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WWF - UK

Rivers on the Edge – an assessment of the impact of sewage pollution

Final Report

AR2182

August 2017

Report title:	**Rivers on the Edge – an assessment of the impact of sewage pollution**
Report number:	**AR 2182**
Date:	**August 2017**
Client:	**WWF-UK**
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Executive Summary

This report provides an analysis and evaluation of the current status of the freshwater ecosystems in England and Wales with particular attention on impacts of the wastewater system and foreseeable future pressures on both freshwater ecosystem and wastewater sector. A separate section is dedicated to chalk streams and analyses their condition in comparison with the overall picture.

Methods of analysis have included the examination of monitoring data and results from freely available and published by the statutory organisations, in particular the Environment Agency and Natural Resources Wales. These include investigations of results from Cycle 2 of the Water Framework Directive and detailed information about the impact wastewater system, such as discharge consents, pollution incidents and relative sanctions. Other examinations have included an analysis of the literature on the wastewater systems and research on current and prospective impacts on the freshwater ecosystem and on sensitive areas. A series of maps and charts have been produced to support the results where possible. Particular attention has been dedicated to statutory organisations' policies, with analysis of planned measures to prevent further stress on waters. Finally, the more recent information about climate change, population growth and housing development scenarios have been used to assess possible future pressures.

The report found that the overall pictures one of a general poor ecological status, with a small percentage of waters reaching good ecological status by the 2015. This is confirmed by the extension of the deadline for reaching the WFD objectives up to the 2021. Three key national significant management issues seem to impact the surface waters most; these are:

- Physical Modification
- Pollution from Rural Areas
- Pollution from wastewater systems

The situation appears similar for chalk streams, which are also affected by changes in the natural flow and levels of waters due to their sensitive nature, with complex and delicate geo-physical characteristics.

Particular attention has been dedicated to the analysis of the wastewater system. The report found that sewage activities impact almost half of the rivers that failed to reach good ecological status; in particular, continuous discharge affecting more than a third of the failing rivers. Intermittent discharges, such as CSOs appear to be identified with a lower frequency, even though statutory agencies have fined wastewater companies with important monetary fines in the last decades, as confirmed by published dataset and news bulletin published by statutory agencies themselves. The report found that monitoring around CSO systems is still far from being sufficient to address the issue around them. In particular, compliance monitoring is responsibility of CSO owner and special regulation on spill frequency is only in place for discharges into areas defined as sensitive by the legislation. Programmes are planned to increase the quality and amount of monitoring; however they seems to be still not implemented.

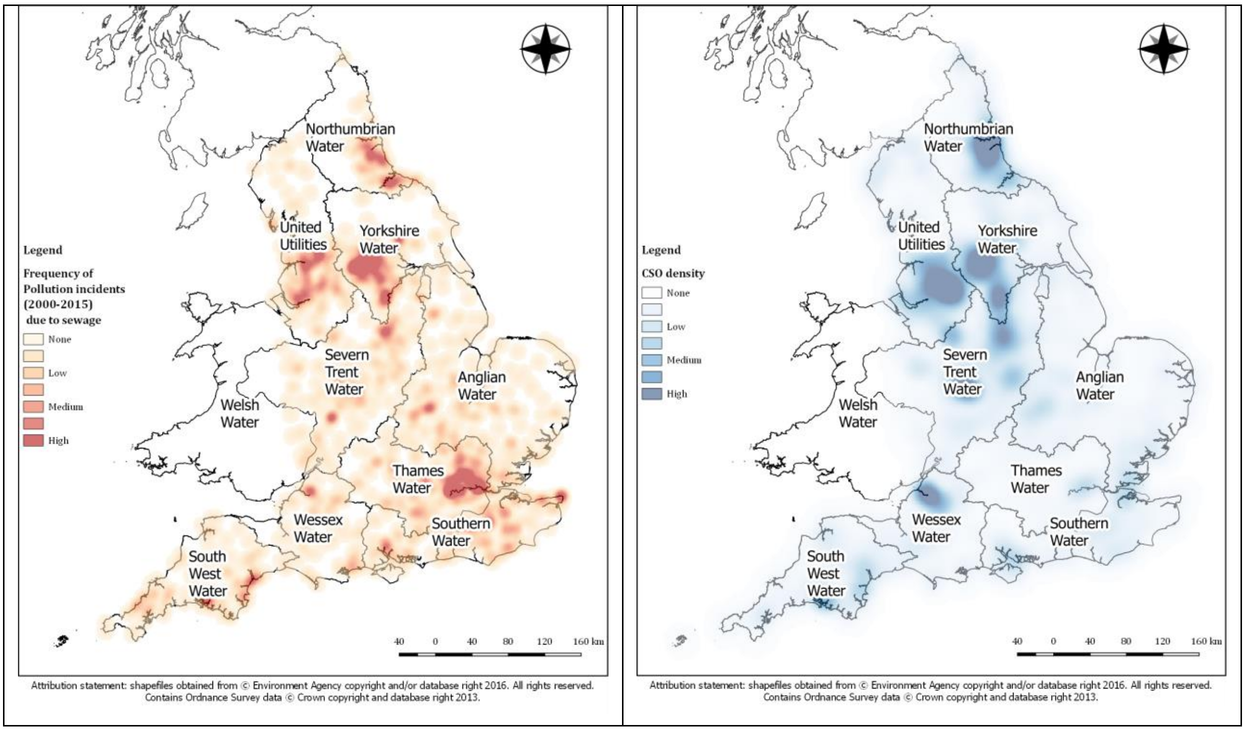
Analysing the information around impacts of wastewater activities, the report found that phosphorus is considered one of the biggest pressure. In particular, the load discharged by the waste water system constitute the biggest fraction of total load into surface waters.

Further, phosphate affects multitude of classification elements and can spring important episode of eutrophication which can dramatically disrupt wildlife and the chemical conditions of waters. Moreover, new pollutant are discharged into the system daily and have not been studied long enough to be assessed and treated properly by the wastewater infrastructure; however they can affect wildlife with significant effects; and it is evident that in case of pharmaceuticals and microplastics, there is increasing public and expert concern. Moreover, future pressures of climate change and further development and population increase will create further pressures if sufficient infrastructure and improvements are not made; further studies are needed to understand the implications of these changes.

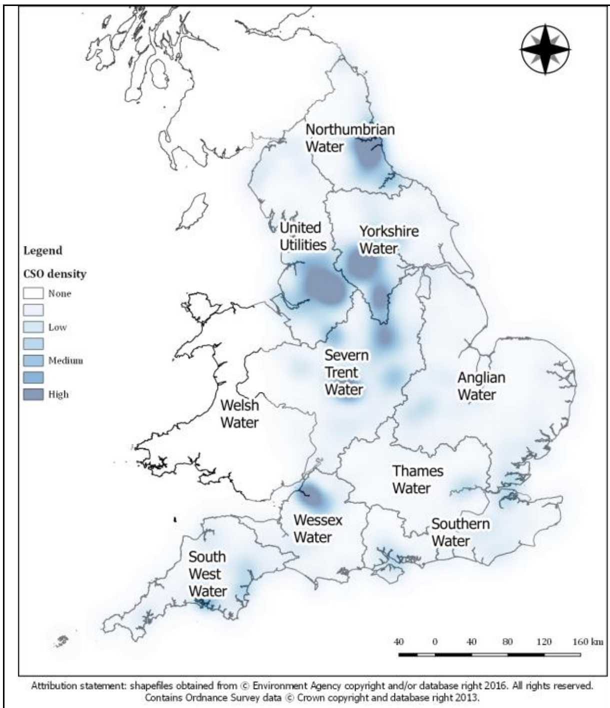
The report also investigated pollution incidents reported to the Environment Agency (EA) affecting the waters at a significant level. Incidents appears to be decreasing in the last few years; however most of the reported ones appear to be concentrated in specific region such as Humber, Thames and North West, where the urban condition and wet weather can put pressure on the waste water system .

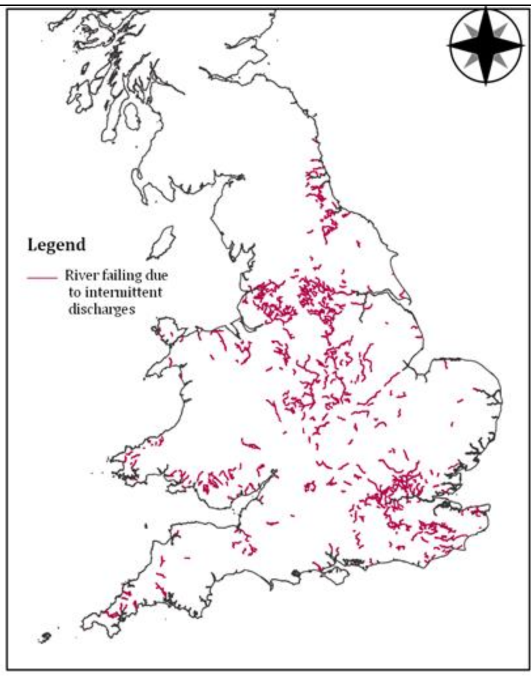
When looking at legislation around waste water and discharges, the report found that compliance is generally good but some key issue as older consents, temporal deemed consents and consents discharges into sensitive areas have not been properly assessed by statutory agencies and waste water companies. European Commission reports confirm the issue regard sensitive areas, with the UK being the Member States further away from the objective of the legislation.

In attempting to draw out some conclusions regarding the extent of river pollution and its causes within a wastewater company location, the datasets available do not help. Data from the EA provides some glimpses in to the threats and it is possible to compare data; but not conclusively. For instance below is a "heat-map" comparison between the location density of CSOs on the right and the seriousness of sewage pollution events for 2001. Some hotspots in the north correlate, but around London and Bristol they do not.

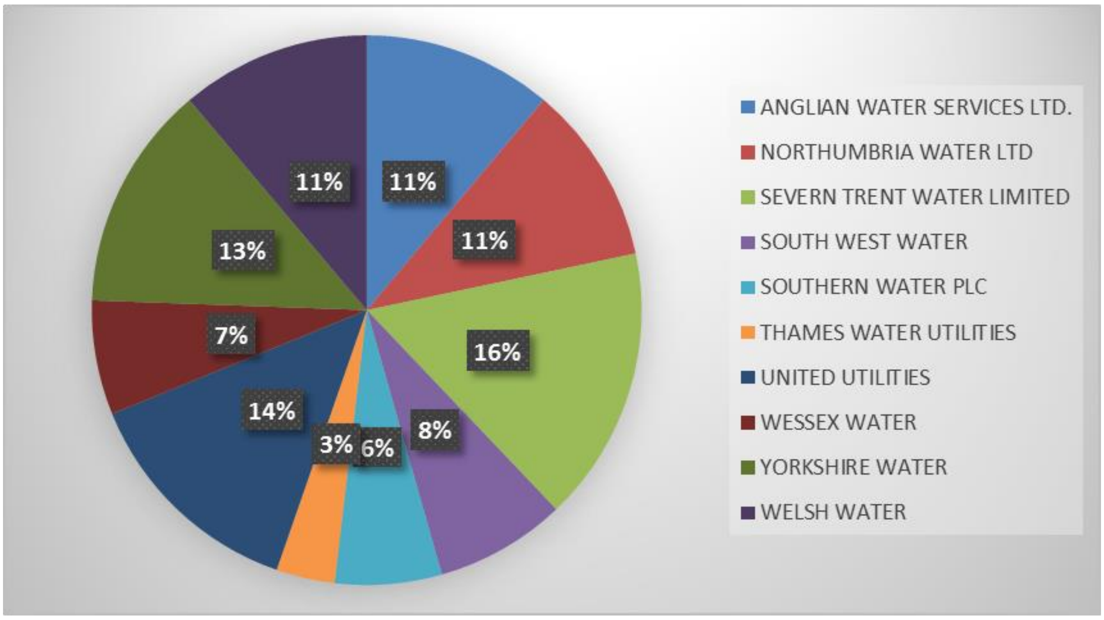


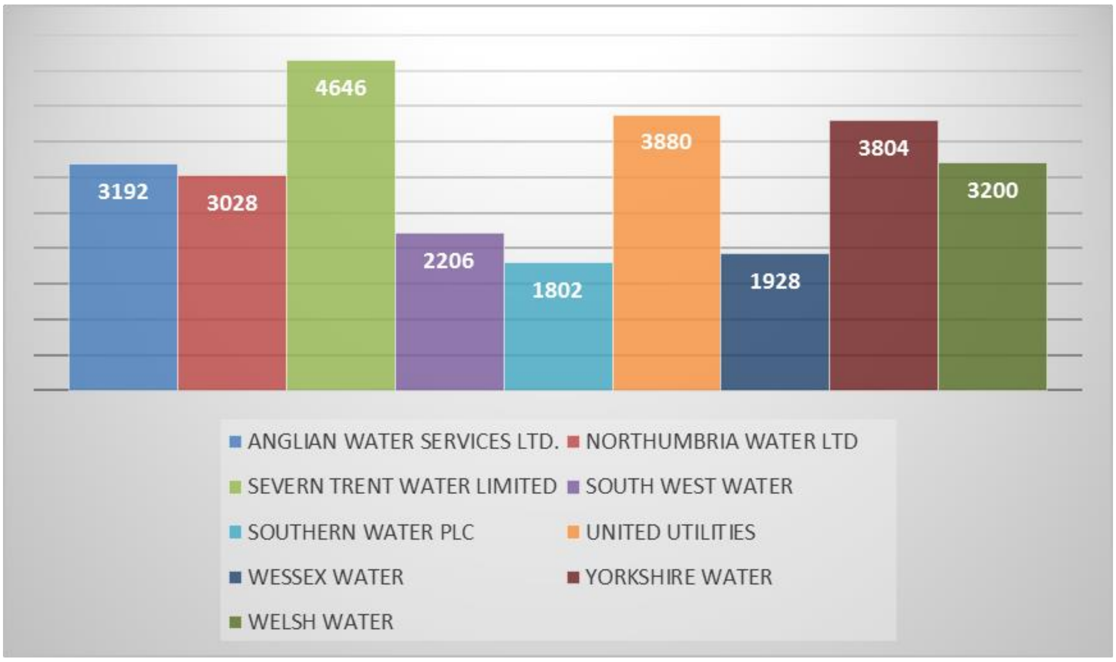
Similarly, when the density of CSOs is compared with the instances of failing CSO discharges it becomes clear that these primarily occur in the north and potentially are a significant contributor to the discharge failures; but that where river discharges fail does not necessarily match the density of CSOs.



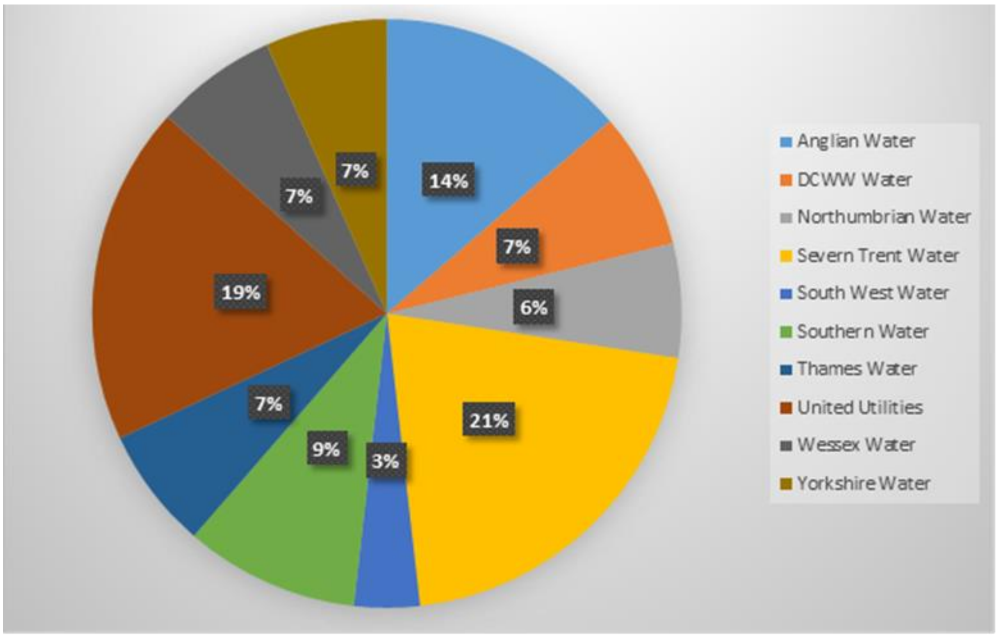


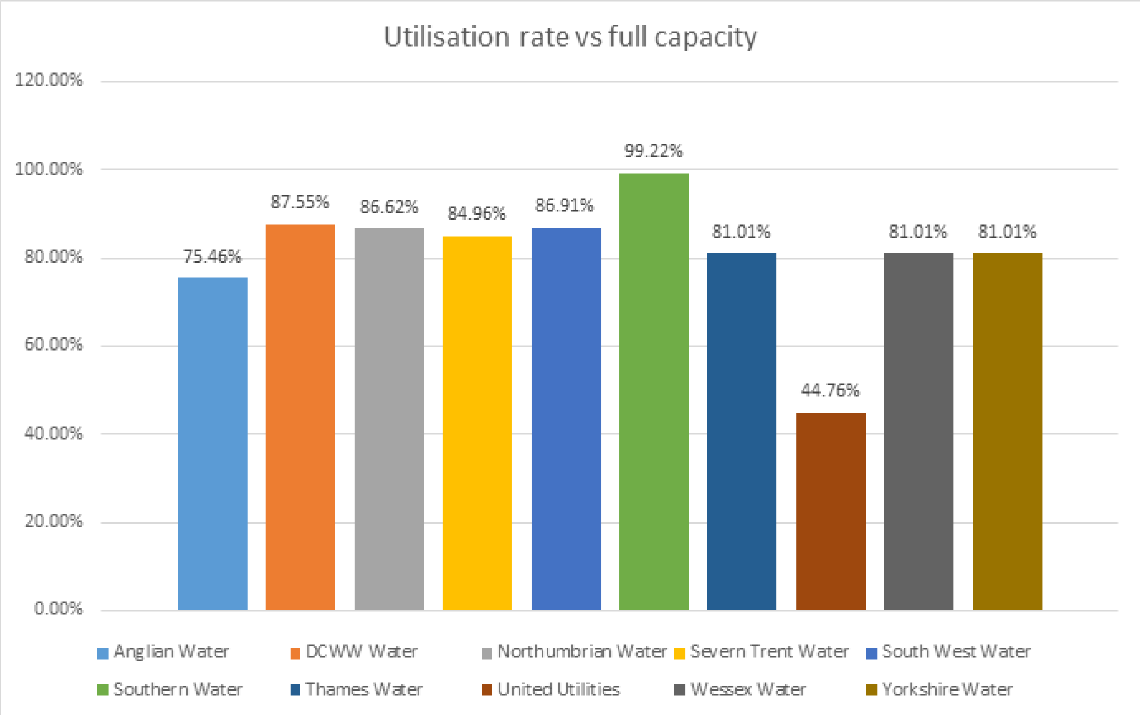
The following two charts come from EA consent discharge dataset, they refer just to England (database date is 2016) therefore Severn Trent might be underestimated because it excludes their Wales locations. Welsh Water figure comes from their 2015 financial report.



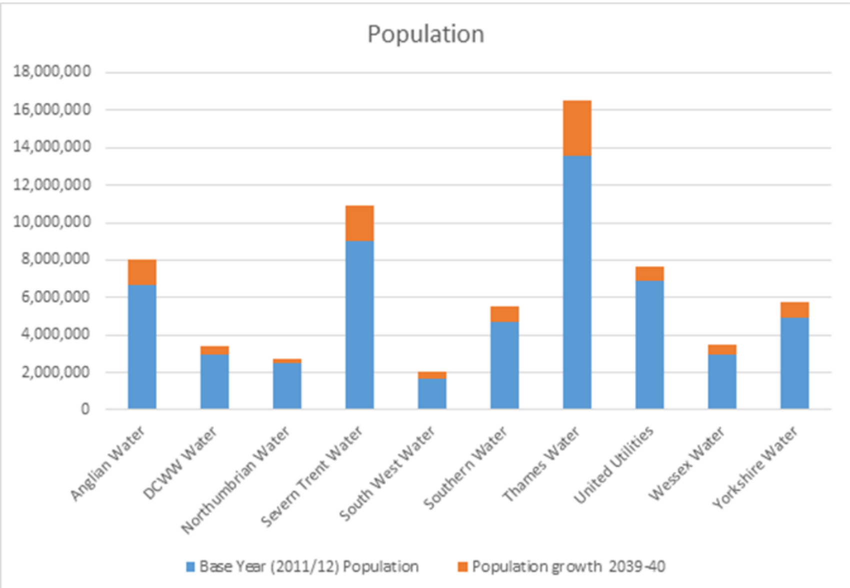


The following two diagrams come from EA Urban Wastewater treatment works shapefile, report data referring to 2012 (spatial dataset containing wastewater treatment plants monitored and reported under the Urban Waste Water Treatment Directive in England). These UWWT plants serve population equivalent (PE) greater than 2000 if discharging to freshwater or greater than 10000 if discharging to coastal/transitional waters.

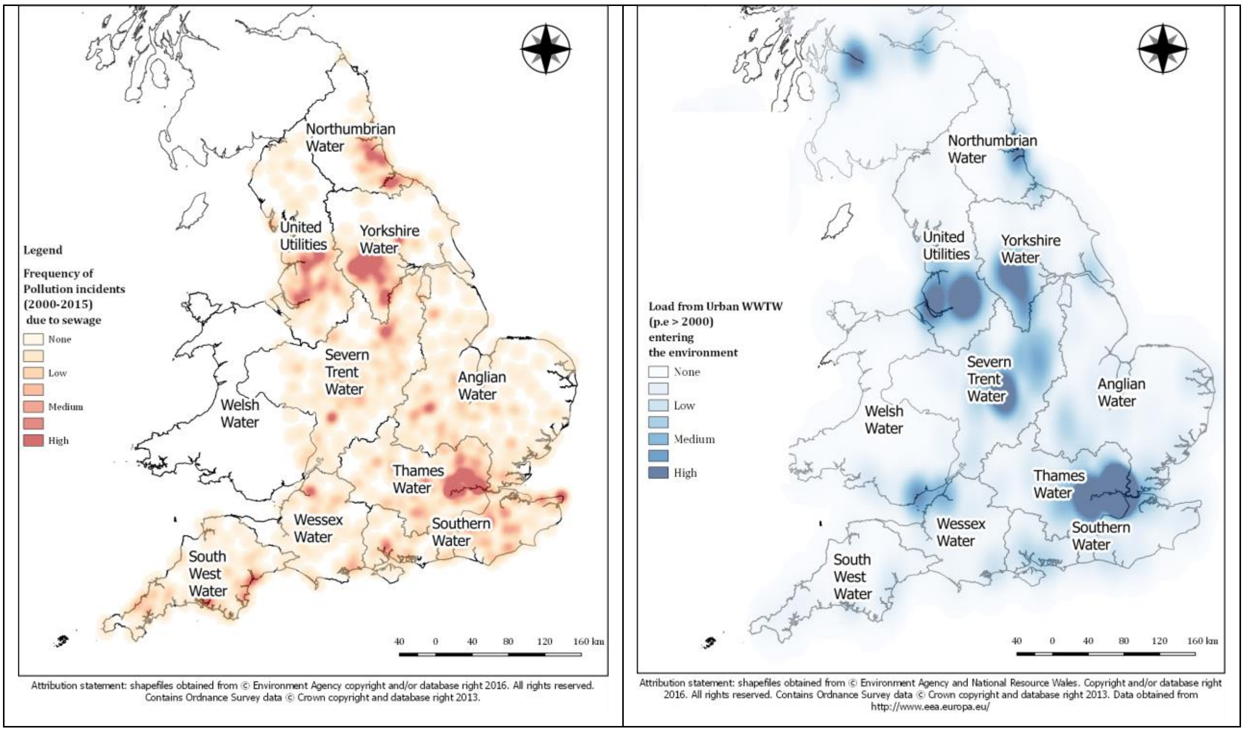




Understanding current levels of utilisation of treatment capacity is not only important for considering current "resilience" to climate change pressures and increasing intensity of rainfall events but also in planning for future demands on the wastewater infrastructure from population and property development growth (see next table which indicates ONS base population 2011/12 and projected population by wastewater company to 2039/40). The above figures show the wastewater companies being broadly similar in the capacity levels; but with Southern and United Utilities as outliers – For United Utilities the value is low because the EA dataset (dated 2012) report an high capacity value for one of the UU plant (Manchester and Salford (Davyhulme) with a correspondent low load entering this particular treatment work.



Comparing load volumes to WWT plants with pollution incidents (both figures are "heat-maps" from the datasets; there does appear to be a correlation between the volumes of wastewater (generated) and loaded to WWT plants. With population and development growth (without SUDS), this generated load of foul waste and rainfall drainage waste seems likely to continue and intensity pressures on wastewater infrastructure and the aquatic environment.



Overall it appears that the impacts of pollution from wastewater are subjected to a degree of uncertainty revolving around many points:

- Often it is uncertain which activity is causing an impact and to what degree
- For some issues no technical solution is available and/or cost benefit are disproportioned. Further studies, investment and development of technology are needed to overcome this condition.
- The new risk based approach to discharges means that further studies will be needed on resilience of environment, wastewater network and on affordability of solutions proposed.
- Regarding intermittent events, which affect the system occasionally but have the potential to highly impact the waters, there is recognition that better monitoring is required. Not every CSO is monitored real time, therefore it exists the possibility that some events are not picked up. Further, there might be uncertainty following an improvement or amendment in CSO design.
- The current condition of much of the underground sewer network is not known and the rate of deterioration is largely uncertain.

- It is recognised that phosphate load (of which a high proportion comes from the wastewater system) impact the riverine system to a great degree. However, there is to recognition that there is a lot of uncertainty around it and that models produced so far have not been able to analyse the ramifications of the issue and the interaction of phosphate with other nutrients (nitrate). Nitrate can also play a big role and will require further studies. Finally, there is lack of quantitative studies about the contributions from septic tanks and small package plants in local situations.

- Further study are needed on new pollutant entering the wastewater system, such as chemical and Synthetic pollutants (Ethinyl estradiol, microbeads and microplastics, pharmaceuticals and other)

- Further pressure coming from climate change, housing and population growth are still unknown. The White Paper mentions that over 40 per cent of local planning authorities do not have a plan that meets the projected growth in households in their area; this further creates uncertainty for associated infrastructure planning such as increasing capacity at wastewater treatment works and within the sewerage and drainage systems.

In light of the analysis conducted, a list of Top River at risk from pollution from wastewater has been produced for England and Wales. This takes into account number of elements failing in general, predicted outcome of ecological status (for 2021 and 2027) and number of RNAG attributed to wastewater pollution during Cycle 2. The lists are detailed below.

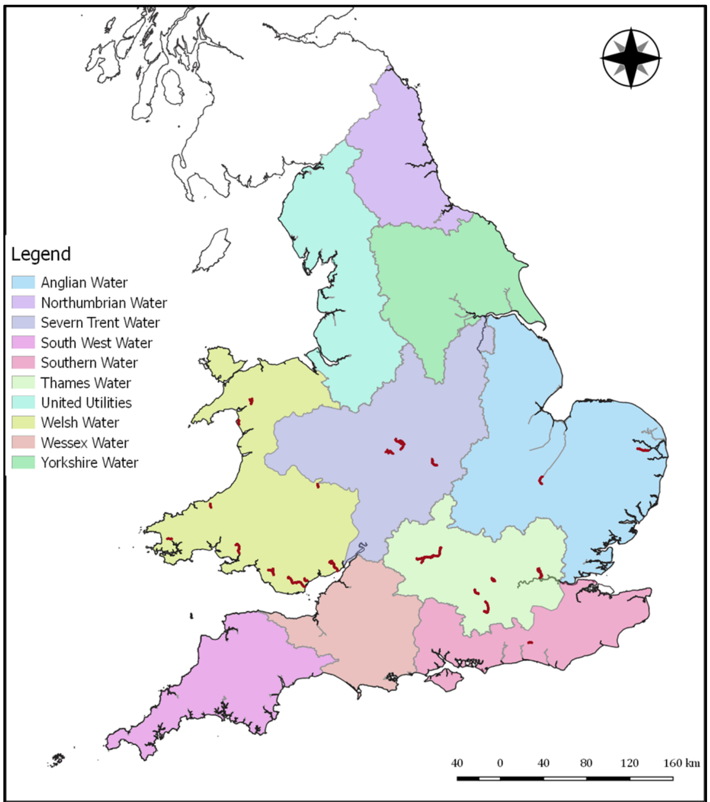
England

Lee (Tottenham Locks to Bow Locks/Three Mills Locks)
Tame (W/ton Arm) source to conf Oldbury
Crane Brook - source to FootherleyBrook
Thames (Leach to Evenlode)
Blackwater (Aldershot to Cove Brook confluence at Hawley)
Swavesey Drain
Wem Brook from Source to River Anker
Roundmoor Ditch and Boveney Ditch
Barkham Brook
Chet
Adur East (Goddards Green)
Footherley Brook from Source to Black-Bourne Brook

Wales

Norton Bk - source to conf R Lugg
Nedern Bk - souce to R Severn Estuary

Roath Brook
Ely R - conf Nant Clun to Allot Gardens, Ely
Llynfi - Lletty Brongu STW to conf with Ogmore
Gwili - headwaters to tidal limit
Pelcomb Brook - headwaters to conf with W. Cleddau
Dyffryn Ardudwy - Main Drain
Dulas - headwaters to conf Ceri
Goedol



Attribution statement: shapefiles obtained from © Environment Agency and National Resource Wales. Copyright and/or database right 2016. All rights reserved. Contains Ordnance Survey data © Crown copyright and database right 2013.

Finally, the reports acknowledge the fact that are some limitations in the analyses. These includes information that is not published, such as Wales's datasets about consents, and older Cycle 1 information that are not published because copyrighted. Another limitation was that waste water companies are not bound to distribute their boundaries shapefiles, therefore the digitisation of the map has been conducted on low resolution images. This will alter some of the calculation due to the digitisation process. The top river at risk ranking is also subjected to some assumptions, these have been detailed in the document in the appropriate section.

Contents

Tables

Figures

1 Introduction

This research project has assessed where possible the current impact of sewage pollution, attempting to generate a picture across England and Wales, looking also at the status of chalk streams. It is intended that the analysis and presentation of the findings contained in this Final Report, for example using maps to clearly show the geographical impact, will be used by WWF in a public-facing policy advocacy report.

2 Understanding the Data Sources

The data on water bodies status and pollution events collected over the years by the Environment Agency **(EA)** and other statutory bodies is available on the Government data web search website[1]; the data resources for Wales are hosted on the National Resource Wales **(NRW)** website for water-related information[2] (a list of all the shapefiles downloaded is below the reference section).

These have been the main repositories used for developing an understanding of the data sources. The data comprises information about all the River Basin Districts in England and Wales

In detail the data used for this analysis has been:

- **Consented discharges** – (EA). This is a list of all permit details as required under the Environmental Permit Regulation. Information is held for all permit holders and covers all substances that are controlled. The database provides 3 tiers of information:
    - *Site and General Information* - details about consent holder and discharge location. Data is also held on the effluent type e.g. Sewage effluent, Overflow.
    - *Effluent* - Further detail is provided on the amount that can be discharged and in which time period in months. Further data about the permit type and treatment type from lookup lists are provided.
    - *Determinand Limits* - Determinands are the substances and numerical limits that make up the effluent. This could include chemical, biological, and physical limits.
- **Pollution incidents** – (EA). This is a database that contains all reported incidents brought to EA attention. Only substantiated incidents, where environmental impact category is either major or significant to at least one medium, are reported.
- **Water Framework Directive (WFD) reports** – (EA and NRW). This include data for Cycle 2 for 2013, 2014 and 2015 (NRW only hosts 2015 data). Specifically, it includes:
    - *Classification Status and Objectives for Surface Water Bodies in England* - This covers many attributes, including chemical, physical and biological assessments for each water body. It also lists future objectives for attributes.
    - *Reason for not achieving good* - This classification status and reasons for not achieving good status (RNAG) updated to the last Cycle (2015)

- **Measures** – (EA and NRW). These list activities planned to address significant management issues at national and local scale.

- **EA prosecutions** – (EA). This is a list information on prosecutions by the Environment Agency under its regulatory powers. Cases completed from January 2000 that resulted in a conviction are included.

- **Chalk Streams** – (EA). This comprises a list (with geographic attributes) of the Chalk Streams as defined by the EA. It include main rivers and some tributaries. An updated list from WWF has been also used.

- **Discharge and small sewage discharge regulation**[3] – (EA). This is a set of files that explicates rights and rules about sewage discharge

- **Sewage treatment regulation –** (EA). General binding rules about sewage treatments

- **8th UWWTD (Urban waste water treatment directive) report**[4] **–** Published in 2016. The eighth report, from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions, on the implementation status and the programmes for implementation (as required by article 17) of council directive 91/271/EEC concerning urban waste water. This document describes compliance results and status for all Member States.

- **Other published papers and reports -** A number of other papers, reports, notes and other sources has been used. Each reference has been clearly stated when utilised.

2.1 Data manipulation

The EA provides the datasets in either spreadsheet, shapefile or database format. Considering that the time span varies greatly amongst the different dataset, different timeframes have been selected and will be clearly indicated in the appropriate sections.

Further manipulation was required for most of the datasets for analysis purposes and consistency. In detail the main activities involve:

- **Obtaining Water body ID for all water bodies and Chalk Streams** – this is a unique water body reference used by EA and NRW for all their analysis.

- **Obtaining Easting and Northing Coordinates for most of the datasets** – EA and NRW provide British National Grid (BNG) Coordinates for most of its datasets. Each set has been converted to Easting and Northing coordinates using "The National Grid Converter" that is freely downloadable from https://digimap.edina.ac.uk/ . The pairs of coordinates obtained can be easily geocoded by a GIS into a data layer of points.

- **Merging and querying** – Most of the datasets contains separated set of information that can be linked through unique codes and/or piece of information. This operation is different for each dataset, however unique keys are indicated within the datasets themselves.

- **Shapefile manipulation** – Shapefiles obtained from sources have been cleaned, buffered and interpolated when deemed necessary for graphic purposes and easiness of use.

However, distribution and analysis of EA/NRW results have been conducted on original data without modification. Other maps have been created from location points, whenever original shapefiles were not available, such as location of discharges. Other have been constructed querying and merging information available in non-geographical formats, such as classification status. No information is freely available on waste water company boundaries. Waste water companies are not legally obliged to release this information, hence shapefile are not available. A Wastewater company shapefile has been created digitising available images

Original shapefiles used include:

- WFD Cycle 2 water bodies for EA and NRW
- River Basin District boundaries
- Urban wastewater treatments location

- **Heatmap** - Heatmaps have been produced with the Heatmap plugin in QGIS. Heatmaps are used to identify clusters where there is a high concentration of points. All the maps have been created with a Quartic (Biweight) kernel shape, which approximates a circular distance from the point. Choice of radius was of 10km. The urban wastewater treatment plant heatmap has been produced with the same process; however, points have been weighted by the amount of p.e. load entering the environment. This has been used to increase the influence of the p.e. load on the resultant heatmap. No other interpolation technique has been used.

- **Effluent type and Treatment type identification** – This includes the analysis, filtering and geo-localisation of different discharge types and treatment characteristics.

2.2 Operational Areas

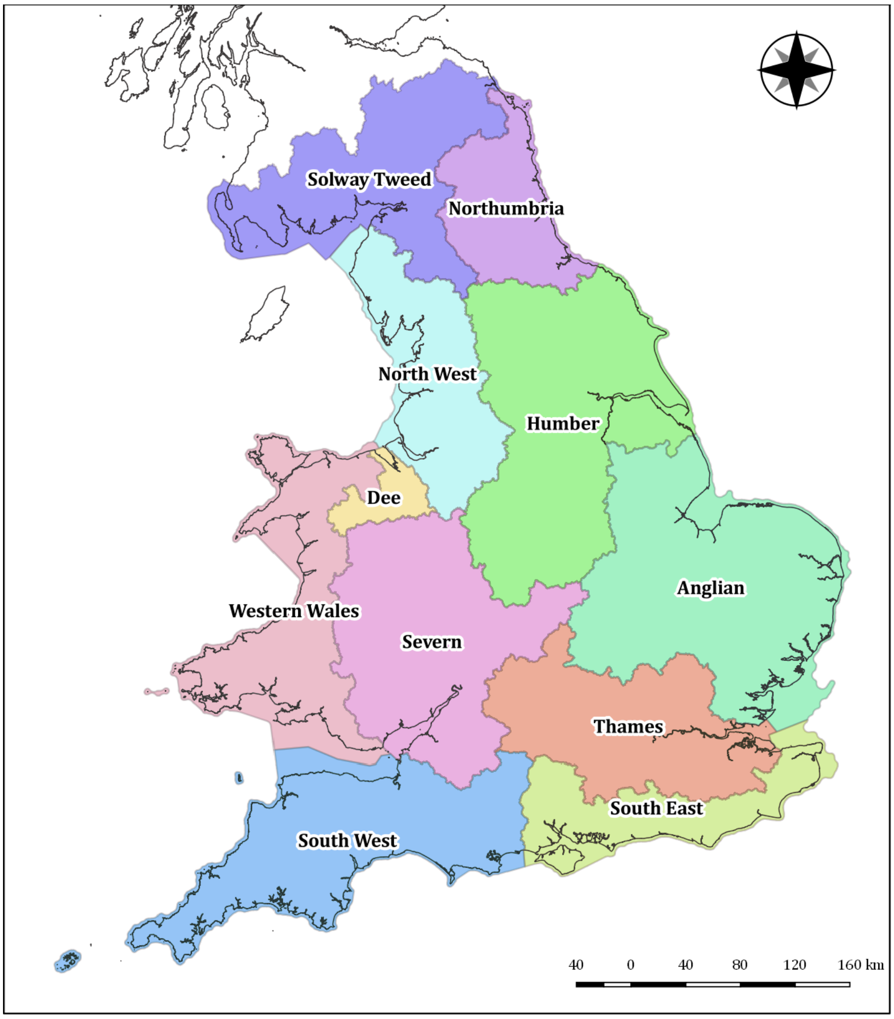
2.2.1 River Basin District

The EA and NRW manages surface waters based upon the River Basin District and catchments; data on all aspects of rivers are collected and collated on the basis of the river catchments which then feed in to the River Basin District Plans reported under the requirements of the Water Framework Directive.

Since the publications of the Water Framework Directive (WFD)[5], Member States have had to identify and create River Basin Districts (RBD) as standard operational areas for management of water bodies, groundwater and catchments. For each RBD a River Basin Management Plan (RBMP) is designed to protect and improve the quality of the water environment. Concurrently, a Catchment based approach (CaBa) is employed as a policy framework to encourage a wider but focused integrated approach to local decision making for support of RBMPs.

The current River Basin Districts in England and Wales are shown in the following figure. Districts are shaped based on consideration regarding natural conditions and geography; therefore, they do not necessarily fall within national boundaries.

Figure 1 England River Basin Districts



2.2.2 Operational Management

The EA and NRW operate and investigate water bodies and catchments on different resolution levels. All analysis and results are reported following a hierarchical structure. Figure 2 summarises the organisation of the operational level from largest to smallest. The EA changed its operating structure on 1 April 2014, moving from a 'region' to 'area' structure. However most of the datasets, such as pollution incidents, consented discharge and WFD reports, are still structured by region.

The different subdivision are shown in Figure 3 and Figure 4.

Figure 2 Diagram showing the hierarchy of River Basin Districts (RBD), management catchments (MC), operational catchments (OC), and water bodies (WB) - from EA website

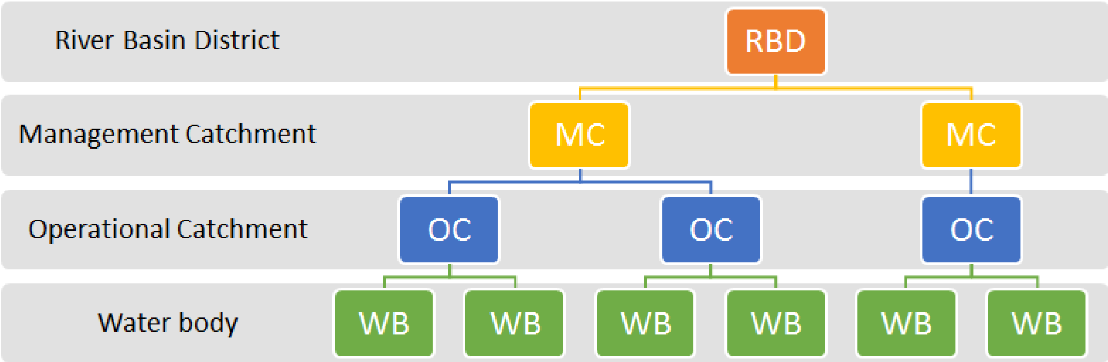


Figure 3 EA operational areas (SOURCE: EA website)

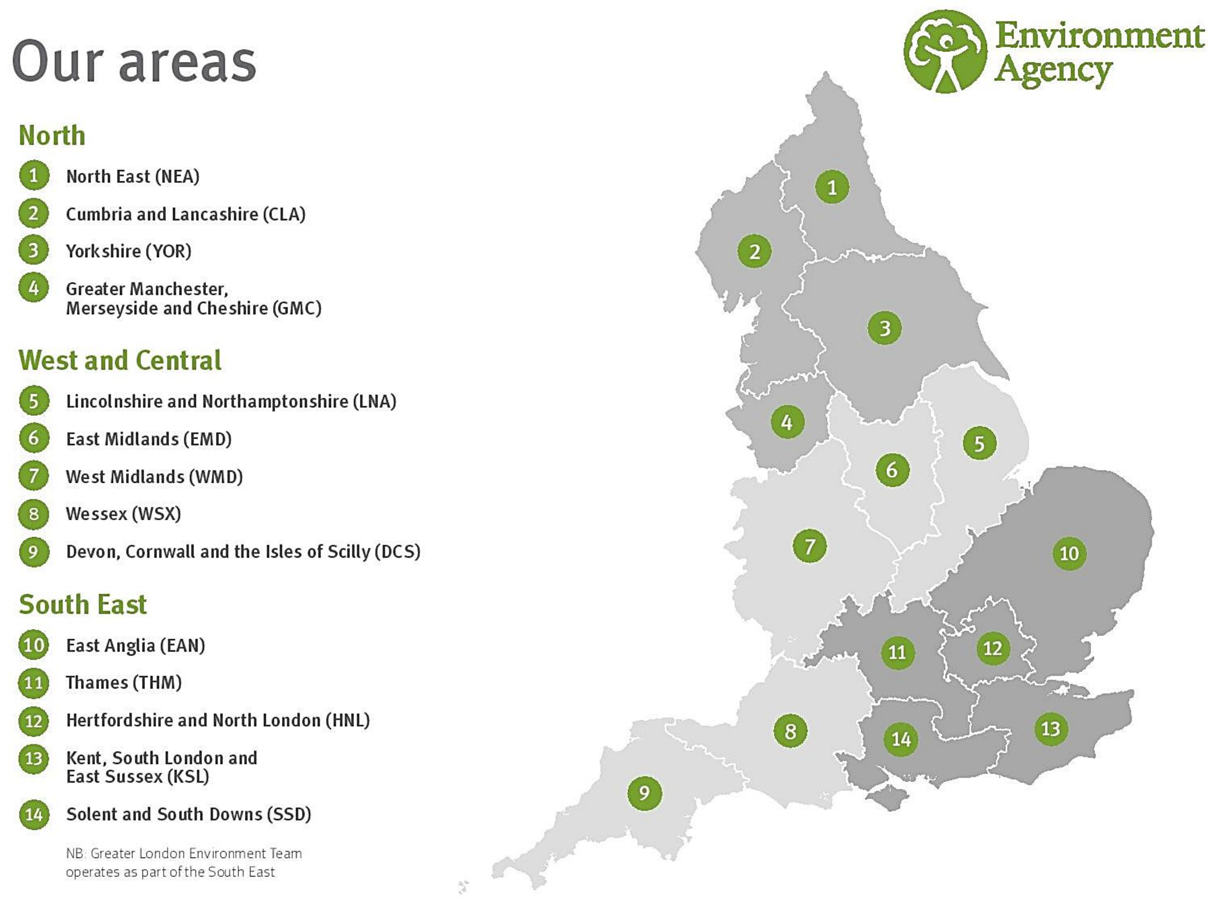


Figure 4 EA regions - used prior to 2014

3 Ecological status of water bodies in England & Wales Water

3.1 Water Framework Directive (WFD) Monitoring

The WFD is the primary legislative instrument for managing river water quality and sets the pathway for regulation which is the responsibility of the Environment Agency. The WFD is the main driver for the manner in which the EA monitors, collects and reports data on river water quality so a short description of the WFD context is a starting point.

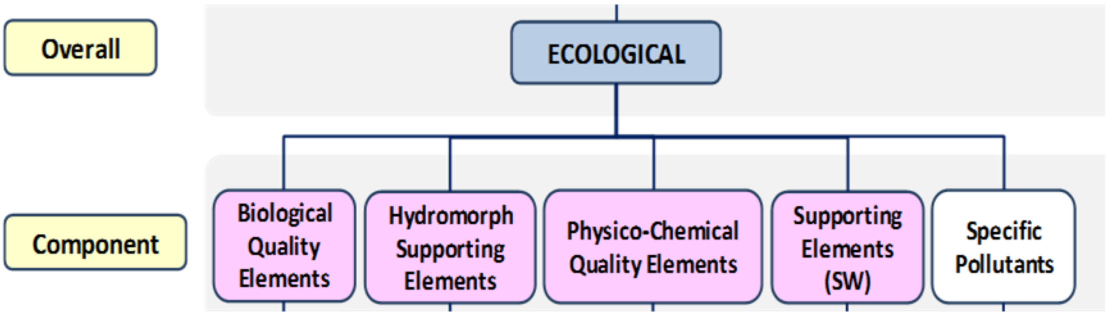
Article 8 of WFD sets out the requirements for the monitoring of surface water status, groundwater status and protected areas: "*Monitoring programmes are required to establish a coherent and comprehensive overview of water status within each river basin district*."

The Directive provides guidelines for the analysis of the ecological and chemical status of waters, including detailed monitoring methods. Surveillance monitoring requires Member States to monitor parameters covering of all biological, hydro-morphological and physico-chemical quality elements at least for a period of a year. Other pollutants would also need to be monitored if they are discharged in significant amount in the basin. Operational monitoring specifications require Member States to examine and monitor for biological and hydro-morphological quality elements most sensitive to the pressures to which the water body is subject[6].

As for ecological component of surface water bodies, the system follows a hierarchical process and includes the examination of different parameters (classification elements) (Figure 5), such as:

- Biological quality
- Hydromorphology
- Physical and Chemical elements
- Specific pollutant
- Supporting Elements (i.e. mitigation measures, expert judgment etc.)

