Lowland fens

Identifying sites and mapping hydrological risk zones in South Oxfordshire and Vale of White Horse

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Summary

The fens of South Oxfordshire and Vale of White Horse support some of the rarest and most threatened biodiversity in the UK. However, as wetland ecosystems that receive water from their surroundings, fens and their special wildlife are highly sensitive to impacts of land use on the quality and quantity of this water.

This report presents the results of an assessment of hydrological risk to irreplaceable lowland fens priority habitat in the South Oxfordshire and Vale of White Horse local authority districts. The work was conducted by Freshwater Habitats Trust and collaborators to support a bespoke framework for protecting and enhancing fens through the Joint Local Plan.

The assessment consisted of 1) identifying sites supporting irreplaceable fen habitat in and around South Oxfordshire and Vale of White Horse, and 2) mapping zones around each site where development could have a risk of hydrological impacts to fen habitat.

South Oxfordshire and Vale of White Horse holds most of Oxfordshire's resource of irreplaceable fen habitat, with 13 sites identified in South Oxfordshire and 38 in Vale of White Horse. As is widely known, most of the county's special fen habitat is distributed across the Corallian Ridge, the range of limestone and sandstone hills running across the middle of Oxfordshire, and which largely falls within the two authority districts. There is a further series of sites across both districts north of the chalk escarpment. Around half of sites are protected by some form designation, with 12 Sites of Special Scientific Interest and 18 Local Wildlife Sites. Cothill Fen in Vale of White Horse is protected as a Special Area of Conservation for its internationally important fen habitat. Slightly less than half have no designation.

For all fen sites identified, risk zones have been defined that characterise areas where development could impact water quality (contamination) or levels and flows (water balance), either of surface water or groundwater. The zones were based on delineation of surface water and groundwater catchment areas, as well as the larger groundwater body (aquifer) in which the latter is situated, using topographic, hydrological and hydrogeological data in the public domain.

For contamination, the groundwater catchment was divided into zones of increasing risk based on proximity to the site. For water balance, all areas of each zone were described as carrying equal risk. In practice, different regions of the zones will be more or less sensitive for different sites, groundwater flows may be more important than surface water, and different kinds of development activity will have different risks. Given this complexity, it was outside the scope of this work to provide more detailed spatial mapping of risks. However, guidance on applying the zones and site-based methods to investigate risk are described.

The risk zones developed as part of this work provide a tool for planning development around fens to protect the hydrological processes they depend on. However, the sites themselves are often isolated and forgotten, and as a result in poor ecological condition. It is therefore imperative to support landowners, land managers and local communities to restore and manage fens to make them resilient places where their special wildlife can thrive. Only in this way, by protecting and enhancing fen habitat at both site and landscape scales, will the nationally important wetland heritage of South Oxfordshire and Vale of White Horse be preserved for the future.

Contents

1 Introduction

1.1 Background

South Oxfordshire and Vale of White Horse District Councils are working together to produce a Joint Local Plan that will guide development in the districts to 2041. In early 2024, the councils undertook consultation on the Joint Local Plan preferred options, which included proposed 'Policy NH2 - Biodiversity Designations' which seeks to protect the most valuable habitats and species in the councils' areas, including irreplaceable habitats.

Responses to the Joint Local Plan preferred options consultation suggested that the councils could do more to protect lowland fens. Whilst lowland fens fall within the National Planning Policy Framework (NPPF) definition of irreplaceable habitats, it was suggested that lowland fens' particular characteristics mean that a more bespoke policy approach, supported by additional evidence, should be considered.

Lowland fens are wetland ecosystems that can receive water from various sources, but this is often dominated by groundwater and surface water. They are highly sensitive to changes in water supply, quality and chemistry. Background information about fens is provided in section 2. A glossary of technical terms is provided in Appendix 1.

There is potential for development within a fen's hydrological catchment, individually or cumulatively, to have an impact on hydrology and subsequently to lead to the loss or deterioration of lowland fens which is contrary to paragraph 186 of the NPPF. Being irreplaceable habitats, they are technically very difficult (or would take very significant time) to restore, recreate or replace once destroyed. It is therefore important to protect and enhance these habitats within the councils' areas.

