Appendix 5.3.A.2 – Annex 1 and 2 - Nitrate Schemes

Wessex Water

September 2018

Business plan section		Supporting document	
	Board vision and executive summary		
1	Engaging customers		
2	Addressing affordability and vulnerability		
3	Delivering outcomes for customers		
4	Securing long term resilience		
5	Markets & innovation: wholesale	5.1	Protecting and enhancing the environment
		5.2	Using water efficiently
		5.3	**Providing excellent drinking water quality**
		5.4	Minimising sewer flooding
		5.5	Bioresources
		5.6	Maintaining our services
		5.7	Accommodating growth and new development
		5.8	Water resources bid assessment framework
		5.9	Water resources RCV allocation
		5.10	Bioresources RCV allocation
6	Markets & innovation: open systems & DPC		
7	Markets & innovation: retail		
8	Securing cost efficiency		
9	Aligning risk and return		
10	Financeability		
11	Accounting for past delivery		
12	Securing trust, confidence and assurance		
13	Data tables and supporting commentaries		

Annex 1. Fonthill Bishop

Proposals to carry out improvements for drinking water quality reasons – submission of information.

An up to date regulation 28 risk assessment report must be appended with all submissions.

This annex lists all of the information that companies should provide to the Inspectorate with PR19 proposals for drinking water quality. If the information is already included in the regulation 28 reports submitted with proposals, or in other documents appended to the submission, there is no need for companies to provide the information again separately.

Scheme details:

Water Company:	Wessex Water
Date of submission:	28 December 2017
Name of supply system & Reg. 28 Report ref. number:	Zone 101 Shaftesbury Z44000101 WSX-Risk-R66065000-12-17
Name of Water Treatment Works/Distribution System/Service Reservoir/Other asset:	Fonthill Bishop Water Treatment Works T33081000
Water quality hazard/drivers identified:	Nitrates
Reference to outcome in company's long-term strategy:	'*Our Strategic Direction'* Strategic Direction Statement Page 11 ' Excellent Quality Drinking Water' Page 12 'Resilient Services'

Please note that all sample results are expressed in mg N/L. The regulatory limit when nitrate is expressed in this unit is 11.3mg/l.

Sample data in the regulatory mgNO3/l unit for which the regulatory limit is 50 mgNO3/l can be found in Appendix 1.

Stage One – Details of water treatment works and associated supply system
Provide supply arrangements and treatment works details:
A description and diagram of the supply system related to the treatment works [In many cases, companies include this information, including schematic diagrams, in regulation 28 risk assessment reports, in which case it is acceptable to refer here to the report, which should be appended]
Fonthill Bishop is within Water Quality Zone 101 Shaftesbury as detailed in the schematic below. **<u>Water Quality Zone 101 Schematic</u>** ✂ Fonthill Bishop is a borehole source located just off the A303 15km north east of Shaftesbury. Water is currently supplied direct to ✂ Service Reservoir (SR) in Shaftesbury as well as supplying communities in between ✂ SR is a key point in the main north south link in our integrated regional grid as illustrated below. ✂

Should Fonthill Bishop water treatment works be out of service then it is possible to temporarily ‘substitute’ the site and transfer water into the zone (via ✂ SR) from ✂ pumping station and ✂ SR. These transfers were constructed as part of the integrated supply grid.

<u>Schematic of Fonthill Bishop within the wider network</u>

✂

Design capacity Ml/d

Site	Design Capacity
Fonthill Bishop	7.00 Ml/d

Volume supplied: Daily average and daily maximum Ml/d
[Please include a commentary if there are any constraints on deployable output due to limitations associated with any part of the treatment process]

Site	Daily average	Daily maximum	Commentary on Constraints
Fonthill Bishop	4.83 Ml/d	5.50 Ml/d	Licence constraint is equivalent of 6.986Ml/d.

Sources of raw water, continuous, seasonal or standby
[Include names of individual sources, nature of the source (e.g. surface direct abstraction; surface impounding reservoir; borehole; spring; type of aquifer)

Continuous borehole source - ✂

Treatment processes currently employed (including pre-treatment of raw waters)
[In this case, blending is defined as treatment. This includes blending of raw waters prior to treatment. Please also indicate if bankside storage of raw water is utilised, and average retention time in the reservoir]

✂.

<u>Fonthill Bishop Site Schematic</u>

✂

✂

When nitrate levels exceed the internal action level of 10mg N/L they appear on the daily laboratory generated exception report and are investigated by the local operational supply scientist. A decision may then be taken to isolate a borehole or commence temporary tankering.

Service reservoirs/booster pump details

✂

Water supply zones supplied
[If the supply is blended with waters from other treatment works in the zone, please indicate the relative proportions (as %)]

Z44000101 Shaftesbury

Population of each water supply zone supplied

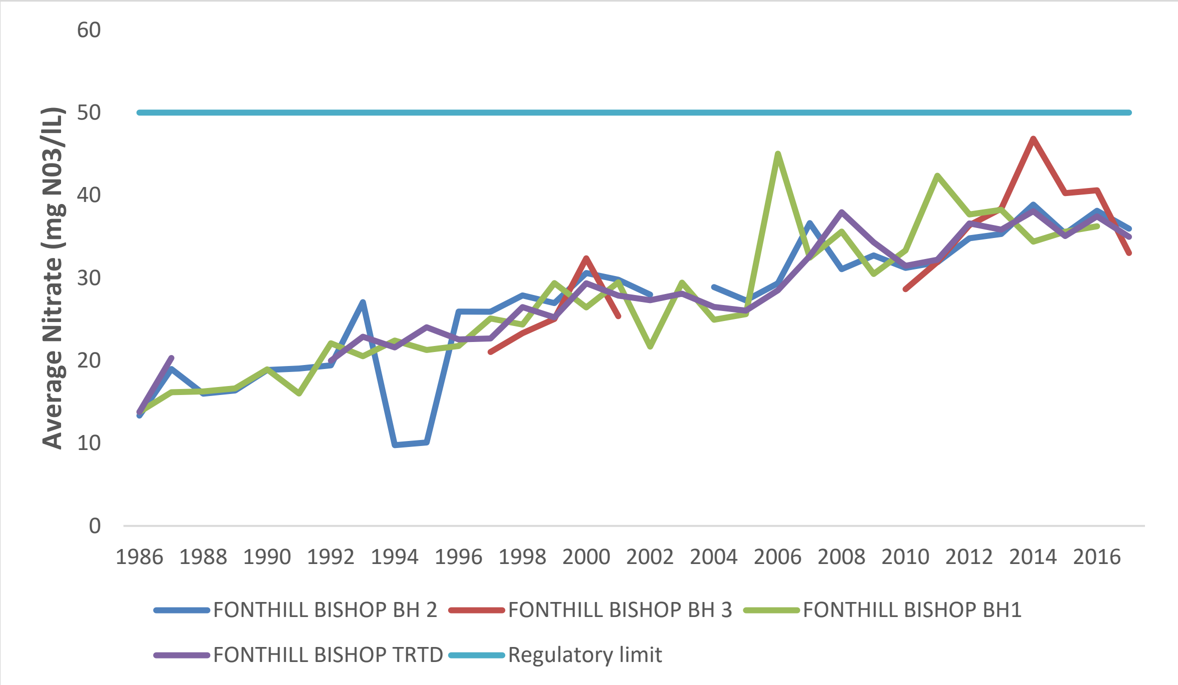
✂

Stage Two – Hazard identification and Risk Characterisation
Provide details of methodology used to identify hazard i.e. historic data, events/incidents including near miss situations, operator knowledge, modelling and site visits/technical audits
Summary of historical data on the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in the raw water source and the water entering supply from the relevant treatment works from compliance, investigative, or operational sampling

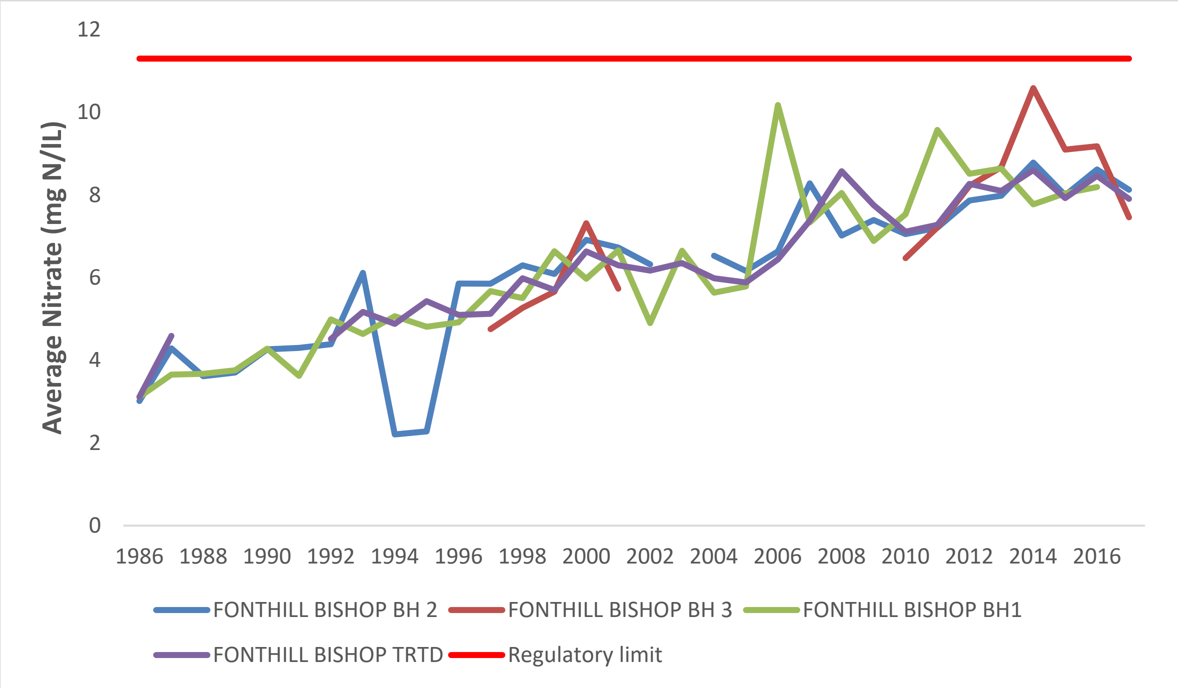
Please note that all sample results are expressed in mg N/L. The regulatory limit when nitrate is expressed in this unit is 11.3mg/l.

Sample data in the regulatory mgNO3/l unit for which the regulatory limit is 50 mgNO3/l can be found in Appendix 1.

Summary graphs of annual average Nitrate (mg NO_3/L) concentrations for Fonthill Bishop water treatment works (regulatory limit is 50mg NO_3/L)



Summary graphs of annual average Nitrate (mg N/L) concentrations for Fonthill Bishop water treatment works (regulatory limit is 11.3mg N/L)



Average nitrate concentrations across all raw borehole and treated samples show an increase over time. More detailed explanation of individual trends is provided below.

Fonthill Bishop Borehole 1

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	2.89	3.39	3.12	4
1987	2.99	4.78	3.65	3
1989	3.09	5.29	3.68	7
1990	3.19	5.39	3.76	17
1991	3.09	5.89	4.28	21
1992	3.50	3.80	3.62	8
1993	3.19	8.39	4.99	17
1994	3.40	6.90	4.64	33
1995	3.24	9.30	5.07	31
1996	3.81	7.65	4.81	38
1997	3.66	9.63	4.92	47
1998	4.07	10.30	5.67	52
1999	4.24	8.76	5.50	52
2000	4.43	9.63	6.64	51
2001	4.40	9.32	5.97	48
2002	5.08	9.68	6.66	24
2003	4.90	4.90	4.90	1

2004	5.52	7.55	6.65	3
2005	4.89	6.71	5.64	28
2006	5.42	6.60	5.79	19
2007	6.51	11.50	10.18	4
2008	5.56	11.80	7.34	49
2009	5.47	11.70	8.05	55
2010	4.60	9.60	6.89	72
2011	5.48	10.60	7.53	83
2012	6.32	13.80	9.57	93
2013	5.69	11.20	8.51	84
2014	6.12	12.60	8.64	72
2015	3.07	9.62	7.77	40
2016	6.22	11.40	8.04	56
2017 YTD	6.41	10.90	8.19	77

Based on the number of maximum values exceeding the 11.3mg N/l (50mg N03/L) this borehole presents the greatest compliance risk. The long term trend shows in increased in average nitrate concentrations.