Figure 5 Elements included in the analysis of ecological status of rivers



At the end of the process, classification elements receive a class level (Not Assessed, Bad, Poor, Moderate, Good, and High); for heavily modified and artificial water bodies (HMAWBs), where the water body is heavily impacted by anthropic activities, the classification assesses the "potential" status, this is because is recognised that physical modification have substantially altered the natural condition of that particular water body. Monitoring frequency is not the same for each water body and varies highly amongst them and for different years. It is also worth noting that not all the possible classification element are monitored in each water body, if no monitoring data are available previous results can be rolled over.

If part of a water body fails on any one of the criteria monitored, it will fail to achieve good status. This is defined as the "**one out all out**" approach.

The final goal set by the WFD was to reach good ecological status (GES) for all water bodies by 2015; however this has been extended as, for almost all Member States, the objective was not realistically achievable by the proposed deadline. The new extension allows States to postpone the deadline up to 2027 as a maximum.

3.2 Understanding the current situation

3.2.1 Ecological Status of Waters in England and Wales

The last cycle result published by Member State is Cycle 2, which covers data spanning from 2013 to 2015.

The relevant EA datasets that cover investigations and results for England water bodies from 2013 to 2015; and the NRW reports results for 2015 were compiled and Figure 6 summarises the results for England, while Figure 7 and Figure 8 show the overall ecological condition of surface waters and rivers in England and Wales as of 2015.

Figure 6 Ecological Status of England Water bodies - Cycle 2

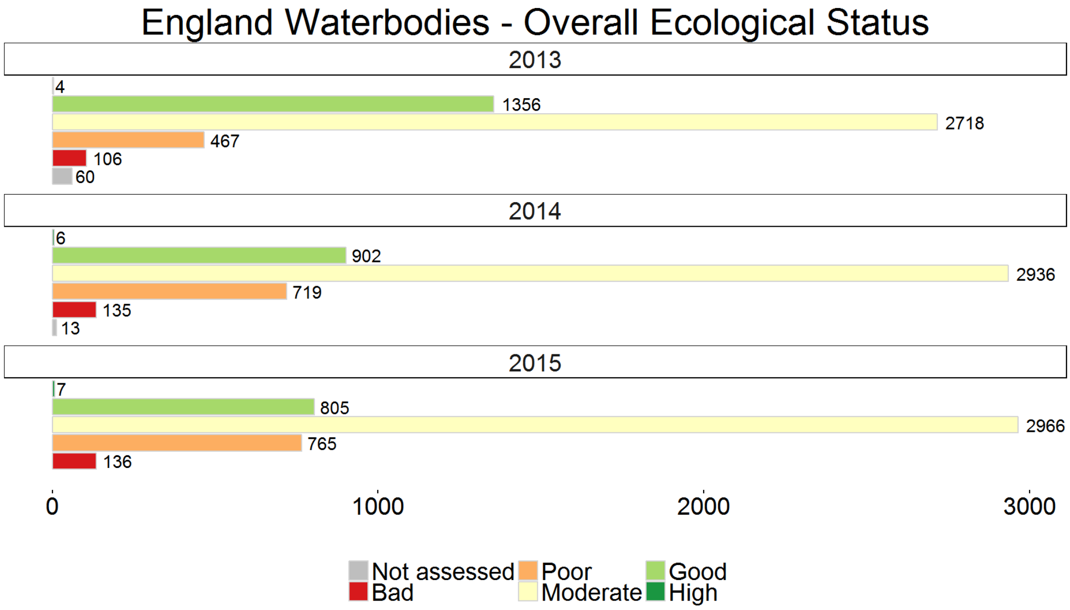


Figure 7 Ecological status of Surface Water bodies as of 2015 – Cycle 2

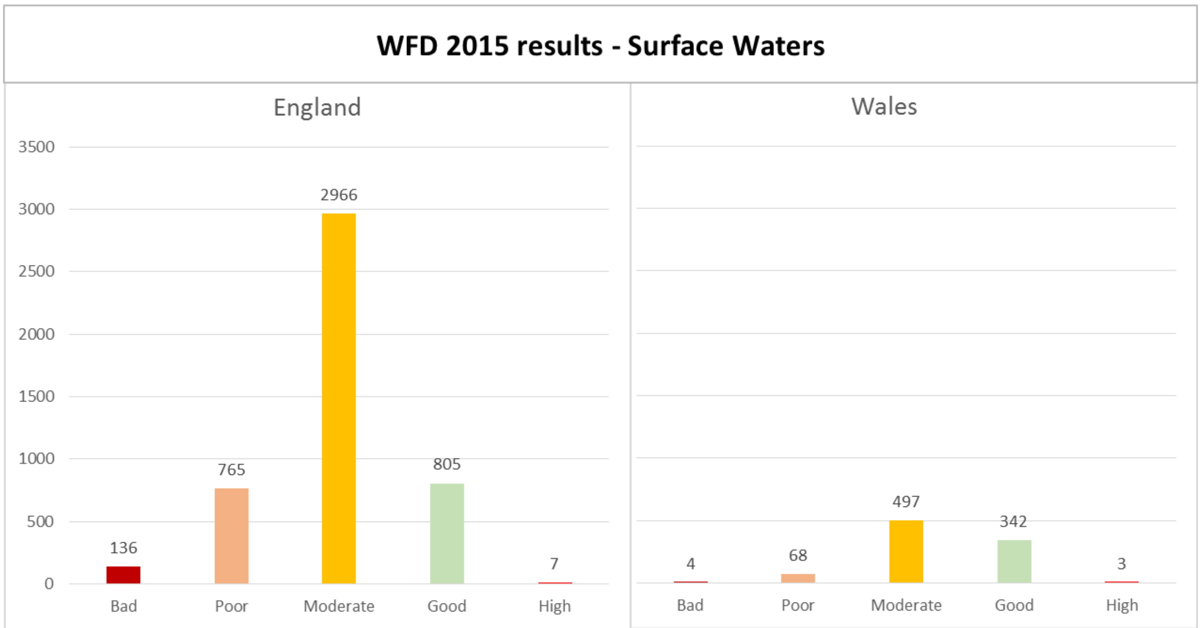


Figure 8 Ecological status of Rivers as of 2015 – Cycle 2

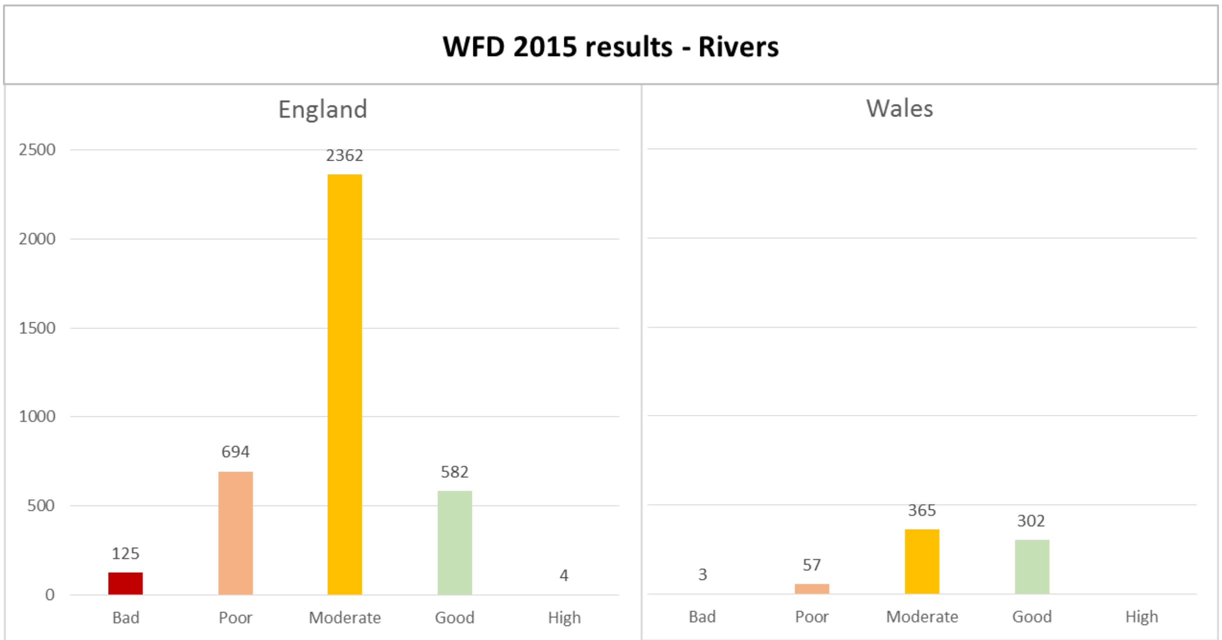


Table 1 Surface waters and rivers meeting good ecological status in 2015 (WFD 2015 - Cycle 2 results)

	Meeting good ecological status (WFD 2015 - Cycle 2)	
	All surface waters	**Rivers only**
England	17.35%	15.56%
Wales	37.75%	41.54%
England – Wales Combined	20.69%	19.76%

The results indicate that in 2013 in England, over 450 water bodies that were in good ecological status and that this number has declined to a lower classification in subsequent years. Concurrently, number of waters in bad, poor or moderate condition has increased. However, it is worth noting that number of waters and methodology has changed slightly during Cycle 2, with the tightening of assessment procedures by the statutory agencies and modification of number of waterbodies.

As of 2015 (Table 1 and Figure 7) the data indicates that, in England, only 17% of surface waterbodies meet at least the good ecological status, while the percentage is higher for Wales with around 38% of surface waters that have passed; hence between England and Wales only around 21% of the surface waterbodies have passed cycle 2.

Considering rivers only (Table 1 and Figure 8), the situation appears similar with around 16% of rivers that passed in England and 41% in Wales. Overall, only around 20% rivers were at good ecological status in 2015. Figure 9 highlights the situation in England and Wales at a catchment level.

Table 2 shows the situation at RBD level, confirming high proportion of water bodies failing for all England districts, with welsh RBDs showing better conditions (Solway tweed percentage considers only rivers analysed by the EA; therefore, it does not include Scottish catchments and water bodies). Further, in RBDs such as Humber, Thames and Severn, the number of waters in bad of poor conditions is quite high, meaning that they will likely need longer to reach good ecological status.

The general picture across the country is one of declining water quality in rivers. However, restructuring of number of waterbodies and tightening of assessment might have had a role in this.

Figure 9 Catchments that passed Cycle 2 for Ecological Class

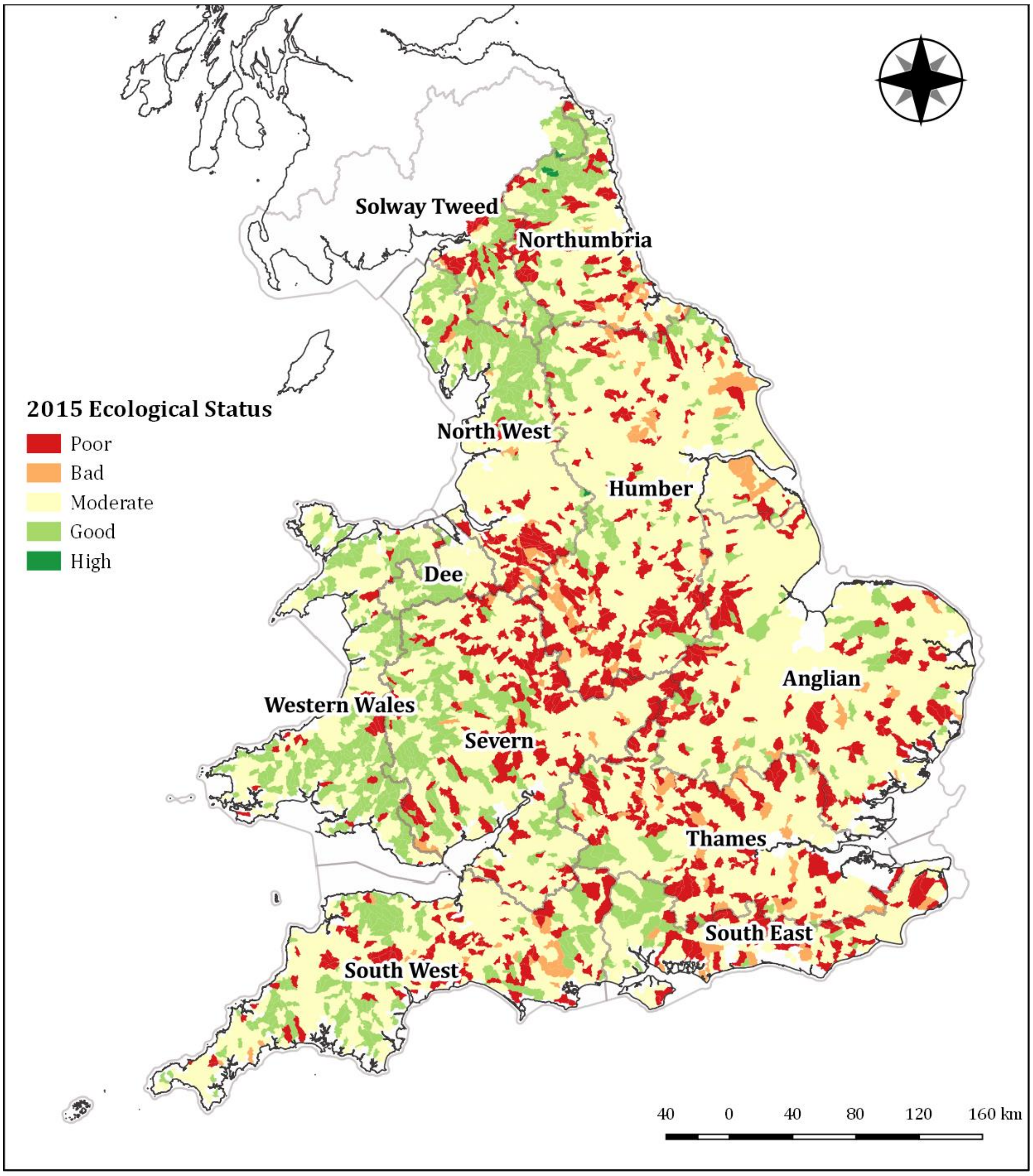


Table 2 Percentage of failed water bodies at RBD level

RBD	Bad	Poor	Moderate	Good	High	% failed
Anglian	13	106	419	65	0	89.22%
Dee	0	9	68	26	0	72.83%
Humber	32	136	671	148	0	85.01%
North West	12	63	405	131	2	78.30%
Northumbria	13	62	199	98	2	73.26%

Severn	8	134	462	151	0	80.16%
Solway Tweed	3	25	51	58	1	57.25%
South East	10	60	169	43	0	84.75%
South West	21	94	420	160	2	76.76%
Thames	27	112	320	39	0	92.17%
Western Wales	1	32	279	228	3	57.46%

3.3 Reasons For Not Achieving Good (RNAG)

3.3.1 RNAG Methodology

The EA and NRW provide the list of reasons that rivers do not achieve good status (RNAG), and for each failing elements (reason) where an activity (source of pressure) is identified as "certain" or "probable" as being the cause. Both organisations uses a set of characteristics to identify the main pressures and sector responsible in affecting the waters. The following table summarises the main attributes used to analyse the RNAG dataset.

Table 3 RNAG main attributes

Water Body ID	The unique identifier for each water body
Classification Item	The name of the item or element being classified (e.g. Fish)
Significant Water Management Issue (nSWMI)	The Significant Water Management Issue in that water body that will need to be addressed to achieve environmental objectives under the Water Framework Directive
National Significant Water Management Issue (nSWMI)	The 'National Significant Water Management Issue' field is a field created from the base data which allows users to group the nSWMIs into higher level summary groups.
Activity	More information on the (n)nSWMI i.e. source of pressures, such as Dairy/beef field, Surface water abstraction
Sector (level 1)	The sector responsible for the nSWMI (e.g. water industry)
Overall Pressure	This is derived from other pressure tiers to provide high level pressure groupings in order to create the Pressure v Sector analysis.

The analyses of pressures and impacts must consider how pressures develop and how they would be likely to develop in the future. This comprises an analysis of current and future policies, economic and technical factors and ultimately, is considered for the implementation of objectives and measures to achieve WFD requirements.

The nSWMI (national Significant Water Management Issues) is derived through the nSWMI Mapping Matrix, which is a list of activities and corresponding sector that impact on elements of the classification. The nSWMIs are "key themes" under which different reasons and activities fall, and help tackle down the main issues within the catchments (Table 4). NRW uses a similar approach; however, the mapping matrices are not reported. For consistency, the matrix has been used to analyses NRW dataset as well.

Table 4 National Significant Management Issues

nSWMI
Changes to the natural flow and levels of water
Natural conditions
Non-native invasive species
Other pressures
Physical modifications
Pollution from abandoned mines
Pollution from rural areas
Pollution from towns, cities and transport
Pollution from waste water
Suspect data
Unknown (pending investigation)

Overall pressure

The Overall Pressures are obtained via the Pressure Mapping Matrix, produced by the EA as a complementary resource for assessing pressures. The list highlights pressure-activities relationships, grouping "key pressures" affecting the catchments (Table 5).

Table 5 Overall Pressures

Overall Pressure
Abstraction and flow
Ammonia
Biochemical Oxygen Demand (BOD)
Chemicals
Dissolved oxygen (DO)
Fine sediment
Fish stocking
Invasive non-native species
Nitrate (DIN)
Organic pollution
Other
pH
Phosphate
Physical modification

Salinity
Temperature
Unknown (pending investigation)

The Overall Pressures matrix is useful to identify key pressure that affect river classification elements at scale that is different to the nSWMIs. This matrix has been produced because it has been recognised that some pressure may not fall under a single nSWMI (i.e. ammonia, which may be included in more than one nSWMI category).

For example: in the following case, the river stretch fails due to the Macrophytes "element", which is affected by both the wastewater system and agriculture activities. Phosphate is identified as a key pressure even though the "phosphate classification element" has not failed. This is likely due to the fact that the phosphate element has not been assessed during Cycle 2.

Table 6 Example dataset - Overall pressure affecting a different classification element

River	Classification element	Activity	nSWMI	Overall Pressure
Glen from Source to College Burn	Macrophytes and Phytobenthos Combined	Sewage discharge (continuous)	Pollution from waste water	Phosphate
Glen from Source to College Burn	Macrophytes and Phytobenthos Combined	Unsewered domestic sewage	Pollution from waste water	Phosphate
Glen from Source to College Burn	Macrophytes and Phytobenthos Combined	Agriculture - Arable	Mixed agricultural	Other

When analysing the potential risks for water bodies, both the nSWMI and Pressure matrices are ultimately employed by the EA to identify cross-cutting pressures and issues. Ultimately, understanding the RNAG at different resolutions is important to set out measures and objectives that would address the main issues within the catchments and for each river. The information retrieved from the analysis are than included in the RBMPs and shared with all the stakeholders involved.

It is important to note that:

- Many of the key nSWMI and pressures are complex and occur in combination,
- Often either the reasons for failure are unknown, or it is uncertain which activity is causing an impact.
- Because the classification methodology has changed, it now comprises a wider range of elements than the previous monitoring schemes.

3.4 Methodology employed to analyse the dataset

RNAG are listed each time an activity (or source of pressure) is deemed “certain”, “suspected” or “probable” cause of an element failing the good status. In reality, activities affect waters concurrently; it follows that a water body might have more reasons listed for each element and these reasons can fall under one or more key nSWMIs or Overall Pressure.

Following this implications, the analysis of the RNAG dataset can be undertaken by following two methods; these are:

- **Number of RNAG identified per each attribute** – These report how many RNAG are assignable to an attribute (e.g. nSWMI, activity, overall pressure). As a water body can be distressed by an nSWMI for more than one element (more activities affect the same element), this does not correspond to the number of rivers affected.

- **Number of rivers affected by each attribute** - This level of analysis reports whether the attribute (e.g. nSWMI, activity, overall pressure) appears as the reason for each water body failing at least once. The rationale behind is that if an attribute appears as reason for at least one element, by the “**one out, all out**” approach, the attribute is causing the river not to reach good ecological status. This approach is consistent with the methodology utilised by the EA and NRW when reporting figures for nSWMI in the updated RBMPs. The data has been analysed considering percentages related to failing waters and not all water bodies.

Over the next paragraphs an example of the different outputs achievable through the two methodologies is provided from the analysis of a small dataset of 3 rivers.

Table 7 Example RNAG dataset

Water Body Name	Classification Item	National Significant Water Management Issue	Activity
Wampool (Upper)	Fish	Pollution from rural areas	Dairy/beef field
Wampool (Upper)	Fish	Physical modifications	Land use - improved grassland
Wampool (Upper)	Phosphate	Pollution from rural areas	Dairy/beef field
Waver	Invertebrates	Pollution from rural areas	Dairy/beef field
Waver	Macrophytes and Phytobenthos Combined	Pollution from rural areas	Dairy/beef field
Wiza Beck	Fish	Pollution from rural areas	Dairy/beef field
Wiza Beck	Hydrological Regime	Physical modifications	Flood protection - water level management
Wiza Beck	Macrophytes and Phytobenthos Combined	Pollution from rural areas	Dairy/beef field
Wiza Beck	Mitigation Measures Assessment	Physical modifications	Other (not in list)
Wiza Beck	Phosphate	Pollution from rural areas	Dairy/beef field

Table 7 has been extracted from the RNAG dataset and reports three rivers with different element not achieving good, with corresponding nSWMI and causes for failure. It is evident in the case where one element might fail due to two nSWMI (e.g. fish element for Wampool Upper river fails as a result of two activities that are grouped into different nSWMIs).

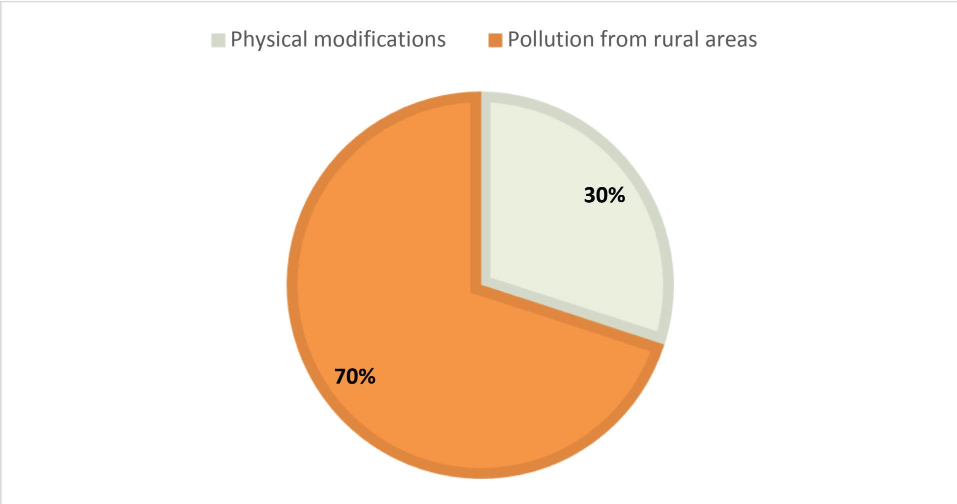
Number of RNAG identified per each nSWMI: Analysing the example dataset with this method, it could be reported that "*70% of the listed reasons for not achieving good are due to Pollution from rural areas, 30% are due to Physical Modifications*". This means that a high proportion of reasons are attributed to activities falling under these nSWMIs (including the ones where the nSWMI affects an element and/or a river more the once). It is not possible to perceive how many rivers are affected by the single nSWMI.

The figures are summarised below.

Table 8 Example dataset - Number of RNAG

	number of RNAG
Physical modifications	3
Pollution from rural areas	7
TOTAL number of RNAG	10

Figure 10 Example dataset - Percentages of reasons for not achieving good, broke down by nSWMI



Number of rivers affected by each nSWMI: Analysing the example dataset with this method, then the results reveal that pollution from rural areas appears (at least once) for all 3 rivers, while Physical modification appears (at least once) for only two rivers. It is possible, therefore to report that: "*2 out of 3 (66.67%) rivers are affected by Physical modifications and 3 out of 3 (100%) by Pollution from rural areas*".

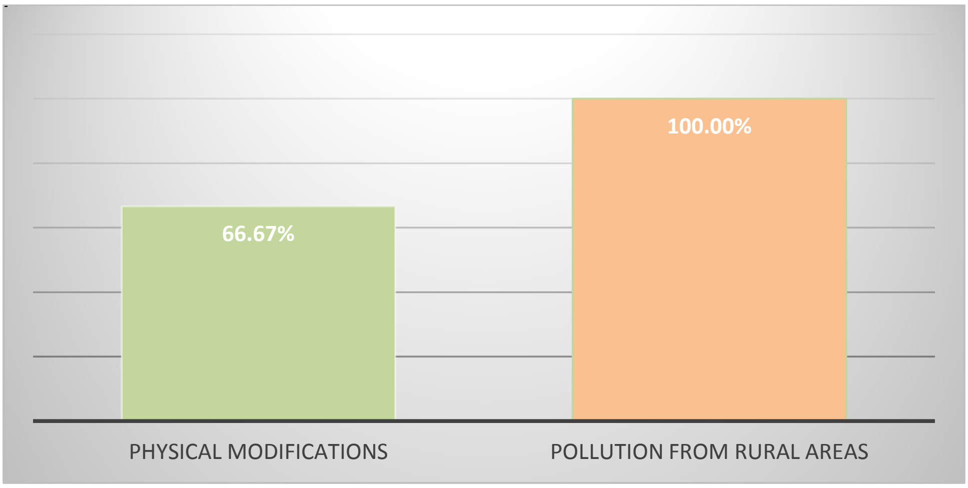
However it is not possible to observe how many causal elements are affected by each nSWMI. Also, it would be not viable to create a pie chart as the nSWMI affects the rivers concurrently and these causes are not mutually exclusive of each other.

The figures are summarised below.

Table 9 Example dataset - Number of river affected by nSWMI

	number of Waters affected	percentage of river affected
Physical modifications	2	66.67%
Pollution from rural areas	3	100.00%
TOTAL number of water bodies	3	

Figure 11 Example dataset - Percentages of failing rivers affected by a specific nSWMI



3.5 Pressures Analysis

3.5.1 National Significant Management Issues

The identification of an nSWMI helps tackling the most significant issues to be addressed, exploring planning measures and establishing realistic objectives. The RNAG dataset list reasons for 4,774 water bodies.

Figure 12, Figure 13 and Figure 14 summarise the nSWMIs identified in England and Wales during Cycle 2.

Figure 12 nSWMI pressure in England and Wales

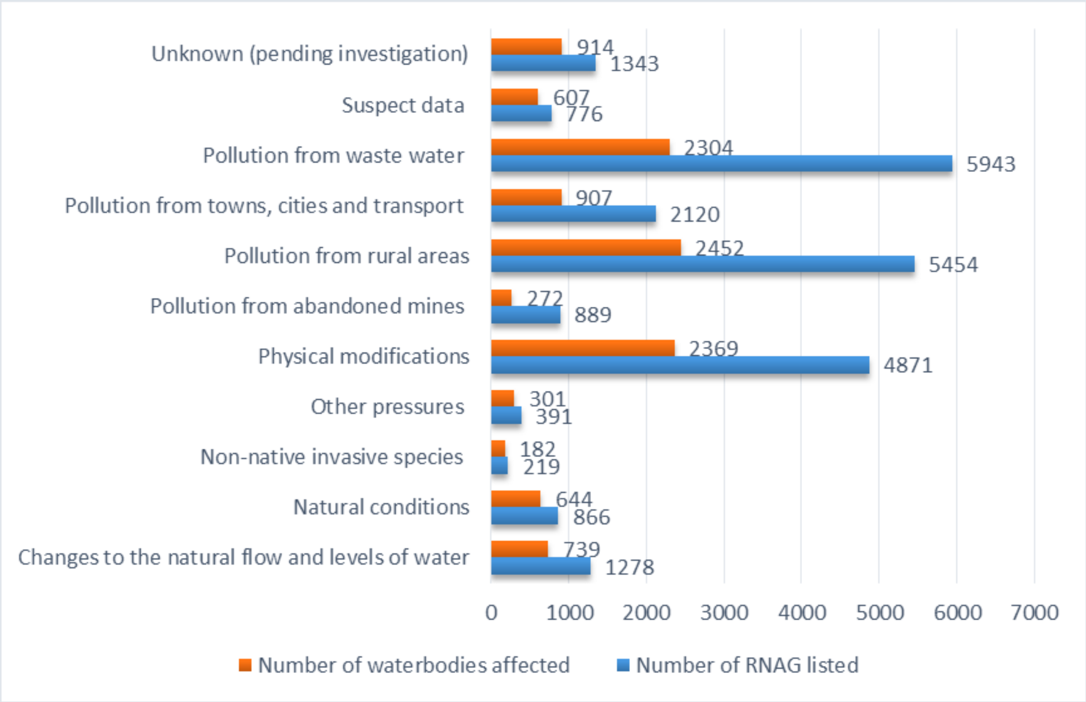


Figure 13 nSWMIs responsible for RNAG

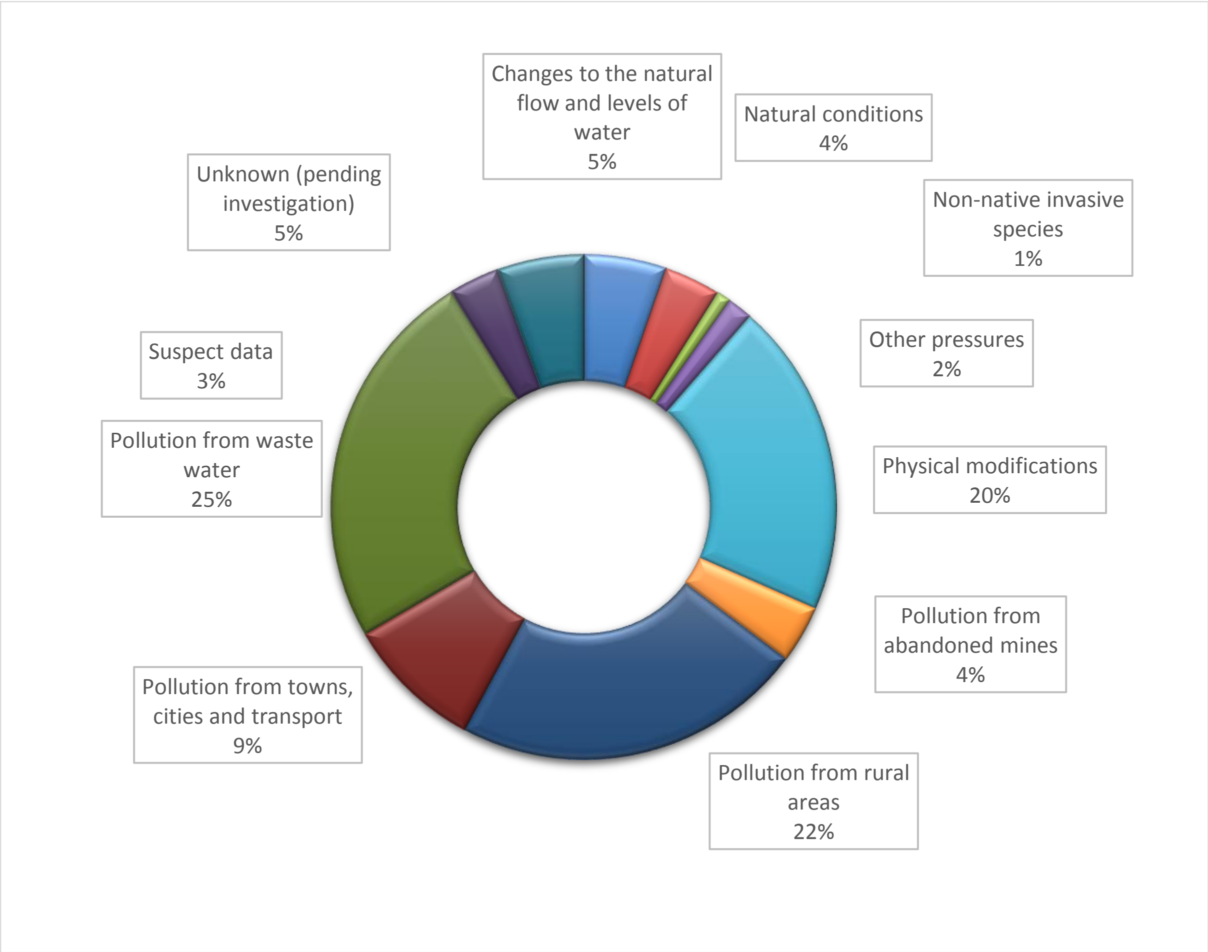
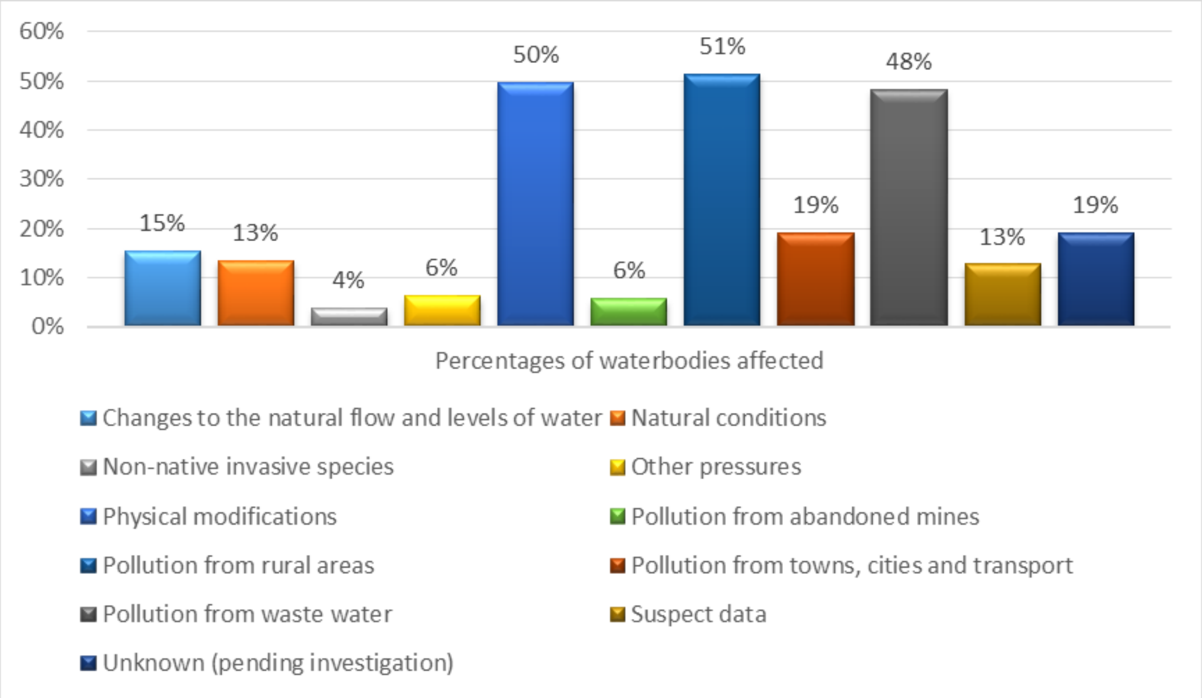


Figure 14 Percentages of failing water bodies affected by each nSWMI



From this the three main key management issues affecting the highest number of water bodies are

- Pollution from rural areas (affecting 51% of failing waters)
- Physical modification (50%).
- Pollution from Waste water (48%)

Concurrently, they also are responsible for the higher proportion of RNAG.

An overview of the main three nSWMI is presented below.

Physical Modification – Includes activities and/or artificial barriers and alterations that can cause changes to the natural conditions of a river, altering the flow, water level and habitats. This is the case of barriers and many other modifications to the natural course of a water body. These alterations have important impact on flora and fauna.

Pollution from Rural Areas – Includes activities that can cause changes to the amount of nutrients and chemical composition of a river. Pesticides and high concentration of nutrients due to fertiliser are common causes. This highly impacts freshwater flora and fauna, but can also affect humans.

Pollution from Waste water – Nutrients and pollutants from sewage and waste water can be highly concentrated and have a profound effect on the water environment. The concentration and quality of the waste water discharged into the water body will differ according to it treatments and sources. This nSWMI groups and includes different activities linked to the waste water sector, such us continuous sewage discharges from treatment works and intermittent sewage activities (i.e. combined sewage overflows (CSOs) and septic tanks).

3.5.2 Overall Pressures

When considering the overall pressure affecting water bodies, Phosphate is the pressure that impacts most of the waters (59% of failing waters and responsible for 35% of the RNAG), followed by Physical modifications (49% of failing waters and responsible for 19% of the RNAG).

Figure 15, Figure 16 and Figure 17 report the overall pressure impacting the failing rivers.

Figure 15 Overall Pressures in England and Wales

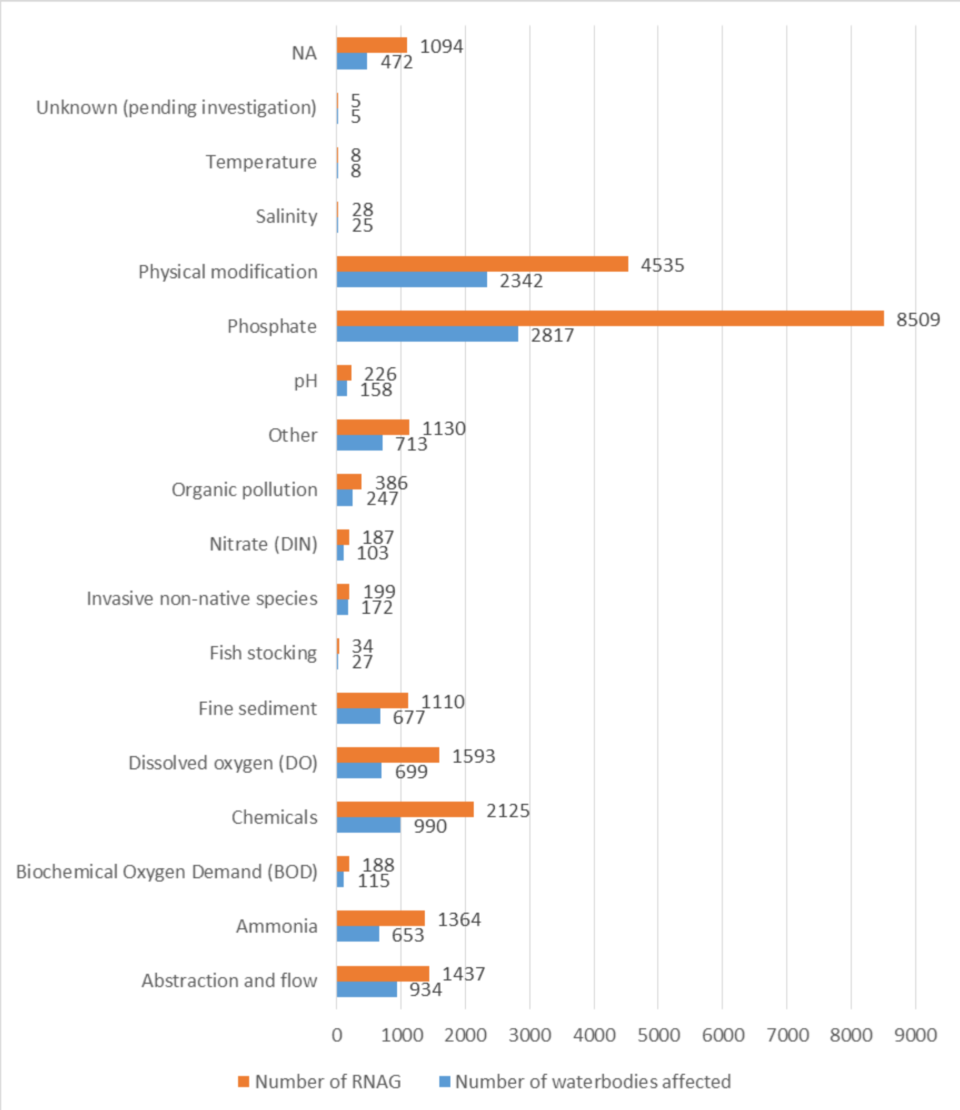


Figure 16 Overall activities responsible for RNAG

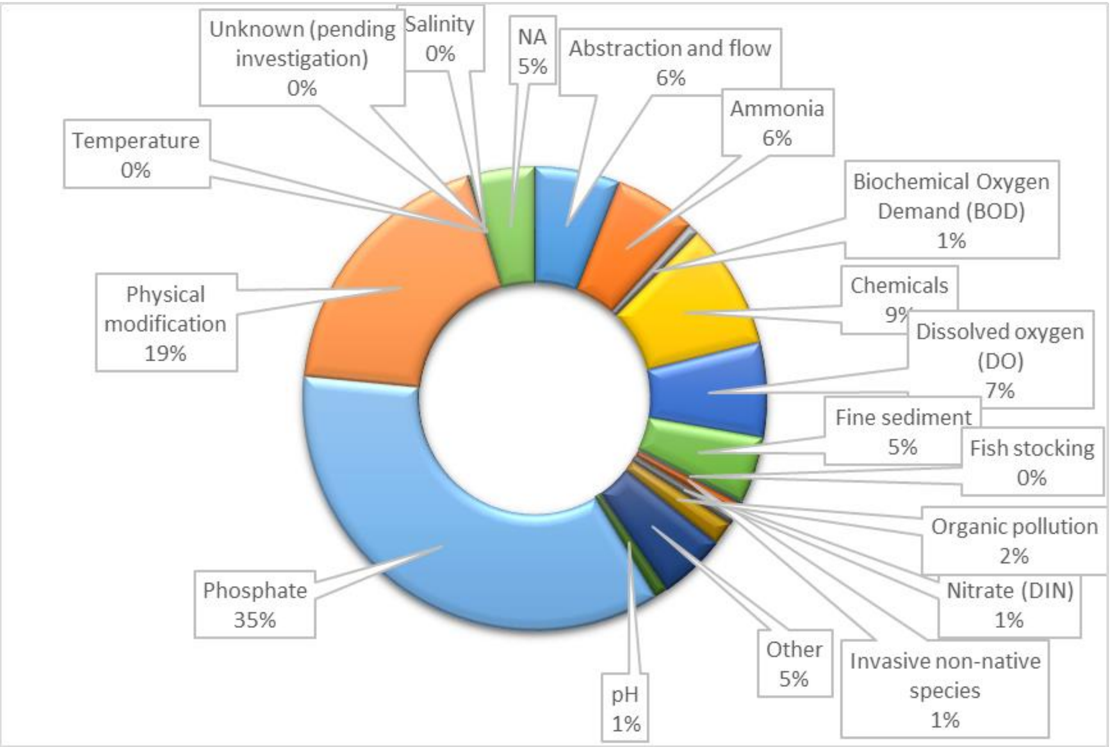
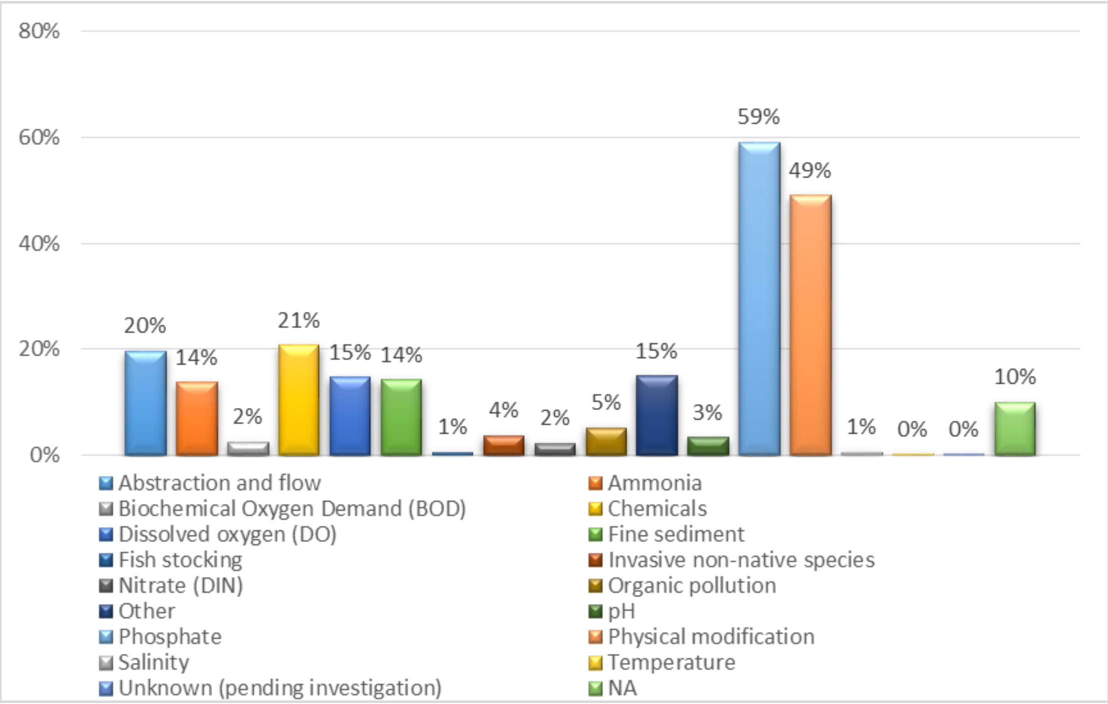


Figure 17 Percentages of failing water bodies affected by each Overall Pressure



Phosphate

The EA has devoted particular attention to phosphate, and phosphorus in general, as it can impact different elements. The Pressure Matrix reports that high phosphate levels can cause the following classification elements to not reach good status:

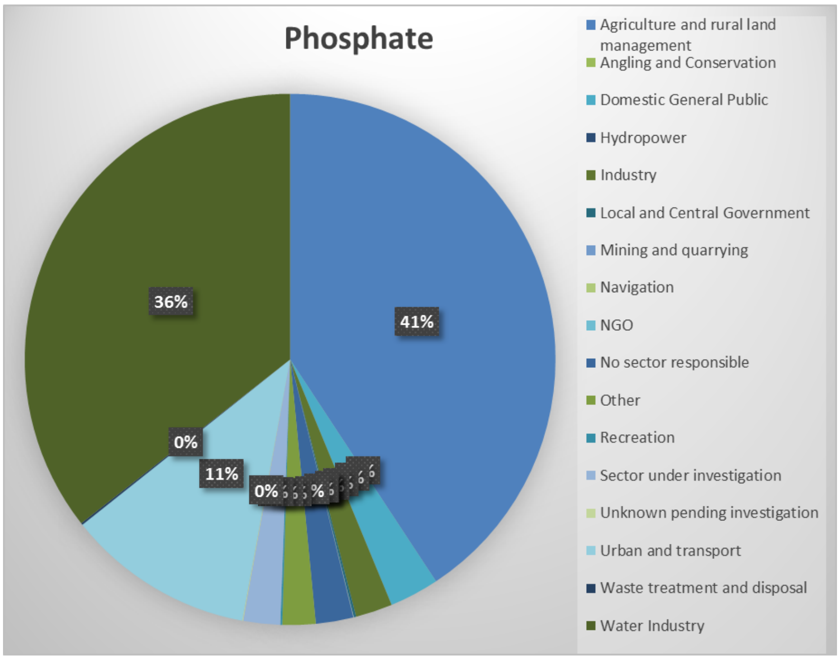
- Angiosperms
- Chironomids (CPET)
- Invertebrates
- littoral Invertebrates
- Macroalgae
- Macrophytes
- Macrophytes and Phytobenthos Combined
- Phosphate
- Phytobenthos
- Phytoplankton blooms
- Total Phosphorus

Phosphate can derive from different activities. When analysing the sector that are the main source of phosphate for number of RNAG, the dataset reports that:

- Agriculture and rural land management (41% of phosphate pressure RNAG)
- Water Industry (36%)

Nevertheless, considering the total phosphate load entering the waters instead of number of RNAG, the EA reports that loss of phosphorus to water bodies constitutes a very small (1-10%) percentage of the total applied on agricultural land, but still accounting for 20-30% of the phosphorus load in rivers. On the other side, waste water discharge from sewage treatment plants (STPs) is the highest source with 60-80% load contribution in England and 48% in Wales. Other minor sources include diffuse urban pollution (3%) and septic tanks and small containerised sewage treatment plants (3%)[7]; for further analysis on phosphate pressure refer to section 4.4.1.

