Environment Agency

SEPA
Scottish Environment Protection Agency

Solway Tweed River Basin District

Characterisation and impacts analyses required by Article 5 of the Water Framework Directive

SUMMARY REPORT











Cover images

Main - Pond, Paxton, Berwickshire

Top to bottom - Marshes, Borders

- Yetholm Loch, Borders
- Peebles
- River Tweed

The Future of Our Waters

River Basin Characterisation

- Analysis of its characteristics, and
- Review of the impact of human activity on the status of surface waters and on groundwater

Published 22 March 2005

Foreword





Over the coming years, important decisions are going to be made about how we protect and improve our valuable water resources and on the pages that follow we set out some important information about the pressures and impacts upon the water environment.

This work is one of the first steps under the Water Framework Directive which came into force in Europe in 2000 and established new and better ways of protecting, improving and using Europe's rivers, lochs, lakes, estuaries, coasts, canals, wetlands and groundwater.

We have worked hard during the last three years to collect information that is informative and useful to key individuals, organisations and decision-makers. However, there is still much to be done to fully understand the impacts, and further work is planned for the years ahead.

In Scotland work has been undertaken by a range of organisations including the Scottish Environment Protection Agency (SEPA), British Geological Survey, British Waterways, Fisheries Research Services (marine and fresh water laboratories), Macaulay Institute, Scottish Executive, Scottish Natural Heritage and Scottish Water. In England, the Environment Agency has undertaken the work with input from English Nature and support from environmental consultancies. A wide range of organisations also completed a review of the work.

SEPA consulted on a draft of this report, which covered the whole of Scotland, between July and September 2004 and the Environment Agency held a review with external stakeholders between September and November 2004. This report takes into account the responses received for which SEPA and the Environment Agency are very grateful. We intend to continue this participative approach throughout our work on the Directive as we monitor, assess, plan and take action to improve our water environment.





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Executive Summary

This report is the most detailed description ever produced on the pressures and impacts on the water environment in the Solway Tweed river basin district. It represents one in a series of reports on the United Kingdom's water environment. The work has been undertaken by a range of organisations including the Scottish Environment Protection Agency (SEPA), British Geological Survey, British Waterways, Fisheries Research Services (marine and fresh water laboratories), Macaulay Institute, Scottish Executive, Scottish Natural Heritage and Scottish Water. The Environment Agency and the Department for Environment, Food and Rural Affairs have undertaken the work with partner organisations including English Nature.

Water bodies

In order to be able to better manage and report on our water environment, it has been divided into smaller units called water bodies. This has been done in accordance with the requirements of the Directive and having regard to UK guidance. Water bodies may be entire bodies of water such as lochs or lakes, or parts of bodies of water such as river sections. The water body units have been identified using natural features, for example where two rivers join, as well as pressures acting on waters, for example where a large dam has been built. In total 521 river, 32 lake, 11 transitional, 8 coastal and 24 groundwater water bodies have been identified in the Solway Tweed river basin district.

All of these water bodies have been assessed to determine if the pressures upon them may put at risk attainment of the Directive's objectives unless management measures are taken. This assessment has necessarily been carried out in advance of an internationally agreed definition of good status being finalised, so will be subject to future revision as more information becomes available.

Point source pollution and assessment of impact

A total of 50 river, 2 lake, 5 transitional, 2 coastal and 6 groundwater water bodies are affected by or at risk from point source pollution pressures. The main cause is sewage disposal activities.

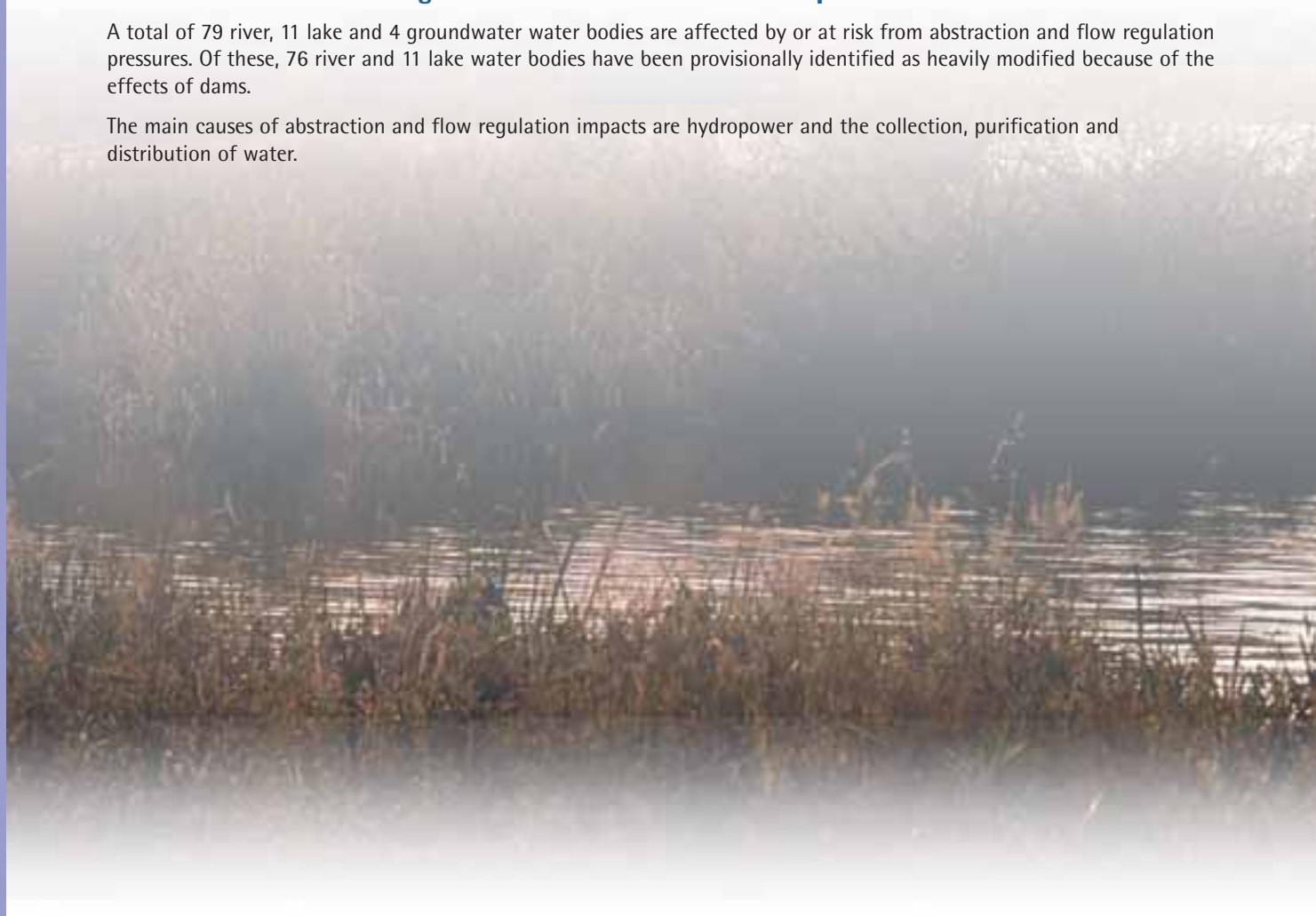
Diffuse source pollution and assessment of impact

A total of 198 river, 13 lake, 3 transitional, 2 coastal and 16 groundwater water bodies are affected by or at risk from diffuse source pollution pressures. The main cause of diffuse pollution is agriculture. The next most important causes are forestry and the production of power and transport, resulting in acidification.

Abstraction and flow regulation and assessment of impact

A total of 79 river, 11 lake and 4 groundwater water bodies are affected by or at risk from abstraction and flow regulation pressures. Of these, 76 river and 11 lake water bodies have been provisionally identified as heavily modified because of the effects of dams.

The main causes of abstraction and flow regulation impacts are hydropower and the collection, purification and distribution of water.



Morphological alterations and assessment of impact

A total of 174 river, 13 lake and 5 transitional water bodies are affected by or at risk from morphological alterations. Of these, 76 river, 11 lake and 2 transitional water bodies have been provisionally identified as heavily modified. These water bodies have been identified on the basis that it is unlikely that they will be able to achieve good ecological status because of the impact of modifications which support beneficial uses.

Morphological alterations arise from a variety of causes such as agriculture and forestry, flood defence walls, land claim and dredging.

Summary of water bodies affected by all pressures

The initial characterisation assessment indicates that overall 56% of water bodies in the Solway Tweed river basin district may not meet the Directive's environmental objectives, including 289 river, 21 lake, 6 transitional, 2 coastal and 16 groundwater water bodies.

In the Solway Tweed river basin district, diffuse pollution and morphological pressures are the most common causes of rivers and lakes being at risk. Transitional water bodies are mainly at risk from point source pollution and morphological pressures. Coastal water bodies are at risk from point and diffuse source pollution, whereas groundwater bodies are mainly at risk from diffuse pollution.

These causes reflect the geographic nature of the district. Much of the area is rural in nature and agriculture is the predominant land use.

Future work

This assessment is only the first step in improving our water environment through integrated river basin management. Information will continually be improved and refined making the next cycle of characterisation more accurate than this first assessment. The next stage will be to further develop characterisation by improving our information from all sources, including regulated and non-regulated sectors and by incorporating additional monitoring data. This will help generate the report on *'Significant Water Management Issues'* in the river basin in 2007, as required by Article 14 of the Directive.

SEPA and the Environment Agency will use the information in this report to help amend the environmental monitoring programme. We will continue to work in partnership with other organisations and sectors in order to design and carry out a programme of measures to achieve the environmental objectives of the Directive.

Further information on river basin characterisation and other Water Framework Directive related work is available on SEPA's website at http://www.sepa.org.uk/wfd/index.htm and the Environment Agency's website at www.environment-agency.gov.uk/wfd.



Marshes, Borders

1. Introduction

1.1 Overview

The Water Framework Directive (the Directive)[1] is a wide ranging and ambitious piece of European environmental legislation transposed in the Solway Tweed river basin district via the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act) and the Water Environment (Water Framework Directive) (Solway Tweed river basin district) Regulations 2004.

The Directive's overall objective is to bring about the effective co-ordination of water environment policy and regulation across Europe in order to:

- prevent deterioration and enhance the status of aquatic ecosystems, including those dependent on groundwater;
- promote sustainable water use;
- reduce pollution;
- help reduce the effects of floods and droughts.

This report summarises (as required under Article 15) the most detailed assessment ever produced on the pressures on the water environment in the Solway Tweed river basin district. This analysis has been reported separately to the Commission. The work has been undertaken by a range of organisations including the Scottish Environment Protection Agency (SEPA), British Geological Survey, British Waterways, Fisheries Research Services (marine and fresh water laboratories), Macaulay Institute, Scottish Executive, Scottish Natural Heritage and Scottish Water. The Environment Agency and the Department for Environment, Food and Rural Affairs (Defra) have undertaken the work with partner organisations including English Nature.

It represents one in a series of reports on the United Kingdom's water environment and is the start of a new era of environmental protection as we modernise the way we manage and protect the water environment. The Directive requires man-made pressures on the water environment to be assessed and managed in an integrated way across surface and groundwaters.

The Directive sets out a planning cycle for river basin management which consists of four main parts:

- **characterisation** of river basin districts including an assessment of water bodies at risk of not achieving the Directive's objectives as a result of man-made pressures;
- environmental **monitoring** informed by river basin characterisation;
- setting of environmental **objectives**; and
- design and implementation of a **programme of measures** to achieve environmental objectives.

A timetable for the Directive's main requirements is shown below in Table 1.

Table 1: Water Framework Directive timetable

Year	Requirement
2000	• Directive comes into force
By 2003	• Transpose requirements to member state law • Identify river basin districts (RBD) and Competent Authorities
By 2004	Undertake RBD characterisation to include: • Assessment of pressures and impacts on water status • Economic analysis of water use • Provisional identification of heavily modified and artificial waters • Register of protected areas
By 2006	• Monitoring programmes operational • Finalise EU register of intercalibration sites • Consult on RBMP production work programme
By 2007	• Consult on significant water management issues overview in RBD
By 2008	• Publish full draft RBMP for consultation

[1]A copy of the Water Framework Directive is available at http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf

Year	Requirement
By 2009	Publish final first RBMP to include: • Environmental objectives • Programme of measures • Monitoring networks • Register of protected areas • Heavily modified and artificial water body designations
By 2012	• Programme of measures operational
By 2013	Review for the first RBMP: • Characterisation assessments • Economic analysis Consult on significant water management issues overview for 2nd RBMP
By 2015	• Achieve environmental objectives of first RBMP • Publish 2nd RBMP and thereafter every six years

This report covers the initial **characterisation** of the cycle, including an assessment of pressures and impacts on the district's waters. This is important because it will help determine the monitoring strategy and provide a starting point for the design of a programme of measures.

The main steps of characterisation are:

- identifying water bodies and their physical characteristics (Sections 3 and 4);
- identifying protected areas (Section 5);
- assessing the pressures and impacts on rivers, lochs, lakes, estuaries, coasts, groundwaters and groundwater dependent ecosystems, such as wetlands (Section 6);
- identifying which water bodies are at risk of not achieving the Directive's objectives;
- an economic analysis of water users and services in the district (this is presented in a separate report).

To be able to better manage and report on our water environment, it has been divided into **water bodies**. Water bodies may be entire bodies of water such as lochs or lakes or parts of bodies of water such as river sections. These units have been identified using natural features, for example where two rivers join, as well as pressures acting on waters, for example where a large dam has been built. As a result 24 groundwater, 521 river, 32 lake, 11 estuarine and 8 coastal water bodies have been identified in the Solway Tweed river basin district.

The physical and chemical nature of these water bodies has been described and each water body assigned to one of a limited number of **types**. The type indicates, in very general terms, the sorts of plants and animals that are likely to be present, for example, the sorts of animals and plants that are found in shallow, exposed coastal waters are very different to those found in deep sea lochs. The type is important because it affects what the environmental objectives mean for the different types of water.

The next step is to identify water related **protected areas**. These have mainly been designated under a number of other European directives because they require special protection. Examples include bathing waters and areas identified for the protection of water dependent species and habitats. Establishing a register of protected areas will help to ensure water bodies are managed in a way that meets the protected area objectives.

A key part of characterisation is the **assessment of pressures and impacts** on the water environment. This information is used as part of a risk screening exercise to identify those water bodies that are at risk of failing the environmental objectives set out in the Directive. The results will be used to prioritise both our environmental monitoring and those water bodies where management action is required. The assessment will also identify where it is already evident that pressures need to be tackled and, therefore, where the planning of appropriate improvement action can start immediately.

The difficulty and complexity of such an analysis should not be underestimated. Previous environmental assessments by SEPA and the Environment Agency have focused on pollution pressures (and abstraction pressures in England) and have been supported by extensive chemical and biological monitoring information. The new assessment has involved integrating and interpreting information on different types of pressures, and we have had to develop new methods in a short space of time. The following pressures have been examined for their impacts on water bodies (Sections 6.2 to 6.7):

- point source pollution: such as effluent from waste water treatment works and industrial discharges
- diffuse source pollution: including run-off from farmland, urban areas and acid rain
- abstraction and flow regulation: including abstractions for water supply, manufacturing processes; and impoundment of water by dams or weirs for a range of uses such as hydropower and navigational purposes

- morphological alterations: for example land claim for ports or housing, structures for coastal protection
- alien species: introduced species which can result in a loss of natural biodiversity.

1.2 Interpreting the results of the pressure and impact assessments

The main purpose of this assessment is to identify which water bodies are likely to fail to meet their environmental objectives. Annex 1 outlines the environmental objectives and discusses some of the issues surrounding the assessment. These issues and plans for further characterisation are further discussed in the introductions to the reports sent to the Commission.

Achievement of 'good status' is one of the key environmental objectives of the Directive. Good status means that certain standards have been met for the ecology, chemistry and quantity of waters. In general terms, good status means that waters show only a slight change from what would normally be expected under undisturbed conditions. Another key objective is to achieve protected area objectives. We have undertaken an assessment, using the latest compliance reporting where possible, of whether protected areas are likely to achieve their objectives.

Further stages in the pressure and impact assessment are likely to change the number of waters at risk of failing the Directive's objectives as better information becomes available and practical constraints allowed for in the Directive (for example, the technical feasibility of improvement actions) are taken into account.

Action on the water bodies likely to fail their environmental objectives may take the form of a programme of measures or further assessment to decide on appropriate steps.

It is important to remember that the purpose of the assessment is to help determine the monitoring programme and to provide a starting point for river basin management planning. SEPA consulted on proposals for river basin management planning between May and July 2004. The Environment Agency undertook a formal three month consultation on a Strategy for River Basin Management beginning in late January 2005.

1.3 Purpose of this document

This report covers the initial characterisation stage of the process outlined above, including a risk screening assessment of pressures and impacts on the Solway Tweed river basin district waters. The economic analysis of water use is presented in a separate report.

Some of the terminology used in this report comes from the Directive. It will allow the European Commission to assess the UK's compliance with the Directive and will also allow other member states to use the document more easily. In some instances where particular Directive requirements are presented, lochs may be referred to as lakes and estuaries may be referred to as transitional waters.

A general introduction to some of the technical aspects of the Directive can be found in SEPA's previous consultation document "The Future for Scotland's Waters" published in May 2002[2] and the Environment Agency's previous consultation document "The Water Framework Directive - Guiding principles on the technical requirements" published in June 2002[3].

1.4 Next steps

SEPA and the Environment Agency will use the information in this report to help establish an environmental monitoring programme, improve the risk assessments where appropriate and start to look at risk management options. We will work in partnership with other organisations and sectors that contribute to the risks to the environment to design and carry out a programme of measures to achieve the environmental objectives of the Directive.

Further information on river basin characterisation and other Water Framework Directive related work is available on SEPA's website at http://www.sepa.org.uk/wfd/index.htm and the Environment Agency's website at www.environment-agency.gov.uk/wfd.

[2]See http://www.sepa.org.uk/publications/wfd
[3]See http//www.environment-agency.gov.uk/wfd

2. Solway Tweed river basin district

River basin districts are the main areas used for co-ordinating the management of the water environment. They comprise river basins and their associated transitional waters, coastal waters and groundwaters. The Solway Tweed river basin district crosses the border between Scotland and England.

The Scottish Executive and the Department for Environment, Food and Rural Affairs are responsible for implementation of the Water Framework Directive, and SEPA and the Environment Agency have carried out the characterisation in Scotland and England respectively. It has therefore been necessary to modify the approach otherwise taken in both England and Scotland to ensure that the requirements of the Directive are applied in relation to the district as a whole in a coordinated way.

Map 1 shows the river basin districts in mainland UK including the Solway Tweed river basin district to which this report refers.

Environmental characteristics

The Solway Tweed river basin district covers around 17,500 km^2 and around 300,000 people live in the district. The landscape varies from the rolling hills of the Southern Uplands to the sandy beaches and rocky shorelines along the west coast.

The rolling hills of the Southern Uplands are drained to the Solway Firth in the west by the rivers Nith, Annan and Esk. The River Tweed drains the catchment to the east. Agriculture accounts for the largest land use in the district, this is followed by forestry and woodlands. Very little of the district is covered by developed land for towns and settlements. The district supports important habitats and wildlife, including 36 water dependent Special Areas of Conservation and Special Protection Areas. There are also many excellent salmon rivers in the district such as the Tweed and Eden.

The environmental problems are relatively evenly spread over the whole district and largely reflect the land use. Agriculture and forestry can give rise to diffuse pollution and morphological pressures. A smaller number of environmental problems are associated with abstraction, waste water treatment and the manufacture of goods.

The Solway Tweed river basin district has a moderately high rainfall in relation to the rest of the UK, with rainfall being higher in the west than the east. About 90% of water supplies come from surface waters, the remainder from groundwater.



Burn at Bucleuch, Borders

3. Surface waters: water bodies, types and reference conditions

3.1 Water bodies

Water bodies are the basic management and reporting units of the Directive. For surface waters they can be whole or parts of rivers, canals, lakes, estuaries or coastal waters. The main purpose of identifying water bodies is for their status to be accurately described and compared with their environmental objectives.

Across the river basin district, surface water bodies have mainly been identified using natural features but known pressures and existing water quality information[4] have also been used in the Scottish part. In England and Wales surface water bodies have been identified mainly using natural features. This has resulted in surface waters in the Solway Tweed river basin district being divided into 521 river, 32 lake, 11 transitional and 8 coastal water bodies.

The Directive applies to inland surface waters, transitional waters, coastal waters and groundwaters but for practical purposes, size thresholds taken from the Directive's typology system have been used to initially identify river and lake water bodies. These thresholds are 0.5 km^2 for the surface area of lakes and 10 km^2 for river catchment area. Water bodies identified using these thresholds are referred to as baseline water bodies.

In Scotland, SEPA has identified and assessed additional small waters[5] where justified by environmental concerns and to meet the requirements of regulatory legislation such as drinking water supplies. These small waters are indicative of the range of issues encountered for many other small waters. A total of 62 small rivers and 13 small lochs have been identified in the Scottish part of the Solway Tweed river basin district. Better information is needed to characterise these and other small waters and this will be taken forward in future years[6].

In England, the Environment Agency has provisionally identified additional small waters for assessment in initial characterisation. Lakes and saline lagoon clusters with a surface area greater than 0.05 km^2 and which are designated features under the Habitats and the Birds Directives or are drinking water supplies have been provisionally identified as water bodies. Rivers with catchments smaller than 10 km^2 and which are not part of a larger catchment but with a river stretch greater than 1 km in length have been provisionally identified as water bodies. Better information is needed to characterise these and other small rivers, lakes and lagoons and this will be taken forward in future years.

For the Scottish part of the Solway Tweed river basin district, numbers presented throughout this report refer only to baseline water bodies. The length of baseline rivers is measured to their source mapped at 1:50,000 scale. For the English part, numbers presented throughout this report refer to all baseline water bodies and the additional small water bodies described above. All water bodies have been assessed and reported at 1:50,000 scale.

3.2 Water body types and reference conditions

Surface water bodies are grouped into different types according to their physical and chemical characteristics. The types indicate, in very general terms, the sorts of plants and animals that are likely to be present in water bodies of that type in undisturbed conditions. For example, the sorts of animals and plants that are found in upland, rocky, fast flowing streams are very different to those found in lowland, slow flowing, meandering rivers.

Reference conditions (equivalent to high status) are set in relation to the ecology expected to be found in each type and represent undisturbed or nearly undisturbed conditions. They provide the basis on which the quality status classification scheme will be built, consisting of high, good, moderate, poor and bad status.

River types and reference conditions

River types in the Solway Tweed river basin district are defined according to system A of the Directive[7]. This system uses altitude, catchment size and geology to define the types. This system creates 27 possible types of which 15 types are found in the Solway Tweed river basin district (Map 2).

Reference conditions[8] for river types describe the plants, macroinvertebrates, fish and physicochemical conditions expected to occur in undisturbed or nearly undisturbed conditions. The approach used to establish reference conditions in rivers varies with the availability of data. Where rivers or stretches of river were found in a specific type that display only very minor effects from pressures, these were used to help define reference conditions. However, for river types with few examples of undisturbed sites, reference conditions were derived by expert judgement and modelling.

[4]More detailed information on the guiding principles on water body identification followed can be found in the European guidance paper http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/identification_bodies&vm=detailed&sb=Title
[5]See http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5420/view for more detailed information on small waters
[6]Small waters are included in the interactive map and downloadable data available at http://www.sepa.org.uk/wfd/characterisation.htm
[7]The technical processes used in constructing the river typology are summarised in the UKTAG paper accessible at http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5312/view
[8]Descriptions of reference conditions for rivers can be found at http://www.wfduk.org/tag_guidance/Article_05/Type%20specific%20reference%20conditions/view

Lake[9] types and reference conditions

The ecological conditions of lakes, like other surface waters, change naturally to form a continuous variety of types. These types are determined principally by the characteristics of their catchments. To achieve a balance between dividing lakes into a large number of different types and a smaller, manageable number, the lake types in the UK are based on the natural characteristics that have the greatest bearing on their ecological condition. These are the geology of the catchment, expressed as the base status (alkalinity) of the lake, and the depth of the lake, expressed as the mean depth[10].

This approach complies with system B of the Directive. The other factors in system B (altitude, latitude, longitude and size) are of less relevance to ecological character at this scale and are therefore allocated to a single category for the UK. This results in twelve possible lake types, with a shallow and deep version of each of six geological types. The reference conditions described for these types will inform non-specialists which fauna and flora might be expected to occur in each lake in an undisturbed condition[11].

Of the twelve possible lake types, seven types are present in the Solway Tweed river basin district (Map 3).

Transitional and coastal water types and reference conditions

In the UK system B is used to divide transitional and coastal waters into types[12]. In this system the obligatory factors are latitude, longitude, tidal range and salinity. Optional factors of mixing characteristics, mean substratum composition and wave exposure are also used, as these are important in determining the ecology of transitional and coastal waters. This approach results in five transitional and nine coastal water types for Scotland, England and Wales. Of these, two types of transitional waters and three types of coastal waters are represented in the Solway Tweed river basin district (Map 4 and Map 5).

This small number of physical types does not fully describe the diverse range of habitats that are found in transitional and coastal waters. SEPA and the Environment Agency are developing, in conjunction with UKTAG, additional habitat-specific reference conditions to be able to allocate a mix of appropriate habitat-specific reference conditions to each of the physical types[13].

3.3 Artificial and heavily modified water bodies

Artificial water bodies

Artificial Water Bodies (AWBs) are bodies of surface water created by human activity. There are a number of reasons why AWBs are important including:

- many AWBs currently or potentially support important aquatic ecosystems;
- some AWBs may have a significant impact on non-AWBs and it is beneficial to manage them to protect the non-AWBs;
- many AWBs are important for water supply reasons and it is important to manage their water quality and hydrology for the purposes of satisfying the Directive requirements;
- many AWBs have secondary uses (e.g. artificial reservoirs are often used for recreation), which requires the water quality, ecology or water quantity to be managed appropriately;
- AWBs have been designed to support specified uses, which provide valuable social and economic benefits, which should be allowed to continue within a framework of sustainable management;
- many AWBs support significant wider environmental interests such as wetlands and heritage features.

A separate classification scheme will be developed for AWBs that need to attain good ecological potential, as opposed to good ecological status.

As part of the characterisation work we have identified provisional AWBs. To date lake-type AWBs, such as man-made reservoirs and flooded gravel pits, have been provisionally identified as AWBs. In Scotland canals have been identified and divided into water bodies. In England canals and other 'linear' waters (open water transfers) have been identified and flagged as artificial, and will be split into water bodies following an approach coordinated across the river basin district. This work will be developed in the near future as classification schemes are developed. Map 6 shows provisional AWBs, canals and water transfers (water transfers are only shown for the English part of the Solway Tweed and data mapping will be available for the Scottish part in the near future).

[9]Lakes has been used in place of lochs where this is a term defined by the Directive.
[10]The technical processes used in constructing the lake typology are summarised in the UKTAG paper accessible at http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5312/view
[11]Descriptions of reference conditions for lakes can be found at http://www.wfduk.org/tag_guidance/Article_05/Type%20specific%20reference%20conditions/view
[12]More detailed information on transitional and coastal water typology can be found at http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5312/view
[13]pDescriptions of reference conditions for transitional and coastal waters can be found at http://www.wfduk.org/tag_guidance/Article_05/Type%20specific%20reference%20conditions/view

Heavily modified water bodies

Sometimes it is not possible for a water body to achieve good status because of substantial alterations made for specified purposes such as navigation, water storage, flood defence and land drainage. The Directive recognises that the benefits of such uses need to be retained and allows these water bodies to be designated as heavily modified water bodies (HMWBs). The presence of physical alterations does not lead automatically to designation and neither does designation necessarily mean that mitigation measures will not be required. Designation enables objectives to be set that allow the benefits of the use to be maintained while ensuring that other pressures can be managed and, where possible, the adverse effects of the physical alterations mitigated. A separate classification scheme will be developed for HMWBs that need to attain good ecological potential, as opposed to good ecological status.

As part of the characterisation work we have identified provisional HMWBs. In the Solway Tweed river basin district 76 river, 11 lake and 2 transitional water bodies have been provisionally identified as heavily modified.



Peebles and the River Tweed

4. Groundwaters: water bodies and characteristics

4.1 Water bodies and characteristics

The UK is geologically diverse, containing many aquifers with differing characteristics. The aquifers are grouped into categories based on how groundwater flows within them and how much water is available for abstraction. They range from the low productivity mountainous highlands to low lying, highly productive sandstone basins.

The flow mechanism and size of the aquifer is important as this indicates how much interaction there is between the rock and the groundwater. Greater interaction means that more contaminants are likely to be removed or reduced by physical filtration, chemical or biological reactions. In general, with the exception of a few locations in the central valley and southern Scotland, bedrock aquifers are dominated by flow in fractures and hence the potential for reducing contaminants is minimal. The protection provided by overlying rock layers and deposits is, therefore, the key element in the assessment of vulnerability to pollution in bedrock aquifers.

Groundwater bodies have been identified to reflect the aquifer types; currently there are 480 groundwater bodies in Scotland, England and Wales of which 24 are assigned to the Solway Tweed river basin district. Where groundwater bodies do not fully follow a particular river basin, they have been assigned to the most appropriate river basin district. The groundwater maps show the groundwater bodies assigned to the river basin district. The overall number of water bodies may rise in the future as some of the large groundwater bodies are subdivided due to ongoing pressure and impact analysis.

In Scotland, in areas above high productivity aquifers, groundwater bodies have been identified using geological and major catchment boundaries. In areas above low productivity bedrock aquifers, groundwater bodies have been identified using surface water sub-catchments as a surrogate for groundwater boundaries. Islands have been included where:

- there is a population of greater than 50 people; or
- a groundwater public water supply exists; or
- a groundwater dependent ecosystem or surface water has been identified; or
- current activities already impact on groundwater.

In England, groundwater bodies have been identified by dividing aquifers into 'aquifer types' according to hydro-stratigraphic boundaries and then dividing these on the basis of Catchment Abstraction Management Strategy (CAMS) catchment hydrological boundaries. Where available, information on groundwater catchment divides has also been used. The main groundwater types are Primary, Secondary, Significant Drift and Unproductive Strata.

Although the two identification methods have varied slightly, they have been coordinated so that the groundwater bodies and their types are clearly identified as the Directive required and this is shown in Map 7[14].

4.2 Terrestrial ecosystems and surface water bodies dependent on groundwater

The environmental objectives for groundwater also consider ecosystems and waters dependent on groundwater quality and quantity. For example, a wetland or river fed by groundwater may require certain amounts or quality of water to allow it to function properly. Land based areas like this are called groundwater dependent terrestrial ecosystems (GWDTE) and have been identified using surveys and predictive tools.