Fonthill Bishop Borehole 2

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	2.89	3.19	3.02	4
1987	3.19	5.19	4.29	4
1988	3.29	4.29	3.62	8
1989	3.09	4.59	3.70	7
1990	3.99	5.29	4.27	20
1991	3.78	5.09	4.30	15
1992	3.80	7.10	4.39	16
1993	4.10	8.50	6.12	5
1994	1.20	6.39	2.21	13
1995	1.57	4.50	2.28	27
1996	4.36	7.42	5.86	40
1997	5.19	7.36	5.86	45
1998	5.10	7.62	6.30	52
1999	4.71	7.90	6.09	51
2000	5.42	9.19	6.91	48
2001	4.71	9.01	6.73	48
2002	5.05	7.65	6.32	22

2004	6.53	6.53	6.53	1
2005	4.83	6.96	6.16	27
2006	6.11	7.28	6.64	21
2007	7.44	9.02	8.28	4
2008	5.75	8.76	7.02	43
2009	5.66	9.64	7.39	67
2010	3.75	8.56	7.06	72
2011	5.14	8.67	7.21	99
2012	6.26	11.50	7.87	86
2013	6.08	9.74	7.98	57
2014	6.85	11.00	8.79	114
2015	6.94	8.80	8.00	85
2016	6.77	10.40	8.62	109
2017 YTD	7.10	9.00	8.13	110

Borehole 2 shows a long-term increase in average and maximum nitrate values. Of the three boreholes borehole 2 is the most compliant with regulatory parameters, however the maximum values still threaten compliance. Should the nitrate concentrations continue to increase then operational blending between boreholes will no longer be effective.

Fonthill Bishop Borehole 3

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1997	3.58	7.24	4.76	14
1998	2.73	9.86	5.27	48
1999	4.10	7.35	5.66	39
2000	6.73	7.73	7.32	3
2001	4.25	6.47	5.73	7
2010	5.06	7.38	6.47	35
2011	5.31	9.03	7.22	38
2012	6.46	10.80	8.22	11
2013	6.24	10.90	8.67	31
2014	6.01	13.00	10.59	40
2015	5.94	11.30	9.10	40
2016	6.14	11.90	9.18	67
2017 YTD	6.33	8.49	7.46	31

Average nitrate concentrations in borehole 3 have also shown a strong increase over time with maximum values exceeding regulatory limits.

Fonthill Bishop Treated

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	2.99	3.39	3.12	4
1987	4.49	4.69	4.59	2
1992	3.70	6.00	4.52	5
1993	3.30	7.00	5.17	12
1994	3.60	6.20	4.88	42
1995	4.32	7.90	5.43	54
1996	3.97	7.17	5.10	52
1997	4.50	7.51	5.13	52
1998	4.81	9.22	5.98	52
1999	4.60	8.65	5.70	52
2000	4.73	9.12	6.64	52
2001	4.75	9.24	6.30	52
2002	5.00	9.01	6.17	53
2003	5.06	10.20	6.35	51
2004	0.20	7.86	5.99	51
2005	4.12	7.54	5.89	69
2006	5.41	9.98	6.44	59
2007	5.44	10.20	7.38	55
2008	7.15	10.00	8.58	13
2009	1.33	10.70	7.75	71
2010	3.77	9.66	7.11	130
2011	5.29	9.26	7.28	173
2012	5.73	11.60	8.27	145
2013	4.54	10.90	8.10	133
2014	6.45	11.50	8.60	160
2015	6.83	9.90	7.92	130
2016	6.52	10.60	8.47	154
2017 YTD	6.78	9.97	7.91	137

Average and maximum nitrate concentration in treated water show an upward trend. Maximum nitrate values have exceeded the regulatory limit and present an ongoing risk to compliance.

Whilst operational borehole selection to blend sources does improve treated water compliance this is increasingly less adequate a control measure given the raw water deterioration across all three boreholes as evidenced above.

Zone 101 Distribution Samples

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
2000	2.98	9.33	6.03	51
2001	3.22	10.9	6.04	50
2002	2.74	9.45	5.60	56
2003	0.2	8.23	5.47	49
2004	3.29	7.66	5.34	51
2005	3.59	6.87	5.31	50
2006	3.36	6.52	5.07	36
2007	2.96	9.01	5.51	15
2008	2.99	9.39	5.62	16
2009	3.34	7.85	5.64	13
2010	4.69	8.29	6.51	13
2011	3.17	8.85	6.65	24
2012	4.08	10.6	7.13	39
2013	4.61	10.6	8.23	21
2014	1.01	10.8	9.58	90
2015	4.63	9.86	8.03	21
2016	6.8	10.2	8.38	34
2017	6.52	9.27	8.12	30

To date we have had no contraventions of the prescribed concentration value for nitrate at consumer taps. However, the average nitrate concentration at consumer taps shows an upward trend, with maximum values close to exceeding the regulatory limit.

Details of any existing contraventions of regulatory requirements and whether they are likely to recur (at WTW, SR and/or at consumers taps)

The compliance monitoring point for nitrate is at the consumer tap. To date we have not had any contraventions of the prescribed concentration value for nitrate at consumer taps. However as detailed above, the average nitrate concentration at consumer taps shows an upward trends with maximum values close to exceeding the regulatory limit. In the last five years the average concentration measured at consumers taps has been greater than 3/5 the standard and in 2014 reached the level of 4/5 the standard.

As detailed above, raw and treated nitrates show an upward trend with the maximum values in raw, and occasionally treated contravening the regulatory requirement of 11.3 mg/l N.

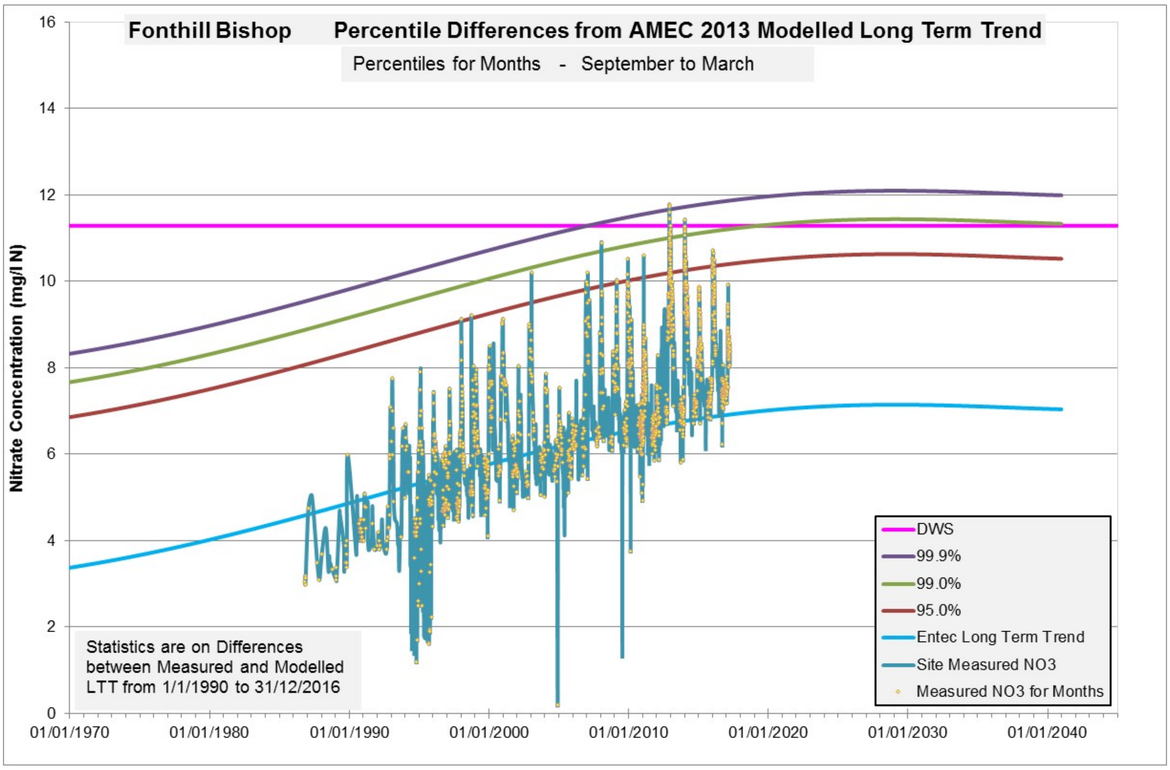
If evidence of likely to contravene any regulatory requirement, details of when this is likely to occur (at WTW, SR and/or at consumers taps) including trend analysis & prediction modelling

Since 2005 we have carried out active catchment work at Fonthill Bishop, however Fonthill Bishop is not responding to catchment management and nitrate levels in the raw boreholes regularly breach the regulatory standard.

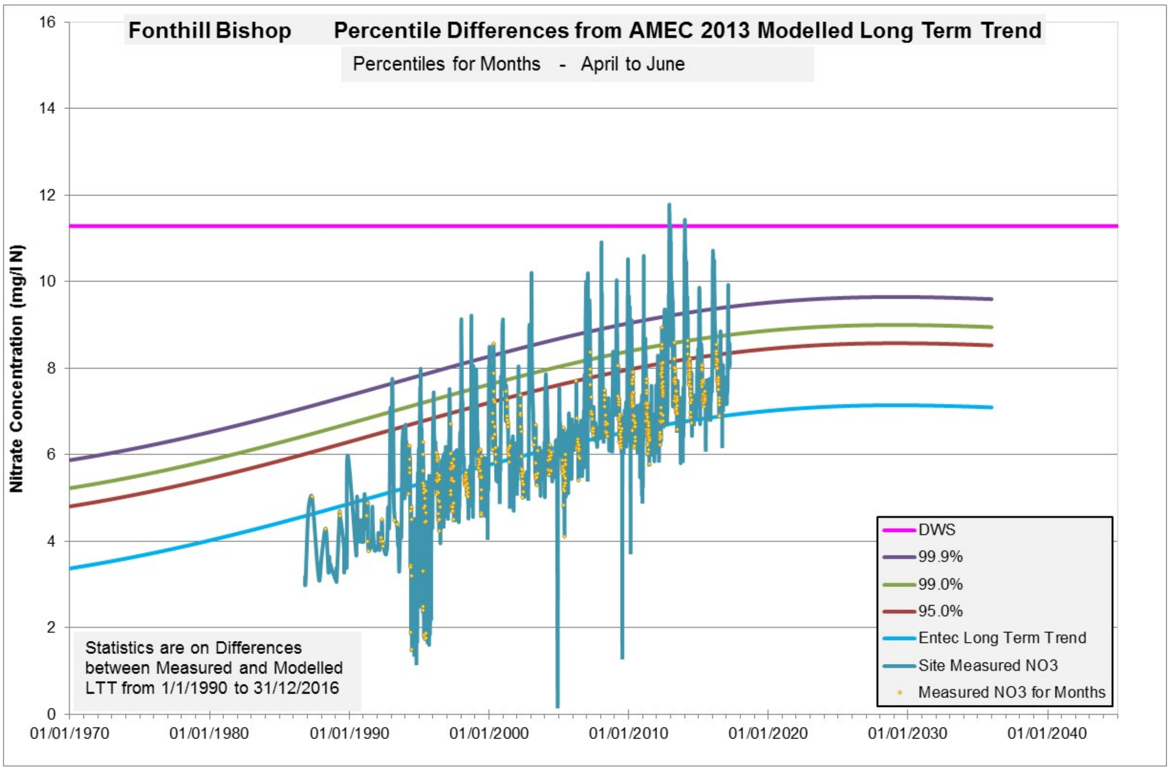
Trends below show the increasing nitrate concentration trend across time and frequent breaches of the prescribed concentration value for nitrate (11.3mgN/L or 50 $mgNO_3$/L) in the raw water. The modelled trend in 2013 does not match reality, with measured nitrate concentrations increasing at a higher rate than predicted.

The graph below for the winter, spring and summer periods show site measured nitrate levels increasing higher than the modelled long term trend (blue line); and with the regulatory standard likely to be exceeded for more often and for longer periods (including summer as well as winter) within the next five years in the absence of a new solution.

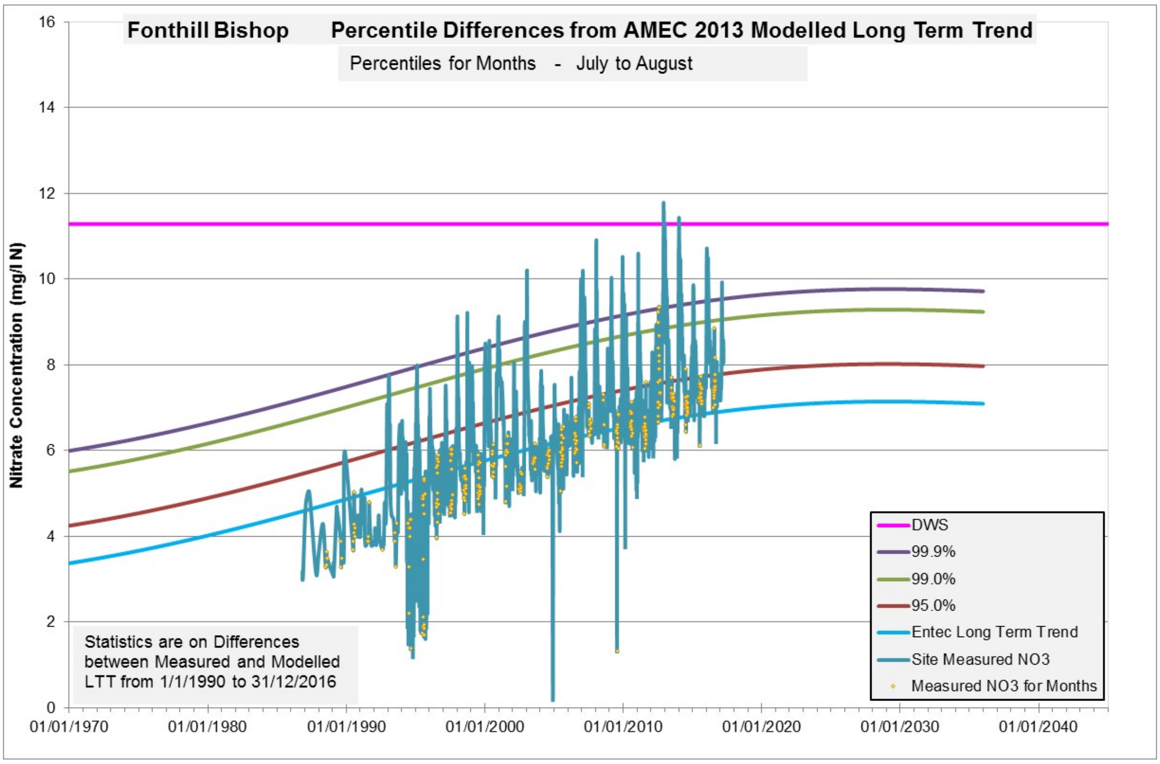
Winter (September – March)



Spring (April – June)



Summer (July – August)



Note: These charts are from a WW / Rukhydro worksheet developed in 2010 and updated in 2017 and uses the most recent long term trend available (AMEC 2013). The percentile lines are based on differences between the long term trend and monitoring data available for the period 01/01/1990 to 31/12/2016. For this report the monitoring data have been updated to 30 March 2017.