Figure 18 Sector responsible for phosphate pressure



3.5.3 *Failing Elements*

Figure 19 and Figure 20 narrow down the classification elements that fail more often and the number of reasons listed for each. Other elements failing less frequently are not included in the figures. It is worth noting that not all elements are investigated by monitoring activities.

Phosphate is by far the elements that has failed the most with 2,290 water bodies failing for phosphate levels (and do not reach good status for 48% of failing waters), followed by Macrophytes and Phytobenthos combined (37%), Fish (30%) and Invertebrates (27%). Alongside, they have the highest number of RNAG listed, meaning that they fail because of multiple pressures.

Mitigation Measures Assessment is another element that does not reach good status for many water bodies (31% of failing water bodies). Under the European Water Framework Directive, Mitigation measures are defined as practicable steps that can be taken to mitigate adverse impact from human activities; the index is used only for heavily modified or artificial water bodies (HMAWBs).

Figure 19 Most frequent failing elements and number of RNAG for each

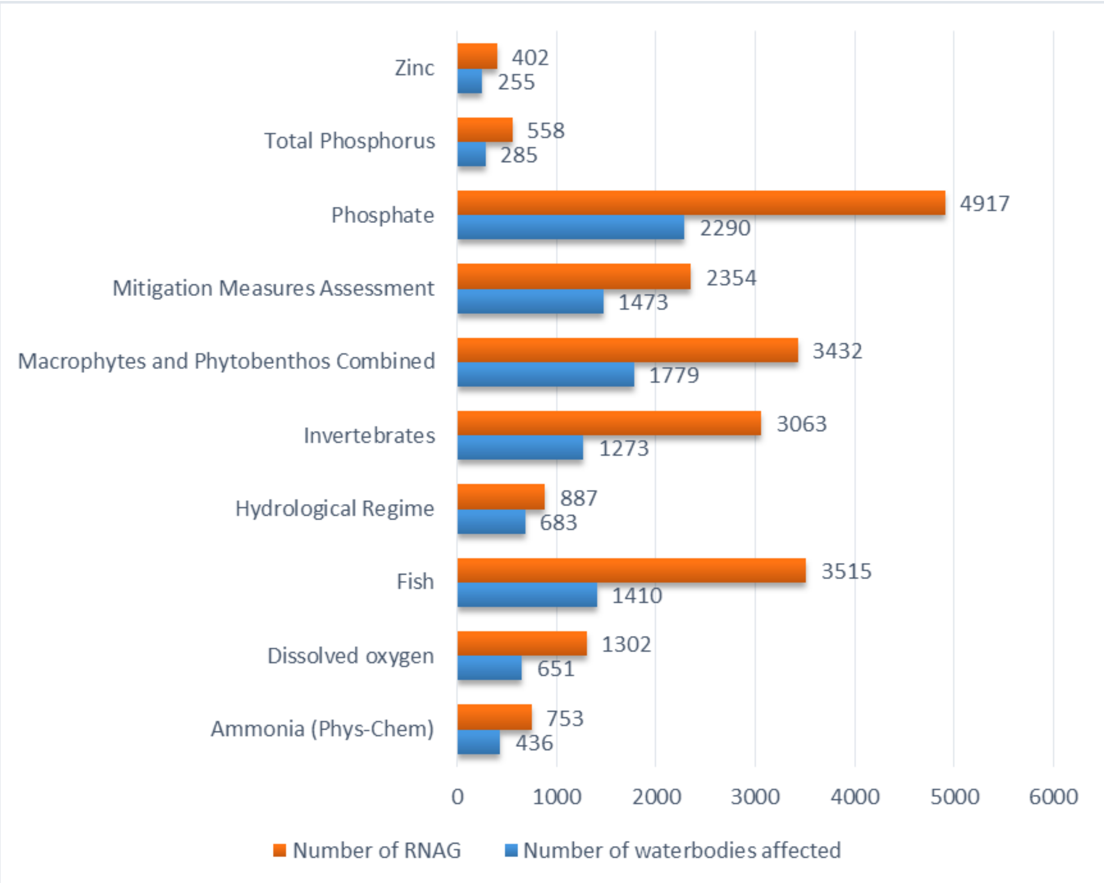
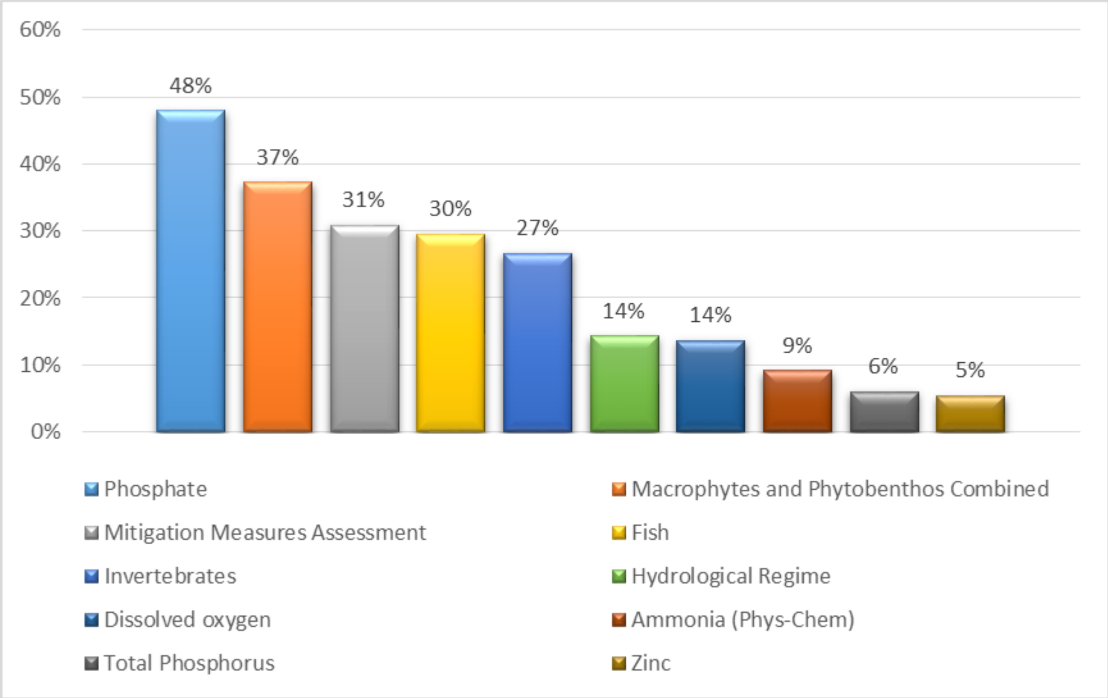


Figure 20 Elements not reaching good status in failing water bodies



3.6 Overall state of water bodies in England and Wales

The analysis of the WFD results shows that there has been a decrease of water bodies in good ecological status between 2013 and 2015; while the water bodies in poor or bad condition have slightly decreased, with some achieving moderate status in 2015.

As of 2015, the data indicates that the situation in England is worse than in Wales, with only 17% of water bodies meeting good ecological status, in contrast with around one third of the surface waters for Wales. RBDs such as Humber, Severn and Thames show a higher number of waters in poor of bad ecological status than other RBDs.

Overall, the figures show a quite challenging situation, with multiple pressure affecting the water bodies at the same time.

The three main key management/pollution and reason for failure issues affecting the highest number of waters are:

- Pollution from rural areas (affecting 51% of failing waters and causing 25% of the RNAG)
- Physical modification (affecting 50% of failing waters and causing 20% of the RNAG).
- Pollution from Waste water (affecting 48% of failing waters and causing 20% of the RNAG)

As for overall pressures, Phosphate is considered the pressures that impacts most of the waters (59% of failing waters and responsible for 35% of the RNAG), followed by Physical modifications (49% of failing waters and responsible for 19% of the RNAG).

Phosphate is also the classification element that has failed the most with 2290 water bodies failing for phosphate levels (does not reach good status for 48% of failing waters).

4 Pollution from wastewater

From the previous sections it can be seen that water quality pollution contributes to approximately 48% of water body failures to achieve “good ecological status”. This section now considers in depth the impacts of sewage pollution on rivers.

4.1 The waste water system

4.1.1 Overview

Regulation

The Urban Waste water Directive[8] regulates urban waste water discharges, commonly referred to as sewage, and discharges from certain industrial sectors. This comprises the collection, treatment and discharge of:

- Domestic waste water
- Mixture of waste water
- Waste water from certain industrial sectors

Collection of these discharges can be intermittent or continuous, due to the different nature of the sources, which are:

- Treated effluent from urban sewage treatment plants (continuous) ;
- Combined sewer and emergency overflows from sewerage systems (intermittent) ;
- Septic tanks (intermittent) ;
- Storm discharges from urban sewage treatment plants (intermittent) ;
- Crude sewage discharges at some coastal locations (continuous).

In 2011 the Water Industry (Schemes for Adoption of Private Sewers) Regulations[9] became law, assigning the responsibility and maintenance of private sewers connected to the public sewer network to water and sewerage companies. In England and Wales, 10 waste water companies are responsible of the sewage system.

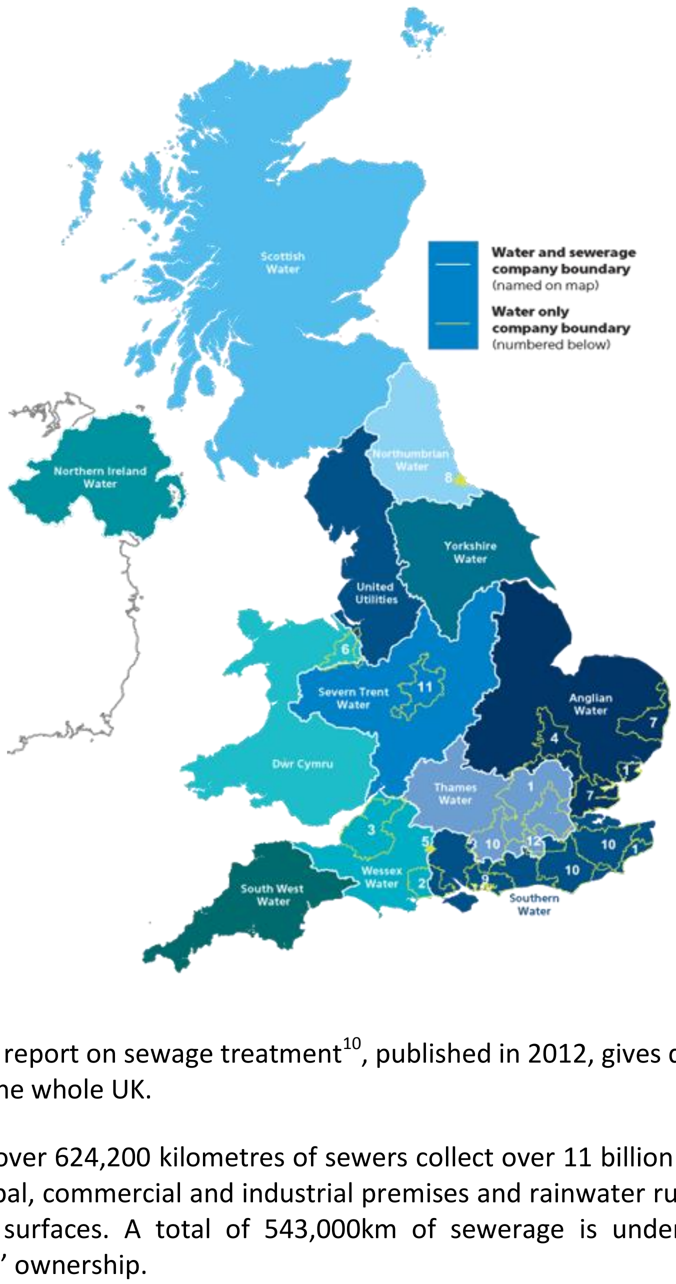
The map for England and Wales waste water companies has been produced working on two base maps available:

- The wastewater companies map published on the WaterUK webpage at the following link http://www.water.org.uk/consumers/find-your-supplier

- The Water Management Boundaries provided by the EA on the government website. These boundaries (areawm_10k) align to catchment boundaries. They are developed by hydrological modelling of catchments using a 10k river network and the NextMap DTM. Some discrepancies occur where small changes have been made to a boundary for operational reasons, such as to ensure some sites are contained within one area/region. Water Management boundaries reflect the way the Environment Agency was divided for operational purposes.

The EA map has been used as main base to get the boundaries for all the waste water companies. Boundaries have been modified in correspondence of Severn Trent Water - Welsh Water border and Thames Water – Southern Water border mainly. This has been done digitising the WaterUK map and re-drawing them. Due to the poor resolution of the original map, the boundaries have to be considered to contain a degree of error. Wastewater companies' boundaries have been used in maps throughout the report. The following figure show the original image used to digitise the boundaries.

Figure 21 Waste water companies in the UK. Source: WaterUK



The last government report on sewage treatment[10], published in 2012, gives details about the new system referring to the whole UK.

Every day in the UK over 624,200 kilometres of sewers collect over 11 billion litres of waste water from homes, municipal, commercial and industrial premises and rainwater run-off from roads and other impermeable surfaces. A total of 543,000km of sewerage is under English and Welsh sewerage companies' ownership.

Wastewater generally comprises a mixture of wastes from domestic sources (toilets, sinks, baths, washing machine etc.), wastewater from industry and rainwater run-off from roads and surfaces. The impacts of untreated or poorly treated waste water is strongly governed by its chemical composition, which is usually quite heterogeneous and depends on the nature of activity that produced the waste.

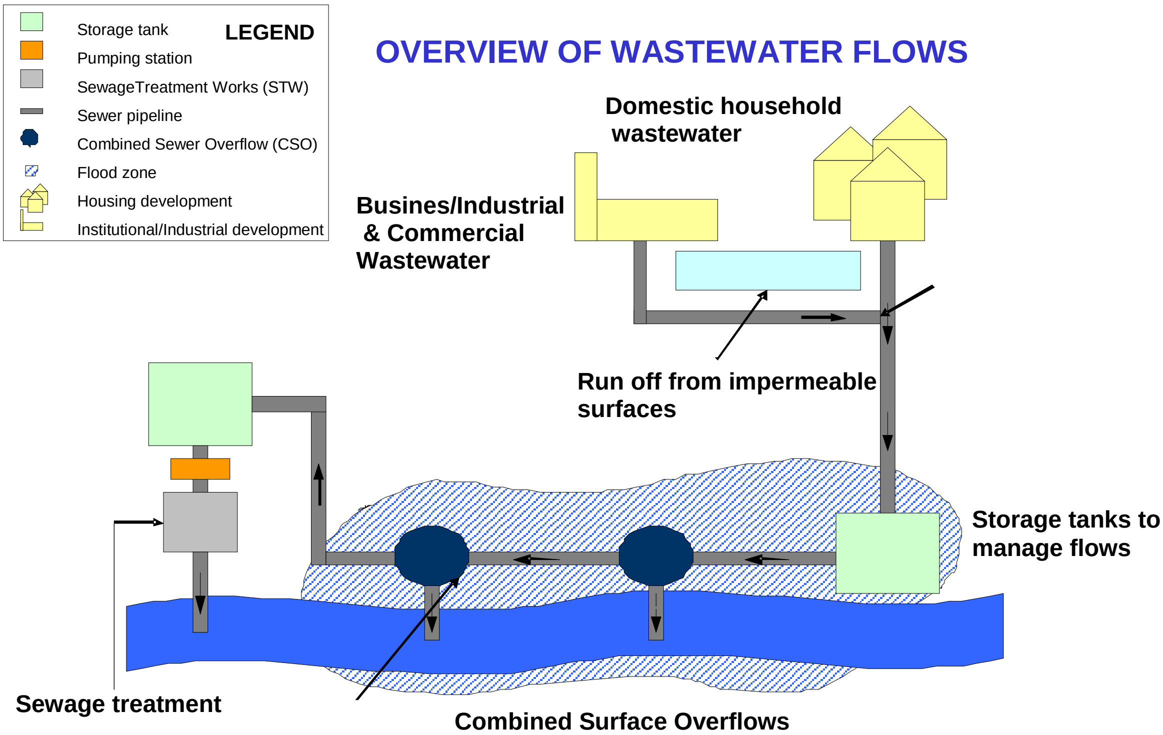
- **Oxygen depletion due to high organic matter**. This can potentially kill fish and other aquatic wildlife.

- **Eutrophication occurrences**. The nutrients discharged encourage algae populations to grow exponentially, asphyxiating wildlife. Some algae species are potentially toxic too. Eutrophic waters require expensive treatment of water abstracted for industrial or domestic use.

- Some toxic substances from industry, households and road run-off in the sewage do not degrade and can accumulate within the trophic chain (**bioaccumulation**).

- **Sewage-related debris**. Physically waste water usually comprises of around 0.1% of solid material: if the solid content is significant it can affect the flow conditions, altering also the amenity value of rivers and beaches. It can also cause damage at treatment works.

- **Bacteria and viruses.** Pathogens in the sewage can cause health problems, can also affect water-related activities and sports.



4.1.2 Discharge Consents

Discharge consents are issued by the EA following a request by a company or an individual and are assessed following the Environmental Permitting Regulations (EPR), which sets the guidelines for discharge into the environment. One consents can relate to multiple discharge within the same site, such as consenting a sewage treatment work final treated effluent plus a storm tank).

For discharge of wastewater, the legislation states that:

"You may need an environmental permit if you discharge liquid effluent or waste water (poisonous, noxious or polluting matter, waste matter, or trade or sewage effluent):

- *into surface waters, for example, rivers, streams, estuaries, lakes, canals or coastal waters (known as water discharge activities)*
- *onto or into the ground, for example, land spreading waste sheep dip, or discharging treated sewage effluent to ground via an infiltration system (known as groundwater activities)*

You need to apply to the Environment Agency for a permit for any standalone water discharge or groundwater activity - standalone means the activity isn't part of a waste operation, installation or mining waste operation".

You don't need a permit:

- *to discharge uncontaminated water, for example, clean rainwater from roofs or small areas of hardstanding to surface water*
- *to discharge uncontaminated water collected from public roads and small parking areas (that's been through a maintained oil separator or sustainable urban drainage system) to surface water*
- *for certain low-risk groundwater activities, known as groundwater activity exclusions*

If any part of the building your treatment plant serves is within 30 metres of a public sewer, the Environment Agency will not allow you to start a new discharge from a sewage treatment plant under the general binding rules.

If you are building a development of more than one property, this distance must be multiplied by the number of properties, e.g. if there are 3 properties then the distance will be 3 x 30 metres = 90 metres.

Standard permits: Standard permits are issued as follows:

"You may be able to apply for a standard rules permit if you operate a package treatment plant for secondary treatment of domestic sewage. Your package treatment plant must discharge between 5 and 20 cubic metres of domestic treated sewage to surface water daily (for example, your plant treats sewage from a small hotel or bed and breakfast, not a single household). If your sewage discharge is less than 5 cubic metres per day and you meet the general binding rules, you do not need a permit".

Different limits are sets for activities such as:

- septic tanks, cesspools or small sewage treatment plants unless you have a package treatment plant and meet the requirements of the standard rules permit
- open-loop heat pump systems
- dewatering building sites and other excavations
- discharging substances as part of a groundwater tracer test or remediation scheme
- cutting vegetation in or near inland freshwaters

Bespoke permits: Bespoke permit can be issued for activities not included in the list above and other particular circumstances. A risk assessment may be required if applying for a bespoke permit that includes discharging hazardous pollutants to surface water. Under the regulation the individual (or company) applying for a permit must do a risk assessment if wants to apply for or change (vary) a bespoke permit. However, the EA states that "*For permits for continuous water discharge activities to inland rivers, you may do the assessment yourself, but if you prefer you can provide us with the details of the discharge you wish to make, and we may be able to do the assessment for you. [...]As a general rule, we cannot undertake assessments of discharges to estuarine or coastal waters on your behalf, but we can offer advice as to what needs to be done. If you do not have the skills to do this yourself, then you will need to engage a consultant to advise you and to undertake the assessment. For intermittent discharges of storm sewage we can advise what assessment work needs to be done, but where sewerage or environmental impact modelling is required, we are unable to undertake this work on your behalf*".

Discharge consent analysis

The Consent discharge dataset published by the EA holds information about permit holders, issue dates, eventual revocation dates, effluent types, treatment type and geographical info. The dataset covers only England discharges. NRW has not yet published its data. In analysing the dataset, some descriptors have been grouped together by sector. It is also worth noting that a permit can authorise more than a single effluent, this has been considered when analysing the number of discharges (effluents).

Breaking down the type of permits by sector, the dataset reports that the highest proportion of consents is issued for sewage discharges, with water companies sewage discharges accounting for 22.1% of the effluents and permit issued to other entities (non-water-company) accounting for 69.6%. This is due to the high number of discharge requested by activities such as mixed farming, single and mixed domestic properties with small treatment package plants which all require single permits and can discharge into more than one effluent.

Figure 22 % number of Discharge Consents by sector

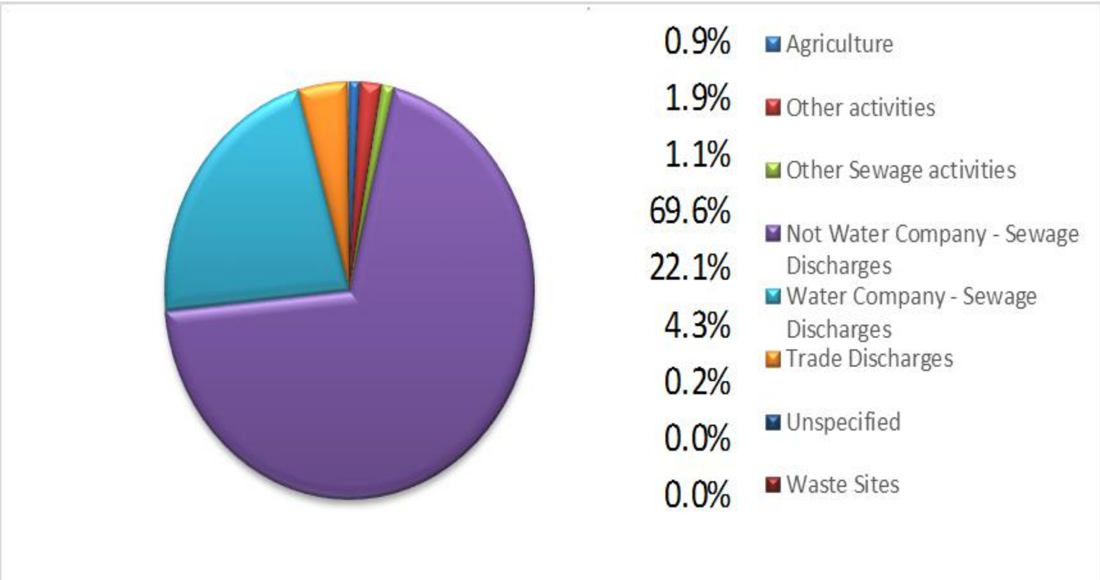


Figure 23 analyses the date of issue of consents, including modification of previous consents. Starting from the early eighties, a high number of permits for sewage discharges were issued to non-water-company businesses and/ or individuals, with a peak in 2012, before dropping in the subsequent years. Consents to water companies started growing more or less in the same period, peaking in 2010, when The Environmental Permitting Regulations was published, restructuring the regulation around discharges into the environment.

Analysing the last two decades in details, it can be seen that a proportion of these consents comprises historic consents issued before 1991 that have been re-issued after being re-evaluated and revised (Figure 24). On the contrary, the highest proportion consists of new and modified consents that are dispensed following the Water Resource Act published in 1991 (WRA 91) and the Environmental Permitting Regulation in 2010 (EPR 2010).

Figure 23 Issue Dates of Consented Discharges

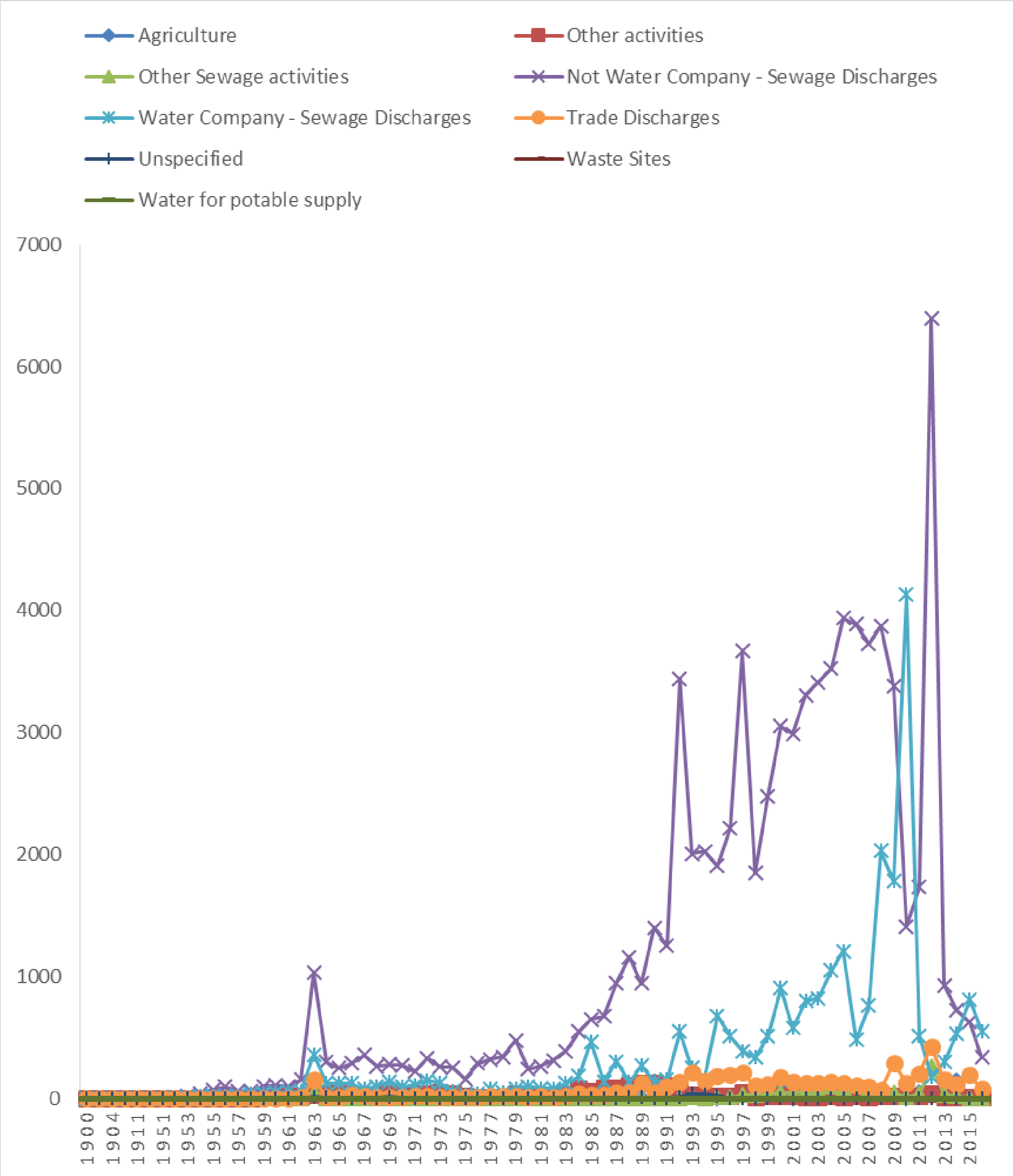
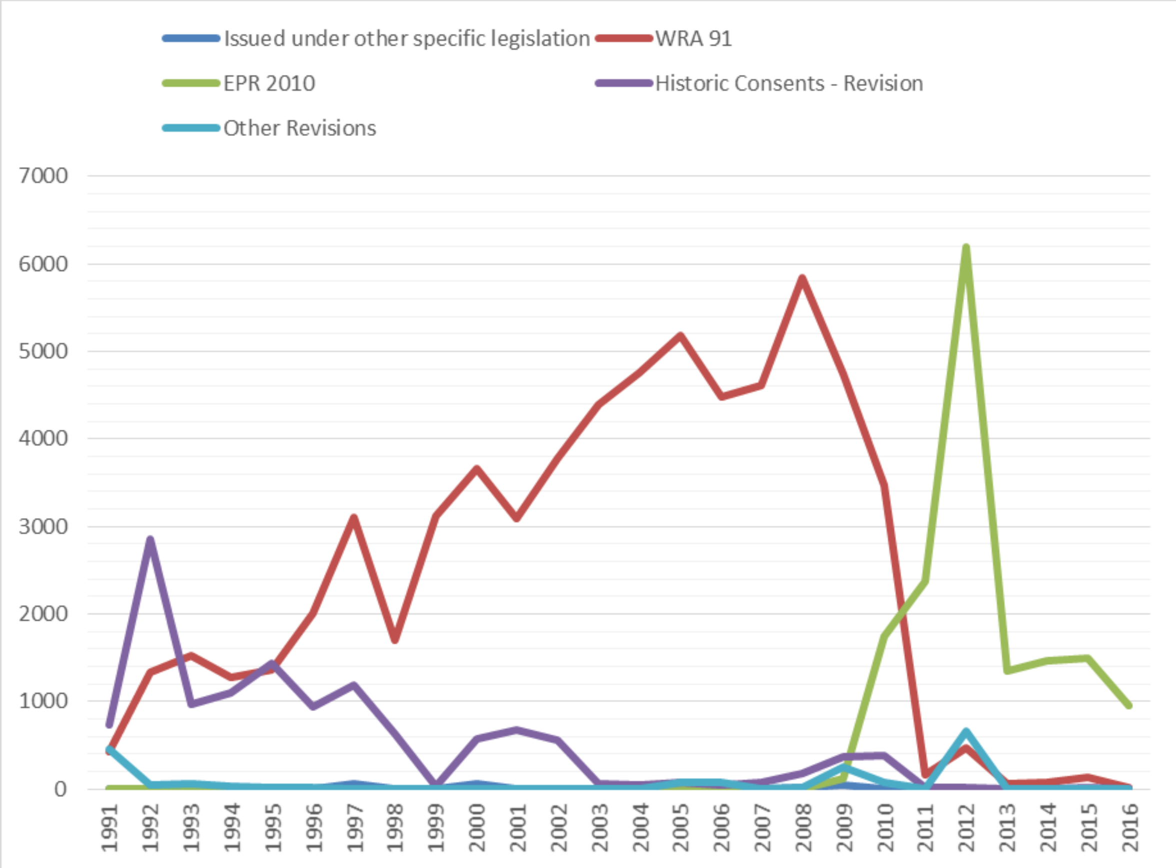
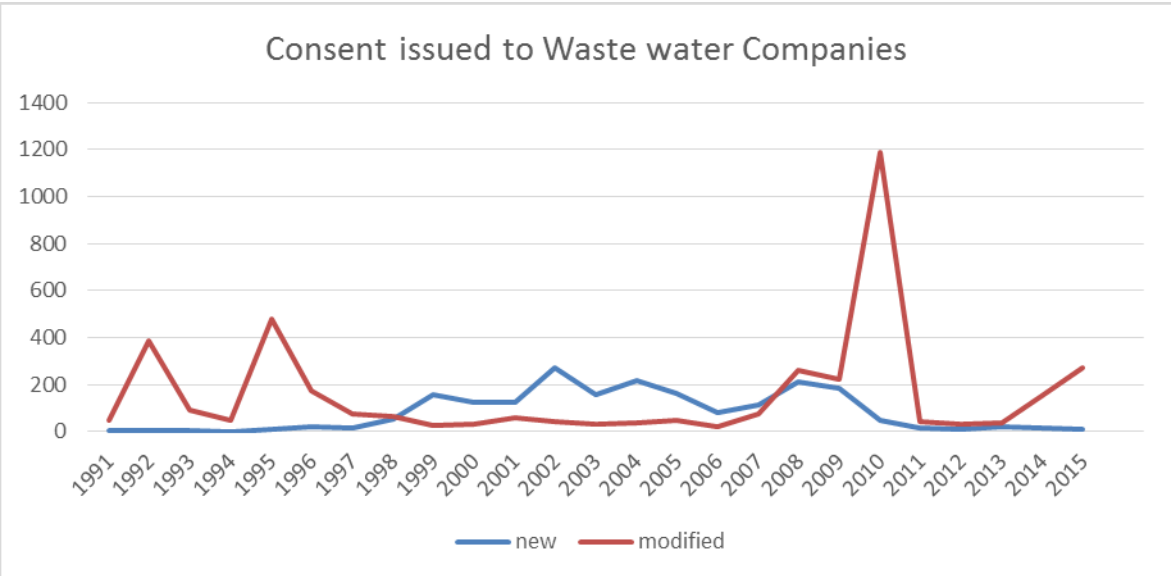


Figure 24 Consents issued since 1991



Breaking down the number of consents issued to only waste water companies from 1991, the following figure follow the same trend, with many consents modified around 2010. New consents are more limited in number.

Figure 25 Consents issued to Waste water companies (1991-2015)



4.1.3 Discharge Treatments

Wastewater treatment plants need to have sufficient capacity to deal with such weather. They also need to cater for seasonal changes in the organic load they receive for treatment, for example, to cater for increases in the populations of seaside towns, capital cities and other tourist destinations during holiday seasons. At such times treatment processes may need to be optimised to deal with variations in organic load concentrations associated with seasonal population changes.

The heterogeneity of the source is reflected by the chemical and physical composition of the different Waste water. This means that several treatments are required in order to release back the Waste water into the environment without danger of pollution.

Treatments comprise:

- **None** - this is the case of crude sewage, which is released into the environment as it is;

- **Preliminary** - physical treatments, such as screening and/or maceration, to remove solid matter;
- **Primary** - other physical treatments, such as settling, which help to remove suspended solids. These actions are useful to reduce BOD, suspended solids, and chemical compounds containing nitrogen and/or phosphorus ;
- **Secondary** - biological treatment to reduce the organic matter content. These further reduce BOD, suspended solids, nitrogen and phosphorus from the untreated sewage.
- **Tertiary** – combination of other treatments (UV radiation, nutrient reduction, etc.), to reduce the load of microorganisms in the effluent.

The breakdown for the whole UK as reported by the 2012 dataset is:

- primary treatment - 4
- secondary treatment - 1797
- tertiary treatment - 96

One consequence of sewage treatment is that significant quantities of sewage sludge are generated. Sewage sludge is the residual organic matter and dead bacteria used in the treatment process. This semisolid substance concentrates heavy metals and organic compounds that are poorly biodegradable, as well as potentially pathogenic organisms (viruses, bacteria etc.). However, nutrients such as nitrogen and phosphorous and other organic matter can be useful as a fertiliser.

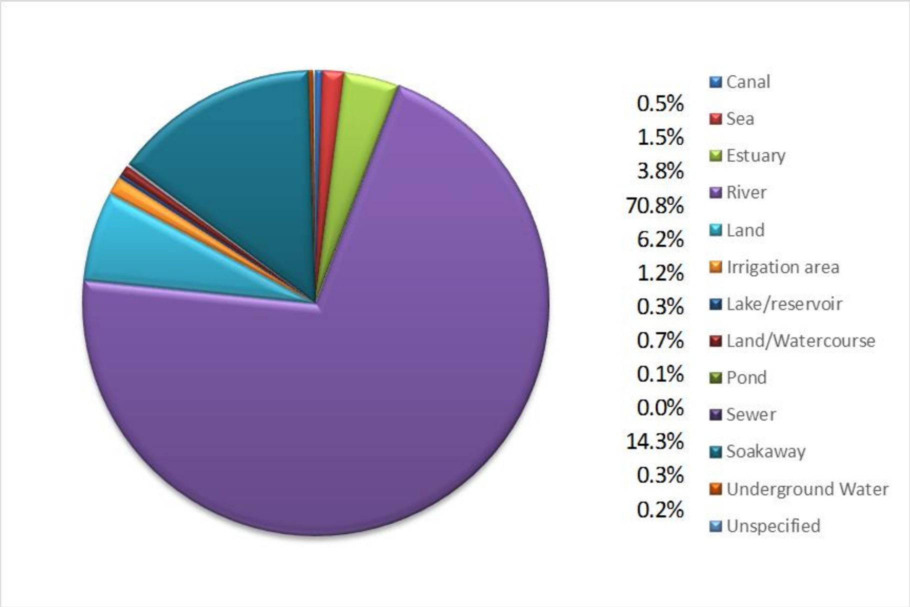
The Directive recognises that standards depends on the quality of the wastewater to treat and the **population equivalent** (p.e.), which measures the oxygen used to break down organic matter and it provides a common measure for the organic content or 'organic load' in wastewater (whether or not the wastewater is from domestic type properties, containing human foul wastes; food processing plants, containing food particles and food preparation washings, or rainwater run-off containing organic debris washed from roads and draining to sewers. Another important element is the **agglomeration**, which defines a communities of homes, industries and services that are enough concentrated to be served by a Waste water treatment plan. The largest collection systems in the UK are linked to around 9,000 wastewater treatment plants. Approximately 1,900 of these plants serve communities of greater than 2,000 p.e. above which the secondary treatment standards must apply to discharges made to freshwaters and estuaries, and to discharges from treatment plants of greater than 10,000 p.e. made to coastal waters. The directive is less specific with regards to plant with less than 2,000 p.e, where states that appropriate treatment must be put in place if a sewage treatment is already installed it is considered that the wording of Article 7 implies a standard of care in relation to the collecting system. If agglomeration with less than 2,000 p.e do not have a collecting system there is no legal obligation under the UWWTD. Further details are provided in section 4.7.

Secondary treatment is identified as normal standard, with tertiary treatment as minimum for Sensitive Areas (areas identified as having particular value and needing special protection).

Receiving waters Analysis

The Figure below shows that the highest proportion of effluents (including all discharge consents) discharge into rivers (70.8%), with 14.3% that discharges into soakaways. Around 5.3% of consents discharge into estuarine or sea waters.

Figure 26 Receiving waters of Discharge Consents



4.1.4 Limits

Yet again, the regulation around discharges reflects the heterogeneous conditions of both the discharge chemical/physical conditions and the receiving environment. Therefore, consents consider both on the type of effluent discharged and the frequency of the discharges. In general, continuous discharges have consents with numeric conditions for different substances; intermittent discharge consents do not report numeric limits but describe to the number of discharge events in a specified time period (termed the spill frequency).

Continuous discharges: Numeric consents for sewage effluents report

- **95 percentile** – indicates that samples of the effluent must not exceed the numeric condition for that substance on more than 95 percent of occasions,
- **Maximum** –maximum threshold for the substance
- **Mean** – average sample measure for the substance

- **Minimum -** used for descriptive conditions (such as pass/fail conditions**)**

The limits are set individually for each consent, so that the quality of the medium receiving the waste water is kept to a good standard and complies with statutory requirements. The identification of these limits can be quite intricate due to diverse circumstances where the environmental conditions are complicated. In this case the agencies identify “Mixed areas” where the numeric consents can be temporarily exceeded; this involves complex modelling and is subjected to expert judgment.

Intermittent discharges: For intermittent discharges of sewage, such as Combined Sewer Overflows (CSOs), limits can be established on spill frequency and also on water quality of receiving water[11] (further details in section 4.3.1).

Temporal limits: Some permits are temporary and issued with a time limit.

The consented discharge dataset reports time limits for some of discharges; the data shows that over the next 5 years 1,553 consents are due to be revoked; the highest proportion of them relates to permits issued to non-water-company individuals or businesses. No rationale is reported on why there is a temporal limits, however a high proportion of these are permits modified under new regulation.

Table 10 Consents due to be revoked in the next 5 years

Sector	Permit due to be revoked in the next 5 years
Agriculture	8
Other activities	6
Other Sewage activities	36
Not Water Company - Sewage Discharges	1369
Water Company - Sewage Discharges	75
Trade Discharges	58
Unspecified	1
Waste Sites	0
Water for potable supply	0
Total	**1553**

An example of consents with temporal limits are the **temporary deemed consents (TDCs)**, which were issued after water privatisation in 1989 to address outfalls that had no legal consents but were discharging into the environment. The consents were meant to be a temporary solution to allow privatisation to continue and were to be subjected to review in subsequent years.

According to EA data, between 10000-11000 TDCs have been updated or revoked by 2009; however, The Anglers’ Conservation Association (now Fish Legal) reported there were still thousands of TDCs with no permits condition as of 2009. Following this, the EA tried to apply blanket conditions for all TDCs but water companies appealed and the appeal was upheld by the Planning Inspectorate. The EA and water companies reached an agreement on new permit conditions for remaining TDCs. In 2016, Fish Legal submitted a freedom of information request, which showed that, since 2009, for some company such as Anglian Water, United Utilities and Yorkshire very few of the consents have been examined. In total 1968 consents still are unknown to the EA (Table 11).

Table 11 Wastewater Companies' progresses in reducing TDC. SOURCE: Fish Legal

WATER COMPANY PROGRESS IN REDUCING TDCs

	Original no. TDCs	Current no. TDCs
Anglian	328	328
Northumbrian	9	9
Severn Trent	901	188
South West	62	46
Southern	29	29
Thames	1,787	400
United Utilities	650	650
Wessex	152	84
Yorkshire	234	234
Total	4,152	1,968

Source: Fish Legal

4.1.5 Monitoring and Reviewing

Discharge consents may be checked by the EA via different methods:

- **Assessment,** which is a desk based check (i.e. all the information sent by the permit holder are compliant and updated);
- **Inspection**, which involves a visit from an officer;
- **Sampling** of the permitted water discharge.

One other tool for monitoring is the MCERTS scheme which is the Environment Agency's Monitoring Certification Scheme that regulates monitoring of businesses' emissions into the environment. When the EA issues a permit, this will include monitoring requirements including whether the permit owner must monitor continuously or at times permit (spot tests or periodic monitoring). For emissions to water bodies, MCERTS standards require the monitoring of flow-measurement data (volume/time) with pollutant concentration (mass/volume).

A general assessment of the monitoring performance of an operator is carried out by the EA using the OMA (Operator Monitoring Assessment) scheme. The OMA produce evaluations regarding:

- management,
- training and competence of personnel
- periodic and laboratory monitoring

- continuous monitoring
- quality assurance of monitoring

OMA site inspections normally include a check that the site operator is complying with all the conditions of any permits, as well as examining sampling points and equipment.

Whenever an assessment is carried out, the agency compiles a Compliance Assessment Report (CAR) that records the evaluation. A score is assigned if the permit owner is found not compliant with standards and the owner could be subjected yearly permit fee (subsistence fee).

If a permitted activity is responsible for a pollution incident, the agency classify the pollution incidents according to their impact on the environment and people, from category 1 (the most serious) to category 4 (little or no impact). Where appropriate, action is taken against those responsible for the pollution (i.e. fines). The information pertinent to pollution incidents are recorded in a dataset (refer to section 4.6.1 for more info).

The EA has to review consents periodically (every two years). Following the revision, the consent can be:

- Modified – for a series of reason, such as:
  - Implementation of new conditions;
  - To comply with new legislation;
  - To protect the environment and/or human health;
  - In response to any representation or objection made to the Secretary of State or otherwise.
- Revoked
- Stay unchanged

Consents can be also subjects to review before the two years if required by specific circumstances.

4.2 Pressures Analysis

This section covers the analysis of the RNAG dataset, restricting the information to the pollution from waste water nSWMI.

4.2.1 Overall Pressures on water bodies

Pollution from waste water affects water bodies with regards to a series of elements. Cycle 2 reports that waste water is one of the reasons for not achieving good for about 48% of failing water bodies in England and Wales, where at least one element has been not passed due to this issue (refer to section 3.5.1 for figures).

4.2.2 Overall Pressures on rivers

Restricting the analysis to only rivers, where the influence of waste water is more significant, pollution from waste water is identified as affecting around 55% of failing rivers during Cycle 2 and responsible of about 26% of RNAG (5421) (Figure 28 and Figure 29). The distribution of rivers affected by waste water pollution is mapped in Figure 30).