GWDTEs have been identified in association with Scottish Natural Heritage (SNH), English Nature and Countryside Council for Wales following UK guidance[15]. In order to be able to prioritise work on these ecosystems, only GWDTEs in areas designated under the Habitats and Birds Directives were included in this initial assessment. Further work will be required to assess other GWDTEs in the future.

Ecosystems have been considered to rely on groundwater when:

- groundwater dependent ecosystems have been mapped; or
- a productive aquifer is at the surface and it is predicted that groundwater could be sustaining an ecosystem.

The second, predictive, assessment was used in areas where ecosystem mapping is not in place and followed UK Technical Advisory Group (UKTAG) guidance. It is likely that future assessments will rely more heavily on ecological mapping and surveys rather than on this predictive method.

Surface water bodies are considered to be groundwater dependent when they are thought to be linked to a productive aquifer at the surface. Present understanding of these links is limited and our current assessments will be improved as we consider these relationships in later studies.

Map 8 shows terrestrial ecosystems and surface water bodies dependent on groundwater.

[14]For more detailed information on how groundwater bodies were delineated see http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5420/view
[15]See http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%205a-b%20%2801%29/view
[16]The register can be viewed at http://www.sepa.org.uk/wfd/characterisation.htm and http://www.environment-agency.gov.uk/wfd
[17]More detailed information on how these areas were selected can be found at http://www.wfduk.org/tag_guidance/Article_06-07/view

5. Protected areas

Protected areas are given particular protection under the Directive. They include areas designated under a number of other EC Directives and areas identified in accordance with Article 7 of the Directive itself, to protect the surface water or groundwater within them.

The Directive requires that a register of protected areas is established[16]. This will help to ensure that water bodies are managed to achieve the protected area objectives. The register consists of a list of sites and a set of maps showing the relevant protected areas (Maps 8 to 11).

There are regular reviews of designations included within the Protected Area Register. In particular reviews are currently underway for designations covering Bathing Waters, Shellfish Waters, Nutrient Sensitive Areas and Freshwater Fish. These reviews will result in changes to the Protected Area Register over the next two years.

5.1 Waters used for the abstraction of drinking water

Drinking water protected areas are the only protected areas which must be identified by virtue of the Water Framework Directive itself, rather than as a result of another Directive. They will replace the system of drinking water protection currently provided by the Surface Water Abstraction Directive (75/440/EEC), to be repealed at the end of 2007.

Protected areas for drinking water supplies have been identified as water bodies that supply a daily average of more than 10 m^3 water for drinking or supply more than 50 people. In the Solway Tweed river basin district there are 61 water bodies identified as Drinking Water Protected Areas (Map 9).

5.2 Areas designated to protect economically significant species

These are protected areas established under earlier EC directives aimed at protecting shellfish (79/923/EEC) and freshwater fish (78/659/EEC). There are four shellfish waters and 4869 km of designated freshwater fish stretches in the Solway Tweed river basin district (Map 10).

5.3 Recreational waters

These are bathing waters designated under the Bathing Water Directive (76/160/EEC). There are eight bathing waters in the Solway Tweed river basin district (Map 10).

5.4 Nutrient sensitive areas

These comprise nitrate vulnerable zones designated under the Nitrates Directive (91/676/EEC) and areas designated as sensitive areas under the Urban Waste Water Treatment Directive (91/271/EEC). In the Scottish part of the Solway Tweed river basin district there are two areas designated as Nutrient Sensitive Areas. In the English part there are both surface water and groundwater nitrate vulnerable zones and one sensitive area river (Map 11).

5.5 Areas designated for the protection of habitats or species

These are areas previously designated for the protection of habitats or species where maintaining or improving the status of water is important for their protection. They comprise the aquatic part of Natura 2000 sites designated under the Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC)[17]. In the Solway Tweed river basin district there are 36 areas designated as water dependent Natura 2000 sites (Map 12).

5.6 Assessment of protected area objectives

An assessment of whether protected areas are likely to achieve their objectives was undertaken where possible using 2003 compliance reporting for Shellfish Waters Directive, Freshwater Fish Directive and Bathing Waters Directive. The exceptions to this approach are nutrient sensitive protected areas and water dependent habitats and species protected areas.

For nutrient sensitive protected areas, designation as vulnerable zones under Directive 91/676/EEC (Nitrates Directive) and sensitive areas under Directive 91/271/EEC (Urban Waste Water Treatment Directive) was taken to indicate a risk of failing the objectives.

[16]The register can be viewed at http://www.sepa.org.uk/wfd/characterisation.htm and http://www.environment-agency.gov.uk/wfd
[17]More detailed information on how these areas were selected can be found at http://www.wfduk.org/tag_guidance/Article_06-07/view

Protected areas for water dependent habitats and species were assessed within the district in partnership with Scottish Natural Heritage and English Nature using data from English Nature on the conservation status of the areas and Environment Agency information from Habitats Regulations assessments. The assessments made by SNH and English Nature are preliminary and do not pre-empt those to be reported under the Habitats Directive in 2007.

There is no assessment for Drinking Water Protected Areas as these are new protected areas established by the Directive and no objectives have yet been set.

For the Scottish part of the Solway Tweed river basin district the results of the assessments are incorporated into Sections 6.3 to 6.6. For the English part results are presented separately in Map 13 (economically significant species), Map 14 (recreational waters), Map 15 (water dependent conservation areas (Habitats Directive)) and Map 16 (water dependent conservation areas (Birds Directive)).



Pond, Paxton, Berwickshire

6. Pressure and impact analysis

6.1 Introduction

The pressure and impact analysis reviews the impact of human activity on surface waters and on groundwater. It identifies those water bodies that are at risk of failing to meet the Directive's environmental objectives. The first iteration of characterisation is a risk screening exercise. Protected area objective assessments are based mainly on compliance reporting (see Section 5.6). **Annex 1 summarises the environmental objectives and discusses the issues and difficulties surrounding the analysis. The assessment is important because it will shape monitoring programmes and provide a starting point for river basin management planning.**

A significant uncertainty in carrying out this pressure and impact assessment is that good status has not yet been defined across Europe. This task is underway and will feed into further iterations of risk assessment and the final classification scheme used. For this report, criteria set by the UKTAG have been used in the assessments[18]. Additional information on the assessments is provided on the SEPA and Environment Agency websites which detail where additional or alternative methods have been used[19]. For England, some assessments undertaken in relation to the district are not covered by UKTAG guidance. In such cases, alternative methods were used[20].

The principal objective of the Directive is for member states to aim to achieve good status, and to comply with protected area standards and objectives, by 2015. Because of the difficulty of predicting changes in pressures between now and 2015 we have made the general assumption that if a water body is at risk in 2004 it will still be at risk in 2015. There are a few exceptions to this where we have accurate trend data to suggest otherwise and where planned investment is already funded.

The Directive requires water bodies to be reported as either at risk or not at risk of failing their objectives by 2015. In order to help prioritise future action, results are reported using the following agreed UK categories shown in Table 2. This will enable us to concentrate our efforts first on the most significant risks[21]. In addition to the risk assessments, we will also use new monitoring data, information on classification status and other information gathered from stakeholders through the river basin planning and management process.

Table 2. Agreed UK reporting categories and subsequent action

Directive reporting category	UK reporting category	Action
At risk	(1a) Water bodies at significant risk.	Consideration of appropriate measures can start as soon as practicable.
	(1b) Water bodies probably at significant risk but for which further information is needed to make sure this view is correct.	Focus for more detailed risk assessments to determine whether or not the water bodies in this category are at significant risk in time for the interim overview of significant water management issues in 2007.
Not at risk	(2a) Water bodies probably not at significant risk.	Focus on improving quality of information in time for second pressure and impact analysis report in 2013.
	(2b) Water bodies not at significant risk.	Review for next pressure and impact analysis report in 2013 to identify any significant changes in the situation.

The pressure and impact analysis has used a variety of methods and data sets reflecting differences in availability and quality of data. Some assessments have used data on environmental impacts, such as water quality and fish populations. Others have been based on pressures on the environment, such as water abstraction points and location of physical structures (such as barrages and weirs) which themselves may lead to an environmental impact.

These different approaches reflect the nature of the data and information available to these first assessments. The extent and quality of available data and information will improve in future cycles making later assessments more comprehensive and robust. Nevertheless, we believe that this first analysis provides a sound basis from which to develop monitoring programmes, improve the risk assessment and progress river basin management planning.

[18]Detailed information on these is available from the following link http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/view
[19]See www.sepa.org.uk/groundwater/wfd
[20]Detailed information on Environment Agency pressure and impact assessment methodologies is available at http://www.environment-agency.gov.uk/wfd
[21]More detailed guidance on the general principles for the pressure and impact analysis can be found at http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/view.

6.2 Impact data - general quality assessment biology

What is the issue?

The Environment Agency reports annually on the biological quality of the main freshwater watercourses in England. The General Quality Assessment (GQA) scheme classifies water quality in rivers and canals. The scheme provides a way of comparing river quality from one river to another and for looking at changes over time.

GQA biology provides a partial assessment of the aquatic ecology and is the closest measure for status we have for the macro-invertebrate biological quality element of the WFD's classification schemes. This information has been used to provide impact information for some assessments that follow in this report. However, the GQA biology system mainly reflects the impact of sanitary pollutants (e.g. oxygen demanding substances and ammonia) on invertebrates in river systems and so does not reflect all pressures that are covered by the WFD. The GQA biology assessment and map may assist in providing context for the pressure and impact analyses.

How did we do the assessment?[22]

Between 2001 and 2003, a third of the 7,000 GQA monitoring sites in England and Wales were sampled for macro-invertebrates. The range of species found is compared with the range that would be expected in the river if it was not polluted or physically damaged. This takes account of natural differences expected due to different types of geology and flow. One of six grades – very good to bad (A to F) – is allocated to each river length.

In Scotland, SEPA reports annually on the classification of rivers, estuaries and coastal waters[23]. At present loch water quality is reported less frequently. For rivers, the classification is based on very similar chemical and biological criteria except that five rather than six classes are used. In estuaries and coastal waters, SEPA uses chemical and biological data to classify waters whilst in lochs the classification scheme uses chemical data. This information has been used in the pressure and impact assessments. In addition information on fish populations from the Fishery Boards and Trusts has been incorporated. Results have been incorporated into Sections 6.3 to 6.6.

What does the map show?

Map 17 shows the latest GQA Biology results (from 2001, 2002, 2003) for the English part of the Solway Tweed river basin district.

6.3 Point source pollution and assessment of impact

What is the issue?

Discharges from sewage works and industrial processes can contain substances that damage the ecology of waters. Authorised point sources are all those sites that have consents to discharge at a specific place, like sewage works or industrial discharges.

SEPA and the Environment Agency use consents and permits to control the amounts of substances discharged from point sources. Operators of sewage works and industrial sites commonly discharge effluent at a quality that is much better than their consent or permit allows. This gives them a safety margin to guard against failure of the consent or permit conditions. Therefore, most of the sites we have looked at currently pass the targets we have used.

The European Commission has identified a list of 33 priority substances based on their toxicity, persistence and liability to bioaccumulate. While European environmental quality standards (EQS) for these substances have not yet been set, failure of existing UK standards, where they exist, has been taken to indicate a risk of not achieving good chemical status.

How was the Scottish part assessed?

For surface waters we used water quality information obtained from our monitoring programmes. Our current monitoring network is geared towards assessing the impact from point source pollution. Less information exists in relation to groundwaters. The methods of groundwater assessment are therefore more predictive and use simple models to indicate where impacts on groundwater are likely to occur.

Surface water bodies are considered as being at risk of not achieving good status if there is a risk that Environmental Quality Standards (EQS) are exceeded for any of the priority substances. Assessments are predominantly based on existing SEPA data but a research project to identify possible point sources based on types of use has also been undertaken. The EC list of priority substances includes many for which there is little discharge or environmental data available in Scotland as they have not beeen identified as being used in significant quantities.

An assessment to identify water bodies at risk from radioactive substances was carried out[24]. This work shows that no water bodies are at risk from radioactive substances.

[22]The Environment Agency's GQA assessment for 2003 can be found at: www.environment-agency.gov.uk/gqaresults/.
[23]SEPA's water quality results can be found at: http://www.sepa.org.uk/data/classification/
[24]A copy of the full report can be found at http://www.sepa.org.uk/pdf/publications/technical/wfd_Assessment_pressures_impacts.pdf.

How was the English part assessed?[25]

For rivers we used the permit limits for each substance to calculate what its concentration would be in rivers at average flows. We used permit limits that have been revised and tightened as a result of improvements being undertaken as part of the approved five-year programmes of the water companies. We compared these concentrations with the most stringent targets that applied to each water body. During further refinement the Environment Agency will use datasets of actual discharge pollutant concentrations to ascertain a more accurate measure of risk.

For transitional and coastal waters we calculated the load discharged and took into account the rate of flushing of the estuary. These load calculations were ranked for metals and ammonia to show the risk of not achieving the Directive objectives. An assessment of the impact of oxygen-demanding substances in transitional and coastal waters was undertaken. It used the calculated load of biological oxygen demand, from both direct point sources and the river catchment, water-quality monitoring data of dissolved oxygen levels, evidence of impact on migratory fish, such as salmon, and the diversity of the seabed invertebrate community. Some of these oxygen-demanding substances may also come from diffuse as well as point sources.

For lakes, the most significant point source pressure is considered to be phosphorus from sewage discharges. These discharge either directly to the lake or indirectly to rivers that subsequently discharge to lakes. We also looked at diffuse sources of phosphorus where this, in combination with point sources, caused a lake to be at risk.

Surface water bodies are also considered as being at risk of not achieving good chemical status if there is a risk that Environmental Quality Standards (EQS) are exceeded for any of these substances under the Dangerous Substances Directive. This assessment was done using existing EQS, although work under Article 16 of the WFD may tighten these standards in the future. Note that some of these EQS exceedences may be due to diffuse source pressures, however it is not possible to distinguish the sources at the present time.

The assessment of groundwater used our existing knowledge of groundwater pollution incidents and pollution pressures to identify groundwater bodies at risk of pollution, particularly those with dependent wetlands or those used as sources for public water supply.

Assessments to identify water bodies at risk from radioactive substances were also carried out for the Solway Tweed river basin district[26]. This work shows that no water bodies are at risk from radioactive substances.

What do the maps show?

Map 18 shows examples of the pressures considered in carrying out the risk assessments. Many of these point sources are already subject to existing controls and are not causing any damage to the water environment.

For the Scottish part of the Solway Tweed river basin district, Map 19 (surface waters) and Map 20 (groundwater) show water bodies affected by point source pollution pressures. For each water body considered to be at risk, we have recorded the nature of the pressure and the general industry sector[27] to which this pressure can be attributed. The assessments have also recorded whether a particular pressure is considered to be a primary or contributory one and figures presented in this report include both (see Box 1). Summary information is provided in the following tables and bar charts. This information can be viewed in detail for individual water bodies via the website at http://www.sepa.org.uk/wfd/characterisation.htm.

For the English part, Map 19 (surface waters) and Map 20 (groundwater) show river, lake, transitional, coastal and groundwater bodies at risk of not achieving good status because of point source discharges, including metals, nutrients, ammonia and oxygen-demanding substances and pesticides.

Tables 3 to 7 show the number, length and area of water bodies affected by (Scotland) or at risk from (England) point source pollution for rivers, lakes, transitional waters, coastal waters and groundwaters respectively.

Figures 1, 3, 4, 5 and 6 apply to Scotland and show the general industry sectors affecting water bodies in categories 1a and 1b for rivers, lakes, transitional waters, coastal waters and groundwaters respectively. A water body is often affected by more than one sector and can therefore be counted more than once in the bar chart.

Figure 2 applies to England and shows the main point source pressures that affect river water bodies at risk of failing WFD objectives. There is no figure for lake water bodies as the main point source pressure is phosphorus from sewage. There are no transitional, coastal or groundwater water bodies at risk from point source pressures in the English part. A water body is often affected by more than one substance or pressure and can therefore be counted more than once in the bar chart.

[25]Further information on point source assessment methods can be found at http://www.environment-agency.gov.uk/wfd
[26]For further details see http://www.environment-agency.gov.uk/wfd
[27]For a list of sectors used see http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%207a%20%2802%29/view

Box 1

Primary and contributory pressures (Scottish part)

For each water body at risk, we have recorded the nature of the pressure and whether a pressure is considered to be a primary or contributory one. A primary pressure is one that on its own is likely to cause the water body to fail the environmental objectives. A water body can have more than one primary pressure. We have used expert judgement to determine whether a pressure is a primary or contributory one. This information will be useful when we come to establish the programme of measures. All maps, tables and bar charts include both primary and contributory pressures. This is because in some cases a water body does not have any primary pressures and is at risk from several contributory pressures.

Table 3. River water bodies affected by/at risk from point source pollution

	Reporting category	Number of water bodies	% of number	Length (km)	% of length
Rivers	1a	14	2.7	125	2.1
	1b	36	6.9	761	12.6
	2a	4	0.8	102	1.7
	2b	467	89.6	5053	83.6
Total		521	100	6041	100
Total at risk	1a + 1b	50	9.6	886	14.7

Figure 1. General industry sectors affecting 1a and 1b river water bodies (point source pollution) (Scottish part)

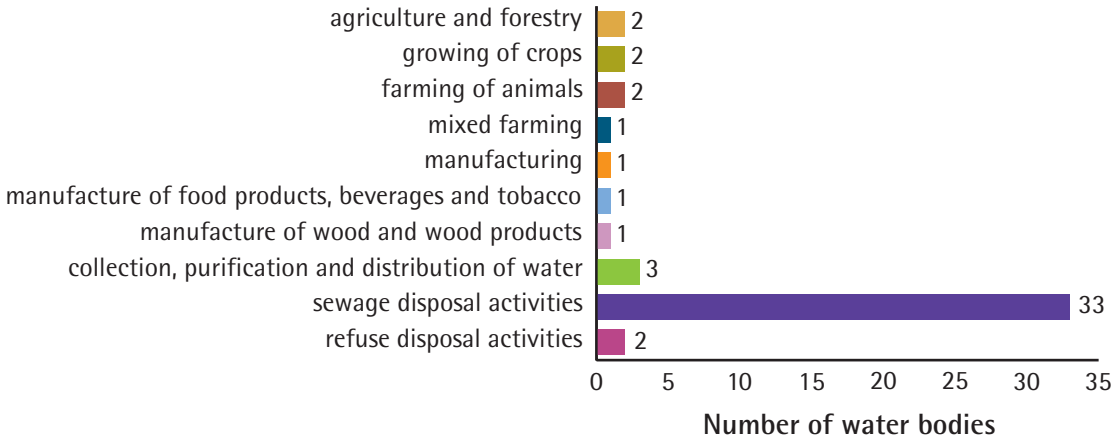


Figure 2. Point source pressures in 1a and 1b river water bodies (English part)

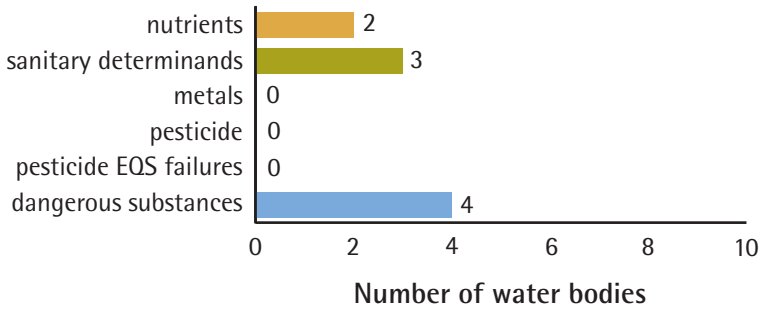


Table 4. Lake water bodies affected by/at risk from point source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Lakes	1a	1	3.1	1	1.7
	1b	1	3.1	7	15.7
	2a	5	15.6	1	1.6
	2b	25	78.1	36	81.0
Total		32	100	44	100
Total at risk	1a + 1b	2	6.3	8	17.4

Note: Includes diffuse source pressures where these, in combination with point source pressures, cause a water body to be at risk (England)

Figure 3. General industry sectors affecting 1a and 1b lake water bodies (point source pollution) (Scottish part)

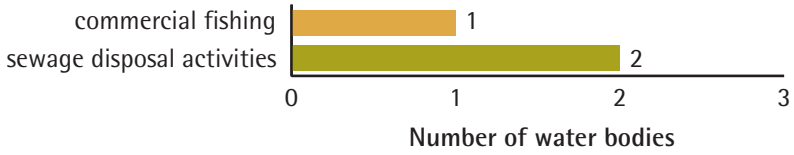


Table 5. Transitional water bodies affected by/at risk from point source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Transitional	1a	2	18.2	321	82.3
	1b	3	27.3	4	1.0
	2a	1	9.1	2	0.6
	2b	5	45.5	63	16.1
Total		11	100	390	100
Total at risk	1a + 1b	5	45.5	325	83.3

Note: Includes some diffuse sources in combination with point source pressures where it was not possible to disaggregate sources (England)

Figure 4. General industry sectors affecting 1a and 1b transitional water bodies (point source pollution) (Scottish part)

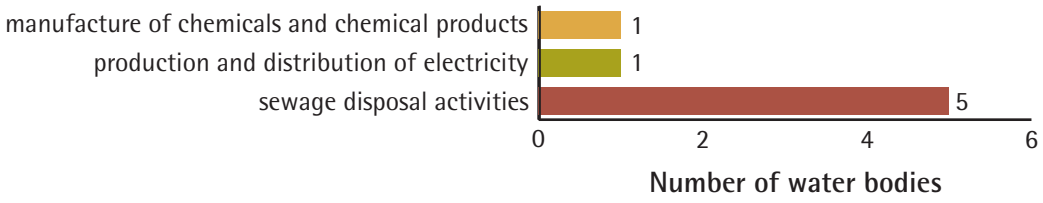


Table 6. Coastal water bodies affected by/at risk from point source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Coastal	1a	2	25	177	9.2
	1b	0	0	0	0
	2a	0	0	0	0
	2b	6	75	1736	90.8
Total		8	100	1913	100
Total at risk	1a + 1b	2	25	177	9.2

Note: Includes some diffuse sources in combination with point source pressures where it was not possible to disaggregate sources (England)

Figure 5. General industry sectors affecting 1a and 1b coastal water bodies (point source pollution) (Scottish part)

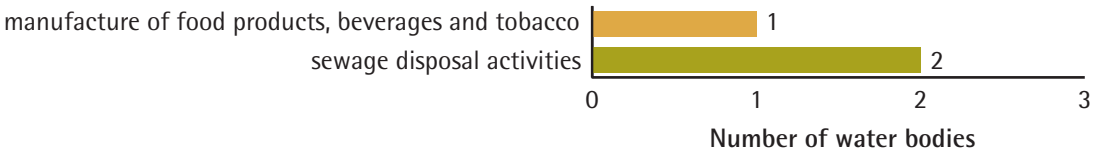
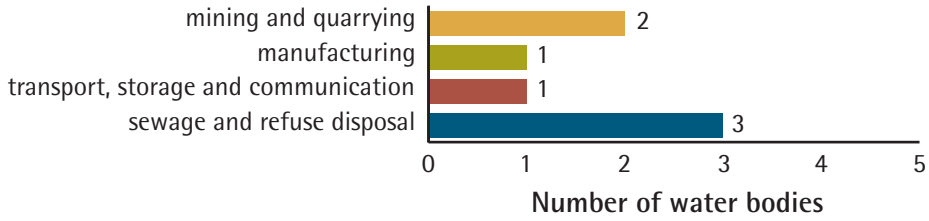


Table 7. Groundwater water bodies affected by/at risk from point source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Groundwater	1a	2	8.3	1949	12.2
	1b	4	16.7	2952	18.5
	2a	10	41.7	7189	45.1
	2b	8	33.3	3859	24.2
Total		24	100	15949	100
Total at risk	1a + 1b	6	25	4901	30.7

Figure 6. General industry sectors affecting 1a and 1b groundwater bodies (point source pollution) (Scottish part)



6.4 Diffuse source pollution and assessment of impact

What is the issue?

Diffuse pollution arises from a variety of activities. It can arise from land use activities, both rural and urban, which are dispersed across a catchment and may have an individually minor, but collectively significant environmental impact. Examples of diffuse pollution include the transport of nutrients and sediment from farmland or the run-off of water contaminated with pollutants from vehicle emissions from hard surfaces in towns to groundwater and/or surface waters. Diffuse pollution is often associated with heavy rainfall when pollutants are flushed into watercourses.

Atmospheric pollution also causes diffuse water pollution. Acidification is truly diffuse in nature. It occurs when gases such as ammonia, oxides of nitrogen and sulphur dioxide, emitted from transport and industry, react in the atmosphere to form nitric and sulphuric acids. When acid rain falls on catchments, particularly upland ones where there are thin soils and little to buffer or neutralise the acid, the rivers and lakes become affected by acidification. Fish populations, particularly salmon, sea trout and brown trout, and the invertebrates that these species feed on, can often be severely affected. Although emissions dropped substantially during the 1990s[28], acidification continues to be a problem particularly in the west and north of Scotland where underlying rocks have minimal capacity to neutralise acidic rainfall.

Transitional and coastal waters are not affected by acidification. Groundwaters have not been considered in their own right but consideration of sub-surface buffering conditions has formed the core of the surface water assessment. In this sense the groundwaters and surface waters have been considered together.

Enrichment of surface waters by nutrients, particularly compounds of phosphorus and nitrogen, may give rise to eutrophication. This is the process by which nutrients cause excessive growths of algae (some of which may be toxic) and other plants. This can lead to adverse effects on biodiversity and water quality, and reduces the value of the water body for amenity, recreation and water supply. Nutrients enter water bodies from point sources and deposition from the atmosphere, as well as from land use activities.

Unless carefully managed, some mines can contaminate the water environment whether they are working or closed. Poor quality water can be discharged to streams and rivers from pumping to de-water working mines or from rising minewaters in closed sites where pumping has stopped. Rivers can also be polluted by contaminated water running off mine wastes such as spoil heaps. The main problems are acidity, heavy metals (such as iron, manganese, aluminium, copper, nickel, zinc), high salinity and high chemical oxygen demand, which reduces concentrations of dissolved oxygen.

How was the Scottish part assessed?

SEPA's current surface water monitoring is predominantly designed to assess the impacts on water bodies from point sources. As a result, knowledge of diffuse source pressures at a national scale is less than that for point sources. The groundwater monitoring regime focuses on nitrate and pesticide issues. Nevertheless, water quality and fish monitoring data do indicate where pollution pressures are impacting water quality, regardless of whether the pressures are from point or diffuse sources. These data in combination with expert judgement and land use maps have been used in the risk assessments presented here.

SEPA recognises the limitations of this approach and therefore a screening method using a suite of models has been developed to assess the risks from diffuse pollution based on pollutant inputs to the land surface and outputs to water bodies. Landscape factors, such as land use, climate, topography, geology and soils, which affect the source and location of potential pollutants have been compiled in a database. This information is used alongside land management practice data such as pesticide usage surveys, numbers of livestock, maps of atmospheric deposition and population density. Model results have been used in addition to water quality monitoring data. The suite of models will provide a very useful tool for future use in river basin management planning.

Where possible, we have estimated the pressure trend to 2015 for nutrients in rivers and groundwater.

How was the English part assessed?[29]

To reflect these various causes of diffuse pollution, the Agency separately assessed whether water bodies are at risk of failing the Directive's objectives from the following pressures or activities: nutrients, sediment, pesticides and sheep dip, urban land use, acidification, mines and minewaters. We have combined these assessments to present the overall risk of water bodies not achieving the Directive's objectives as a result of diffuse source pressures. Different combinations of pressures are used for different water categories, depending on data availability.

For the nutrient nitrogen assessment, in the absence of an operational regulatory standard relating to the environmental impact of nitrate in surface waters, and the absence of agreement of the groundwater daughter directive, a 50 mg/l risk threshold has been used as providing an initial basis for assessment of risk of not meeting the environmental objectives of the Water Framework Directive.

For the nutrient nitrogen assessment in groundwaters we have estimated the pressure trend to 2015.

The assessment for groundwater bodies must also take into account whether groundwater dependent ecosystems (see Section 4.2) are at risk of being damaged by chemical inputs from groundwater.

What do the maps show?

Diffuse pollution is strongly linked to land use activity and Map 21 shows a land use map for the Solway Tweed river basin district.

For the Scottish part of the Solway Tweed river basin district, Map 22 (surface waters) and Map 23 (groundwater) show water bodies affected by diffuse source pollution pressures. For each water body considered to be at risk, we have

[28]http://themes.eea.eu.int/Environmental_issues/acidification
[29]Further information on diffuse source assessment methods can be found at http://www.environment-agency.gov.uk/wfd

recorded the nature of the pressure and the general industry sector[30] to which this pressure can be attributed. The assessments have also recorded whether a particular pressure is considered to be a primary or contributory one and figures presented in this report include both (see Box 1). Summary information is provided in the following tables and bar charts. This information can be viewed in detail for individual water bodies via the website at http://www.sepa.org.uk/wfd/characterisation.htm.

For the English part, Map 22 (surface waters) and Map 23 (groundwater) show water bodies at risk from diffuse source pressures.

Tables 8 to 12 show the number, length and area of water bodies affected by (Scotland) or at risk from (England) diffuse source pollution for rivers, lakes, transitional waters, coastal waters and groundwaters respectively.

Figures 7, 9, 11, 13 and 14 apply to Scotland and show the general industry sectors affecting water bodies in categories 1a and 1b for rivers, lakes, transitional waters, coastal waters and groundwaters respectively. A water body is often affected by more than one sector and can therefore be counted more than once in the bar chart.

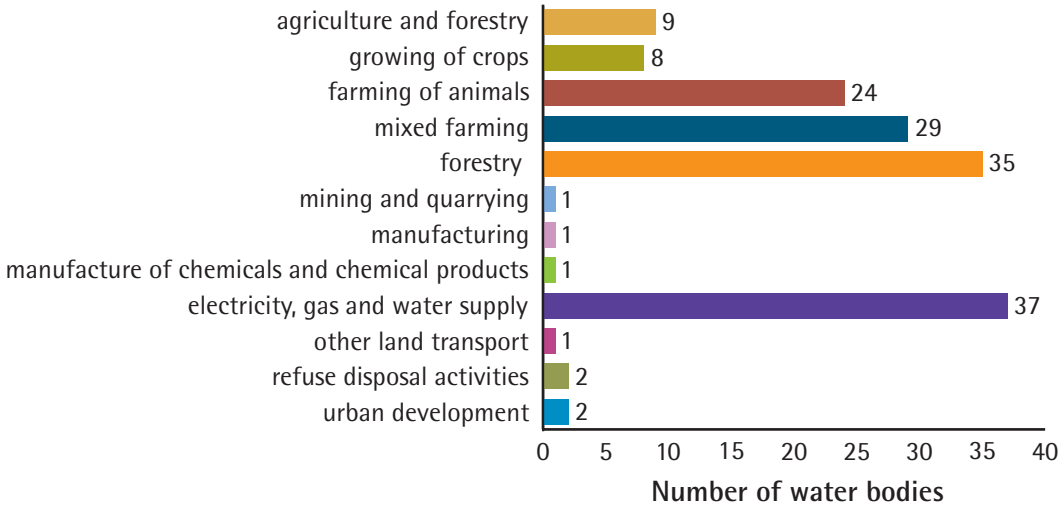
Figures 8, 10, 12 and 15 apply to England and show the pressures or activities that affect water bodies in each category at risk of failing the WFD objectives. A water body is often affected by more than one pressure or activity and can therefore be counted more than once in the bar chart.