These models collaborate our empirical test results for borehole sources and water quality zone samples discussed earlier and help demonstrate new control measures are required to prevent contravention of the nitrate standard; which are otherwise likely during the next AMP period.

Please refer to the 'PR19 catchment intervention to control nitrates' appendix for further detail and supporting evidence.

Details of any other data relevant to the hazard identified

No other relevant data.

If appropriate, summary of data/information on consumer complaints

The following consumer contacts have been received regarding nitrates within the past three years:

Incident Ref	DMA	WQ Zone	Date and Time	Notes
032716086001	SHAFTESBURY TOWN	ZONE 101 SHAFTESBURY	03/02/2017 15:38:00	The customer contacted us to request a sample to check the nitrate level. Multiple attempts were subsequently made to arrange samples but we were unable to make contact with the customer.

Details of any events that have occurred in catchment, at treatment works and in supply that are associated with hazard identified

Process Stage	Events associated with hazard
Catchment	No nitrate associated notified events
Treatment	No nitrate associated notified events
Supply	No nitrate associated notified events

Details of any existing control measures that might influence the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in catchment, treatment and in supply

Process Stage	Control measure
Catchment	Ongoing catchment management
Treatment	
Supply	The ability to substitute Fonthill Bishop water via the Grid was completed in January 2016.

Details of monitoring of the control measure (including validation monitoring)

At a field scale, the catchment scientists monitor the effectiveness of catchment management with field monitoring equipment, particularly focusing on leaching using soil sampling for Soil Mineral Nitrogen (SMN) and porous pot sampling. Monitor residual N in fields to monitor improvement in farm practices.

Raw and treated nitrate samples further inform on nitrate levels in the groundwater, effectiveness of catchment management and verify the accuracy of nitrate monitors. When nitrate levels exceed the internal action level of 10mgN/L they appear on the daily laboratory generated exception report and are investigated by the local operational supply scientist.

Details of any changes in practices or policy which might have influenced the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in water supplied to consumers, i.e. in relation to resources, blending arrangements, treatment or supply arrangements and the dates of those changes
There have been no changes to practices or policy in the local area.
Details of any licensed abstraction issues which might influence the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in raw water
No abstraction issues are associated with the hazard,
Reasons for the presence of the hazard, if known, otherwise details of what is being done to identify source of hazard
The presence of the hazard is from historic agricultural land use. Detailed investigations by the catchment team are ongoing. Please refer to the 'PR19 catchment intervention to control nitrates' appendix for further detail and supporting evidence.
Outline Risk characterisation i.e.
Details and score arising from consequence v likelihood matrix,
Within the DWSP methodology nitrates have a fixed consequence score of 3. The likelihood scoring is then based on modelling and sample data results using the DWSP methodology risk matrix for nitrates. Based on the evidence we have gathered together with the deterioration of the source water, need for these resources, and inadequate control measures to prevent a failure; we have assigned a likelihood score of 5.

Site	Object Name	Event Title	DWI Category	PH
12055-Fonthill Bishop	Fonthill Bishop - Disinfection	Nitrate carry over from catchment	E - Mitigation under investigation	15
12055-Fonthill Bishop	Fonthill Bishop - General	Nitrate carry over from catchment	A - Target risk mitigation received, verified and maintained	15
12055-Fonthill Bishop	Fonthill Bishop Borehole No. 1 (12055)	High nitrate levels in the raw water	A - Target risk mitigation received, verified and maintained	15
12055-Fonthill Bishop	Fonthill Bishop Borehole No. 2 (12055)	High nitrate levels in the raw water	A - Target risk mitigation received, verified and maintained	15
12055-Fonthill Bishop	Fonthill Bishop Borehole No. 3 (12055)	High nitrate levels in the raw water	A - Target risk mitigation received, verified and maintained	15
12055-Fonthill Bishop	Fonthill Bishop Catchment (56038)	Nitrates entering the raw water	G - No mitigation in place : control point downstream	15

Where score sits in risk profile for supply system
The residual risk for nitrate carry over from the catchment is the highest scoring risk in the Fonthill Bishop supply system.
Stage 3 – Control Measures Required
Provide details of short, medium and long terms control measures i.e.
Details of short term actions currently in place to mitigate against risk & their effect

Short term measures currently in place	Nitrate monitors installed on at the water treatment works. Raw boreholes 1, 2 and 3 are sampled for nitrates. nitrate samples are collected from the treated sample tap to monitor compliance. Continue with ongoing catchment management

Details of mid to long term control measures identified for any residual risk:

(i) Options the company has considered which should, where appropriate, include catchment management controls; or communications controls in association with other stakeholders

A Real Options Analysis (ROA) has been carried out where a review of our current catchment management approach shows that an alternative approach is required.

The options that the company has considered are detailed as follows:

Option	Description
1	Catchment management
2	Source abandonment
3	Treatment
4	Temporary removal of the site from supply (substitution)
5	Blending

i. Catchment management

Active catchment management has been ongoing since 2005. To date the nitrate trend continues to rise with peaks that in average and wet winters breach compliance for nitrate.

Enhanced catchment management would include wide scale cover cropping, arable reversion to low input grassland and the use of low nitrogen input crops. The catchment is owned largely by one owner and farmed, under contract by a large, national farming contractor. Given this, enhanced catchment management would be costly and there is no evidence to suggest it would reduce nitrate levels.

Please refer to the 'PR19 catchment intervention to control nitrates' appendix for further detail and supporting evidence.

ii. Source abandonment

This option would involve permanently removing the source from supply.

iii. Treatment

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✂

iv. Temporary removal of the site from supply (substitution)

This is the solution in place at present through isolating one/multiple boreholes or the entire site from supply when nitrate levels are elevated.

✂

The current substitution arrangement was based on trending analysis carried out five years ago and was based on short outages in Winter. Work has been carried out to compare the model with observed values and the model has been found to not fit reality, with observed values exceeding modelled trends. Observed and modelled trends suggest that these unplanned outages are likely to increase in duration and frequency in the future.

✂

✂

v. Blending

This option would involve converting the existing system from ✂ into a dedicated high nitrate pipeline for blending at Littledown SR and utilisation within our regional grid as illustrated in the following figure.

✂

✂

(ii) Timescale for delivery of each option

Option	Description	Delivery timescale
1	Catchment management	Ongoing
2	Source abandonment	Within 12 months of a decision being made. Not a long term viable option
3	Treatment	At least three years (subject to planning permission)
4	Temporary removal of the site from supply (substitution)	Ongoing. Not a long term viable option
5	Blending	At least three years (subject to planning permission)

(iii) Capital costs and net additional operating costs of each option considered

Option	Description	Capital costs	Operating costs
1	Catchment management	Not viable	Base CM £45K-50K/yr Enhanced CM £250k/yr
2	Source abandonment	N/A – not a viable option	N/A – not a viable option
3	Treatment	£10m to £12m.	at least £200k/yr
4	Temporary removal of the site from supply (substitution)	N/A – not a viable option	N/A – not a viable option
5	Blending	£6m to £8m	£50k/yr

(iv) Summary of costs and benefits of each option

Option	Costs	Benefits
1. Catchment management	This major change to standard practice has been discussed and would come at a significant cost in terms of compensation to the farmer and landowner. Risk in terms of the extent of farmer engagement, the effectiveness of the measures and the timescale to impact, it is concluded that while catchment management should continue in some form. Does not represent a viable option on its own to achieve compliance.	Sustainable Does not rely on chemicals or energy
2. Source abandonment	The deployable output of Fonthill Bishop is 6.6Ml/d; this is equivalent to around a quarter of the predicted regional surplus. Fonthill Bishop is effectively a single source for large amounts of zone 101. Abandonment would require importing water from elsewhere resulting in reduced local and regional resilience as a single trunk main would be supplying the majority of the water quality zone. There are viable engineering solutions that can utilise the available water resource by constructing either a blending solution or treatment plant.	N/A – not a viable option due to resultant sufficiency and resilience concerns
3. Treatment	A multimillion capital scheme would be required. High energy usage and increased reliance on chemicals.	

	Tankering would be required for the waste stream which would have a high environmental and operation cost.	
4. Temporary removal of the site from supply (substitution)	The current substitution arrangement was based on trending analysis carried out five years ago and was based on short outages in Winter. Work has been carried out to compare the model with observed values and the model has been found to not fit reality, with observed values exceeding modelled trends. Observed and modelled trends suggest that these unplanned outages are likely to increase in duration and frequency in the future.	N/A – not a viable option due to resultant sufficiency and resilience concerns
5. Blending solution at Littledown SR	A multi million capital scheme is required.	Lowest whole life cost option for providing compliant water.

(v) Reasons for choosing the preferred option

Catchment management has been actively pursued in the catchment since 2005, however raw nitrate levels continue to increase and in some cases breach the regulatory limit in treated water. Enhanced catchment management is costly and there is no evidence to suggest that this will work well enough within the catchment to prevent breaches of the standard.

Please refer ‘PR19 water quality submission to the Drinking Water Inspectorate’ and ‘PR19 catchment intervention to control nitrates’ appendix for further detail and supporting evidence.

(vi) Specific supporting evidence that the preferred option will address risk of hazard within the required timescale

The observed and modelled nitrate trends demonstrate that all options apart from treatment or blending are not viable for achieving resilient and compliant water for our consumers in the long term.

A capital blending solution is in the process of being commissioned at , which was constructed in response to rising nitrate trends.

In ‘blending mode’ the flow ratio between the two sources would be interchangeable depending on the anticipated nitrate levels. A science driven manual input into the system would therefore be utilised to ensure the hazard is successfully addressed

We anticipate that approximately three years will be required to deliver planning, design and construction and therefore we propose:

Action	Target Date
Land agreements/completion of detailed design/planning permission approval	March 2022
Completion of construction	March 2024
Completion of commissioning and monitoring of hazard	March 2025

Full details of how the company intends to assess and measure the benefits delivered (the outcome), including details of proposed sampling programme, number of samples to be taken over the specified period and parameters to be monitored.

Nitrate monitors would be installed ✂ to monitor nitrate levels within distribution. These monitors would be connected to ✂.

Nitrate monitoring would also be undertaken through compliance and operational sampling. ✂ These would establish that levels of nitrate being supplied to consumers are maintained at 3/5 – 4/5 the regulatory limit.

