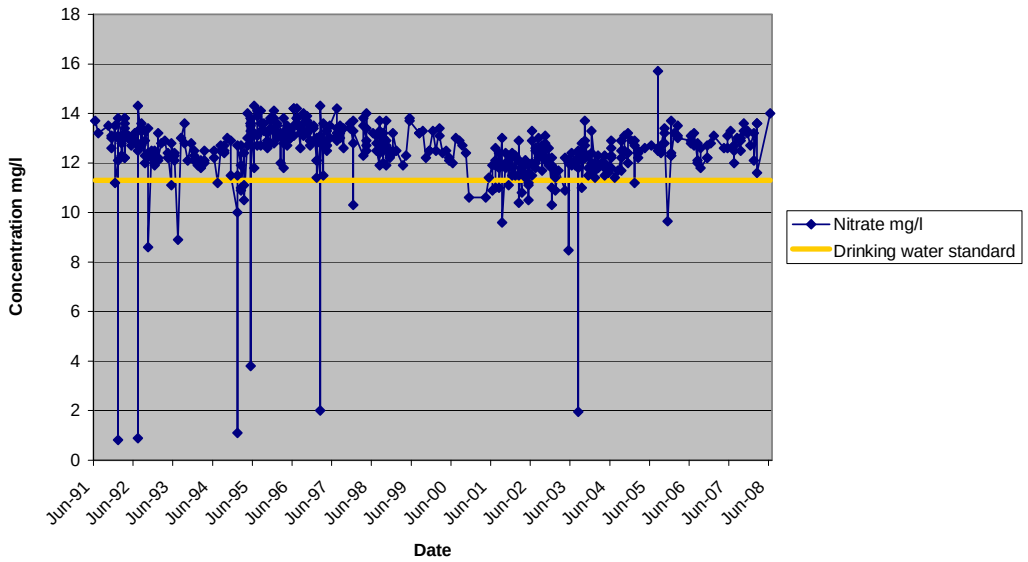
Better Thames Network
Groundwater Workshop

Case Study 3
Understanding groundwater – surface water interactions to help prioritise catchment work to decrease nitrate / ammonia inputs

Introduction
Many surface water systems (wetlands, streams, rivers and estuaries) are detrimentally impacted by nutrients, particularly ammonia and phosphates. Traditionally efforts to decrease the inputs have focussed on direct inputs to the surface water, such as discharges from sewage treatment plants, or surface inputs, such as fencing to decrease run-off / direct access from farm land. This case study is based on the River Stour between Wye and Canterbury but could equally apply to any river that is groundwater fed in the country.

		
River Stour, Kent	**Sewage works discharge**	**Cows in river (not local photo)**

In many areas the groundwater is known to be impacted by elevated levels of nitrates. In East Kent these tend to be over the drinking water standard or rising towards it. There is no available data in the immediate catchment, other than immediately adjacent to the river.



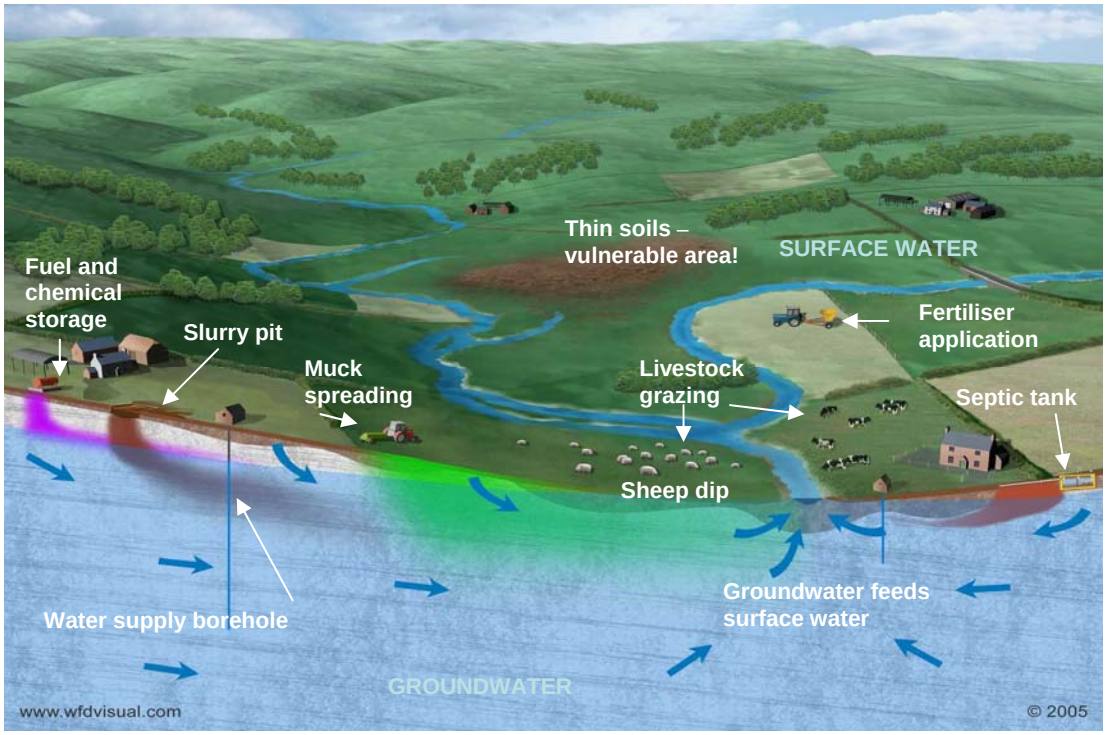
Elevated concentrations of nitrates in groundwater in East Kent