Table 8. River water bodies affected by/at risk from diffuse source pollution

	Reporting category	Number of water bodies	% of number	Length (km)	% of length
Rivers	1a	73	14	847	14.0
	1b	125	24	1668	27.6
	2a	99	19	1163	19.3
	2b	224	43	2363	39.1
Total		521	100	6041	100
Total at risk	1a + 1b	198	38	2515	41.6

For England the pressures considered for rivers are nutrients, sediment, pesticides and sheep dip, urban land use, acidification, mines and minewaters.

Figure 7. General industry sectors affecting 1a and 1b river water bodies (diffuse source pollution) (Scottish part)



[30]For a list of sectors used see http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%207a%20%2802%29/view

Figure 8. Diffuse source pressures in 1a and 1b river water bodies (English part)

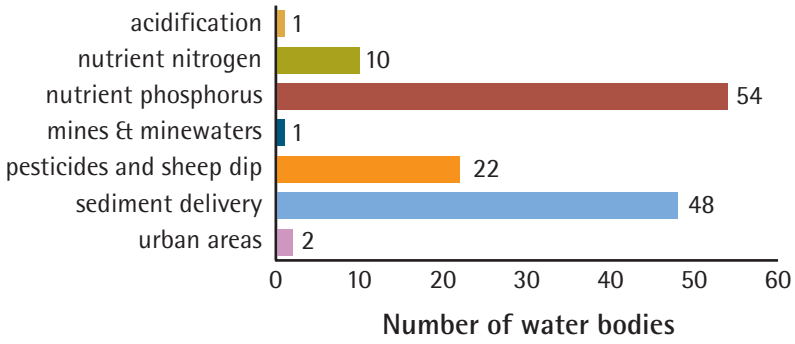


Table 9. Lake water bodies affected by/at risk from diffuse source pollution

	Reporting category	Number of water bodies	% of number	Area (km²)	% of area
Lakes	1a	4	12.5	4	8.0
	1b	9	28.1	14	32.0
	2a	6	18.8	2	5.1
	2b	13	40.6	24	54.9
Total		32	100	44	100
Total at risk	1a + 1b	13	40.6	18	40

Note: Includes point source pressures for nutrients where these, in combination with diffuse source pressures cause a water body to be at risk (England)

For England the pressures considered for lakes are nutrients and acidification.

Figure 9. General industry sectors affecting 1a and 1b lake water bodies (diffuse source pollution) (Scottish part)

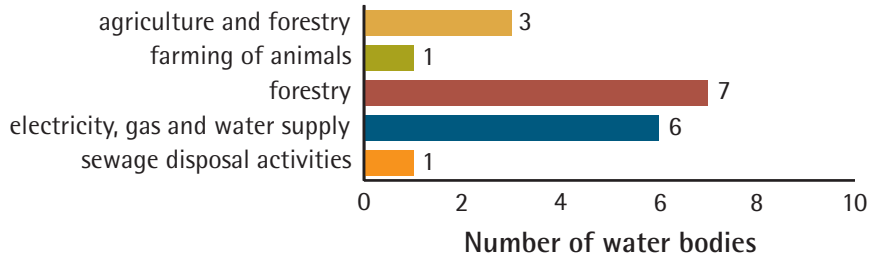


Figure 10. Diffuse source pressures in 1a and 1b lake water bodies (English part)



Table 10. Transitional water bodies affected by/at risk from diffuse source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Transitional	1a	1	9.1	306	78.5
	1b	2	18.2	4	0.9
	2a	0	0	0	0
	2b	8	72.7	80	20.6
Total		11	100	390	100
Total at risk	1a + 1b	3	27.3	309	79.4

Note: Point source pressures may be included in this assessment as it is not currently possible to disaggregate these pressures from diffuse source pressures (England)

For England the pressures considered for transitional waters are nutrients and pesticides.

Figure 11. General industry sectors affecting 1a and 1b transitional water bodies (diffuse source pollution) (Scottish part)

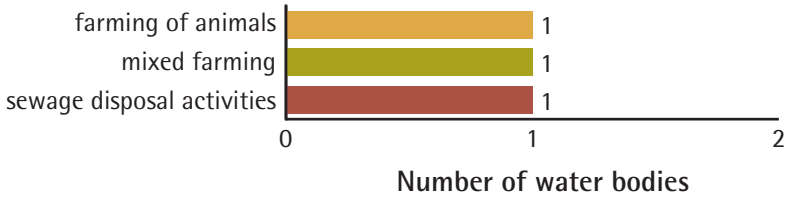


Figure 12. Diffuse source pressures in 1a and 1b transitional water bodies (English part)

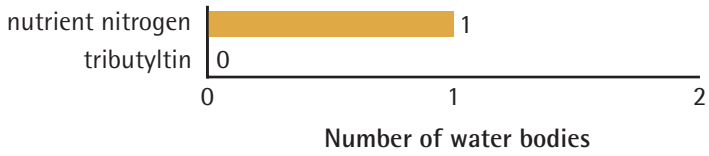


Table 11. Coastal water bodies affected by/at risk from diffuse source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Coastal	1a	2	25	177	9.2
	1b	0	0	0	0
	2a	0	0	0	0
	2b	6	75	1736	90.8
Total		8	100	1913	100
Total at risk	1a + 1b	2	25	177	9.2

Note: Point source pressures may be included in this assessment as it is not currently possible to disaggregate these pressures from diffuse source pressures (England)

The pressures considered for coastal waters are nutrients and pesticides.

Figure 13. General industry sectors affecting 1a and 1b coastal water bodies (diffuse source pollution) (Scottish part)

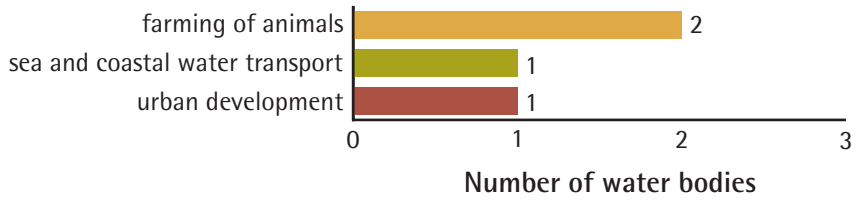


Table 12. Groundwater water bodies affected by/at risk from diffuse source pollution

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Groundwater	1a	7	29.2	3630	22.8
	1b	9	37.5	6760	42.4
	2a	8	33.3	5559	34.9
	2b	0	0	0	0
Total		24	100	15949	100
Total at risk	1a + 1b	16	66.7	10390	65.1

Note: Some of the pressures included here can be considered to be point or diffuse source in nature depending on the scale of assessment. They are grouped under diffuse source pressures for convenience (England).

For England the pressures considered for groundwater are nutrients, pesticides and sheep dip, urban land use, mines and minewaters, List I and List II Dangerous Substances. The nutrient nitrogen assessment is based on the projected situation for 2015. The assessment for List I and List II Dangerous Substances under the Groundwater Directive 80/68/EEC is included pending agreement of the Daughter Directives.

Figure 14. General industry sectors affecting 1a and 1b groundwater bodies (diffuse source pollution) (Scottish part)

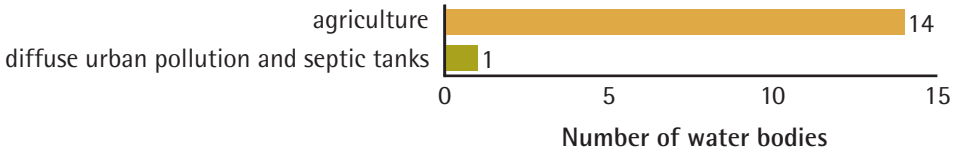
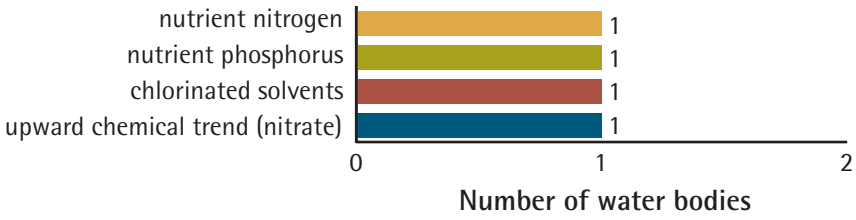


Figure 15. Diffuse source pressures in 1a and 1b groundwater bodies (English part)



6.5 Abstraction and flow regulation and assessment of impact

What is the issue?

Water is abstracted from rivers, canals, reservoirs, lakes or underground rocks (aquifers) to provide public water supplies and serve industry and agriculture. The main challenge in managing abstraction is to meet the reasonable needs of water users, while leaving enough water in the environment to conserve river, lake and wetland habitats and species.

Abnormally low river flows can damage river and estuarine ecology, which may take years to recover. Low river flows may be caused by periods of low rainfall, but the effects can be prolonged or made worse by abstraction at critical periods. Unsustainable abstraction from groundwater can lower groundwater levels and have knock-on impacts on river flows or wetlands.

In England and Wales, abstraction is controlled by a licensing system administered by the Environment Agency. We also regulate other major influences on water flows, including transfers of water from one catchment to another and flow-controlling structures, such as dams.

Coastal water bodies are not at risk from abstraction pressures. Flow regulation pressures on coastal water bodies, such as barrages, are reported under the morphological assessment for convenience.

How was the Scottish part assessed?

Compared to many other European countries Scotland generally has sufficient supplies of water but the demand on our water supplies continues to increase. Unlike point source pollution pressures, pressures arising from abstraction and flow regulation have not been comprehensively regulated in Scotland before now. As a result, limited quantitative information is available and the risk assessment has relied to a large extent on predicted impacts. Much effort went into establishing a national database of abstraction and flow regulation pressures. Information came largely from:

- existing legislation, including those acts with a direct control on the management of water resources (for example electricity and water orders, reservoirs acts) and those which may provide some control (planning conditions and legislation targeting other pressures such as discharges);
- request to key water users either directly or through industry associations;
- British Geological Survey database;
- local and expert knowledge.

The risk assessment for surface waters is based on the premise that the habitats and organisms are able to tolerate a specified departure from the flow (or level) regimes that would normally be expected for that water body. This boundary is defined as the ecological flow (or level) objective and is quantified in the guidance given by UKTAG[31]. For groundwaters, the overall water balance within the groundwater body is considered, along with the potential for more localised groundwater abstraction to impact dependent surface ecosystems or to cause an intrusion of saline water.

How was the English part assessed?[32]

The Environment Agency is developing Catchment Abstraction Management Strategies (CAMS) for managing water resources at a local level. CAMS will include an assessment of water resources in rivers and groundwater. This helps us to meet the requirements of the Water Framework Directive to assess the risks from abstraction and flow regulation to rivers and groundwaters. CAMS for all catchments in England and Wales will be completed by 2008.

For this initial assessment the best-available national datasets have been used to estimate the risk to river flows, lakes, estuaries and groundwater, using methods developed from CAMS. The return of good quality water to the river system by discharges is an important resource and is taken into account. Abstraction trends projected to 2015 have been included in the assessment as far as possible, based on existing Environment Agency Water Resource Strategies.

If water bodies are water supply reservoirs the risk of not achieving Directive objectives as a result of abstraction pressures is not currently reported, as the assessment method was not appropriate for this. This is because the method uses the change in annual flow estimates as an indicator of human impact on residence time. While this is appropriate for natural lakes it does not reflect the large water level fluctuations that reservoirs can experience throughout the year. Further work to assess the risk of not achieving good ecological potential for artificial and heavily modified water bodies will be developed in the future. See Section 3.3 for further detail on artificial and heavily modified water bodies.

The assessment for groundwater bodies takes into account the groundwater balance and whether dependent ecosystems, such as rivers, lakes and wetlands, are at risk of being damaged by groundwater abstraction.

[31]See http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%207b%20%2802%29/view
[32]Further information on abstraction and flow regulation assessment methods can be found at http://www.environment-agency.gov.uk/wfd

What do the maps show?

Map 24 shows examples of the pressures that have been considered in carrying out the risk assessments.

For the Scottish part of the Solway Tweed river basin district, Map 25 (surface waters) and Map 26 (groundwater) show water bodies affected by abstraction and flow regulation pressures. The map for surface waters also shows water bodies that have been provisionally identified as being heavily modified or artificial. Further work to assess the risk of not achieving good ecological potential for heavily modified and artificial water bodies will be developed in future. See Section 3.3 for further detail on artificial and heavily modified water bodies.

In Scotland, for each water body considered to be at risk, we have recorded the nature of the pressure and the general industry sector[33] to which this pressure can be attributed. The assessments have also recorded whether a particular pressure is considered to be a primary or contributory one and figures presented in this report include both (see Box 1). Summary information is provided in the following tables and bar charts. This information can be viewed in detail for individual water bodies via the website at http://www.sepa.org.uk/wfd/characterisation.htm.

For the English part, Map 25 (surface waters) and Map 26 (groundwater) show rivers, lakes, transitional waters and groundwaters at risk of not achieving good status as a result of water abstraction and flow regulation.

Tables 13 and 14 show the numbers, length and area of water bodies affected by (Scotland) or at risk from (England) abstraction and flow regulation for rivers and lakes respectively. Table 15 shows the number and area of water bodies affected by (Scotland) or at risk from (England) abstraction for groundwaters. There are no transitional or coastal water bodies at risk from abstraction and flow regulation.

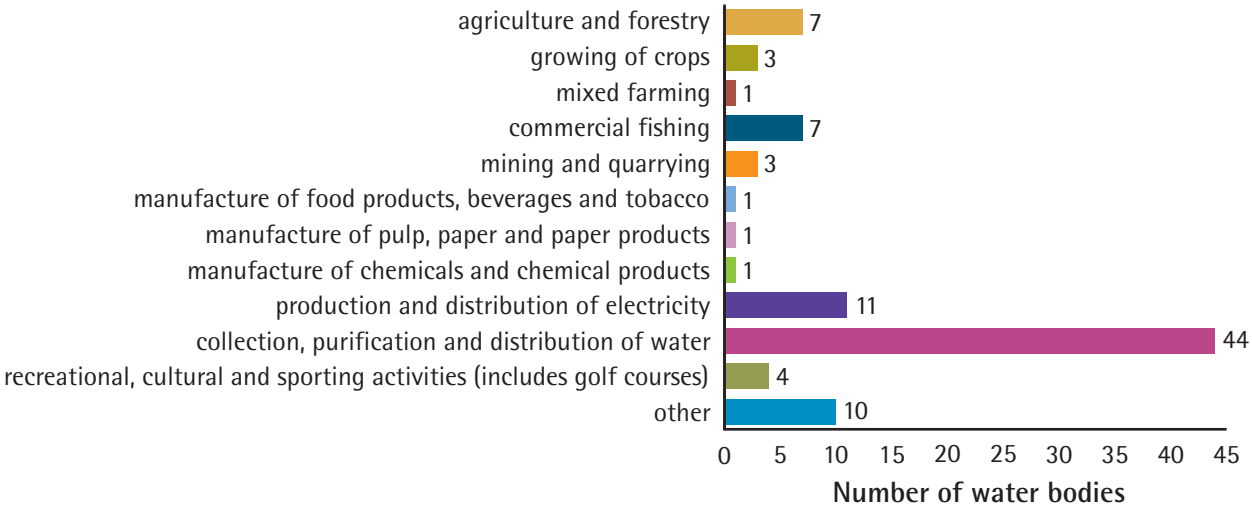
Figures 16, 17 and 18 apply to the whole river basin district and show the general industry sectors affecting water bodies in categories 1a and 1b for rivers, lakes and groundwaters respectively. A water body is often affected by more than one sector and can therefore be counted more than once in the bar chart.

Table 13. River water bodies affected by/at risk from abstraction and flow regulation

	Reporting category	Number of water bodies	% of number	Length (km)	% of length
Rivers	1a	6	1.2	33	0.5
	1b	73	14.0	985	16.3
	2a	23	4.4	315	5.2
	2b	419	80.4	4709	77.9
Total		521	100	6041	100
Total at risk	1a + 1b	79*	15.2	1017	16.8

* A total of 76 and 0 river water bodies have been provisionally identified as HMWB and AWB respectively. Canals are AWB.

Figure 16. General industry sectors affecting 1a and 1b river water bodies (abstraction & flow regulation)



[33]For a list of sectors used see http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%207a%20%2802%29/view

Table 14. Lake water bodies affected by/at risk from abstraction and flow regulation

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Lakes	1a	6	20.7	9	22.0
	1b	5	17.2	12	30.7
	2a	1	3.4	0	0.4
	2b	17	58.6	19	46.9
Total		29	100	40	100
Total at risk	1a + 1b	11*	37.9	21	52.7

* A total of 11 and 0 lake water bodies have been provisionally identified as HMWB and AWB respectively.

Figure 17. General industry sectors affecting 1a and 1b lake water bodies (abstraction & flow regulation)

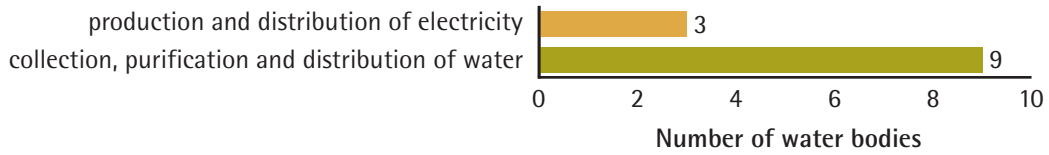
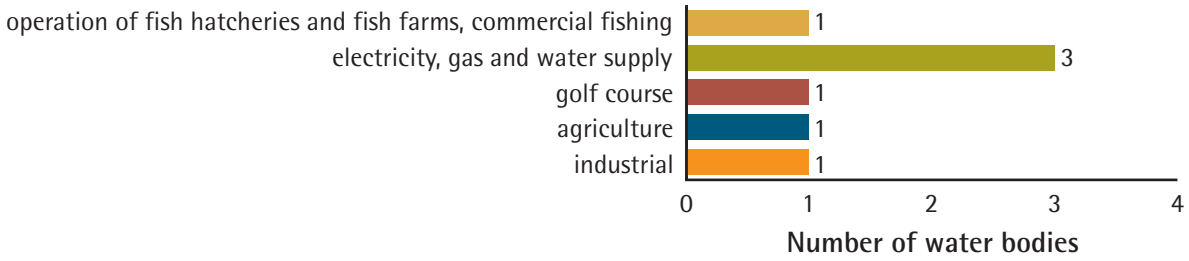


Table 15. Groundwater water bodies affected by/at risk from abstraction

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Groundwater	1a	2	8.3	2436	15.3
	1b	2	8.3	219	1.4
	2a	12	50.0	8324	52.2
	2b	8	33.3	4970	31.2
Total		24	100	15949	100
Total at risk	1a + 1b	4	16.7	2655	16.6

Figure 18. General industry sectors affecting 1a and 1b groundwater bodies (abstraction)



6.6 Morphological alterations and assessment of impact

What is the issue?

Physical alterations to a river, lake, transitional or coastal water can cause habitat damage or loss that results in a loss or decline of species.

Land claim, shoreline reinforcement or physical barriers (such as flood defences, barrages and sluices) can affect all categories of surface waters. Weirs, dams and barrages can alter water and sediment movements, and may impede the passage of migratory fish such as salmon. Activities such as maintenance and aggregate dredging, placement of dredged material and commercial fishing using towed bottom-fishing gear can also damage physical habitats. Using water for transport and recreation often requires physical alteration to habitats and affects the flow of water.

How did we do the assessment?

The risk assessments have been carried out using a variety of information. In Scotland some information is available from River Habitat Survey (RHS) and System for Evaluating Rivers for Conservation (SERCON) monitoring, however these sites only cover a proportion of rivers. In order to identify any further pressures, a map based approach was used to identify morphological alterations. By examining maps for features such as river straightening, land claim, presence of ports and harbours, additional water bodies at risk were identified. Local knowledge and, where possible, a site visit confirmed this assessment. In transitional and coastal waters the physical pressures assessed included land claim, shoreline reinforcement and commercial fishing using towed bottom-fishing gear. In future years additional monitoring and regulation aimed at morphological pressures will enable more robust assessments to be carried out.

In England, the assessment for rivers used information from our River Habitat Survey, our flood defence asset databases and data on the extent of urbanisation[34]. The assessment of lakes took into account the presence of roads, buildings and the land use around lakes, as well as water level changes and impoundment of upstream rivers.

In transitional and coastal waters, the physical pressures assessed included:

- reclamation of land from the sea by human intervention;
- shoreline reinforcement and physical barriers such as barrages, weirs and sluices;
- maintenance and aggregate dredging, placement of dredged material and commercial fishing using towed bottom-fishing gears and hydraulic harvesting devices.

As part of the risk assessment process we have identified provisional HMWBs (see Section 3.3) within the river basin district. EU guidance[35] splits the process of identifying HMWBs into provisional identification (for 2004) and formal designation (for 2009 or before). Initially as part of this process water bodies are assessed against good ecological status (not potential). In England we have applied this guidance so that if a water body is at risk or probably at risk as a result of morphological pressures, it is provisionally identified as a HMWB. In Scotland we have used the morphological pressure information along with expert judgement to provisionally identify HMWBs. It should be noted that a proportion of HMWB and AWB that are at risk of failing good ecological status may meet good ecological potential in future assessments and will therefore no longer be considered at risk. Further data will be gathered as a basis for the identification of HMWBs in draft river basin management plans in 2008. Operational guidance for the identification and designation of heavily modified water bodies is currently being drafted based on the approach set out in EU guidance.

What do the maps show?

Map 27 shows examples of the pressures that have been considered in carrying out the risk assessments as well as the RHS monitoring sites.

For the Scottish part of the Solway Tweed river basin district, Map 28 shows water bodies affected by morphological alterations. The map also shows water bodies that have been provisionally identified as being heavily modified or artificial. For each water body considered to be at risk, we have recorded the nature of the pressure and the general industry sector[36] to which this pressure can be attributed. The assessments have also recorded whether a particular pressure is considered to be a primary or contributory one and figures presented in this report include both (see Box 1). Summary information is provided in the following tables and bar charts. This information can be viewed in detail for individual water bodies via the website at http://www.sepa.org.uk/wfd/characterisation.htm.

For the English part, Map 28 shows water bodies at risk through morphological alterations. These water bodies have been provisionally identified as a HMWB.

Tables 16 to 18 show the numbers, length and area of water bodies affected by (Scotland) or at risk from (England) morphological alterations for rivers, lakes and transitional waters respectively. There are no coastal water bodies affected by morphological alterations.

[34]Further information on morphological pressure assessment methods can be found at http://www.environment-agency.gov.uk/wfd
[35]See http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/modified_guidance&vm=detailed&sb=Title
[36]For a list of sectors used see http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%207a%20%2802%29/view

Figures 19, 20 and 21 apply to Scotland and show the general industry sectors affecting water bodies in categories 1a and 1b for rivers, lakes and transitional waters respectively. A water body is often affected by more than one sector and can therefore be counted more than once in the bar chart.

Figure 22 applies to England and shows the specific activities or pressures affecting transitional water bodies at risk of failing their objectives. A water body is often affected by more than one activity or pressure and can therefore be counted more than once in the bar chart. Data constraints mean it is not yet possible to report against river and lake water bodies in this way.

Table 16. River water bodies affected by/at risk from morphological alterations

	Reporting category	Number of water bodies	% of number	Length (km)	% of length
Rivers	1a	41	7.9	417	6.9
	1b	133	25.5	1647	27.3
	2a	121	23.2	1590	26.3
	2b	226	43.4	2387	39.5
Total		521	100	6041	100
Total at risk	1a + 1b	174*	33.4	2064	34.2

* A total of 76 and 0 river water bodies have been provisionally identified as HMWB and AWB respectively. Canals are AWB.

Figure 19. General industry sectors affecting 1a and 1b river water bodies (morphological alterations) (Scottish part)

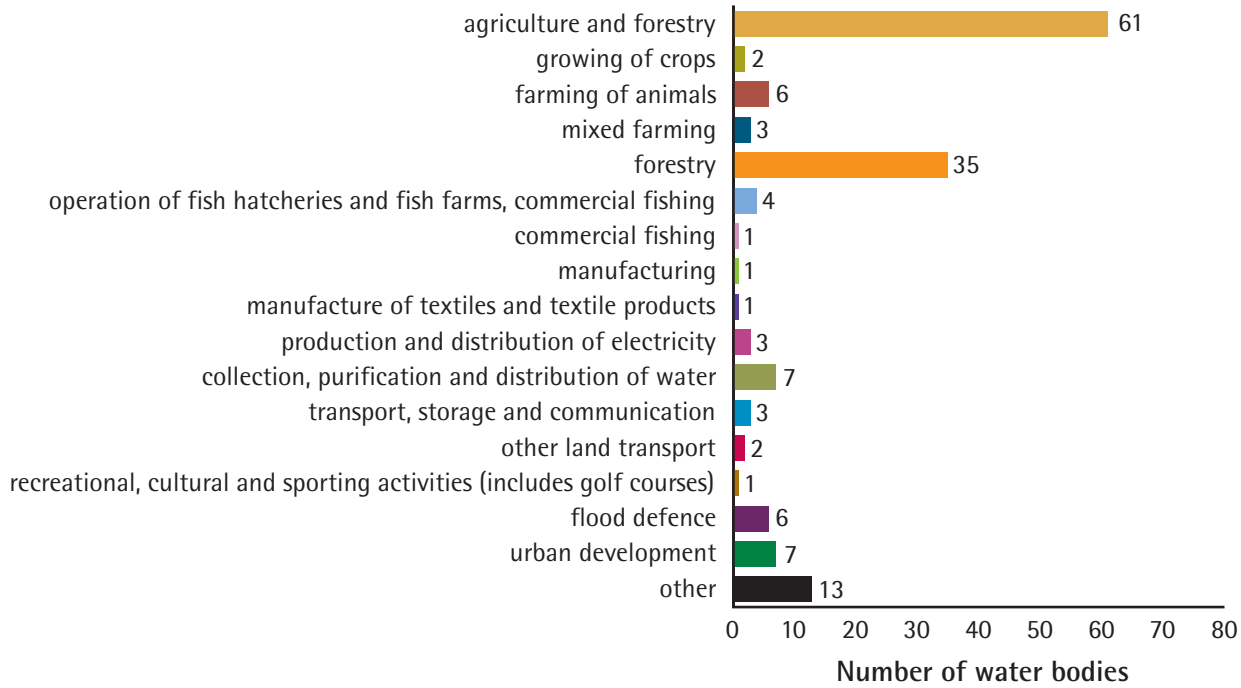


Table 17. Lake water bodies affected by/at risk from morphological alterations

	Reporting category	Number of water bodies	% of number	Area (km²)	% of area
Lakes	1a	8	25.0	10	22.0
	1b	5	15.6	9	20.7
	2a	5	15.6	10	22.0
	2b	14	43.8	16	35.2
Total		32	100	44	100
Total at risk	1a + 1b	13*	40.6	19	42.8

* A total of 11 and 0 lake water bodies have been provisionally identified as HMWB and AWB respectively.

Figure 20. General industry sectors affecting 1a and 1b lake water bodies (morphological alterations) (Scottish part)

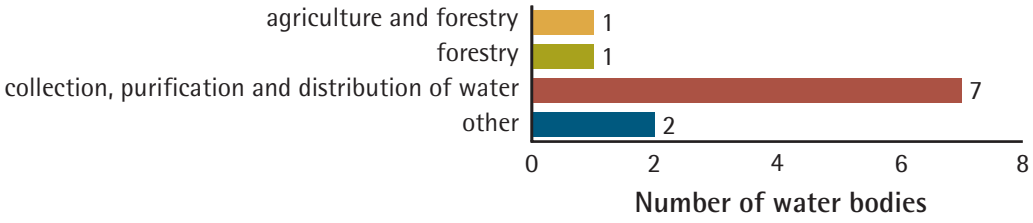


Table 18. Transitional water bodies affected by/at risk from morphological alterations

	Reporting category	Number of water bodies	% of number	Area (km²)	% of area
Transitional	1a	1	9.1	306	78.5
	1b	4	36.4	6	1.5
	2a	0	0	0	0
	2b	6	54.5	78	20.0
Total		11	100	390	100
Total at risk	1a + 1b	5*	45.5	312	80

* A total of 2 and 0 transitional water bodies have been provisionally identified as HMWB and AWB respectively.

Figure 21. General industry sectors affecting 1a and 1b transitional water bodies (morphological alterations) (Scottish part)

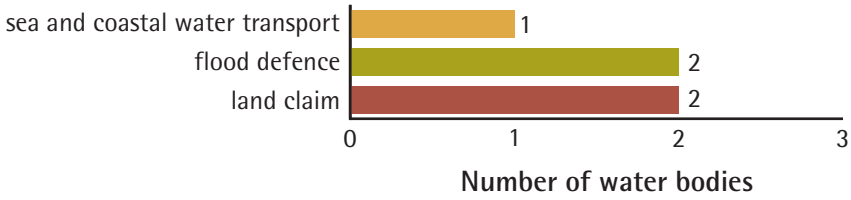
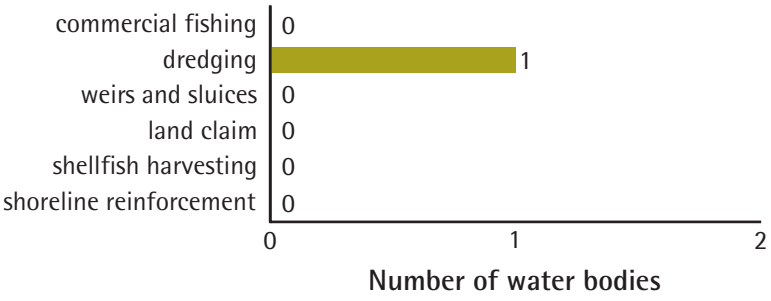


Figure 22. Morphology pressures in 1a and 1b transitional water bodies (English part)



6.7 Other human pressures and assessment of impact

What is the issue?