It is also important to protect and enhance lowland fens as part of action to address climate change, as lowland fens can hold peat deposits that are valuable carbon stores. Natural England identifies that peat-forming wetlands, such as lowland fens, can store up to four times the amount of carbon of 100-year-old native woodland (Gregg *et al.*, 2021). If a lowland fen were to dry out, the carbon stored within its peat would oxidise and be released as carbon dioxide, contributing to climate change.

To support a bespoke framework for protecting and enhancing fens through the Joint Local Plan, the councils commissioned this study to gather evidence about 1) the location of fens, 2) their catchments and 3) the potential hydrological impacts to fens from different types and scales of development.

1.2 Fen site identification and hydrological risk zone mapping

This report presents the results of a risk zone mapping assessment for irreplaceable lowland fens priority habitat in the councils' areas. The work was undertaken as a collaboration between Freshwater Habitats Trust, Harding Hydro Ltd., Wildland Research Ltd and Milestone Environmental Ltd. Together, these organisations bring a breadth of expertise covering practical and scientific aspects of the ecology and hydrology of wetlands, including survey, management and restoration of wetlands, detailed studies of the levels, flows and quality of waters in and around wetlands, assessment of development impacts to wetlands, and spatial analysis and data processing.

The assessment consisted of 1) identifying all known, relevant fen sites and 2) identifying spatial risk zones around each site where hydrological impacts of development in these zones could result in adverse effects to the site's fen habitat and biodiversity.

Sites supporting irreplaceable lowland fens priority habitat were identified using past and contemporary biological records, habitat and site inventories, and other biological and

environmental data, and expert judgement. Methods and results of this identification process are presented in Section 3.

The approach to risk zone mapping and results are presented in Section 4. The following is a summary of the assessment process:

1) Surface water catchment mapping – Estimation of the surface water catchment of each site, using topographic data.
2) Hydrogeological mapping – Estimation of the groundwater catchment of each site, using the estimated surface water catchment, geological mapping, and characterisation of the relevant aquifer(s).
3) Risk zone mapping – Using the mapped catchments and other data, for each site identify relevant potential hydrological impacts and map risk zones for each potential impact.

Full methods and limitations, including available data and data quality, are described. Limitations for each site assessed are described in the results.

1.3 Next steps

The fen site and risk zones mapping have been developed as tools to enable the councils to make effective planning decisions and target nature restoration.

The risk zones for each site are the result of a desk-based exercise and are necessarily precautionary. To refine these zones and assess potential risks of developments, either individually or cumulatively, within each zone, site-based ecological and hydrological investigations would be required. Section 5 describes considerations and methods for further site assessments.

2 Fens

2.1 Fens in legislation and policy

Fens have long been recognised as important habitats for biodiversity and a priority for conservation action at international, national and sub-national scales. Annex I of the EC Habitats Directive lists types of fens for European-wide conservation, including '7230 Alkaline fens'. Alkaline fens are endangered across Europe (European Commission: Directorate-General for Environment *et al.*, 2016), and the British Isles supports a significant proportion of the continent's remaining resource of this habitat (Joint Nature Conservation Committee, 2024).

In England, 'lowland fens' are a priority habitat (BRIG, 2008). The National Planning Policy Framework[1] recognises lowland fens as 'irreplaceable habitat', i.e. '*habitats which would be technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity.*'

2.2 Concepts of fen

The concept of 'fen' habitat encompasses a diversity of types of biological communities. The habitat can be supported by a complexity of different hydrological and other environmental conditions and can be found in many different landscapes and situations within them, from tiny springs to vast floodplain wetlands. This complexity means that the concept of 'fen' can vary between geographic regions, and there is a profusion of scientific typologies emphasising different facets of the wetland environment (Wheeler and Proctor, 2000). In non-technical settings, the wealth of scientific and vernacular terms for fens and other wetlands can lead to confusion.

In this report, 'fens' are minerotrophic mires. Mires are terrestrial habitats with a consistently high, but rarely above-surface, water table. Minerotrophic refers to the predominance in a wetland's water balance of sources of water that have been in contact with the mineral ground, such as surface run-off, flood water or groundwater. The technical term for a wetland supplied largely by direct rainfall onto the wetland surface is 'bog'. The sources of water supplying a wetland is one of the main controls on its chemistry and hydrology, determining for example the chemical environment in which wetland organisms live, and how water levels vary seasonally.