Caution! The data used in this example is raw groundwater quality. Please note that the water is tested regularly and treated appropriately prior to putting it in to supply. A high standard of drinking water is available for public supply.

It is very likely that the nutrient nitrate rich groundwater will be adding to the concentrations found in the surface water systems.

Water Framework Directive investigations
The Water Framework Directive (WFD) established a new legislative regime for the integrated management, protection and improvement of Europe's rivers, lakes, estuaries and groundwater.

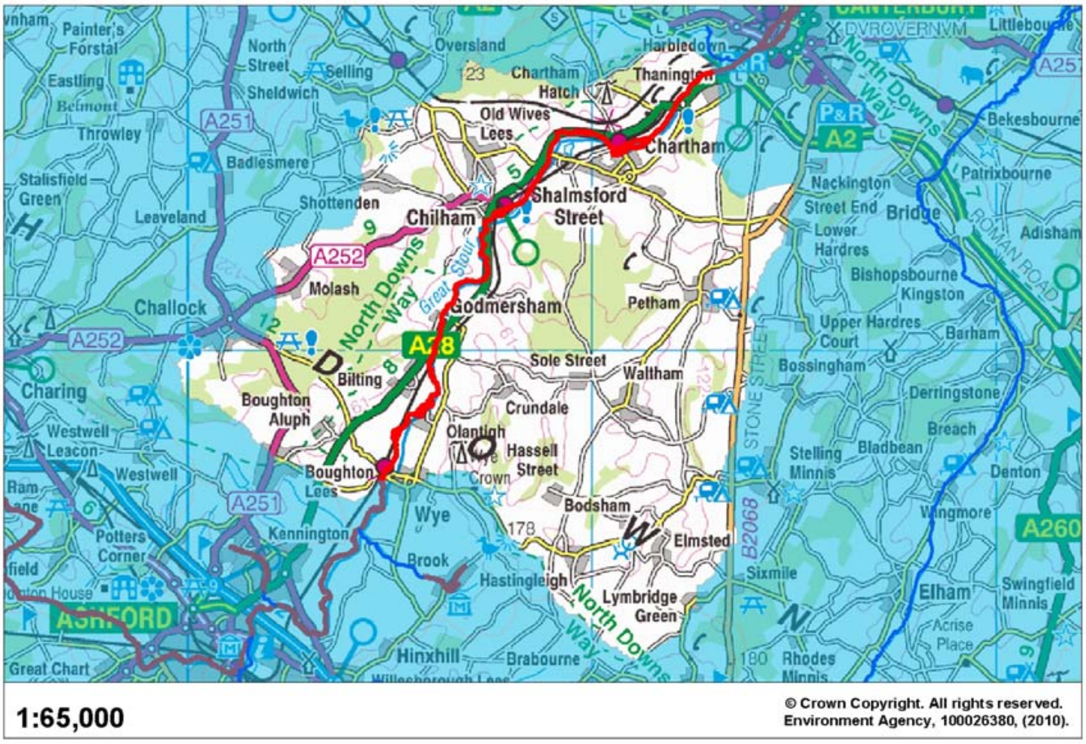
The WFD states that if a surface water body fails to achieve good status (i.e. it is bad, poor or moderate status) as a result of interactions with, or discharges or abstraction from, an associated groundwater body, then the groundwater body thereby fails to achieve good status. If a water body is of poor status, a Programme of Measures must be put in place to ensure that its condition is improved so that the water body achieves good status. This means that investigations are required to identify and prioritise the actions that will resolve the issue.



