peak in 2013/14 was reduced to a combination of performance (4,395 properties) and flooding which affected power supplies (2,661).

The AMP5 reference level and control level used to develop the AMP6 control and failure threshold are outlined in Table 30.

**Table 30: Analysis for unplanned interruptions to customer**

AMP5 Ref Level	AMP5 Control Level	AMP6 Ref Level	Control Band (AMP 5 Ref – AMP 5 Control limit)	AMP6 Control Limit
1,568	3,269	1,354	1,701	3,055

Source: Thames Water calculations



The AMP6 control limit is the difference from the AMP5 band to the AMP5 control limit added to the AMP6 reference level. On this basis the AMP6 control level is set at 3,055, which is below the AMP5 level. We have taken this approach because of the inherent variability in the underlying data does not change between AMP5 and AMP6. Using this approach reduces the control limit in line with the reduction in the reference level.

#### Failure threshold

We have set the failure threshold one band width (1,701) beyond the control limit. This gives a failure threshold of 4,756. Again we believe this is appropriate because of the inherent variability in the underlying data.

#### Impact of external factors on performance

The number of interruptions to supply which occur will be influenced by the year-on-year variability in the weather. Although severe weather has been used to set the upper and lower bands the number of bursts could exceed the control limit if more extreme weather is experienced. Extreme weather, beyond that experienced since 2006, could cause excessive ground movement such as prolonged periods of cold weather, prolonged periods of hot/dry weather or surface water flooding.

Third party damage to the assets is excluded on a consistent basis with past performance. Some extreme weather, such as flooding, may impact the performance.

#### Summary

- Control limit for AMP6 has been set at 3,055 Interruptions.
- The failure threshold has been set at 4,756 Interruptions.
- External factors that may affect performance are extreme weather (prolonged cold winter, hot/dry summer or flooding), third party impacts, national/regional event/incident or external direction.

## 5.3 Iron mean zonal non-compliance

#### Calculation of the control limit

This is an Ofwat indicator with a history of assured values that is derived from Thames Water systems (water sampling) using the DWI methodology. The data set used to derive the control limit is shown in Table 31.

**Table 31: Data for iron mean zonal non-compliance**

Year	2006	2007	2008	2009	2010	2011	2012	2013
Performance	0.22	0.12	0.15	0.24	0.23	0.12	0.11	0.08

Source: Thames Water Annual Return Data



The AMP6 reference level is unchanged from AMP5 and is the same as the mean performance since 2006. The mean and standard deviation of the data are shown in Table 32, with the AMP5 and AMP6 reference levels. The AMP5 control limit was set at 0.23%.

**Table 32: Analysis for iron mean zonal non-compliance**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level + 1SD
0.16	0.06	0.16	0.16	0.22

Source: Thames Water Annual Return data

The AMP6 control limit is set based on reference level plus one standard deviation, which gives a limit of 0.22%

#### Failure threshold

The failure threshold is set at one standard deviation beyond the control limit. This gives a failure threshold of 0.28%

#### Impact of external factors on performance

There are no specific factors that have been identified that may influence this sub-measure.

#### Summary

- The control limit for AMP6 is set at 0.22%.
- The failure threshold is set at 0.28%.

## 5.4 Inadequate pressure (DG2)

### Calculation of the control limit

This is an Ofwat indicator with a history of assured values that is derived using modelling and interrogation of pressure logging records, requiring elements of judgement. Reporting uses the Ofwat methodology. The data set used to derive the control limit is shown Table 33.

**Table 33: Data for inadequate pressure**

Year	2011	2012	2013	2014
Performance	14	3	4	0

Source: Thames Water Annual Return data

The mean and standard deviation of the data are shown in Table 34, along with the AMP5 and AMP6 reference levels. The use of two standard deviations above the mean is considerably more challenging than the current AMP5 reference level of 192 and control limit of 700.



**Table 34: Analysis for inadequate pressure**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level + 2SD
5.3	6.1	192	34	46

Source: Thames Water Calculations

As the AMP6 reference level is significantly tighter than the AMP5 level we have adopted a control limit of 2 standard deviations above the reference level. This gives a control limit of 46 properties.

#### Failure threshold

The failure threshold is calculated as one standard deviation beyond the control limit, which gives a total of 52 properties

#### Impact of external factors on performance

This sub-measure will continue to be recorded using the same process as AMP5. More extensive datasets that record customer contacts on low pressure are being developed, but will not be used in this process. We note that a new methodology for measuring pressure will be developed in AMP6, and this new measure will be linked to customer contacts and will use this wider dataset.

#### Summary

- The control limit for AMP6 has been set at 46 properties.
- The failure threshold is set at 52 properties.
- External factors that may affect performance are changing in reporting requirements.

## 5.5 Planned network rehabilitation

#### Calculation of the control limit

This is a new indicator, with an AMP6 reference level of 650km, which relates to the length of mains rehabilitation completed by the end of the AMP6 period. Upper and lower bands are not considered appropriate for this indicator.

We believe from the customer perspective the requirement should be that we will deliver at least 650km of mains replacement in the period.

#### Failure threshold

A pragmatic view is that the failure threshold is reached if we deliver less than 650km of mains replaced over the period.



### Impact of external factors on performance

No reasonably foreseeable external impacts that affect the performance of this sub-measure have been identified

### Summary

- At the end of AMP6 the failure threshold is 650km of mains.
- On an annual basis we will provide information on progress towards this target.

## 5.6 Customer complaints discolouration/white water

### Calculation of the control limit

This is an Ofwat/DWI indicator with a history of assured values that is derived from Thames Water systems (customer contacts) using the Ofwat/DWI methodology. The data set used to derive the control limit is shown in Table 35.

**Table 35: Data for customer complaints due to discolouration or white water**

Year	2010	2011	2012	2013
Discolouration	0.118	0.124	0.115	0.109
White water	0.239	0.136	0.127	0.126
Performance	0.357	0.260	0.242	0.235

Source: Thames Water Annual Return data

While discolouration complaints was an AMP5 indicator, the AMP6 sub-measure is new, as it combines the discolouration and white water complaints into a single indicator.

As a combined sub-measure, it is considered appropriate to set the bands using the reference level  $\pm 2$  standard deviations. The mean and standard deviation of the data are shown in Table 36 with the calculated control limit calculation, and the AMP6 reference level.

**Table 36: Analysis for customer complaints due to discolouration or white water**

Mean	Standard deviation	AMP5 reference level	AMP6 Reference level	AMP6 reference level + 2 SD
0.380	0.057	N/A	0.38	0.49

Source: Thames Water Calculations

The AMP6 control limit is therefore set at 0.49 complaints per 1,000 population.



# AMP6 OUTCOMES REPORTING POLICY

## ANNEX 2 – WHOLESALE

### ASSET HEALTH CONTROL LIMITS & FAILURE THRESHOLDS



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#### Failure threshold

The failure threshold is set at one standard deviation beyond the control limit, which gives the threshold of 0.55 per 1,000 population.

#### Impact of external factors on performance

This sub-measure is sensitive to way the complaints are collected, and what constitutes a complaint. The assessment of the sub-measure will be based on the AMP5 approach and will follow established processes. If new data sources or methods of analysis are available, these will be recorded and made available but will not be used in the calculation of the performance against this measure.

#### Summary

- Control limit for AMP6 has been set at 0.49 per 1,000 population.
- The failure threshold is 0.55 per 1,000 population.
- External factors that may affect performance are changes in reporting requirements.