Alien species are non-native organisms that establish themselves in, and may disrupt, native ecosystems. Alien species have been deliberately or accidentally introduced by humans and there is growing evidence that they can cause a major threat to native flora and fauna. They can result in loss of natural biodiversity and may have significant economic impacts.

How have we done the assessment?

The assessment[37] carried out for this report has focused on ten species in rivers, lakes, transitional and coastal waters that have been selected because of data availability and the severity of their impact.

The species assessed are:

Australian swamp stonecrop	*Crassula helmsii*
Floating pennywort	*Hydrocotyle ranunculoides*
Water fern	*Azolla filiculoides*
Parrot's feather	*Myriophyllum aquaticum*
Common cord-grass	*Spartina anglica*
Japanese weed	*Sargassum muticum*
North American signal crayfish	*Pacifastacus leniusculus*
Zebra mussel	*Dreissena polymorpha*
Chinese mitten crab	*Eriocheir sinensis*
Slipper limpet	*Crepidula fornicata*

Scottish Natural Heritage and English Nature identified records of known locations of alien species. Their presence indicates a risk that the water body will not achieve Directive objectives. The analysis is not a comprehensive assessment of all alien species but indicates the potential extent of the problem in the Solway Tweed river basin district.

What does the map show?

Map 29 shows surface water bodies that have known occurrences of the alien species.

In Scotland, due to the nature of the information provided, it has not always been possible to identify which water body is affected by alien species. Some of the grid references are not sufficiently accurate to enable a specific water body to be identified. Further work will be required to correct this in future.

At this stage in the Solway Tweed river basin district a total of 7 river and 2 lake water bodies have been identified as being at risk from alien species.

[37]For more detailed background information and the method used for assessment see the UKTAG paper at http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG%202004%20%28PR1-16-03-04%29/view and Environment Agency methods at http://www.environment-agency.gov.uk/wfd

6.8 Summary of water bodies affected by all pressures

Sections 6.2 to 6.7 present information in relation to the different types of impacts and pressures on water bodies and the resulting risk of not achieving the Directive's objectives in the Solway Tweed river basin district. Many water bodies are affected by more than one type of pressure and this section provides an overall summary of the main issues in this district.

Analysis of results

Map 30 (surface waters) and Map 31 (groundwater) show all water bodies at risk of failing the Directive's environmental objectives.

Tables 19 to 23 show the numbers, length, area and percentages of surface and groundwater bodies at risk from all pressures in the Solway Tweed river basin district.

Figures 23 to 27 show the relative causes of all water bodies at risk.

As can be seen from the table, many of the transitional waters are at risk of failing the environmental objectives (about 84% of the total surface area). This is because the Solway Estuary is the largest transitional water body in the district and it is at risk. This is not surprising given the heavy use that occurs there. The larger population centres in the district are situated close to large estuaries and human activity brings with it pressures on the water environment.

About 67% of our groundwaters are at risk of failing the environmental objectives and this is mainly due to diffuse pollution along with some point source pollution.

Approximately 55% of our rivers and 65% of lakes are at risk of failing the environmental objectives. The causes are mainly diffuse pollution and morphological pressures which reflect the land use of the area.

Coastal areas have the lowest proportion of water bodies at risk of failing the environmental objectives (about 9% of the surface area). The relatively long coastline on the west of the Solway Tweed is generally not at risk from human activity.

It is important to remember that this is a risk screening assessment and not the result of a classification scheme. This assessment is only the first step in an ongoing process to improve our understanding of impacts on the water environment. Over the next two years further characterisation and the application of the regulatory regimes will help improve our understanding of pressures and impacts.

Table 19. River water bodies affected by/at risk from all pressures

	Reporting category	Number of water bodies	% of number	Length (km)	% of length
Rivers	1a	85	16.3	973	16.1
	1b	204	39.2	2570	42.5
	2a	83	15.9	986	16.3
	2b	149	28.6	1512	25.0
Total		521	100	6041	100
Total at risk	1a + 1b	289	55.5	3543	58.6

Table 20. Lake water bodies affected by/at risk from all pressures

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Lakes	1a	10	31.3	12	26.6
	1b	11	34.4	19	41.6
	2a	6	18.8	11	24.3
	2b	5	15.6	3	7.5
Total		32	100	44	100
Total at risk	1a + 1b	21	65.6	30	68.2

Table 21. Transitional water bodies affected by/at risk from all pressures

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Transitional	1a	2	18.2	321	82.3
	1b	4	36.4	6	1.5
	2a	0	0	0	0
	2b	5	45.5	63	16.1
Total		11	100	390	100
Total at risk	1a + 1b	6	54.5	327	83.9

Table 22. Coastal water bodies affected by/at risk from all pressures

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Coastal	1a	2	25	177	9.2
	1b	0	0	0	0
	2a	0	0	0	0
	2b	6	75	1736	90.8
Total		8	100	1913	100
Total at risk	1a + 1b	2	25	177	9.2

Table 23. Groundwater water bodies affected by/at risk from all pressures

	Reporting category	Number of water bodies	% of number	Area (km^2)	% of area
Groundwater	1a	10	41.7	7326	45.9
	1b	6	25.0	3064	19.2
	2a	8	33.3	5559	34.9
	2b	0	0	0	0
Total		24	100	15949	100
Total at risk	1a + 1b	16	66.7	10390	65.1

Figure 23. Relative cause of river water bodies at risk

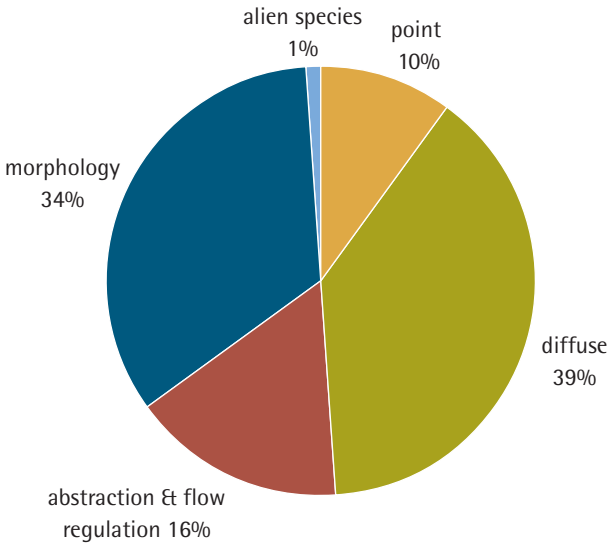


Figure 24. Relative cause of lake water bodies at risk

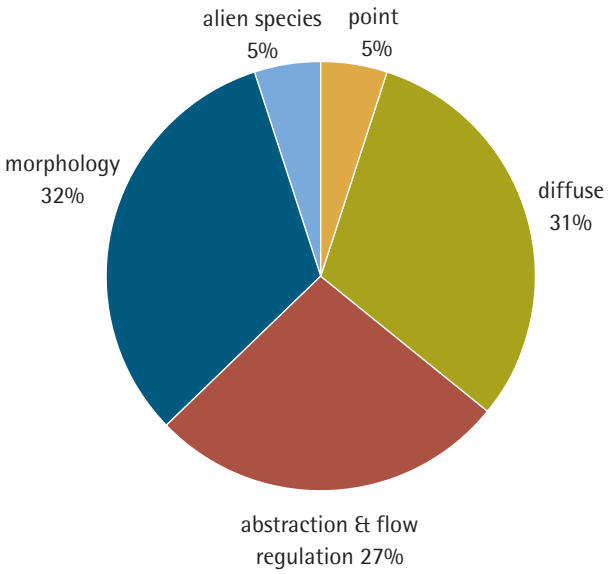


Figure 25. Relative cause of transitional water bodies at risk

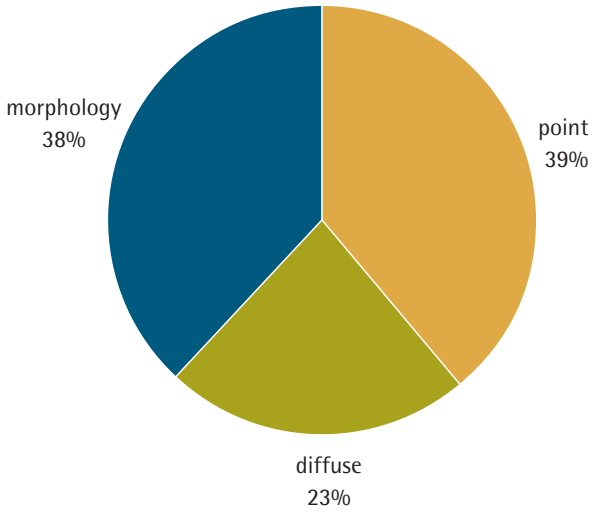


Figure 26. Relative cause of coastal water bodies at risk

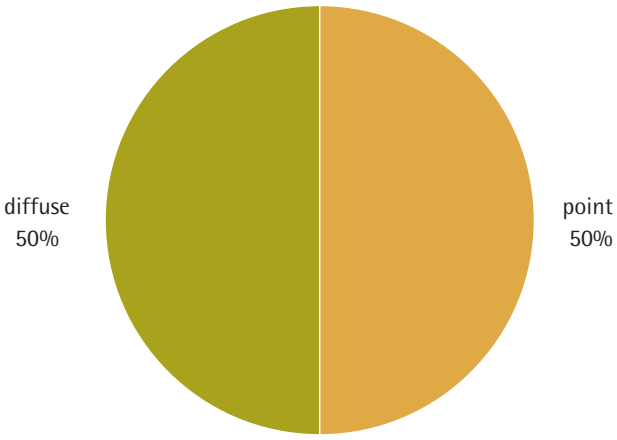
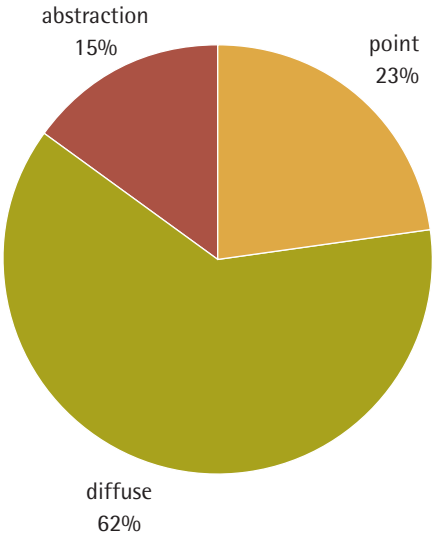


Figure 27. Relative cause of groundwater bodies at risk



6.9 Groundwater bodies for which lower objectives may be specified

Sections 2.4 and 2.5 of Annex II of the Directive require member states to identify those bodies of groundwater for which lower objectives are to be specified under Article 4 including where achieving good groundwater chemical and quantitative status is infeasible or disproportionately expensive.

Such groundwater bodies are provisionally identified within this river basin district in Map 32.

This provisional identification is based on a hydrogeological expert judgement assessment of whether remedial action will be sufficiently effective by 2027 and the likelihood of remedial action being disproportionately expensive[38].

The identification of such bodies of groundwater should be regarded as preliminary. It is based on the best available information at the present time. However, the gaps in current information and the uncertainties include:

- a daughter directive on groundwater, which will clarify the approach to 'good status' has yet to be agreed;
- standards to be applied in setting 'good status' have yet to be established;
- uncertainties remain on the meaning of ecological and chemical status for surface waters, on which the definition of good groundwater status is dependent;
- consideration (at EU and UK level) of how exemptions including lower objectives should operate in accordance with Article 4 are at an early stage. The identification of bodies of groundwater likely to require such exemptions at this stage pre-empts much of this ongoing work;
- no consideration of socio-economics has yet been undertaken.

Further characterisation will provide more information about groundwater characteristics and pressures and impacts. This work, together with progress establishing the approaches to good status, setting lower objectives and considering socio-economic factors, should address uncertainties listed above. Consequently revisions are likely to be made to the number of bodies of groundwater likely to require lower objectives included in this report, when the time comes to identify such groundwater bodies in river basin management plans in 2009.

6.10 General trends and future pressures

While there is no direct relationship between economic activity and pressures, considering trends in activity may assist in understanding and responding to future pressures. Specific trends and pressures are considered in turn below.

Land cover changes

Water quality can be impacted by land use decisions and management practices. Diffuse pollution can result from urban areas, roads, forestry and agricultural land.

Although the changes in urban expansion and increased farmland have slowed somewhat in more recent years, the land cover changes described have had an effect on the water environment. Water quality can be impacted by land use

[38]For further details see http://www.sepa.org/groundwater/wfd and http://www.environment-agency.gov.uk/wfd

decisions and management practices. Diffuse pollution can result from urban areas, roads, forestry and agricultural land. Many of these problems are currently being addressed (for example through sustainable urban drainage systems and agricultural best management practices) but in areas where these types of land use changes continue, measures will need to be put in place to ensure that no deterioration in status occurs.

Following the Biodiversity Convention at the Earth Summit in Rio de Janeiro in 1992, the UK Biodiversity Action Plan set out a programme of action to conserve and enhance biological diversity throughout the UK. A classification of 'broad habitats' was defined for consistent reporting and as context for 'priority' habitats and species requiring conservation action. The extent of fen, marsh and swamp increased significantly as did the area of broadleaved, mixed and yew woodland. There was no clear evidence of change in the extent of arable and horticultural land in Scotland, nor was there clear evidence of change in the extent of developed land in rural areas.

The common agricultural policy[39] (CAP) has led to land use changes over the last 30 years. Agricultural intensification, such as increased stocking, fertiliser and pesticide use, has resulted in increased pressures and impacts on the water environment. Intensification has slowed in recent years and the reform of CAP, which will become effective from 2005, may provide water quality, landscape and biodiversity benefits. Whilst CAP reform is expected to lead to an overall de-intensification, some farmers are likely to expand and intensify production.

A further major land use change is in forestry with the Scottish Forestry Strategy aiming for 25% forestation. In addition, economics will determine when the areas of mature timber will be felled. In England a continued steady expansion of woodlands is also anticipated. The impacts of these changes on the water environment are being studied by the Environment Agency and the Forestry Commission.

Future development pressures

A research project was commissioned to identify potential pressures and impacts on water bodies as a consequence of land use proposals within the current suite of Scottish development plans and other published strategy documents. Development plans post 1998 were reviewed and 691 strategic development sites, representing about 0.35% of Scotland's land area, were identified as being relevant to the study. Sites are mainly concentrated in the Central belt with a lower density in the Borders and lower lying areas of north east Scotland. Residential (39%), industrial (22%) and mixed use (15%) make up the majority of strategic development site allocations identified. These future development pressures identified will need to be borne in mind when programmes of measures are established. Map 33 shows the future development pressures in the Scottish part of the river basin district[40].

Increased renewable energy sources

The UK government has set a target to increase the amount of energy produced from renewable sources. The target set is that generation from renewable sources should supply 10% of the UK electricity by 2010, rising to 20% by 2020. The development of renewable energy is vital to meeting government targets for reducing carbon dioxide emissions. For Scotland this is likely to mean an increase in hydropower schemes, wind power schemes and schemes harnessing wave power. These schemes may impact the water environment as a result of abstraction and flow regulation pressures or morphological alterations. Northwest Scotland and coastal areas are likely to be the main areas for such renewable energy schemes.

Climate change

Climate change will affect all aspects of the water environment but we are still unsure what the impacts will be and where they will occur. For example, increased rainfall may dilute the pollutants present in water bodies but will also flush a greater concentration of compounds into receiving waters, such as nitrates in winter, or cause more frequent sewer overflows in the summer, both resulting in deteriorating water quality.

The Directive states that temporary deterioration in the status of water bodies is allowable if this arises from exceptional circumstances such as extreme floods and prolonged droughts, but less severe weather changes will also impact indirectly on the water environment. The increasing variability of weather patterns will make it more difficult to assess the risks and pressures, the long-term effectiveness of the programmes of measures and the efficacy of sampling and monitoring regimes. We expect to see changes in land-use and water consumption because of climate change, and these may prove to be a significant factor in achieving the overall objective of good status. Surveillance monitoring will be designed to assess the impact of climate change.

[39]For further information on the common agricultural policy see http://europa.eu.int/comm/agriculture/publi/capleaflet/cap_en.htm
[40]For a full copy of the report see http://www.sepa.org.uk/pdf/publications/reports4sepa/national_planning_policy_dev.pdf

7. Conclusions and next steps

This report summarises the results of the characterisation and pressures and impacts analyses of the Solway Tweed river basin district's water environment. The Water Framework Directive requires a much wider range of pressures to be considered, in contrast to our historic focus on point source pollution in Scotland and point source pollution and abstraction in England. This will start to allow SEPA, the Environment Agency and stakeholders in the Solway Tweed river basin district to take a more integrated approach to water management in the future.

This assessment is the first step in the overall process of improving our aquatic environment through river basin management planning. The next stages include:

- review of water bodies probably at risk of failing the environmental objectives prior to 2007 (reporting category of 1b). This will be done using additional information that will become available from regulated and non-regulated sectors, new environmental monitoring and modelling data and, in Scotland, the application of new regulations.
- design of a new monitoring programme by 2006 taking into account the wider range of pressures that need to be considered. The results from the pressure and impact assessment and further characterisation will be used to define the network. A Scottish Aquatic Environment Monitoring Strategy is currently being taken forward by SEPA in partnership with other organisations. The Environment Agency is also taking forward a monitoring strategy in partnership with other organisations.
- preparation of data presentation for use in river basin management planning. In Scotland, SEPA is proposing to form a network of Area Advisory Groups to support RBMP production. Pressure and impact information will be used by these groups to help identify risk management measures and establish a programme of measures. In England and Wales, the Environment Agency has undertaken a formal consultation on a Strategy for River Basin Planning and will be developing its policy on this taking into account views expressed in the consultation responses.

The process of river basin management is iterative. Information will continually be improved making the next cycle of characterisation easier and more robust than this first assessment. This iterative process will improve our water environment and support the sustainable uses of our water resources bringing economic and social benefit to the people who live in the district.

Glossary

AWB	artificial water body
CAMS	catchment abstraction management strategies
CAP	Common Agricultural Policy
Defra	Department for Environment, Food and Rural Affairs
EC	European Community
EQS	environmental quality standards
EU	European Union
GWDTE	groundwater dependent terrestrial ecosystem
GQA	general quality assessment
HMWB	heavily modified water body
RBD	river basin district
RBM	river basin management
RBMP	river basin management plan
SEPA	Scottish Environment Protection Agency
SSSI	Site of Special Scientific Interest
UKTAG	United Kingdom Technical Advisory Group
WEWS Act	Water Environment and Water Services (Scotland) Act 2003



Yetholm Loch, Borders

Annex 1. Summary of environmental objectives and issues surrounding their assessment

Objectives

The environmental objectives that need to be achieved under the Directive are summarised as:

	Environmental objectives
For surface waters	• achievement of good ecological status and good surface water chemical status by 2015 • achievement of good ecological potential and good surface water chemical status for heavily modified water bodies (HMWB) and artificial water bodies (AWB) • prevention of deterioration from one status class to another • achievement of water related objectives and standards for protected areas
For groundwater	• achievement of good groundwater quantitative and chemical status by 2015 • prevention of deterioration from one status class to another • reversal of any significant and sustained upward trends in pollutant concentrations and prevent or limit input of pollutants to groundwater • achievement of water related objectives and standards for protected areas

Water bodies are identified as being at risk if they are likely to fail any of these environmental objectives. For the English part of the Solway Tweed river basin district, protected area objectives are assessed and reported separately as they are not always set against water bodies.

Prediction of risk to 2015

The risk assessment is generally based on the current situation and does not take into account future scenarios or planned improvements. Therefore we assume that if a water body is currently at risk, it will also be at risk in 2015. There are exceptions to this:

- Improvements that are assumed to occur under Scottish Water improvement plans which are already financed under the Quality & Standards 2 programme and are due for completion by end 2005.
- Improvements being undertaken in England as part of the approved five year programmes of the water companies (2000-2005, 2005-2010) – rivers only.
- Where we have accurate trend data these are used to predict the situation in 2015, for example nitrate trends to 2015 in groundwaters and water resource demands predicted in the Environment Agency's Water Resource Strategies.

Relative scale of water bodies and assessment

Groundwater bodies and some transitional and coastal water bodies are typically very large and may be identified as being at risk from localised pressures that affect only small portions of a water body. This scale issue is relevant to all water bodies to some extent, although particularly in the larger bodies, and any monitoring strategy and programme of measures established will take this into account.

Pressure and impact assessment issues

A number of difficulties surround the assessments. Below we highlight the main issues encountered and how we have dealt with them.

Difficulty	Solution	Outcome
Good ecological status has not yet been defined across Europe.	A European process of intercalibration is currently addressing this matter and in the meantime we have used preliminary criteria established by UKTAG.	A water body 'at risk' cannot automatically be interpreted as meaning the water body is not of 'good ecological status'.

Difficulty (continued)	**Solution** (continued)	**Outcome** (continued)
Good chemical status has not yet been defined as EQSs for the priority substances have not yet been agreed. The approach to dealing with other specific pollutants has not yet been determined in detail, and it is not clear whether standards will be set for sediments or biota.	As an initial indication of the risk of not achieving good chemical status, existing UK standards, where they exist, have been used in the assessments.	A water body 'at risk' cannot automatically be interpreted as meaning the water body is not of good chemical status.
The alternative objective of good ecological potential has not yet been defined. This standard applies to heavily modified and artificial water bodies. Related to this, heavily modified and artificial water bodies don't need to be designated until 2009.	Heavily modified and artificial water bodies have been provisionally identified and have been assessed in relation to good status (as recommended by European guidance).	A large proportion of heavily modified and artificial water bodies identified as at risk may in fact meet good ecological potential in future.
Exceptions (e.g. extended deadlines or lower objectives) and disproportionate costs have not been taken into account at this stage, apart from provisional proposals for lower objectives for groundwater bodies.	Groundwater bodies which may require lower objectives have been provisionally identified. This will be considered for other water bodies at a later stage, as recommended by European guidance. At present we have assessed water bodies in relation to good status by 2015.	Some water bodies identified as at risk may later be exempted from achieving good status by 2015.
The aim is to achieve the environmental objectives (Annex 1) by 2015. It is difficult to predict changes between now and 2015 in relation to good status and other objectives, especially since good status or the other objectives have not yet been defined.	We have made the general assumption that if a water body is at risk in 2004 it will be at risk in 2015. There are a few exceptions to this where we have accurate trend data to suggest otherwise and where planned investment is already funded.	Water bodies at risk will be taken forward into the first river basin management process to determine appropriate programmes of measures.
Drinking water protected areas have only recently been identified so we have not assessed specific objectives for these areas.	This will be considered at a later stage and reported in the next characterisation report in 2013. At present we have assessed water bodies in relation to an estimation of good status.	Water bodies at risk will be taken forward into the first river basin management process to determine appropriate programmes of measures.
Lack of nationally consistent data or absence of data.	We have used the best information available. In the absence of data we have used alternative methods such as modelling or expert judgement.	Many of the water bodies affected by these difficulties have been identified as 'probably at risk' or 'probably not at risk'. Water bodies probably at risk will be reviewed before 2007 and water bodies probably not at risk will be reviewed before 2013 (see Section 6.1).
Protected area objectives for water dependent Natura 2000 sites have been assessed by Scottish Natural Heritage and English Nature to determine if there is a risk of failure of objectives.	This work pre-empts reporting under the Habitats and the Birds Directives due in 2006.	These assessments should be seen as provisional until reported under the Habitats and the Birds Directives.

Annex 2. Sources of information

Environment Agency's consultation, June 2002, The Water Framework Directive, Guiding principles on the technical requirements:
http://www.environment-agency.gov.uk/wfd

Environment Agency's GQA assessment for 2003:
http://www.environment-agency.gov.uk/gqaresults

Environment Agency: method statements and protected area register for England and Wales:
http://www.environment-agency.gov.uk/wfd

Europa: European guidance on heavily modified water bodies:
http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/modified_guidance&vm=detailed&tsb=Title

Europa: European guidance on identification of surface water bodies:
http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/identification_bodies&tm=detailed&tsb=Title

Europa: European information on common agricultural policy:
http://europa.eu.int/comm/agriculture/publi/capleaflet/cap_en.htm

Europa: Water Framework Directive text:
http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf

European Environment Agency information on acidification:
http://themes.eea.eu.int/Environmental_issues/acidification

Scottish Environment Protection Agency consultation, May 2002, *"The Future for Scotland's Waters"* provides a general introduction to technical requirements of the Water Framework Directive:
http://www.sepa.org.uk/publications/wfd/

Scottish Environment Protection Agency, guidance on groundwater assessments:
www.sepa.org.uk/groundwater/wfd

Scottish Environment Protection Agency, research project on future development pressures:
http://www.sepa.org.uk/pdf/publications/reports4sepa/national_planning_policy_dev.pdf

Scottish Natural Heritage, A-Z index, land cover change in Scotland:
http://www.snh.org.uk/

UKTAG guidance on groundwater body delineation:
http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5420/view

UKTAG guidance on groundwater dependent terrestrial ecosystems (identification):
http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/TAG2003%20WP%205a-b%20%2801%29/view

UKTAG guidance on pressure and impact analysis (various papers):
http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5332/view

UKTAG guidance on protected areas (identification):
http://www.wfduk.org/tag_guidance/Article_06-07/view

UKTAG guidance on small waters:
http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5420/view

UKTAG guidance typology (rivers, lakes, transitional and coastal waters):
http://www.wfduk.org/tag_guidance/Article_05/Folder.2004-02-16.5312/view

UKTAG reference condition descriptions:
http://www.wfduk.org/tag_guidance/Article_05/Type%20specific%20reference%20conditions/view

Annex 3: Characterisation maps

Map 1: River basin districts in mainland UK

Map 2: Main river catchments and types

Map 3: Lake types

Map 4: Transitional water types

Map 5: Coastal water types

Map 6: Artificial water bodies and canals

Map 7: Groundwater body types

Map 8: Groundwater dependent surface water bodies and terrestrial ecosystems

Map 9: Waters used for the abstraction of drinking water

Map 10: Areas designated to protect economically significant aquatic species and bathing water directive beaches

Map 11: Nutrient sensitive areas

Map 12: Water dependent conservation areas

Map 13: Assessment of areas designated to protect economically significant aquatic species (England)

Map 14: Assessment of recreational waters (England)

Map 15: Assessment of water dependent conservation areas (Habitats Directive) (England)

Map 16: Assessment of water dependent conservation areas (Birds Directive) (England)

Map 17: General Quality Assessment Biology (England)

Map 18: Point source pressures

Map 19: Surface water bodies affected by/at risk from point source pollution pressures

Map 20: Groundwater water bodies affected by/at risk from point source pollution pressures

Map 21: Land use in the Solway Tweed River Basin District

Map 22: Surface water bodies affected by/at risk from diffuse source pollution pressures

Map 23: Groundwater water bodies affected by/at risk from diffuse source pollution pressures

Map 24: Abstraction and flow regulation pressures

Map 25: Surface water bodies affected by/at risk from abstraction and flow regulation pressures

Map 26: Groundwater water bodies affected by/at risk from abstraction pressures

Map 27: Morphology pressures and river habitat survey sites

Map 28: Surface water bodies affected by/at risk from morphological pressures

Map 29: Surface water bodies affected by/at risk from alien species pressures

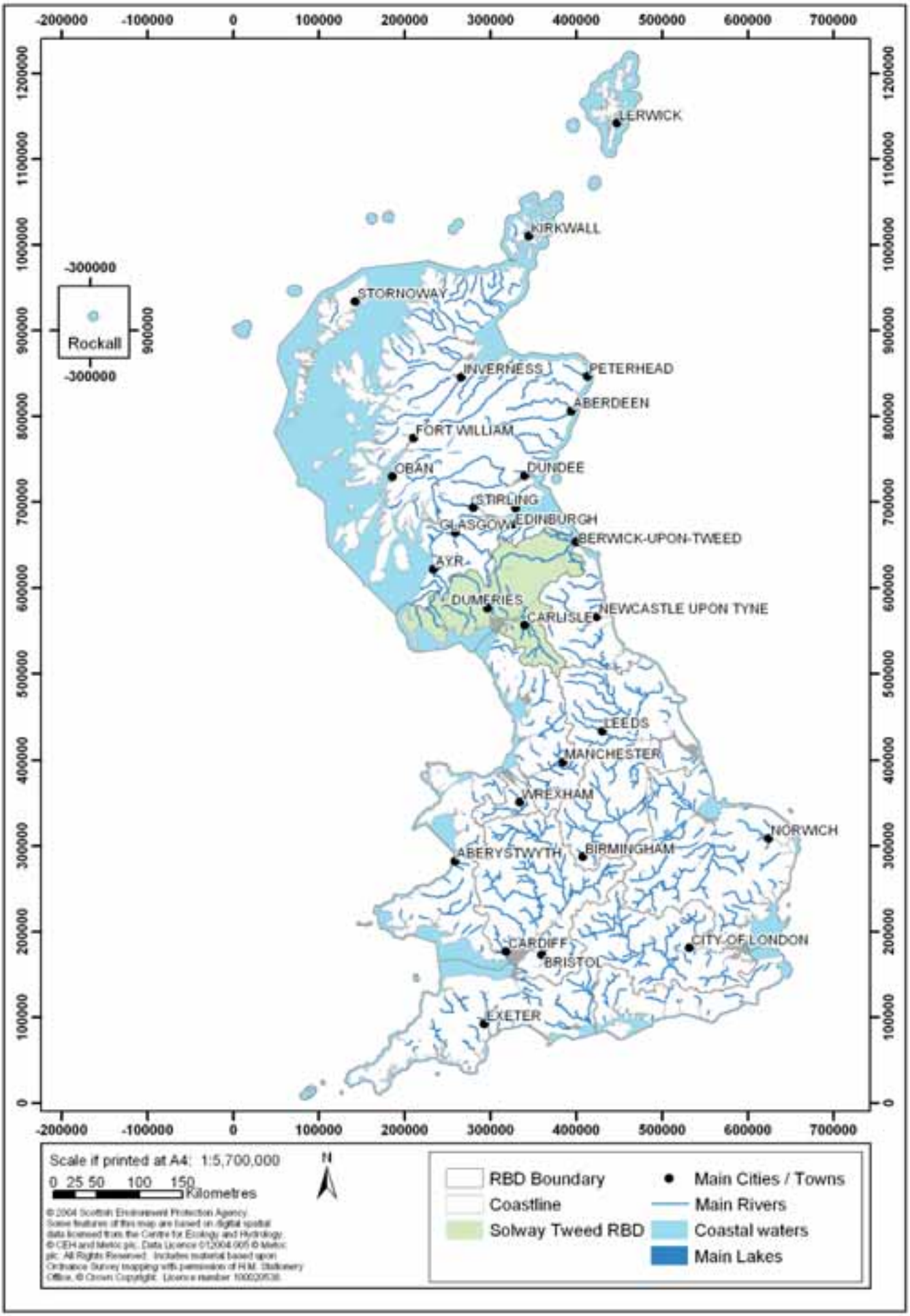
Map 30: Surface water bodies affected by/at risk from all pressure types

