Wessex Water Position Statement on Nitrogen Levels in Poole Harbour Updated October 2017

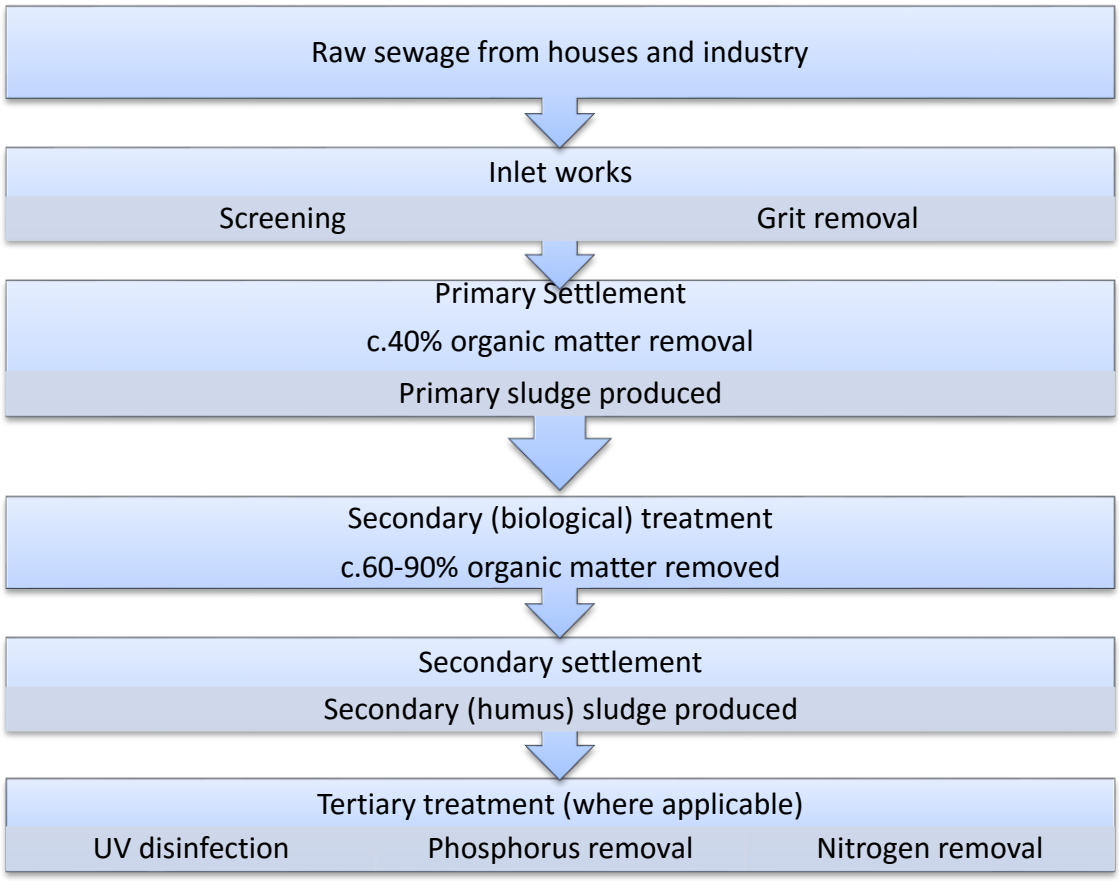
Introduction

Wessex Water is the regional water and sewerage company with an operating area of 10,000km^2, and providing 2.7m people with sewerage and 1.3m people with water services.

Water companies in England and Wales undergo price reviews at five yearly intervals. The last review was in 2014 and prices were determined for the five year period commencing April 2015 by the Water Services Regulatory Authority (Ofwat). Part of the price review process involves each company formulating an Asset Management Plan (AMP) which takes into account projected investment levels to maintain its assets, meet new demands and undertake quality and environmental improvements driven by legislation or required by Government or Government agencies. We are currently in the sixth AMP period, known as AMP6, which runs from April 2015 to March 2020.

Sewage Treatment Processes

Sewage treatment processes have been designed primarily to reduce the suspended solids and organic polluting loads on the environment. Bespoke tertiary treatment processes are used where legislation dictates, to reduce bacterial loads from works discharging near bathing waters or nutrients where discharges are to sensitive areas. The diagram below illustrates the key stages in a sewage treatment process:



Nitrogen is found in domestic sewage in a number of forms, but primarily as ammonia which is a breakdown product from urine derived from our diet. Most sewage treatment works which discharge to watercourses will have a consented limit for the ammonia concentration as it is toxic to fish. In order to achieve this limit biological treatment is used to convert the ammonia to nitrate which is then discharged to the receiving watercourse.