Fonthill Bishop Data (mg N03/L)

Fonthill Bishop Borehole 1

Year	Minimum Nitrate (mg N03/L)	Maximum Nitrate (mg N03/L)	Average Nitrate (mg N03/L)	Number of samples
1986	12.8	15.0	13.8	4
1987	13.2	21.2	16.2	3
1989	13.7	23.4	16.3	7
1990	14.1	23.9	16.6	17
1991	13.7	26.1	18.9	21
1992	15.5	16.8	16.0	8
1993	14.1	37.1	22.1	17
1994	15.0	30.5	20.5	33
1995	14.3	41.2	22.4	31
1996	16.9	33.9	21.3	38
1997	16.2	42.6	21.8	47
1998	18.0	45.6	25.1	52
1999	18.8	38.8	24.4	52
2000	19.6	42.6	29.4	51
2001	19.5	41.2	26.4	48
2002	22.5	42.8	29.5	24
2003	21.7	21.7	21.7	1
2004	24.4	33.4	29.4	3
2005	21.6	29.7	24.9	28
2006	24.0	29.2	25.6	19
2007	28.8	50.9	45.0	4
2008	24.6	52.2	32.5	49
2009	24.2	51.8	35.6	55
2010	20.4	42.5	30.5	72
2011	24.2	46.9	33.3	83
2012	28.0	61.1	42.4	93
2013	25.2	49.6	37.7	84
2014	27.1	55.8	38.2	72
2015	13.6	42.6	34.4	40
2016	27.5	50.4	35.6	56
2017 YTD	28.4	48.2	36.3	77

Fonthill Bishop Borehole 2

Year	Minimum Nitrate (mg N03/L)	Maximum Nitrate (mg N03/L)	Average Nitrate (mg N03/L)	Number of samples
1986	12.8	14.1	13.3	4
1987	14.1	23.0	19.0	4
1988	14.6	19.0	16.0	8
1989	13.7	20.3	16.4	7
1990	17.7	23.4	18.9	20
1991	16.7	22.5	19.0	15
1992	16.8	31.4	19.4	16
1993	18.1	37.6	27.1	5
1994	5.3	28.3	9.8	13
1995	6.9	19.9	10.1	27
1996	19.3	32.8	25.9	40
1997	23.0	32.6	25.9	45
1998	22.6	33.7	27.9	52
1999	20.8	35.0	26.9	51
2000	24.0	40.7	30.6	48
2001	20.8	39.9	29.8	48
2002	22.3	33.9	28.0	22
2004	28.9	28.9	28.9	1
2005	21.4	30.8	27.3	27
2006	27.0	32.2	29.4	21
2007	32.9	39.9	36.6	4
2008	25.4	38.8	31.1	43
2009	25.0	42.7	32.7	67
2010	16.6	37.9	31.2	72
2011	22.7	38.4	31.9	99
2012	27.7	50.9	34.8	86
2013	26.9	43.1	35.3	57
2014	30.3	48.7	38.9	114
2015	30.7	38.9	35.4	85
2016	30.0	46.0	38.1	109
2017 YTD	31.4	39.8	36.0	110

Fonthill Bishop Borehole 3

Year	Minimum Nitrate (mg N03/L)	Maximum Nitrate (mg N03/L)	Average Nitrate (mg N03/L)	Number of samples
1997	15.8	32.0	21.0	14
1998	12.1	43.6	23.3	48
1999	18.1	32.5	25.0	39
2000	29.8	34.2	32.4	3
2001	18.8	28.6	25.4	7
2010	22.4	32.7	28.6	35
2011	23.5	40.0	31.9	38
2012	28.6	47.8	36.4	11
2013	27.6	48.2	38.4	31
2014	26.6	57.5	46.8	40
2015	26.3	50.0	40.3	40
2016	27.2	52.7	40.6	67
2017 YTD	28.0	37.6	33.0	31

Fonthill Bishop Treated

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	13.2	15.0	13.8	4
1987	19.9	20.8	20.3	2
1992	16.4	26.5	20.0	5
1993	14.6	31.0	22.9	12
1994	15.9	27.4	21.6	42
1995	19.1	35.0	24.0	54
1996	17.6	31.7	22.6	52
1997	19.9	33.2	22.7	52
1998	21.3	40.8	26.5	52
1999	20.4	38.3	25.2	52
2000	20.9	40.4	29.4	52
2001	21.0	40.9	27.9	52
2002	22.1	39.9	27.3	53
2003	22.4	45.1	28.1	51
2004	0.9	34.8	26.5	51
2005	18.2	33.4	26.0	69
2006	23.9	44.2	28.5	59

2007	24.1	45.1	32.7	55
2008	31.6	44.3	37.9	13
2009	5.9	47.3	34.3	71
2010	16.7	42.7	31.5	130
2011	23.4	41.0	32.2	173
2012	25.4	51.3	36.6	145
2013	20.1	48.2	35.8	133
2014	28.5	50.9	38.1	160
2015	30.2	43.8	35.1	130
2016	28.9	46.9	37.5	154
2017 YTD	30.0	44.1	35.0	137

Zone 101 Shaftesbury

Year	Minimum Nitrate (mg N03/L)	Maximum Nitrate (mg N03/L)	Average Nitrate (mg N03/L)	Number of samples
2000	13.2	41.3	26.7	51
2001	14.2	48.2	26.7	50
2002	12.1	41.8	24.8	56
2003	0.9	36.4	24.2	49
2004	14.6	33.9	23.6	51
2005	15.9	30.4	23.5	50
2006	14.9	28.8	22.4	36
2007	13.1	39.9	24.4	15
2008	13.2	41.5	24.9	16
2009	14.8	34.7	25.0	13
2010	20.7	36.7	28.8	13
2011	14.0	39.2	29.4	24
2012	18.0	46.9	31.5	39
2013	20.4	46.9	36.4	21
2014	4.5	47.8	42.4	90
2015	20.5	43.6	35.5	21
2016	30.1	45.1	37.1	34
2017	28.8	41.0	35.9	30

Annex 2. Shapwick/Sturminster Marshall

Annex: Proposals to carry out improvements for drinking water quality reasons – submission of information

An up to date regulation 28 risk assessment report must be appended with all submissions.

This annex lists all of the information that companies should provide to the Inspectorate with PR19 proposals for drinking water quality. If the information is already included in the regulation 28 reports submitted with proposals, or in other documents appended to the submission, there is no need for companies to provide the information again separately.

Scheme details:

Water Company:	Wessex Water
Date of submission:	
Name of supply system & Reg. 28 Report ref. number:	Zone 92 Shapwick Z44000092
Name of Water Treatment Works/Distribution System/Service Reservoir/Other asset:	Sturminster Marshall/Shapwick Water Treatment Works: T33126200
Water quality hazard/drivers identified:	Nitrates
Reference to outcome in company's long-term strategy:	'*Our Strategic Direction'* Strategic Direction Statement Page 11 ' Excellent Quality Drinking Water' Page 12 'Resilient Services'

Please note that all sample results are expressed in mg N/L. The regulatory limit when nitrate is expressed in this unit is 11.3mg/l.

Sample data in the regulatory mgNO3/l unit for which the regulatory limit is 50 mgNO3/l can be found in Appendix 1.

Stage One – Details of water treatment works and associated supply system
Provide supply arrangements and treatment works details:
A description and diagram of the supply system related to the treatment works [In many cases, companies include this information, including schematic diagrams, in regulation 28 risk assessment reports, in which case it is acceptable to refer here to the report, which should be appended]
Sturminster Marshall/ Shapwick water treatment works is located in Zone 92 Shapwick. The water treatment works is fed by raw boreholes at Sturminster Marshall and Shapwick Source.

Water Quality Zone 92

Sturminster Marshall and Shapwick are borehole sources located north west of Poole. Raw water from Shapwick is pumped to the adjacent Sturminster Marshall WTW before being distributed into our integrated regional grid as illustrated below.

Sturminster Marshall and Shapwick within wider network

Design capacity Ml/d

Site	Design Capacity
Sturminster Marshall	30 Ml/d
Shapwick	9.1 Ml/d

Volume supplied: Daily average and daily maximum Ml/d
[Please include a commentary if there are any constraints on deployable output due to limitations associated with any part of the treatment process]

Site	Daily average	Daily maximum	Commentary on Constraints
Sturminster Marshall	15.91Ml/d	20.00 Ml/d	Licence limitations at source (annual equivalent of 15.945Ml/d)
Shapwick	3.91Ml/d	5.88 Ml/d	BH2 is long term OOS due to water quality.

When nitrates allow Shapwick typically produces around 4Ml/d, against a daily licence of 9.1Ml/d, but there are times of the year when nitrates can be too high to allow blending at Sturminster Marshall and the Shapwick source is not utilised.

Sources of raw water, continuous, seasonal or standby
[Include names of individual sources, nature of the source (e.g. surface direct abstraction; surface impounding reservoir; borehole; spring; type of aquifer)

Shapwick source is located approximately 1.5km North West of Sturminster Marshall WTW. Water is pumped from Shapwick to Sturminster Marshall WTW for treatment. When nitrates allow Shapwick typically produces around 5Ml/d, but there are times of the year when nitrates can be too high to allow blending at Sturminster Marshall and the Shapwick source is not utilised.

Sturminster Marshall WTW is supplied with water from two boreholes at Shapwick and three boreholes on site at Sturminster Marshall. Sturminster Marshall also has a disconnected well which is no longer in use. Shapwick borehole 2 has been out of supply since 2006.

Treatment processes currently employed (including pre-treatment of raw waters)
[In this case, blending is defined as treatment. This includes blending of raw waters prior to treatment. Please also indicate if bankside storage of raw water is utilised, and average retention time in the reservoir]

Sturminster Marshall WTW Process Flow Diagram

Sturminster Marshall WTW is supplied with water from two boreholes at Shapwick and three boreholes (borehole 2, 3 and 4) on site at Sturminster Marshall. Sturminster Marshall also has a disconnected well which is no longer in use. Shapwick borehole 2 has been out of supply since 2006 and only borehole 1 is in use.

The boreholes have varying nitrate levels so operational blending takes place in the combined raw main and the contact tank. An on-site blending calculator has been created to facilitate scientists when calculating the blend to ensure compliant water for our consumers; as shown below.

Operational blending calculator

Through our disinfection policy Sturminster Marshall has been categorised as Category 2a water quality source with a disinfection requirement of Chlorination and contact time to give an effective Ct (ECt) of at least 15mg.min/l.

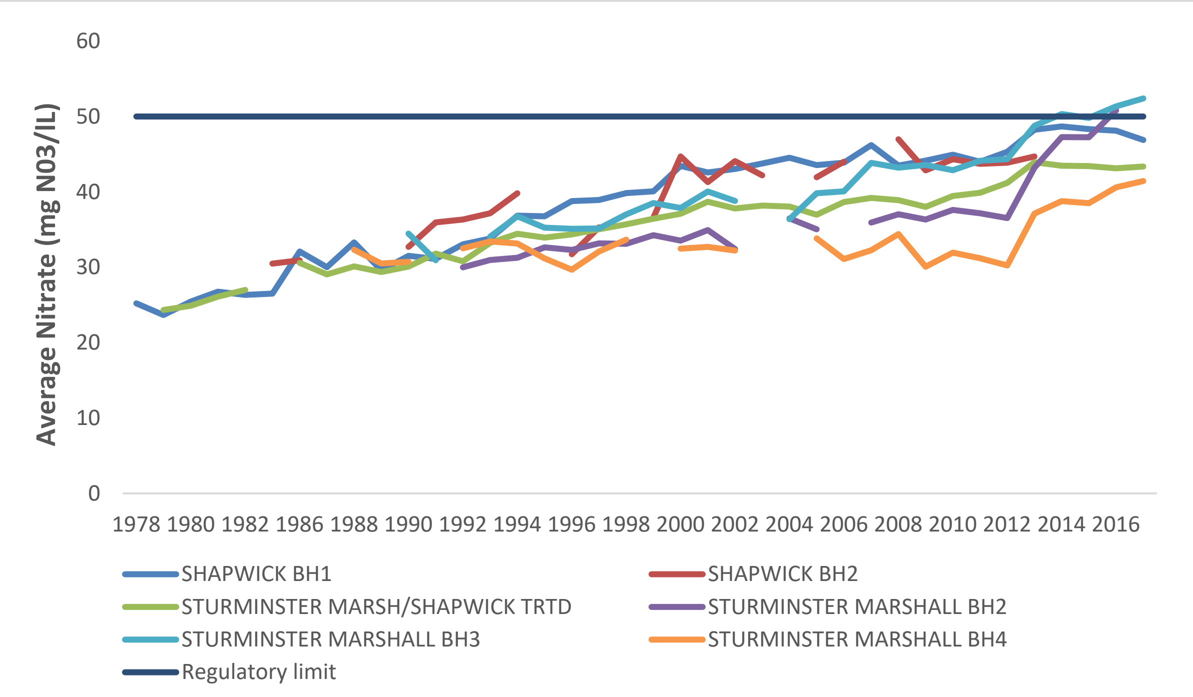
Service reservoirs/booster pump details

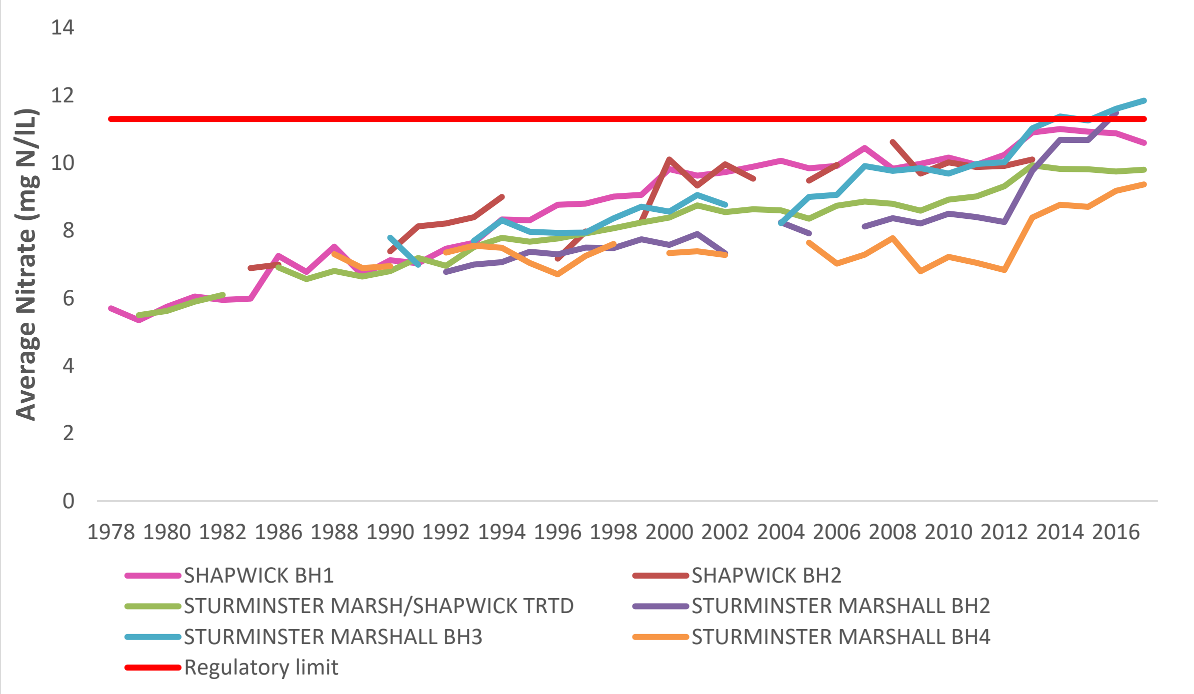
Water supply zones supplied
[If the supply is blended with waters from other treatment works in the zone, please indicate the relative proportions (as %)]