Figure 27 Number of Rivers affected by nSWMI

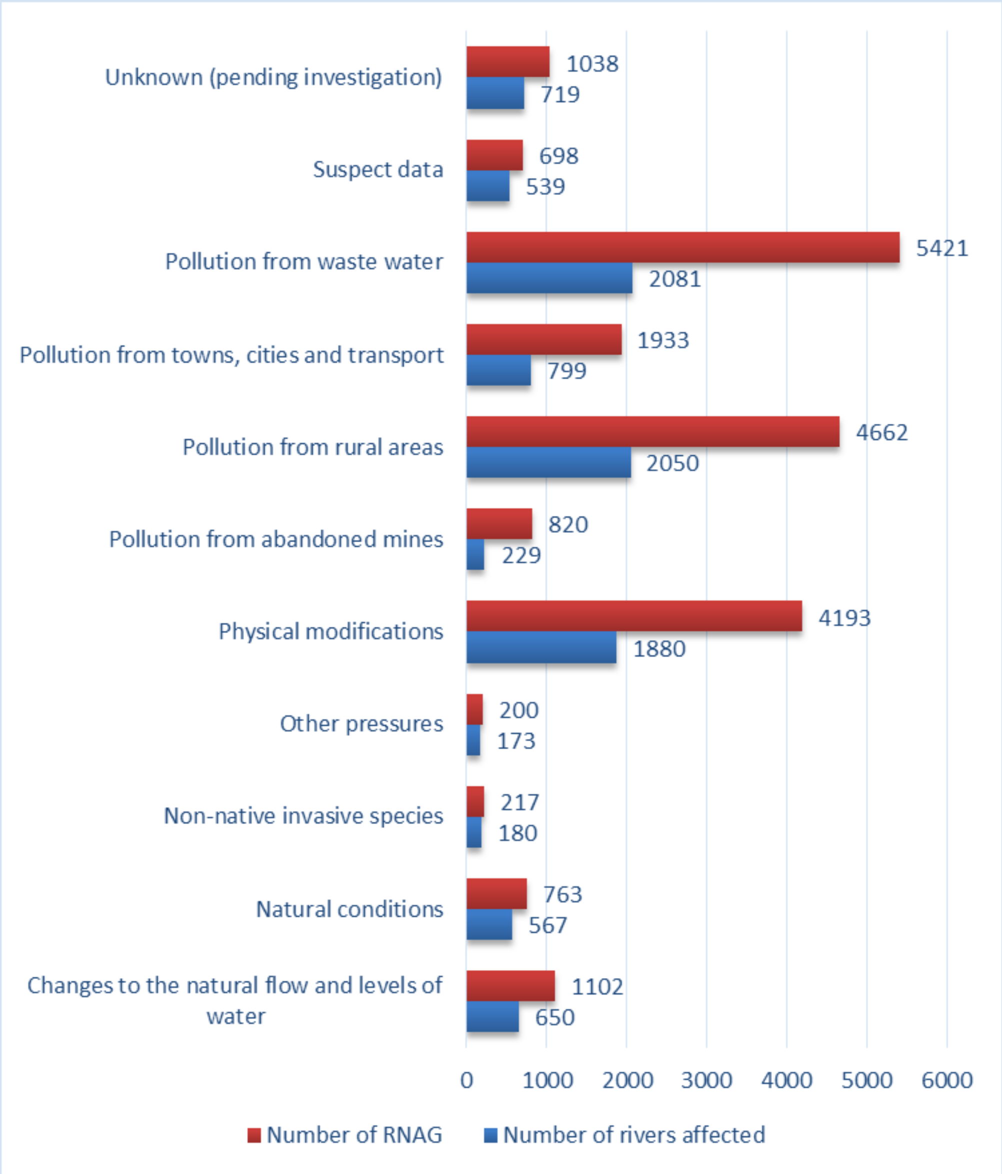


Figure 28 Percentages of rivers affected by each nSWMI

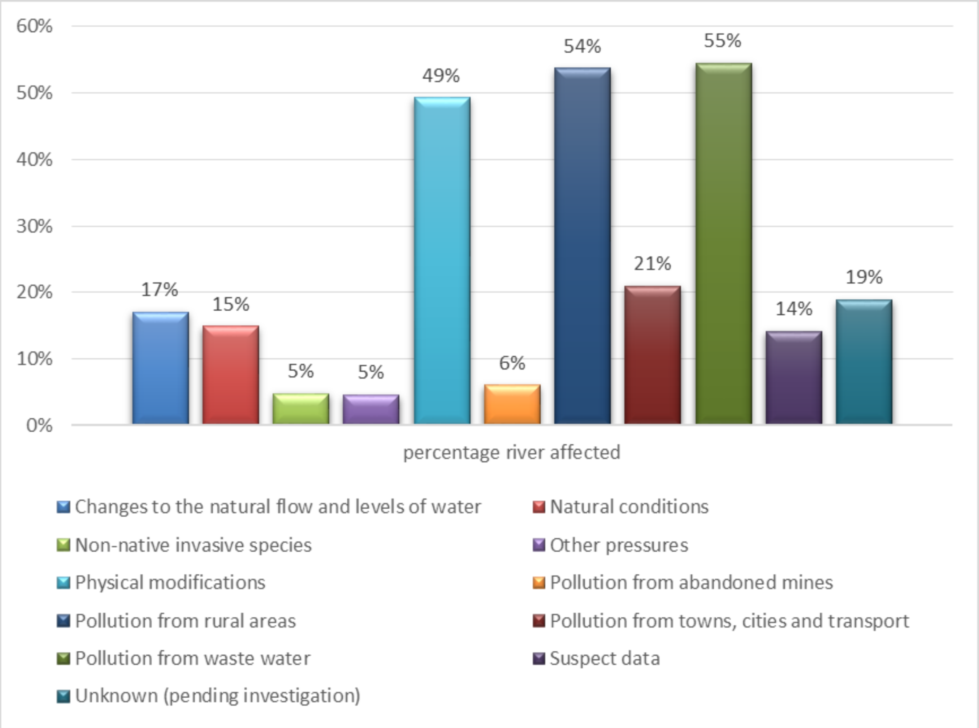


Figure 29 nSWMIs responsible for rivers RNAG

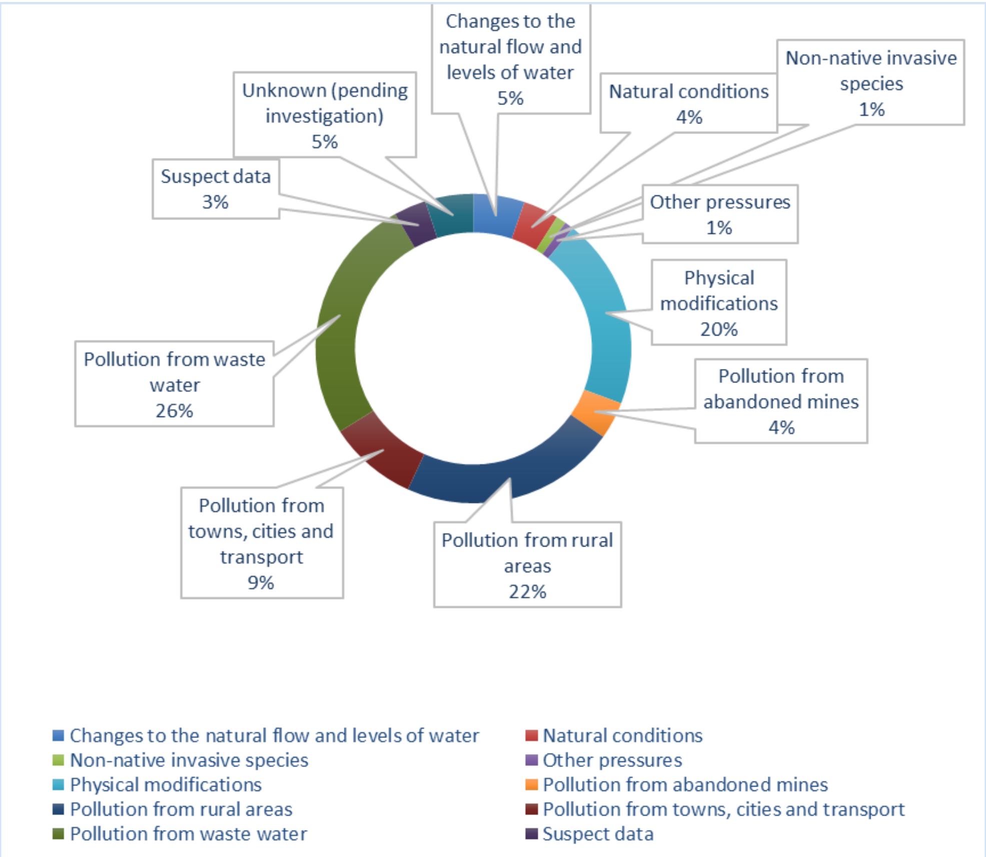
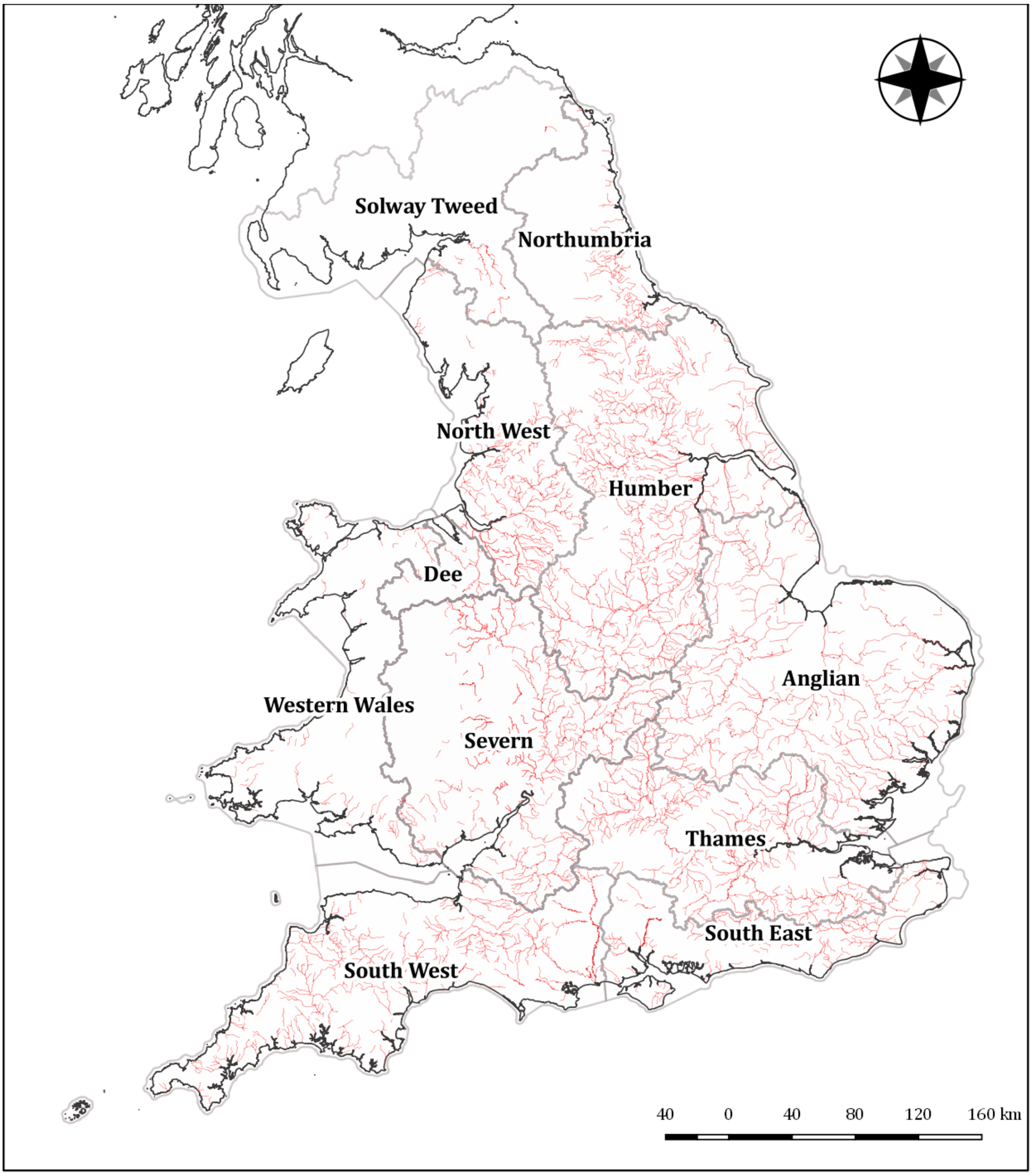


Figure 30 Rivers affected by Waste water pollution during Cycle 2



Attribution statement: shapefiles obtained from © Environment Agency and National Resource Wales. Copyright and/or database right 2016. All rights reserved. Contains Ordnance Survey data © Crown copyright and database right 2013.

The problem appears quite generalised, with only Wales and the northern part of England less affected. The map appears to match to a certain degree with the figures reported by RBMPs in 2015, concerning the percentage of (total) number of water bodies affected by waste water pollution and summarised in the table below.

Table 12 RBMPs figures about waste water pollution impacts on all waterbodies

RBD	Impacts reported in the RBMPs
Anglian	"Pollution from waste water – affecting 50% of water bodies in this river basin district"

Dee	“Pollution from sewage and waste water – affecting 23% of water bodies”
Humber	"Pollution from waste water – affecting 38% of water bodies in this river basin district”
Northumbria	"Pollution from waste water – affecting 13% of water bodies in this river basin district”
North-West	"Pollution from waste water – affecting 24% of water bodies in this river basin district”
Severn	"Pollution from waste water – affecting 29% of water bodies in this river basin district”
South East	"Pollution from waste water – affecting 40% of water bodies in this river basin district”
South West	"Pollution from waste water – affecting 33% of water bodies in this river basin district”
Thames	"Pollution from waste water – affecting 45% of water bodies in this river basin district”
Wester Wales	“Pollution from sewage and waste water – affecting 16% of water bodies”

The figures using the wastewater companies’ boundaries to analyse the % of rivers affected by wastewater pollution are presented below.

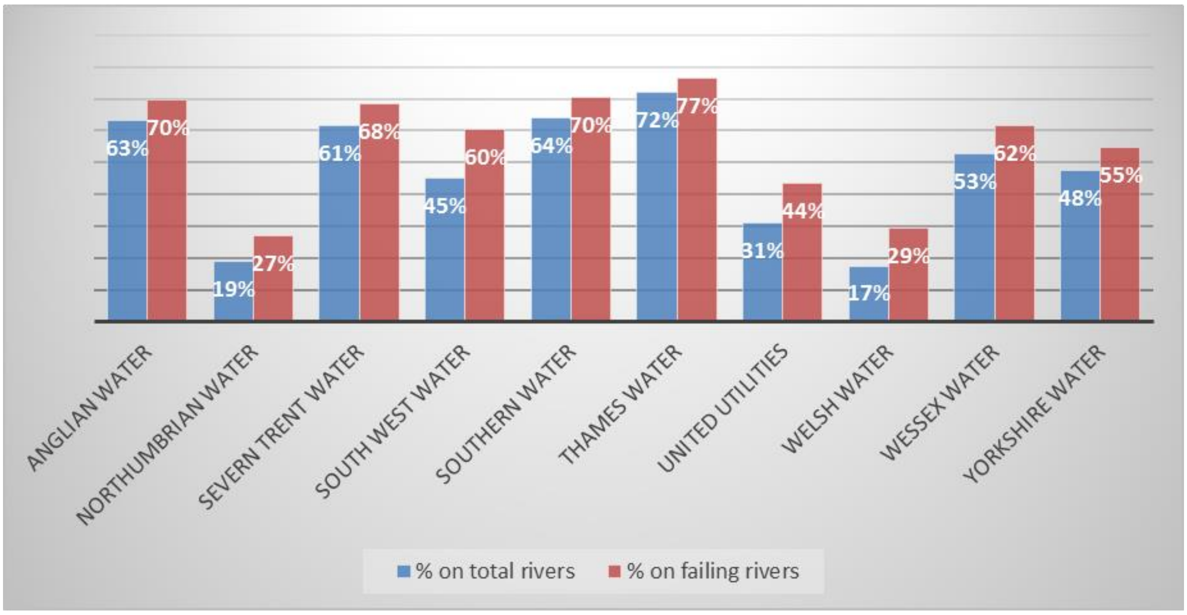
It is important to note that the following figures have to be considered as having a margin of error. This needs to be accounted for due to the intrinsic inaccuracy produced when digitising the map from a low quality base image. The processes can also affect the assignment of a river within the correct wastewater company area. Therefore, this error is likely higher for Severn Trent Water, Thames Water and Southern Water, which are the boundaries affected the most by the digitisation process.

It is also worth noting that it would not be possible to compare figures between the two tables due to the fact that the boundaries are different and that RBMPs also account for groundwater and lake, while the below table just report % for rivers.

Table 13 % of rivers affected by pollution from waste water (Cycle 2) – by wastewater company

Name	% on total rivers	% on failing rivers
Anglian Water	63%	70%
Northumbrian Water	19%	27%
Severn Trent Water	61%	68%
South West Water	45%	60%
Southern Water	64%	70%
Thames Water	72%	77%
United Utilities	31%	44%
Welsh Water	17%	29%
Wessex Water	53%	62%
Yorkshire Water	48%	55%

Figure 31 % of rivers affected by pollution from waste water (Cycle 2) – by Wastewater Company



The following section analyses in details specific waste water pollution activities.

4.2.3 *Activities*

Different activities are listed under the waste water pollution nSWMI. These are showed in the following table and comprise activities directly correlated to the sewage system and more specific ones related to landfill operations and industrial discharges.

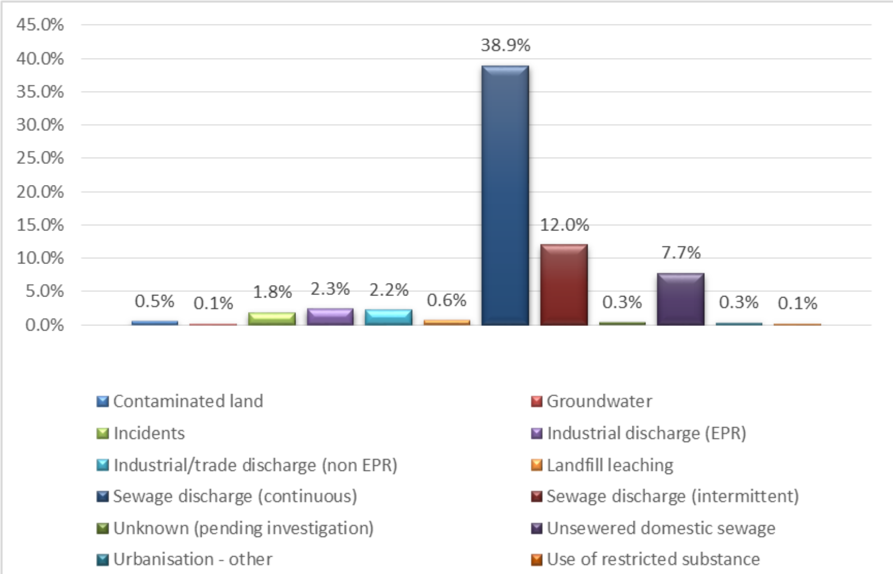
Table 14 Waste water activities

Waste water pollution activities
Contaminated land
Groundwater
Incidents
Industrial discharge (EPR)
Industrial/trade discharge (non EPR)
Landfill leaching
Sewage discharge (continuous)
Sewage discharge (intermittent)
Unknown (pending investigation)
Unsewered domestic sewage
Urbanisation - other
Use of restricted substance

Considering all waterbodies, the waste water activities that affect the highest proportion of failing waters are,

- Sewage discharge (38.9% of failing water bodies are affected),
- Intermittent sewage discharge (12.0%)
- Unsewered domestic sewage (7.7%)

Figure 32 Activities responsible for failing water bodies

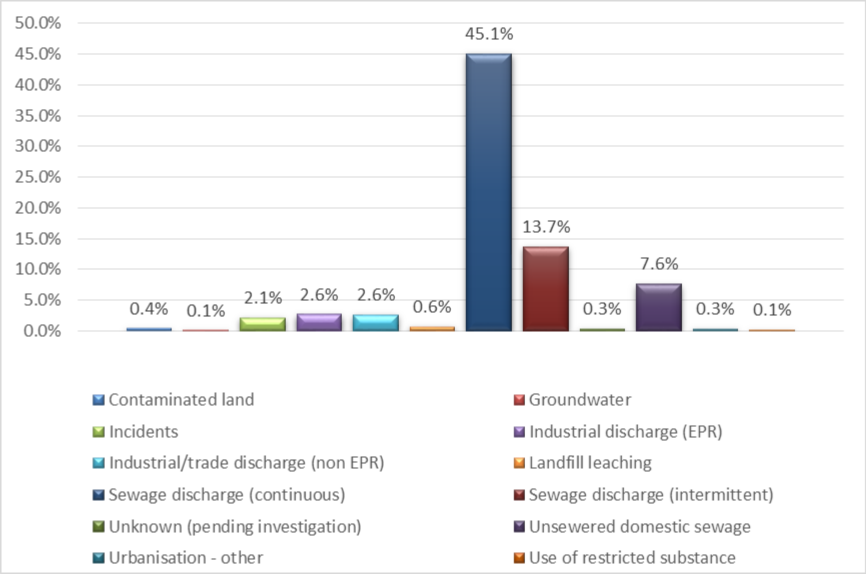


Rivers

Narrowing down to rivers, the figures reflect the same situation. Waste water activities that affect the highest proportion of failing rivers are:

- Continuous sewage discharge (45.1% of failing rivers are affected),
- Intermittent sewage discharge (13.7%)
- Unsewered domestic sewage (7.6%)

Figure 33 Activities responsible for failing rivers



The dataset suggests that continuous discharge is generally considered the activity affecting the river more consistently. This is likely due the process being constant and continually discharging into the environment. At the same time, monitoring procedures are more effective in assessing continuous process than at capturing intermittent activities, which are more likely to be not picked up by the compliance monitoring.

4.2.4 Failing Elements

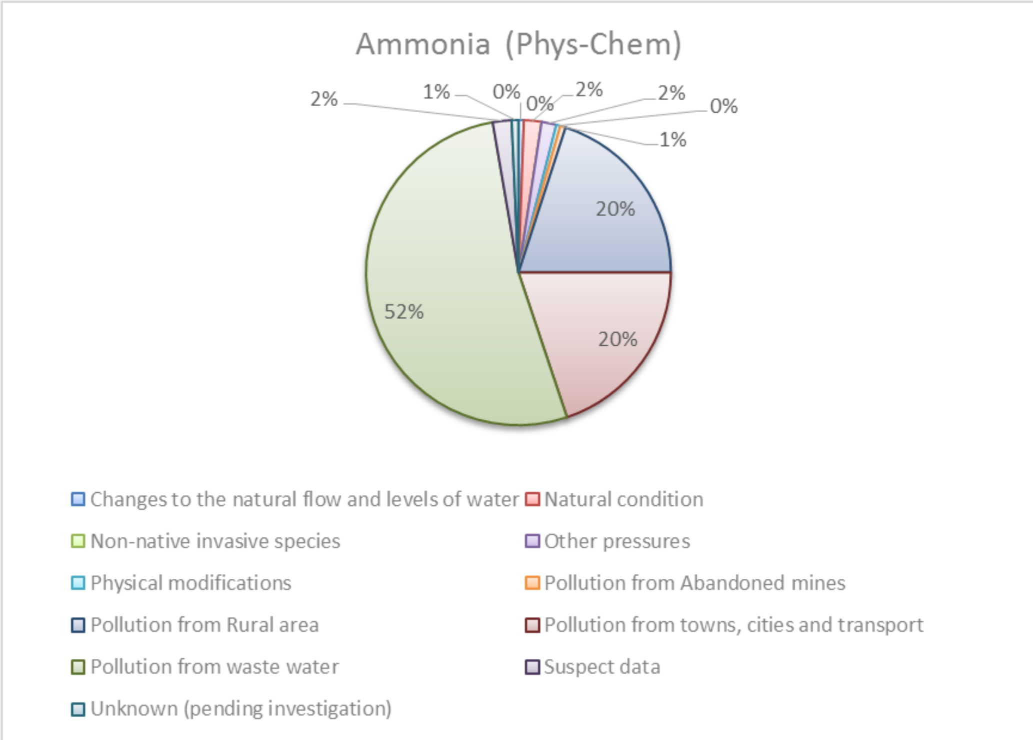
The following figures summarise which elements fail more often due to waste water activities. The analysis has been conducted considering all water bodies.

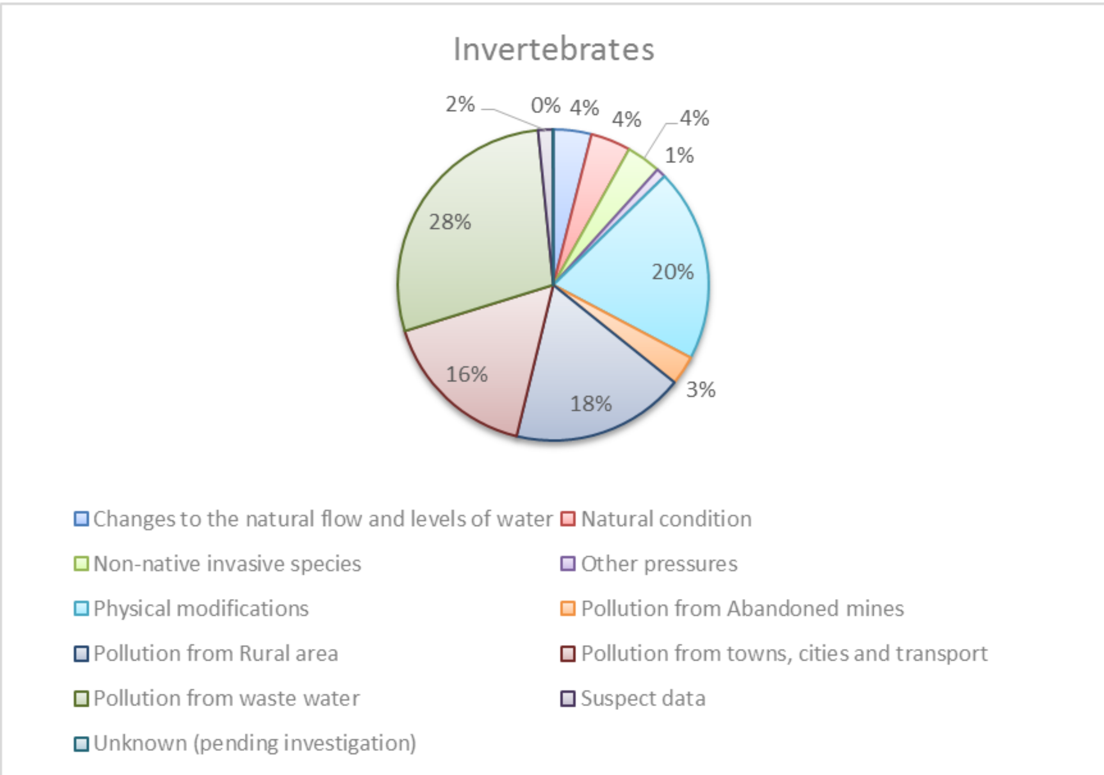
Concordant with the result obtained for all the nSWMIs, phosphate is the element that is failed more frequently and pressured most. Waste water activities are also deemed responsible of failing elements such as Fish, Invertebrates, Macrophytes and Phytobenthos. Ammonia and Dissolved Oxygen are also represented with a high number of cases.

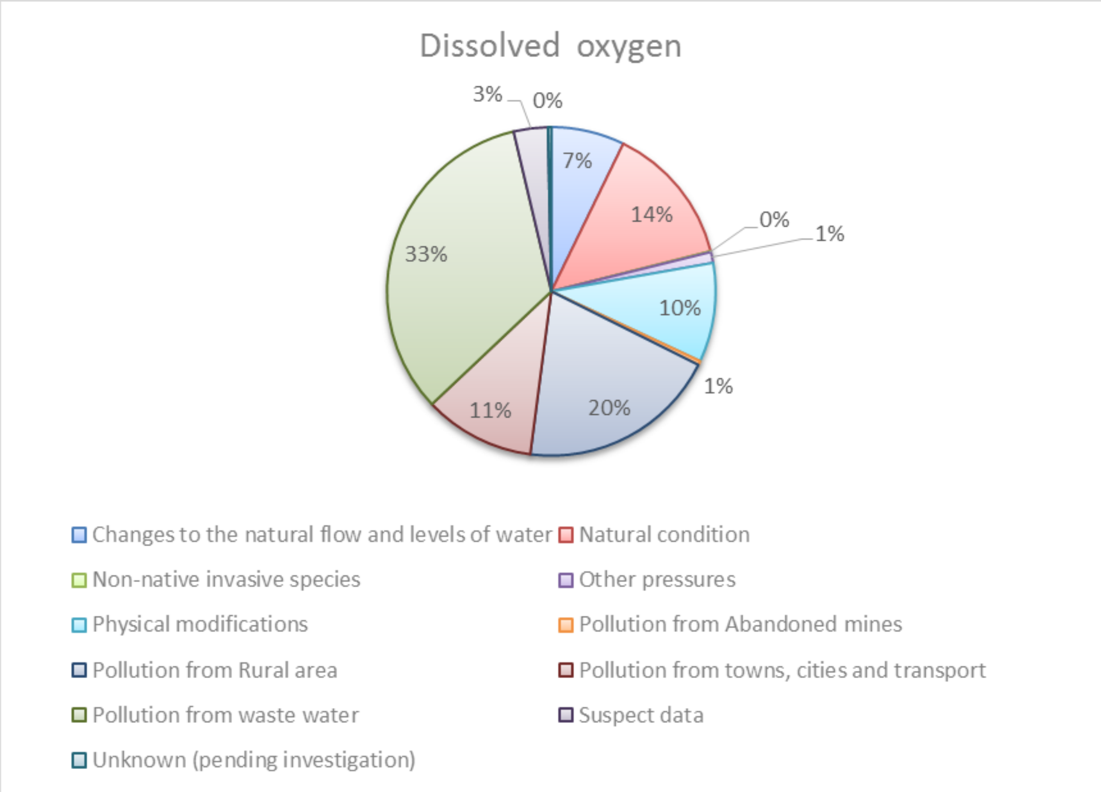
Considering the number of reasons listed, the following figures show that **waste water pollution activities are responsible** for a high proportion of RNAG for some important element such as:

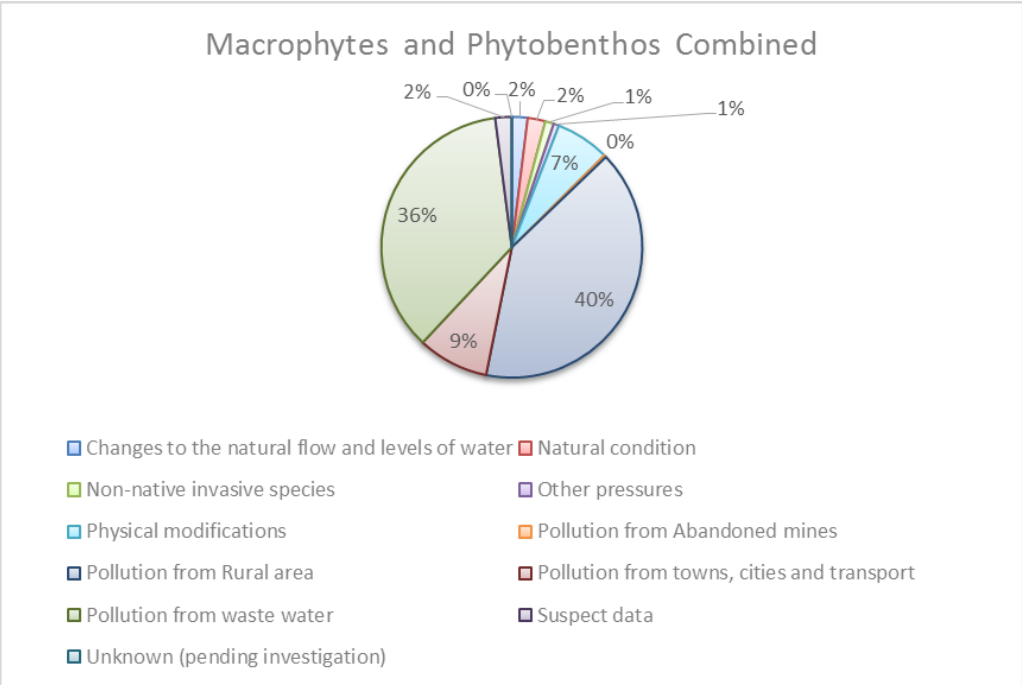
- **Ammonia (52% of RNAG)** – waste water pollution activities are responsible of the highest number of RNAG
- **Dissolved oxygen (33%)** - waste water pollution activities are responsible of the highest number of RNAG
- **Invertebrates (28%)** – waste water pollution activities are responsible of the highest number of RNAG
- **Macrophytes and Phytobenthos combined (36%)** - waste water pollution activities are the second most responsible of RNAG
- **Phosphate (46%)** - waste water pollution activities are responsible of the highest number of RNAG

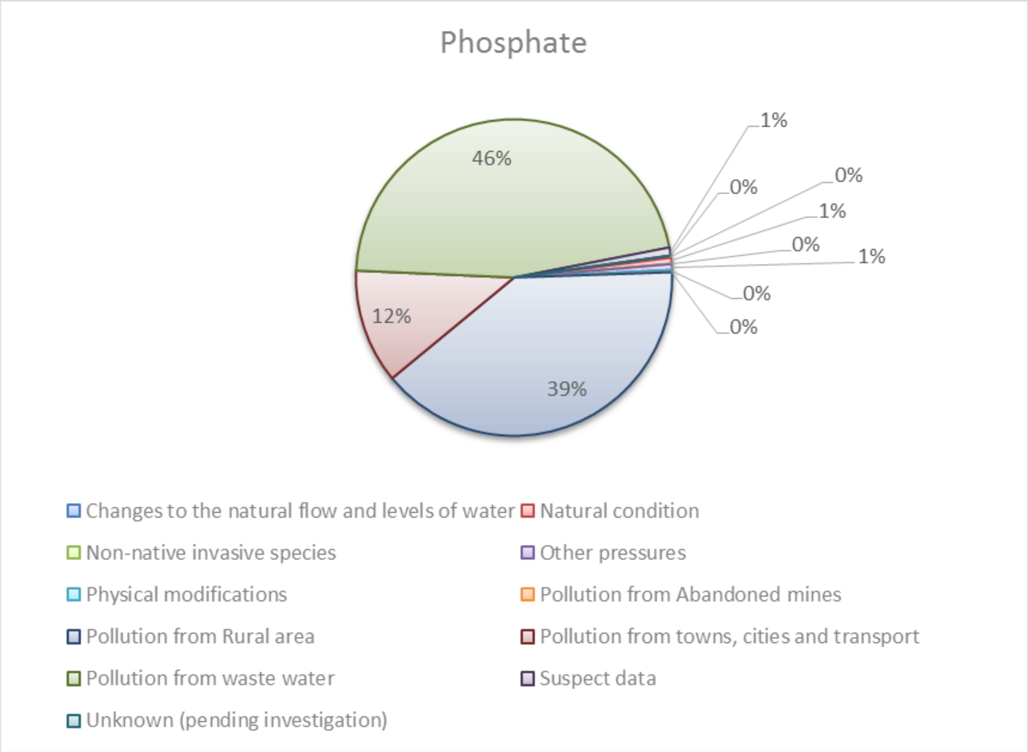
Figure 34 Proportion of RNAG per different classification elements






Dissolved oxygen
3%
0%
7%
14%
0%
1%
33%
10%
1%
11%
20%
Changes to the natural flow and levels of water
Natural condition
Non-native invasive species
Other pressures
Physical modifications
Pollution from Abandoned mines
Pollution from Rural area
Pollution from towns, cities and transport
Pollution from waste water
Suspect data
Unknown (pending investigation)


Macrophytes and Phytobenthos Combined
2%
0%
2%
2%
1%
1%
0%
7%
36%
40%
9%
Changes to the natural flow and levels of water
Natural condition
Non-native invasive species
Other pressures
Physical modifications
Pollution from Abandoned mines
Pollution from Rural area
Pollution from towns, cities and transport
Pollution from waste water
Suspect data
Unknown (pending investigation)



4.3 Intermittent Discharges

Artesia were asked to look into Combined Sewer Overflows (CSOs) and Septic tanks. This section covers these two aspects.

4.3.1 Combined Sewer Overflows (CSOs)

Overview

Combined Sewer Overflows (CSOs) are overflow pipes and other systems that divert flow in excess. These systems can be connected to the main sewage and are designed to relieve pressure during extreme wet periods, when the sewage treatment plant capacity is exceeded.

The systems collects volume of household & industrial wastewater plus surface water runoff that is generated during significant rainfall events. In these conditions it is generally not economically feasible or environmentally cost effective to transport the flow for large distances via a combined sewer system or to treat it at the sewage treatment works when delivered. CSOs collects the excess water and act as release points on the wastewater network.

Discrepancy exists regarding what it has to be considered an overflow. This is probably due to the confusion within and outside of the water industry regarding the definition of a CSO, and probably because there is no single industry-standard definition. The EA suggests that they currently use the following six categories of storm/sewage overflows when requesting information from water companies:

- CSOs on the sewerage system;
- Storm overflows at inlet works at WwTWs (Waste water Treatment works);
- Storm tank discharges from WwTWs;

- Emergency Outfalls at WwTWs;
- PSs with emergency overflows only; and
- PSs with emergency overflows and storm overflows.

Regulation

Due to their nature, CSOs operate during stress periods when the waste water system is pressured by weather events. The amount of flow collected can occasionally exceed CSOs capacity and the system can spill and flood.

The spill frequency on the discharge consent will vary between no more than 3 spills a bathing season and 10 spills a year. Control of CSO discharges in other waters is less well defined apart from CSO affecting the waters protected by specific legislation (Table 15).

Table 15 Frequency of spill standards. SOURCE: Water Discharge and Groundwater (from point source) Activity Permits - 2012

Directive	Design standard
Revised bathing waters	3 spills per bathing season, for good and sufficient stratus, 2 spills per bathing season for excellent status, 6mm screening or equivalent aesthetics control and discharges below the mark of Mean Low Water Spring tides.
Current bathing waters	3 spills per bathing season, 6mm screening or equivalent aesthetics control and discharges below the mark of Mean Low Water Spring tides.
Shellfish waters	10 spills per annum and appropriate aesthetic control where required.
Freshwater fish	Fundamental Intermittent Standards (FIS), 99%ile standards and relevant Freshwater fish directive standards. Appropriate aesthetic control where required based on UPM2 requirements.
CRoW Act or Habitats (BOD or ammonia)	Fundamental Intermittent Standards (FIS), 99%ile standards and appropriate aesthetic control where required based on UPM2 requirements.
Urban waste water treatment	UPM standards derived using UPM2 methodology. For rivers these will include FIS and 99%iles based on the significance of the discharge. Retained flow of formula `A' (or equivalent storage) and/or appropriate aesthetic control may be appropriate for low significance discharges. For storm tank discharges the minimum capacity is 68 l/head served or storage equivalent to 2 hours at the maximum flow rate to the storm tanks.
Groundwater	Refer to requirements for groundwater in the groundwater section of this document.
WFD (BOD or ammonia)	Fundamental Intermittent Standards and appropriate aesthetic control where required.

Storm overflows can also impact the amenity value of environment due to the gross solid portion of the sewage. The 2012 “Water Discharge and Groundwater (from point source) Activity Permits” reports that Amenity value is assigned by the Agency in accordance with the following categories.

- High Amenity
    - Influences area where bathing and water contact sport (immersion) is regularly practised (e.g. wind-surfing, sports canoeing).
    - Receiving watercourse passes through formal Public Park.

  - Formal picnic site.
  - Shellfish waters

- Moderate Amenity

  - Boating on receiving water.
  - Popular footpath adjacent to watercourse.
  - Watercourse passes through housing development or frequently used town centre area (e.g. bridge, pedestrian area, shopping area).
  - Recreation and contact sport (non-immersion) areas. Low Amenity

- Basic amenity.

  - Casual riverside access on a limited or infrequent basis, such as a road bridge in a rural area, footpath adjacent to watercourse.

- Non-Amenity

  - Seldom or never used for amenity purposes.
  - Remote or inaccessible area.

Spill frequency for different amenity Areas is defined as per below table.

Table 16 Frequency of spill standards per Amenity Value. SOURCE: Water Discharge and Groundwater (from point source) Activity Permits

High Amenity	> 1 Spill per year <=1 Spill per year	6mm solids separation 10mm solids separation
Moderate Amenity	>30 Spills per year <=30 Spills per year	6mm solids separation 10mm solids separation
Low Amenity & Non Amenity	Solids separation to be achieved through good engineering design (eg, high- sided weir, stilling pond with or without scum boards or vortex separation).	

The new risk based approach employed by the EA refers back to "Water Discharge and Groundwater (from point source) Activity Permits". Further, it confirms the requirement for solid screening in vicinity of high amenity value areas and stress the importance of compliance with the relevant water quality standards. Overall, the objective is for no deterioration in the wet weather quality of the receiving water. In general for rivers and estuaries this means no deterioration in the quality of the water at any percentile, no increase in the number of exceedances.

For storm tanks, the regulation identifies the following standards, which are considered as minimum standards. Higher or lower standards may be appropriate depending on receiving water quality standards and any no deterioration requirements.

Storm tanks:

- Should only be filled whenever incoming flows exceed FFT (flow to full treatment)

- Should be properly designed to settle suspended solids

- Should have a storage capacity of either 68 litres/head of population served or 2 hours storage for the maximum flow received.

- Should not discharge a significant quantity of solid matter having a size greater than 6mm in any one dimension. This requires some form of solids separation having a performance equivalent to a 6 mm 2 dimensional aperture screen.

- Their contents should be passed to full treatment as soon as practicable after it has stopped filling. This usually requires an automated system to return stored flows whenever the flow arriving at the sewage works is less than the FFT.

Monitoring

EA encourages companies to self-report and *"It is for the individual companies to decide how they will effectively monitor and review future performance against design horizon predictions"*.

Monitoring methods vary depending on CSO design and receiving waters. The agency expects companies to update their monitoring systems to industry standards; however, methodologies are up to single companies. "*For example companies may report actual spill frequencies against design assumptions for bathing waters or continued compliance with population assumptions for less sensitive sites"*[11].

Spill event time and duration monitoring and recording may be required subject to expert judgment. Reasons might include: previous report problem with the system, uncertainty following an improvement or amendment in the CSO design, an expensive or high profile improvement has been implemented and needs to be checked. Monitoring of spill event time and duration could be achieved by any kind of telemetry; other monitoring may be required when the CSO might affect vulnerable areas, such as shellfish waters.

Event Duration Monitoring (EDM) systems are sometimes installed. These systems monitor how much water has discharged and for how long.

Between 2013 and 2015, Welsh Water invested £2 million installing EDM technology at nearly 500 CSOs, located within 2km of bathing and shellfish waters which has enabled us to start monitoring these CSOs.

Distribution

The EA reports discharge consents permit with various tier of info; on the contrary no freely-available information is published for Wales.

In the analysis of the EA dataset only the following descriptor have been chosen as representative of CSOs:

- Sewer storm overflow - not water company
- Sewer storm overflow - water company
- STW storm overflow/storm tank - not water company
- STW storm overflow/storm tank - water company

Table 17 shows the 13,463 listed storm overflow differentiated by type. The highest proportion of CSOs are installed at pumping stations, in proximity of sewage disposal works and alongside the sewage network. Of all the CSOs, 99% are owned by the wastewater companies (Figure 35).

Figure 35 CSO ownership

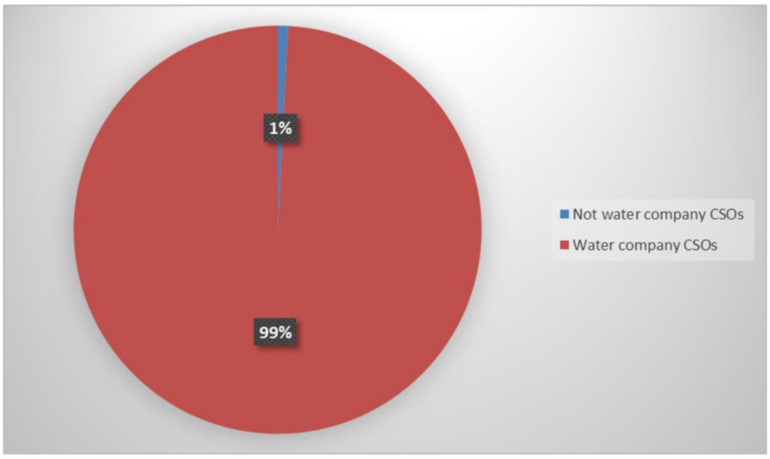


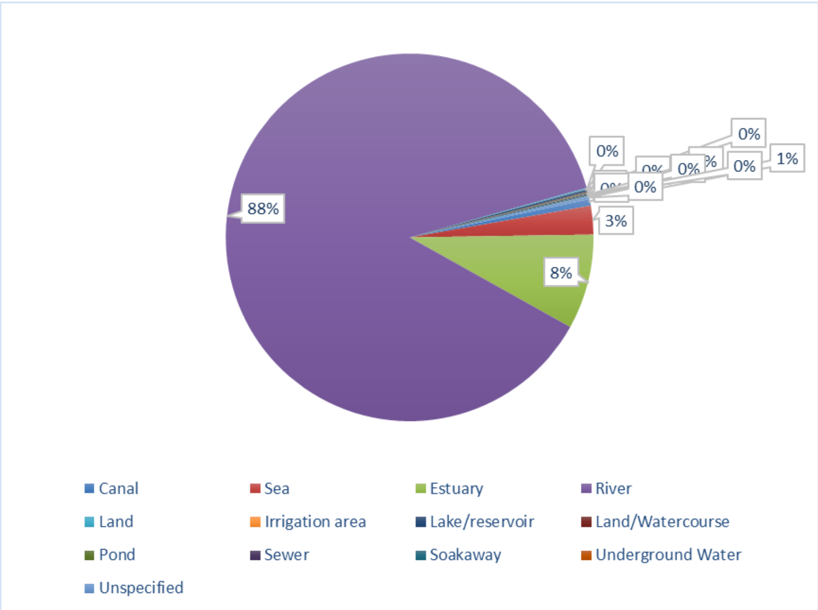
Table 17 Table of CSOs by type

Description	SEWER STORM OVERFLOW - NOT WATER COMPANY	SEWER STORM OVERFLOW - WATER COMPANY	STW STORM OVERFLOW/STORM TANK - NOT WATER COMPANY	STW STORM OVERFLOW/STORM TANK - WATER COMPANY
Any MOD Establishment	8	0	7	1
Basic Ind. Chemicals Inorganic	0	1	0	0
Basic Ind. Chemicals Organic	1	0	0	0
Coal Extraction, Surface - abandoned	0	0	1	0
Domestic Property (Multiple)	5	1	2	0
Domestic Property (Single)	5	0	3	0
Domestic waste site	0	1	0	0
Education	1	1	1	0
Ferrous Foundries	0	1	0	0
General Construction Work	1	0	0	0
Hotel Trade	1	0	1	0
Industrial estates	1	2	0	1
Livestock Prod. Food Prod.	0	1	0	0
Mixed Farming	0	3	0	0
Nuclear Fuel Production & waste processing	0	0	1	0
Other Tourist/Short Stay Accommodation	0	0	1	0
Physico-chemical Treatment Facilities	0	2	0	0
Production and Distribution of Electricity	1	0	0	0
Public Conveniences	0	3	0	0
Public Houses and Bars	0	0	1	1
Recreational and Cultural	2	1	2	0
Retail Distribution	1	0	0	0

Sea Transport	1	0	0	0
Sewage disposal works - other	8	10	20	15
Sewage Disposal Works - water company	0	564	1	2807
Sewerage Network - Pumping Station - others	4	12	3	1
Sewerage Network - Pumping Station - water company	0	1912	0	228
Sewerage Network - Sewers - others	6	22	1	5
Sewerage Network - Sewers - water company	7	7169	1	405
Trade (Unknown/Other)	1	44	1	5
Undefined or Other	4	117	3	10
Water Supply Administration	0	1	0	1
Water Supply Grid	0	2	0	0
Water Treatment Works	0	3	0	1
Not Available	0	0	1	0

Effluents coming from CSOs usually discharges into one water body, however, some systems can discharge into two receiving waters (i.e. sea plus estuarine system). The majority of CSO discharge into rivers (88%), with 8% discharging into estuaries and 3% into sea Figure 36.