Initial investigations on the River Stour between Wye and Canterbury identified several key potential inputs of nitrate and ammonia to the groundwater and surface water systems. These included:

- Sewage discharges
- Agricultural activities
- Activities at stables
- Industry and industrial effluents
- Landfills

Study area:


Painter's Forstal
North Street
Oversland
Selling
Sheldwich
Chartham Hatch
Harbledown
Thanington
Eastling
Belmont
Throwley
A251
Old Wives Lees
Chartham
Badlesmere
Stalisfield Green
Leaveland
Shottenden
Chilham
Shalmsford Street
Nackington
Street End
Bridge
Lower Hardres
Patrixbourne
Bekesbourne
Adisham
A252
Molash
North Downs Way
Great Stour
Godmersham
Petham
Bishopsbourne
Kingston
Upper Hardres Court
Barham
Challock
A28
Sole Street
Waltham
Bossingham
Derringstone
Charing
Bilting
Boughton Aluph
Crundale
Olantigh
Hassell Street
Westwell Leacon
Westwell
Stelling Minnis
Bladbean
Breach
Denton
Boughton Lees
A251
Wye
Bodsham
Elmsted
B2068
STONE STREET
Wingmore
A260
Potters Corner
Kennington
Brook
Sixmile
Hastingleigh
Lymbridge Green
Elham
Swingfield Minnis
ASHFORD
Acrise Place
Great Chart
Hinxhill
Brabourne
Rhodes Minnis
A2
P&R
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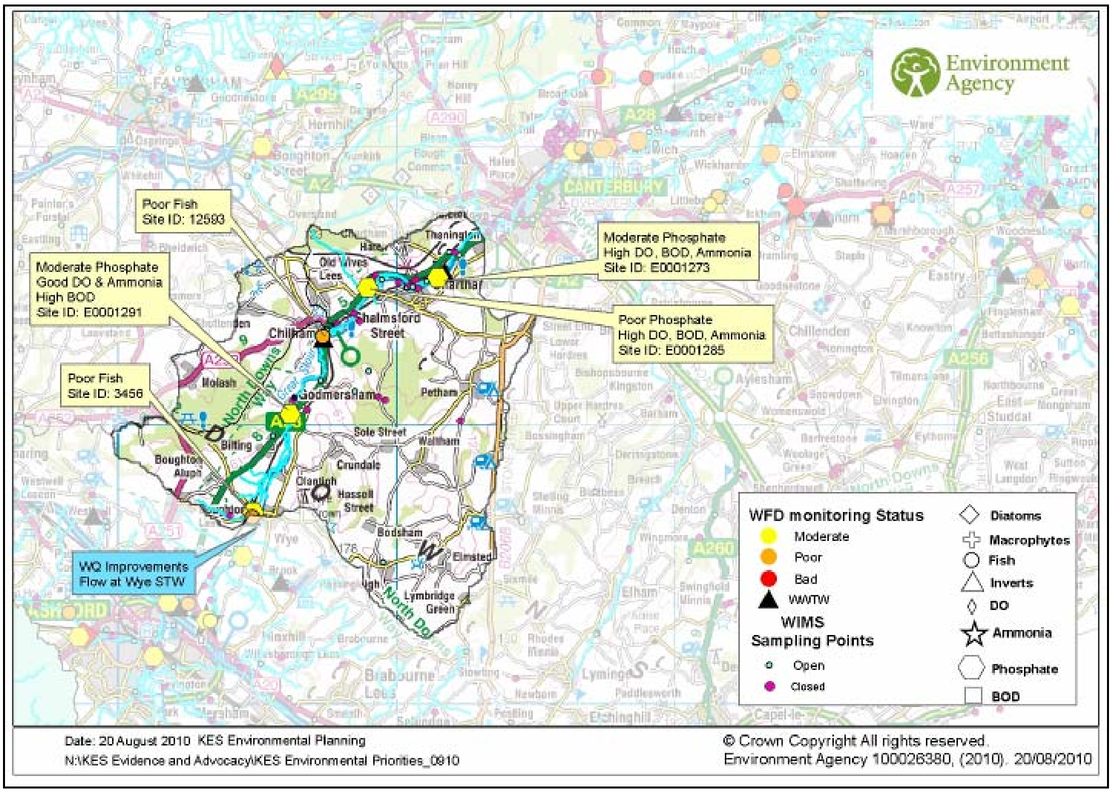
Environment Agency, 100026380, (2010).