Population of each water supply zone supplied

Stage Two – Hazard identification and Risk Characterisation

Provide details of methodology used to identify hazard i.e. historic data, events/incidents including near miss situations, operator knowledge, modelling and site visits/technical audits

Summary of historical data on the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in the raw water source and the water entering supply from the relevant treatment works from compliance, investigative, or operational sampling
Please note that all sample results are expressed in mg N/L. The regulatory limit when nitrate is expressed in this unit is 11.3mg/l.   **Sample data in the regulatory mgNO3/l unit for which the regulatory limit is 50 mgNO3/l can be found in Appendix 1.**   **Summary graphs of annual average Nitrate (mg NO_3/L) concentrations for Shapwick/Sturminster Marshall water treatment works (regulatory limit is 50mg NO_3/L)**      **Summary graphs of annual average Nitrate (mg N/L) concentrations for Shapwick/Sturminster Marshall water treatment works (regulatory limit is 11.3mg N/L)**



Average nitrate concentrations across all raw borehole and treated samples show an increase over time. Average raw nitrate concentrations are either breaching or close to breaching the regulatory limit. More detailed explanation of the individual trends is provided below.

Shapwick Borehole 1

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	6.99	7.68	7.25	3
1987	5.89	7.39	6.78	3
1988	6.09	10.46	7.52	5
1989	6.69	6.69	6.69	1
1990	6.59	7.89	7.12	18
1991	6.79	7.29	7.03	17
1992	6.70	8.80	7.47	13
1993	7.50	7.80	7.64	7
1994	7.70	10.90	8.33	18
1995	7.70	8.92	8.31	13
1996	8.31	9.24	8.76	13
1997	7.81	9.46	8.80	15
1998	7.93	9.60	9.00	11
1999	8.09	9.70	9.06	21
2000	9.29	11.34	9.82	16

2001	7.57	10.92	9.62	40
2002	8.86	10.20	9.73	35
2003	8.49	11.00	9.89	36
2004	8.39	10.80	10.06	15
2005	7.49	11.30	9.84	116
2006	8.43	11.70	9.91	72
2007	8.80	11.70	10.44	9
2008	7.84	11.40	9.83	175
2009	7.38	11.20	9.98	61
2010	2.01	11.20	10.16	75
2011	8.59	11.20	9.95	83
2012	9.21	11.30	10.24	29
2013	9.68	11.90	10.90	135
2014	9.94	11.90	11.00	129
2015	7.74	11.70	10.92	167
2016	10.20	11.80	10.88	99
2017	9.13	11.30	10.59	112

Average nitrate concentrations show an increase over time with maximum nitrate concentrations exceeding the 11.3 mg N/L (50mg NO3mg N/L) prescribed concentration value every year for the past 6 years.

Shapwick Borehole 2

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	6.99	6.99	6.99	1
1990	7.39	7.39	7.39	1
1991	7.80	8.49	8.12	6
1992	6.80	10.30	8.21	12
1993	8.00	8.80	8.40	3
1994	9.00	9.00	9.00	1
1996	7.17	7.17	7.17	1
1997	7.40	8.42	7.98	3
1999	8.27	8.27	8.27	1
2000	7.67	11.60	10.10	13
2001	9.17	9.49	9.33	3
2002	8.93	12.80	9.96	9
2003	9.13	10.20	9.53	4

2005	9.06	9.88	9.48	3
2006	9.31	10.80	9.94	24
2008	9.99	11.00	10.62	5
2009	8.96	10.10	9.69	19
2010	8.87	11.00	10.02	17
2011	8.99	11.00	9.88	9
2012	8.95	10.60	9.91	7
2013	10.10	10.10	10.10	1
2015	10.20	10.90	10.57	24
2017	10.80	10.80	10.80	1

Shapwick borehole 2 has been out of supply since 2005. Samples are periodically collected when the borehole is run to waste. Average and maximum nitrate trends show an increase over time.

Sturminster Marshall Borehole 2

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1985	6.29	6.29	6.29	1
1987	6.39	6.39	6.39	1
1990	6.49	6.99	6.79	3
1992	6.59	7.00	6.78	11
1993	6.50	7.59	7.00	15
1994	5.70	8.20	7.07	9
1995	6.79	8.11	7.37	13
1996	6.77	7.64	7.30	17
1997	6.83	8.15	7.50	11
1998	5.42	8.02	7.48	13
1999	7.24	8.59	7.74	21
2000	7.37	7.77	7.58	10
2001	7.36	8.29	7.90	14
2002	6.95	7.69	7.33	4
2004	7.61	8.88	8.25	2
2005	7.39	9.22	7.92	12
2007	8.12	8.12	8.12	1
2008	7.55	9.99	8.37	37
2009	7.33	10.00	8.21	86
2010	7.72	9.61	8.50	126

2011	7.31	10.00	8.40	135
2012	1.13	9.47	8.25	130
2013	8.25	11.30	9.77	166
2014	8.66	11.70	10.68	134
2015	9.86	11.20	10.68	151
2016	10.50	14.20	11.48	87

Average nitrate concentrations in Sturminster Marshall borehole 2 show a marked increase over time with maximum nitrate concentrations exceeding the 11.3 mg N/L (50mg NO3mg N/L) prescribed concentration for three of the past four years. Furthermore, the average nitrate concentration shows an increasing trend and in 2017 to date exceeds the prescribed concentration value.

Sturminster Marshall Borehole 3

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1990	7.79	7.79	7.79	1
1991	6.99	6.99	6.99	1
1993	7.10	8.19	7.70	8
1994	7.70	9.60	8.31	14
1995	7.37	8.61	7.97	7
1996	7.38	8.36	7.93	10
1997	7.38	8.43	7.94	11
1998	7.99	8.76	8.36	16
1999	7.94	9.56	8.71	13
2000	8.09	8.80	8.56	13
2001	7.85	9.75	9.05	10
2002	7.75	9.41	8.77	12
2004	7.29	9.28	8.22	3
2005	7.62	9.62	9.00	13
2006	8.52	9.71	9.06	17
2007	9.64	10.20	9.91	5
2008	8.60	10.50	9.77	20
2009	7.68	10.50	9.85	30
2010	8.10	12.00	9.69	49
2011	7.63	11.20	9.97	58

2012	5.47	11.40	10.02	122
2013	10.40	11.50	11.02	35
2014	11.00	11.70	11.38	8
2015	10.80	11.70	11.26	19
2016	10.90	12.10	11.60	41
2017	10.80	13.50	11.84	57

Average nitrate concentrations in Sturminster Marshall borehole 3 show a marked increase over time with maximum nitrate concentrations exceeding the 11.3 mg N/L (50mg NO3mg N/L) prescribed concentration value every year since 2012. Furthermore, the average nitrate concentration shows an increasing trend and exceeds the prescribed concentration value limit for three out of the past four.

Sturminster Marshall Borehole 4

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	6.79	6.99	6.87	5
1988	6.89	7.89	7.30	7
1989	6.49	7.39	6.89	4
1990	6.59	7.69	6.95	7
1992	5.80	9.20	7.35	15
1993	6.60	8.40	7.55	16
1994	6.30	8.50	7.49	15
1995	6.09	7.71	7.05	6
1996	6.66	6.77	6.71	3
1997	6.55	7.64	7.25	3
1998	7.38	7.76	7.61	11
2000	7.18	7.49	7.34	3
2001	7.39	7.39	7.39	1
2002	7.28	7.28	7.28	1
2005	6.14	8.35	7.65	8
2006	6.66	7.30	7.03	6
2007	7.11	7.41	7.29	3
2008	0.20	8.88	7.78	23
2009	6.73	6.86	6.80	2
2010	3.65	8.09	7.22	22
2011	6.52	7.95	7.05	7
2012	6.26	7.55	6.83	13

2013	7.28	9.35	8.39	83
2014	8.26	9.91	8.76	141
2015	7.94	9.24	8.70	155
2016	6.20	10.10	9.17	178
2017	8.03	10.00	9.37	160

Sturminster Marshall borehole 4 is the most compliant borehole and is used for operational source blending pre-chlorination.

Shapwick/Sturminster Marshall Treated

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	6.79	7.09	6.91	5
1987	6.09	7.59	6.56	4
1988	5.99	7.29	6.80	7
1989	6.19	6.99	6.64	4
1990	6.49	7.19	6.80	10
1991	7.19	7.19	7.19	1
1992	6.00	7.40	6.96	5
1993	7.10	8.10	7.51	13
1994	7.20	10.20	7.78	43
1995	6.61	8.44	7.67	53
1996	7.17	8.59	7.76	54
1997	7.42	8.51	7.92	51
1998	6.79	8.79	8.07	51
1999	7.08	9.25	8.24	53
2000	7.68	9.87	8.39	55
2001	8.04	10.10	8.74	54
2002	1.74	9.50	8.55	53
2003	6.34	9.57	8.63	51
2004	6.80	9.45	8.60	54
2005	0.20	9.63	8.35	85
2006	7.53	10.10	8.74	60
2007	7.70	9.91	8.86	49

2008	8.23	9.52	8.79	68
2009	4.85	9.71	8.59	63
2010	7.94	9.78	8.92	54
2011	7.79	10.20	9.01	54
2012	7.94	10.10	9.31	58
2013	8.87	10.50	9.93	98
2014	9.21	10.30	9.83	60
2015	8.28	10.60	9.81	173
2016	5.73	10.50	9.75	156
2017	7.77	10.60	9.80	138

As a result of the existing operational blending treated nitrate remains compliant both in terms of maximum and average values. Both average and maximum values continue to increase and are greater than 4/5 of the prescribed concentration value for nitrate.

Zone 92 Distribution Samples

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
2000	6.03	9.96	7.84	13
2001	6.16	9.3545	8.14	12
2002	6.3	9.11	8.29	12
2003	5.72	9.04	7.27	15
2004	5.88	9.48	8.16	12
2005	5.88	8.88	7.95	12
2006	6.11	9.34	8.23	12
2007	6.77	9.4	8.72	12
2008	6.75	9.45	8.59	13
2009	5.8	9.25	8.32	12
2010	6.71	9.11	8.56	12
2011	5.96	9.58	8.76	12
2012	6.1	9.81	8.56	12
2013	6.42	10	9.29	12
2014	8.98	11.1	9.83	12
2015	6.05	10	9.38	12
2016	5.48	10	8.76	12
2017	5.45	9.93	8.96	12

Nitrate in distribution remains compliant, however shows an overall increasing trend. Zonal samples consist of water wholly supplied by Sturminster Marshall WTW and are not subject to further blending.

Conclusion

Both average and maximum nitrate concentrations continue to increase presenting a major challenge to maintain compliance with regulatory limits. Operational borehole selection to blend sources does improve compliance, however given the continued deterioration of raw borehole quality; this will become increasingly less adequate as detailed above.

Details of any existing contraventions of regulatory requirements and whether they are likely to recur (at WTW, SR and/or at consumers taps)

The compliance monitoring point for nitrate is at the consumer tap. To date we have not had any contraventions of the prescribed concentration value for nitrate (11.3mgN/L or 50mgNO_3/L) at consumer taps. However as detailed above, the average and maximum nitrate trends at consumer taps shows an upward trend, with maximum values overserved in distribution close to breaching the regulatory limits.

As detailed above, Shapwick borehole 1 and Sturminster Marshall borehole 2 and 3 maximum nitrate values frequently contravene the regulatory requirement of 11.3 mg/l N.

Sturminster Marshall/Shapwick treated nitrate remains compliant, however demonstrates an increased maximum and average nitrate trend.

Whilst Sturminster Marshall borehole 4 is currently compliant, this too demonstrates an increasing upward maximum and average nitrate trend, which will in time reduce, if not eliminate the capability for internal blending on site.