Map 31: Groundwater water bodies affected by/at risk from all pressure types

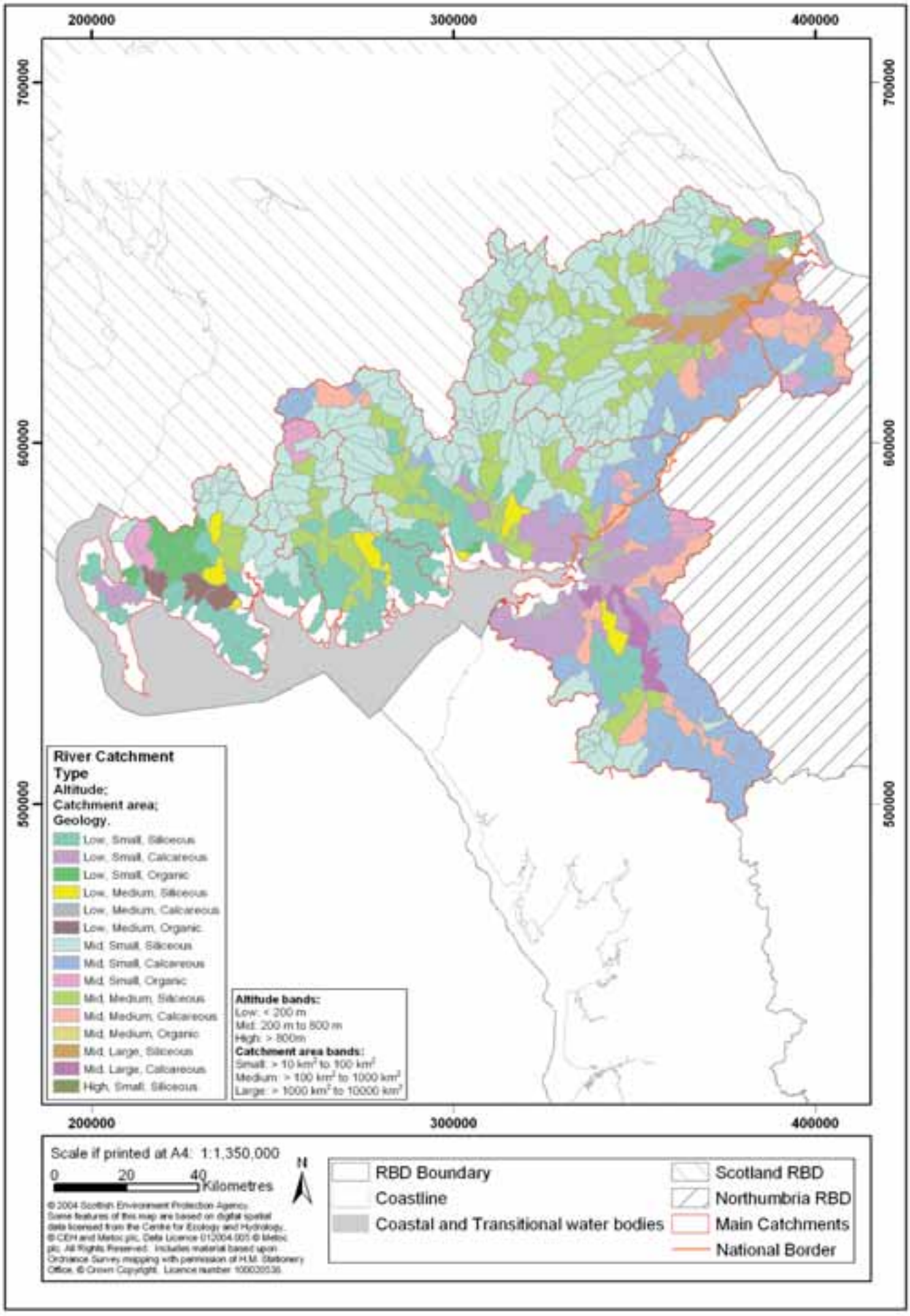
Map 32: Groundwater bodies for which lower objectives may be specified

Map 33: Future development pressures (Scotland)

Map 1: River basin districts in mainland UK

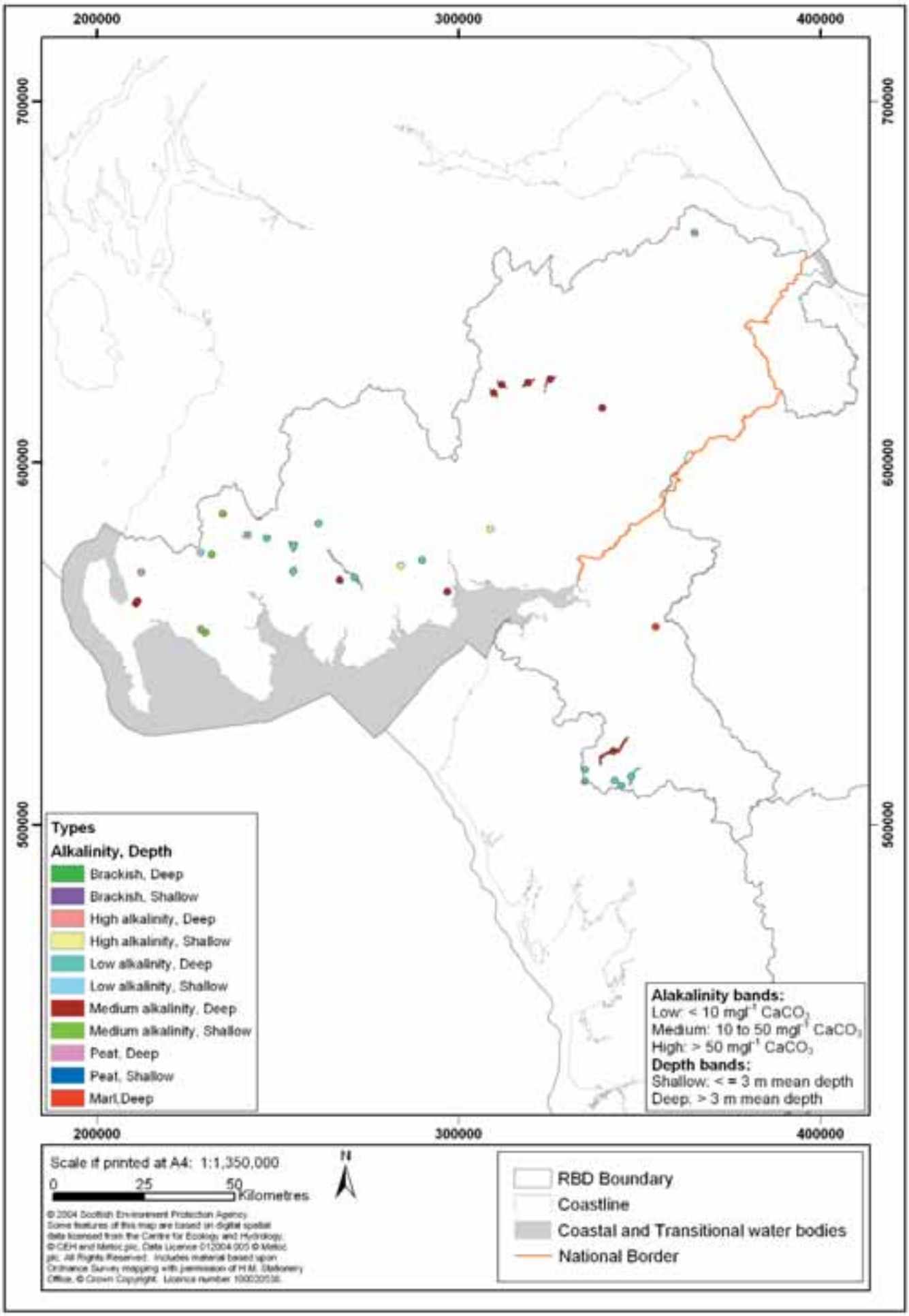


Map 2: Main river catchments and types



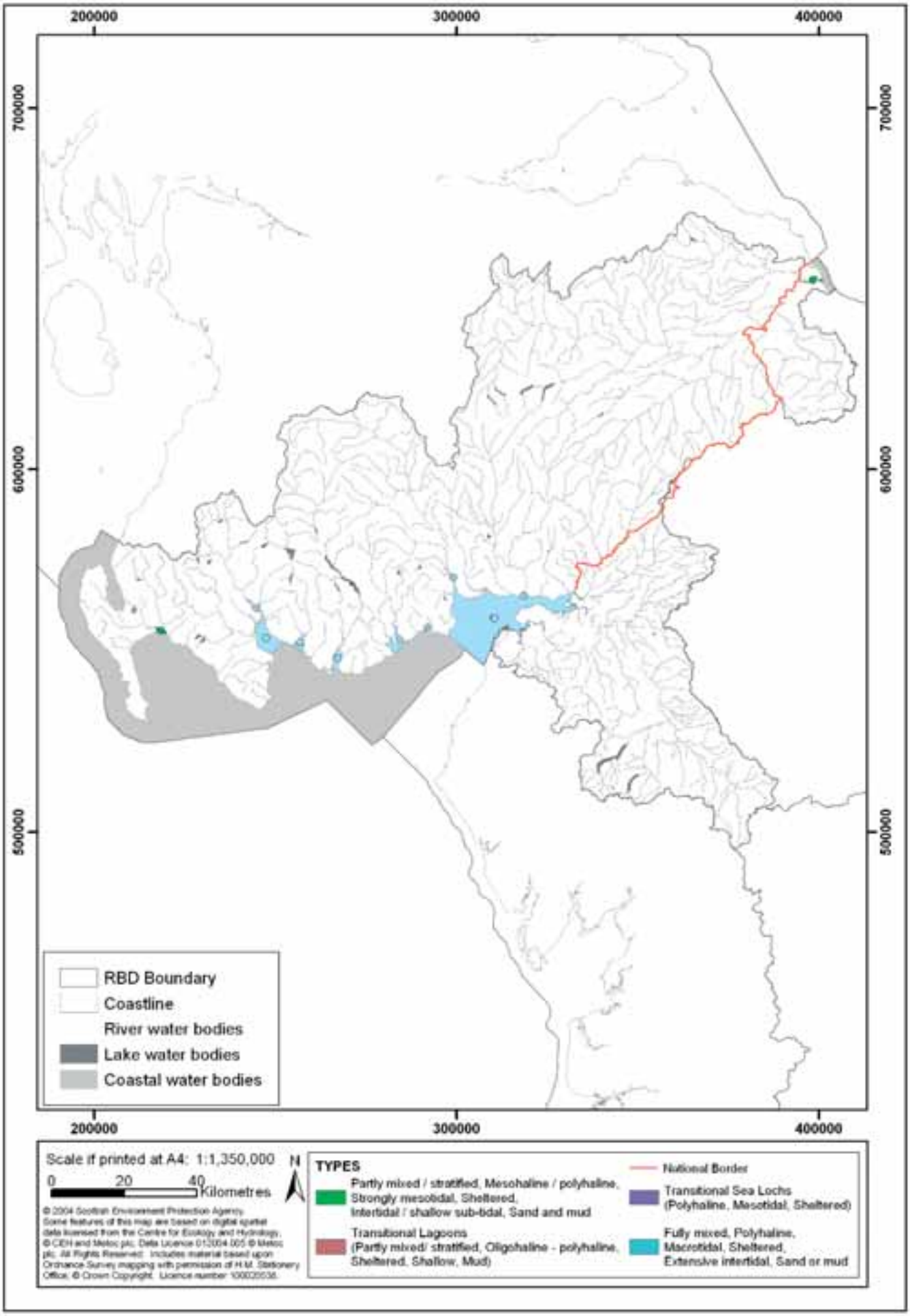
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Map 3: Lake types



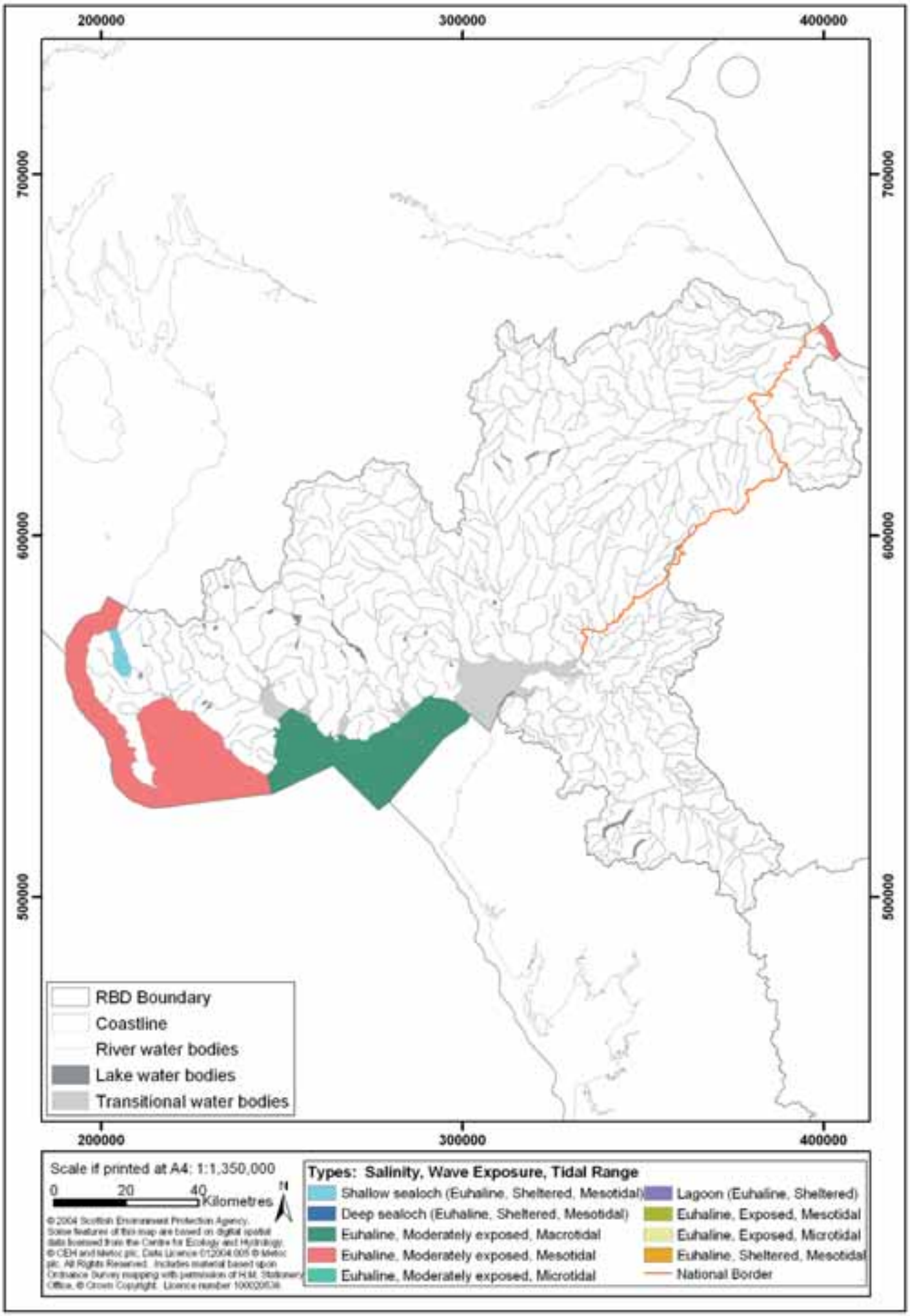
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Map 4: Transitional water types

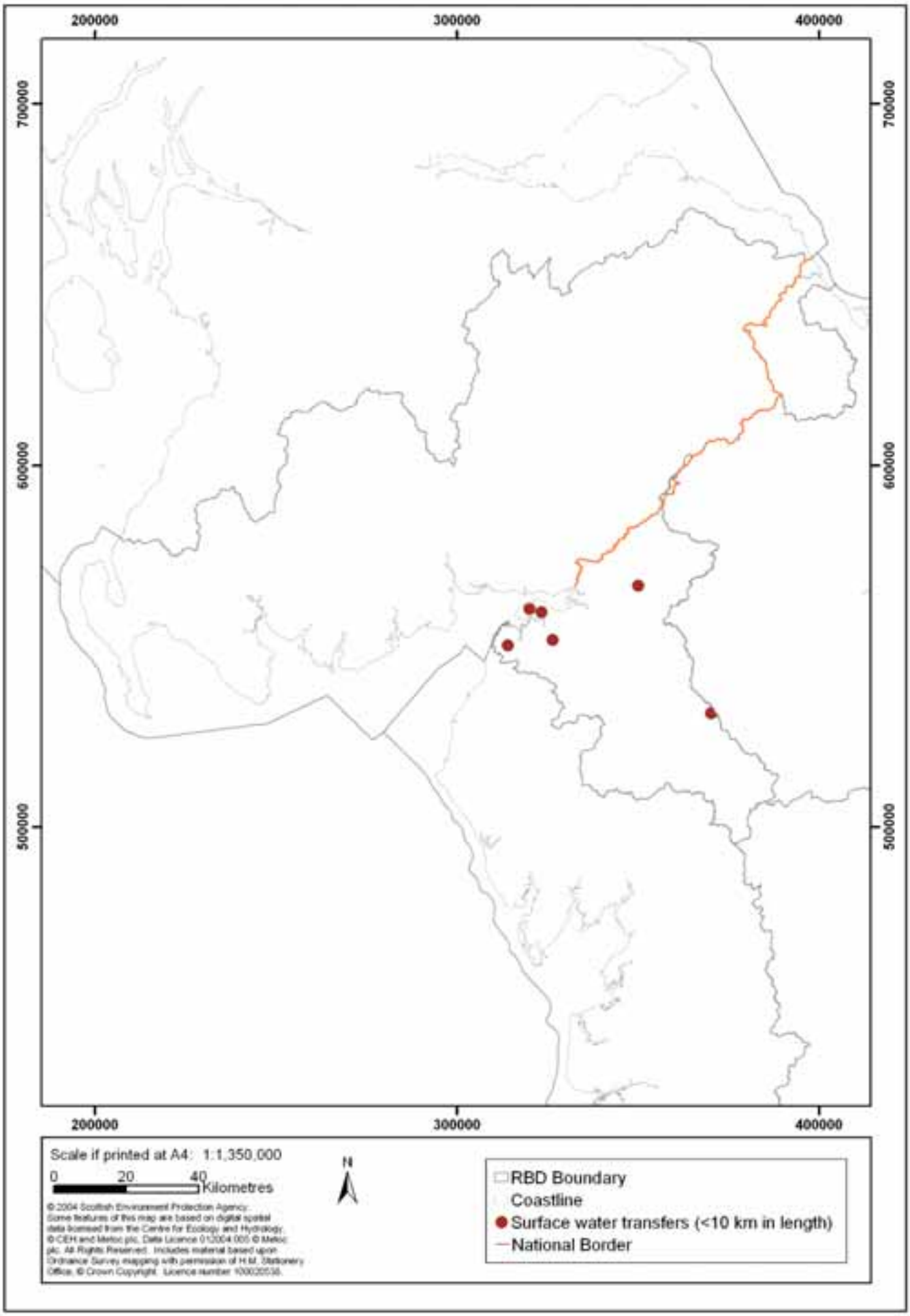


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Map 5: Coastal water types

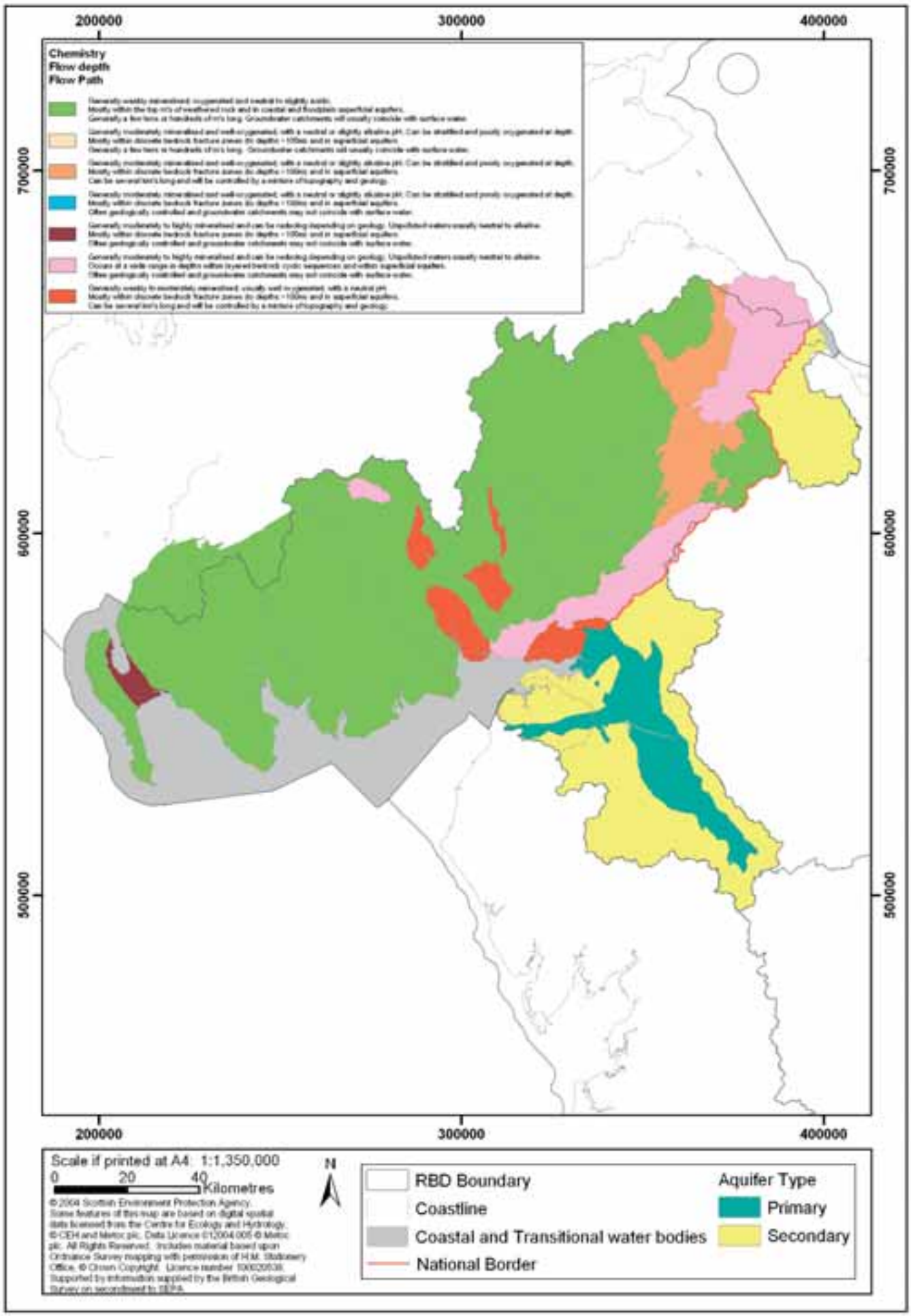


Map 6: Artificial water bodies and canals

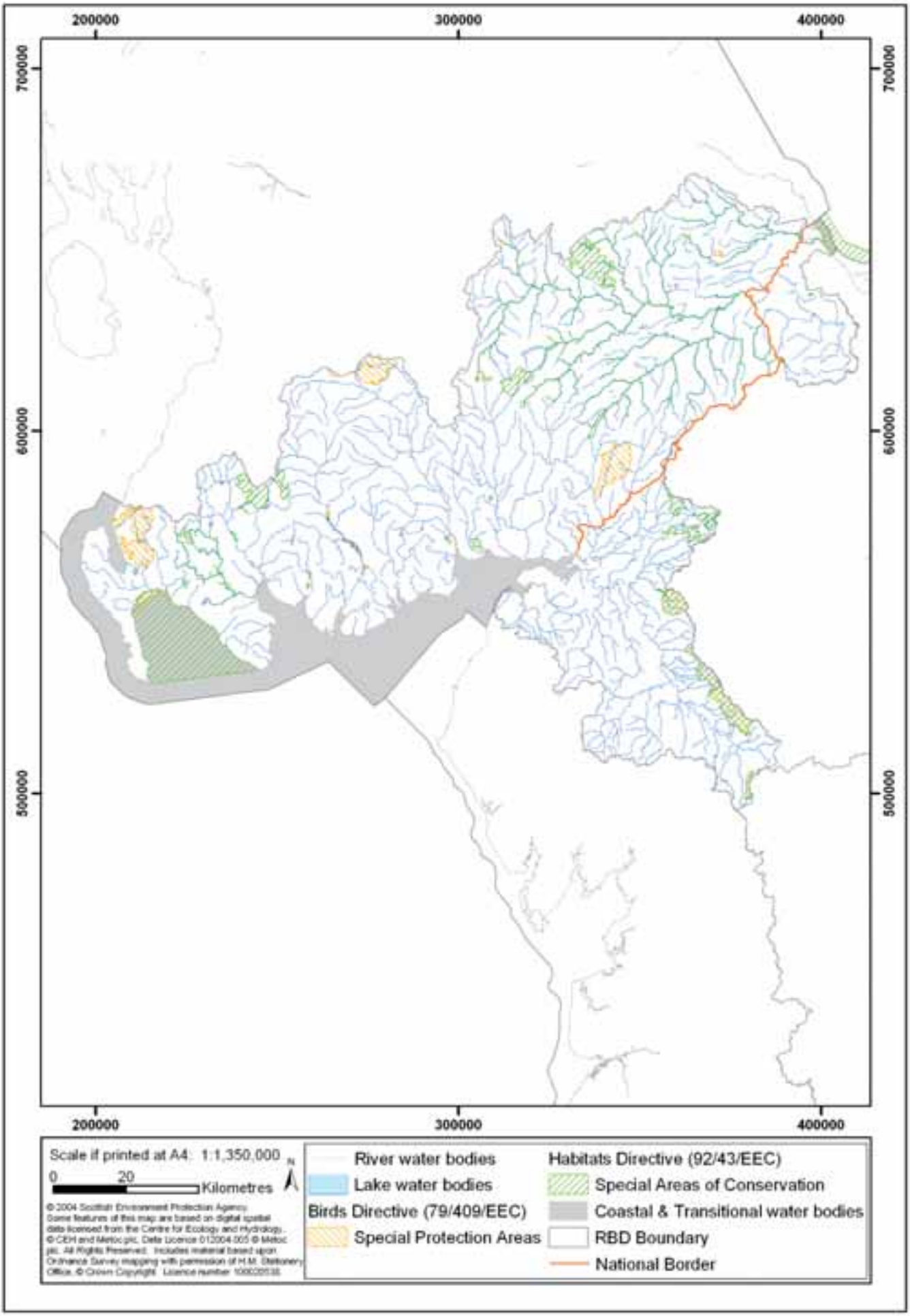


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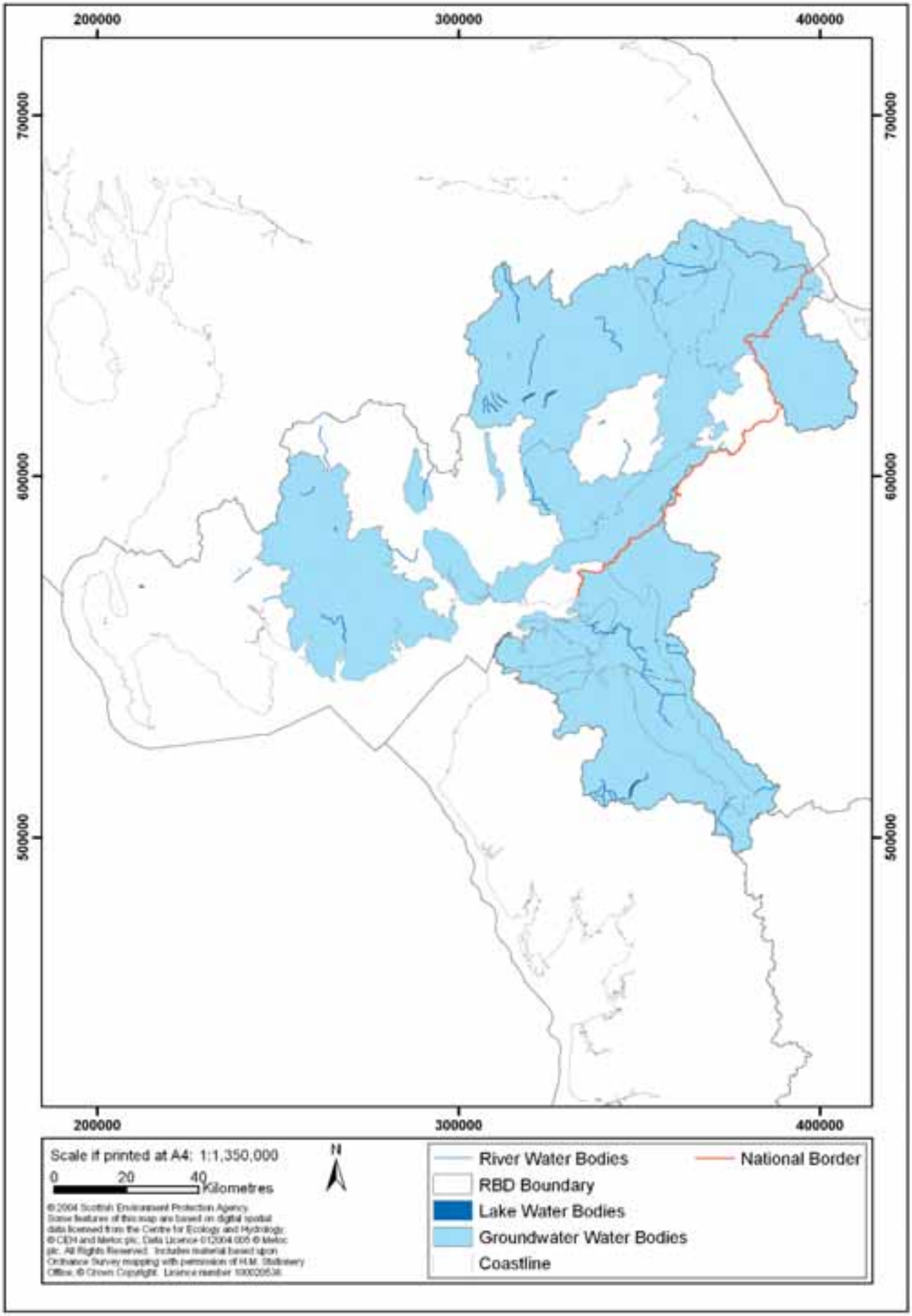
Map 7: Groundwater body types