Standard sewage treatment works will reduce the overall nitrogen load, in addition to converting the incoming ammonia to nitrate. The level of removal depends on the process type, as illustrated in the table below. A small amount of nitrogen will be removed through the settlement process and transferred into the sludge. Process data from the sewage treatment works within the Poole Harbour catchment suggest the following nitrogen removal rates:

Process type	Average N removal	Catchment Data source
Biological filter works	23.5%	Data from 14 STWs
Activated sludge plant	56.5%	Data from 6 STWs
Poole N removal	85%	Data from Poole STW

The process is illustrated below:

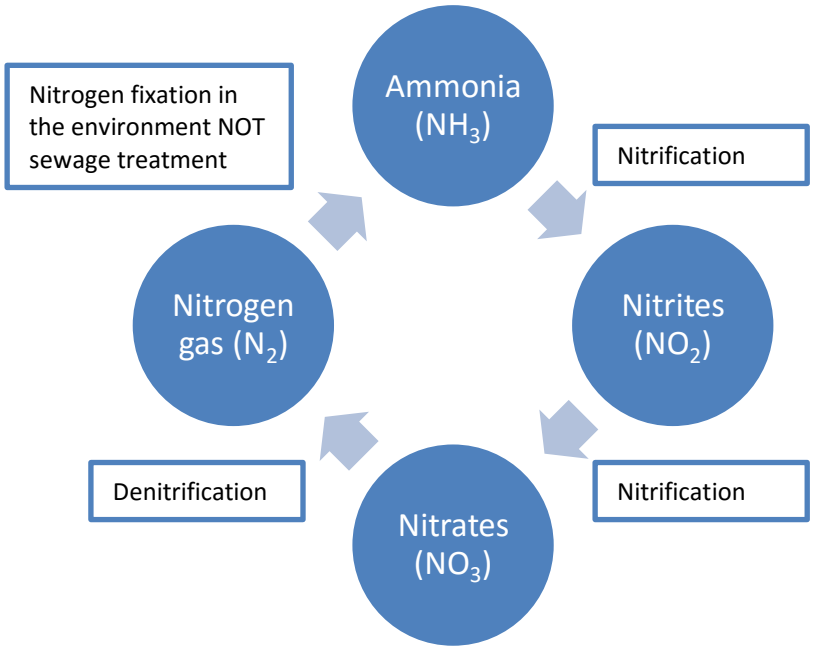


Figure 1: Nitrogen Cycle in Sewage Treatment Works

However, nitrate can also cause eutrophication (nutrient enrichment) and is believed to be the limiting nutrient in marine or estuarine waters (as phosphorus is in freshwaters). Eutrophication can lead to extensive weed and algal growth which can harm the natural habitat.