If evidence of likely to contravene any regulatory requirement, details of when this is likely to occur (at WTW, SR and/or at consumers taps) including trend analysis & prediction modelling

Since 2005 we have carried out active catchment management work at Sturminster Marshall WTW, however this is having limited success and nitrate concentrations in four of the five boreholes supplying the works regularly breach the regulatory standard

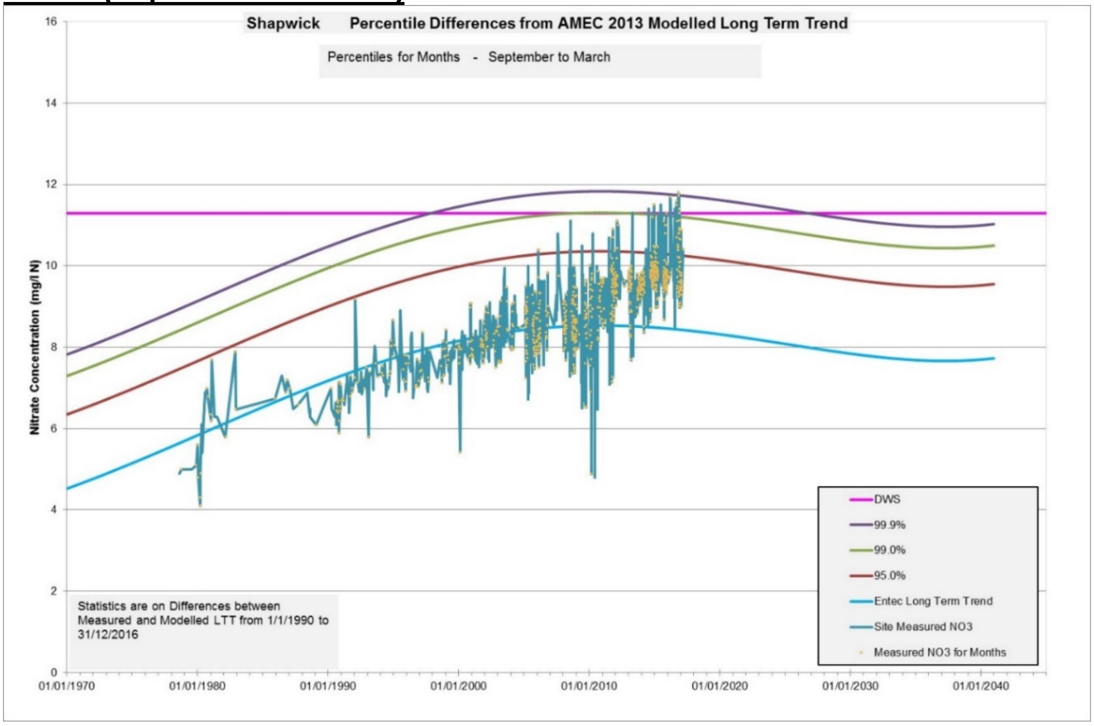
Measured nitrate concentrations at both Sturminster Marshall and Shapwick are much higher than projected in the 2013 modelled trends. The models do not match reality and projections across both sites demonstrate that the regulatory standard is likely to be exceeded more often and at a higher level for the foreseeable future across winter, spring and summer.

Trend analysis below shows the increasing nitrate concentration trend and contravention of regulatory requirements in the raw water.

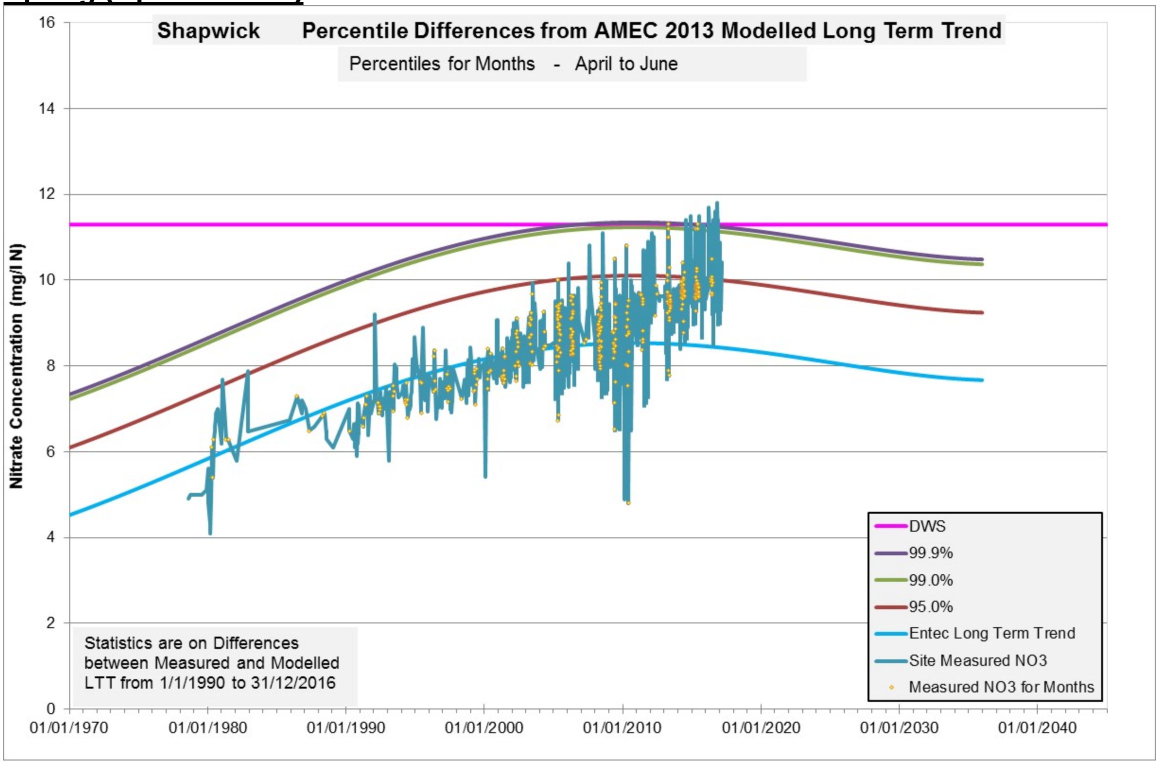
Shapwick

The modelled projections below for the winter, spring and summer periods shows site measured nitrate levels increasing much higher than the modelled long term trend (blue line); and with the regulatory standard (pink line) likely to be exceeded for more often and for longer periods within the next five years.

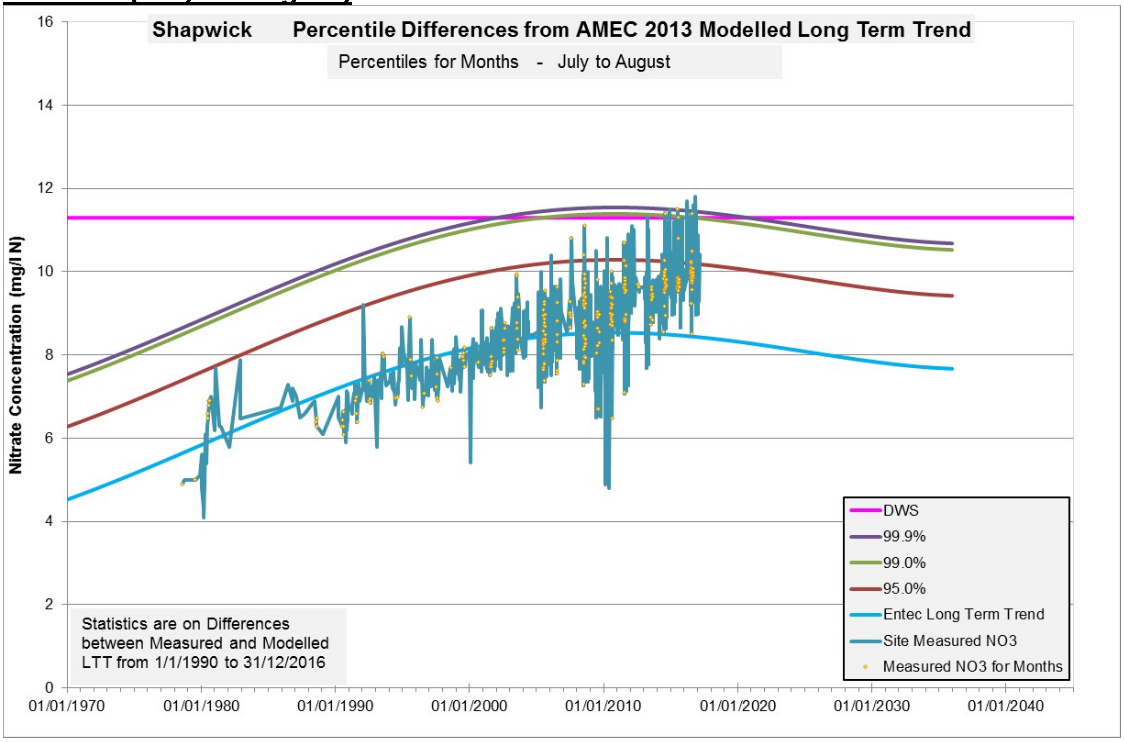
Winter (September to March)



Spring (April to June)



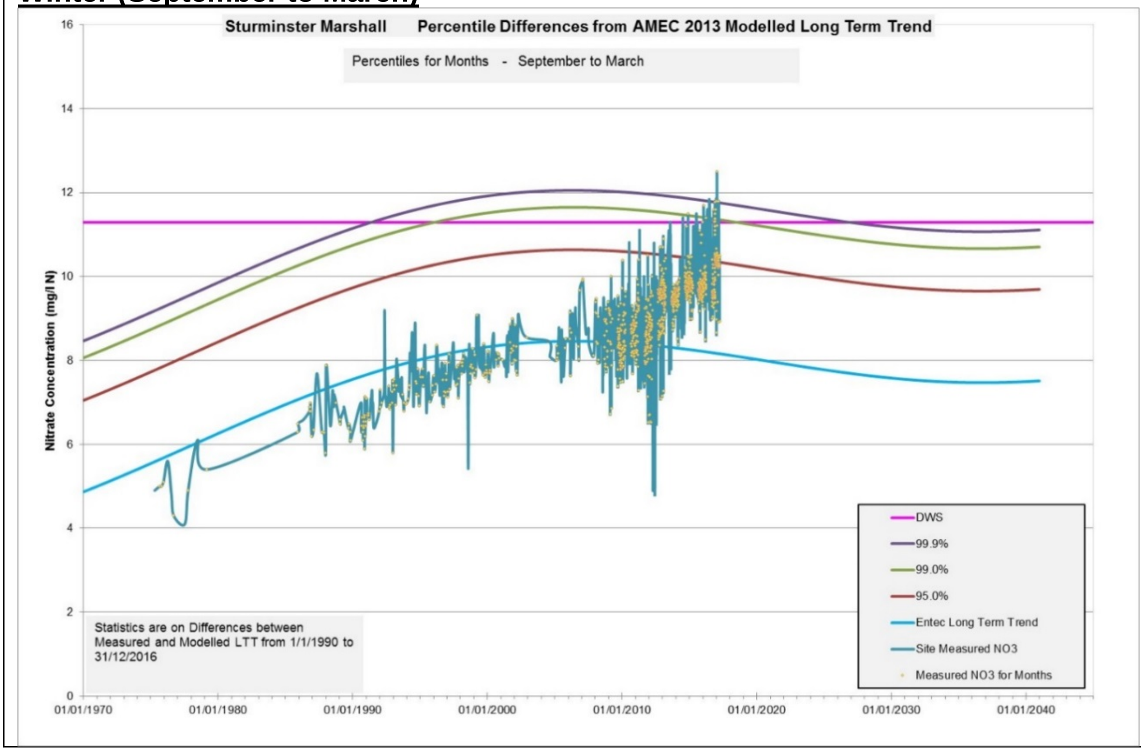
Summer (July to August)



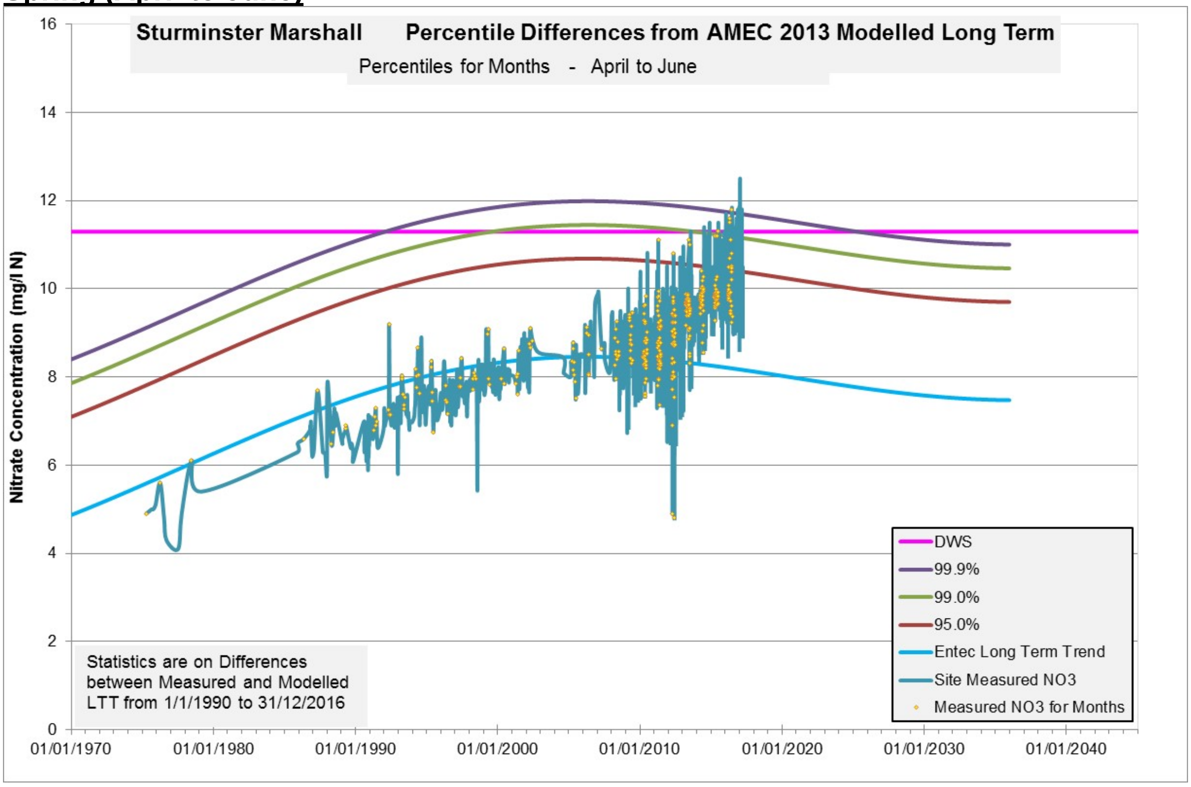
Sturminster Marshall

The graphs below for the winter, spring and summer periods shows site measured nitrate levels increasing much higher than the modelled long term trend from 2013; and with the standard likely to be exceeded for more often and for longer periods for the foreseeable future.