Figure 36 CSOs receiving waters



Location of CSO as provided by the EA dataset of consented discharges is mapped in the following figure; Midland regions and North West seem to have the higher density of CSO systems; this seems to be consistent with wetter weather conditions in the north. Distribution in the rest of the England is more or less even. The number of CSOS by EA region is reported in the dataset and shown in Figure 38. For Wales, Dwr Cymru, (Welsh Water) reports 3,200 CSOs, no spatial information was available on this

Figure 37 CSOs location

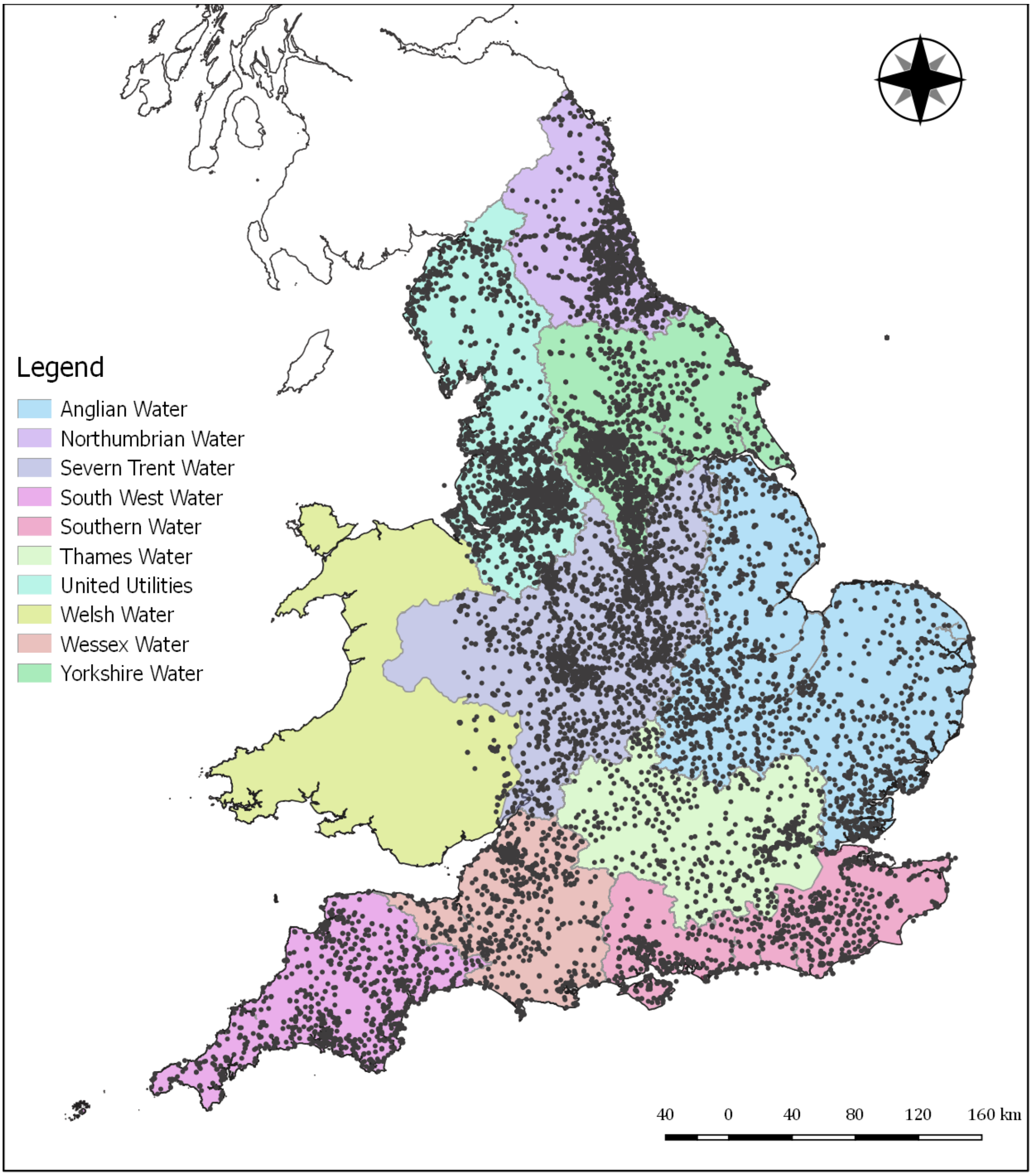


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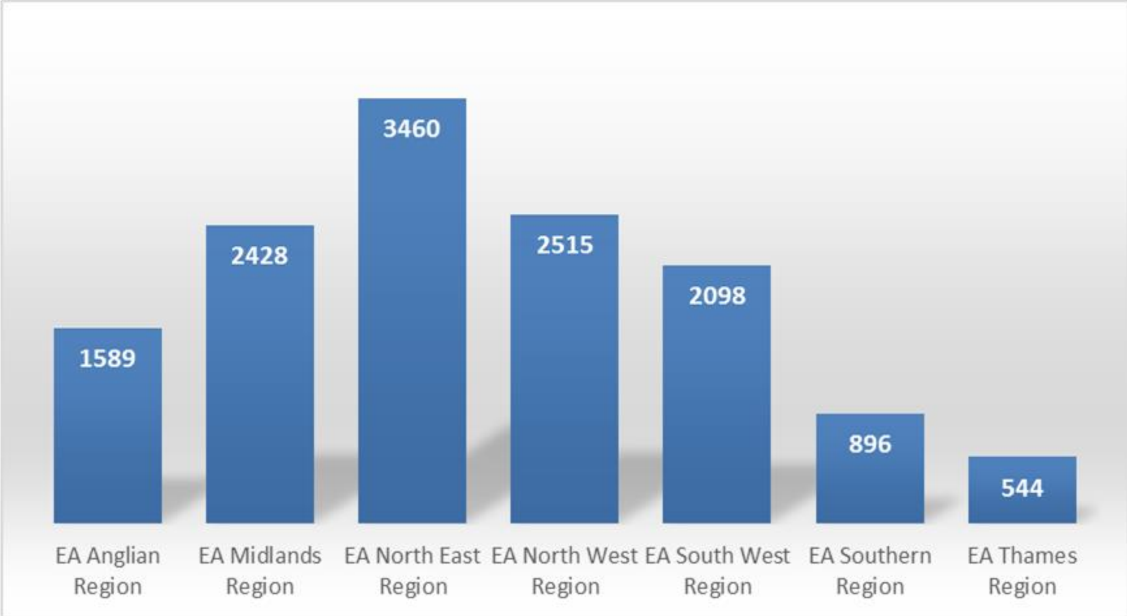
Figure 38 CSO by EA region



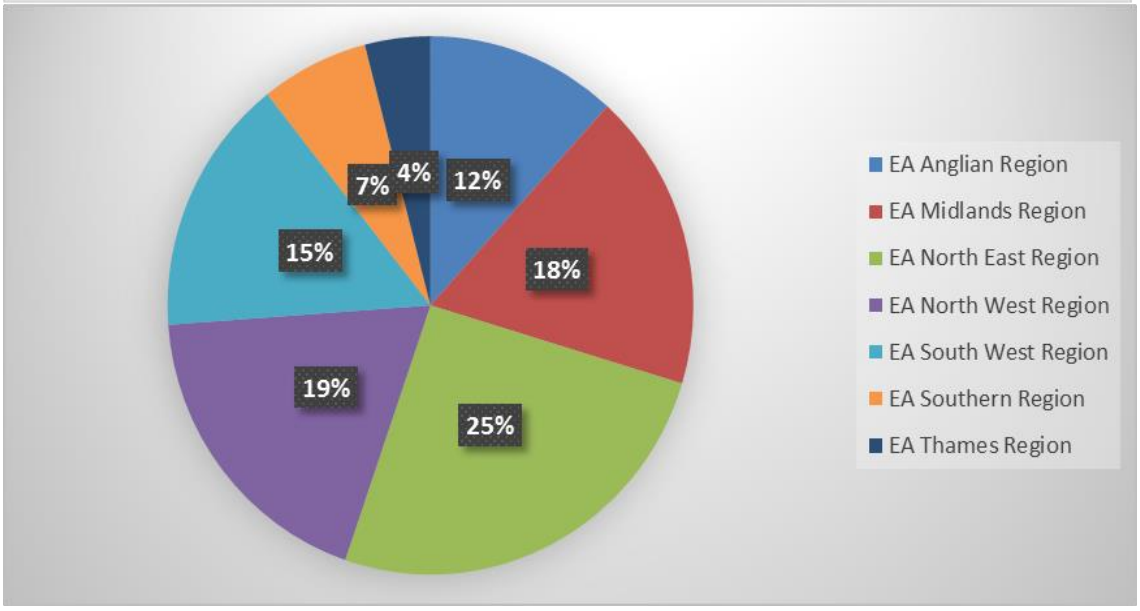
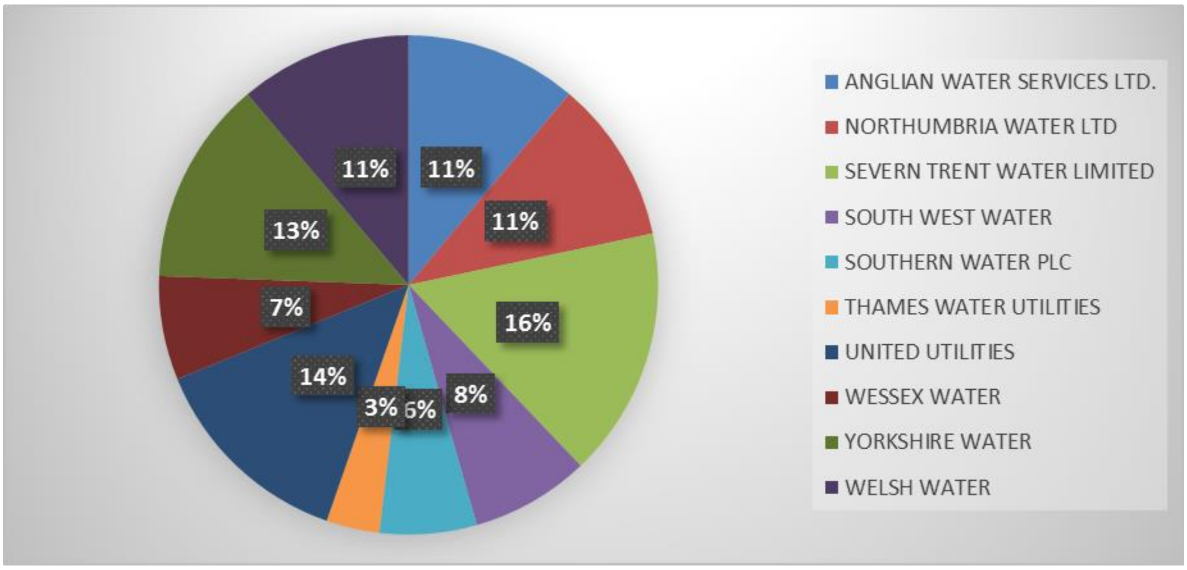
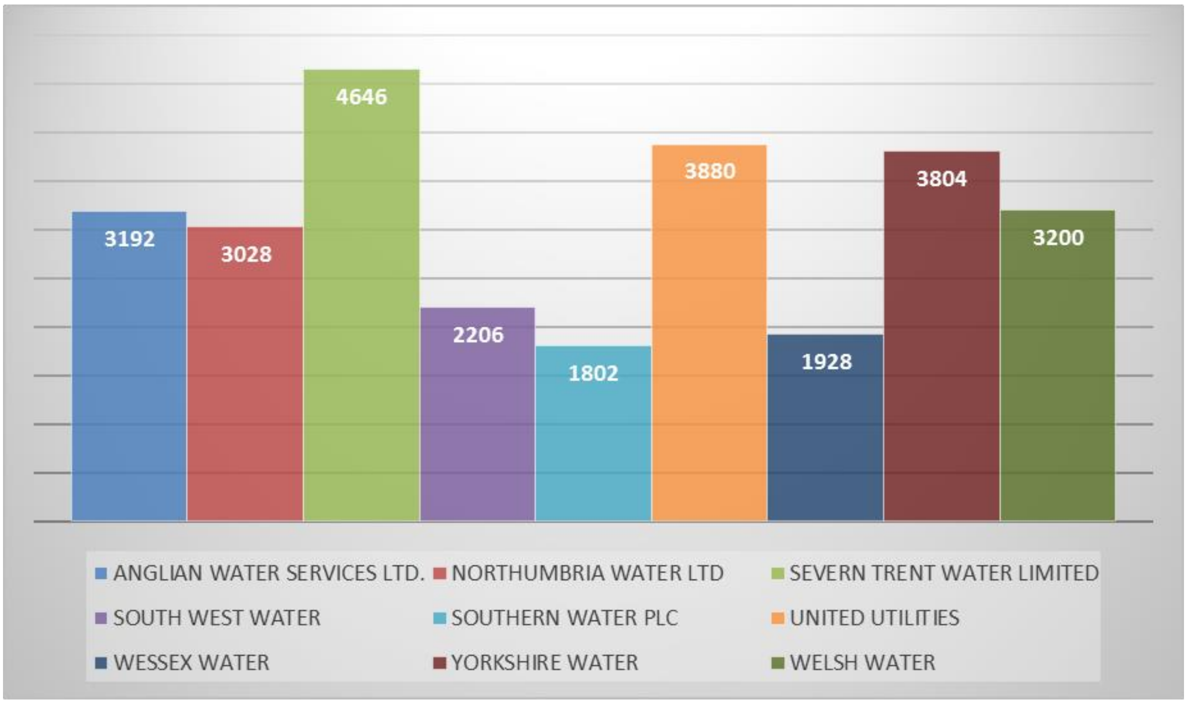


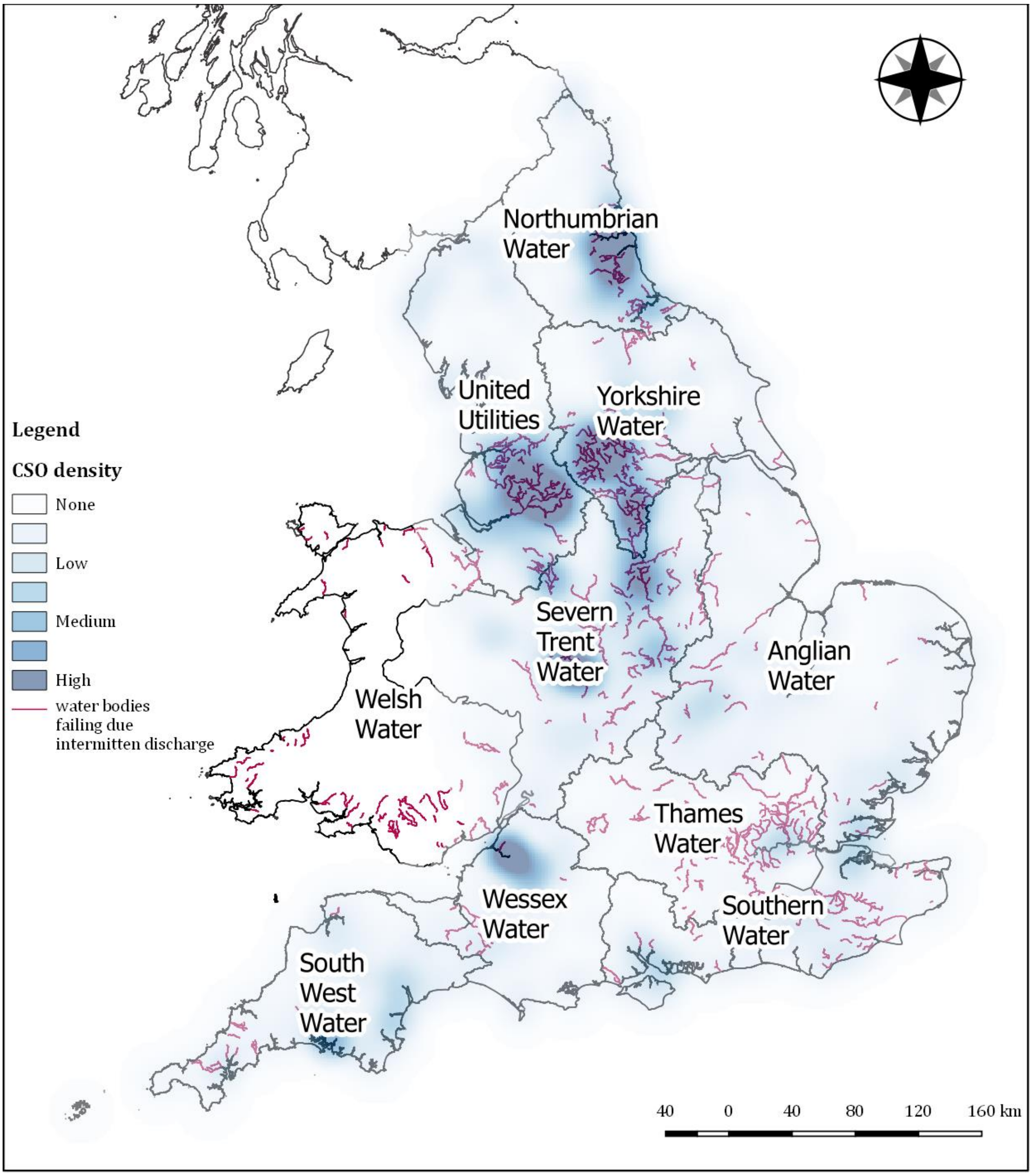
Figure 39 CSO by Wastewater Company





Mapping out the location of rivers the EA and NRW failing due intermittent sewage discharge (Figure 40), it is possible to notice that a high number is located in the north-east, north-west and midland areas, where the CSOs number is higher and weather conditions are wet. Thames area is also quite affected, even if the number of CSO is smaller, likely due to the more urbanised contest that reduces the permeability of the ground, increasing runoff processes. When overlaying the two map, it appears to be a degree of correlation for middle and north cluster, while in the Thames area the lower number of CSO seems to be not correlated to the number of river failing.

Figure 40 Rivers failed due to intermittent discharges



Pressures

In the "Environmental impacts of combined sewer overflows (CSOs)", published in 2004 by the Chartered Institution of Water and Environmental management (CIWEM)[12], it was already recognised *"that the capacity of the underground drainage infrastructure is finite and that therefore CSOs, which are the safety valves of the system, are inevitable. However, CIWEM believes that it is environmentally desirable that discharges from CSOs should be minimised where there is a negative environmental impact, wherever this is technically and economically feasible".*

The report highlights a series of considerations:

- It is, and will remain for the foreseeable future, impractical to totally eliminate discharges from CSOs.
- Despite the considerable dilution of household and industrial wastewater base flows by surface water runoff, storm sewage discharges from CSOs may contain significant loads of a wide variety of pollutants.
- Inadequacy of traditional CSO design practice have been recognised for many years.

Spills can also affect sensible areas such as Shellfish waters, with studies suggesting that CSOs can stimulate microbial growth during and after spills. The CSOs are also highly susceptible to future pressure such as population growth and climate change, which would increase the load discharged and likely the frequency of stress on the systems. Different studies analyse and report these issues: (sourced from the EA report "CSO Monitoring and The Environment Agency", published in 2014).

- **OFWAT Future Impacts on Sewer Systems 2011** - Climate change, growth, urban creep by 2040 = increase in flood volumes of about 51%

- **DEFRA Statement of Obligations 2012** - Water companies must understand how their networks currently perform and how they interact with other drainage systems, so that they can effectively manage future pressures.

- **EA / Ofwat Drainage Strategy Framework 2013** - Improve understanding of network performance (and improve models) by using long term flow and level monitoring on sewers and CSOs.

- **UK Government Water Act 2014 Resilience Duty** - Promote action to respond effectively to pressures on the environment (including climate change), population growth and changes in behaviour.

Overall, the uncertainty around the CSO situation in England and Wales is still high. Not much has been published at national scale. A report published by the EA in 2016 for the Cleaner Seas Forum Technical Meeting states that over 7,000 overflows improved since 1990 but there is still much to go. In EA intention, the objective is to update the approach, employing:

- **Forward Planning** - Sewerage Catchment Strategies assessing future pressures and uncertainty

- **Understanding and Communicating** - Performance Event Duration Monitoring and reporting

- **Investigate & Implement** - Spill Frequency trigger Permitting

Recommendations

Sustainable drainage system (SuDS) are systems designed to deal with the surface water management in a way that is less impacting on the waste water system and the environment. These systems involve both design and technical solutions to deal with surface water.

The implementation of SuDS systems could reduce the pressures on CSOs, such as that spill events would be less frequent. The intention of the Flood and Water Management Act (2010) was to require developers to include (SuDS) in new and redevelopments built to national standards that reduce flood risk and improve or protect water quality. Nevertheless, it is recognised that new housing development represents just a small percentages of the volume pressuring on system. Hence, SuDS retrofitting it also been suggested and there are many associated technologies available[13].

CIWEM also suggests the developing of an Event Duration Monitoring (EDM) systems. In the "Event Duration Monitoring: Good Practice Guide" report, published in 2016[14], CIWEM sets out recommendations and technical guidance for the implementation of a monitoring system. A key focus is on CSOs that affect sensible areas, for which "Near real-time warnings" would be desirable.

4.3.2 Septic Tanks

Septic tanks are underground systems that are used to treat waste water. These systems make use of gravity to settle the solids in the sewage and of bacteria that treat the organic component. The liquid septic effluent is then discharged into the ground through a drain field. This is a set of pipes and trenches that let the liquid component drip into the ground for further treatment by naturally occurring bacteria.

The EA decided to take a more risk-based approach to evaluating the impact of small sewage discharges and employed new general binding rules. In these, the EA describes as "existing discharge" for any septic tank installed up to the last day of 2014, and "new discharge" for any installed after that date.

All septic tank owner are required to make sure that the septic tank

- Does not pollute surface water or ground water.
- Is maintained in accordance with the manufacturer's instructions.
- Is regularly de-sludged.
- Is used only used for domestic sewage.

Also, under the new General Binding Rules, all septic tanks discharging into water course must be replaced or upgraded by the 1 January 2020.

Both existing and new septic tanks are therefore required to "*settle the solids in the sewage and then discharge the liquid septic effluent to ground via a correctly designed and constructed drainage field - NOT a soakaway pit, soakaway crates, tunnels or Ezy Drain. They cannot discharge into ditches, streams, canals, rivers, surface water drains or any other type of watercourse".*

New, higher standards have been set:

- BS EN 12566-1 for septic tanks.
- BS 6297:2007 for drainage fields. No other method of effluent disposal is allowed.

For new discharges, *"The Environment Agency expects developments discharging domestic sewage to connect to the public foul sewer where it is reasonable to do so"* [15].

Water discharge or groundwater activity permit are not usually granted for a private sewage treatment system where it is reasonable to connect to the public foul sewer. No new septic tank system can be installed if within 30m distance of a public sewer; however exemptions might apply in some cases.

In particular, planning permission and Building Regulations approval is required for all new septic tanks. Discharge limits and loads are set by the general binding rules. A different permit is needed for the installation of a septic tank in the proximity of the following special areas:

- Special conservation areas
- Special protection areas
- Ramsar sites
- Biological sites of special scientific interests.

Under current regulations, the solid part has to be removed before it exceeds the maximum capacity and, as a minimum, at least once a year. Maintenance, size and installation are regulated under standards and need to be executed by an accredited company. Further, the owner must check the area once a month for signs of pollution and keep records of work done to empty, maintain or repair the septic, such as invoices, bills or receipts. Written copy of accidents, problems with the equipment and the way these were dealt with must also be kept.

Distribution: The EA dataset reports septic tanks as treatment types. Distribution of known septic tanks in England is showed in the map below. This includes tanks used temporary with seasonal permits, for a total of 15,466 known septic tanks permits. South east region seems to have a higher density of septic tanks that any other area.

Figure 41 Map of Septic Tanks

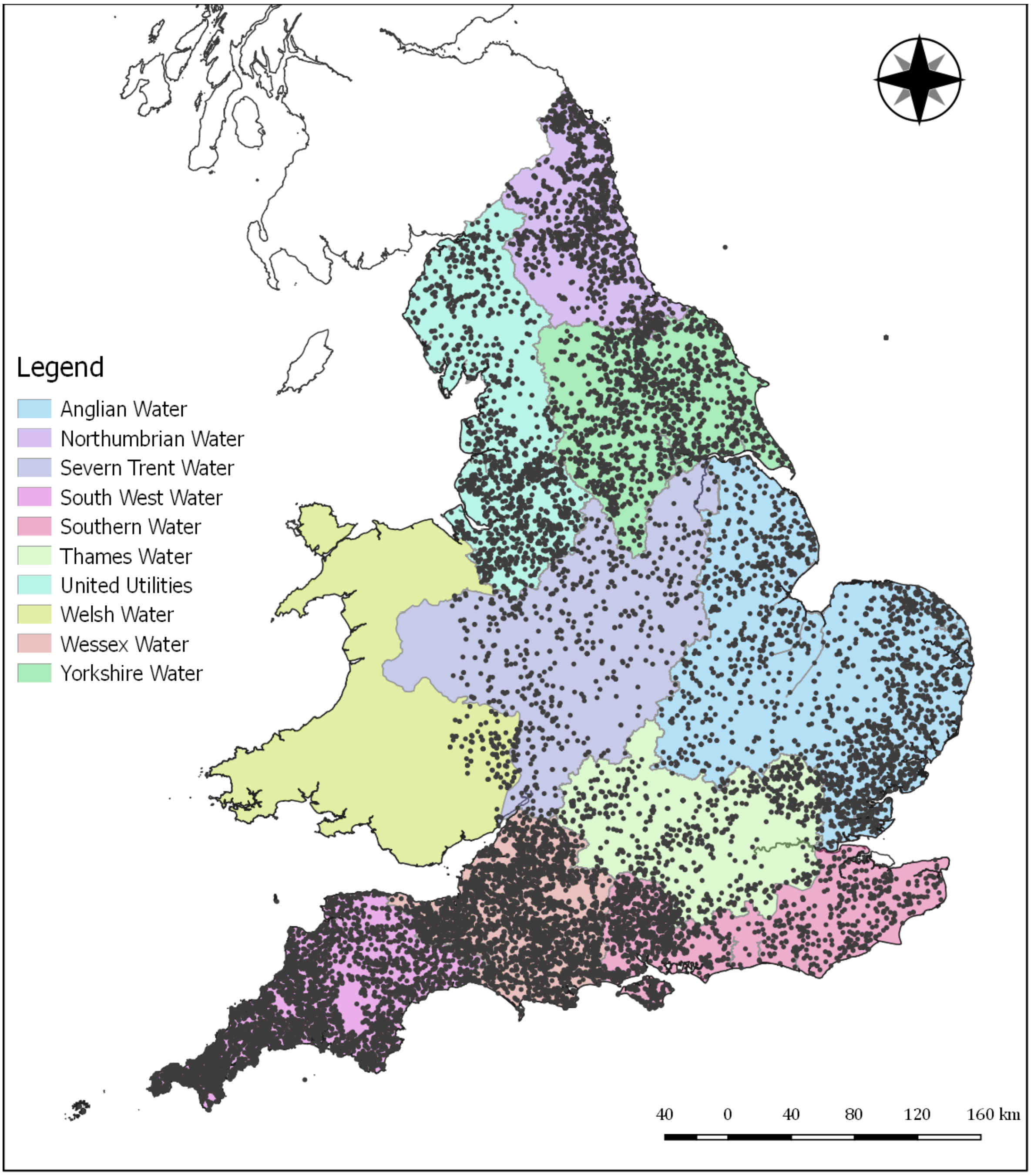


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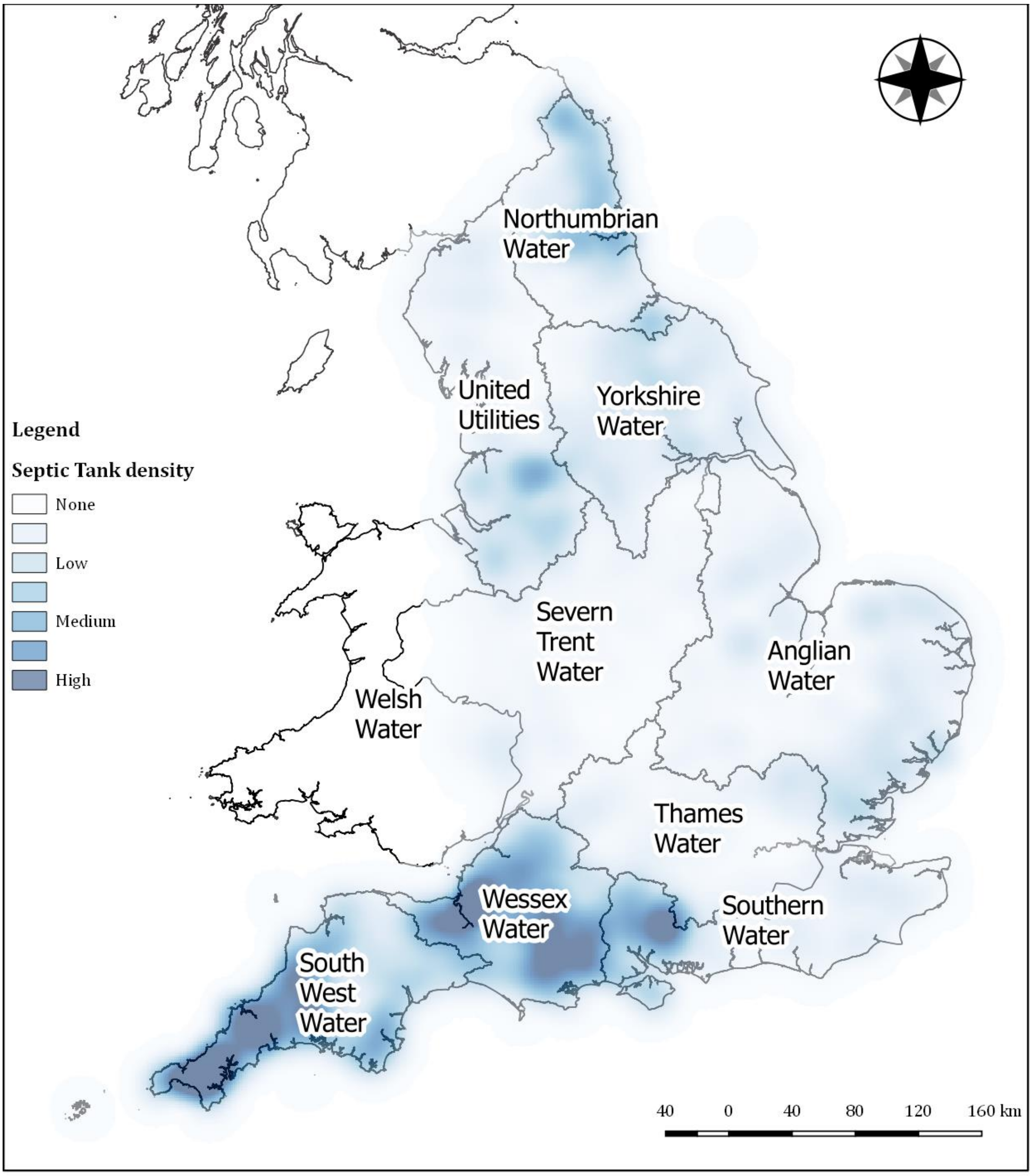
Figure 42 Septic tank heatmap - with Wastewater Company



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Pressures

When septic tanks are not correctly maintained, they will present a pollution threat to the local water supplies, rivers and surrounding wildlife.

Nowadays, the new regulation does not permit septic tank to discharge into soakaways or streams anymore; owner have till 2020 to comply. Improperly treated septic tanks depend on the quality of the source and what kind of pollutant is collected into the system; issues can occur when septic tank overflow or seep into groundwater.

Septic tanks are a potential source of nutrient emissions to surface waters but few data exist in the UK to quantify their significance for eutrophication. Studies conducted before the new regulation indicated that septic tanks would affects waterways more than from what expected considering only their load in nutrients, with difference in the effectiveness of permeable and impermeable soils to treat septic tank effluent effectively[16]. If the septic tank is not updated to meet new standards, potential flows into ditches, streams or effluents can highly alter the cycle of phosphorus and nitrogen, especially in sensitive areas as rural ones.

4.4 Waste water activities impact in England and Wales

The integration of EA/NRW datasets and figures included in reports published by statutory agencies depicts a complex situation where knowledge gaps are evident. Nevertheless, a series of key impacts are recognised as significant. They are detailed in the following sections.

4.4.1 Phosphorus impact

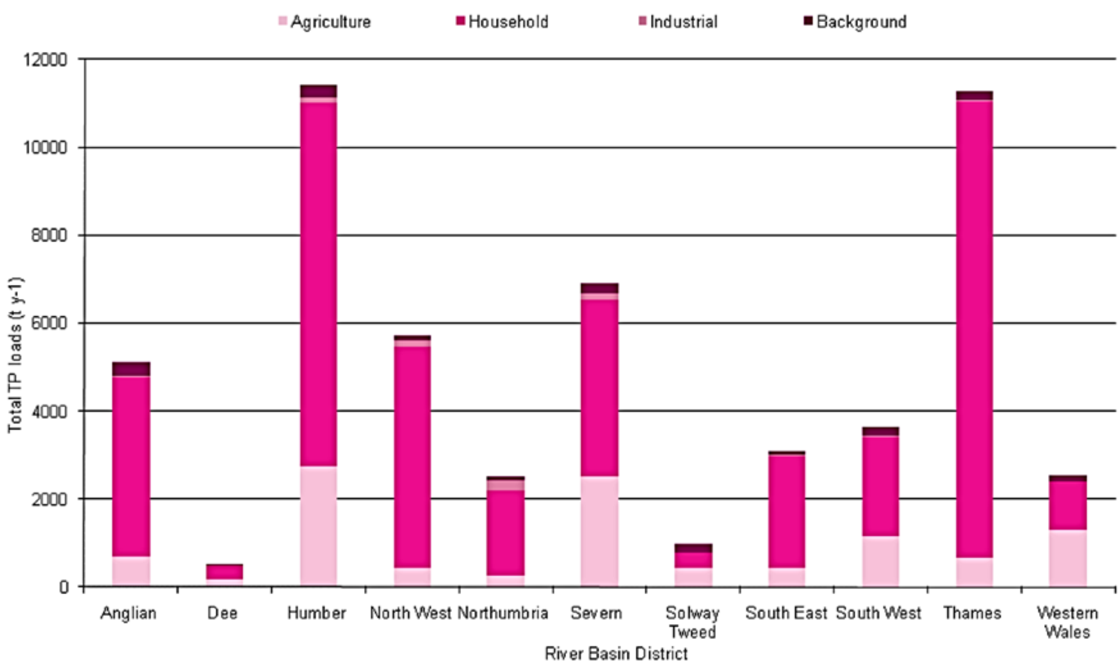
Phosphorus is considered a primary driver of eutrophication, being one of the limiting nutrient in the freshwater ecosystem. When phosphate levels become high species, such algae, can reproduce and thrive thanks to the increased nutrient. This can lead to eutrophication problems, with subsequent reduction in biodiversity. Further, the attention around phosphate levels is becoming predominant due to recognition that there is a lot of uncertainty around it and that models produced so far have not been able to analyse the ramifications of the issue.

Concordant with the analysis of the RNAG dataset, the EA has identified phosphorus as a nationally significant water management issue. Quantitative studies on phosphate levels have been published assessing load and sources in England and Wales. This information is modelled from different sources such as compliance monitoring thus complementing the qualitative statuses reported by the RNAG dataset. In particular**,** the Science and Technology Office of the House of Parliament reports EA statements and figures about phosphate levels in UK[7].

EA states that loss of phosphorus to water bodies, as a percentage of the total applied on agricultural land, is very small (1-10%); however, it still accounts for 20-30% of the phosphorus load in rivers. On the other side, waste water discharge from sewage treatment plants (STPs) is the highest source with 60-80% load contribution in England and 48% in Wales[17]. Other minor sources include diffuse urban pollution (3%) and septic tanks and small containerised sewage treatment plants (3%).

The regions with the higher phosphate load are Humber and Thames, followed by the Severn area, as reported by “Source of Phosphate in England and Wales”[18], published in 2009 and cited by the EA in the following years. The contribution of household sewage appear consistently higher than any other source for all RBDs.

Figure 43 Source of Phosphate in England and Wales as of 2009. SOURCE: Hammond and White



Uncertainty

The assessment of risks from phosphorus is subjected to uncertainties that revolve around a series of key themes. Addressing this uncertainties is a key point in all RBMPs and a recurring theme in reports produced by statutory agencies.

- Difficulty to set standards due to complex chemical and ecological relations between phosphorus and the environment
- Different ecological responses amongst catchments
- The role of nitrogen, alongside phosphorus, in freshwater eutrophication, particularly in lakes and coastal locations.
- The role of phosphate in freshwater cycles, which leads to uncertainties in assessing models and design solutions
- Groundwater contributions are not well understood but may be important in some situations/ periods.
- Lack of quantitative studies about the contributions from septic tanks and small package plants in local situations.

4.4.2 Eutrophication

The information on total phosphorus load is used, in combination with other criteria, to design sensitive areas, which are areas, as defined under the art. 5 of the UWWTD, more sensitive to pollution and impacts that are to be protected by more stringent limits and standards.

The UK government utilises three criteria for the identification of sensitive areas, these are:

- Water found to be eutrophic as result of discharges from relevant agglomerations or that may become eutrophic from such discharges;
- Waters used as abstraction source waters with high nitrate levels are results from discharges from relevant agglomerations'
- Waters identified under other directives that require tertiary treatment to meet their parent directive's quality requirements

All waters draining the catchments of the sensitive receiving water are included in the sensitive area designations under the UWWTD. Once an area has been identified as sensitive, treatment works and consents discharging either directly or indirectly into the sensitive area must have in place more stringent processes for the treatment of urban waste water.

England and Wales have proceeded to design a total of 443 area, detailed as below:

Table 18 Sensitive Areas in England and Wales

SA type	England	Wales	Totals
Bathing Water	181	24	205
Eutrophic Water	165	5	170
Freshwater Fish Water	0	0	0
Abstraction source water	8	0	8
Shellfish Water	48	12	60
Totals	402	41	443

The composition of these areas can comprise different water body type and made up of surface areas (km^2) and length (km). The coverage of sensitive areas for England and Wales is detailed in the below table.

Table 19 Length and Area of Sensitive areas in England and Wales

Sensitive area type	Unit	England	Wales	Total
Bathing Water	km²	159.06 km²	34.82 km²	194 km²
Eutrophic Water	km	4,338.47	120.62	4,459
	km²	221.16 km²	12.52 km²	234 km²
Freshwater Fish	km	-	-	0

Water	km²	-	-	0.00 km²
Abstraction source water	km	4,338.47	-	4,338
	km²	-	-	0.00 km²
Shellfish Water	km²	159.06 km²	34.82 km²	194 km²
Total length (km) *		8,677	121	8,798
Total area km² *		539 km²	82 km²	621 km²

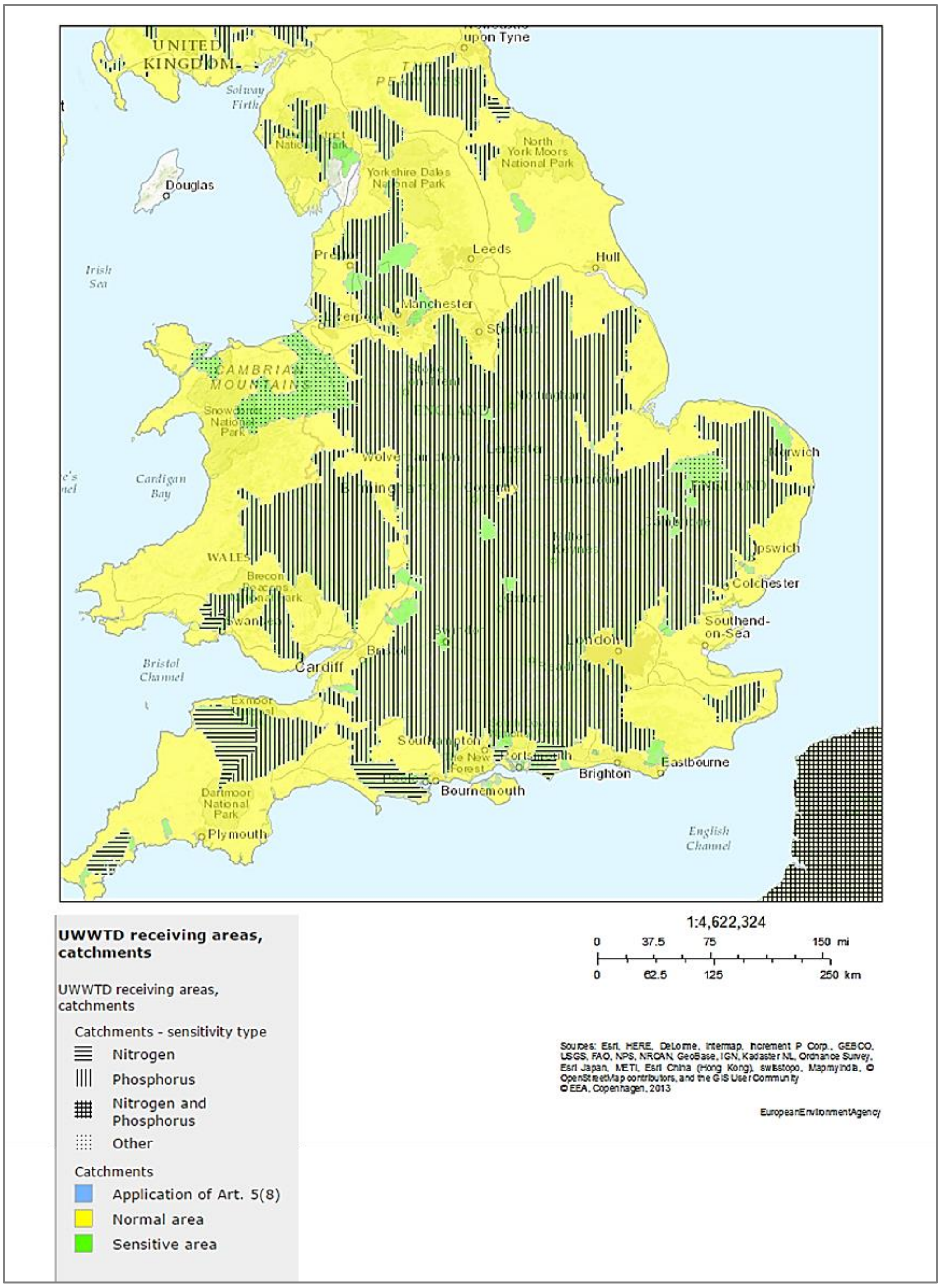
Overall, the UK has designed a number of specific areas (Figure 44) as sensitive under the art. 5 of the UWWTD; the areas appear to cover the RBDs where phosphorus load is reported as higher (Humber, Thames and Severn RBDs).

Further, the 8th report on Member States UWWTD compliance states that UK is still behind in the proper identification and protection of the sensitive areas (96.15% compliance). Sensitive area designations generally arise from four-yearly reviews as required by Article 5.6 of the UWWTD. The Directive allows a maximum of seven years from the designation date for the provision of tertiary treatment at treatment plants serving agglomerations of greater than 10,000 p.e. whose discharges are made to or affect sensitive areas.

In detail: *"United Kingdom […]]has nationally designated 589 sensitive areas as well as 232 catchment areas of sensitive areas due to different criteria (nitrogen and/or phosphorus, criterion b and criterion c related to requirements of the Bathing Water Directive). Different designation dates (between the years 1994 and 2007) are in place. In the year 2011, 45 sensitive areas and 36 catchment of sensitive areas were newly designated. However, it has to be noted that not all sensitive areas (only 391 sensitive areas) are reported in this report (such as sensitive areas that receive no direct discharges) and that* ***United Kingdom is not legally designating the catchments of sensitive areas****. Compared to the last report and information received by national authorities, the number of sensitive areas (331 as reported for the reference year 2010) and catchment of sensitive areas (196 as reported for the reference year 2010) significantly increased from the last report to the year 2012".*

The report describes a situation where the UK has not initiated the necessary action to protect vulnerable zone and a compliance level for these area that is not adequate. More information about UK compliance are reported in section 4.7.

Figure 44 Current (as of 2012 dataset) Sensitive Area Boundaries and sensitivity type. SOURCE: http://www.eea.europa.eu/



Regarding eutrophication trend, not much has been published at national level.

The "Climate change and eutrophication risk in English rivers" report[19], published in 2016, is the most recent attempt to assess the issue at a national scale. The research studied 116 sites across the UK as representative for phosphorus load. The results indicate that "*current management interventions are inadequate to achieve good status by the 2050s*". Different scenarios have also been contemplated, including climate change forecasts; nevertheless, changes in phosphorus treatment at STWs still would fail to achieve good status in most sites across the climate change scenarios. Overall, the report states that any assessment requires a greater understanding of the factors driving phosphorus dynamics.

4.4.3 Other pollutants

Waste water can also affect environment, recreational and drinking water and human health in relation with other pollutants.

Enterococci

Both drinking and recreational waters are monitored for microbial quality. In drinking water, coliforms, including total and faecal coliforms, are the primary method of assessing contamination.

Enterococci are common bacteria, commensal members of gut communities in mammals and birds, however, they are also opportunistic pathogens that cause millions of human and animal infections annually. In the European Union (EU), enterococci are used as indicators of drinking water contamination; they are not permitted in a 100 mL sample of tested drinking water that flows from a tap, and they are not permitted in a 250 mL sample of bottled water.

Sources of enterococci in recreational waters include sewage, agricultural and urban runoff, storm water, direct input by animals via defecation, bather shedding, boats, plant debris (for example, wrack), polluted groundwater, soils, sediments, and sands.

Untreated waste water can hosts high concentration of enterococci; however, in developed countries one of the main source of enterococci can be run off from urban locations and spills from CSOs., so that during storm events this untreated waste water can impact recreational waters. The source of enterococci in runoff can include soil, animal faeces, infiltrated raw sewage, and decaying plant material.

A report from Defra, with respect to drinking water, state that In England in 2014, *only 31 out of a total of 150,248 samples contained faecal indicator organisms (E.coli and Enterococci) compared to 60 1 out of a total of 146,760 in 2004*. This show a declining trend.

Further, in the UK Escherichia coli and Intestinal enterococci are now the only parameters measured for the assessment of Bathing Waters. These are assessed against the Directive's standards to produce a classification for each bathing water. The old assessment was based on 80% of the samples of bacterial parameters passing the set levels.

The 2015 report on the status of UK Bathing Waters states that: "*Bathing water quality improved steadily between 1988 and 2014, largely as a result of improvements to the sewerage system by water companies. Latterly, variations from year to year have related to weather conditions, as combined sewer overflows operate more frequently during wet weather, diffuse pollution from urban and agricultural sources is increased, and in poor summers there is less sunlight to kill off bacteria in water*"[20]. Nevertheless, not all bathing waters have been monitored; some sites have been analysed with less than four years' worth of data and for three sites there was no access for public so they have not been monitored.

Synthetic pollutants

Nowadays sewage effluent contains a complex mixture of chemicals, including pharmaceuticals, which are collected from household when people excrete them through urine. These chemical are new source of potential pollutant yet to be assessed properly by waste water treatment.

One of the most impactful chemical is the Ethinyl estradiol (EE2), which is the main active ingredient of contraceptive pills. Studies found that EE2 plays an *extraordinary role as a pollutant because of its high estrogenic potency and because it is, in the aquatic environment, more stable and persistent than natural oestrogens"*. The chemical can trigger a condition known as intersex in freshwater fish, which has caused significant drops in populations in many species.

A research published in 2012 found that in 45 sites on 39 rivers in the UK, steroidal oestrogens played a major role in causing intersex in wild freshwater fish in rivers[21]. Nevertheless earlier signs were visible already in the precedent decades[22]. In 1978, in the Thames areas, were found eggs developing in the testes of five out of 26 male fish of the commonly caught species *Rutilus rutilus* (the roach). Field trials in the late 1980s, confirmed that oestrogen-inducted modifications in male trout placed for just two weeks in the sewage treatment plant effluent from Rye Meads sewage treatment works (which entered the River Lea) underwent a 100 000 fold increase, reaching levels equivalent to those in mature females.