Environment Agency
Poor Fish
Site ID: 12593
Moderate Phosphate
Good DO & Ammonia
High BOD
Site ID: E0001291
Moderate Phosphate
High DO, BOD, Ammonia
Site ID: E0001273
Poor Phosphate
High DO, BOD, Ammonia
Site ID: E0001285
Poor Fish
Site ID: 3456
WQ Improvements
Flow at Wye STW
CANTERBURY
ASHFORD
WFD monitoring Status
Moderate
Poor
Bad
WWTW
WIMS
Sampling Points
Open
Closed
Diatoms
Macrophytes
Fish
Inverts
DO
Ammonia
Phosphate
BOD
Date: 20 August 2010 KES Environmental Planning
N:\KES Evidence and Advocacy\KES Environmental Priorities_0810
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Environment Agency 100026380, (2010). 20/08/2010

Sewage discharges
A total of 82.6m^3/d of sewage effluent from septic tanks and package treatment plants discharge to ground within the study area, covered by 41 individual permits ((Environmental Permitting Regulations 2010). There are 7 discharges which are of concern, as they are either relatively large, in a Source Protection Zone 1 or near the river and, therefore, very little unsaturated zone will be available.

Agriculture
The land-use mapping undertaken as part of the study shows that the study area is dominated by arable land, grassland (including meadows and verges) and deciduous wood. As arable land covers a large amount of the study area, there is likely to be a contribution of ammonia and nitrate from agricultural activities into the ground.

Stables
The locations of several stables in study area has been identified. Two stables present a higher risk of pollution to the groundwater and surface water than the others due to their size and location, near to the public water supply abstractions or the river valley.

Industry and industrial effluents
There are no major towns or cities within the study area. There are two major industrial sites that are permitted by the Environment Agency, a paper mill and a transfer station. The local council permit a rendering plant with a large effluent discharge (currently not operating but may have a historical input). Along the main road from Ashford to Canterbury there are a few light industries. Activities undertaken at these industrial sites may have the potential to cause pollution.

Garden Centre
One garden centre has been identified that lies in the study area. It is located in Source Protection Zone 1 of a public water supply and within 200m from the river. It is therefore in a vulnerable location. This is a large garden centre that sells range of products including fertilisers, Weed Control and Pest Control. The maintenance and drainage of the storage areas is not known, but will be key to understand any risks to the groundwater and river water quality. The risk from this site is initially high, so a visit to the site to understand the activities and risks they pose, and provide advice would help reduce this risk.

Landfills
There are seven historic landfills identified in the study area. Three of these lie in a vulnerable location and present a risk of causing pollution of the underlying groundwater and river. Limited information is available on the construction of the landfills and the nature of the waste accepted, so further information is required to assess the risk further. Considering the land use is mainly agriculture, there may also be other small historical farm tips in the study area, that we hold no information on.

Considerations

The aim of the Water Framework Directive is for groundwater to reach good status by 2027 at the latest. For the groundwater Surface Water Test good status of groundwater will be will be achieved when the contribution of a particular pollutant no longer contributes to the surface water body being classified as Bad, Poor or Moderate status, returning to Good or High Status.

Surface Water Bodies	Groundwater Bodies
Bad	Poor
Poor	
Moderate	
Good	Good
High	

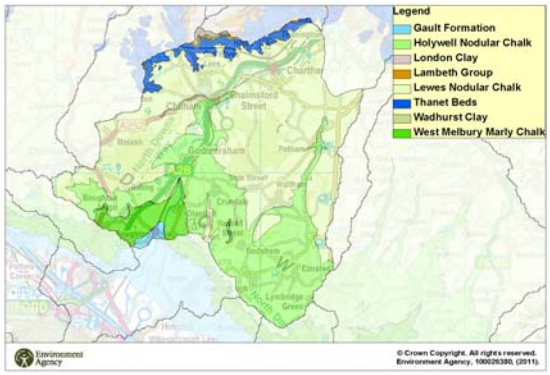
This part of the river Stour is of poor status. We are concerned that the contribution of nitrate and ammonia maybe having a detrimental impact on the water quality in the River Stour.

Further research is already underway

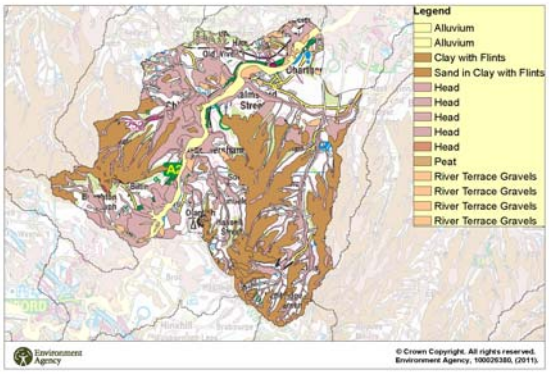
The study area is large and historically the sites nearest the river have been seen as a higher priority. By combining the information on site layout with information on groundwater-surface water interactions (study of the hyporheic zone) it is expected that better capture and prioritisation of sites will be possible. This work is underway with Lancaster University but could equally be applied to other catchments.