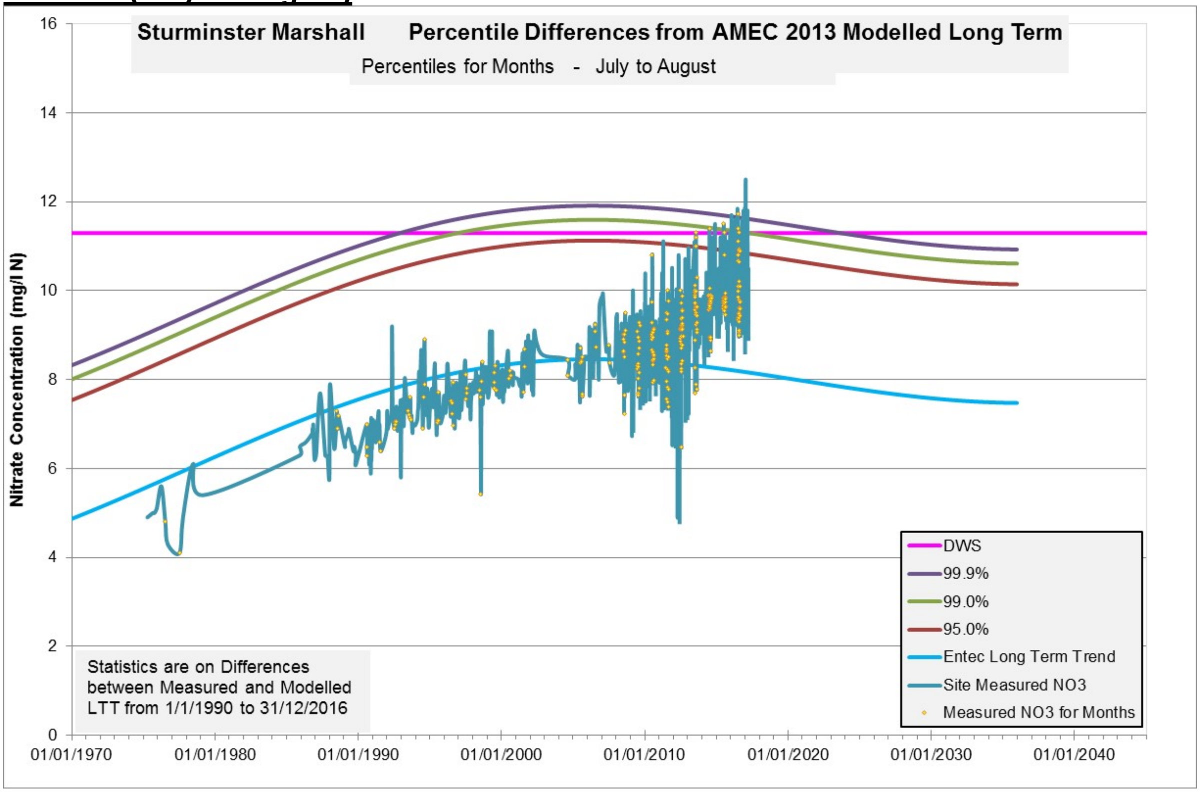
Winter (September to March)



Spring (April to June)



Summer (July to August)



These models collaborate our empirical test results for borehole sources and water quality zone samples discussed earlier and help demonstrate that new control measures are required to prevent contravention of the nitrate standard in treated water; which are otherwise likely during the next AMP period.

Please refer to ‘PR19 catchment intervention to control nitrates’ appendix for further detail and supporting evidence.

Details of any other data relevant to the hazard identified

The table below summarises the outage duration and output loss as a result of nitrates.

The high nitrates in Shapwick borehole 1 are a particular problem. When nitrates in the Sturminster Marshall borehole 4 also increase, it makes achieving a compliant blend between the two sites problematic resulting in a loss of output to protect compliance and reduced resilience in the local area.

Site Name	Date From	Date To	Output Loss	Outage duration (days)	Issue
Shapwick	30-Oct-06	09-May-07	3.5	192	WQ - Nitrates
Shapwick	04-Jul-07	18-Jul-07	4	15	WQ - Nitrates
Shapwick	03-Aug-07	06-Aug-07	5	4	WQ - Nitrates
Shapwick	09-Aug-07	26-Aug-07	5	18	WQ - Nitrates
Shapwick	16-Jan-09	27-May-09	9.1	132	WQ - Nitrates
Shapwick	28-May-09	05-Jul-09	5	39	WQ - Nitrates
Shapwick	05-Jul-09	06-Jul-09	4	2	WQ - Nitrates
Shapwick	10-Jul-10	12-Jul-10	6	3	WQ - Nitrates
Shapwick	08-Feb-11	20-Jun-11	6	133	WQ - Nitrates
Shapwick	21-Jun-13	12-Jul-13	6	22	WQ - Nitrates
Shapwick	29-Jul-13	27-Aug-13	6	30	WQ - Nitrates
Shapwick	07-Jun-14	11-Jun-14	6	5	WQ - Nitrates
Shapwick	29-Dec-15	23-Jun-16	6	178	WQ - Nitrates
Sturminster Marshall	17-Jan-15	23-Jan-15	7	7	WQ - Nitrates

If appropriate, summary of data/information on consumer complaints

The following consumer contacts have been received regarding nitrates within the past three years:

Incident Ref	DMA	WQ Zone	Date and Time	Notes
No consumer complaints have been received about nitrates				

Details of any events that have occurred in catchment, at treatment works and in supply that are associated with hazard identified

Process Stage	Events associated with hazard
Catchment	No nitrate associated notified events
Treatment	No nitrate associated notified events
Supply	No nitrate associated notified events

Details of any existing control measures that might influence the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in catchment, treatment and in supply

Process Stage	Control Measure
Catchment	Ongoing catchment management
Treatment	Onsite operational blending (using lower nitrate borehole 4) Nitrate monitors linked to automatic shutdown system
Supply	None

Details of monitoring of the control measure (including validation monitoring)

At a field scale, the catchment scientists monitor the effectiveness of catchment management with field monitoring equipment, particularly focusing on leaching using soil sampling for Soil Mineral Nitrogen (SMN) and porous pot sampling. Monitor residual N in fields to monitor improvement in farm practices.

Raw and treated nitrate samples further inform on nitrate levels in the groundwater, effectiveness of catchment management and verify the accuracy of nitrate monitors. When nitrate levels exceed the internal action level of 10mgN/L they appear on the daily laboratory generated exception report and are investigated by the local operational supply scientist.

Details of any changes in practices or policy which might have influenced the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in water supplied to consumers, i.e. in relation to resources, blending arrangements, treatment or supply arrangements and the dates of those changes

Commissioning of the water supply grid has provided greater resilience to the local network.

Details of any licensed abstraction issues which might influence the values and concentrations of the organism, substance(s) or parameter(s) associated with the hazard in raw water

None identified.

Reasons for the presence of the hazard, if known, otherwise details of what is being done to identify source of hazard

The presence of the hazard is from historic agricultural land use. Investigations are ongoing by the catchment team.

Outline Risk characterisation i.e.

Details and score arising from consequence v likelihood matrix,

Within the DWSP methodology nitrates have a fixed consequence score of 3. The likelihood scoring is then based on modelling and sample data results using the DWSP methodology risk matrix for nitrate.

Based on the evidence we have gathered together with the deterioration of the source water, need for the resources, and inadequate control measures we have assigned a likelihood score of 5.

Site	Object Name	Event Title	**DWI Category**	**PH**
12110-Sturminster Marshall	Sturminster Marshall - Disinfection	Nitrate carry over from catchment	A - Target risk mitigation received, verified and maintained	15
12110-Sturminster Marshall	Sturminster Marshall - General	Nitrate carry over from catchment	A - Target risk mitigation received, verified and maintained	15
12110-Sturminster Marshall	Sturminster Marshall Borehole No. 2 (12110)	High nitrate levels in the raw water	G - No mitigation in place : control point downstream	15
12110-Sturminster Marshall	Sturminster Marshall Borehole No. 3 (12110)	High nitrate levels in the raw water	G - No mitigation in place : control point downstream	15
12110-Sturminster Marshall	Sturminster Marshall Borehole No. 4 (12110)	High nitrate levels in the raw water	G - No mitigation in place : control point downstream	15
12110-Sturminster Marshall	Sturminster Marshall Catchment (56072)	Nitrates entering the raw water	G - No mitigation in place : control point downstream	15

Site	**Object Name**	**Event Title**	**DWI Category**	**PH**
12104-Shapwick	Shapwick Borehole No. 1 (12104)	High nitrate levels in the raw water	G - No mitigation in place : control point downstream	15
12104-Shapwick	Shapwick Borehole No. 2 (12104)	High nitrate levels in the raw water	G - No mitigation in place : control point downstream	15
12104-Shapwick	Shapwick Catchment (56068)	Nitrates entering the raw water	G - No mitigation in place : control point downstream	15

Where score sits in risk profile for supply system
The residual risk for nitrate carry over from the catchment is the highest scoring risk in the Sturminster Marshall/Shapwick supply system.
Stage 3 – Control Measures Required
Provide details of short, medium and long terms control measures i.e.
Details of short term actions currently in place to mitigate against risk & their effect
✂ nitrate samples are collected from the Sturminster Marshall/Shapwick treated compliance tap per year to monitor compliance. ✂
Details of mid to long term control measures identified for any residual risk:
(i) Options the company has considered which should, where appropriate, include catchment management controls; or communications controls in association with other stakeholders

A Real Options Analysis (ROA) has been carried out where a review of our current catchment management approach shows that an alternative approach is required.

The options the company has considered are detailed as follows:

Option	Description
1	Catchment management
2	Source abandonment
3	Treatment
4	Substitution of individual boreholes/ the site as a whole
5	Blending

1 Catchment management

Active catchment management has been ongoing since 2005. Some catchment farmers have engaged very positively. However, the size of this combined catchment, the number of catchment farmers, the variety of farm types and the complex linkages between the aquifer and surface water (Rivers Stour, Tarrant and North Winterbourne) make this a problematic catchment to work in. Sturminster Marshall site displays significantly different nitrate concentrations between the three site boreholes. Compliance depends upon blending the lower nitrate borehole (Borehole 4) with the other two site boreholes and Shapwick Borehole 1. Given the degree of land use change required and the complexities of the catchment it is unlikely that catchment management will be effective in achieving compliance in the short term.

Please refer to 'PR19 catchment intervention to control nitrates' appendix for further detail and supporting evidence.

2 Source abandonment

This option would involve permanently removing the source from supply.

3 Treatment

4 Temporary removal of the site from supply (substitution)

This is the solution we have at present. However based on the prediction that nitrates continue to rise then the source utilisation will fall such that this approach is not considered viable for the future.

Whilst substitution of individual boreholes or the site as a whole is a viable option for relatively short periods in winter. Substitution during the summer period will have a similar impact on resource resilience as source abandonment. Hence we conclude this is not a long term viable option for future resilience and sufficiency for our consumers.

5 Blending

At present the existing on site operational blending is limited to blending Shapwick boreholes with Sturminster Marshall boreholes, when relative nitrate levels allow. If nitrates continue to increase as indicated by the latest trending then this could frequently result in neither source being available.

The works to enable this option would therefore be to construct upgraded blending facilities at Sturminster Marshall.