Fens are characterized by communities of plants and other organisms adapted to a permanently wet environment. These communities make fens distinct from seasonal or fluctuating wetlands, such as marshes and grassland. Fens may be peat-forming ecosystems, but wetland types are included here that do not or may no longer form peat. They may be biologically similar to peat-forming wetlands or form other characteristic wetland deposits such as tufa.

The main biological and chemical gradient in fens reflects the pH of the water in the wetland, more-or-less equivalent to the concentration of calcium (Wheeler and Proctor, 2000). Fens with high concentrations of calcium are known as 'rich-fens', and tend to be richer in species, while those with low concentrations are known as 'poor-fens'. The latter support a more limited range of species, and fens at the lower, more acidic end of the pH gradient (around pH 5.5) are characterized by vegetation with an abundance of bog mosses (*Sphagnum* spp.). Such fens span the transition between rich-fens and bogs.

[1] https://www.gov.uk/government/publications/national-planning-policy-framework--2

2.3 Fens in South Oxfordshire and Vale of White Horse

Fens are an important habitat for regionally and nationally rare and endangered wetland biodiversity. The fens in Oxfordshire are an important peat resource in a region where peat is otherwise rare (Parker and Goudie, 1998), storing thousands of years of accumulated carbon, and providing a rich archive of information about environmental change in the Thames basin.

The county's fens are found in two situations: 1) as spring-fed wetlands, formed in areas where groundwater flows out of underlying rocks, such as around the sources of small headwater streams; and 2) on floodplains.

Spring-fed fens are found in and around the edges of Oxfordshire's 'upland' areas: in the Cotswolds in the north; the Corallian Ridge across the middle of the county; and the foot of the Chalk hills in the south. The Corallian Ridge, the low range of limestone and sandstone hills running west-south-west to east-north-east from Swindon, around Oxford, to Aylesbury, falls largely within Vale of White Horse district, with a smaller area north-east of Oxford within South Oxfordshire. The Chalk also falls within both districts: the Berkshire Downs in Vale of White Horse and Chilterns in South Oxfordshire. As such, the two districts encompass a significant proportion of the county's spring-fed fen habitat.

Oxfordshire is well known for its spring-fed fens supplied by alkaline and calcium-rich groundwater flowing from the county's complex geology of limestones and other calcareous rocks (Fojt, 1991; Huxley-Lambrick, 2002) and is recognised as a national hotspot for this type of habitat (Diack, 2024). Most of these sites fall within South Oxfordshire and Vale of White Horse districts.

In this report, fens supplied by alkaline and calcium-rich groundwater are referred to as 'alkaline fen'. Most sites do not presently support the Annex I habitat '7230 Alkaline fens', but share a similar hydrology, chemistry, vegetation and specialised fen biodiversity. Some sites are known to have supported the Annex I habitat in the recent past, and more are likely to have once done so, but have become degraded. The 'jewel in the crown' of the county's alkaline fen series is the Cothill Fen Special Area of Conservation (SAC), west of Abingdon-on-Thames in Vale of White Horse district, notified for its alkaline fen Annex I habitat.

Oxfordshire's alkaline fens support a wealth of rare and endangered plants and animals. The main vegetation types found in alkaline fens in Oxfordshire are described in Table 1. The habitat is regionally important for 'brown mosses', including species such as Giant Spear-moss (*Calliergon giganteum*), Intermediate Hookmoss (*Scorpidium cossonii*) and Thick-nerved Apple-moss (*Philonotis calcarea*), and rare flowering plants such as Broad-leaved Cottongrass (*Eriophorum latifolium*), Fen Pondweed (*Potamogeton coloratus*) and Grass-of-Parnassus (*Parnassia palustris*). They support outstanding assemblages of wetland invertebrates, such as whorl snails (*Vertigo* spp.), the legally protected Southern Damselfly (*Coenagrion mercuriale*), and a wealth of flies (Diptera), including the endangered Clubbed General (*Stratiomys chamaeleon*). These species have lived in Oxfordshire's alkaline fens for thousands of years, supported by the county's stable, wet, clean and calcium-rich fens.

