Enabling land development stalled by the ‘nutrients crisis’

LAND DEVELOPERS ARE USED TO NAVIGATING A MYRIAD OF PLANNING HURDLES BUT INCREASING LEVELS OF NUTRIENT POLLUTION HAVE BECOME THE LATEST CHALLENGE TO THREATEN THE DEVELOPMENT OF NEW HOMES THAT WILL HELP ACHIEVE THE GOVERNMENT’S AMBITIOUS HOUSING TARGETS AND SUPPORT THE ‘BUILD BACK BETTER’ AGENDA.

In November 2018 the European Court of Justice ruled on the well documented ‘Dutch Nitrogen’ case, determining that any additional nutrient loading to ‘designated sites’ that were already in an unfavourable condition would not be permissible by law. ‘Designated sites’ in this instance refers to Special Areas of Conservation (SAC), Ramsar, Special Protection Areas (SPA) and potential SPA sites.

Excessive nutrient input into water ecosystems is a significant environmental issue with over 50% of English waterbodies and Natura 2000 (N2K) sites (better known as special areas of conservation and special protection areas which are protected under the Habitats and Birds Directive including both terrestrial and Marine Protected Areas) failing their targets for phosphorus and/or nitrogen. Nutrient pollution is caused by human behaviour, from our agricultural and domestic land run-off, to sewage works discharge and storm drainage.

Nutrients flow into our rivers and groundwater, and then into our estuaries and coastal waters. Excess amounts of nutrients entering the water environment causes eutrophication – the rapid growth of algae which depletes the oxygen needed by other plants and animals in the eco-system. In our rivers, phosphorus is the nutrient largely responsible. In estuaries and coastal waters, nitrogen is the main nutrient involved.

Blue-green algae is a type of bacteria which form visible blooms when nutrient levels are high. It produces harmful toxins which take effect when ingested, inhaled or when they come into contact with the skin, making impacted water unsuitable for drinking, recreation or agricultural use.

Natural England have a responsibility to protect designated sites in the UK, and have instructed local authorities in civic areas not to grant planning permission unless they can demonstrate nutrient neutrality. They introduced new restrictions around phosphate and nitrate levels that seek to address the environmental issues but could have an adverse impact on our national housing ambitions and growth.

Inevitably, nutrients have become a hot topic for land developers and local authorities as many residential and commercial developments (which include overnight stay potential) are put on hold, and new planning applications are stalled due to the requirement of a Habitat Regulation Assessment (HRA) to demonstrate the actions that will be put in place to mitigate risk and achieve nutrient neutrality.

There is an urgent requirement for new housing in the UK, but this needs to be balanced with the urgency to protect our environment and waters. The guidance from Natural England is clear - where a development does not achieve nutrient neutrality then local authority planning permission will not be granted.

NUTRIENT POLLUTION IS TYPICALLY CAUSED BY TWO MAIN SOURCES; POINT SOURCES (SEWAGE WORKS AND STORM DRAIN DISCHARGES), AND DIFFUSE SOURCES (RUN-OFF FROM AGRICULTURAL AND URBAN LAND). SOLUTIONS NEED TO CONSIDER BOTH.

IMPACTED AREAS:

RIVER CAMAL
SOMERSET
SOLENT
STODMARSH

*this list will expand over time.

NATURE-BASED SOLUTIONS TO A COMPLEX CHALLENGE

At Stantec, our expert teams can help navigate your project through the planning stage by providing innovative solutions to complex nutrient challenges whilst enhancing and protecting the environment, from our rivers to the sea. There are a number of ways to address this challenge and mitigate the impact of phosphates and nitrates. Purchasing credits as part of a strategic nutrient mitigation scheme is often favoured and in certain instances maybe the only viable option (where available), but we believe that nutrient management needs a long term-strategic, and most importantly nature-based approach, that delivers a permanent solution beyond the challenge of achieving neutrality for developments. Our expert teams have developed and implemented a wide range of strategies for our clients to overcome complex nutrient challenges, submit successful planning applications and accelerate their land development programmes.