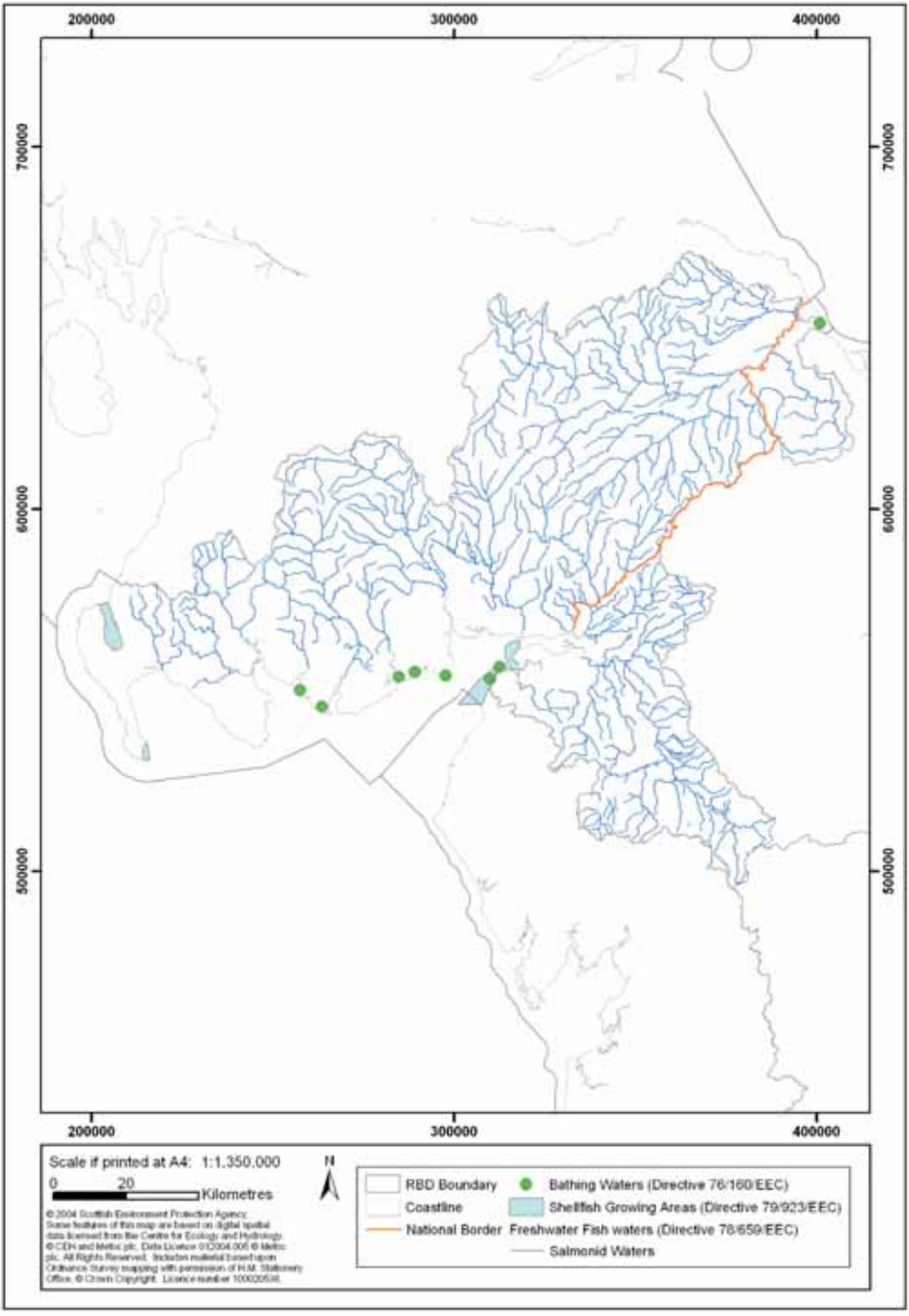
Map 8: Groundwater dependent surface water bodies and terrestrial ecosystems



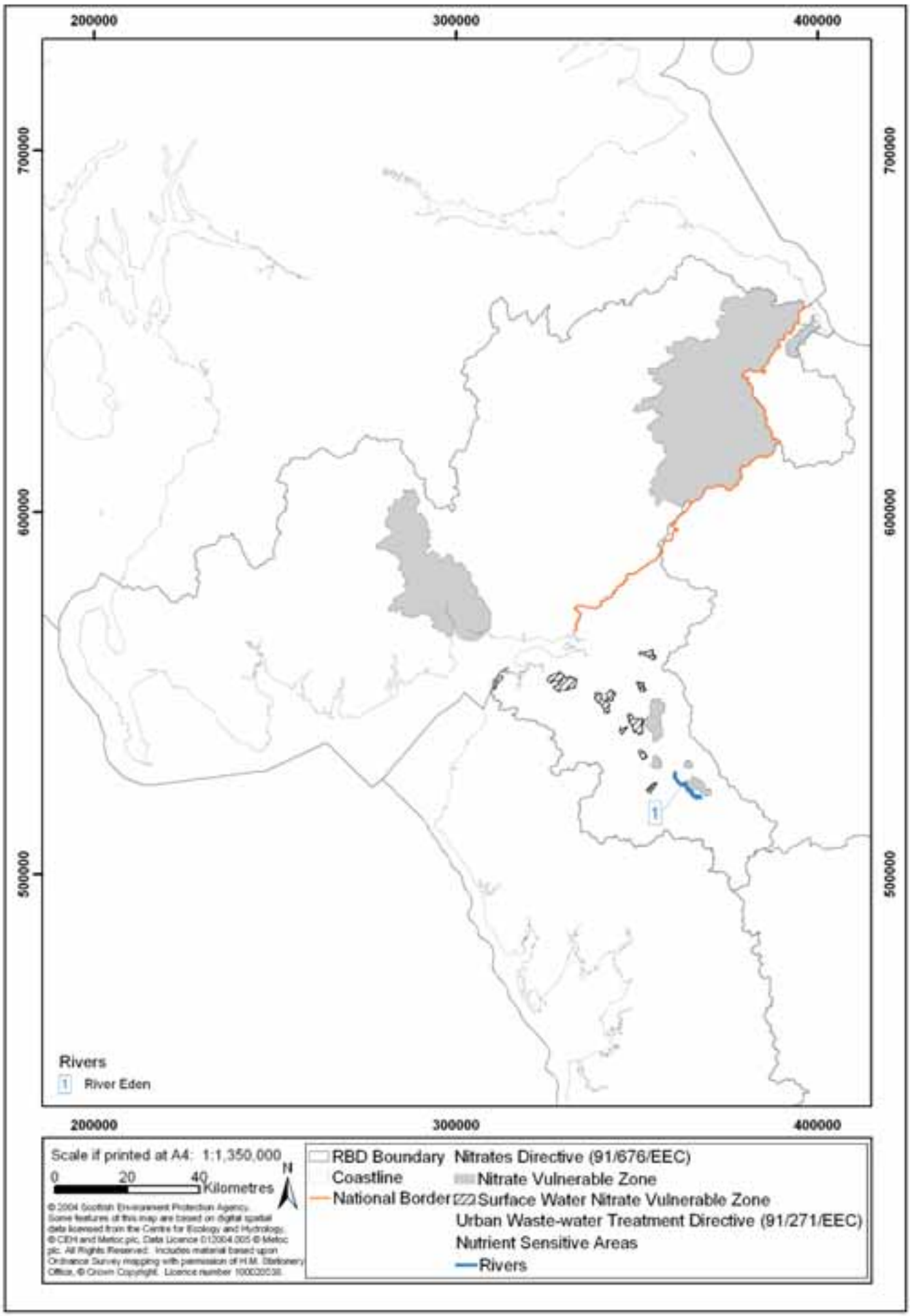
Map 9: Waters used for the abstraction of drinking water (proposed)



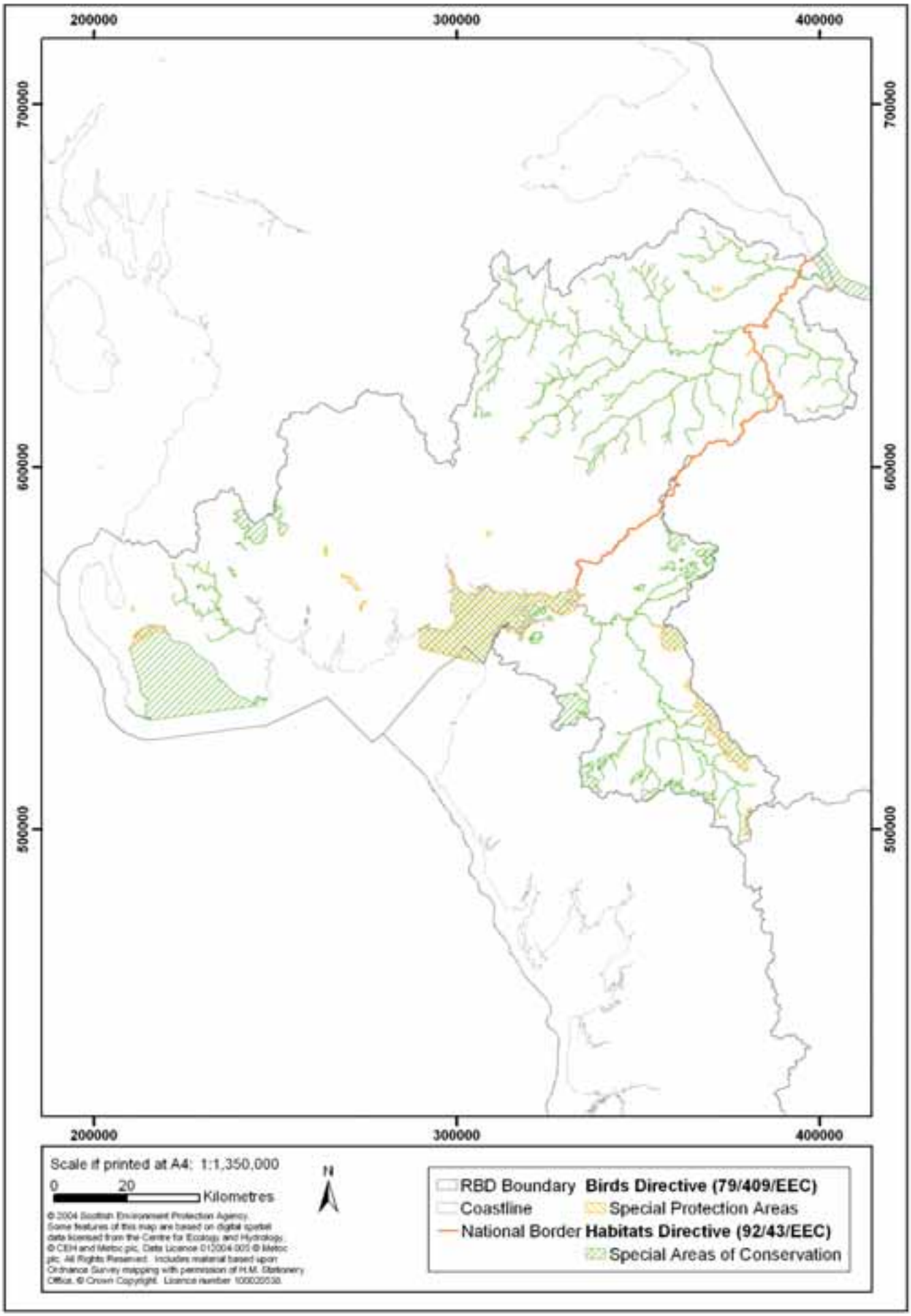
Map 10: Areas designated to protect economically significant aquatic species and Bathing Water Directive beaches



Map 11: Nutrient sensitive areas

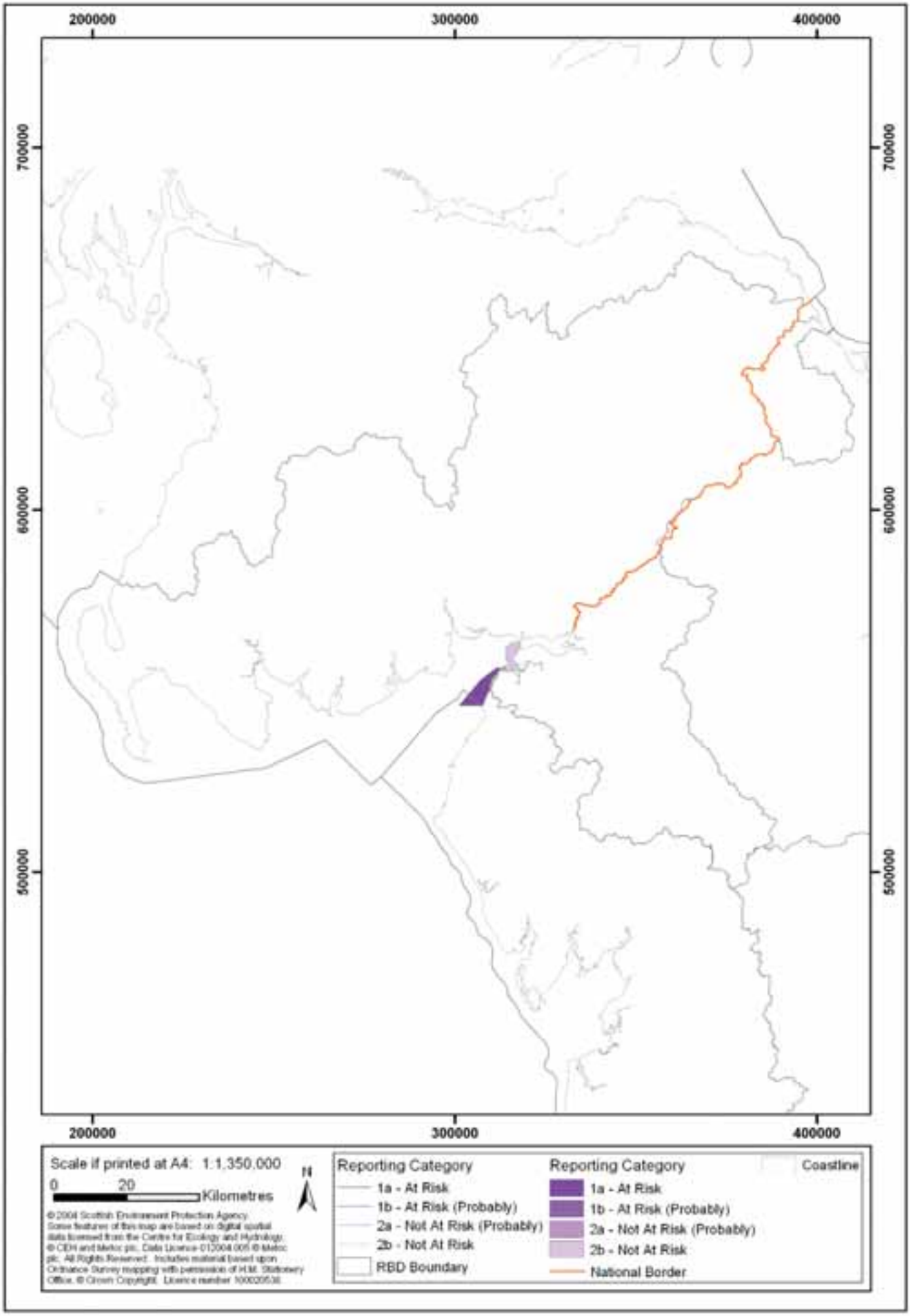


Map 12: Water dependent conservation areas

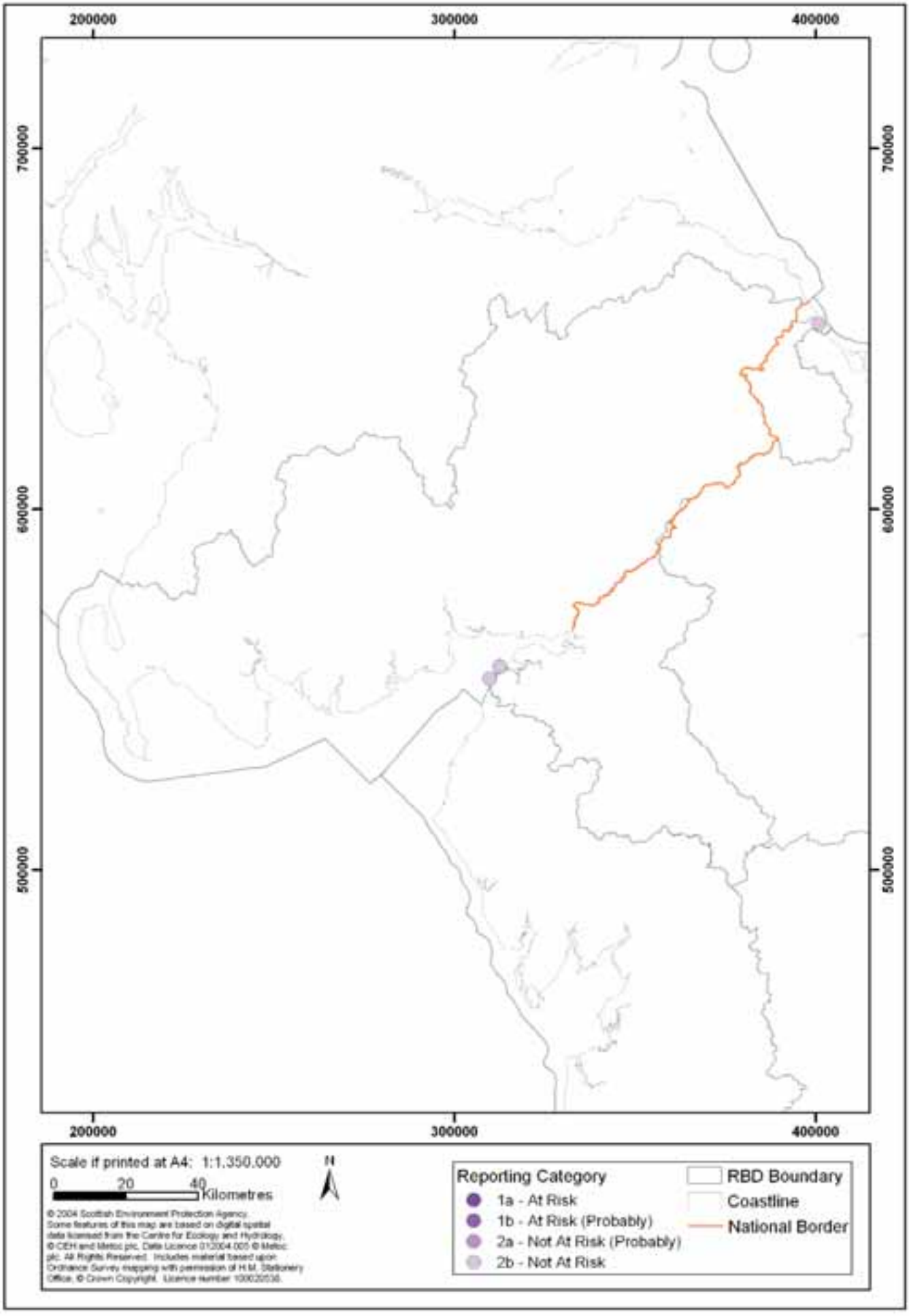


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Map 13: Assessment of areas designated to protect economically significant aquatic species (England)

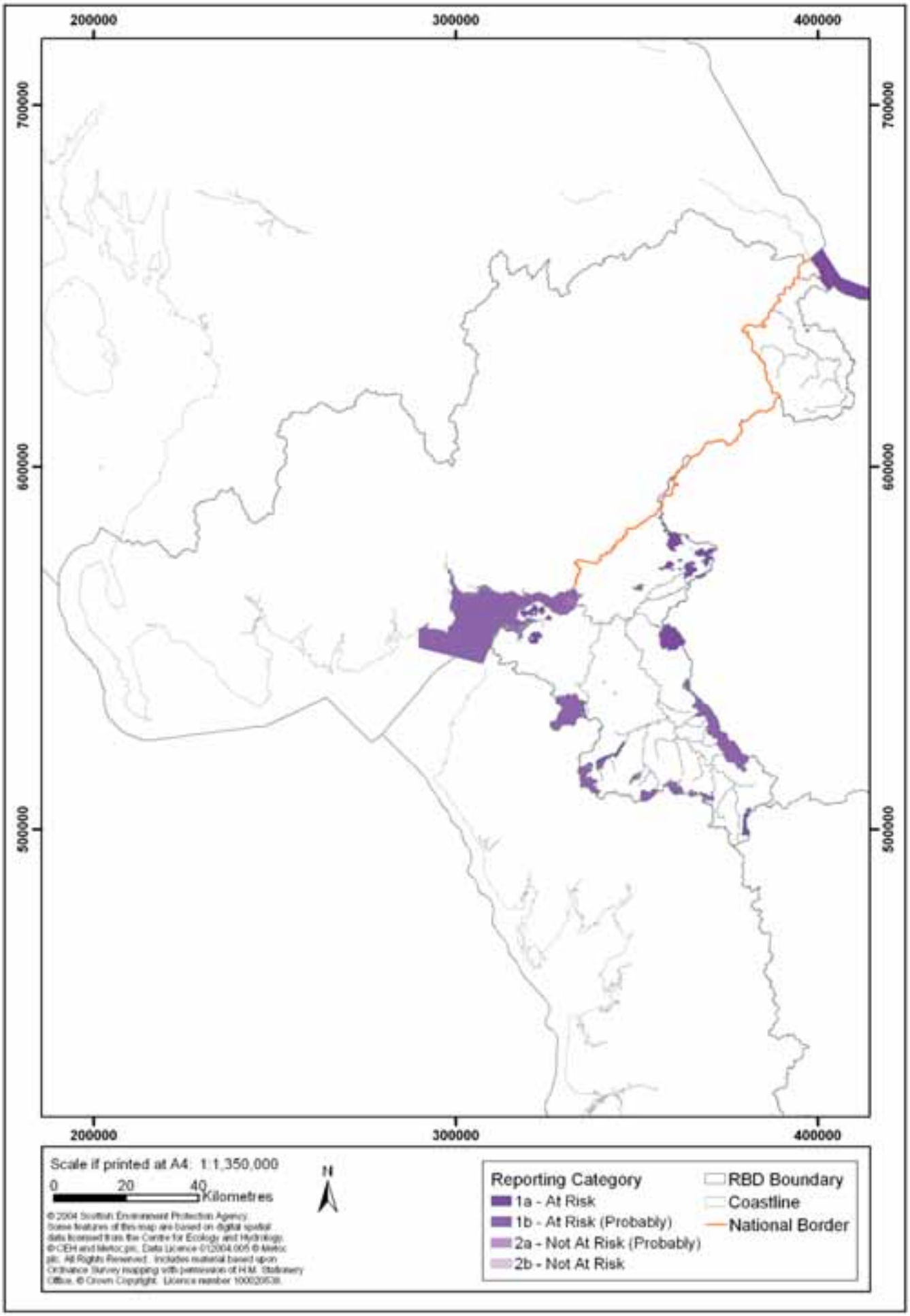


Map 14: Assessment of recreational waters (England)

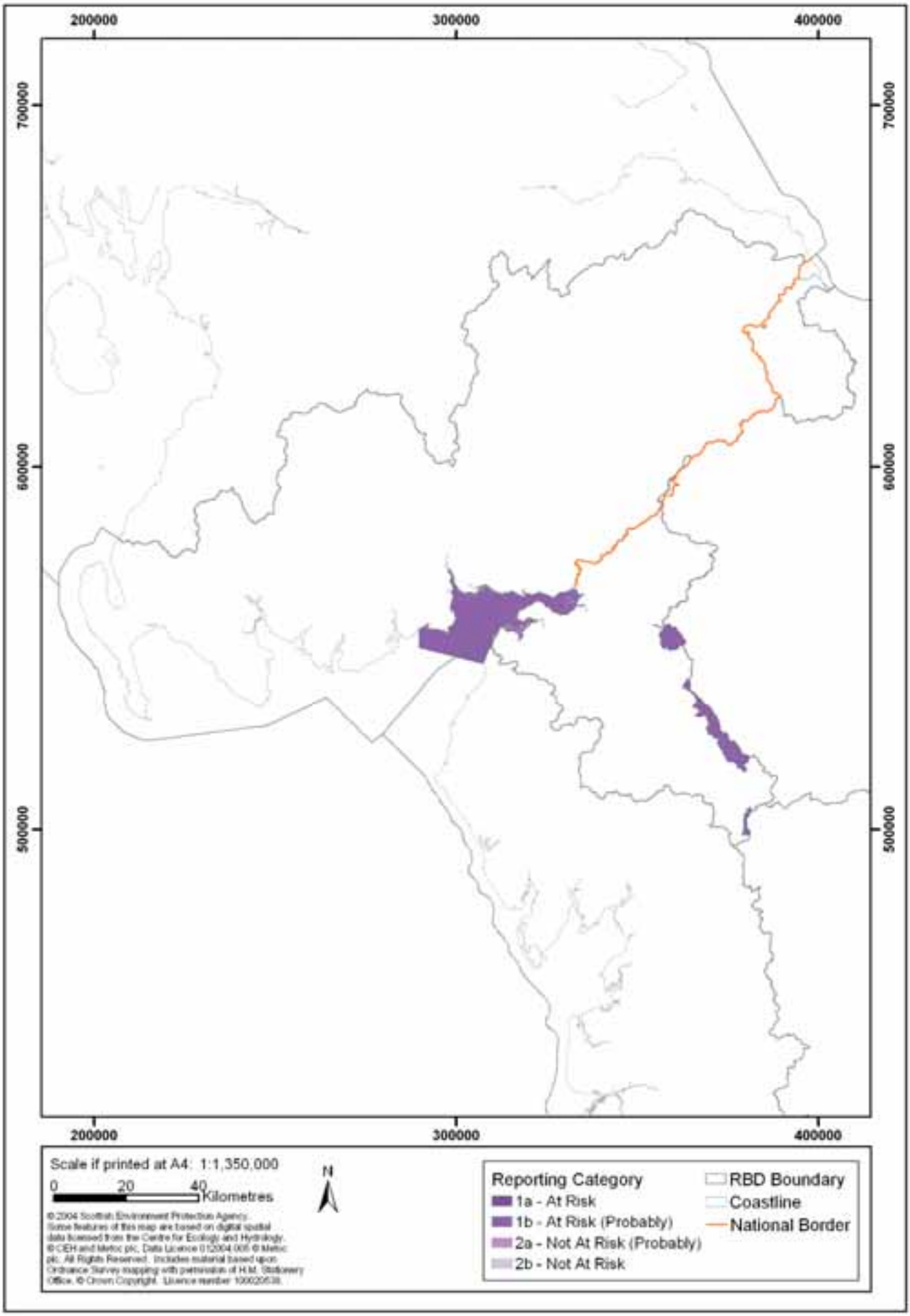


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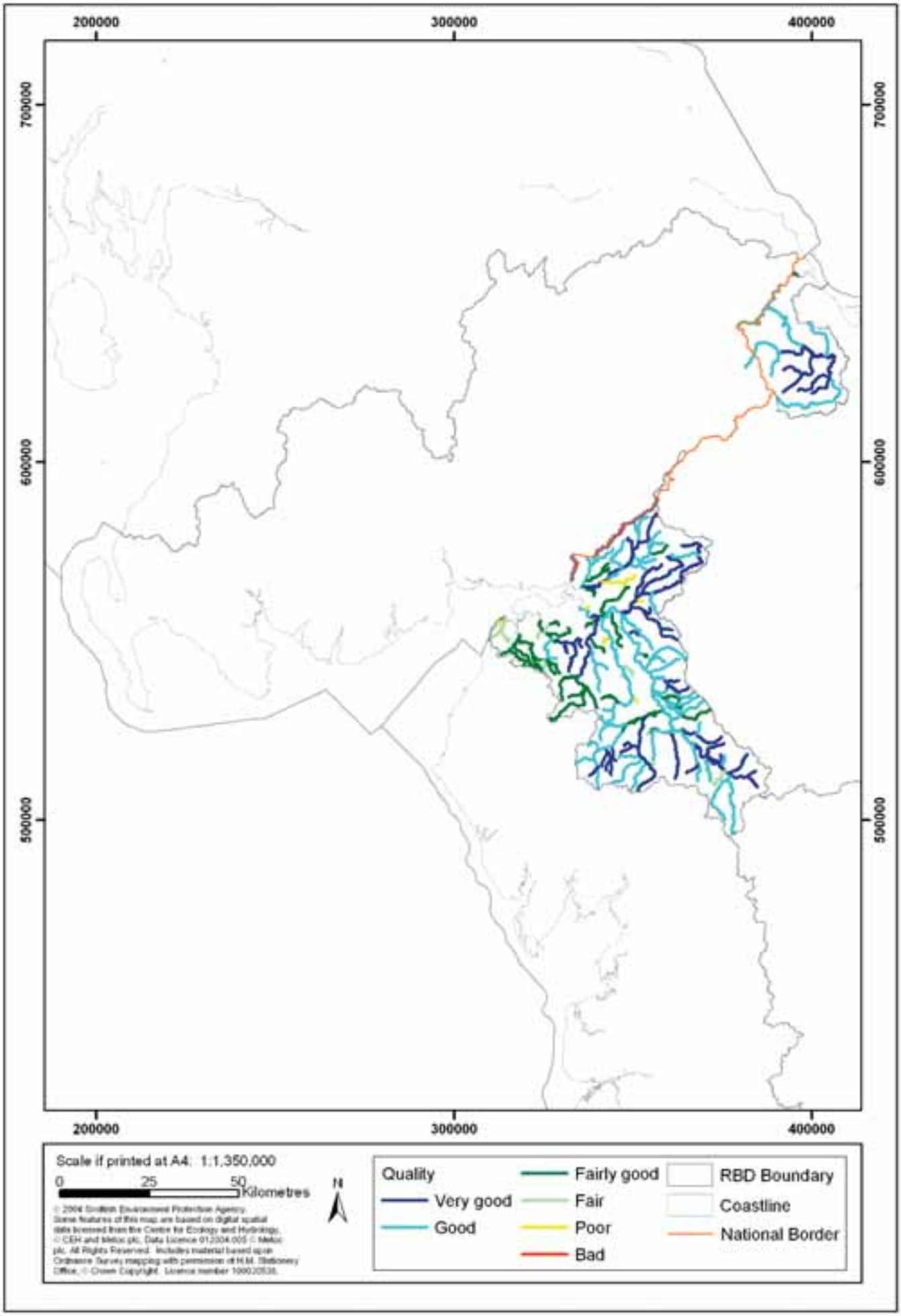
Map 15: Assessment of water dependent conservation areas (Habitats Directive) (England)