In addition to alkaline fens, there are a small number of fens supplied by less mineral-rich water derived from non-calcareous bedrocks. These once supported a diverse poor-fen flora (Druce, 1897), including species now extinct in the county (Erskine *et al.*, 2018).

Floodplain fens are found in seasonally wet, unmanaged areas of floodplain that have become colonised by large sedges (*Carex* spp.), Common Reed (*Phragmites australis*) and other tall emergent plants. They are largely surface water dependent and become drier in summer, though they may be partially supported by groundwater in gravel deposits that underlie the county's floodplains. Floodplain fens are usually species-poor and a result of recent succession; most of Oxfordshire's floodplains would develop into this habitat without mowing for hay or cultivation. Floodplain fens are therefore generally not considered irreplaceable habitat in this report.

Table 1. Characteristic plant communities of alkaline fens in Oxfordshire, following the National Vegetation Classification (Rodwell, 1991; 1997)

Plant community	Description
M9 *Carex rostrata-Calliergon cuspidatum/giganteum* mire	This is one of the three core vegetation types forming the Annex I habitat '7230 Alkaline fens' in the UK. It is characterised by an abundance of Bottle Sedge (*Carex rostrata*) and other smaller sedges such as Common Cotton-grass (*Eriophorum angustifolium*), a rich variety wetland herbs, and carpets of brown mosses with species such as Intermediate Hook-moss, Pointed Spear-moss (*Calliergonella cuspidata*) and Yellow Starry Feather-moss (*Campylium stellatum*). This vegetation is characteristic of very wet semi-aquatic zones, where nutrient-poor, base-rich water collects, such as in runnels below springs or depressions collecting percolating water. Stands usually occupy a very small area. This vegetation is very rare across lowland England and is known only from two sites in Oxfordshire.
M13 *Schoenus nigricans-Juncus subnodulosus* mire	The second of the vegetation types present in Oxfordshire forming the Annex I habitat '7230 Alkaline fens'. It is recognised by its short, open structure with a well-developed mat of brown mosses and diversity of small sedges and other wetlands herbs. At its most characteristic, the tall, tussock-forming Black Bog-rush (*Schoenus nigricans*) is abundant, but this species has declined greatly in Oxfordshire. Blunt-flowered Rush (*Juncus subnodulosus*), Purple Moor-grass (*Molinia caerulea*), small sedges and a variety of wetland herbs are abundant, and brown mosses of nutrient-poor base-rich environments are very prominent. The habitat supports a wealth of regionally and nationally rare plants and invertebrates. This type of vegetation is found in permanently wet areas with alkaline, calcium-rich and nutrient-poor water, either directly in contact with groundwater or water derived from it, such as around springs, in zones of strong seepage or areas where there is significant percolation of water of suitable chemistry. It can occur on relatively deep peat or on mineral substrates. Tufa formation is often abundant. This is one of the UK's most geographically restricted types of vegetation, and Oxfordshire is a hotspot. Natural England's inventory of alkaline fens[2] identifies a total of just 19 ha of habitat unequivocally assigned to M13, approximately 3 ha of which is in Oxfordshire. Formerly present at 9 sites in the county, and probably more in the past, it remains at just four.

[2] https://naturalengland-defra.opendata.arcgis.com/maps/25b917e001604570b37a9b1800a4e886/about