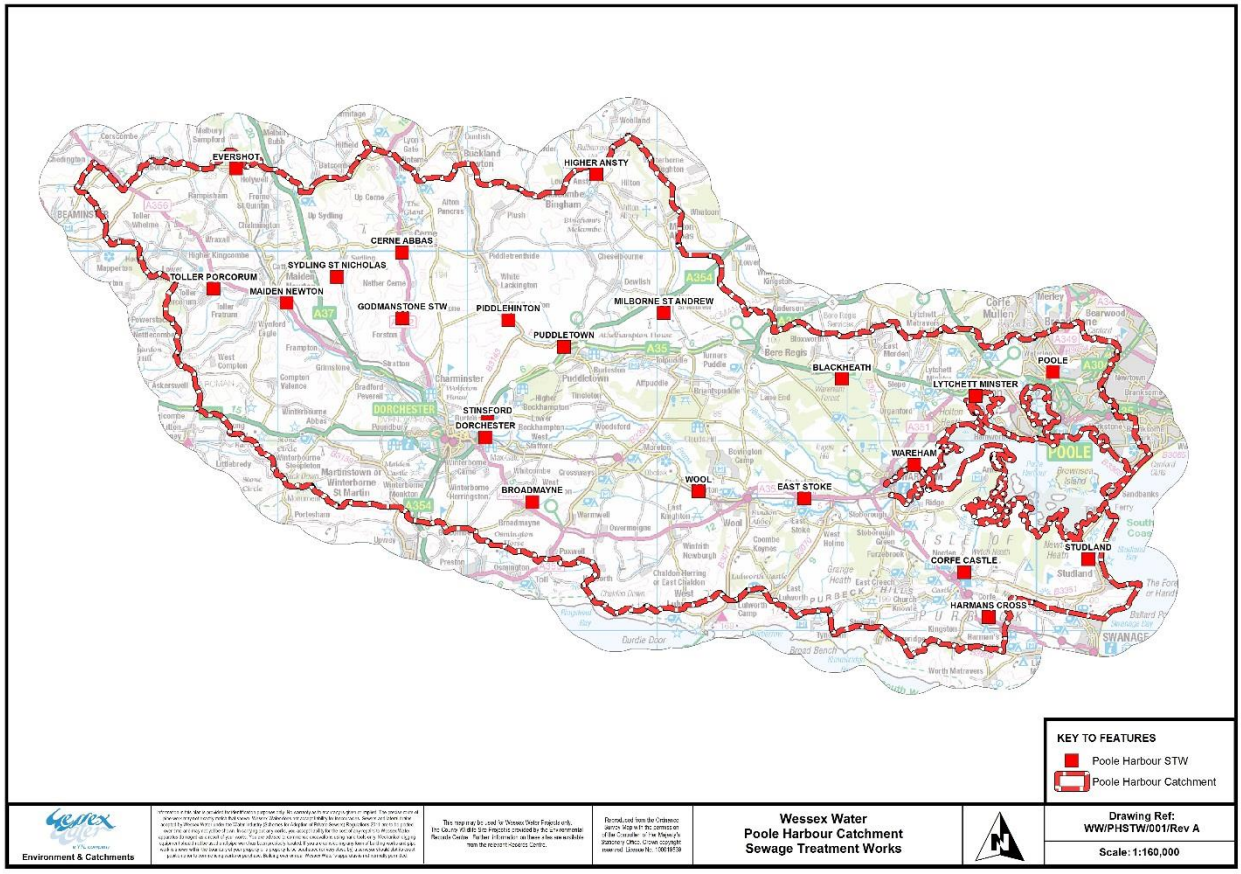


Figure 2: Wessex Water sewage treatment works in the Poole Harbour catchment

Legal Context

Waterbodies designated as sensitive or eutrophic under the EU Urban Wastewater Treatment Directive set limits for nitrogen in wastewater discharges depending on the population served. Poole Harbour was designated as a sensitive area in 2002. As a result, Wessex Water was obligated to install nitrogen removal plant at Poole sewage treatment works (STW) in the last AMP period to comply with the Directive.

The Water Framework Directive (WFD) provides the mechanism for assessing water quality according to European wide standards and requires that action plans are in place to aim to deliver good status by 2015, 2021 or 2027, depending on the constraints and costs associated with the relevant methods. Assessed according to WFD criteria (UKTAG standards), the water quality in Poole Harbour is considered at moderate status in terms of nitrogen concentration. This is the nitrogen concentration allowing for salinity and turbidity.

The Harbour is also designated as a Site of Special Scientific Interest (SSSI), a Special Protection Area (SPA) under the Habitats Regulations 1994, and as a Ramsar site. In fulfilment of obligations under the Habitats Regulations, the Environment Agency compiled a Review of Consents ("RoC") for the SPA, to Stage 4 in 2010. Nutrients were identified as a key aspect of the RoC process, in terms of the:

- Level of and trends in inorganic nitrogen loads
- Levels of inorganic nitrogen in estuarine water

- The biological response to nutrient loads in terms of macro algae (algal mats).

The RoC Stage 3 concluded that there were seven Wessex Water STWs where it had not been possible to conclude no adverse effect on the integrity of the Site, due to their inorganic nitrogen loadings to Poole Harbour, however the final Stage 4 concluded that with the new nitrogen consent at Poole STW, no further changes to discharge consents were required. This assessment was based on the consented limits rather than actual and therefore allows for some increases in future flows to the STWs.

Urban Waste Water Treatment Directive Requirements
Waterbodies designated as a Sensitive Area under the EU Urban Waste Water Treatment Directive set limits for nutrient discharges (nitrogen in this case) depending on the population served at STWs.