The research appear to confirm that EE2 is not properly treated. To reduce dangers posed by these concentrations, the EU proposed in January that it would set a level of 0.035ppt for EE2 in water in Europe.

Another fairly new synthetic pollutant, which arose to the public attention are microbeads and microplastics. Microplastics are generally classified as particles smaller than 5mm. They are used in some cosmetic and personal care products, for example as exfoliation microbeads.

The Environmental Investigation Agency (EIA) estimated that there are between 80,000 and 219,000 tonnes of microplastics entering the marine environment from Europe per year. Impact on the environment can vary, from ingestion of microbeads by both fish and birds, to intoxication due to the synthetic polymer itself.

In a recent report published in 2016, the House of Common Environmental Committee listed a series of study that demonstrated that microbeads were affecting different species[23]. It also recognised that more studies are need, however it stressed the impact of microbeads on the environment are not to be underestimated. Another important point was the link between microplastics and human health; the report states that it is uncertain whether microplastics that are ingested by humans can be transported into tissues; however microplastics are widely used as carriers for medicines, and can transfer into tissues in humans. Studies are needed to understand the potential harm to humans.

Overall, further studies and research are needed to understand the impact and extent of new pollutant that can be discharge into the environment through the waste water. These considerations cover not only "new" pollutant that have been publicised more and on which research has started, but also new chemical developed by pharmaceutical companies and other industries for human consumption.

4.5 The rivers most at risk (due to waste water pollution) in England and Wales

Artesia were asked to produce a list of the top rivers at risk for wastewater pollution in England and Wales. Due to the lack of weighting system in the RNAG dataset, the ranking has been produced following the rationale below:

- Ranked at higher risk rivers that
    - Do not have the classification objective reaching Good in the foreseeable future. – i.e. rivers that EA and NRW predict will be having bad, poor or moderate ecological status in the foreseeable future (2021 or 2017);
    - Have a higher number of element failing in 2015.
    - Having a high proportion of the RNAG attributed to wastewater pollution during Cycle 2.
    - Described as not having technical feasible solution and/or disproportionate costs.
    - Described as having cause of adverse impact unknown (as additional ranking element).

The rationale behind the technique is that river failing more elements, predicted as not reaching good status by 2027 and with additional technical problems have more issues.

Due to the way the method is developed, the method cannot take into consideration rivers where:

- RNAG are not described;
- Element are not assessed;
- RNAG are less in number but have a higher "real" impact on the river – i.e. river where one only few elements are failing while other have not been assessed,
- Other concurrent activity that highly impact rivers – i.e. Goedol river , which is also highly impacted by mineral pollution from abandoned mines
- Does not take into consideration the size of the water body – i.e. length of river has not been taken into account for ranking purposes.

The methodology is slightly different for Wales and England, due to the different approach in the status objective and different descriptors for the RNAG dataset that the agencies have used. Therefore, they have been considered separately. The attributes of the rivers, such as: number of element failing, number of RNAG due to wastewater pollution, status objective(s) and technical assessment comments are available in the appendix.

Top 12 rivers at risk – England

- Lee (Tottenham Locks to Bow Locks/Three Mills Locks)

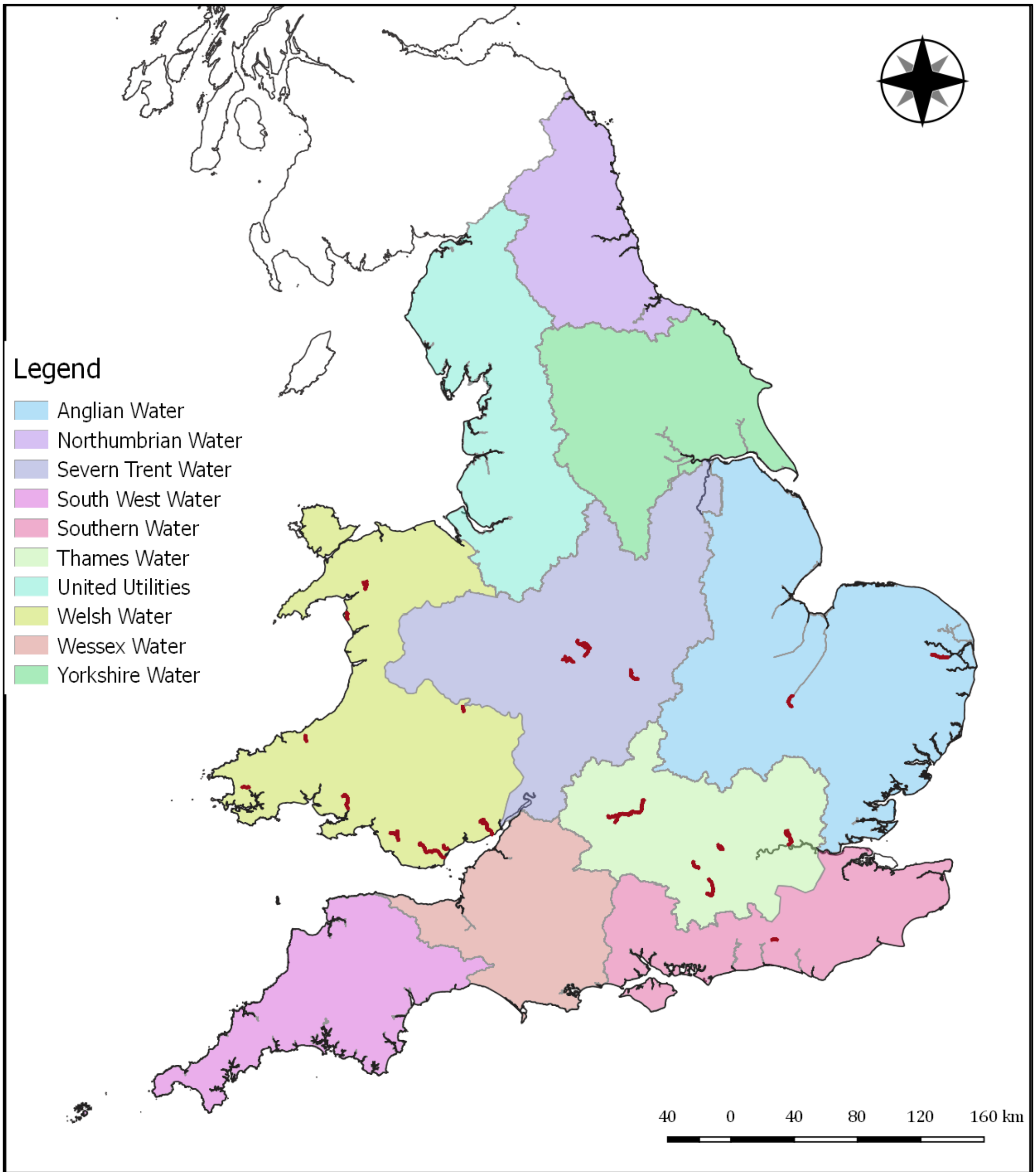
- Tame (W/ton Arm) source to conf Oldbury
- Crane Brook - source to FootherleyBrook
- Thames (Leach to Evenlode)
- Blackwater (Aldershot to Cove Brook confluence at Hawley)
- Swavesey Drain
- Wem Brook from Source to River Anker
- Roundmoor Ditch and Boveney Ditch
- Barkham Brook
- Chet
- Adur East (Goddards Green)
- Footherley Brook from Source to Black-Bourne Brook

Top 10 rivers at risk Wales

- Norton Bk - source to conf R Lugg
- Nedern Bk - souce to R Severn Estuary
- Roath Brook
- Ely R - conf Nant Clun to Allot Gardens, Ely
- Llynfi - Lletty Brongu STW to conf with Ogmore
- Gwili - headwaters to tidal limit
- Pelcomb Brook - headwaters to conf with W. Cleddau
- Dyffryn Ardudwy - Main Drain
- Dulas - headwaters to conf Ceri
- Goedol

Their distribution is mapped below

Figure 45 Top river at risk from pollution from wastewater

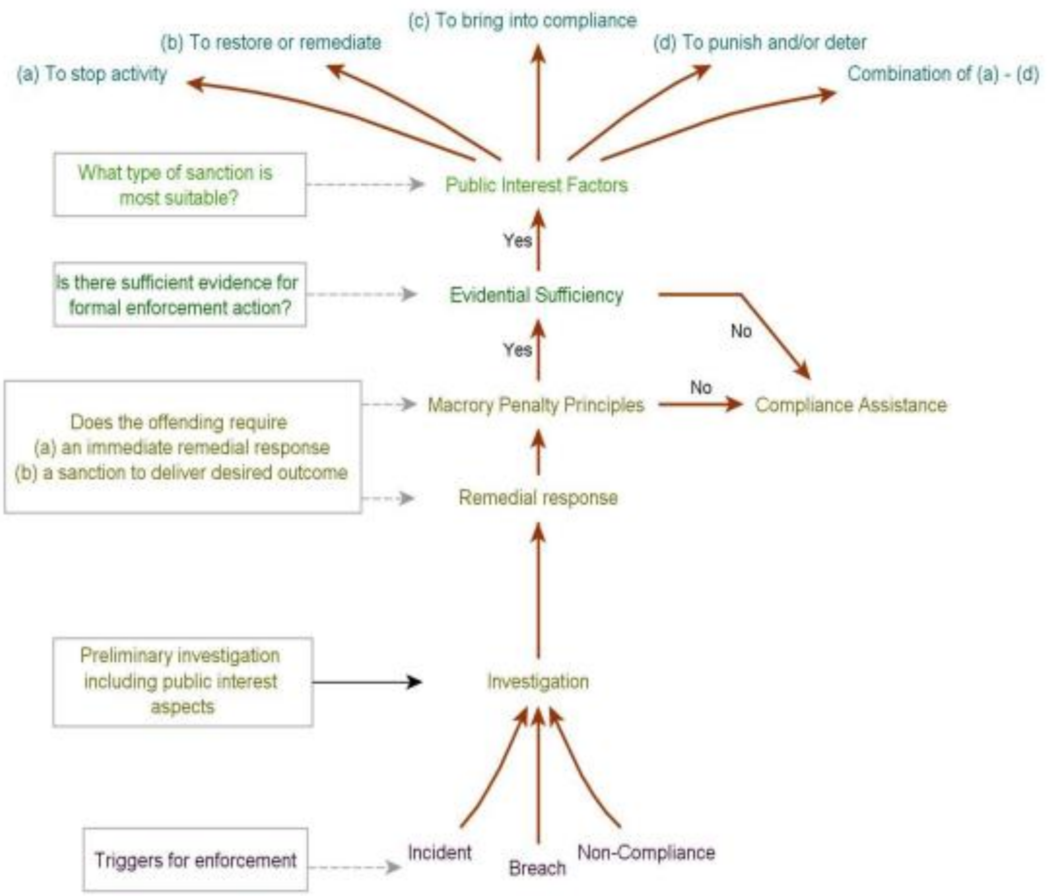


4.6 Enforcement and Sanction

Pollution incidents can play a significant role in affecting the quality of water bodies. When The EA discover an activity that is not compliant with the legislation, the agency can enforce different tools in order to protect the people and the environment.

In the Enforcement and Sanction Guidance[24], the EA sets a list of environmental outcomes to pursue and a list of tools available to achieve the results. These can differ from verbal; or written notices, injunctions, court orders and fines. The decision follows a scrutiny as per following figure.

Figure 46 Sanction decision tree



Before getting to the point of a sanction, the EA purport to offer assistance either verbal or written. Where possible, the EA seeks to achieve a lasting solution to the problem that caused offences to be committed.

4.6.1 Pollution incidents due to the Waste water sector

When an activity causes an incident that affects the environment the EA records the episode in the NIRS2 (National incidents recording system) database when reported. Here, the incidents is assigned to a classification following the magnitude of pollution to a specific medium (water, land, air). The classification is the following:

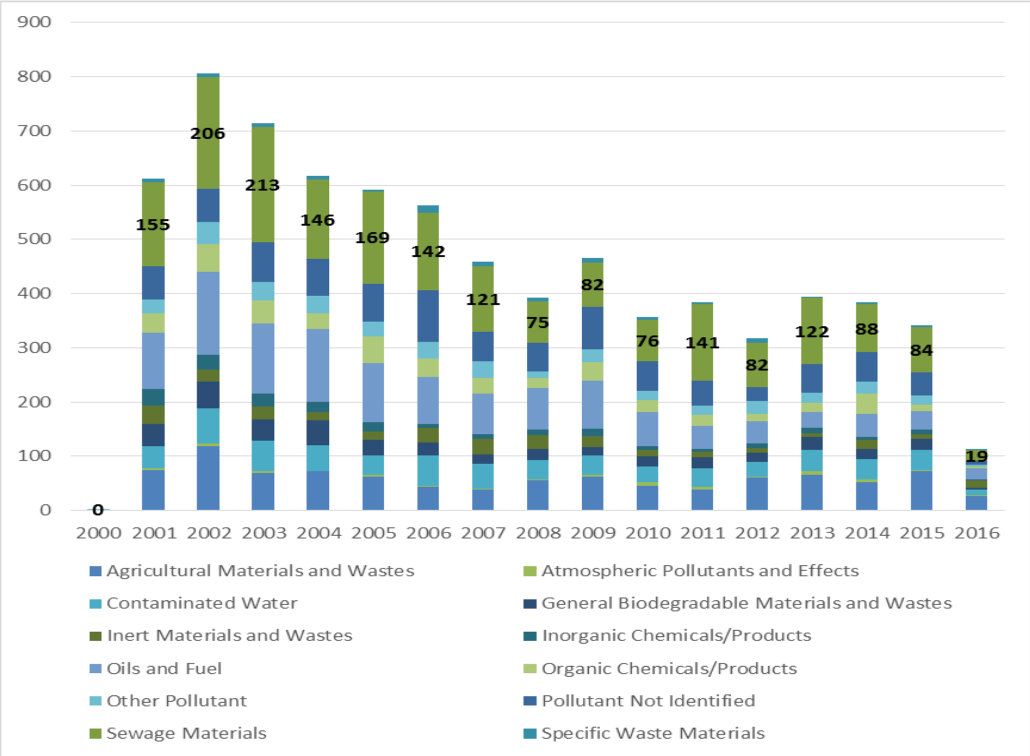
- Category 1 (Major)
- Category 2 (Significant)
- Category 3 (Minor)
- Category 4 (No impact)

To be included in the database, an incident has to be significant for at least one of the pollution parameters. The data provides information about pollution emissions from regulated sites.

No freely available information is present for Natural Resources Wales, therefore the results refer only to data reported for England

The database covers incidents from 2001; around 54% of incidents have affected water quality at least to a **significant level.**

Figure 47 Incidents affecting water (Category 1 & 2) - England



Of all these incidents, 34% are due to sewage materials or contaminated water. Figure 48, Figure 49, and Figure 50 show the trend of sewage-related incidents from 2001.

Figure 48 Sewage incidents by year – England

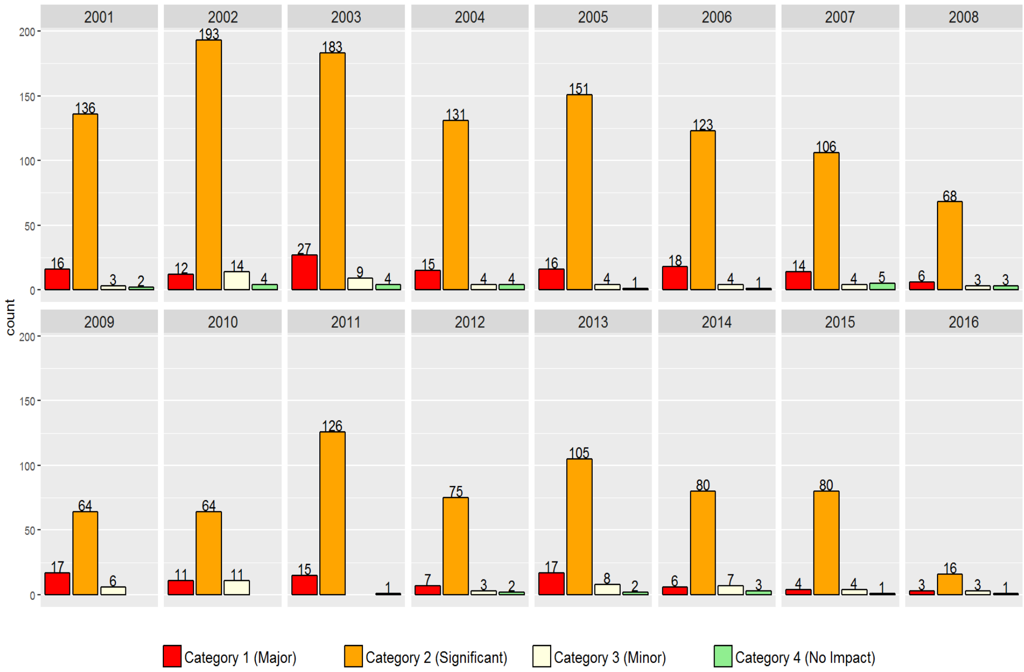


Figure 49 Sewage incidents by EA area

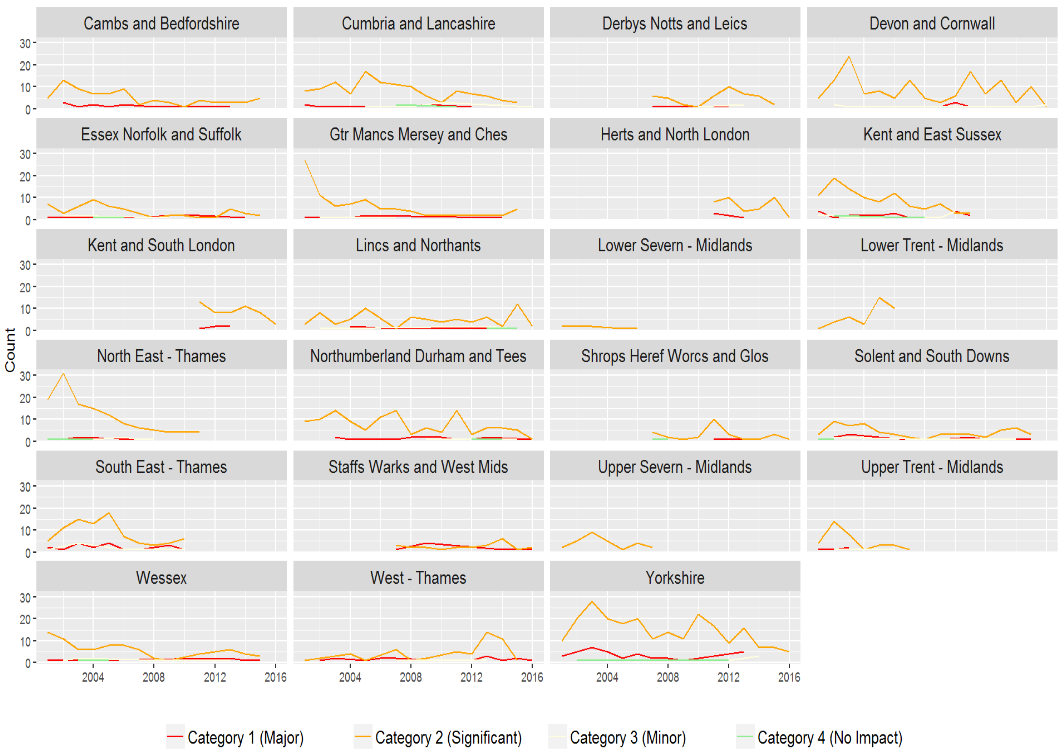
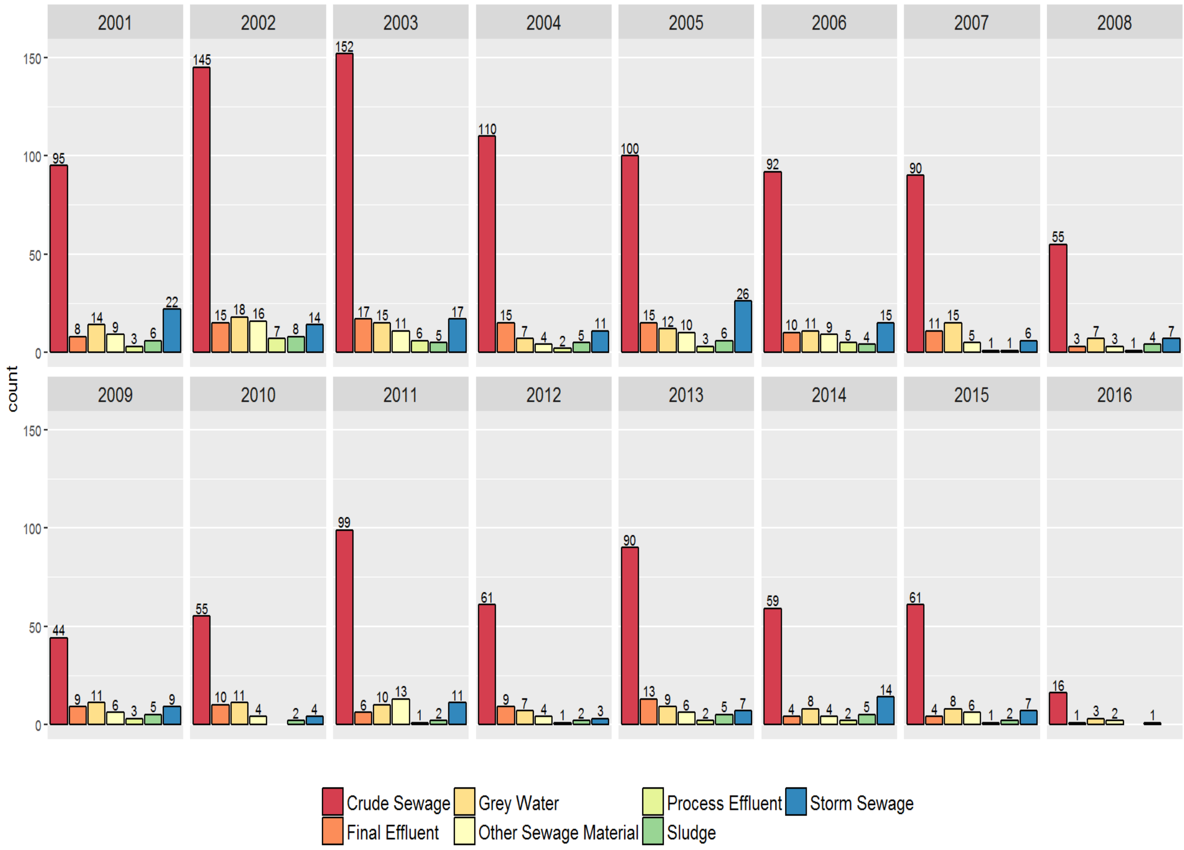


Figure 50 Sewage incidents by type - England



It appears clear that the number of incidents has decreased over the years. An analysis of the pollution incidents investigation and prosecution is conducted in the following section.

Pollution fines

The EA keeps a database (for England) of all fines (monetary or not) that are issued against companies and individuals that pollute the environment. Information about individuals are restricted to the type of pollutant events and omit the date in which the fine occurred and any kind of location identification.

Regarding companies, EA reports also the date when the case was deliberated, the amount of fine and the type of incident type (water, waste, radioactive substance etc.). The dataset give details about duplicated entries, probably indicating that the company or individual was fined for two sanctions on the same day. The dataset has been analysed following this rationale and including all fines reported.

Considering fines due to pollution events that affects water quality or in general the water resources, Figure 51 and Table 20 summarise the total amount of monetary fines that waste water companies have been subjected to from 2000 to early 2016 (not the full year).

Figure 51 Amount of fines per year towards waste water companies - England

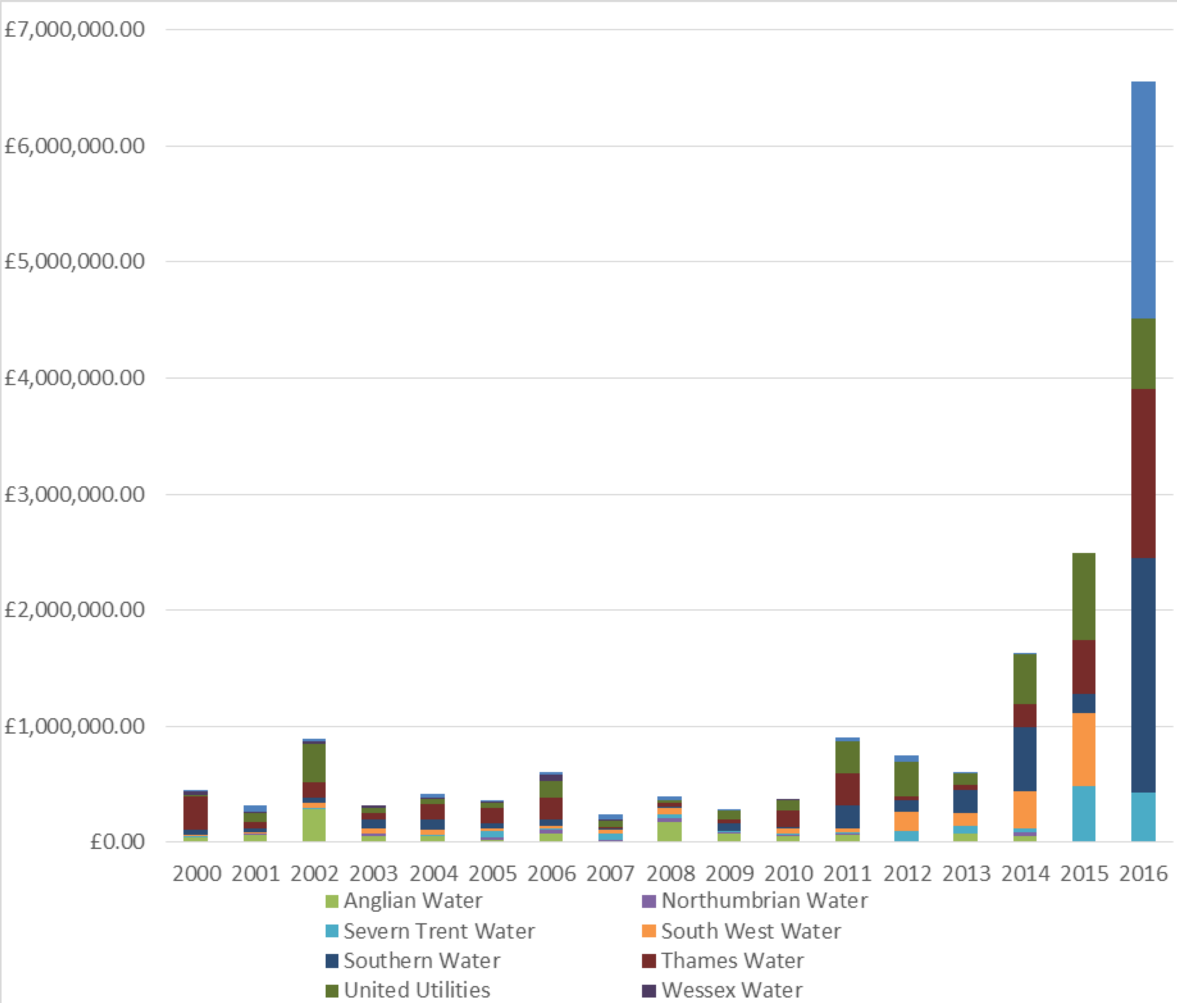
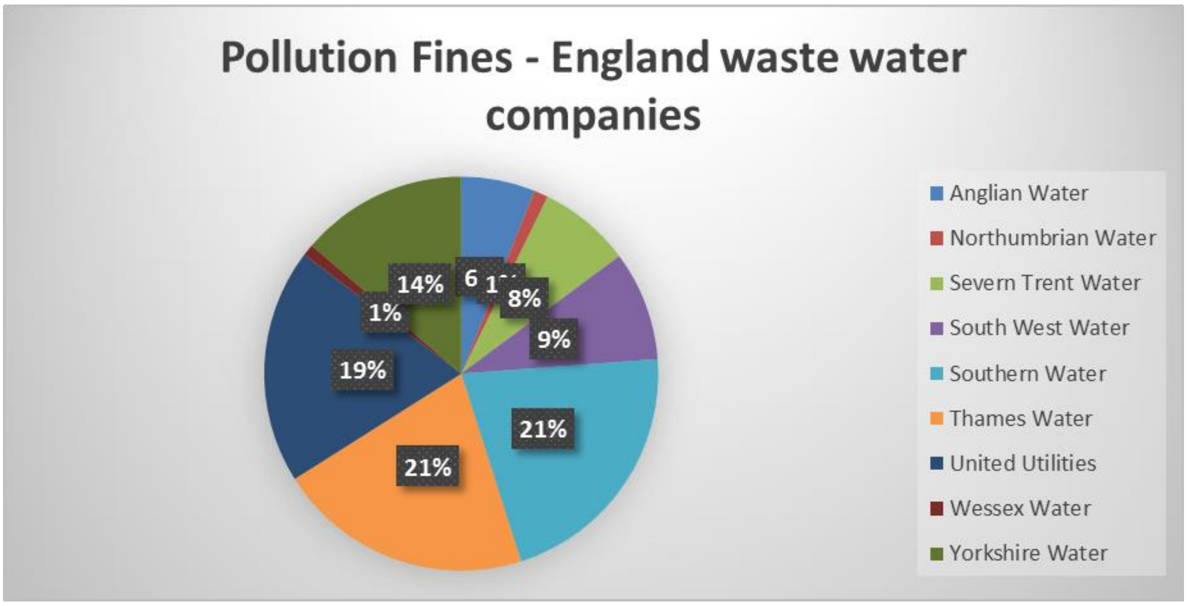


Table 20 Amount of monetary fine per waste water company - England

Year	Anglian Water	Northumbrian Water	Severn Trent Water	South West Water	Southern Water	Thames Water	United Utilities	Wessex Water	Yorkshire Water	Total per Year
2000	£36,500	£3,500	£7,500	£16,500	£45,000	£288,000	£12,000	£27,000	£6,000	£442,000
2001	£59,000	£14,700	£1,000	£7,500	£37,000	£57,600	£70,500	£11,500	£52,000	£310,800
2002	£285,000	£500	£12,000	£46,000	£34,500	£140,000	£327,500	£18,000	£31,500	£895,000
2003	£47,500	£25,500	£5,000	£41,000	£73,200	£60,000	£46,500	£15,000	£0	£313,700
2004	£50,905	£2,000	£5,000	£48,400	£90,500	£132,500	£42,200	£14,000	£33,900	£419,405
2005	£21,500	£20,500	£52,750	£17,800	£53,000	£128,000	£47,500	£6,000	£6,000	£353,050
2006	£75,000	£26,000	£20,000	£21,300	£52,625	£191,600	£137,300	£56,250	£22,000	£602,075

2007	£8,000	£6,000	£63,330	£25,200	£18,000	£6,000	£54,000	£11,500	£52,000	£244,030
2008	£173,000	£29,500	£39,200	£51,600	£16,500	£27,000	£23,000	£3,000	£31,500	£394,300
2009	£75,000	£11,666	£6,700	£4,500	£66,500	£26,500	£79,000	£0	£12,000	£281,866
2010	£49,000	£12,000	£15,000	£36,000	£13,000	£142,500	£95,000	£6,000	£0	£368,500
2011	£67,000	£9,500	£4,000	£40,000	£194,500	£278,985	£272,000	£0	£38,835	£904,820
2012	£0	£3,000	£87,000	£167,900	£103,000	£32,000	£298,000	£0	£57,200	£748,100
2013	£68,000	£10,000	£65,000	£105,000	£200,000	£45,500	£100,500	£0	£8,000	£602,000
2014	£50,000	£30,000	£42,500	£318,000	£550,000	£193,000	£433,000	£0	£7,500	£1,624,000
2015	£0	£0	£480,000	£634,500	£160,000	£470,000	£750,000	£0	£0	£2,494,500
2016	£0	£0	£426,000	£0	£2,024,000	£1,460,000	£600,000	£0	£2,050,000	£6,560,000
Total per Company	£1,065,405	£204,366	£1,331,980	£1,581,200	£3,731,325	£3,679,185	£3,388,000	£168,250	£2,408,435	£17,558,146



As a trend, the amount of fine has increased over the years, with a number of prosecution resulted in headlines on newspaper and TV news. Below are some examples (from gov.uk website and other sources:

Anglian Water

- December 2011 - Fined £32,000 with £3,974 costs at Lincoln Magistrates' Court after polluting a Lincoln stream. Between July 2004 and October 2008 five previous pollutions were attributed to blockages in the foul sewer and two formal cautions were issued to Anglian Water.

- October 2012 - Fined £36,000 with £5,973 costs at Chelmsford Magistrates' Court for polluting a 3 km stretch of the River Chelmer in Thaxted, Essex in June 2012, killing hundreds of fish including lamprey, bullhead, minnow, stickleback and stone loach. The fine was reduced on appeal.

- March 2013 - Fined £20,000 with £2,896 costs after sewage spilled from a pumping station at Filby, near Great Yarmouth, into the Ormesby Little Broad. Between September 2006 and March 2011 there were five previous similar incidents.

Northumbria Water

- In 2014, Northumbria were fined £14,000 and ordered to pay £3,996.04 costs and a £120 victim surcharge for a pollution incident happened the year before. A storm overflow had discharged into a river, killing thousands of invertebrates and polluting the river. The overflow had operated incorrectly because of a blockage, and the company had not been aware because its monitoring equipment on the sewer was not working correctly.

- In the same year, the firm was fined £16,000 and ordered to pay £4,772.52 costs for a pollution incident where a watercourse had been affected with sewage when a blockage in a sewer had caused a manhole cover to lift, allowing sewage to flow out, across a farmland and into the beck. Northumbrian Water was informed about the problem, but failed to investigate the issue for four days claiming difficulty to access the site

Severn Trent Water

- In 2014, the company was fined £25,000 and ordered to pay £10,267.05 in costs, along with a £15 victim surcharge for a pollution incident where sewage was discharging from a blocked manhole in a field of wheat east of Carcar Farm. The sewage then flowed over the field into a ditch known as the Gelder Beck, then into the Catchwater Drain, consequently entering Messingham Reservoir via an overflow pipe. The company pleaded guilty and cooperated with the EA.

- On 21 July 2016, at Nottingham Crown Court, Severn Trent Water Limited were fined £426,000, ordered to pay Environment Agency Costs of £38,642.60 as well as a victim surcharge of £120. Severn Trent Water had previously pleaded guilty to the charges at Nottingham Magistrates Court on 25 November 2015. The fine refers to repeated pollution incidents where crude sewage leaked into the Shire Brook on the border of Derbyshire and Nottinghamshire on three separate occasions.

South West Water

- In 2014, South West Water were fined £40,000 for exceeding the numerical discharge limits set out in the permit and £7,500 for failing to report this to the Environment Agency. South West Water was also ordered to pay £3,200 in costs. The issues related to treatment works that had failed. These issues resulted in a breach of the permit conditions, which require South West Water to ensure that the treatment works operate correctly and to notify the Environment Agency of any problems that might affect sewage quality.

- In 2014, the company was fined £45,000 with costs of £5,700 and a £240 victim surcharge for five occasions when waste that entered a stream had exceeded the limits for pollution set in the permit. On occasions concern had been expressed about the condition of the site and planned site visits were missed. The court took into account the frequent number of visits the company paid to the site, and the steps that had been taken to rectify problems.

Southern Water

- In 2014, Southern Water were fined £500,000 and agreed to pay costs of £19,224 at Canterbury Crown Court after an Environment Agency (EA) investigation found that untreated sewage was discharged into the Swalecliffe Brook, polluting a 1.2 kilometre stretch of the watercourse and killing local wildlife. Swalecliffe Brook flows through the Thanet Coast Site of Special Scientific Interest (SSSI). Untreated sewage discharged via the Brook Road Wastewater Pumping Station's emergency outlet. The pumping station had encountered operational issues in the week leading up to the pollution event. As a consequence of the spillage, restrictions were placed on bathing at local beaches. Local shellfish growers were advised that if tests showed high levels of contamination they would be unable to sell the shellfish harvested locally ahead of the Whitstable Oyster festival 2013. Environment Agency officers found the water was heavily discoloured with dead sticklebacks and eels at regular intervals along the polluted stretch of the watercourse. Water quality monitoring carried out on site recorded high levels of pollution and very low dissolved oxygen. This indicated that the brook had indeed been contaminated with untreated sewage. A survey identified 249 fish had been killed as a result of the polluting discharge, including 155 eels which are a critically endangered species.

- Southern Water has been fined £24,000 and agreed to pay costs of £33,218 after an Environment Agency investigation found that the company failed to meet the conditions set out in its environmental permit for Tunbridge Wells North waste water treatment works. Southern Water pleaded guilty to the charges under the Environmental Permitting Regulations 2010. In mitigation, Southern Water stated that they had already spent £360,000 on improvement to the treatment works and a further £6 million was planned for the future.

Thames Water

- Thames Water Utilities Limited (Thames Water) has been ordered to pay record-breaking £1 million after polluting a canal in Hertfordshire. This was the highest ever fine for a water company in a prosecution brought by the Environment Agency. The case was brought by the Environment Agency after Thames Water caused repeated discharges of polluting matter from Tring STW (Sewage Treatment Works) to enter the Wendover Arm of the Grand Union Canal in Hertfordshire between July 2012 and April 2013. The court heard that poorly performing inlet screens caused equipment at the works to block, leading to sewage debris and sewage sludge being discharged into the canal. The inlet screens should take out the majority of sewage debris referred to as 'rag' from the process, but the screens had repeatedly failed in this case.

- On Monday 7 March 2016 the company was also ordered to pay costs of £23,092.64 and a victim surcharge of £120 for the ongoing management failures at a site the court described as clapped out were lamentable and caused the company to breach the site permit on a number of occasions between February and July 2013.

United Utilities

- Between April 28, 2010 and December 9, 2010 UU had not operated the siloxane plant in accordance with its permit UU had not obtained the EA's prior written approval to install two carbon filters and blank off the stack at the plant, in contravention of its permit conditions. UU was fined a total of £75,000 and have previously been ordered to pay costs of £18,980 at Trafford Magistrates Court.

- On October 2011 a gas holder, which was part of the sludge treatment system, suffered what was described as a 'catastrophic failure' and tilted sideways. As a result, 50,000 cubic metres of biogas – containing methane and hydrogen sulphide – escaped for three weeks. The Environment Agency estimated that the potential contribution to the greenhouse effect in the atmosphere was equivalent to 456 tonnes of carbon dioxide. United Utilities admitted two breaches of environmental permit conditions and was fined £200,000 for each offence at Manchester Crown Court.

Wessex Water

- March 2010 - Fined £6,000 with £2,235 costs at Weymouth Magistrates' Court after allowing sewage to pollute the River Stour near Shaftesbury in March 2009.

- The offer includes actions for Wessex Water to improve its operations and infrastructure, as well as financial contributions totalling £25,500 to environmental organisations and those affected by the offending. It follows a major pollution incident in Bristol on 11 July 2013, when a blockage in a main sewer resulted in raw sewage being discharged into the River Trym. The volume of sewage which entered the river had a large impact, with 112 eels, 200 sticklebacks, 1000 bullheads all found dead as a result of the pollution and an estimated 90% of river invertebrates also killed. The incident was reported to the Environment Agency by concerned members of the public who had seen dead and struggling fish floating on the surface of the water.

Yorkshire Water

- In 2016, Yorkshire Water have been fined £1.1million for illegally discharging sewage that polluted the River Ouse near York. The company was sentenced after previously admitting three environmental offences relating to the operation of its Naburn treatment works in Fulford. The Environment Agency saw a large volume of sewage effluent discharging from the works into the Ouse. It smelled like sewage and could be seen in the water for about 200 metres to Naburn Marina. Water quality in the river was affected for up to a kilometre. The sewage had overflowed into the river because of a pump failure at the treatment works. Three pumps are needed to cope with the volume of sewage, and the company is legally required to have at least one backup pump available in case any of the others fail. But at the time of the incident, when one of the pumps failed, the backup was not operational. It has been out of use for five months - a breach of the firm's environmental permit. With only two pumps working, sewage flowed into emergency storage tanks, filled them up, and approximately 6,000 cubic metres of sewage overflowed through an old outfall into the river, at a location where discharges are not permitted. Had the backup pump been operational, the pollution incident would have been avoided.

- Yorkshire Water Services Ltd has been fined £600,000 after an ageing sewage pipe burst and killed hundreds of fish in a Wakefield lake. The company was sentenced at Leeds

Crown Court on Tuesday 19 January after pleading guilty to one charge of causing a water discharge that was not authorised by an environmental permit. Yorkshire Water was also ordered to pay investigation and prosecution costs of £24,000 to the Environment Agency, which brought the prosecution following a pollution incident at Walton Colliery Nature Park in October 2013.

Dŵr Cymru

- In 2014, Dŵr Cymru were fined £35,000 and ordered to pay more than £3,300 costs. Following an incident where a burst pipe discharged more than 23 million litres of sewage onto an industrial estate closing a factory for several days, blocking a footpath and threatening water quality. Two weeks after the burst in Kinmel Bay in February 2013 there was a second incident which caused more sewage to flood the area. After another burst in July more than two million litres of sewage flooded the same area. Dŵr Cymru officials pleaded guilty to three charges of contravening the requirements of an environmental permit when they appeared at Llandudno Magistrates Court. The court heard Dŵr Cymru were aware of weaknesses in the pipe after a previous incident in 2010 but no action had been taken.

Pollution incidents trend

The previous section shows that fines are issued for several categories of incidents that are caused by different degrees of failure from diverse activities. The amount of fines has also increased considerably in the last few years. It follows that the waste water system is identified as responsible of impacting waters with different magnitude with activities that pressure the environment on diverse scales and levels.

At the same time, compliance with legislation is considered, on a general level, acceptable and in line with the trend of other European countries. This is confirmed by the reduction in the last few year of pollution incidents due to the waste water activities and the correspondent sanctions resolved with monetary fines.

In their last report on pollution incidents, published in 2015, EA states that it spends about £12 million a year in time and materials in responding to pollution incidents to reduce harm[25]. Overall, the EA confirm the decrease of incidents affecting all mediums (land, air, water), with most incidents originating from activities not regulated by Environmental Permitting Regulation (Figure 52). In particular:

"In 2015, water company activities were responsible for 59 (35%) of the total serious pollution incidents caused by activities with permits. All 59 affected water and 3 of the 59 were also recorded as having an impact on land.

The water companies' record of pollution incidents is variable, but it caused fewer than half the incidents in 2015 than it did in 2005 (135 incidents).

The majority of serious pollution incidents caused by water companies in 2015 were on the sewer network (42 of 59, 71%). The network includes foul sewers, rising mains, combined sewer overflows, storm tanks and pumping stations. Most of these incidents were due to containment and control failures (34 of 42 incidents, 81%)".

The biggest changes in the distribution of incidents caused by water companies in 2015 compared with 2014 were:

- an increase in the number of incidents caused by water and surface water related premises (1 incident in 2014 and 8 in 2015)
- a 44% decrease in the number of incidents caused by sewage treatment works (16 incidents in 2014 and 9 in 2015) - serious pollution incidents at sewage treatment works also decreased substantially between 2013 (27 incidents) and 2014 (16 incidents)

Following the increase in serious incidents in 2013, **EA requested each company to produce an action plan to understand and reverse the increase**. There was no common root-cause identified, with causes varying between companies. Key factors included "*inadequate monitoring and management, shortcomings in risk assessments, operational practice and staff culture*".

Figure 52 EA pollution report 2015 - Main Facts. SOURCE: EA

Main facts

In 2015, there were 499 serious pollution incidents:

- 19% fewer than in 2014
- 42% fewer than in 2005
- 56% fewer than in 2000
- 325 (65%) affected the water environment, compared to 360 (59%) in 2014
- 97 (19%) affected air, compared to 199 (32%) in 2014

The source of most (57%) serious pollution incidents are sites or activities that we do not regulate under the Environmental Permitting Regulations.

Since 2014, the number of serious pollution incidents:

- caused by activities with permits decreased by 32%
- caused by non-permitted activities increased by 22%
- where we could not identify the source decreased by 65%

In 2015, the top 5 industry sectors causing pollution incidents were:

- farming (whole sector); 87
- water companies; 59
- biowaste treatment activities with permits; 32
- non-hazardous waste treatment activities with permits; 29
- waste treatment (metals recycling) activities with permits; 12

Between 2014 and 2015, serious incidents caused by the landfill sector decreased by 71%.

The biowaste treatment sector caused the largest number of pollution incidents per 100 permits.

4.7 UK UWWTD compliance

The overall waste water system is also subjected to monitoring requirement by the UWWTD. The 8th Implementation Report on the Urban Waste Water Treatment Directive, published in 2016, reports data regarding UWWTD compliance for all 28 Member States. These are mainly results obtained analysed member states datasets for the year 2012.

The most important articles for which Member States have to report information are described below. These set deadlines, limits and general regulation around compliance, planned measures and forecasts.

Table 21 Description of some important UWWT Directive articles

Article number	What it concerns
3	Deadlines for ensuring that all agglomerates are provided with collecting system for urban waste water. Other special requirements are listed
4	Deadlines for ensuring that secondary treatment is the minimum treatment type. Other special requirements are listed
5	Identification of Sensitive Areas. More stringent thresholds set
10	Regulation about designing and planning of new treatment works

Considering compliance levels, United Kingdom, as a whole, has reported:

"1,811 agglomerations (communities) *≥ 2,000 p.e. with a total generated load of 69,346,038 p.e. 99.5% of the total generated load of all agglomerations ≥ 2,000 p.e. was reported to be collected in a collecting system. 1,806 of all agglomerations (and 1,788 agglomerations for which monitoring results meet the requirements for discharge have installations for secondary treatment in place, while 693 agglomerations report to have more stringent treatment installations in place*. […]*".* Secondary treatment is the standard treatment for 98.9% of these agglomerations, with a compliance level of 98.2% (Table 22); their location is mapped in Figure 56.

Overall, United Kingdom, is compliant at 100% for art.3, 98% for art. 4 and 96% for art.5 of the UWWTD, with one pending judgment for failure to comply with Articles 3, 4 and 10.

Table 22 Number of agglomerations (communities) and Waste water load per treatment type. SOURCE: UWWT 8th implementation report

UK reference date: 2012/12/31	agglomerations		wastewater load	
whole territory	number	[%]	p. e.	[%]
UK total	1,811	100.0	69,346,038	100.0
collecting system in place	1,811	100.0	68,971,891	99.5
secondary treatment				
installation in place	1,806	99.7	68,609,867	98.9
monitoring results meet requirements for discharge	1,788	98.7	68,098,067	98.2
more stringent treatment				
installation in place	693	38.3	29,465,883	42.5
monitoring results meet requirements for discharge	690	38.1	29,330,238	42.3

The judgment refers over failure to ensure that urban waste water is adequately treated in 17 agglomerations. In four of the agglomerations in question (Banchory, Stranraer, Ballycastle, and Clacton), treatment was inadequate. In ten other agglomerations, where the waste water discharges into sensitive areas such as freshwaters and estuaries, the existing treatment failed to meet the more stringent standards required for such areas. The areas concerned are Lidsey, Tiverton, Durham (Barkers Haugh), Chester-le-Street, Winchester Central and South (Morestead), Islip, Broughton Astley, Chilton (also known as Windlestone), Witham and Chelmsford. UK had until the end of 2000 to ensure appropriate treatment from large agglomerations discharging into undesignated waters and until the end of 2005 for discharges from medium-sized agglomerations and discharges to freshwater and estuaries from small agglomerations.