Plant community	Description
M22 *Juncus subnodulosus-Cirsium palustre* fen meadow	This encompasses a range of fen vegetation in which Blunt-flowered Rush is abundant to dominant. Associated species include many commoner fen species, such as Fen Bedstraw (*Galium uliginosum*), Marsh Thistle (*Cirsium palustre*) and Marsh Valerian (*Valeriana dioica*). The brown moss component is poorly developed, but Tall Thyme-moss (*Plagiomnium elatum*) is one of the few less common species to occur frequently. At some sites, Hard Rush (*Juncus inflexus*) is the dominant species. Blunt-flowered Rush dominated vegetation occurs in zones of strong groundwater seepage along the sides of valleys, or in hollows collecting base-rich water. Stands may be very wet and tufa-forming, or seasonally dry. Hydrologically, M22 can occupy a similar range of environments as M13, and controls on the two are unclear but may involve phosphorus limitation (Boyer and Wheeler, 1989). In Oxfordshire, Blunt-flowered Rush has regenerated following former drainage and cultivation, so that disturbance may play a role. With the previous two types of vegetation, this forms the core of fen vegetation of greatest nature conservation value in Oxfordshire. However, it is generally poorer in species, supporting fewer species of conservation value. Nationally a lowland plant community, it is widespread but very local, and much rarer than other types of rush-dominated wetland vegetation.
S7 *Carex acutiformis* swamp	A species-poor type of vegetation dominated by Lesser Pond-sedge (*Carex acutiformis*), occurring in alkaline fens and other types of wetlands. In alkaline fens, it is generally found in unmanaged areas, and extensive stands occur in zones of weak seepage or zones flushed by water from upslope seepage zones occupied by e.g. M22 *Juncus subnodulosus-Cirsium palustre* fen meadow. The substrate is usually of relatively low permeability and water levels may fluctuate significantly. Occasionally it may form floating rafts over standing waterbodies. In fens that have grown over with trees and scrub, essentially this vegetation develops as the woodland field layer, Lesser Pond-sedge being highly shade tolerant.
S25 *Phragmites australis-Eupatorium cannabinum* tall herb fen	In Oxfordshire, this type of tall herb fen is typical of long unmanaged fens, which can become dominated by dense, tall stands of Common Reed (*Phragmites australis*). Associated species are few, except for Hemp Agrimony (*Eupatorium cannabinum*), which can be very abundant. It can be found in areas with seasonally fluctuating water levels or over strong springs and permanently wet areas. It is found on peat substrates. In degraded alkaline fens, such stands of Common Reed may be confused with reedbeds (a separate priority habitat), but is fully terrestrial and includes a range of tall herb fen species.

3 Fen site identification

3.1 Methodology

The following criteria were used to identify relevant sites. Sites meeting these criteria are referred to simply as 'fen sites'.

1) The site is located in South Oxfordshire or Vale of White Horse, or in adjacent authority areas where there could be hydrological impacts from developments within South Oxfordshire or Vale of White Horse.
2) The site supports wetland habitats that include a significant component of groundwater supply in their hydrological functioning.
3) This hydrology supports irreplaceable lowland fens priority habitat and associated biodiversity, including degraded fen habitat that can be restored.

Sites were identified using Freshwater Habitats Trust's spatial database of alkaline and other headwater fen sites. Currently, the database covers sites in South Oxfordshire or Vale of White Horse, as well as other districts in Oxfordshire, and Buckinghamshire. Swindon and districts in Berkshire are not currently covered. The database includes sites on the basis of criteria 2) and 3) above and has been developed using information on statutory and non-statutory designated sites, past and contemporary biological records, technical reports, surveys carried out by Freshwater Habitats Trust, national and local habitat inventories, hydrological / hydrogeological data, and expert knowledge. Sources of information used to identify each site, and limitations of these due to age, detail or quality, are described in the results.

Though the delineation of site boundaries included all identifiable fen habitat, there was often insufficient information about the extent of fen to do this or areas of habitat were dispersed within a larger site, so that a boundary was delineated e.g. using field boundaries. For Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI) and Local Wildlife Sites (LWS), the boundary of the designated site was used by default, unless the site was very large. The placement of site boundaries was also judged against the likely groundwater and surface water catchments, so as not to make these larger than the areas relevant to fen habitat; this was verified at subsequent stages of the risk zone mapping (see Section 4).

Sites in the Freshwater Habitats Trust database were verified using LWS data and county-level priority habitat mapping provided by the councils, as well as interpretation of satellite imagery. These data, together with the national priority habitat inventory and inventory of alkaline fens published by Natural England[3,4], were also used to verify and identify additional fen sites.

3.2 Results

A total of 57 fen sites were identified. The distribution of sites is shown in Figure 1, with sites indicated by a reference number. Site reference numbers and names are listed in Table 2. Full site descriptions are provided in Appendix 2.