For populations above 10,000 the discharge standard is set at 15mg/l. For populations above 100,000 the standard is 10mg/l.

Poole Harbour was designated as a sensitive area in 2002 and as a result, Wessex Water was obligated to install nitrogen removal plant at Poole sewage treatment works (STW) by 31 December 2008 to comply with the Directive.

In December 2015 Wessex Water was informed of the requirement to install nitrogen removal at Wareham STW to comply with the 2002 Sensitive Area designation of Poole Harbour under the Urban Waste Water Treatment Directive.

Wareham STW will be required to achieve a 15mg/l total nitrogen consent limit by December 2021.

Poole Harbour Policy Context
As a result of the international designations associated with Poole Harbour there are a number of policies, translating European and UK legislation, which apply to different organisations to ensure that activities do not cause detriment to the nature conservation status. The relevant documents are listed below:

- Strategy for Managing Nitrogen in Poole Harbour to 2035 [EA / NE led document]
- Draft River Basin Management Plan, published in December 2015
- Biodiversity 2020- national strategy to halt biodiversity decline
- Local Plans, planning policies and development strategies
- Poole and Wareham Coastal Erosion Strategy

Nitrogen Loading
Nitrogen is also derived from other sources, primarily from agriculture where it is used as a fertilizer. Typical fertilizers comprise ammonium nitrate or urea granules which are mixed with water to produce a liquid fertilizer. Manure is another source.

Ploughing up grassland can also lead to high releases of nitrogen as happened during the Second World War

Nitrate is a highly soluble, mobile compound which is readily used by plants but also leaches into groundwater or runs off the land into watercourses if over applied or following rainfall events.

In the Poole Harbour catchment much of the load is as a result of diffuse sources either flowing directly into watercourses, or more commonly being leached (or historically leached) into the groundwater. The groundwater contributes a large volume of flow to the Rivers Frome and Piddle, and their tributaries (over 85%), which flow into Poole Harbour. However, much of this nitrate may be due to historic agricultural usage rather than more recent practices. This high level of nitrate in the groundwater also causes problems for Wessex Water in maintaining compliance with the drinking water standard at most of its groundwater sources in the catchment.

The total input of dissolved nitrogen (N) to the Harbour measured from Wessex Water's STWs in 2009 was around 13%, comprising 1.8% from Poole STW and 11.1% from other STWs, with the main share from Dorchester STW.

However, nitrogen levels are predicted by the Environment Agency to rise in Poole Harbour over the next 20 years at around 25 tonnes/annum, mainly due to rising N levels in groundwater discharging to rivers within the catchment.

The latest source apportionment information is illustrated below[1], demonstrating that 66% of the nitrogen arises from diffuse agricultural inputs, with only 12% from sewage treatment works.

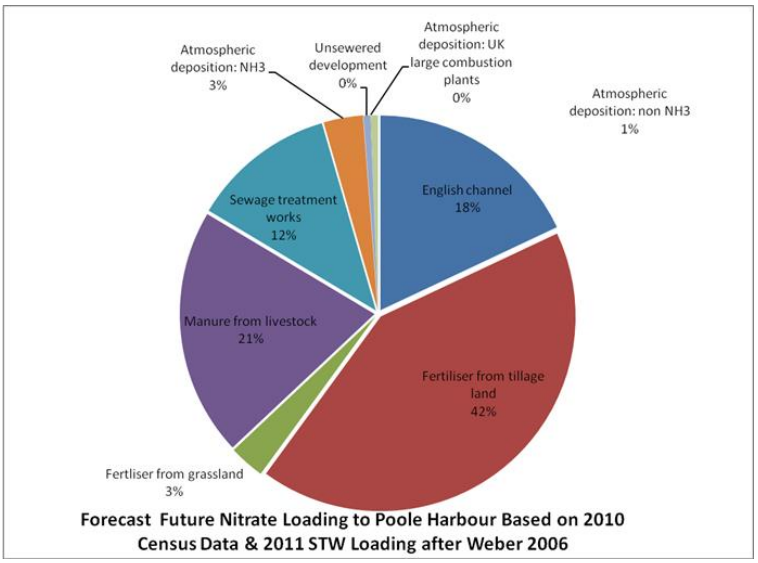


Figure 3: Nitrogen Source Apportionment

[1] Produced by Giles Bryan (Environment Agency) for the Nitrogen Reduction Strategy and reviewed in June 2015 following liaison with the Poole Harbour agricultural group

Sewage Treatment

Poole STW is the only sewage works within the catchment to provide proactive nitrogen removal. The EA's RoC concluded that additional treatment was not required at the other seven STWs in the Poole Harbour catchment.