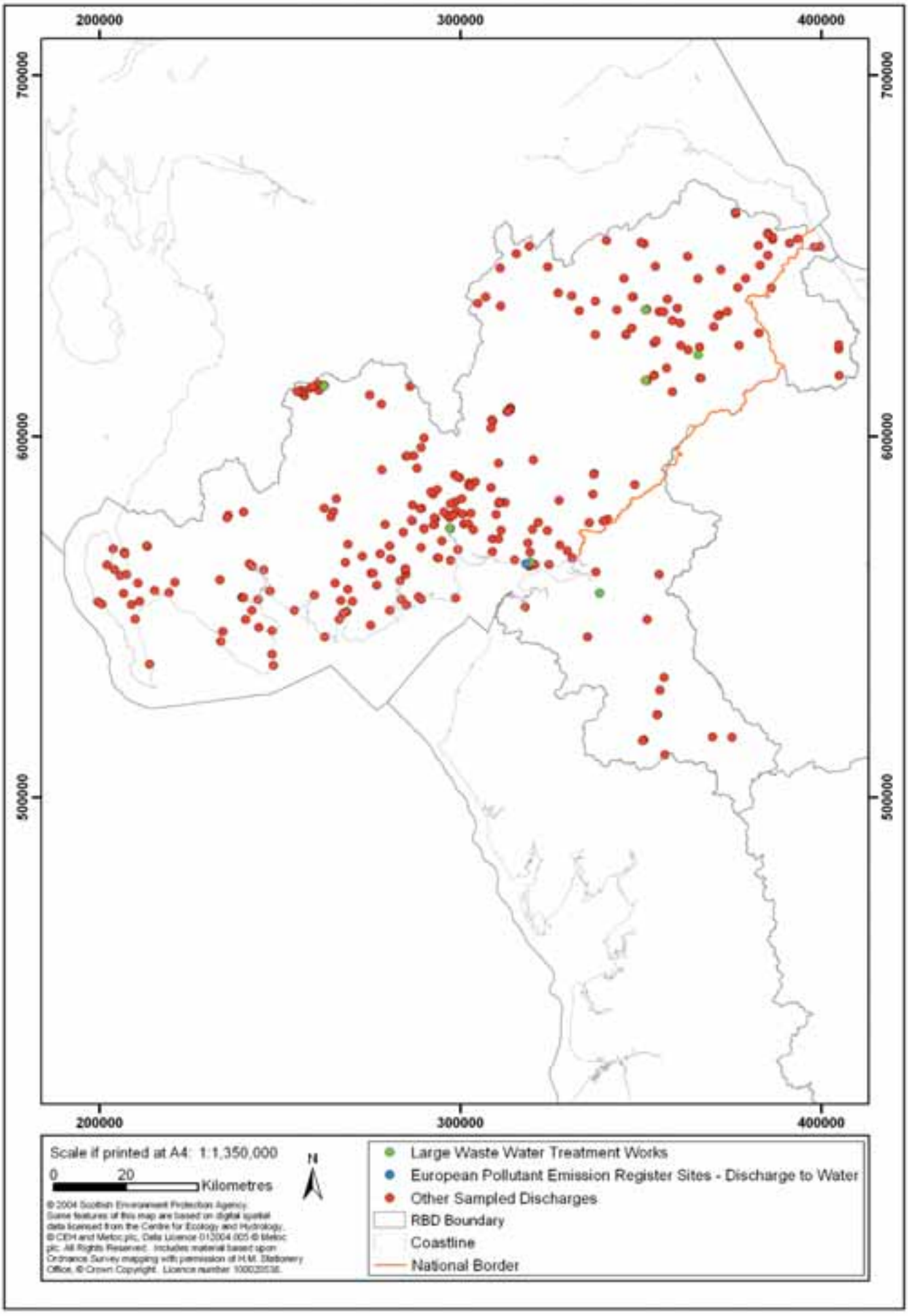
Map 16: Assessment of water dependent conservation areas (Birds Directive) (England)



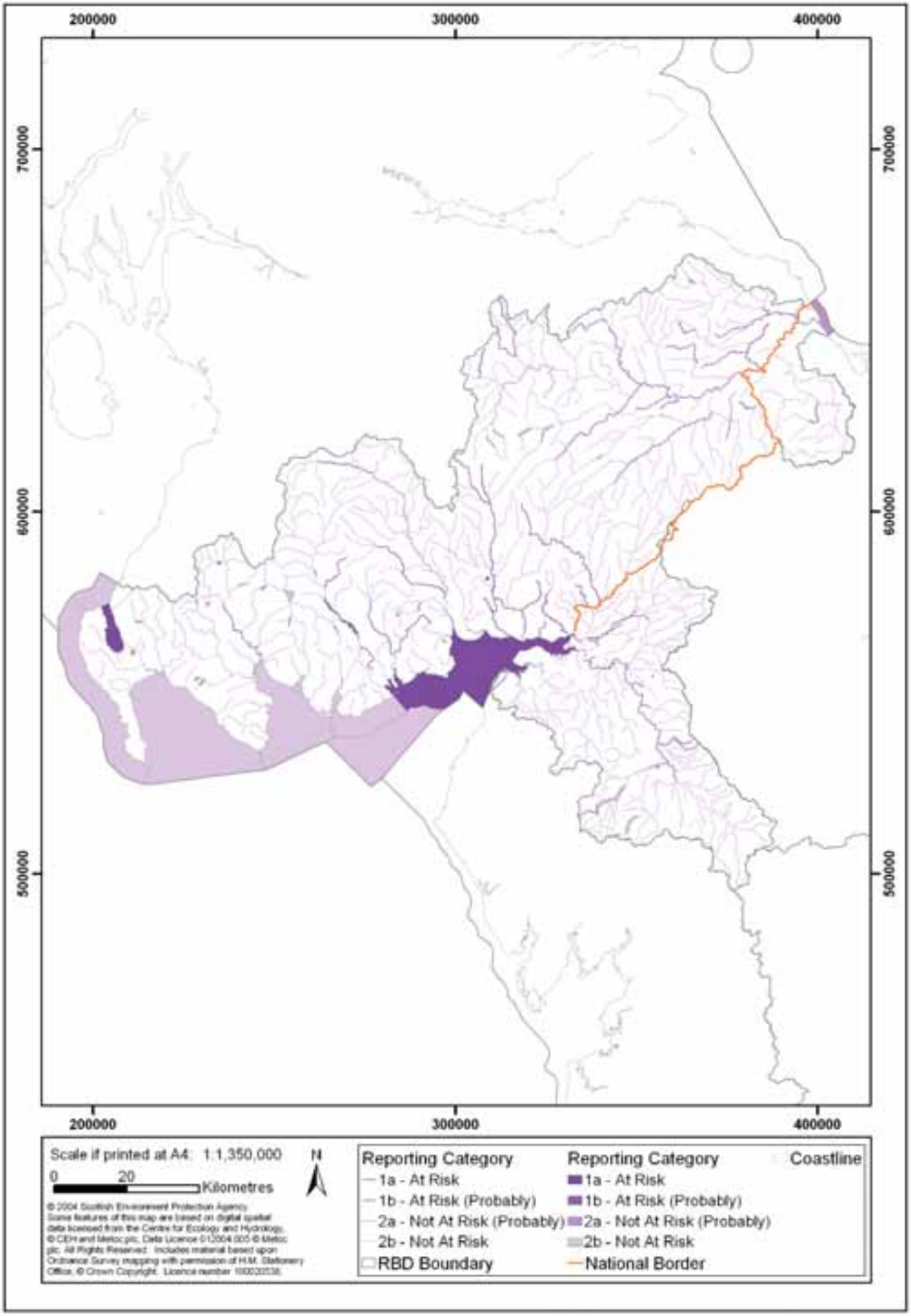
Map 17: General Quality Assessment Biology (England)



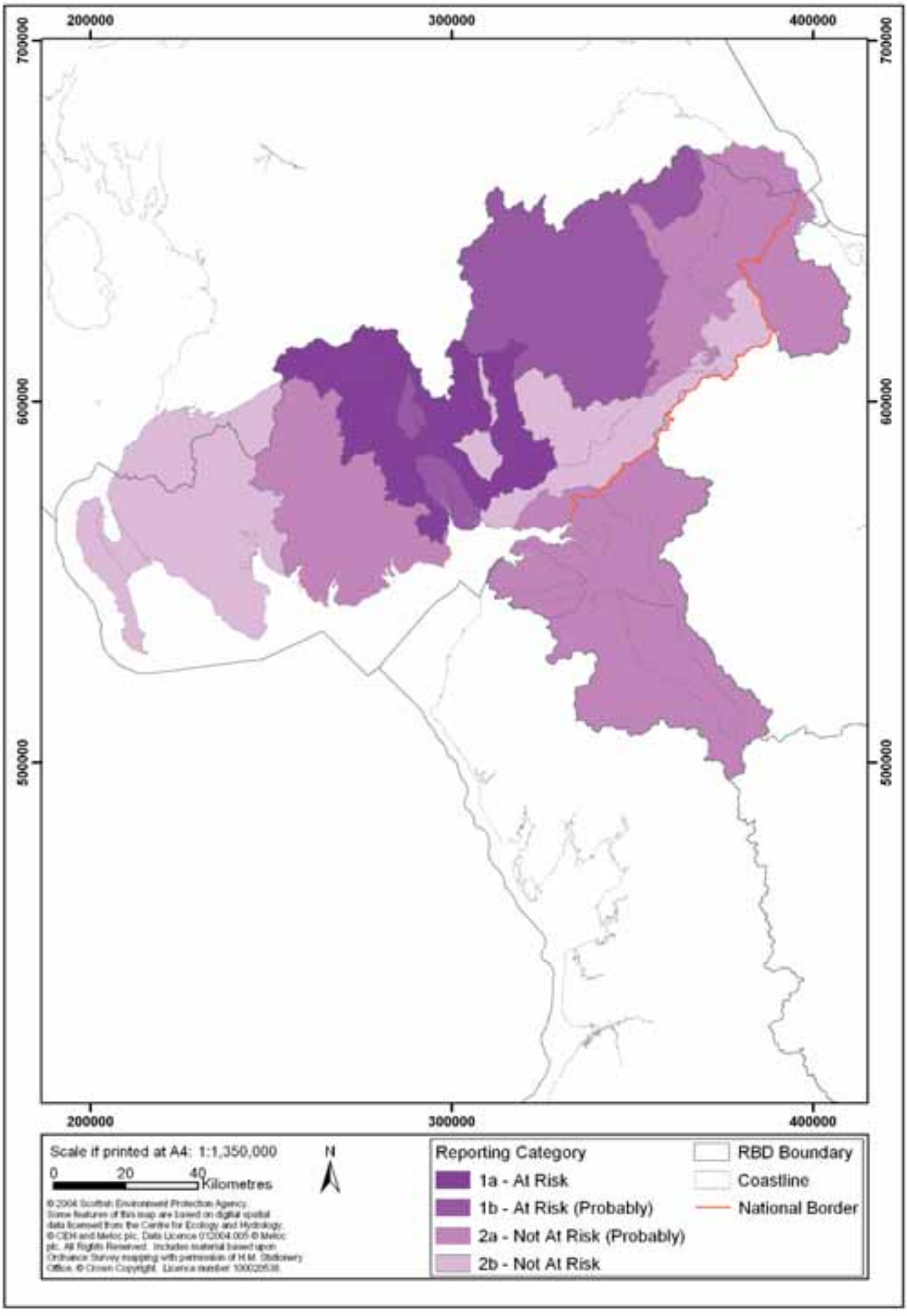
Map 18: Point source pressures



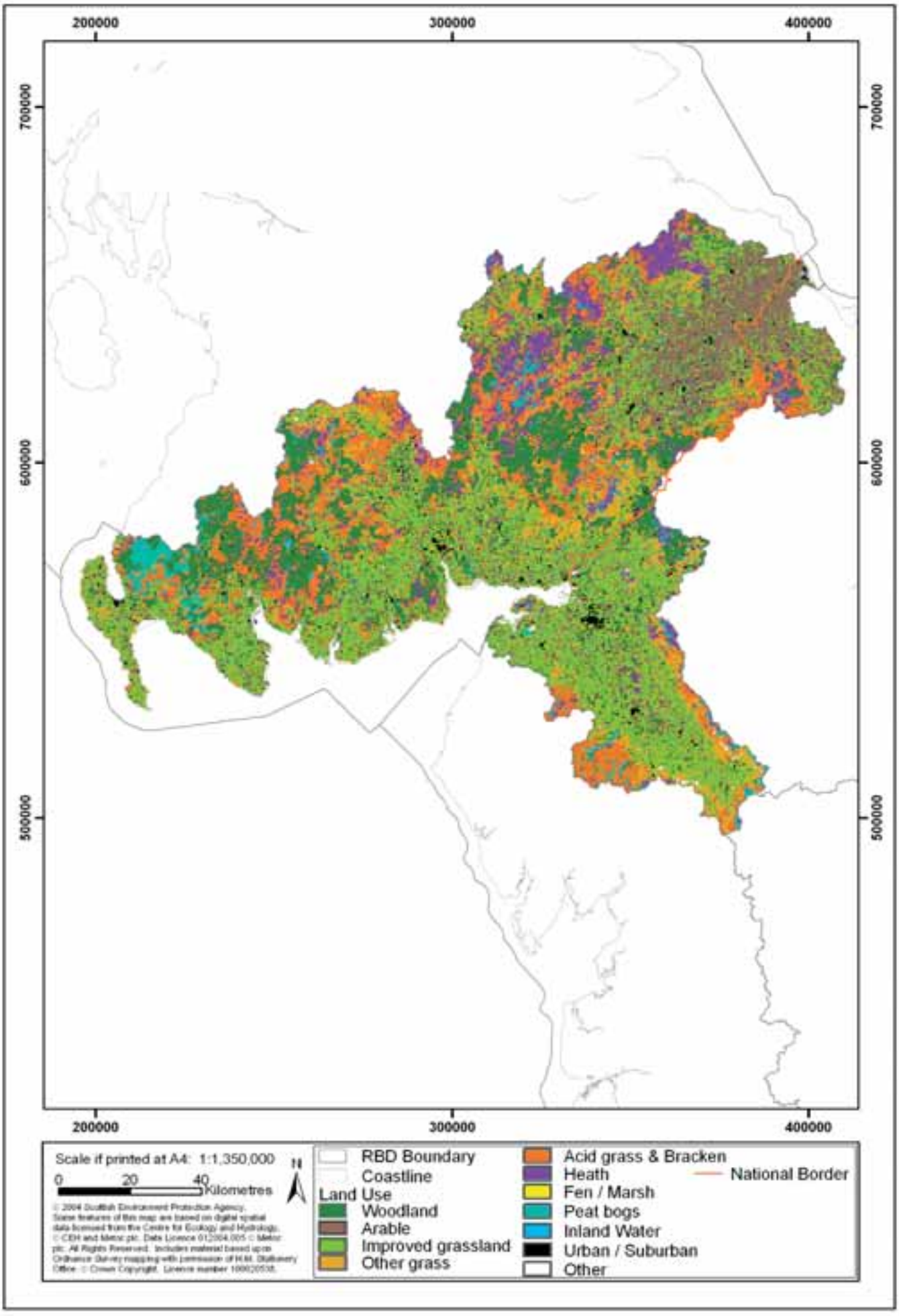
Map 19: Surface water bodies affected by/at risk from point source pollution pressures



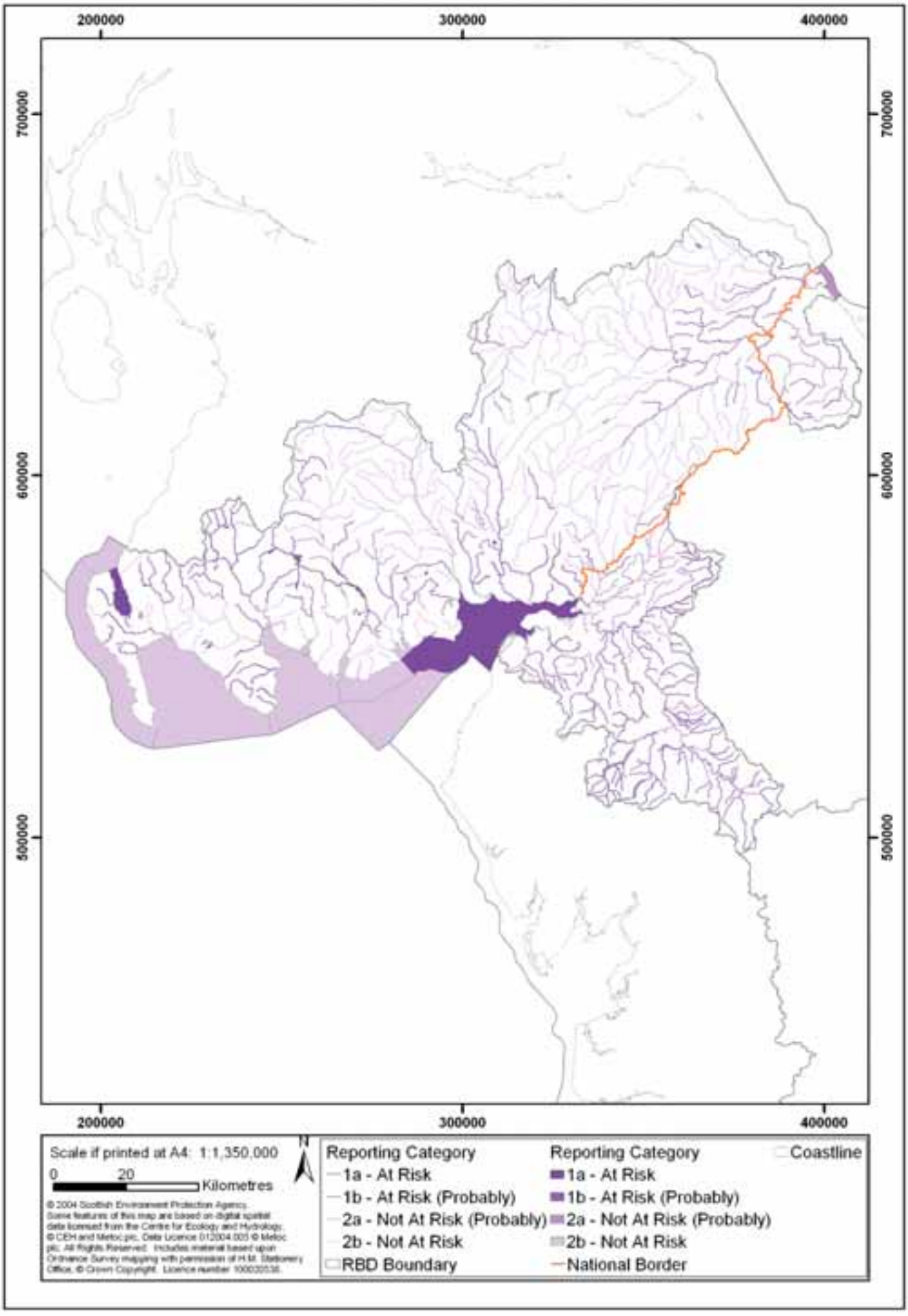
Map 20: Groundwater water bodies affected by/at risk from point source pollution pressures



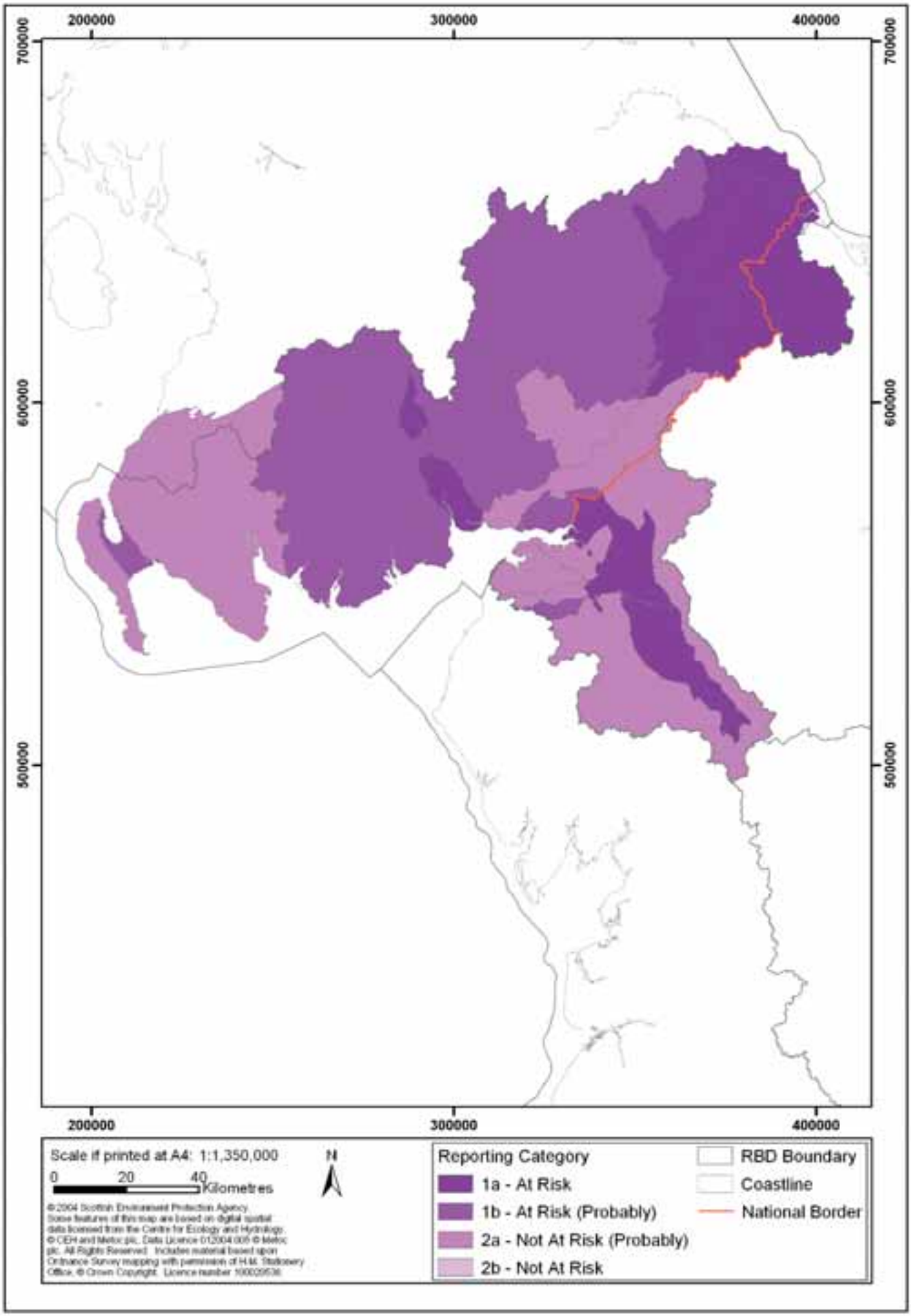
Map 21: Land use in the Solway Tweed River Basin District



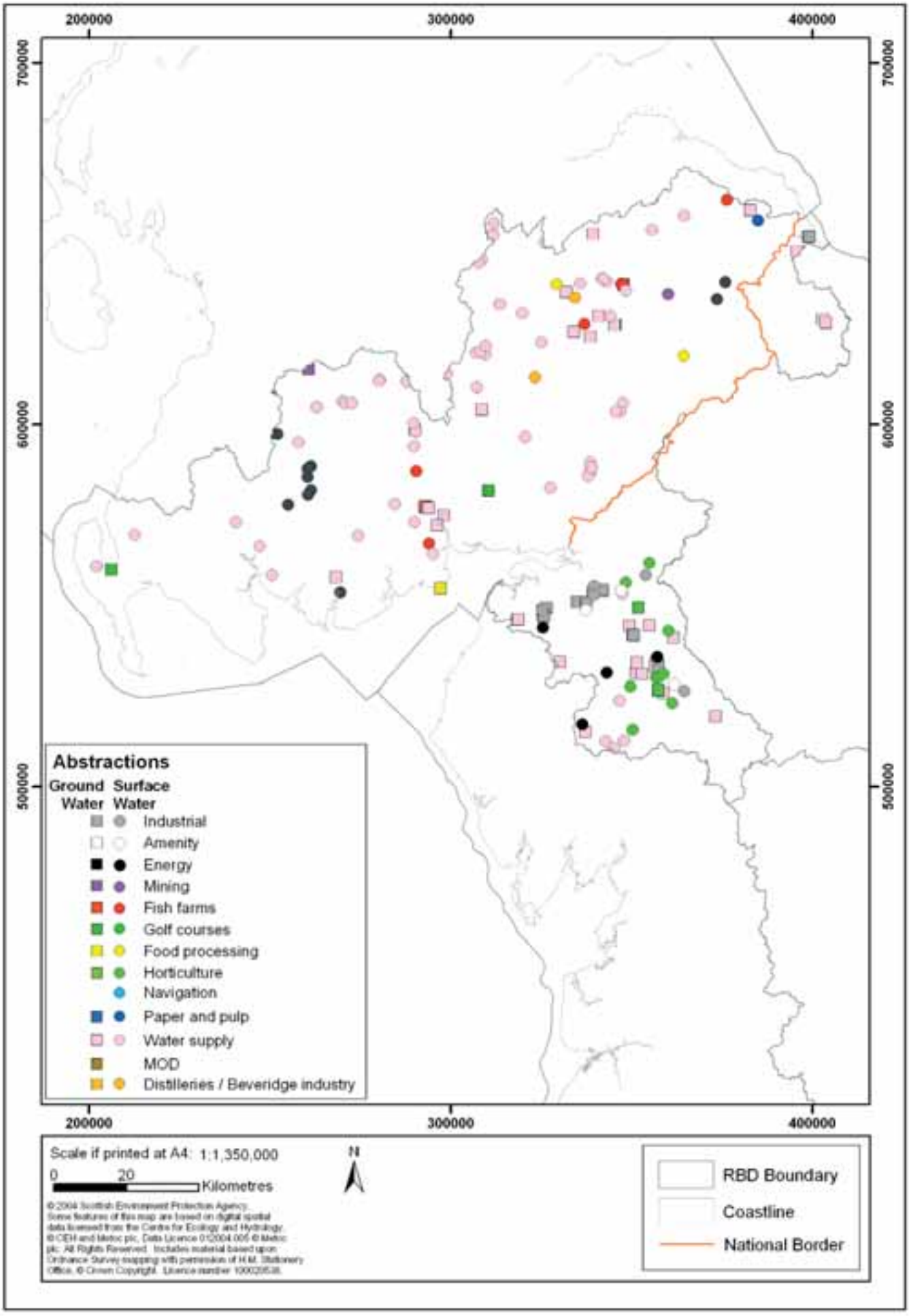
Map 22: Surface water bodies affected by/at risk from diffuse source pollution pressures



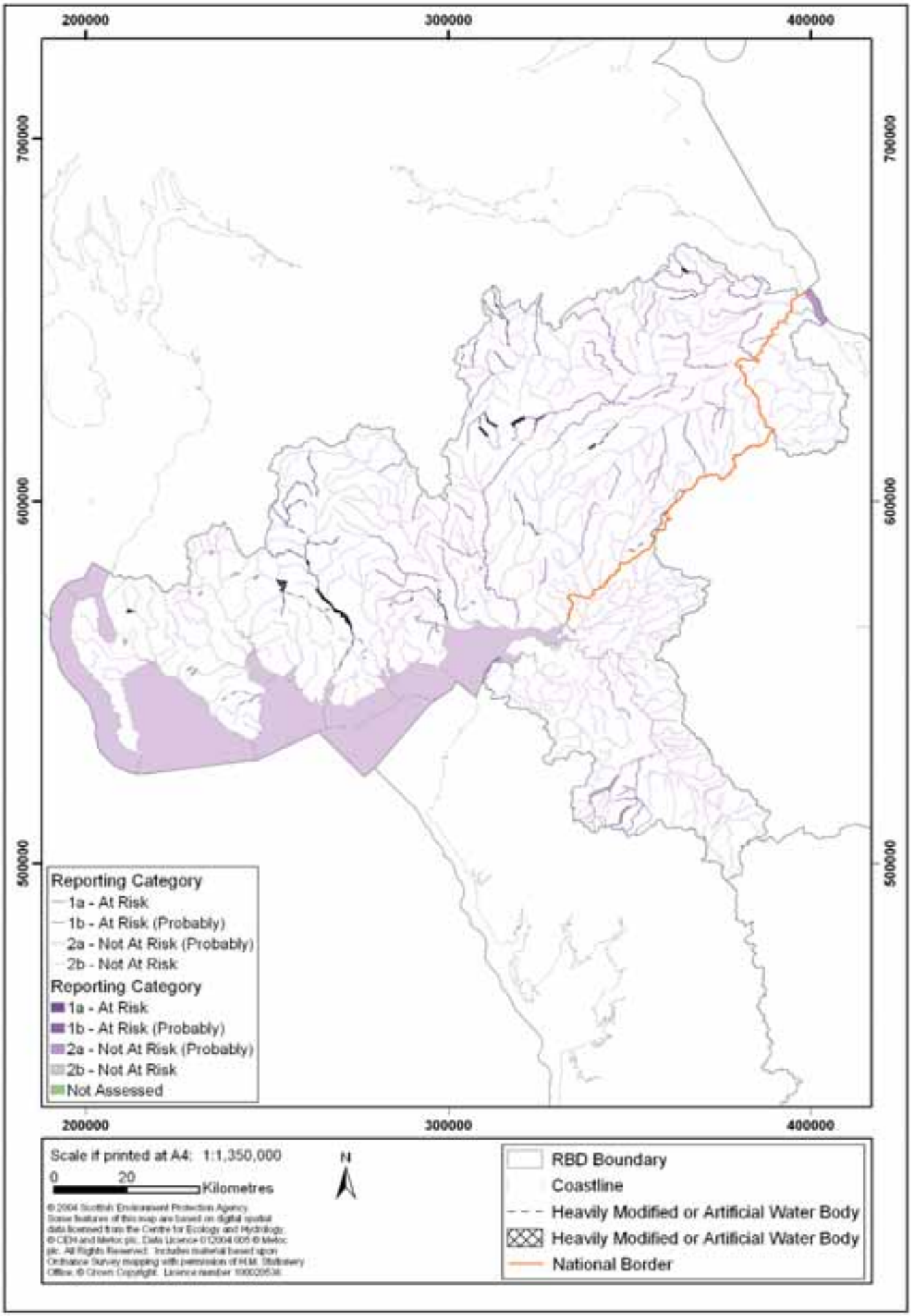
Map 23: Groundwater water bodies affected by/at risk from diffuse source pollution pressures