The case also concerns excessive spills from storm water overflows in collecting systems serving the agglomerations of Llanelli and Gowerton. Innovative and environmentally positive sustainable urban drainage solutions are now being implemented to improve the situation. However the current spill rates (as of 2012) were still too high and compliance is not foreseen before 2020. The deadline for having in place compliant collecting systems for these agglomerations was end 2000.

The UWWTD also requires the identification of measures to reduce pollution risks and achieve 100% compliance in the next future. In order to achieve that, the UK has programmed:

"46 projects […] concerning works on collecting systems and treatment plants. The works are planned to be achieved between 2011 and 2019. The investments in collecting systems and treatment plants (new and renewal) are estimated at an average of 1.42 billion € per year. It represents 22 € per inhabitant".

Table 23 Summary table for planned activity for United Kingdom. SOURCE: UWWT 8th implementation report

Thematic	United Kingdom
Number of collecting system works planned (expired deadlines)	5
Number of WWTP works planned (expired deadlines)	41
Number of collecting system works planned (pending deadlines)	-
Number of WWTP works planned (pending deadlines)	-
Load entering the planed UWWTP (p.e.)	2,812,431
Organic design capacity UWWTP (as planned) (p.e.)	2,933,634
Forecast cost investment needed for the collecting system (as in the national plan) (million €)	1,070
Forecast cost investment needed for the UWWTP (as in the national plan) (million €)	882
Amount of (planned) EU funding needed for collecting systems (million €)	-
Amount of (planned) EU funding needed for WWTP (million €)	-
Name of EU fund planned to be used	-
Current yearly investment collecting system (million €)	892
Current yearly investment treatment plant (million €)	529
Expected yearly investment collecting system (million €)	892
Expected yearly investment treatment plant ((million €)	529
Method used for the calculation of current / expected investment	average 2010-2015 / average 2010-2015
Total organic design capacity (p.e.)	90,498,351
Generated load agglomerations 2011 or 2012 (article 15 reporting)	69,346,038
Ratio load entering the planed UWWTP/total generated load	4.1 %
Types of treatment WWTP (as planned)	2 primary, 21 secondary and 18 more stringent (16 phosphorus and 2 nitrogen phosphorus)
Country population (million)	64.3
Ratio total investment/population	22

Considering the general European trend, the UK seems to be in line with other Member States; however the European Environment Agency recognises that, with regards to Sensitive Areas: "*UK* *is the country that is the furthest away from the implementation objective: its sensitive areas under transitional period in 2012 were, by then, still far from compliant with Article 5*."

Additional assessment of data is reported on treatment plant capacity and reported entering load. The entering load should correspond to the design capacity (provided the monitoring results for compliance assessment are reported as "pass"). When the entering load/capacity >120 % the plant is marked as "overloaded". The following figures show information on capacity of the UWWTW, total load entering the environment and entering load/capacity %.

The dataset report info for UWWTPWs (urban wastewater treatment plant works) by company. The following chart and figures reveal that overall the companies show a similar utilisation rate, but with Southern and United Utilities as outliers – For United Utilities the value is low because the EA dataset (dated 2012) report an high capacity value for one of the UU plant (Manchester and Salford (Davyhulme) with a correspondent low load entering this particular treatment work.

Figure 53 Load entering UWWTWP by Wastewater Company

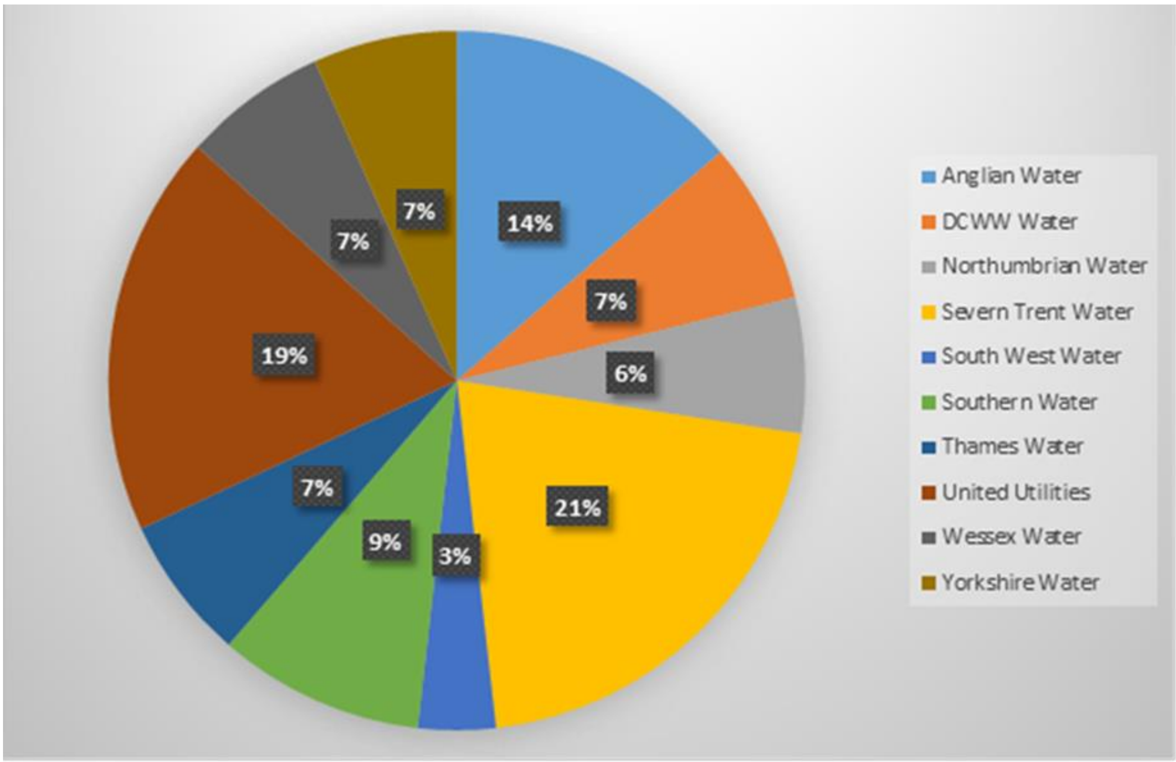


Figure 54 Waste Water company UWWTPW aggregate utilisation rate vs full capacity

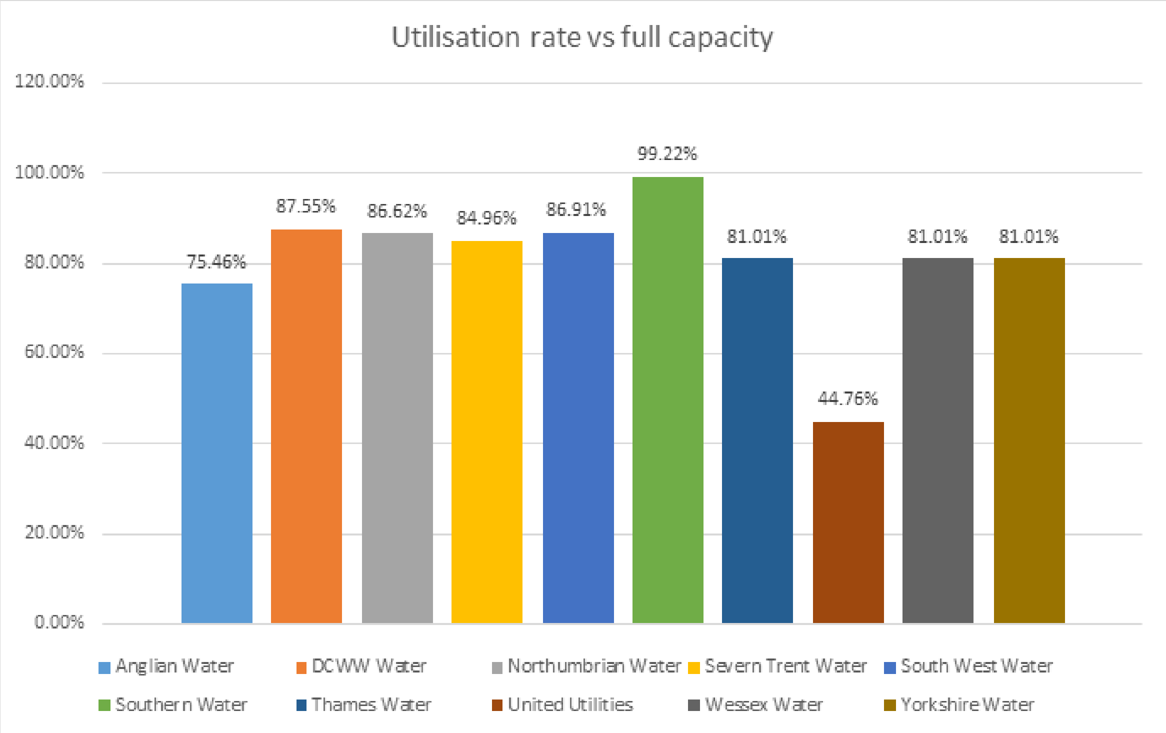


Figure 55 Load (p.e.) entering UWWTPS

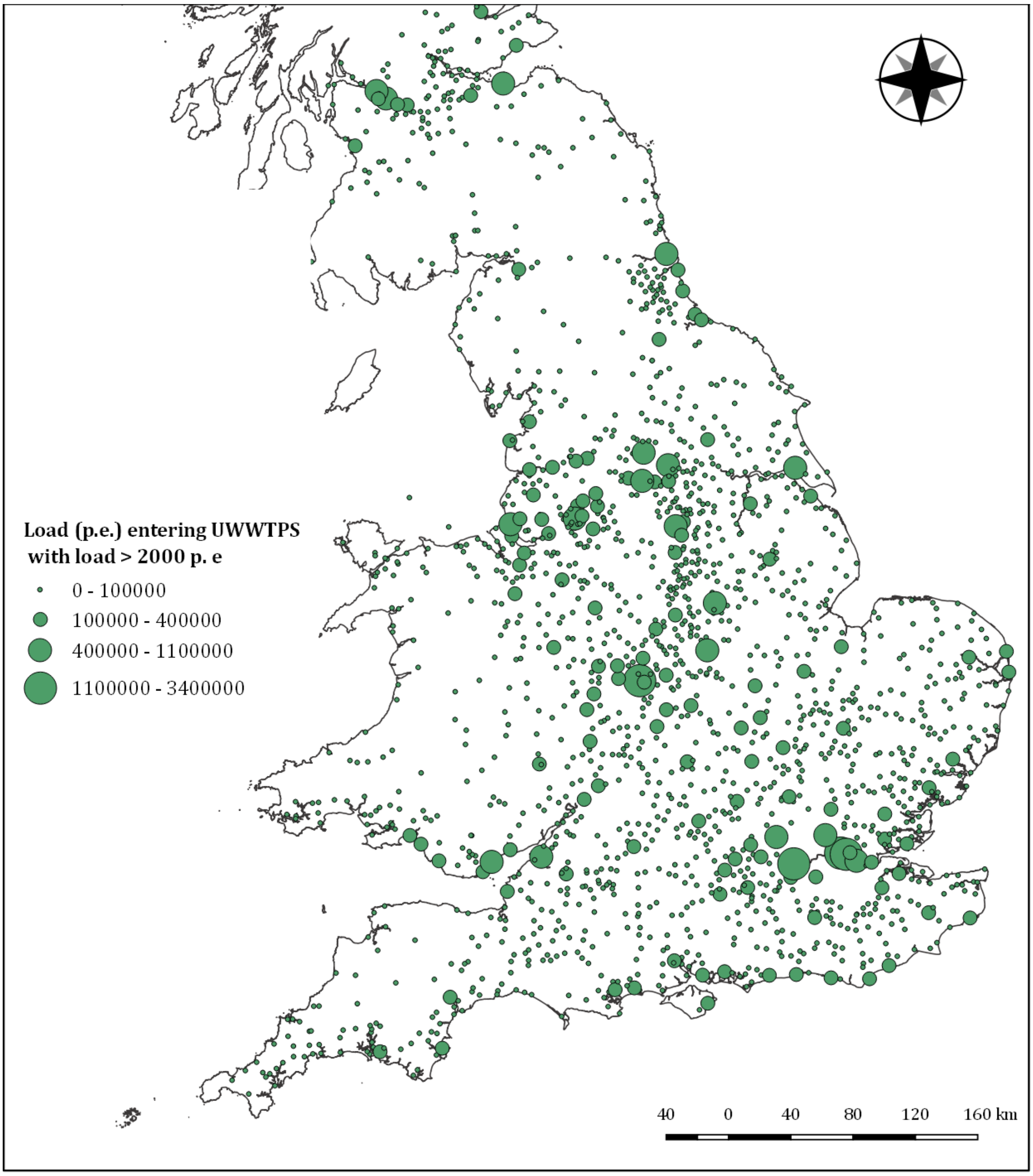


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Figure 56 Overview of UWWT agglomeration treatment pathways, with p.e. values

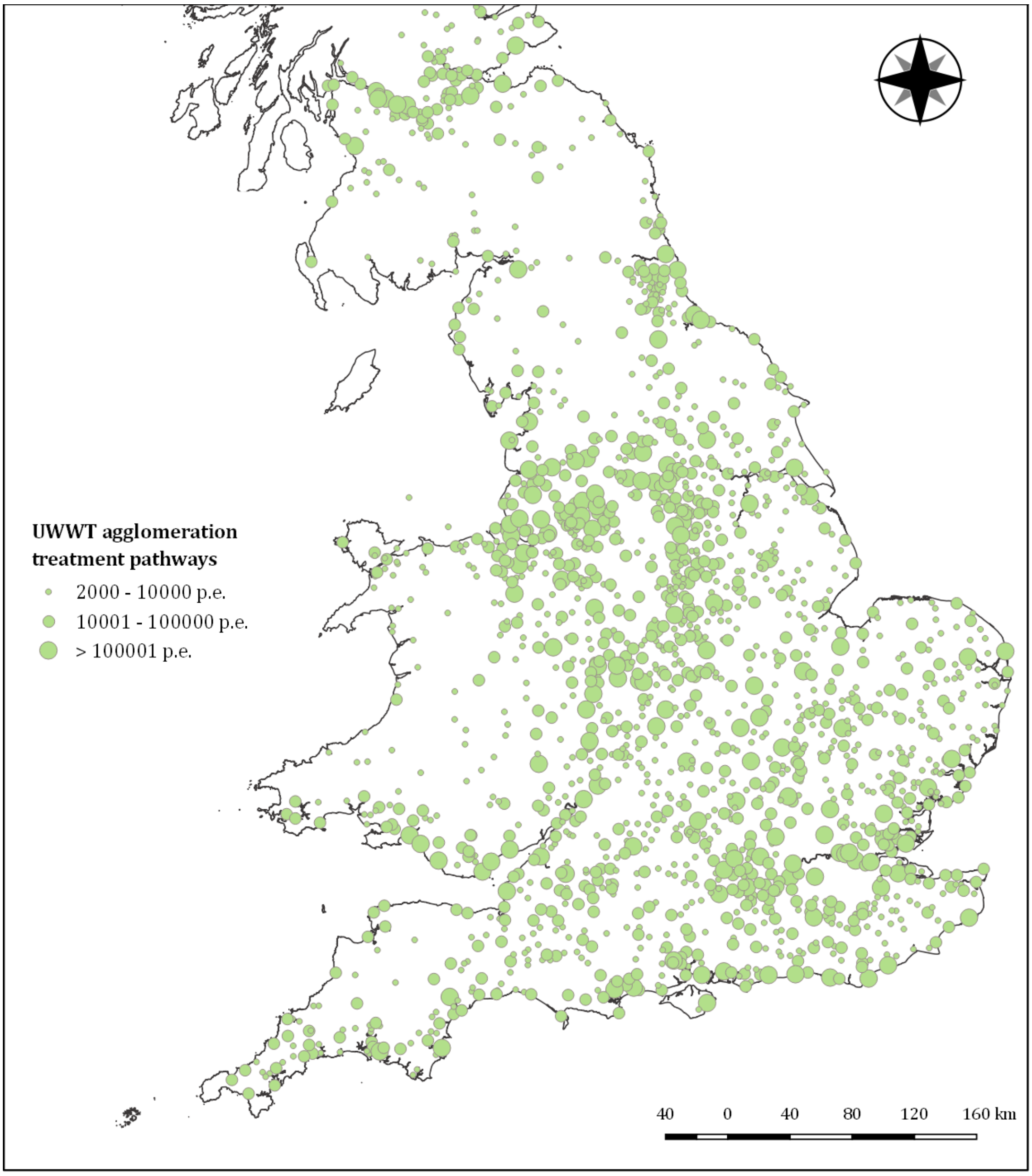

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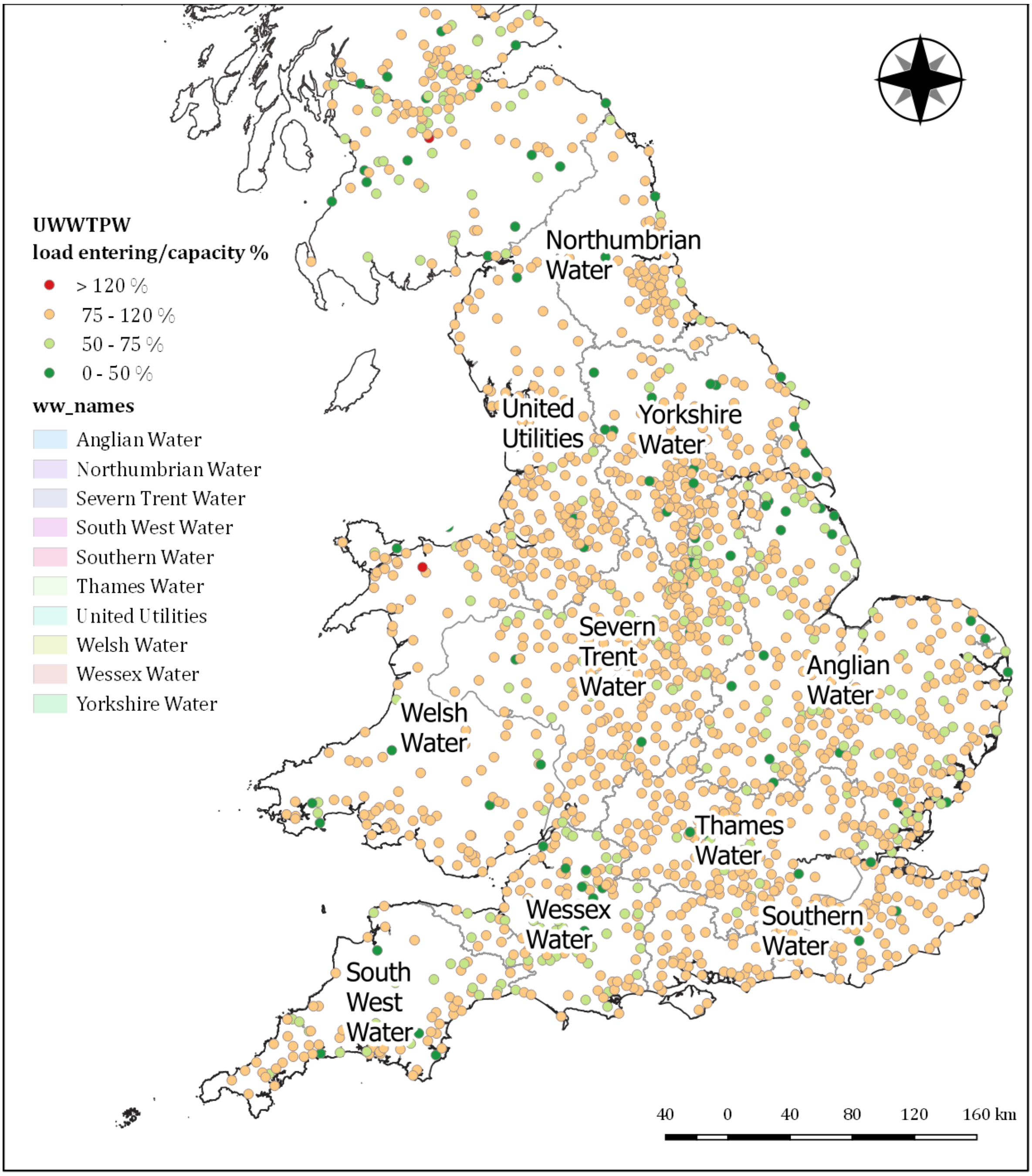
Figure 57 UWWTPW utilisation rate



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5 WFD Objectives and measures

Along the UWWTD, which requires Member States to plan project around the waste water system, the WFD requires Member States to assess the other multitude of pressure and issues that affect their waters and set realistic and feasible objectives and solutions in order to reach the requirement of the directive.

5.1 EA Objectives

The current River Basin Management Plans, updated in 2015, "*set out how a minimum of 680 (14%) of waters will improve over the next 6 years from around £3 billion investment. […] The RBMPs support the government's framework for the 25-year environment plan. And will allow local communities to find more cost-effective ways to take action to further improve our water environment*".

EA also publishes a set of objectives to achieve for each water body classification elements. These objectives act as a support for RBMPs. The standard objective is now reaching Good Ecological Status (GES) for all waters by 2021; nevertheless, the EA recognises that this is not always possible due to a multitude of pressures and/or lacking of information and financial support to develop feasible measures. Therefore the classification status goal can be set at a lower minimum level (bad, poor, moderate).

Table 24 summarises the ecological objectives listed by the EA for water bodies in England. The year specifies when the ecological objective should be achieved and the number indicates how many waterbodies are set to reach that status by that year. A high number of waterbodies have already reached the objective by 2015. It appears clear that some water bodies are not anticipated to reach GES in the foreseeable future.

Table 24 EA Ecological status objectives

Ecological objective	2015	2021	2027	2050
Bad	19	0	0	0
Poor	108	2	12	0
Moderate	842	30	162	0
Good	895	322	2556	2
High	7	0	0	0

When the goal is set a lower classification than GES, EA also tries to report what is the motivation responsible; if no enough information is available this evidence is not described.

5.2 EA Planned Measures

In light of all the possible pressures and impacts caused by several activities on water bodies, the WFD requires member States to identify set of measures that would be needed to reach good ecological status.

EA enumerates a set of measures (activities and bundle of activities) identified by EA staff and other partners, to tackle the most important pressures and reason for not achieving good, both at a national and local level. These activities are assessed using economic analysis tools and expert judgment. The measures are set to give an overview of the types of activities needed to achieve the water body objectives. The list is subjected to change due to new information acquired, new funding available, and change of policy and/or situation. Furthermore, some measures identified in this list may already be funded and planned to be in place in the period 2015 to 2021.

Table 25 summarise the number of activities planned broke down by EA region.

Table 25 Number of Measures (bundle of activities and alternatives) planned by the EA

	Anglian	Humber	North West	Northumbria	Severn	Solway Tweed	South East	South West	Thames
Mitigation Measures for use with MMA	0	575	528	0	13	0	0	0	52
To control or manage abstraction	10	11	13	3	7	0	9	1	11
To control or manage diffuse source inputs	435	594	174	99	213	7	63	9	128
To control or manage alien species	74	7	13	4	10	0	28	6	31
To control or manage point source inputs	156	229	211	63	76	14	64	66	95
To improve modified habitat	590	229	384	189	259	2	283	165	402
To improve regulated flows	7	6	1	3	0	0	21	1	14
Other activities	24	340	39	26	78	0	9	76	21

EA has also lists 459 local measures for which there is enough confidence to predict outcomes for specific water bodies and elements (Table 26).

Table 26 Local measures planned by EA

	Anglian	Humber	North West	Northumbria	Severn	Solway Tweed	South East	South West	Thames
2000	0	1	0	0	0	0	0	0	0
2009	0	3	0	0	0	0	1	0	0
2011	0	4	0	0	0	0	0	0	0
2012	0	1	0	0	0	0	2	0	0
2013	0	1	0	0	0	0	0	0	0
2014	0	1	4	1	0	0	0	0	3

2015	36	11	11	2	1	5	21	3	73
2016	0	28	3	0	1	0	9	8	9
2017	0	1	4	0	1	0	1	0	1
2018	0	0	6	1	11	0	0	0	7
2019	0	0	6	0	4	0	0	1	0
2020	10	76	20	7	41	0	0	1	10
2021	0	0	2	0	0	0	0	1	0
Not specified	0	0	0	1	0	3	0	0	0

A high proportion of measures are planned towards improving habitats and mitigation of point source pollution. This appears consistent with the overall pressures that affect receiving waters, with focus on point source pollution from waste water activities.

Breaking down the planned local measures by activity and number of water bodies, point source pollution again appears one of the main pressure that EA plans to mitigate (Table 27). At a RBD level, the situation appears similar, except for the Thames RBD where the more heterogeneous contest means that measures have to address more issues (Table 28).

Table 27 Number of water bodies affected by local measures

Local Measures	Number of water bodies
Appropriate management of releases	5
Change to operations and maintenance	1
Control pattern/timing of abstraction	51
Education	2
Improvement to condition of channel/bed and/or banks/shoreline	16
Improvement to condition of riparian zone and/or wetland habitats	9
Mitigate/Remediate diffuse pollution impacts on receptor	6
Mitigate/Remediate point source impacts on receptor	307
Operations and maintenance	49
Recreation	2
Reduce diffuse pollution at source	14
Reduce diffuse pollution pathways (i.e. control entry to water environment)	8
Reduce point source pathways (i.e. control entry to water environment)	8
Reduce point source pollution at source	21
Removal or easement of barriers to fish migration	10

Removal or modification of engineering structure	2
Structural modification	23
Use alternative source/relocate abstraction or discharge	2
Water management	13
Working with physical form and function	14

Table 28 Number of water bodies affected by local measures per RBD

Measure Name	Anglian	Humber	North West	Northumbri	Severn	Solway	South East	South West	Thames
Appropriate management of releases	1	1	0	0	0	0	1	0	2
Change to operations and maintenance	0	0	0	0	0	0	0	0	1
Control pattern/timing of abstraction	18	3	4	0	2	2	6	2	14
Education	0	0	0	0	0	0	0	0	2
Improvement to condition of channel/bed and/or banks/shoreline	4	2	0	0	1	0	2	0	7
Improvement to condition of riparian zone and/or wetland habitats	4	1	0	0	0	0	0	0	4
Mitigate/Remediate diffuse pollution impacts on receptor	0	1	0	0	0	0	5	0	0
Mitigate/Remediate point source impacts on receptor	13	116	62	3	60	0	23	12	18
Operations and maintenance	0	0	0	3	0	5	0	0	41
Recreation	0	0	0	0	0	0	0	0	2
Reduce diffuse pollution at source	0	3	3	0	0	1	0	0	7
Reduce diffuse pollution pathways (i.e. control entry to water environment)	1	5	1	0	0	0	0	0	1
Reduce point source pathways (i.e. control entry to water environment)	0	0	2	0	0	0	0	0	6
Reduce point source pollution at source	7	0	0	0	0	0	1	0	13
Removal or easement of barriers to fish migration	0	3	0	4	0	0	1	0	2
Removal or modification of engineering structure	0	0	0	0	0	0	1	0	1
Structural modification	0	4	0	7	0	2	0	0	10
Use alternative source/relocate abstraction or discharge	1	1	0	0	0	0	0	0	0
Water management	0	0	1	6	0	1	0	0	5
Working with physical form and function	0	4	0	0	0	0	0	0	10

Humber district has the highest number of planned measures to address the issue. However, all RBDs show a consistent situation where point source pollution is considered a priority together with mitigation oh physical modifications.

5.3 Natural Resources Wales' Objectives

In accordance with WFD requirements, NRW is required to set out objective for all the waterbodies. The methodology follows the same rationale as the one described for the EA.

Table 27 summarises the ecological objectives listed by the NRW for water bodies in Wales. A higher number of waterbodies than the one listed for England have already reached the objective by 2015. Overall, the situation appears better than the one the EA depicts for England waters. This is due to the fact that Wales has a higher number of waters already on GES, therefore can focus more on waters at a lower classification,

Table 29 NRW ecological objectives

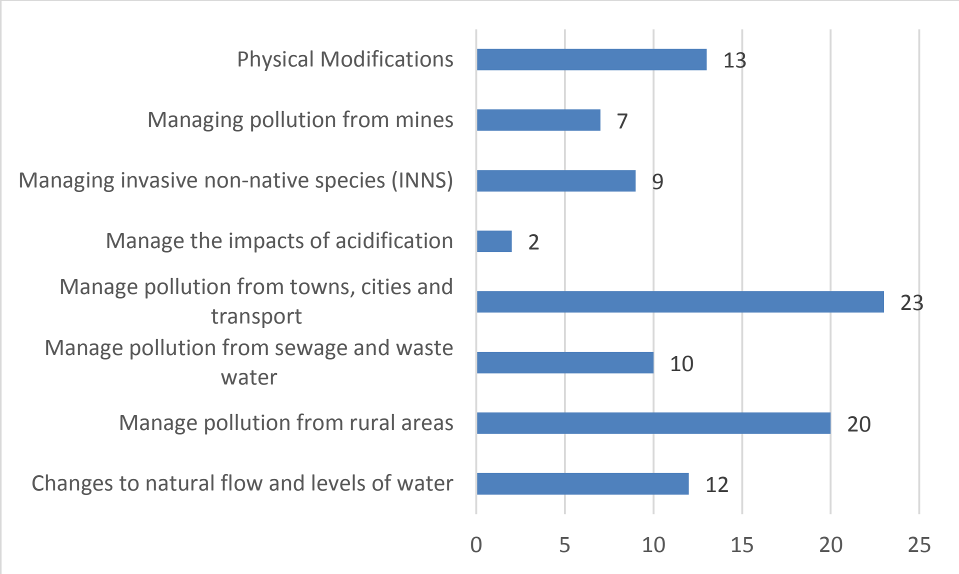
Ecological objective	2015	2021	2027
Bad	0	3	1
Poor	3	45	20
Moderate	14	337	146
Good	342	0	0
High	3	0	0

5.4 NRW Planned Measures

NRW also lists a series of national measures planned to mitigate nSWMIs, following a slightly different format than the EA procedure.

Figure 58 shows that pollution from urban and rural regions are the area where NRW is more focused on. Nevertheless, other nSWMIs are also addressed with a good number of planned activities.

Figure 58 NRW - Planned Measure per nSWMI



At a local level, the planned measures are distributed as showed in Table 30, with measures to reduce diffuse pollution and removal of physical barriers to fish migration being the action the NRW consider most pressing.

Table 30 NRW - Local Planned Measures

Measure name	Dee	Severn	Western Wales
Currently Not available	4	2	3
Appropriate management of impoundment	0	1	0
Appropriate management of releases	0	1	0
Change to operations and maintenance	0	0	1
Control pattern/timing of abstraction	0	0	1
Improvement to condition of channel/bed and/or banks/shoreline	0	3	1
Improvement to condition of riparian zone and/or wetland habitats	0	0	2
Mitigate/Remediate diffuse pollution impacts on receptor	1	0	0
Mitigate/Remediate point source impacts on receptor	1	9	7
Reduce diffuse pollution at source	7	21	16
Reduce diffuse pollution pathways (i.e. control entry to water environment)	0	1	3
Reduce point source pathways (i.e. control entry to water environment)	1	0	1
Reduce point source pollution at source	0	12	0
Removal or easement of barriers to fish migration	0	19	1

Overall, Wales has to deal with different pressure than England. Pollution from urban locations and diffuse pollution are here considered a priority. Reduction of point source pollution and planning measures on the waste water system are also planned and are a priority in the Severn district, which is shared with England.

5.5 Government policy regarding the waste water system

The National Policy Statement (NPS) for the provision of major waste water infrastructure sets out government policy about the managing and devolving of the waste water in the UK. The document identifies a series of key themes that needs to be followed for deciding consent applications for sewage developments[26]. In details:

- ***Sustainable development*** *– to seek waste water infrastructure that allows us to live within environmental limits and that helps ensure a strong, healthy and just society, having regard to environmental, social and economic considerations;*

- ***Public health and environmental improvement*** *– to continue to meet our obligations under the UWWTD by providing suitable collection and treatment systems to limit pollution of the environment;*

- ***To improve water quality*** *in the natural environment and meet our obligations under related European Directives, such as the Habitats Directive, the WFD and its Daughter Directives;*

- ***To reduce water consumption by households and industry*** *which will have the knock-on effect of reducing waste water production and therefore demand for waste water treatment infrastructure;*

- ***To reduce demand for waste water infrastructure capacity*** *by diverting surface water drainage away from the sewer system by using Sustainable Drainage Systems (SuDS);*

- ***Climate change mitigation and adaptation*** *– in line with the objectives of Defra's mitigation and adaptation plans to help deliver the UK's obligation to reduce greenhouse gas emissions by 80% by 2050 and work to carbon budgets stemming from the Climate Change Act 2008, within the context of the EU Emissions Trading System. Also to ensure that climate change adaptation is adequately included in waste water infrastructure planning;*

- ***Waste Hierarchy*** *– to apply the waste hierarchy in terms of seeking to first reduce waste water production, to seek opportunities to re-use and recycle resources and to recover energy and raw materials where possible.*

This key points confirm the attention of the government towards the reduction and monitoring of waste water pollution as set out by the EA and NRW published measures. They also stress the intention of dealing with future pressure, such as Climate change and population and housing development increase. These points are analysed in the following sections.

6 Population, Housing and Development pressures:

It is amply recognised the population growth is going to be a key pressure on the environment. The need of new developments and the pressure on existing agglomerations for accommodating the increased number of people will have the effect of increasing the stress on the sewage system too.

The main points contained in the most recent ONS population released on the 29 October 2015 included a series of considerations on population growth in the next future:

- The UK population is projected to increase by 9.7 million over the next 25 years from an estimated 64.6 million in mid-2014 to 74.3 million in mid-2039

- The UK population is projected to reach 70 million by mid-2027

- Over the 10 year period to mid-2024, the UK population is projected to increase by 4.4 million to 69.0 million. This is 249,000 higher than the previous (2012-based) projection for that year

With regards to the development, the Government white paper "Fixing our broken housing market" (published on 7th February 2017) states that: *"the consensus is that we need from 225,000 to 275,000 or more homes per year to keep up with population growth and start to tackle years of under-supply*". Further, the February 2015 housing projections indicated that 220,000 additional households will be built each year up to 2022.

This 2012-based Household Projections: England, 2012-2037 (27th February 2015) stated:

- The number of households in England is projected to increase from 22.3 million in 2012 to 27.5 million in 2037

- Annual average household growth is projected as 210,000 per year between 2012 and 2037. Average household size is projected to fall from 2.36 in 2012 to 2.21 in 2037

- Over the period from 2012 to 2022, annual average household growth is projected as 220,000 per year, comparable with 2011-based Interim Household Projections figure of 221,000 from 2011 to 2021.

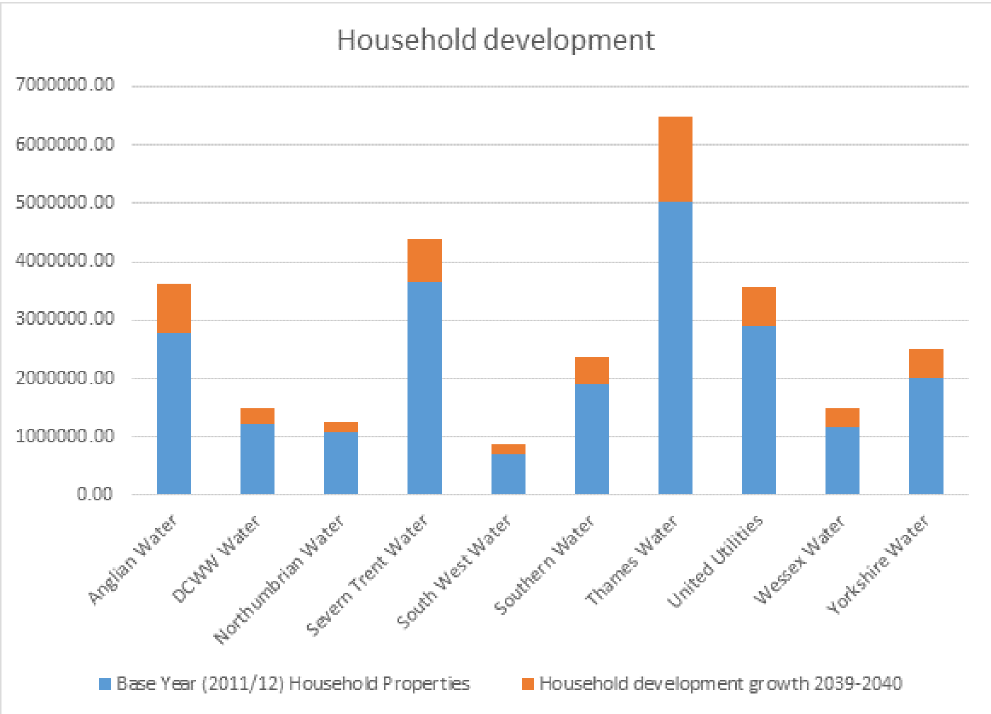
The White Paper also mentions that over 40 per cent of local planning authorities do not have a plan that meets the projected growth in households in their area; this further creates uncertainty for associated infrastructure planning such as increasing capacity at wastewater treatment works and within the sewerage and drainage systems. Water quality problems can occur where surface water and sewage are transported in the same pipes, as in about 70% of the sewerage system – additional population and properties increase the volumes and likely occurrences of the sewerage system and the treatment works being overwhelmed. So the fact that these combined sewers can protect properties from flooding in heavy rainfall, through overflows into watercourses, they will also significantly increase pollution from untreated human, commercial and industrial waste.

Wastewater treatment plants also need to have sufficient capacity to deal with such weather. They also need to cater for seasonal changes in the organic load they receive for treatment, for example, to cater for increases in the populations of seaside towns, capital cities and other tourist destinations during holiday seasons. At such times treatment processes may need to be optimised to deal with variations in organic load concentrations associated with seasonal population changes.

The forecasted growth for each wastewater company areas has been extrapolated from different sources, including figures reported by wastewater companies (as water supply companies) themselves when producing their water resources plans (water only company figures were matched within the corresponding wastewater company) These results constitute an approximations and comprehend a degree of uncertainty. The picture is one of similar growth in all regions, with almost all companies forecasting an increase of between 20-30% in household properties in their competence zone, and between 15-20% in household population growth. Less population growth is forecasted for Northumbrian Water and United Utilities, however they still forecast a significant increases in housing development (Figure 59).

Thes magnitude will likely be important at national level; however, it will likley be more impactful in area where pollution incidents due to failure, overflow and crude sewage emissions have been historically more frequent, such as Thames, Humber and the North West areas (Figure 60), and in areas such Humber and North West where CSO are more frequent(Figure 61).

Figure 59 Forecasted growth by Wastewater Company area



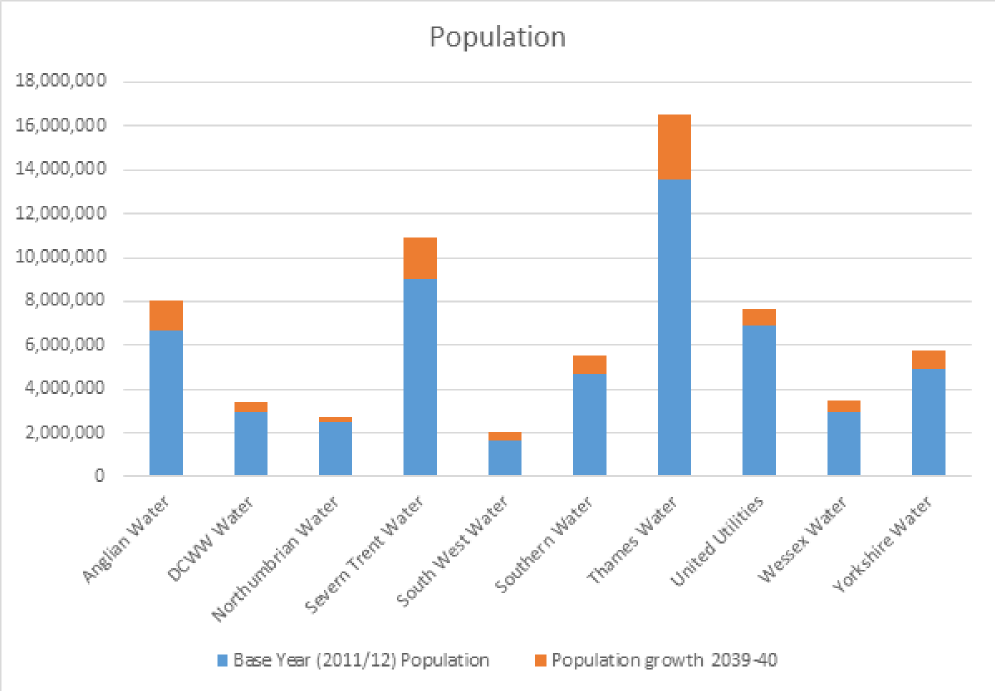

Population
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Anglian Water
DCWW Water
Northumbrian Water
Severn Trent Water
South West Water
Southern Water
Thames Water
United Utilities
Wessex Water
Yorkshire Water
Base Year (2011/12) Population
Population growth 2039-40

Figure 60 Heatmap of significant pollution incidents on waters due to sewage discharges (England)

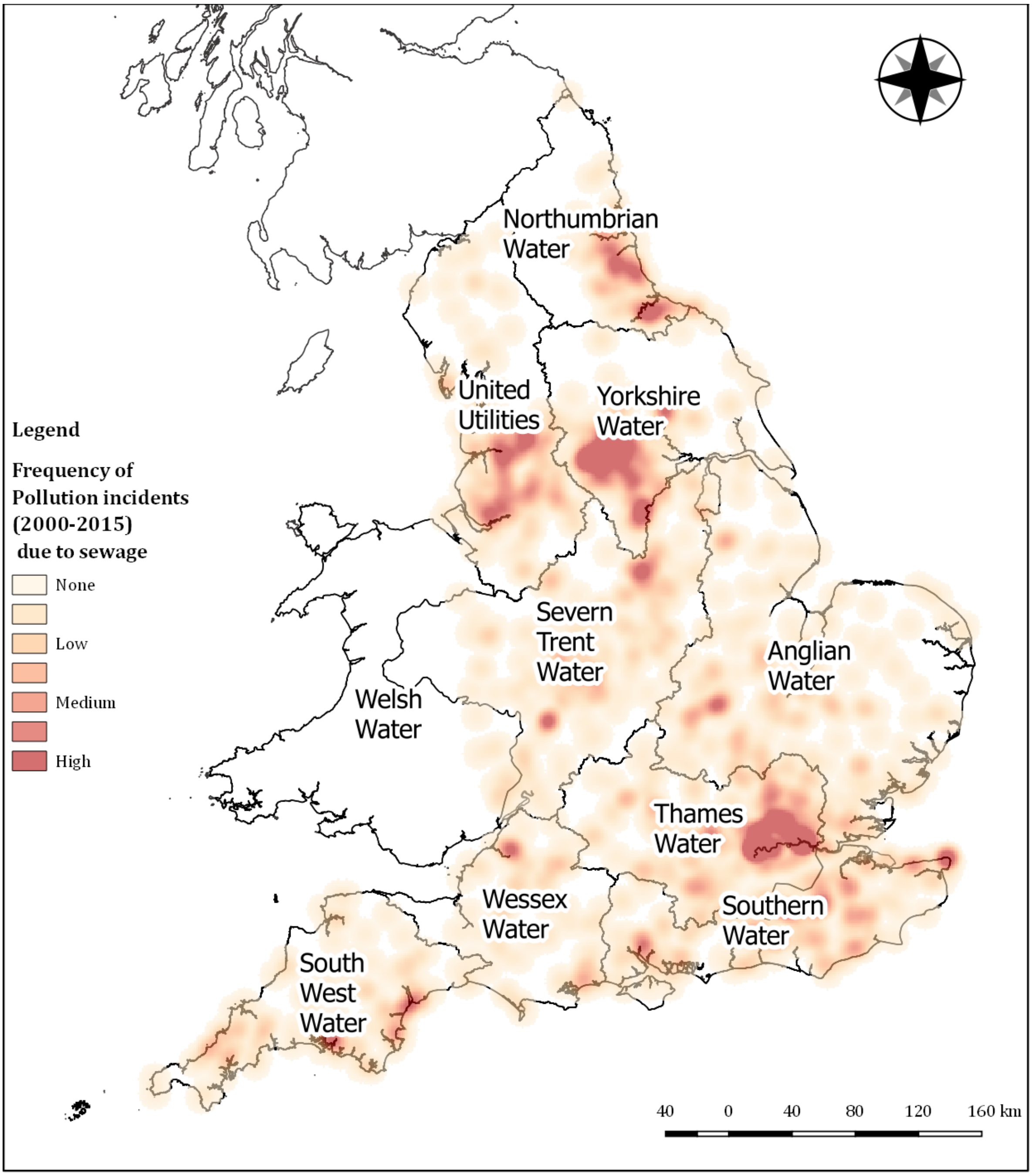


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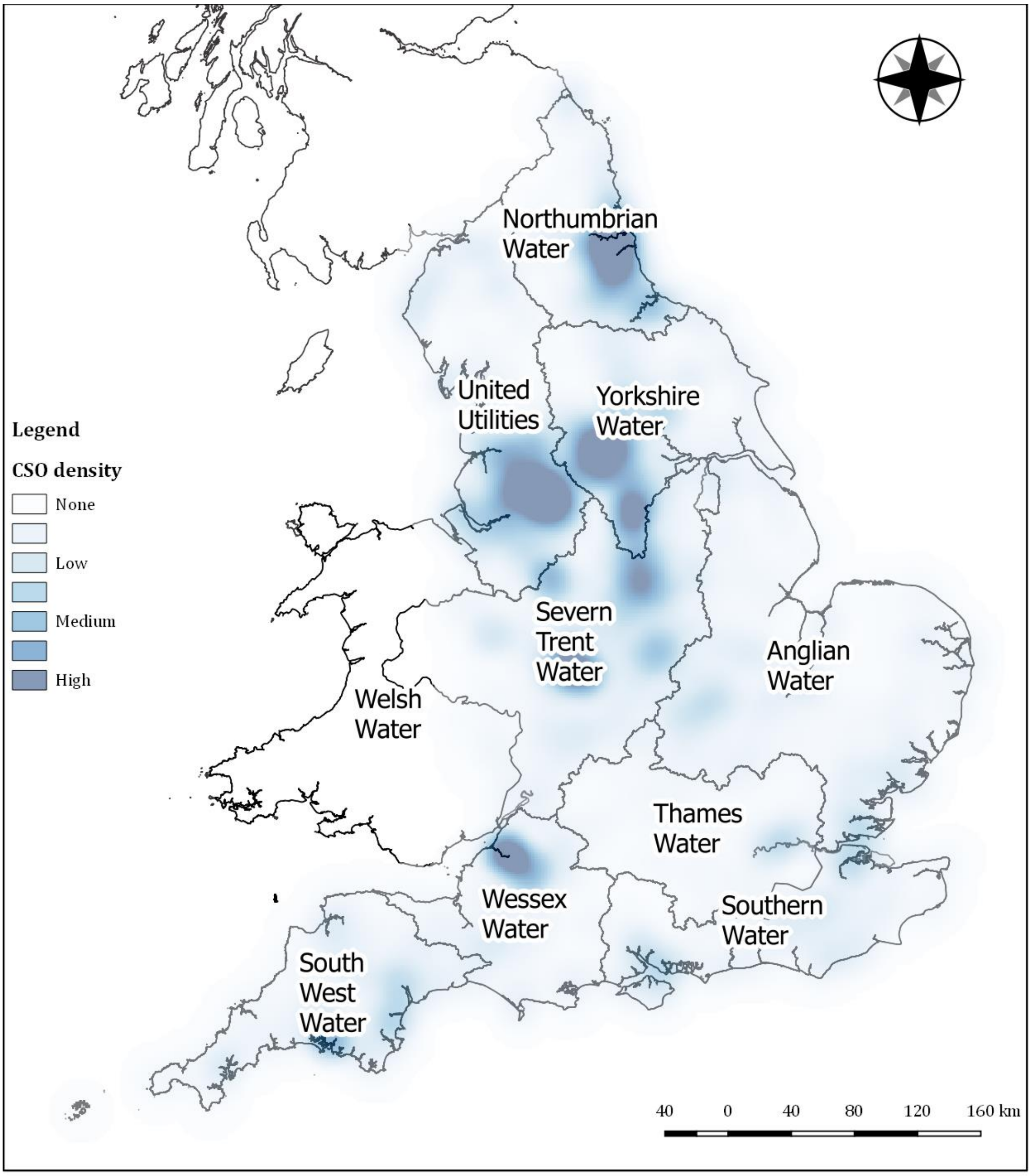
Figure 61 Heatmap of CSOs in England



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Nevertheless, a situation where all areas will confront an increase of the pressures on the waste water system, will likely stress the whole system by a greater degree than the current situation .