The nitrogen removal plant costing £12m was commissioned in 2008 and has to ensure that the treated discharge from the works does not exceed 10mg/l of nitrogen (N) on an annual average basis. The treatment process involved the use of methanol which has a relatively large carbon footprint and accounts for c1.5% of Wessex Water's annual sewage and sludge treatment CO_2 emissions. Annual operating costs were around £0.9m.

Due to the high running and carbon costs of this treatment process, alternative options were sought. In 2013, an additional treatment process was installed, which is the DEMON (or de-ammonification) process which is used more commonly in Europe to provide nitrogen reduction. This process uses anammox bacteria which are anaerobic, reducing the chemical dosing and level of aeration required. The DEMON process represents an estimated £140k/yr saving in chemical dosing costs and a 50% reduction in energy use.

The N removal scheme at Poole took the N input down to 55 tonnes/yr when the works came on stream in 2008. During the first 18 months the site outperformed the 10mg/l consent, typically achieving a 5mg/l concentration. This has now stabilised at a discharge of 114 tonnes/yr in 2015 (9mg/l average discharge concentration) following commissioning and development in the catchment, resulting in increased flows and an increase in the level of sludge treatment provided by the site. The site currently removes 927 tonnes N/yr.

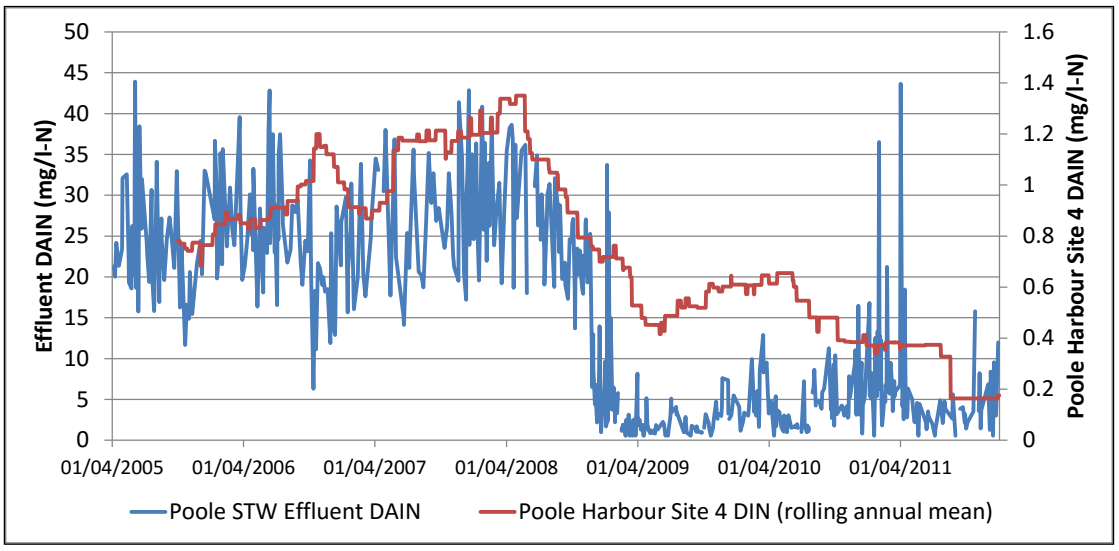


Figure 4: Changes in Poole STW and Poole Harbour Site 4 DAIN concentrations [Site 4 is the sampling point at the mouth of Holes Bay]

Sewerage Network

The sewerage network consists of the pipes and pumps which are used to convey the sewage from domestic and industrial properties to the sewage treatment works (STWs) for treatment. Traditionally, the sewerage network is a combined system conveying both foul and surface water, it is only in newer properties where the surface water has been separated.

The sewerage network has a finite capacity and therefore during wet weather the system may become inundated with surface water, including runoff from hardstanding and roofs. In order to prevent flooding of properties, consented combined sewer overflows (CSO) have been installed, to enable the dilute sewage to spill into the environment at an appropriate location. These overflows have permit conditions which state the flow rates at which they can spill, the level of screening or storage which is required.