At Stantec, we explore innovative approaches and ways of working which achieve water quality objectives, reduce energy use and carbon emissions and realise additional benefits associated with nature-based solutions. Some of the ways we can approach these issues are outlined below.

DELIVERING NUTRIENT MANAGEMENT PLANS

Nutrient pollution sources are very diverse. We often have to take an ‘integrated catchment management’ approach, identifying methods to sustainably manage land, water and human activity in a catchment to reduce overall nutrient loads reaching the watercourses, groundwater and coastal sites.

In the most sensitive catchment areas in England, the Environment Agency and Natural England have put Nutrient Management Plans (NMPs) in place, including protected Natura 2000 sites—the network of core breeding and resting sites for rare and threatened species, stretching across Europe’s mainland and sea. The catchment areas include a number of our harbours, rivers, estuaries and coastal areas, and the NMPs are required to monitor and mitigate their nutrient pollution. When Natura 2000 sites are threatened, we apply NMPs to identify nutrient sources, and how we can manage this as a combined approach. These plans have been enacted for Special Areas of Conservation associated with the rivers Avon, Wye and Clun.

OUR SPECIALIST TEAMS CAN HELP YOU FIND SOLUTIONS TO MEET THE REQUIREMENTS OF NMPS IN AREAS WHERE THEY ARE IN PLACE, INCLUDING BESPOKE ASSESSMENTS OF CATCHMENTS WITH DIVERSE SOURCES OF NUTRIENTS BEYOND JUST SEWAGE EFFLUENT AND AGRICULTURAL RUNOFF.

CLEANING UP OUR AGRICULTURAL BEHAVIOURS

Rivers are a major conduit for nitrogen, from agricultural and domestic land run-off, so if we improve their quality, it's likely we'll benefit habitats downstream. For the agricultural industry, the most effective measures to address the clean-up are:

- Set out a nutrient plan, understand the nitrogen content of fertilisers, and test manures, composts and slurries regularly
- Grow cover crops to reduce the amount of nitrogen leached from fields
- Calibrate fertiliser spreaders with a predicted 8% reduction in leaching
- Land-use change from intensively farmed arable land to less intensively managed grassland or woodland
- Reduce stocking density which is the most effective measure to reduce nitrogen loading from livestock

At Stantec we are very familiar with the issues around quantifying and reducing agricultural diffuse pollution. Our catchment management team has worked extensively with water companies and regulators, using models and monitoring data to estimate agricultural nutrient loads and identifying suitable measures, or suites of measures to reduce them.

FEASIBILITY AND TRACKING OF HOW CATCHMENT MEASURES REDUCE NUTRIENT LOADS

Stantec have undertaken several projects to assess the feasibility of using catchment management (changes in land management and farm practice) to reduce nutrient loads (nitrate and phosphate), in surface and groundwater catchments. And we have developed dashboard tools for tracking progress to support farm advisors.

We regularly use probabilistic modelling to assess the likelihood that catchment management will reduce nutrient loads so that operational or environmental targets can be met. This takes into account the likely rates of farmer's engagement and their uptake and implementation of catchment actions (measures). The modelling also provides times of travel and yields plots of future trends we have used to produce better estimates of how operational blending of nitrate sources can be managed.

When farmers are implementing measures it is important to be able to track the progress in each catchment and for this we have developed dashboard tools that show the reductions to date and the potential for using specific measures to achieve the remaining desired reductions. Where clients want to use the modelling tools in-house, we provide handover training and user guides.

Ultimately, this work provides clients with the data needed to make informed decisions about the success of their catchment management programme.