In order to react to these future challenges, all companies produce plans by either:

- Promoting customer behaviour, thus offering information about more efficient fixture and reducing demand
- Increase efficiency in the system, with more reliable monitoring

- Increase response time in case of failures
- Other actions

Uncertaintes around the future is ackowledge as a primary driver of planning measures so that responses to different scenarios are produced.

7 Climate Change

Changes in climate are expected to increase weather variability which will bring more intense rainfall events. For example the frequency of occurrence flood events is being revisited by planners with for example, a 1-in-50-year event may become a 1-in-20-year event under climate change projections – this will place greater demands on drainage infrastructure. Storm events will also give rise to increased erosion, soil loss, and landslides. And with much of the pollution and eroded soil run off in to rivers ending up in the coastal environment. Increasing intensity of rainfall events are likely to overwhelmed sewerage systems and wastewater treatment plants, resulting in increasing unintended incidents in raw sewage spills from CSOs.

The UK Climate Change Risk Assessment published in 2017 by government continues states that: "*The new report recognises how the trend towards warmer winters, hotter summers and changing rainfall patterns is affecting communities across the UK and sets out the government's ongoing investment and work to tackle these risks".*

Increasing periods of dry weather can also disrupt wastewater treatment through water shortages - lower water levels would cause the normal flow of sewage through the system— which is propelled by gravity—to slow down. Ultimately, this slowdown caused solids to accumulate at pipe joints and increased the frequency of blockages. To make matters worse, the water that does flow into the treatment plant will have higher levels of ammonia and total suspended solids, which led to increased levels of contaminants in the water pumped out of the plant into the receiving waterway.

Climate change impacts are likely to lead to changes in average temperatures and precipitation rates, and with that, weather patterns - the frequency and severity of extreme weather events. Indeed an overloaded or inadequate wastewater infrastructure can harm people's health and the places in which they live through flooding from sewers because of sewer blockage, collapse or equipment failure; and threats to the aquatic environment through increasing raw sewage discharges from CSO outfalls.

Not enough capacity can be a problem and the pressures on capacity are growing as the population increases and rainfall events begin to intensify; but the capacity of that infrastructure is finite. New houses cannot always be simply connected to existing foul and surface water sewers without overloading the network. Some properties are already unable to connect to the sewer. The limit of the environment's ability to take in discharges from STWs and CSOs is being reached in some places. Large, fast flowing rivers or the sea have a greater capacity to dilute and absorb discharges than small vulnerable rivers, where a higher standard of treatment will be needed.

Usually water in surface water sewers is relatively clean and does not need treatment before going into receiving waters. But it can sometimes cause pollution, picking up bacteria, nutrients, oil, detergents and sediment from roads, roofs and gardens.

It is difficult to predict how well the waste water network will cope with the larger volumes of water from new developments. The current condition of much of the underground sewer network is not known and the rate of deterioration largely uncertain.

Climate change could exacerbate the impact of new developments. Climate change means more intense rainfall, so that vverflow volumes could increase significantly. At the same time, hotter, drier summers will make the environment less able to cope with discharges from STWs and CSOs. Low river flows during summer reduces the dilution of the waste water. Higher temperatures mean less oxygen in rivers and lakes. This is partly offset by STWs operating better at higher temperatures.

What can be done!

Making sure that sewage and surface runoff from new developments does not cause pollution is going to be a challenge in some places. Ideally new housing should be built in places with enough existing sewerage and treatment capacity. Increasing capacity and providing adequate sewerage, surface water drainage and sewage treatment will need to be provided for new developments. In some places, the capacity of existing systems can be increased. In others, new systems may have to be built.

In 2009/2010 Artesia did some work for WWF-UK under their partnership with RSA to provide a policy paper on the implementation of SUDS and provided a scoping study for a SUDS implementation project.

There are ways to treat sewage other than pumping it to a few large works. Small, local sewage works in a new development would help to maintain more natural water flows throughout a river catchment. But this has to be balanced against the efficiency that large STWs can provide. Different options will be appropriate for different places.

An alternative approach to surface water drainage, known as SuDS, can reduce and slow down runoff at the same time as improving water quality. Sustainable urban drainage systems can help to prevent diffuse pollution from surface runoff. Artificial wetlands, ponds and other features intercept the runoff and remove pollutants before the water is returned to rivers and other receiving waters.

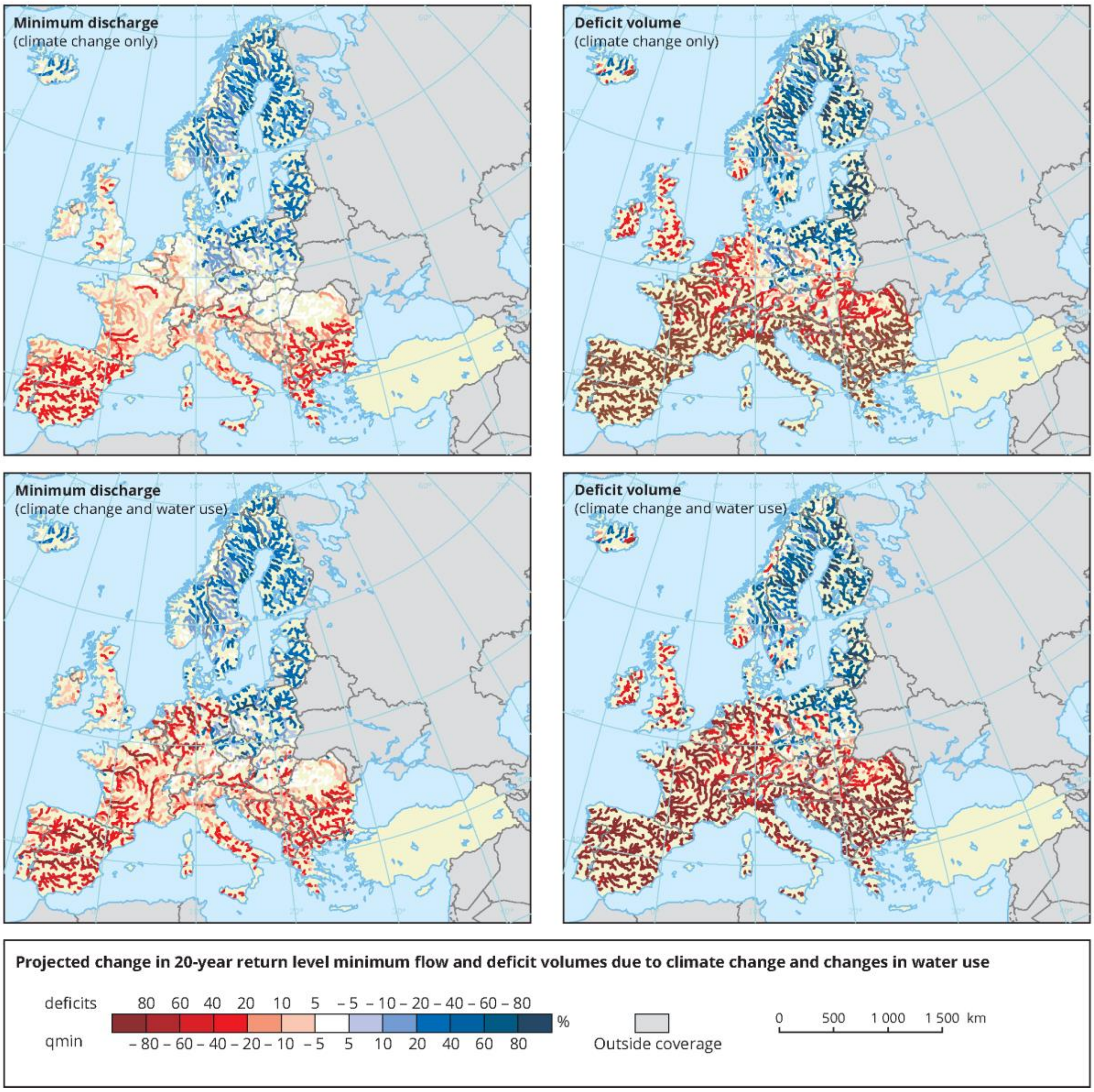
The systems mimic the natural drainage pattern of each site as much as possible, incorporating features which prevent or delay runoff, like permeable surfaces, artificial wetlands or ponds. These can help to prevent large flows of often dirty runoff that characterise urban drainage. Instead cleaner water is returned more gradually to the natural drainage system.

The amount of wastewater that houses produce is largely determined by the amount of water used. Any water use efficiency measures, like grey water recycling and lower water consumption, will reduce the volume of water that foul sewers and STWs have to cope with, and save money. The pollutant load coming from each household would stay about the same.

The European Environment Agency commissioned a forecast of droughts and rivers flow, under a series of scenarios including climate changes and projected water use increment[27]. This analysis confirms that streamflow droughts will become more severe and persistent in many parts of Europe, including the UK, due to climate change (Figure 62, pictures at the top). Future water use will aggravate the situation (Figure 62, pictures at the bottom).

If the models are right, with rivers flow reduced, the quality of waters will be subjected to degradation to different degrees, but with profound effects on ecosystem and chemical/physical conditions of freshwater system. Consequently, the sewage system would be subjected to increasing stress in order to allow a sufficient flow back into the freshwater system, with also particular attention that would need to be focused on the quality of the water discharged.

Figure 62 Projected change in 20 years (base year 2013). Source: European Environment Agency



8 Chalk Streams

Artesia were asked to analyse the status of Chalk streams and compare their situation in the context of the overall conditions in England and Wales; though as the project developed this aspect pf the work became less important and as a consequence it is dealt with in only general terms here.

Characteristics

Chalk Streams describe streams that flow through land where chalk is the main constituent of the bedrock. Chalk is a porous and permeable sedimentary rock composed mainly by calcite; this particular composition let water percolate through the rock and act as a filter. These characteristics make chalk bedrock an excellent aquifer, meaning that it can accumulate groundwater and act as a reservoir; water can then remerge as springs or can recharge water bodies that flow through the aquifer.

Their importance: The conditions that govern the hydrology and sedimentation rate of chalk also regulate the chemical and physical conditions of streams that run through it. Chalk streams usually show slow flow regime, moderate temperatures and slightly alkaline conditions, with little or no solid suspension and gravel beds. This makes them excellent stable environments for a multitude of species, with quite abundant biodiversity and richness of wildlife.

Classification: The identification of a chalk stream is to some degree difficult due to the struggle of classifying the percentage of water that is derived from chalk aquifers and the degree of influence. Regardless of this issue, it is recognised that a high proportion of world’s chalk streams is found in England, due to the geologic history of the British Isles.

8.1 Ecological Status

In 2004 the Environment Agency Indexed 160 chalk-streams in the Biodiversity Action Group report The State of England’s Chalk Rivers. However, many more rivers are influenced by chalk geology. In 2014, WWF commissioned a study on chalk streams and identified a total of 213 chalk streams.

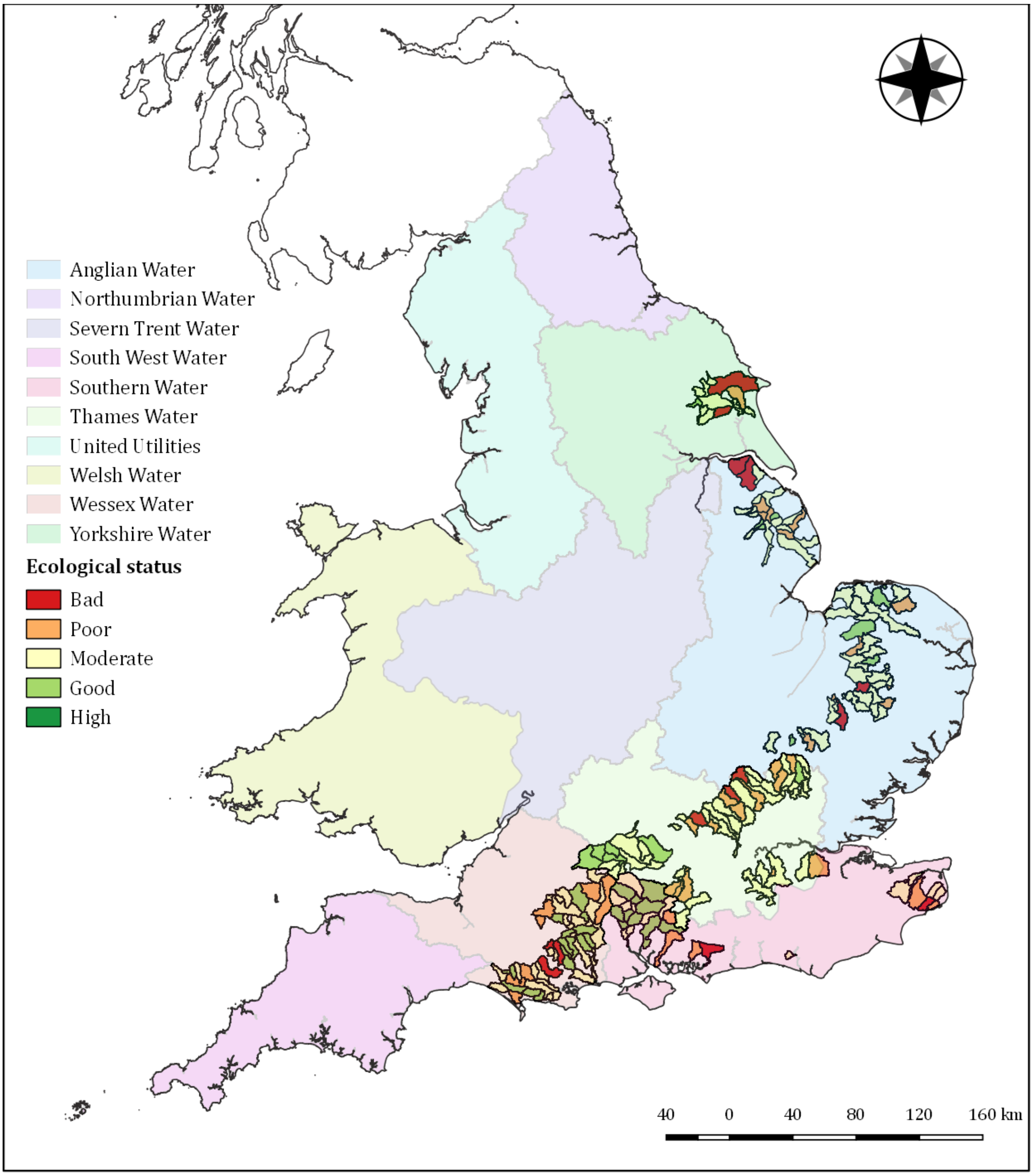
For consistency purposes, the WWF analysis has been used to identify the ID. This study identified 214 streams, the difference is likely due some catchment boundaries that have been modified in the last shapefile available (please refer to the WWF specification for more information on the stretches identified).

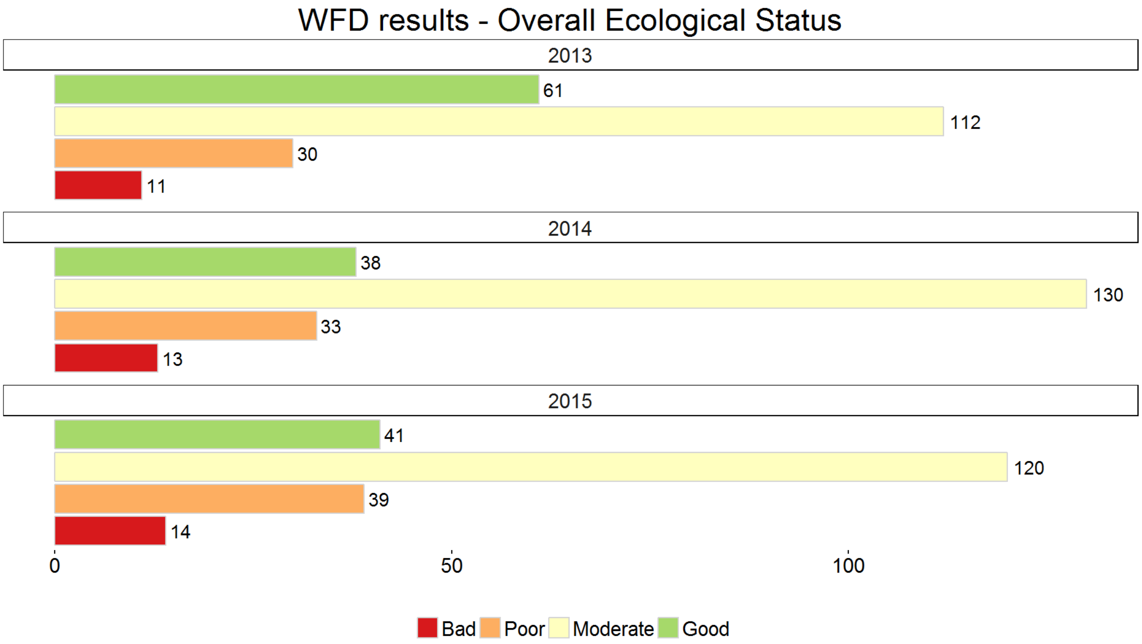
The following map show the distribution of chalk streams as identified by the EA.

Figure 63 Chalk streams as identified by EA

For Cycle 2, the ecological results indicate that chalk streams follow the same trend as the other waters, with around 26 streams dropping from good ecological status to a lower classification. Figure 64 summarises the results over the years.

Figure 64 Ecological status for Chalk Streams





Taking in consideration the 214 water bodies identified, Cycle 2 indicates that around 81% of Chalk Streams are failing to meet the Good Ecological Status, with only 41 streams currently reaching GES. Concurrently, number of streams in poor of bad condition has increased.

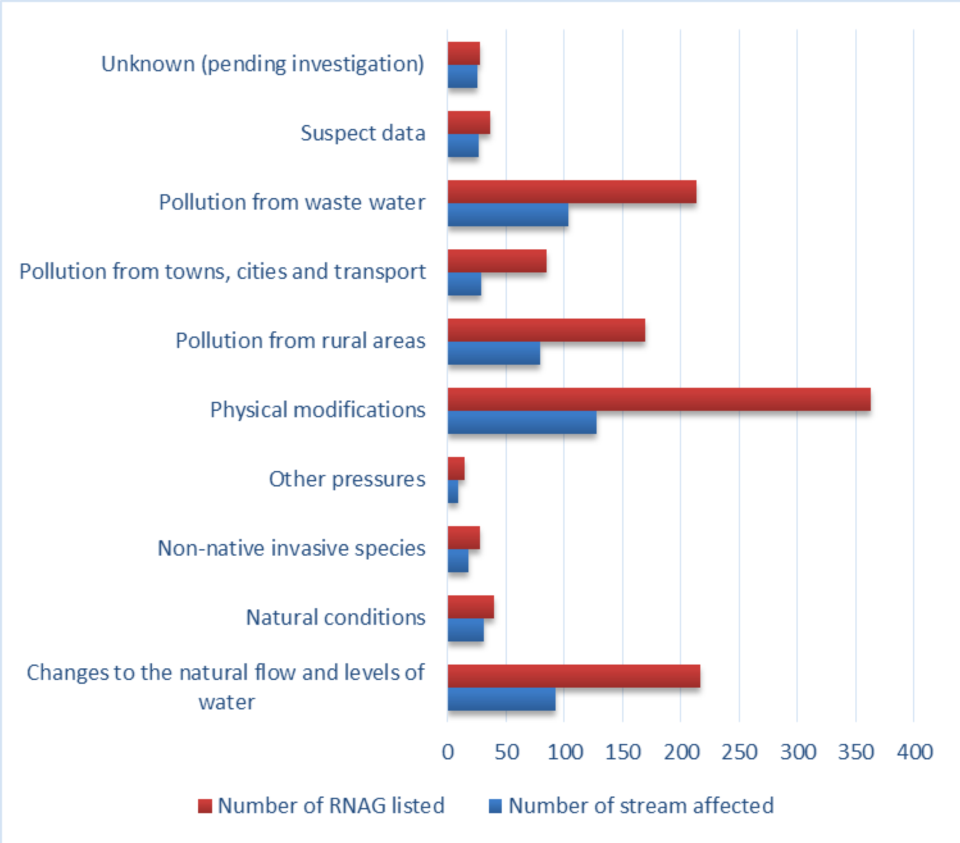
8.2 Main Pressures

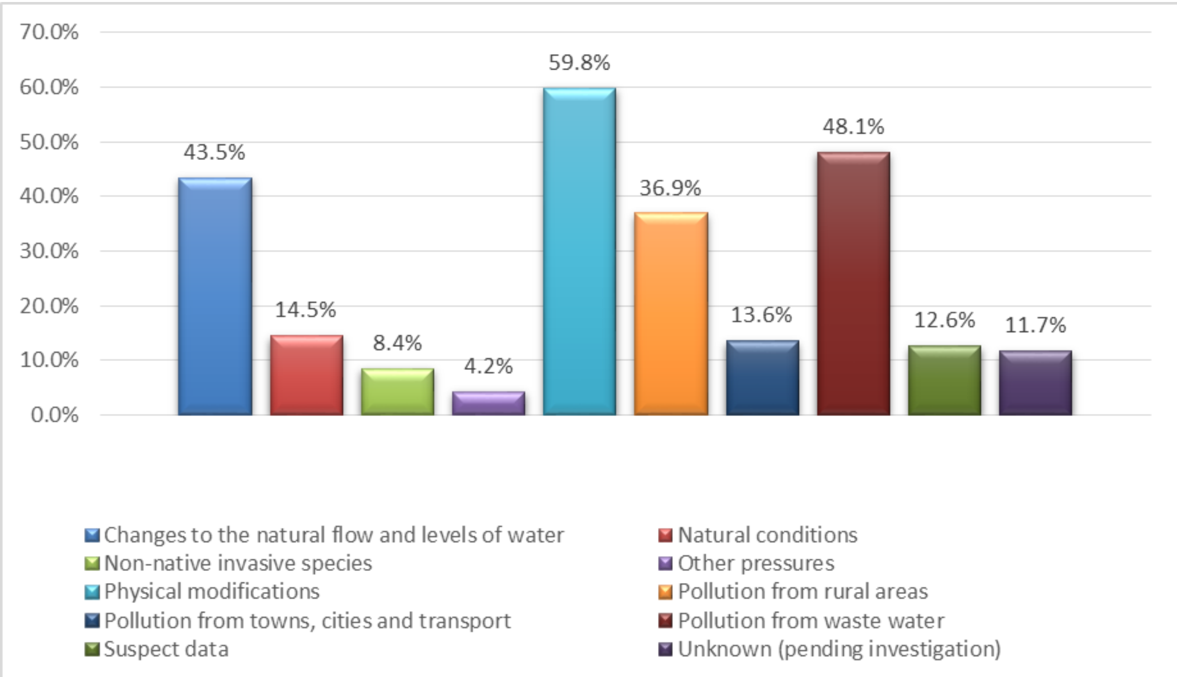
8.2.1 Pressures Overview

Chalk streams seems to face a multitude of threats; Figure 65 shows the nSWMI identified as key pressures on Chalk Streams. The highest number of RNAG and river are affected by physical modifications, with pollution from waste water and changes to natural flow level also highly represented. When considering the percentage of river affected, the four main key management issues affecting the highest number of chalk streams are:

- Physical modification (affecting 59.8 % of all chalk streams)
- Pollution from Waste water (48.1%)
- Changes to natural flow and levels of water (43.5%)
- Pollution from rural areas (36.9%)

Figure 65 nSWMI pressure for Chalk Streams





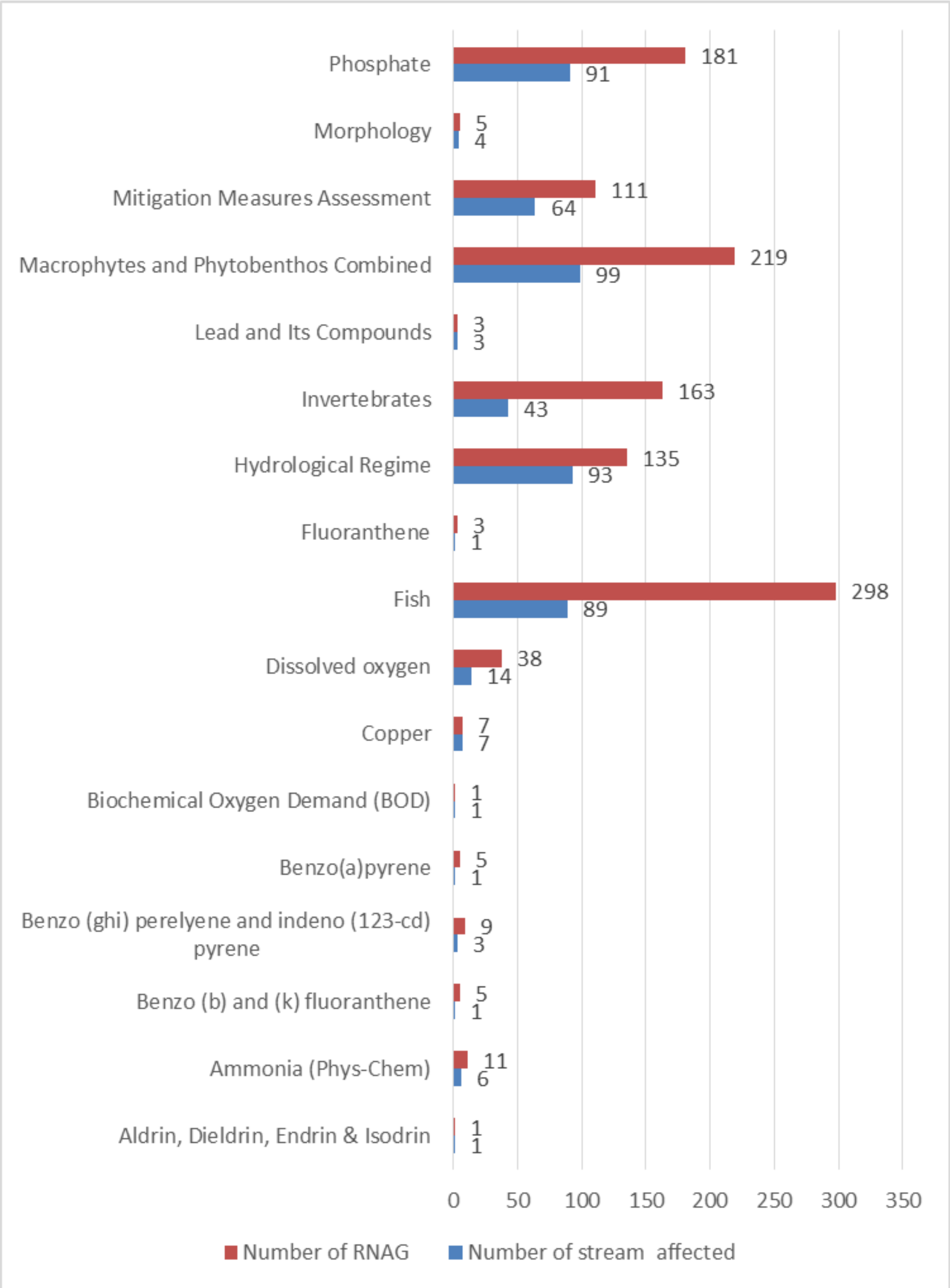
8.2.2 *Failing Elements*

When looking at the element that fail more frequently, the biological component of the ecosystem seems the one more represented. Fish, Macrophytes and Phytobenthos combined and Invertebrates fail repeatedly with a high proportion of RNAG.

Phosphate is again an issue with 90 streams affected and 181 RNAG.

As for the hydrological regime and the assessment of mitigation measures, the results show that chalk streams fail consistently due to alteration of natural condition, implicating that physical modification are indeed highly affecting the system.

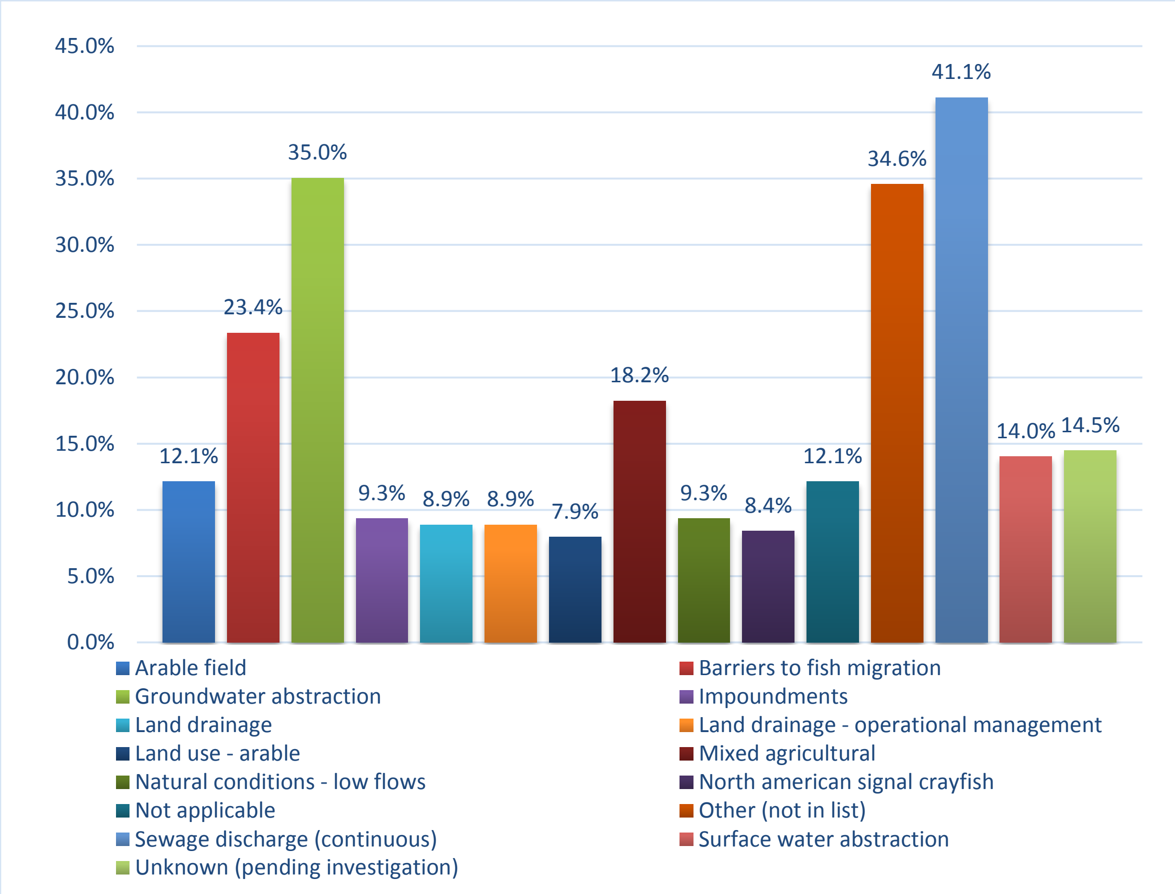
Figure 66 Chalk Stream failing elements



8.2.3 Activities

Again, when looking at what activities are considered impacting the chalk streams, the situation shows a condition of pressure coming from different sources. Continuous Sewage discharge appear to be considered as the one affecting almost half of the stream, followed by groundwater abstraction. Nevertheless, other activities that are not grouped into higher classification represent the second highest proportion (34.6%). Further, activities such as groundwater abstraction, and barrier to fish migration also occurring with a high percentage.

Figure 67 Activities that have the most impact on chalk streams



8.2.4 Overall Status and future pressures

The ecological status of chalk streams reflect the overall freshwater system in England and Wales. The picture is one where pressure are consistent with the national conditions but where the source are more heterogeneous. Considering the chalk stream identified in this study, 81% are failing.

Due of their nature, chalk stream are more subjected to alteration in the natural flow, this is also accentuated by the fact that historically they have been endangered by physical modifications, which seems to be one of the most pressuring issues. These modifications impact both the physical component of the streams but also the biological part, posing a barrier to fish as an example. Further, reduced flows can also alter the cycle of nutrients and affect other components such as invertebrates, which are highly perturbed by altered condition of water levels.

As much as nationally, pollution from waste water is considered an important pressure with over half of the chalk streams affected. The effects of the waste water system on the chalk streams can be devastating due to the sensible nature of chalk catchments. These can vary from eutrophication to anoxic conditions due to nutrient loads. In both cases the ecological component of the system can be quite affected, with high species mortality. Pathogens can also enter the system and bio accumulate into fish or birds, which can then be consumed by humans.

Concurrently, diffuse source pollution from agriculture plays another important role into the ecological status of these streams and can have an additive effect to the impacts of waste water pollution. Again, phosphorus level can increase due the concurrent action of these two nSWMIs.

When looking at future pressure, as much as the freshwater system, chalk streams will be subjected to increase pressure due to climate change, population and development growth. The likely impacts on these systems have not been studied thoroughly; however, they are likely to be increase the stress on chalk catchments.

9 Conclusion

Results of data collected by the EA and NRW show that the majority of water bodies in England and Wales are not in good ecological status. In particular, surface waters in England are way behind on the objectives with only 17% reaching GES. Condition in Wales appear less poor with around 38% of water bodies in good ecological status.

Overall, surface waters appear to be pressure by multitude of pressure; which are recognised to affect waters concurrently, with complex general and local interactions.
Nevertheless, three key national management issues appear impacting waters more frequently:

- Pollution from rural areas
- Physical modification
- Pollution from Waste water

Physical Modification includes activities and/or artificial barriers and alterations that can cause changes to the natural conditions of a river, altering the flow, water level and habitats. These alterations have important impact on flora and fauna. Pollution from Rural Areas includes activities that can cause changes to the amount of nutrients and chemical composition of a river. This highly impacts freshwater flora and fauna, but can also affect humans. Pollution from Waste water can comport nutrients and pollutants from sewage and waste water becoming highly concentrated. The concentration and quality of the waste water discharged into the water body differs due to the treatments and sources. This highly impacts freshwater flora and fauna, but can also affect humans.

It is also recognised that some overarching pressures affect a high proportion of river from different sources. It is the case of phosphate that can be discharge through the waste water but also from runoff from agricultural land. The EA state that agricultural land still accounts for 20-30% of the phosphorus load in rivers. On the other side, waste water discharge from sewage treatment plants is the highest source with 60-80% load contribution in England and 48% in Wales. Other minor sources include diffuse urban pollution (3%) and septic tanks and small containerised sewage treatment plants (3%).

The report focused particularly on the waste water system evaluating current status and challenges. In UK the waste water system is regulated by both European legislation, such as the UWWTD, and national regulations. Treatment type are assessed following judgment of receiving water and agglomerations served while discharge consents are issued by statutory organisations, which address the consents requests singularly with limit following assessment of local situations. Data shows that a proportion of historic and older consents are re-issued after being assessed; nevertheless, it is recognised that some, such as deemed temporal consents, have not been properly addressed and that statutory organisations might not be aware of the volume and quality of a proportion discharged. Majority of consents regulate discharge into the riverine system, with a small proportion of consents discharging into sea or estuaries.

Analysing the results from the last WFD Cycle, the data shows that continuous discharge, particularly from urban areas, affect the highest proportion of rivers, with around a third of the failing waters affected. It is also recognised that intermittent discharges, such as Combined Sewage Overflows (CSOs), concur to impact the riverine system with episodic discharges. EA and NRW recognise that compliance monitoring might fail to pick up localised and less continuous problems, so that some classification elements and eventual incidents cannot be classified and identified on a yearly frequency. CSOs might be particularly affected by this issue as the monitoring of spills is delegated to CSO owner with more strict regulation applied only on CSOs that discharge into catchments designated as sensitive under the UWWTD. CSOs data and location are freely available only for England and they indicate that pressure might be particularly high in region such as Humber, Thames and North West where wet weather conditions and high urban development with reduced soil absorption can increase frequency and volume of overflow after storm events. This is confirmed by river failing for intermittent discharges and also the proportion of pollution events recorded by the EA from 2001, which show that waters and the highest proportion of incidents affecting surface water at a significant level are concentrated in those regions. SuDs scheme and SuDs retrofitting has been recommended as a possible solution to alleviate the pressures on the waste water infrastructure; however not enough has been done as now.

Looking at impacts, it is amply recognised that the sector is the source of the majority of phosphorus load in the environment. Concurrently, it is acknowledged the important role of phosphate in polluting the freshwater system and main cause of eutrophication. Data confirms that phosphate element is the classification element that does not reach good status more frequently and it is also indicated as one of the most pressuring issue on other components. There is recognition that further researches are needed to understand the real implication of higher phosphorus load and its interaction with other nutrients such as nitrogen. These should include solution for proper treatment of phosphorus from households and run off. Issues also arise from lack of recent quantitative studies at a national level.

Other pressure come from pathogens such as enterococci, which can enter the environment through runoff and CSO spills. When the concentration is high enough the bacteria can affect species and human health. Other possible impacts are constituted by new synthetic materials, which can enter the environment through the waste waters. It is the case of pharmaceutical execrated by humans and flushed into the waste water, such as Ethinyl estradiol (EE2), which is the main active ingredient of contraceptive pills. Studies found that EE2 can trigger a condition known as intersex in freshwater fish, which can results in drastic population reductions. Other problem ca arise from micro plastics such as microbeads, which can be ingested by wildlife and accumulate into the tissues.

Statutory agencies tackle issue related to the waste waters by enforcing regulation through monitoring and eventual sanctions if there is evidence of non- compliance. The analysis of pollution and enforcement dataset concerning the amount of monetary fines issued to waste water companies shows that waste water related incidents are dropping in the last few years, with a 44% decrease in the number of incidents caused by sewage treatment works. Nevertheless, it is recognised that single incidents can have devastating effects even if localised and not continuous. This is confirmed by a series of courts case where waste water companies have been fined with amount reaching a million pound.

The WFD also require states to plan measure to tackle the overall pressure affecting the freshwater system. Measured planned by statutory agencies reflect the significant management issues identified, with most measures planned to tackle point source pollution, especially in England, and diffuse pollution, especially in Wales. Local measures are planned for situations concerning small areas. These measures are intended following assessment on feasibility, both technical and economical. In England a high proportion of measures is planned toward the mitigation of point source pollution, while Wales considers agriculture with diffuse source pollution and physical modifications more pressing issues.

From a legislative point of view, data are reported at United Kingdom resolution and most recent European report analyse data dated back to 2012. Results show a good compliance with regards to waste water treatments although 17 treatment plants were not compliant with regulation. In particular, the most recent reports from the European Environment Agency state that the identification and protection of sensitive areas is far from optimal, with the UK being the Member State further away from the objective. Lack of systematic monitoring does not permit to analyse the magnitude of the issue; however; literature confirms that this problem is acknowledged by statutory organisations and researches are in act to implement a more effective control system. When looking at UWWTPWs, the utilisation rate across the companies appear quite similar around 80-85%. However, the data refer back to 2012, which is the last dataset released by the UK for UWWTWD compliance.

Overall, the UK plan is to achieve sustainable development of the water infrastructure and improve water quality by reduce pressure and preparing from future challenges such as increase demand due to population and housing development growth and climate change. The more recent studies forecast a sensible population and housing development growth in almost all regions, with the UK population projected to increase by 9.7 million over the next 25 years from an estimated 64.6 million in mid-2014 to 74.3 million in mid-2039. Concurrently, climate change studies all concur to forecast more extreme weather conditions with more frequent oscillations in precipitation and dry conditions all around Europe, including in Britain. The interaction of both pressure can be particular impactful for region already pressured by system stress, such as Humber, Thames and North West.

A separated analysis has been dedicate to chalk streams, which are quite sensitive and unique streams that flow in chalk catchments. Proper identification is considered complex due to the geology and the extension of stream which might run in chalk catchment for just part of their course. The report identified 200 chalk stream that run in England and analysed their ecological status. Concordantly with the analysis at national level, 81% of chalk stream fail to reach good ecological status. Pressure on the streams seems even more heterogeneous with Pollution from rural areas, Physical modification and Pollution from Waste water again identified as important reason for failing. Further, natural variation of flow and water levels are quite important in these systems due to their complex and sensible catchment geology and flow regime. The analysis confirm previous report published which state that chalk stream are not properly protected and their status is degradation.

In conclusion, the report identified a declining trend in the quality of England and Water rivers. This is likely due to the tightening of assessment procedures by the statutory agencies. Waste water system appears to impact a high proportion of the system, particularly with continuous discharge activities and intermittent events, such as CSOs. Analysis of published reports and literature confirm that knowledge gap are an important issue when identifying the impacts of waste waters on riverine system, particular for phosphorus and new kind of pollutants, which have not been properly studied and assessed by proper treatment processes. At a local level, areas such Humber, Thames and North East, seems more prone to failing, with an high number of pollution events recorded and pressure such as wetter conditions and higher density of urban areas impacting on the waste water infrastructure. Nevertheless, the issues appear quite generalised with all regions that will be facing population growth; more development built and impending climate change. The causes will likely concur to worsen the stress on the waste water system and, consequently, on the environment; if not properly addressed by statutory agencies and water companies.

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Link to Datasets used in the report

WFD related datasets and shapefiles (EA)

- https://data.gov.uk/dataset/wfd-river-canal-and-surface-water-transfer-waterbodies-cycle-2
- https://data.gov.uk/dataset/wfd-transitional-and-coastal-waterbodies-cycle-2
- https://data.gov.uk/dataset/wfd-river-waterbody-catchments-cycle-2
- https://data.gov.uk/dataset/wfd-classification-status-cycle-2
- https://data.gov.uk/dataset/wfd-river-basin-districts-cycle-2
- https://data.gov.uk/dataset/wfd-transitional-and-coastal-waterbodies-cycle-2
- https://data.gov.uk/dataset/wfd-groundwater-bodies-cycle-2
- https://data.gov.uk/dataset/wfd-cycle-2-site-classifications-2015

RNAG dataset (EA)

- https://ea.sharefile.com/share?#/view/s0faa355450243538

Measures for water bodies (EA)

- https://ea.sharefile.com/share?#/view/sabbd14301a44d5e9

WFD results, RNAG, measures and objectives (NRW)

- http://waterwatchwales.naturalresourceswales.gov.uk/en/

Pollution Dataset (EA)

- https://data.gov.uk/dataset/pollution-inventory

Consented Discharge (EA)

- https://data.gov.uk/dataset/consented-discharges-to-controlled-waters-with-conditions

EA prosecutions

- https://data.gov.uk/dataset/environment-agency-prosecutions

UWWTD shapefile

- https://data.gov.uk/dataset/urban-waste-water-treatment-directive-treatment-plants

UWWTD dataset (from European Environment Agency)

- http://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-3
- http://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-4

11 Appendix

England Top River at risk from waste water pollution table

River Name	ecological status (2015)	number of element failing in 2015	number of RNAG in Cycle 2 due to Pollution from wastewater	Predicted outcome 2021	Predicted outcome 2027	no know technical solution	cause of impact(s) unknown	constraint of technical nature	unfavourable balance of costs	disproportionately expensive - disproportionate burdens
Lee (Tottenham Locks to Bow Locks/Three Mills Locks)	Bad	8	8	Poor	Moderate	X				X
Tame (W/ton Arm) source to conf Oldbury	Bad	7	4	Bad	Moderate		X		X	
Crane Brook - source to FootherleyBrook	Poor	7	5	Poor	Poor				X	
Thames (Leach to Evenlode)	Poor	6	4	Poor	Moderate	X	X		X	X
Blackwater (Aldershot to Cove Brook confluence at Hawley)	Poor	6	5	Poor	Poor	X	X		X	X

Swavesey Drain	Poor	6	5	Poor	Poor			X	
Wem Brook from Source to River Anker	Poor	6	5	Poor	Poor		X	X	X
Roundmoor Ditch and Boveney Ditch	Poor	6	5	Poor	Moderate	X	X		
Barkham Brook	Poor	6	5	Poor	Poor	X	X		X
Chet	Poor	6	6	Poor	Moderate	X			X
Adur East (Goddards Green)	Poor	6	5	Poor	Moderate	X			X
Footherley Brook from Source to Black-Bourne Brook	Bad	6	6	Poor	Poor			X	X

Wales Top River at risk from waste water pollution table

River Name	number of element failing in 2015	Ecological Status (2015)	number of RNAG in Cycle 2 due to Pollution from wastewater	Predicted outcome	no know technical solution
Norton Bk - source to conf R Lugg	5	Bad	3	Good by 2027	X
Nedern Bk - souce to R Severn Estuary	6	Poor	6	Good by 2021	
Roath Brook	6	Moderate	3	Good by 2027	X
Ely R - conf Nant Clun to Allot Gardens, Ely	4	Bad	3	Good by 2027	
Llynfi - Lletty Brongu STW to conf with Ogmore	5	Moderate	3	Good by 2021	
Gwili - headwaters to tidal limit	5	Moderate	3	Good by 2027	X
Pelcomb Brook - headwaters to conf with W. Cleddau	4	Moderate	3	Good by 2021	
Dyffryn Ardudwy - Main Drain	6	Moderate	3	Good by 2021	
Dulas - headwaters to conf Ceri	5	Moderate	3	Good by 2021	
Goedol	6	Moderate	6	Good by 2021	
Norton Bk - source to conf R Lugg	5	Bad	3	Good by 2027	X
Nedern Bk - souce to R Severn Estuary	6	Poor	6	Good by 2021	