As CSOs should only operate during periods of unusually intense rainfall, any foul water released from them is very dilute because of the large volumes of rainwater within the system. This also means that they have a very low nitrogen contribution to the environment. The calculated contribution from our assets is illustrated below:

Table 1: Nitrogen loads from sewerage and sewage treatment assets

Nitrogen	tpa	%
Discharged from STWs	316.9	25.4
Discharged from CSOs and SSOs	1.0	0.1
Removed at STWs	930.1	74.5
Total N arriving at all urban wastewater treatment plants	1248.0	100.0
Catchment management Dorchester offsetting	40	77.7

The total nitrogen arriving at all sewerage and sewage treatment assets is 1,248 tpa. Of this load 74.5% of the nitrogen is removed.

The remaining 25.5% is discharged in the final effluent and through overflows.

Note that a further 40 tonnes of nitrogen/yr (60 tonnes in 16/17) is removed by Wessex Water's catchment management work in the Dorchester area *in lieu* of a nitrogen removal plant at the STW.

Public Water Supplies

Rising nitrate levels in groundwater are also of concern for public water supplies. Wessex Water relies on groundwater for public water supply in Dorset. Drinking water regulations place a limit on the level of nitrate and some supply sources have shown a steady increase over time to a point where action has had to be taken to avoid breaches of the regulations. Nitrate removal plants are expensive to build, operate and maintain and are unsustainable. Accordingly, Wessex has looked for

more sustainable means of tackling nitrates in groundwater by means of catchment management.

There are 13 public water supply sources in the Poole Harbour catchment, some of which exceed current Drinking Water Standards, and others have rising trends. The table below indicates the sources within the catchment where ongoing monitoring is undertaken to establish the status of the source.

Source	Current Status
Winterbourne Abbas	DWS exceedance
Belhuish	Rising – and exceeds in winter
Briantspuddle	Rising – very close to the DWS
Alton Pancras	Rising- very close to DWS
Milbourne St Andrew	Exceeds DWS in winter
Hooke	Stable- below DWS
Forston	Stable
Dewlish	Stable
Eagle Lodge	Falling – following WW catchment management work
Maiden Newton	Low
Cattistock	Low
Litton Cheney	Falling- Source Protection Zone inside catchment but actual source is outside
Langdon	Source not used due to nitrate pollution
Empool	Now stable following WW catchment management work

We work with the Drinking Water Inspectorate (DWI) to ensure that all water supply sources comply with the drinking water standard. Many of these have been identified as Safeguard Zones where measures to reverse rising nitrate trends need to be implemented. At these water supply sites within the catchment the DWI has supported Wessex Water implementing the catchment management approach instead of installing treatment.

There is a regulatory requirement on Wessex Water to ensure that the water supplied meets the Drinking Water standards. Under Article 7 of the Water Framework Directive there is also a requirement on Member States to ensure that this can be done without the installation of additional treatment.

Regulatory Requirement

As discussed above, Wessex Water's price limits allowed funding to install a nitrogen removal plant at Poole STW to comply with the Urban Waste Water Treatment Directive.

Although the RoC required no further STW improvements at that time, given the risks of increasing nitrogen from population growth and rising groundwater nitrogen

trends, Wessex Water was funded in AMP5 to undertake two investigations to study the impacts of its discharges, relative to other sources, on the nutrient levels within Poole Harbour and the Rivers Frome and Piddle. These investigations concluded that the introduction of tighter consents at Poole STW was shown to have had a dramatic effect on direct DAIN[2] releases to Poole Harbour, while DAIN loads (2006-2010) are increasing at Dorchester STW. Total STW loads (2006-2010) were 99 to 151 tonnes to the Frome, and 9 to 14 tonnes to the Piddle. Direct STW discharges (Poole, Wareham, Lytchett Minster, Studland and Holton Heath STWs) accounted for 4.3% of the 2009 Dissolved Available Inorganic Nitrogen (DAIN) load to Poole Harbour. Overall STWs accounted for 13% of the 2009 load.

The influence of rising groundwater concentrations in drinking water was assessed. Measured STW influent DAIN concentrations at Dorchester STW over the period 2005 to 2010 were 30mg/l-N. Raw water concentrations therefore contribute up to a third of influent DAIN.

The River Frome constituted the greatest single source (53%), with the River Piddle conveying 31%. 89% of the Frome load and 98% of the Piddle load arose from non-STW sources.