PHOSPHORUS REMOVAL THROUGH WASTEWATER TREATMENTS

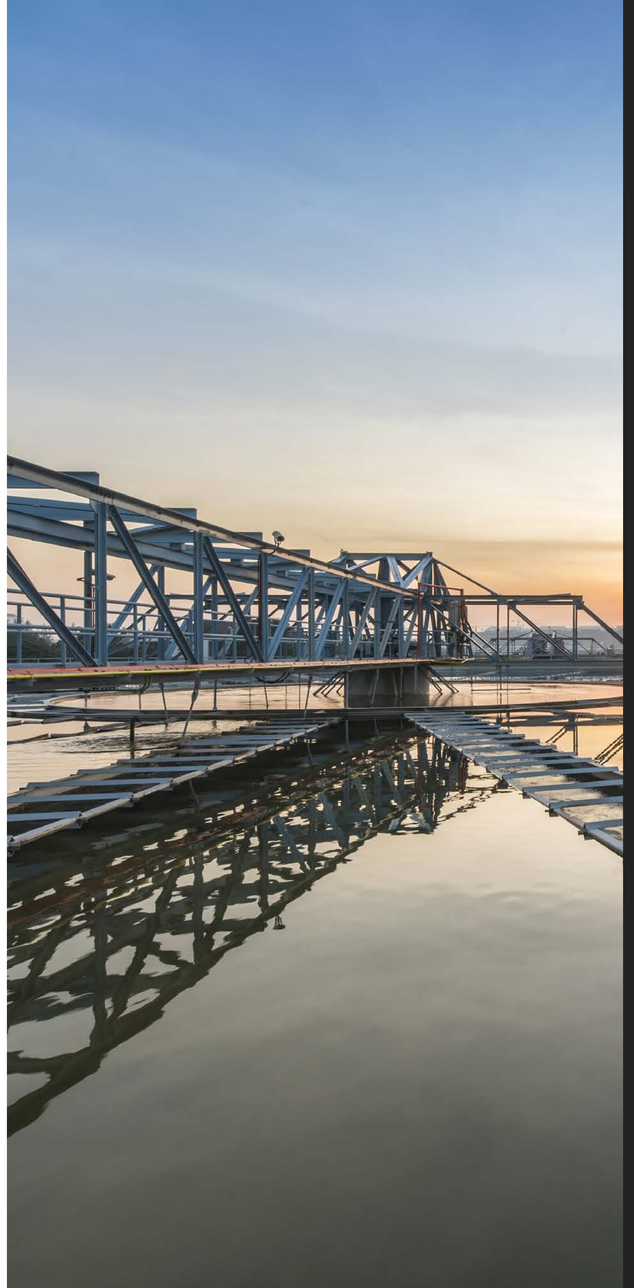
Outfalls from wastewater treatment works are one of the key reasons, with nutrient pollution by phosphorus ornitrogen are one of the most significant, for waterbodies fail to meet pollution-related performance criteria. In addition to stalling planning permissions for land development, there is increasing pressure on water businesses to meet more stringent performance criteria to reduce these impacts.

The water industry has invested heavily in improvements to wastewater treatment over the last 10-15 years, but there remains the potential to do more. Traditionally, improvements to effluent quality were achieved through chemical treatment (so-called “end-of-pipe” solutions) but more recently regulators and water companies have started to explore other options to reduce catchment nutrient levels through working with the agricultural sector. Dedicated catchment management teams are delivering programmes supporting and incentivising farmers to reduce diffuse agricultural production, delivering improvements in water quality in a more cost-effective and sustainable way than chemical treatment. These programmes can reduce the levels of chemical treatment required to achieve regulatory requirements.

However, in the context of nutrient-neutrality, most catchment management solutions cannot deliver nutrient reductions with the level of certainty required by Natural England to enable housing development to proceed.

Whilst it is, in many cases, technically feasible for water companies to increase levels of chemical treatment at wastewater treatment works to achieve nutrient neutrality, and this would achieve the required level of certainty, any such investment in water company assets is subject to regulatory approval through the Periodic Review process.

In the longer term, therefore, improving levels of sewage treatment could provide a solution enabling nutrient neutral housing development, but in the short term, a different approach is required.



CASE STUDY

MEETING PHOSPHORUS REDUCTION TARGETS THROUGH CATCHMENT BASED SOLUTIONS

Stantec were commissioned by Yorkshire Water to drive the concept of low carbon hybrid solutions to help meet the in-river phosphorus reduction targets set out by AMP7 WINEP and achieve a Moderate or Good ecological status. Phosphorus reduction is typically achieved as part of the wastewater treatment process (typically via chemical dosing), so our treatment and catchment experts collaborated to identify an opportunity for cost and carbon efficiency through a hybrid solution incorporating catchment-based solutions such as farm and in-stream measures.