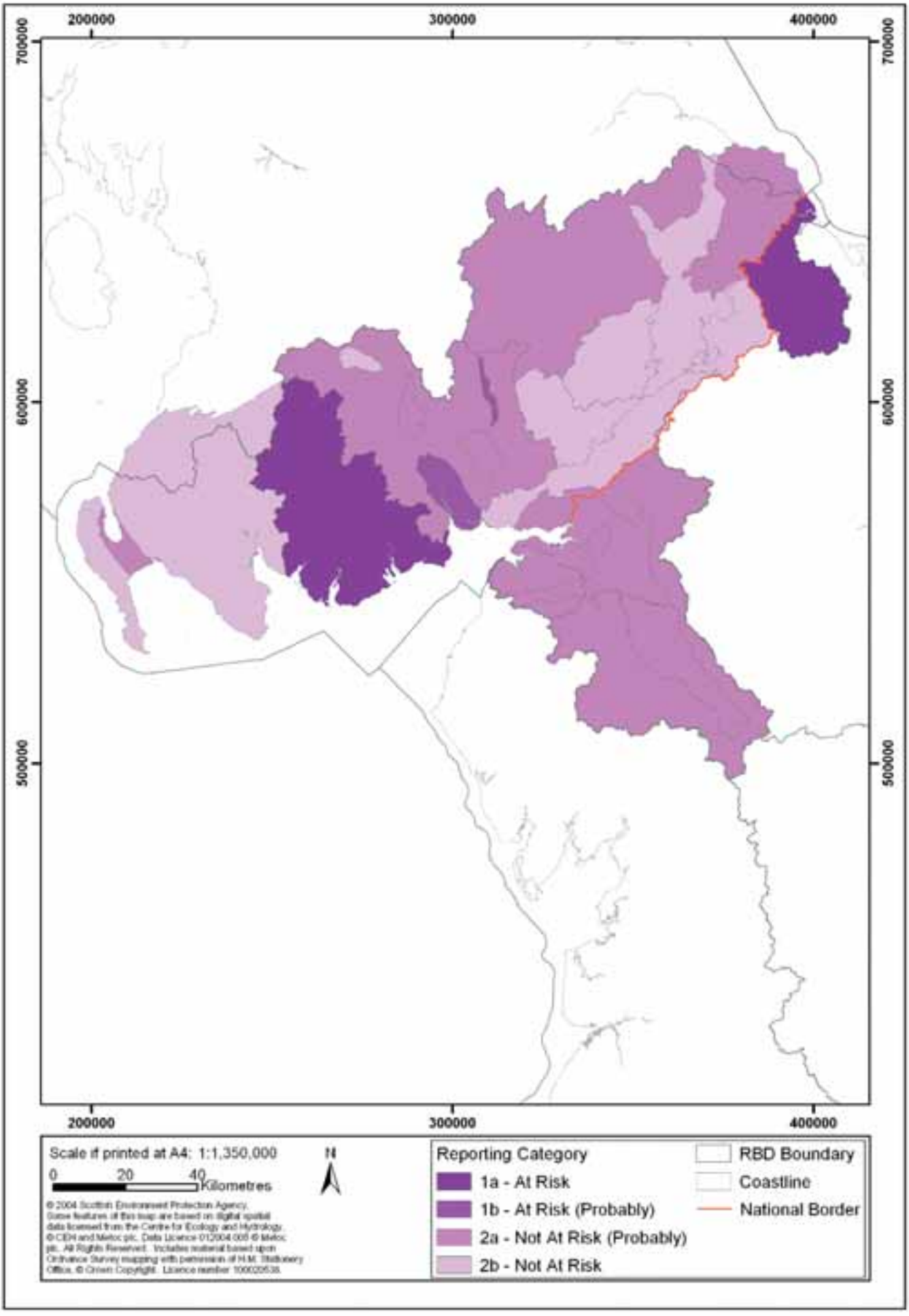
Map 24: Abstraction and flow regulation pressures



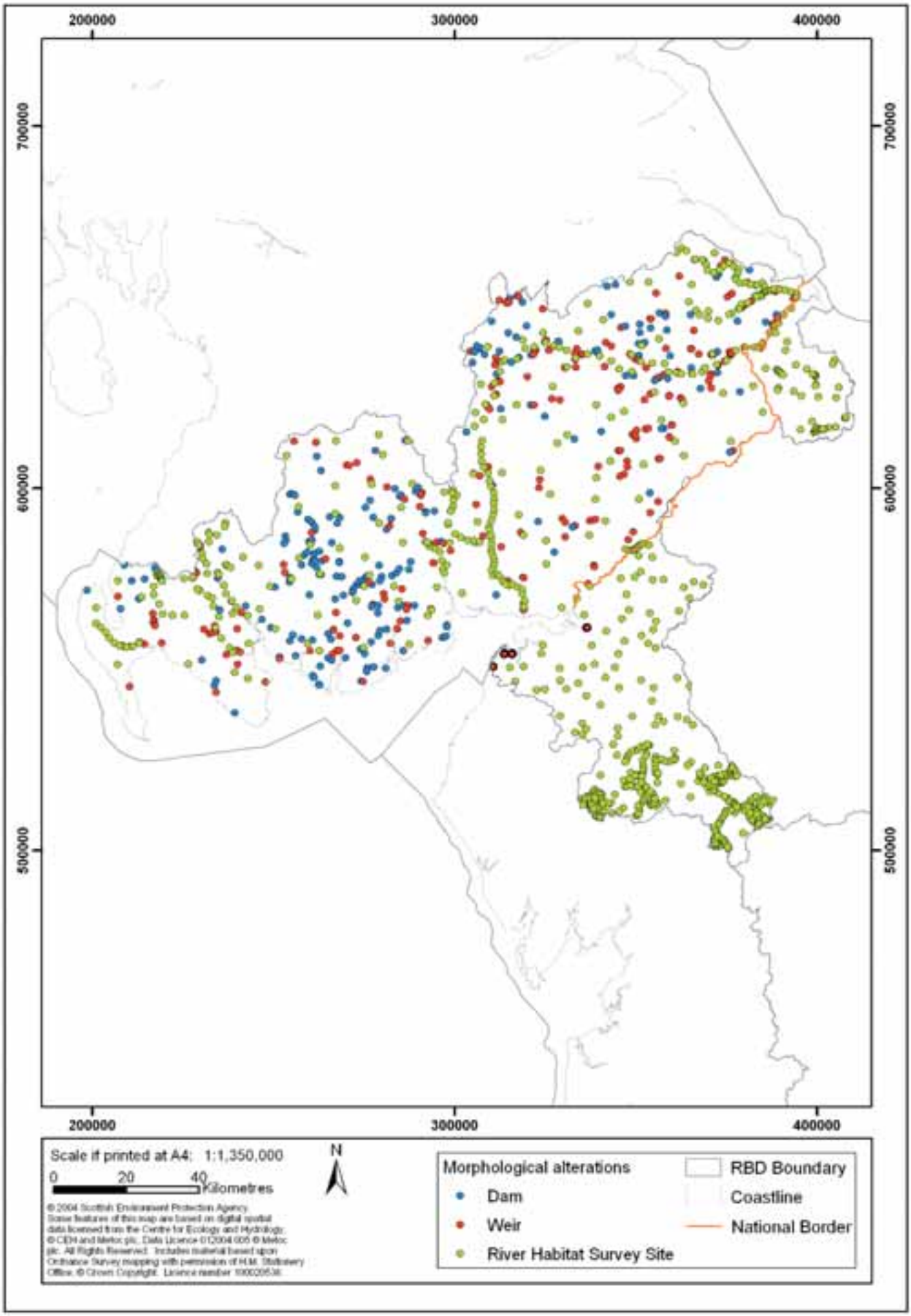
Map 25: Surface water bodies affected by/at risk from abstraction and flow regulation pressures



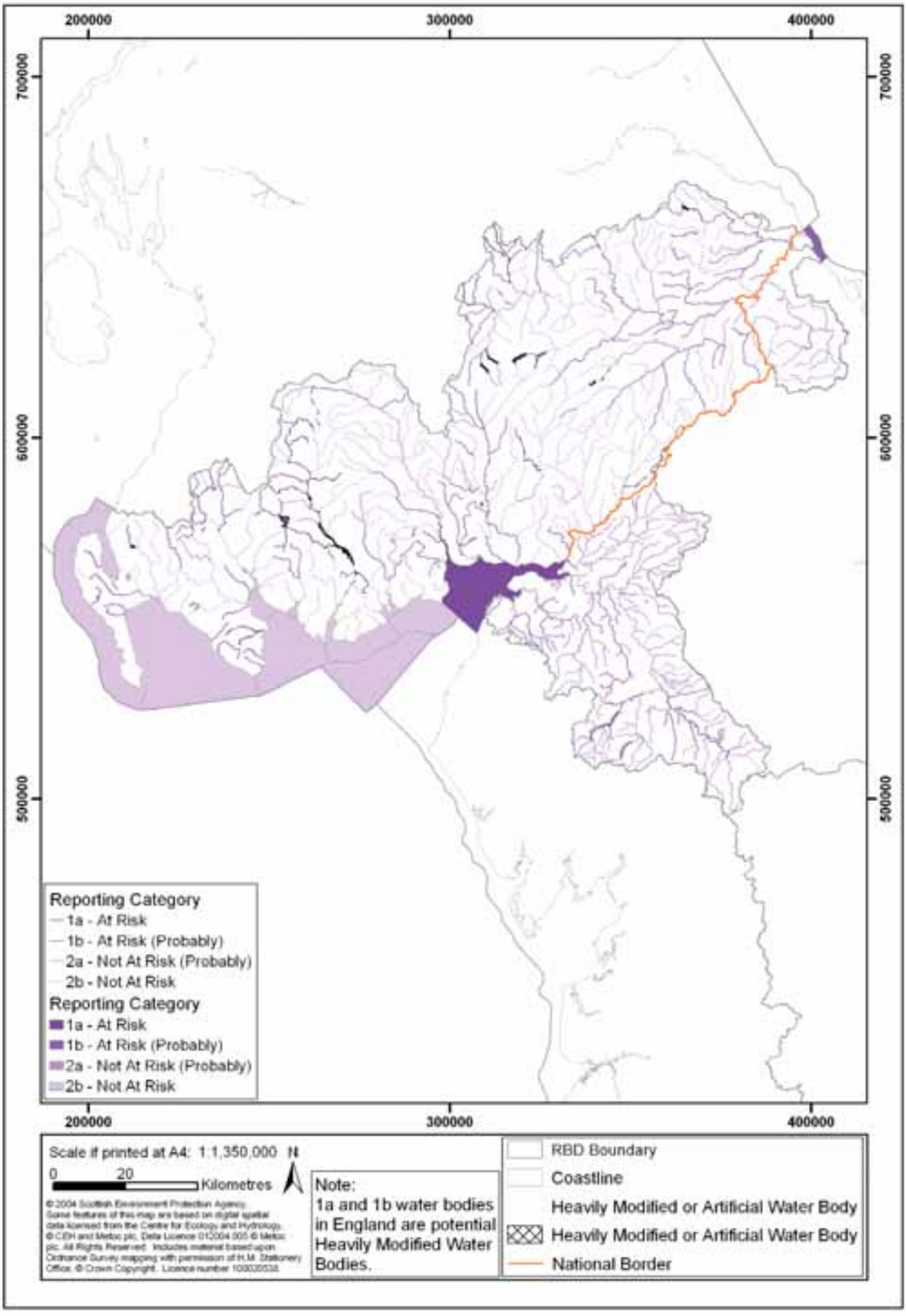
Map 26: Groundwater water bodies affected by/at risk from abstraction pressures



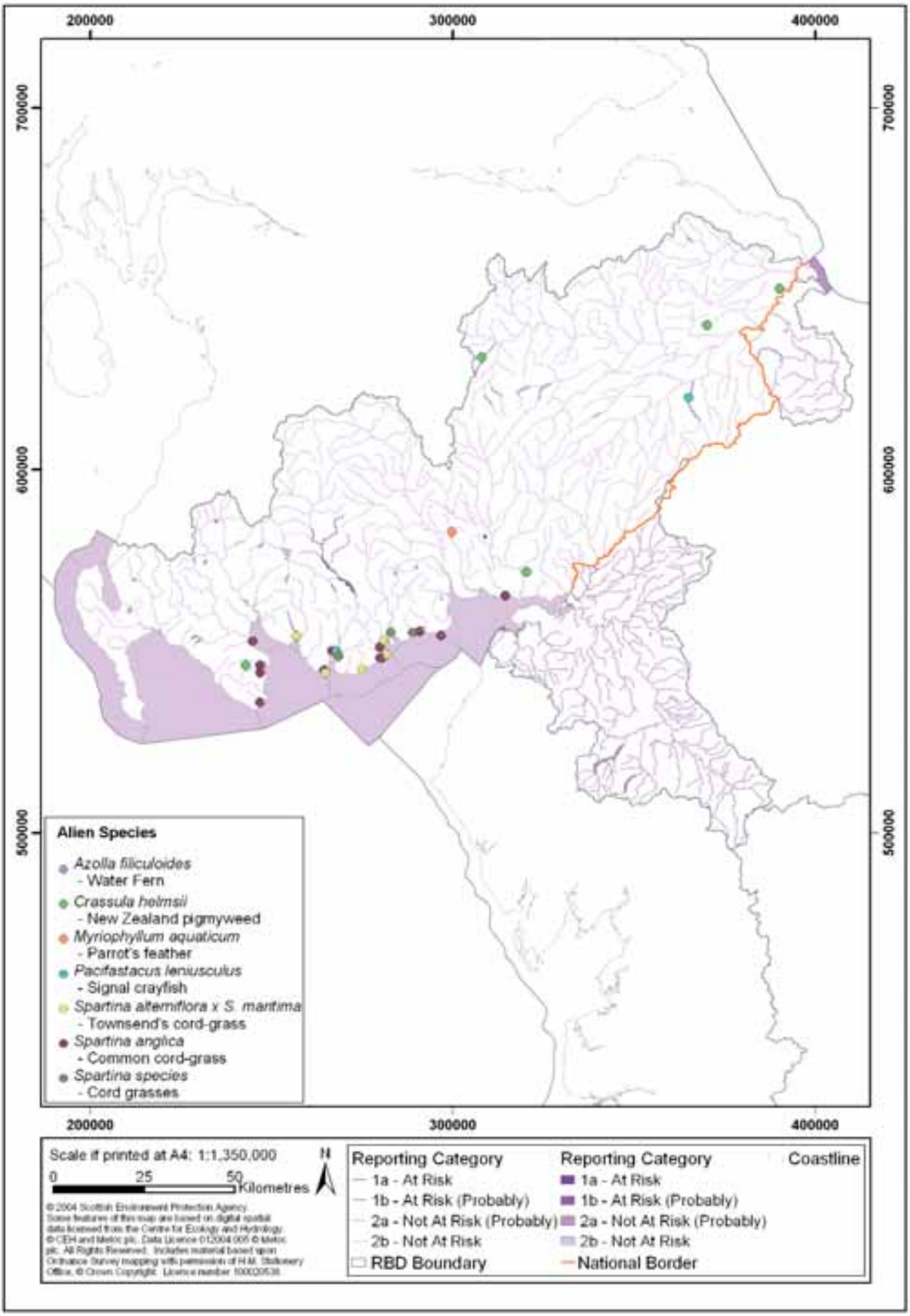
Map 27: Morphology pressures and river habitat survey sites



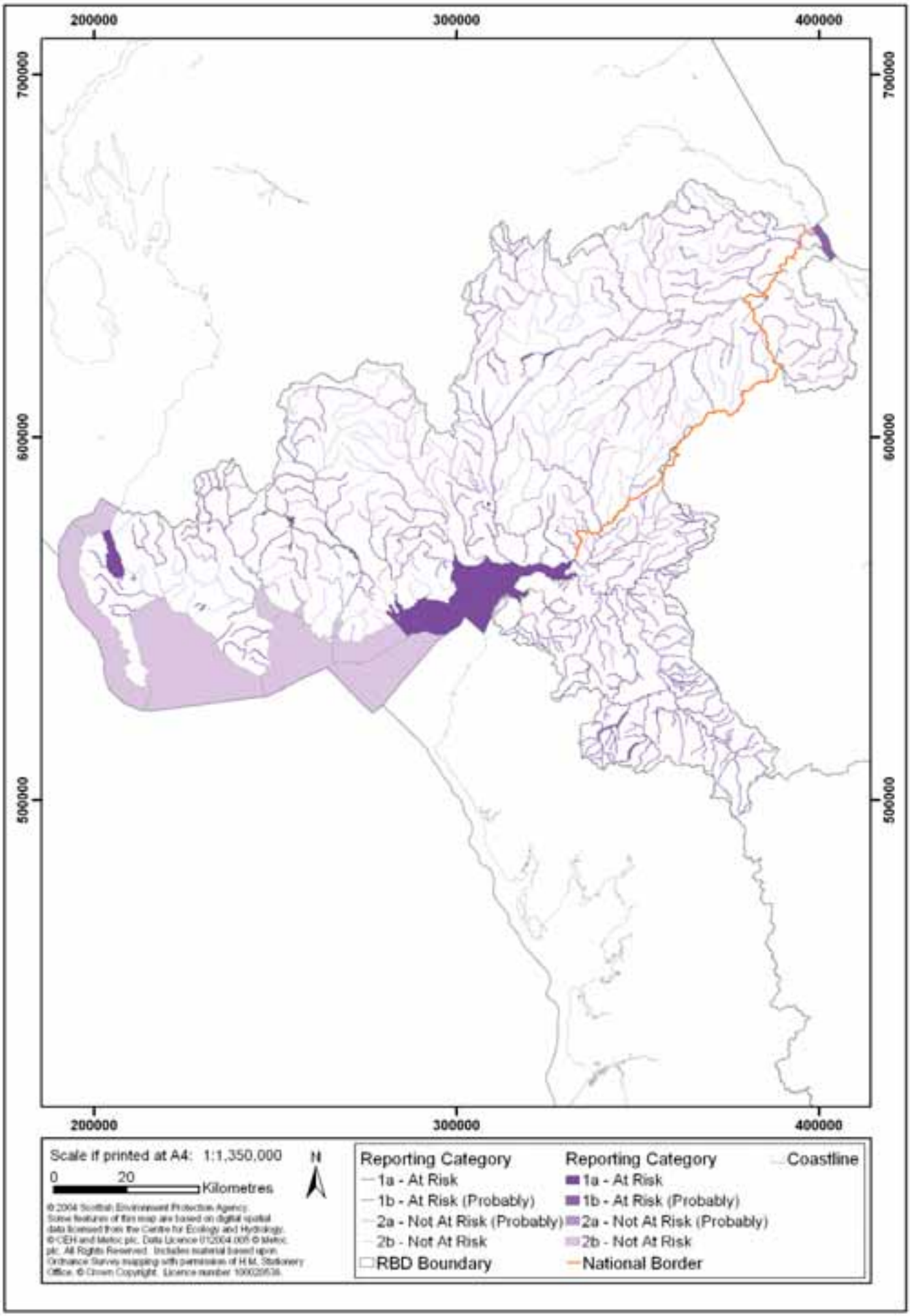
Map 28: Surface water bodies affected by/at risk from morphological pressures



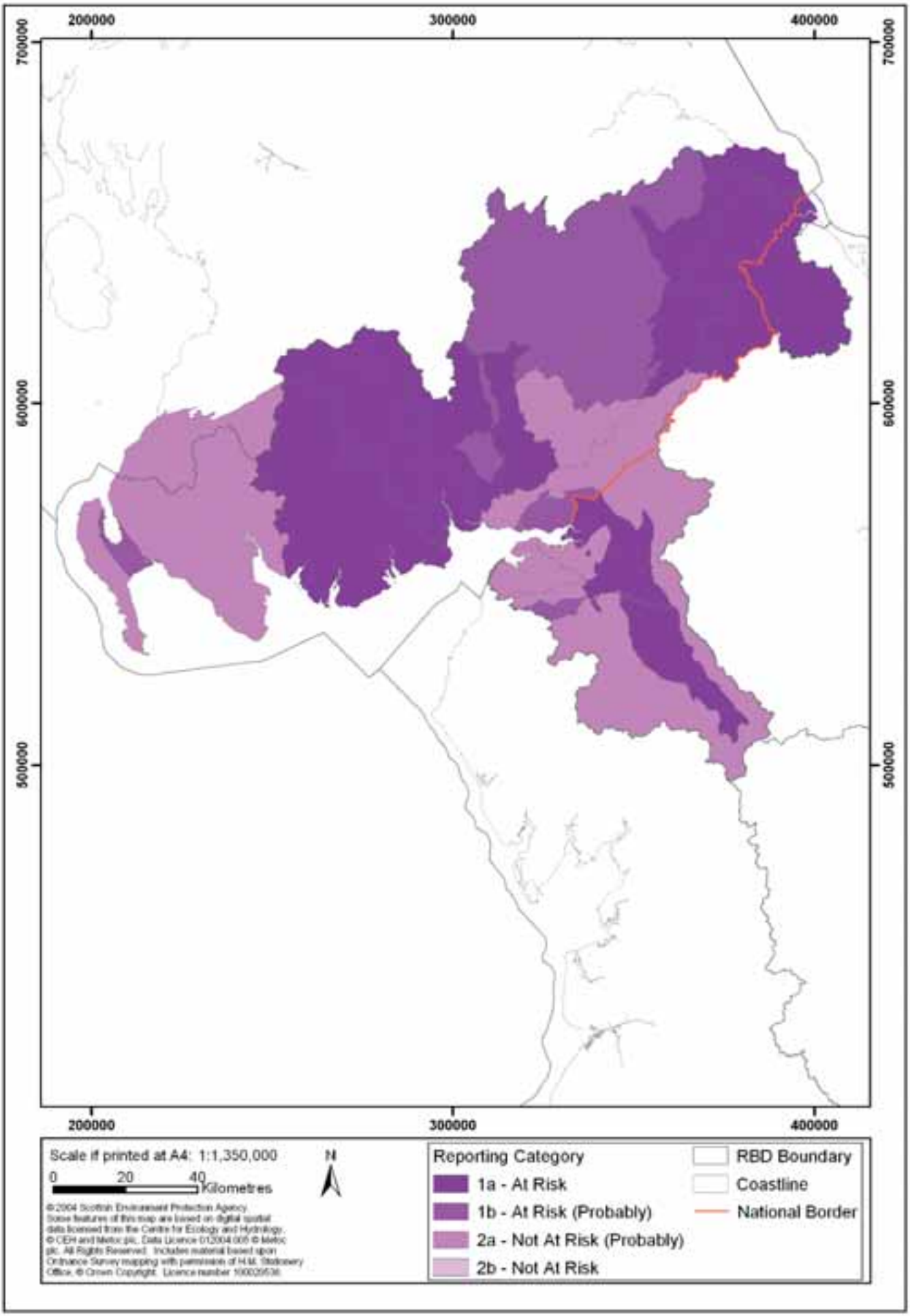
Map 29: Surface water bodies affected by/at risk from alien species pressures



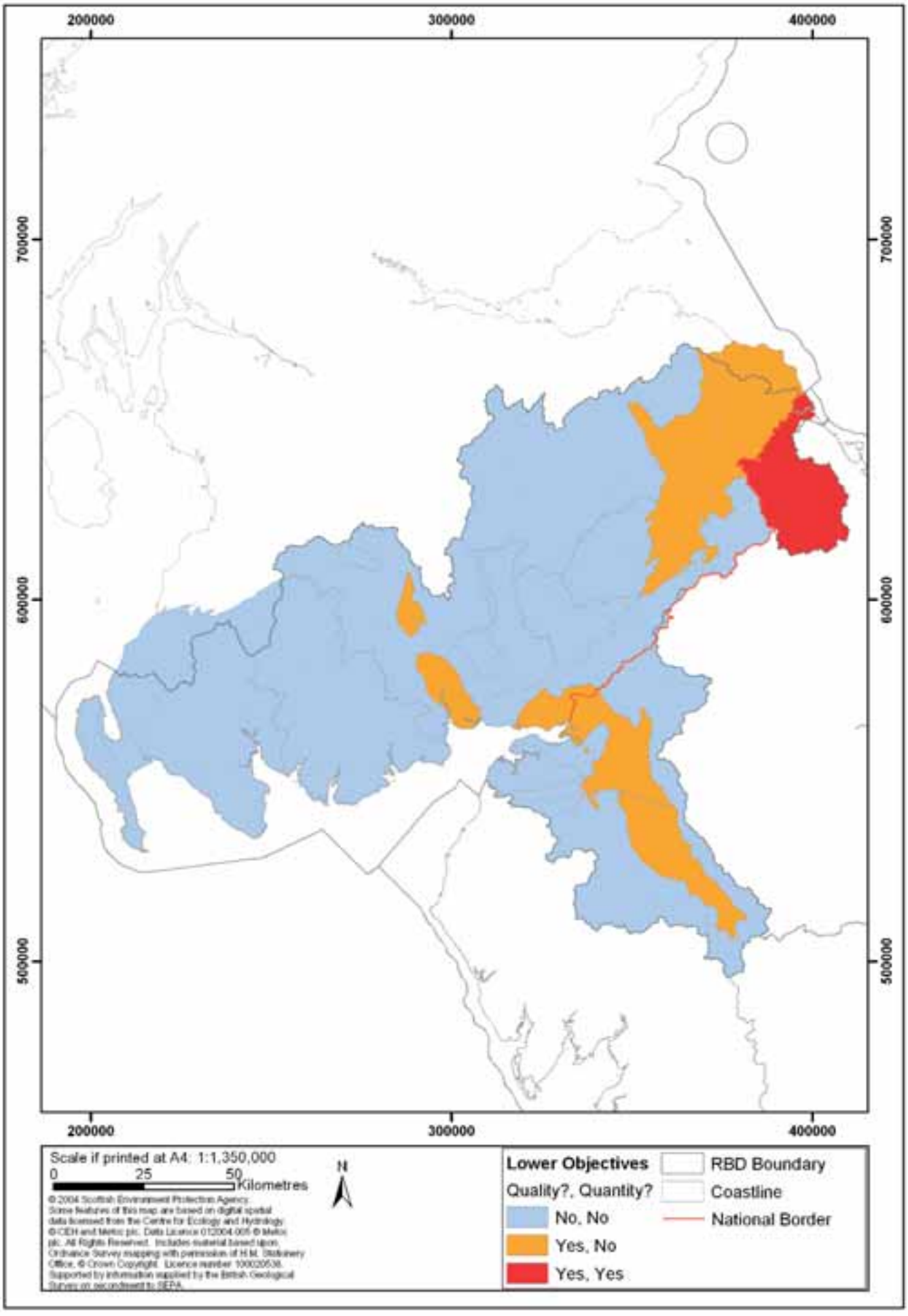
Map 30: Surface water bodies affected by/at risk from all pressure types



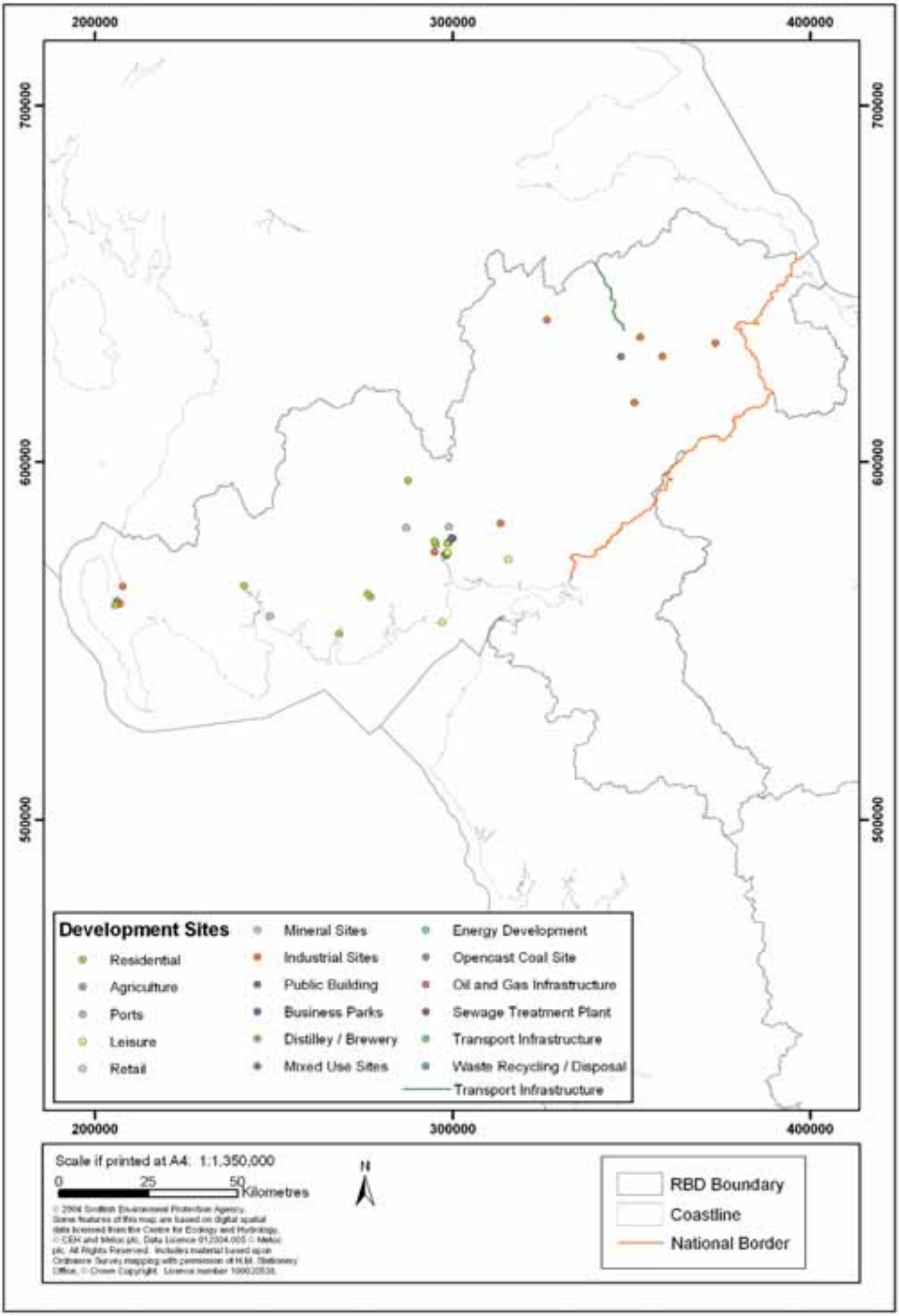
Map 31: Groundwater water bodies affected by/at risk from all pressure types



Map 32: Groundwater bodies for which lower objectives may be specified



Map 33: Future development pressures (Scotland)



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