Results from the cost benefit analysis indicated options to manage diffuse pollution are the most cost efficient and have the lowest impact on the environment. Removal of nitrogen at STWs has significant capital, operational and environmental costs

In AMP6 (2015-2020), we are delivering a nitrogen offsetting scheme in the Poole Harbour catchment. This focuses on working with farmers and landowners to deliver a further 40t/y nitrogen reduction to offset some of the load discharged from Dorchester STW.

The Water Industry National Environment Programme 2, released in September 2017, highlights the need to install nitrogen removal at Wareham STW by December 2021 to comply with the Urban Waste Water Treatment Directive.

The catchment management approach will be implemented at more sites including: Alton Pancras (Upper Piddle), Forston (Lower Cerne) and Milborne St Andrew (Bere Stream).

Engagement

As a consultee on development plans and individual planning applications, Wessex Water has liaised with the district councils on the sewage effects of new development on Poole Harbour. Some development can be met within the headroom available at the STW, at others we are obliged to extend treatment to meet the increased flows.

[2] DAIN = dissolved available inorganic nitrogen

We have had significant input to the Nitrogen Management Strategy (NMS) both in terms of technical data on discharges and the costs for relevant treatment. We appreciate that Natural England and the Environment Agency are under pressure as the Harbour does not achieve the Water Framework Directive standard nor the required nature conservation targets associated with the designations.

Nitrogen levels in the Harbour are predicted to rise for a number of reasons, which include housing development and continued agricultural and diffuse inputs. Wessex Water supports proportionate and cost effective measures to stem this increase from all sectors, rather than focussing on costly mitigation using end-of-pipe treatment.

In parallel to the NMS, Natural England has been advocating a 'Nutrient Neutrality' policy directed at any yet to be determined planning applications for new development within the Poole Harbour hydrological catchment. Under this policy, Natural England would expect to see mitigation measures supporting any planning application in order that there is no additional nutrient loading to the Harbour as a result of the development. As a competent authority within the planning process, this is the advice which Natural England is providing to the relevant planning authorities within the Poole Harbour catchment when considering applications for new development.

Wessex Water Position

We welcome discussions so that we can understand each party's issues and explain our position. Based on our catchment management work, investigations and monitoring to date we are keen to explore further land management options in this AMP period, until 2020, and ideally in future AMPs, to provide increased reductions in nitrogen loading to Poole Harbour.

Wessex Water challenges the need to construct additional nitrogen removal plant on two accounts.

1. The requirements of the UWWTD

The UWWTD states[3] that the requirement for further nutrient removal need not apply, if the overall nutrient load entering all STWs in the designated sensitive area is reduced by at least 75% for total nitrogen.

Nitrogen removed by Wessex Water's activities in the catchment exceed the 75% removal value as illustrated in Table 1 above.

[3] UWWTD Article 5 Para 4 states: '*Alternatively, requirements for individual plants set out in paragraphs 2 and 3 above need not apply in sensitive areas where it can be shown that the minimum percentage of the overall load entering all wastewater treatment plants in that area is at least 75% for phosphorus and at least 75% for total nitrogen.'*

Based on the argument and evidence that STWs are not only a minor (12%) contributor to the nutrient load in the harbour (Figure 2) but also that Wessex Water, by its assets and activities, already remove the vast majority (>75%) of the load, it would seem reasonable that the fair share of nutrient pollution removal has been met.

2. Alternative solutions will achieve the environmental outcomes at much lower cost

Table 2 below illustrates the cost of STW asset solutions and the cost/tonne of nitrogen removed. Of these, only Poole STW currently has a nitrogen removal plant. Dorchester, Wareham and Lychett Minster figures are all estimates.

Table 2 Summary of costs and load reduction using nutrient removal plants

Site	Permit (mgN/l)	Load reduction (tNpa)	Capex (£m)	Opex (£m/a)	Cost per t N removed (£k/tN) (based on 20yr opex)
Poole	10	927	14.1	0.83	1.7
Dorchester*	15	40	9.7	0.23	17.9
Wareham	15	19.5	6.4	0.16	24.9
Lytchett Minster	15	6.5	6.5	0.06	58.5

(*The Dorchester STW cost is for a nitrogen removal plant. However in AMP6 Wessex Water has implemented an alternative catchment management type solution to remove 40tN/a at less than the opex of a nutrient removal plant and with no capital expenditure)

There are two main alternative and significantly more cost effective ways to deliver an equivalent nitrogen reduction across the catchment rather than an asset solution at Wareham STW (and in the future Lytchett Minster STW). However, the solutions do not meet the outputs required by the UWWTD requirements.