This innovative approach could reduce the burden on the treatment process, which relies heavily on process technology, thereby reducing the carbon footprint.

The team screened all of Yorkshire Water phosphorus removal obligations and identified 40 wastewater treatment works where a hybrid solution could potentially work. They then identified treatment technology tipping points to better understand what phosphorus permit level the treatment process could support. This helped identify situations where wastewater treatments could be combined with catchment solutions including flow sacrifice, permit trading, wetlands, flexible permitting and catchment nutrient balancing.

The next step was to calculate the loads and potential reductions available from catchments alongside the carbon reduction achieved by the proposed hybrid solution compared to traditional treatment alone. Bringing together expertise from across our disciplines in environmental services, engineering, treatment, catchment science and farming practices, the Stantec team introduced a series of low carbon hybrid solutions which would help reduce the nutrient loads within the affected watercourses.

This hybrid, low carbon solution approach has been developed further is now being piloted with water companies across the country, including regions affected by the Natural England guidance. Lessons learned from the wetland designs will be applied to other schemes as we continue to assess and understand the feasibility of applying these options to achieve long term sustainable solutions for the industry.

INTEGRATED CONSTRUCTED WETLANDS (ICW)

Integrated Constructed Wetlands (ICW) are a series of shallow, densely-planted, man-made ponds consisting of saturated substrates, wetland plants and microbial communities that help filter water through physical and biological processes.

They provide a nature-based solution for removing pollutants including phosphates from stormwater or wastewater before it enters our streams, rivers and seas.

Our expert teams design ICW's that mimic naturally occurring wetlands and the processes that help to purify water. The combination of the financial and environmental costs of nutrient removal, along with the growing political desire to promote nature-based solutions and societal awareness of biodiversity, wellbeing and circular economy make ICW's a viable solution to addressing nutrient overload.

As a nature based solution, ICWs also provide opportunities for bio diversity net gain credits and carbon offsetting and Stantec can work with Clients and Landowners to develop solutions with multiple benefits.

CASE STUDY - PTARMIGAN

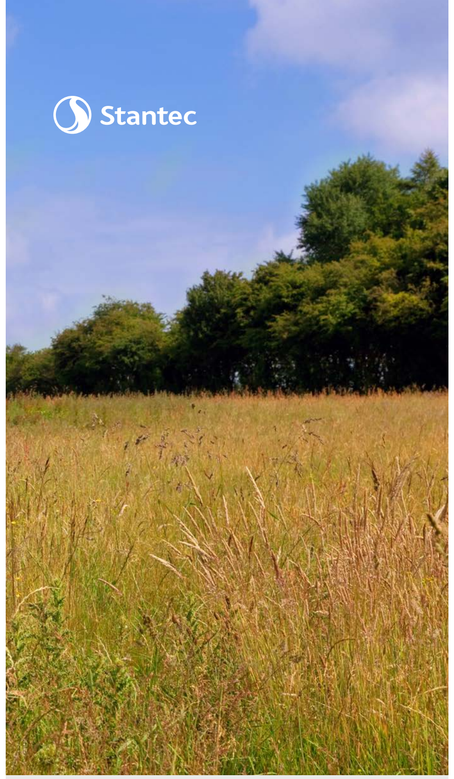
DRIVING FORWARD LAND DEVELOPMENT PLANS IN STAPLEGROVE, SOMERSET

The proposed 39.92 hectare mixed-use development at Staplegrove, Taunton was submitted for outline planning permission in 2017 for the development of 713 homes, employment space, a spine road, landscaping, play areas and sustainable drainage. Subsequently, the Somerset Levels and Moors RAMSAR sites were identified as being at risk of high levels of nutrients and as a result the proposals at Staplegrove were identified as requiring appropriate mitigation to offset the additional phosphate loading. Nutrient offsetting often presents complex and costly technical challenges. Our team set out to achieve nutrient neutrality through the effective design of Integrated Constructed Wetlands (ICW) that would intercept the maximum possible nutrient loading. Following advice from Natural England on total phosphorus (TP) removal rates and utilising a Phosphate Budget Calculator provided by Somerset Council's, the team prepared a detailed analysis of the amount of phosphorus that could be mitigated through the lifecycle of the project.