Theoretically if the flow of water from the Chalk groundwater to the River Stour is:

- Through a thick unit of alluvium it is likely to be slower and so the land-use within the catchment is likely to have less effect on the river via the groundwater
- Directly in to the river from a strong fracture system and unconfined Chalk within the catchment is likely to mean that the area of catchment prioritised needs to be extended and is likely to be having a greater effect on the surface water.

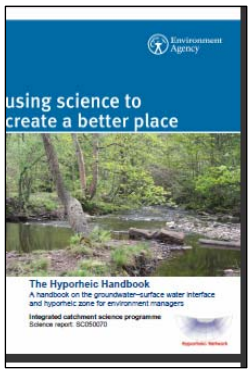


Bedrock Geology



Drift Geology

Traditionally the main methods of study have concentrated on the interactions through the base of the river. It is expected that the interaction through the banks of the river could be very important, and so far underestimated, too.



Further reading:

The Hyporheic Handbook - Hyporheic Network

The Hyporheic **Handbook**. A **handbook** on the groundwater–surface water interface and **hyporheic zone** for environment managers. www.**hyporheic**.net/SCHO1009BRDX-e-e.pdf - Similar

Workshop objectives

1) What methods could be used to understand groundwater to surface water flow?

2) There are many likely inputs of substances within the catchment. The fate and transport of these within the unsaturated zone and groundwater will influence the amount that reaches the river.

- What tools and research are available to help at catchment scale?
- Can anything else be developed or researched to help?

3) Recording the work - How could information from site visits, advice given and work underway be captured and recorded?

It is becoming increasingly important to show the outcomes in a clear manner for everyone to understand easily. Have you got any ideas or great ways of displaying the information?

4) This prioritisation and work on sites could be used in many areas and for a variety of pollutants across the country.

- Have you got any case studies, similar research examples or future project areas ready for investigation?
- How could this be applied in urban catchments?
- Are there any additional tools available?

Workshop Discussion and Feedback

What methods could be used to understand groundwater to surface water flow?

Examples of Tools

- Groundwater levels
- Flow accretion
- Mass balance
- Linking flow, level and quality monitoring
- BGS SuDs database
- INCA
- IGARF
- EA Contaminants Loading spreadsheet tool
- Hyporheic Zone Handbook
- And many many others…

General comments on tools

- Existing tools are not being used (more comms needed?)
- Need tools for dynamic conditions

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- What tools and research are available to help at catchment scale?
- Can anything else be developed or researched to help?

Scale

- We have good tools at catchment scale
- Not so good at sub-catchment / individual site scale

Gaps

- We need a framework to link tools / techniques / data together
- Need common data standards
- Need to link well-used surface water models with unsaturated zone / groundwater models e.g. SIMCAT (there is a Defra proposal that may help to do this)
- Need more robust assessment of the nitrate 'time-bomb'
- Need more evidence of emerging contaminants e.g.
    - Caffeine
    - Carbamazepine
- Better understanding of exfiltration from sewers
- Surface and groundwater monitoring networks don't match-up

Public awareness

There is a need to increase public awareness in general. Specific actions include:

- Signs in drinking water catchments (can learn from Germany)
- Fish signs on drains that flow to surface water (can learn from Australia and the USA)
- Need more effective/robust communications on sewer misconnections
- Oil Care Campaign needs reinvigorating
- Can learn lessons from existing projects where there has been good engagement with the public e.g.
    - CSF
    - Rivers Trust projects
    - South West Water 'Upstream thinking'
    - Demo Test Catchments
- We need wider roll-out of these projects

Recording the work - How could information from site visits, advice given and work underway be captured and recorded?

It is becoming increasingly important to show the outcomes in a clear manner for everyone to understand easily. Have you got any ideas or great ways of displaying the information?

Sharing information

- We need to get smarter at sharing information e.g. between Agencies / Water Companies / Local Authorities (Data Protection Act permitting)
- We need Open Access Databases (can learn from the USA here)
- The EA needs to share recharge information via the web

Displaying information / data

- Wider use of GIS
- Wider use of smart phone apps e.g. iGeology from BGS
- Need time-variant animations, also need the tools to develop these
- BGS SuDs Planning tool is a good practise example

This prioritisation and work on sites could be used in many areas and for a variety of pollutants across the country.

- Have you got any case studies, similar research examples or future project areas ready for investigation?
- How could this be applied in urban catchments?
- Are there any additional tools available?

Out of time – for thought in the future.