The alternative solutions are:

- Provision of catchment management activities
- Improving the current performance at Poole STW i.e. reduce 10mg/l total nitrogen permit to 9mg/l.

Catchment management offers the provision for a greater range of benefits than nitrogen reduction alone, for example, biodiversity and carbon savings. These benefits are experienced over a greater geographical scale than the just the waterbody downstream of the STW.

Improving the performance of the Poole STW nitrogen removal plant to achieve a revised permit of 9mg/l total nitrogen, as opposed to 10mg/l, would provide an estimated 36t/yr reduction in nitrogen load from current levels. This is significantly greater than the load reduction of 19.5t/yr that would be achieved by a new 15mg/l permit at Wareham STW.

Both options would remove more nitrogen from the harbour than an UWWTD compliant solution and at a fraction of the cost

To provide the 40t/yr nitrogen offset from Dorchester STW, as identified in Wessex Water's PR09 Business Plan, the company has successfully developed a nutrient removal reverse auction platform called EnTrade. EnTrade was first piloted during June 2016 with farmers within the Poole Harbour catchment to bid in to receive funding for land management measures which will achieve a quantifiable level of nitrogen leaching reduction.

To date, five EnTrade auctions have been run with over 140 tonnes of nitrogen reduction being bid by the farming community. Of this, Wessex Water has contracted 80 tonnes at an average cost of £4 per kg (or £k/tn) nitrogen reduction, including software, catchment advise, monitoring and overheads. This represents nitrogen reduction delivered at about $^1/_4$ of the cost of constructing an asset solution (see table 2 above).

A catchment approach solution is a more sustainable, lower cost option with better environmental and economic benefits for the following reasons:

- working with the agricultural sector and others would tackle the main contributors of nitrogen to the harbour, making a reduction on the 88% non-sewage contributions rather than the minority (12%) from the sewage treatment works
- the provision of agronomic advice and support, whilst focussed on nitrogen reduction, provides a wide range of benefits including other nutrient reduction, e.g. phosphorus, increased awareness of soil husbandry which can reduce flooding and the opportunity to provide complimentary wildlife interventions
- Catchment management advice can assist farmers across a wider range of issues, including soil and manure management, improving the efficiency of current farming practices and saving money for farmers themselves
- Wessex Water's catchment management work to date has indicated that the costs of catchment solution are considerably less than an asset option, typically around $^1/_4$ of the cost
- Treatment options embody significant environmental costs over a long time period associated with the energy and chemical requirements. e.g. at the time of construction Poole STW nitrogen removal plant accounted for 5% of the company's total carbon footprint.

Conclusion

Wessex Water advocates a more sustainable approach to tackling eutrophication within the Harbour by focussing on the sources of the problem rather than costly, energy and chemically intensive end-of-pipe bolt on treatment solutions. We believe that this approach should look holistically at the water quality problems, including sediment and phosphorus loading, and identify solutions in an integrated way across the catchment.

Whilst Wessex Water accepts that we may have a part to play in further nitrogen reductions, we would like to see a more focussed effort on the larger contributors such as agriculture, poorly managed septic tanks and misconnections. The earlier graph indicates that 88% of the nitrogen load originates from non-STW sources. Our view is that this should be tackled as a priority.

Our catchment management team are working closely with the Environment Agency to understand the contribution diffuse pollution is making to rising nitrate trends in groundwater. This work is looking at numerical modelling results to understand where there is a rise, if the levels have peaked or are declining. This is a key area of work which can help understand where intervention should be targeted, the likely responses and the time required to reduce nitrate levels in the groundwater.

The Poole Harbour Catchment Initiative is working with many partners to identify opportunities to collaboratively deliver Water Framework Directive outputs. The action plan has been agreed by Steering Group members and funding is available to deliver many of the prioritised actions included. This Plan will be revised as more data becomes available and project successes have been demonstrated. This Initiative will inform all parties on the options for tackling nitrogen inputs, and other water quality issues, to ensure that the most appropriate approaches to deliver the greatest environmental benefits at the lowest costs are enacted.