Areal first-order removal rates for TP were quantified using the P-k-C* model (Kadlec and Wallace, 2009). This model is an improvement over earlier models that assumed plug-flow conditions because it accounts for non-ideal flow patterns typical of treatment wetlands through the incorporation of the mixing parameter P. The parameter P represents the apparent number of mixed reactors in series that best represents a given treatment of a wetland system. A P of 1.0 represents a single completely mixed reactor. An infinite P represents an ideal plug-flow reactor. The P-k-C* equation where Ci and Co (mg L-1 P) are the inflow and outflow concentrations of TP, C* (mg L-1 P) is the background concentration and is the minimum possible concentration in wetland outflow, k (m yr-1) is the first-order removal rate constant, q (m yr-1) is the Hydraulic Loading Rate (HLR), and P is the number of reactors in series ((Co-C^*)/(Ci-C^*))=1/(1+k\/Pq)^P With the phosphorus mitigation calculations complete, the next step was to prepare detailed recommendations on the design criteria and operation of the ICWs to meet the identified targets.

Hard engineering design was required to create the right type of habitat and ensure that the right amount of water flows through the wetlands. The design plans considered length to width ratio, water depth, hydraulic sloping and loading, first order removal rates, reactors and provided a detailed planting scheduled. Once the design requirements were understood, the team helped identify a field, known as "Longfield" with good potential to convert to wetlands. The ICW was designed to divert flow from the stream, and where possible drainage ditches, such that the design HLR is not exceeded. Therefore, a diverted flow exceedance assessment check was undertaken to confirm there was sufficient flow for the ICW to treat. A catchment characteristics report was also undertaken. Based on this detailed assessment the Longfield P-k-C* model was populated. The 19.13 kg/year/ha (1.9 g/m2/year) removal rate identified by Stantec was higher than the Natural England requirements. The design criteria of 0.1 m/day aligned with industry best practice and therefore a higher removal rate was proposed, whilst still being within the range stated.

The Stantec team then conducted a detailed assessment of the wetland opportunity of the land holding and upstream catchment to identify potential sites for additional wetland to provide further mitigation for the full development. This assessment identified the natural flow pathways using digital terrain modelling using 5m gridded elevation data and the HydroloGIS model. This identified an additional location within the land holding, together with other areas in the upstream catchment, where flows accumulated in natural depressions within the landscape. The assessment showed that the land holding was well drained with many fields bordered by ditches that provide a potential opportunity to capture flows from upstream farmed areas. A further assessment of the drainage ditch network was achieved using aerial imagery, with additional targeted walkovers to establish flow direction under different hydrological conditions. This helped identify additional potential sites. The work undertaken by the Stantec project team is helping our client fully offset the migration required at Staplegrove West so that they can deliver on their vision to build a new sustainable garden community for Taunton.



The Nutrient Neutrality issue is complex, requires collaboration with multiple stakeholders, and often solutions are site specific so there is rarely a ‘one size fits all’. At Stantec, we are proud to have the opportunity to draw on skills in water, catchment management, treatment, ecology, landscape, flood risk, planning, EIA and more to help develop strategies to manage the Nutrient Problem

MEET THE TEAM

We help our clients to find sites, plan, obtain approval for and deliver major development and infrastructure projects. We provide trusted advice to create value from the land and buildings owned or operated by our clients by overcoming environmental challenges and maximising opportunities. Working throughout the development cycle, we support our client’s in achieving their development aspirations, whilst also enhancing the environment and supporting our communities.

Get in touch with the team to find out more about how we can help you navigate your nutrient challenges and fast track your development project.

Robert McTaggart
Technical Director
robert.mctaggart@stantec.com

Alan Swan
Director, Transport
alan.swan@stantec.com

Andrew Johns
Senior Associate
andrew.johns@stantec.com

Paul Davison
Technical Director
paul.davison@stantec.com

Michael O’Neill
Senior Associate
michael.oneill@stantec.com

Paul Hulme
Technical Director
paul.hulme@stantec.com

Stantec

CONNECT WITH US

STANTEC.COM