The anticipated works required for blending are:

(ii) Timescale for delivery of each option

Option	Description	Timescale
1	Catchment management	Ongoing. However this not a long term viable option as catchment management is not successfully managing nitrate levels.
2	Source abandonment	Within 12 months of a decision being made. However this is not a long term viable option for resilience and resource sufficiency.
3	Treatment	At least three years (subject to planning permission)
4	Temporary removal of the site/boreholes from supply (substitution)	Ongoing. However not a long-term viable option for resilience and resource sufficiency.
5	Blending	At least three years (subject to planning permission)

(iii) Capital costs and net additional operating costs of each option considered

Option	Description	Capital costs	Operating costs
1	Catchment management	N/A – not a viable option	£45-£50k/yr base CM £350k/yr enhanced CM
2	Source abandonment	N/A – not a viable option	N/A – not a viable option due to resource resilience and sufficiency
3	Treatment	£12m-15m	£500k/yr
4	Temporary removal of the site/boreholes from supply (substitution)	N/A – not a viable option	N/A – not a viable option due to resource resilience and sufficiency
5	Blending	£2m	£100k/yr

(iv) Summary of costs and benefits of each option

Option	**Costs**	**Benefits**
Catchment management	Active catchment management has been ongoing since 2005. Some catchment farmers have engaged very positively. However, the size of this combined catchment, the number of catchment farmers, the variety of farm types and the complex linkages between the aquifer and surface water (Rivers Stour, Tarrant and North Winterbourne) make this a problematic catchment to work in. Given the degree of land use change required and the complexities of the catchment it is unlikely that catchment management will be effective in achieving compliance in the short term. Does not represent a viable option on its own to achieve compliance.	A sustainable solution. Does not rely on chemicals or energy. Opportunity to build on existing relationships with farmers.
Source abandonment	✂ Reduced local and regional resilience. There are viable engineering solutions that can utilise the available resource and remove or blend nitrate. ✂ .	N/A – not a viable option due for sufficiency and resilience reasons
Treatment	A multimillion pound capital scheme in the form of a nitrate ion plant would be required. High energy usage and increased reliance on chemicals. Tankering would be required for the waste stream as no suitable sewer nearby which would have a high environmental and capital cost. The capital cost and operating costs for a suitable treatment facility are	The treatment solution would remove nitrates and eliminate the compliance risk.

	estimated at £12m to £15m and £500k/yr respectively.	
Temporary removal of the site/boreholes from supply (substitution)	The current substitution arrangement was based on trending analysis carried out five years ago and was based on short outages in Winter. Work has been carried out to compare the model with observed values and the model has been found to not fit reality with observed values exceeding modelled trends. Observed and modelled trends suggest that these unplanned outages are likely to increase in duration and frequency in the future. Based on the latest rising nitrate trends this option becomes effectively the same as source abandonment and is not a viable option.	Substitution is a low cost solution when used for short periods. No new plant would need to be constructed, however not a viable option in light of rising nitrate levels.
Blending	Capital scheme required Estimated £2m capital cost	Lowest whole life cost option for providing compliant water. Would ensure nitrate compliance is maintained. Does not use extra chemicals. Does not generate a waste stream

Please refer to ‘Catchment management for water supply protection’ appendix for further detail and supporting evidence.

(v) Reasons for choosing the preferred option

As detailed above, additional action is required to mitigate rising nitrate levels and ensure sufficient and compliant water for our consumers.

As detailed above, a number of the options are not considered to be viable in the long term for sufficiency and resilience reasons.

Catchment management has been actively pursued in the catchment since 2005, however raw nitrate levels continue to increase and in some cases breach the regulatory limit. Enhanced catchment management is costly and there is no evidence to suggest that this will work to mitigate rising nitrate levels within the catchment. Further detail and supporting evidence for this is detailed in the 'Catchment management for water supply protection' appendix.

The blending option has been identified as the most cost effective way to optimise source utilisation. When compared with enhanced catchment management and an ion exchange plant treatment solution, blending is the lowest whole life cost option for providing compliant water. Blending is also a more sustainable option than treatment as would not involve a reliance on chemicals or generate a waste stream. Blending would maintain future compliance whilst ensuring the existing source water is utilised.

(vi) Specific supporting evidence that the preferred option will address risk of hazard within the required timescale

The observed and modelled nitrate trends demonstrate that all options except treatment or blending are not viable for achieving compliant water in the long term.

A capital blending solution is in the process of being commissioned at Deans Farm, which was constructed in response to rising nitrate trends.

Installation of a similar blending solution at Sturminster Marshall would include flow control and nitrate monitoring to ensure that the nitrate risk is successfully addressed.

In 'blending mode' the flow ratio between the two sources would be interchangeable depending on the anticipated nitrate levels. A science driven manual input into the system would therefore be utilised to ensure the hazard is successfully addressed.

We anticipate that approximately three years will be required to deliver planning, design and construction and therefore we propose:

Action	Target Date
Land agreements/completion of detailed design/planning permission approval	March 2022
Completion of construction	March 2024
Completion of commissioning and monitoring of hazard	March 2025

Full details of how the company intends to assess and measure the benefits delivered (the outcome), including details of proposed sampling programme, number of samples to be taken over the specified period and parameters to be monitored.

Shapwick/ Sturminster Marshall Data (mg NO3/L)

Shapwick Borehole 1

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	30.9	34.0	32.1	3
1987	26.1	32.7	30.0	3
1988	26.9	46.3	33.3	5
1989	29.6	29.6	29.6	1
1990	29.2	34.9	31.5	18
1991	30.0	32.3	31.1	17
1992	29.6	38.9	33.0	13
1993	33.2	34.5	33.8	7
1994	34.1	48.2	36.8	18
1995	34.1	39.5	36.8	13
1996	36.8	40.9	38.8	13
1997	34.6	41.9	38.9	15
1998	35.1	42.5	39.8	11
1999	35.8	42.9	40.1	21
2000	41.1	50.2	43.4	16
2001	33.5	48.3	42.6	40
2002	39.2	45.1	43.1	35
2003	37.6	48.7	43.8	36
2004	37.1	47.8	44.5	15
2005	33.1	50.0	43.6	116
2006	37.3	51.8	43.9	72
2007	38.9	51.8	46.2	9
2008	34.7	50.4	43.5	175
2009	32.7	49.6	44.1	61
2010	8.9	49.6	44.9	75
2011	38.0	49.6	44.0	83
2012	40.8	50.0	45.3	29
2013	42.8	52.7	48.2	135
2014	44.0	52.7	48.7	129
2015	34.2	51.8	48.3	167
2016	45.1	52.2	48.1	99
2017	40.4	50.0	46.9	112

Shapwick Borehole 2

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	30.9	30.9	30.9	1
1990	32.7	32.7	32.7	1
1991	34.5	37.6	36.0	6
1992	30.1	45.6	36.3	12
1993	35.4	38.9	37.2	3
1994	39.8	39.8	39.8	1
1996	31.7	31.7	31.7	1
1997	32.7	37.3	35.3	3
1999	36.6	36.6	36.6	1
2000	33.9	51.3	44.7	13
2001	40.6	42.0	41.3	3
2002	39.5	56.6	44.1	9
2003	40.4	45.1	42.2	4
2005	40.1	43.7	41.9	3
2006	41.2	47.8	44.0	24
2008	44.2	48.7	47.0	5
2009	39.6	44.7	42.9	19
2010	39.2	48.7	44.3	17
2011	39.8	48.7	43.7	9
2012	39.6	46.9	43.9	7
2013	44.7	44.7	44.7	1
2015	45.1	48.2	46.8	24
2017	47.8	47.8	47.8	1

Sturminster Marshall Borehole 2

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1985	27.8	27.8	27.8	1
1987	28.3	28.3	28.3	1
1990	28.7	30.9	30.0	3
1992	29.2	31.0	30.0	11
1993	28.7	33.6	31.0	15
1994	25.2	36.3	31.3	9
1995	30.0	35.9	32.6	13
1996	30.0	33.8	32.3	17
1997	30.2	36.1	33.2	11
1998	24.0	35.5	33.1	13
1999	32.0	38.0	34.3	21
2000	32.6	34.4	33.5	10
2001	32.6	36.7	34.9	14
2002	30.8	34.0	32.4	4
2004	33.7	39.3	36.5	2
2005	32.7	40.8	35.0	12
2007	35.9	35.9	35.9	1
2008	33.4	44.2	37.0	37
2009	32.4	44.3	36.3	86
2010	34.2	42.5	37.6	126
2011	32.3	44.3	37.2	135
2012	5.0	41.9	36.5	130
2013	36.5	50.0	43.2	166
2014	38.3	51.8	47.3	134
2015	43.6	49.6	47.3	151
2016	46.5	62.8	50.8	87

Sturminster Marshall Borehole 3

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1990	34.5	34.5	34.5	1
1991	30.9	30.9	30.9	1
1993	31.4	36.2	34.1	8
1994	34.1	42.5	36.8	14
1995	32.6	38.1	35.2	7
1996	32.7	37.0	35.1	10
1997	32.7	37.3	35.2	11
1998	35.4	38.8	37.0	16
1999	35.1	42.3	38.5	13
2000	35.8	38.9	37.9	13
2001	34.7	43.1	40.1	10
2002	34.3	41.6	38.8	12
2004	32.3	41.1	36.4	3
2005	33.7	42.6	39.8	13
2006	37.7	43.0	40.1	17
2007	42.7	45.1	43.8	5
2008	38.1	46.5	43.2	20
2009	34.0	46.5	43.6	30
2010	35.8	53.1	42.9	49
2011	33.8	49.6	44.1	58
2012	24.2	50.4	44.3	122
2013	46.0	50.9	48.8	35
2014	48.7	51.8	50.3	8
2015	47.8	51.8	49.8	19
2016	48.2	53.5	51.3	41
2017	47.8	59.7	52.4	57

Sturminster Marshall Borehole 4

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	30.0	30.9	30.4	5
1988	30.5	34.9	32.3	7
1989	28.7	32.7	30.5	4
1990	29.2	34.0	30.7	7
1992	25.6	40.7	32.5	15
1993	29.2	37.2	33.4	16
1994	27.9	37.6	33.2	15
1995	26.9	34.1	31.2	6
1996	29.5	30.0	29.7	3
1997	29.0	33.8	32.1	3
1998	32.7	34.3	33.7	11
2000	31.8	33.1	32.5	3
2001	32.7	32.7	32.7	1
2002	32.2	32.2	32.2	1
2005	27.2	36.9	33.8	8
2006	29.5	32.3	31.1	6
2007	31.5	32.8	32.3	3
2008	0.9	39.3	34.4	23
2009	29.8	30.4	30.1	2
2010	16.2	35.8	32.0	22
2011	28.9	35.2	31.2	7
2012	27.7	33.4	30.2	13
2013	32.2	41.4	37.1	83
2014	36.6	43.9	38.8	141
2015	35.1	40.9	38.5	155
2016	27.4	44.7	40.6	178
2017	35.5	44.3	41.4	160

Shapwick/Sturminster Marshall Treated

Year	Minimum Nitrate (mg N/L)	Maximum Nitrate (mg N/L)	Average Nitrate (mg N/L)	Number of samples
1986	30.0	31.4	30.6	5
1987	26.9	33.6	29.1	4
1988	26.5	32.3	30.1	7
1989	27.4	30.9	29.4	4
1990	28.7	31.8	30.1	10
1991	31.8	31.8	31.8	1
1992	26.5	32.7	30.8	5
1993	31.4	35.8	33.2	13
1994	31.8	45.1	34.4	43
1995	29.2	37.3	33.9	53
1996	31.7	38.0	34.4	54
1997	32.8	37.7	35.0	51
1998	30.0	38.9	35.7	51
1999	31.3	40.9	36.5	53
2000	34.0	43.7	37.1	55
2001	35.6	44.7	38.7	54
2002	7.7	42.0	37.8	53
2003	28.1	42.3	38.2	51
2004	30.1	41.8	38.0	54
2005	0.9	42.6	37.0	85
2006	33.3	44.7	38.7	60
2007	34.1	43.9	39.2	49
2008	36.4	42.1	38.9	68
2009	21.5	43.0	38.0	63
2010	35.1	43.3	39.5	54
2011	34.5	45.1	39.9	54
2012	35.1	44.7	41.2	58
2013	39.2	46.5	43.9	98
2014	40.8	45.6	43.5	60
2015	36.6	46.9	43.4	173
2016	25.4	46.5	43.1	156
2017	34.4	46.9	43.4	138

Zone 92 Shapwick

Year	Minimum Nitrate (mg N03/L))	Maximum Nitrate (mg N03/L)	Average Nitrate (mg N03/L)	Number of samples
2000	26.7	44.1	34.7	13
2001	27.3	41.4	36.0	12
2002	27.9	40.3	36.7	12
2003	25.3	40.0	32.1	15
2004	26.0	41.9	36.1	12
2005	26.0	39.3	35.2	12
2006	27.0	41.3	36.4	12
2007	30.0	41.6	38.6	12
2008	29.9	41.8	38.0	13
2009	25.7	40.9	36.8	12
2010	29.7	40.3	37.9	12
2011	26.4	42.4	38.7	12
2012	27.0	43.4	37.9	12
2013	28.4	44.2	41.1	12
2014	39.7	49.1	43.5	12
2015	26.8	44.2	41.5	12
2016	24.2	44.2	38.7	12
2017	24.1	43.9	39.6	12