There were 13 fen sites in South Oxfordshire and 38 in Vale of White Horse district. In neighbouring authority areas, there were four sites in Oxford, one in Cherwell and one in Buckinghamshire. The sites outside of South Oxfordshire and Vale of White Horse were

[3] https://www.data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitats-inventory-england
[4] https://naturalengland-defra.opendata.arcgis.com/maps/25b917e001604570b37a9b1800a4e886

included because of their proximity to authority boundaries. The hydraulic connection between these sites and South Oxfordshire and Vale of White Horse districts was then considered further. See Section 4.2.

Twelve sites are designated as SSSI. Cothill Fen SSSI is also an SAC and National Nature Reserve. Eighteen sites are designated as LWS, including Shotover Hill (site 38), part of which is also designated as SSSI. Marley Fens (site 8) and Radbrook Common (site 50) are both part of Wytham Woods SSSI.

A total of 35 sites are distributed across the Corallian, with fen habitat mostly in valleys of small streams where these cut down into the bedrock. There are also several sites formed around small springs on the edges of the Corallian outcrop, mostly on its northern side. Four of the Corallian sites are within Oxford authority area: Dunstan Park (site 53); Lye Valley (site 51); Rivermead (site 57); and Simon's Land (site 34).

On younger Jurassic rocks of the Portland Group to the south-east of the Corallian are Shotover Hill (site 38) and Spartum Fen (site 4). Spartum Fen is an SSSI.

A further series of six sites follows springs near the foot of the Chilterns Escarpment in South Oxfordshire (four sites) and Buckinghamshire (one site), and the Berkshire Downs in Vale of White Horse (one site). West Hagbourne Moor (site 22) is in South Oxfordshire, but its southern boundary is the boundary with Vale of White Horse.

Four sites are located on springs on floodplains or river terraces: Abbey Fishponds (site 14); Almonds Farm Bank (site 52); Wheatley Bog (site 17); and Wytham Ditches and Flushes (site 7). Abbey Fishponds is a relatively large site in a valley through the river terrace deposits underlying Abingdon. Fen habitat at the other sites is formed around small springs.

These sites are all alkaline fen sites (as defined in Subsection 2.3). In addition, there are four sites around Boars Hill on the Lower Greensand with more neutral to acid water chemistry: Birch Copse (site 39); Lincombe Lane (site 47); Matthew Arnold's Field (site 48); and Old Berkley Golf Course Springs (site 49).

Figure 1. Fen sites identified across South Oxfordshire, Vale of White Horse and neighbouring authorities

Fen site location and reference number (see Table 2 and Appendix 2)

N

Scale: 1:250,000 @A3

0 2.5 5 10 15 20 km

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Table 2. Fen site names and reference numbers

Ref. no.	Site name	Ref. no.	Site name	Ref. no.	Site name
1	Cothill Fen	21	Pennyhooks Brook Marsh	41	Chinham Copse
2	Hinksey Heights	22	West Hagbourne Moor	42	Old Pump House
3	Barrow Farm Fen	23	Turfpit Copse	43	Fyfield
4	Spartum Fen	24	Lower Ash Bed	44	Wicklesham Copse
5	Dry Sandford Pit	25	Turf Pits Covert	45	Tubney Wood
6	Sidling's Copse and College Pond	26	Lovell's Court Wood	46	Hydes Farm Fen
7	Wytham Ditches and Flushes	27	Vale Ground	47	Lincombe Lane
8	Marley Fens	28	Marcham Bog South	48	Matthew Arnold's Field
9	Tuckmill Meadows	29	Roke Marsh	49	Old Berkley Golf Course Springs
10	Gozzards Ford Fen	30	Henton Fen	50	Radbrook Common
11	Limekiln Copse	31	Noke Wood	51	Lye Valley
12	Louie Memorial Fields	32	Cookes Copse	52	Almonds Farm Bank
13	Raleigh Park	33	The Osiers	53	Dunstan Park
14	Abbey Fishponds	34	Simon's Land	54	Bledlow Fen
15	Chilswell Valley	35	Bog Under Stow Wood	55	Little Bradfield Farm
16	Easington Fen	36	Beckley Common	56	Letcombe Fen
17	Wheatley Bog	37	Frilford Heath, Ponds and Fens	57	Rivermead
18	Pea Pits Copse	38	Shotover Hill		
19	Chawley Pastures	39	Birch Copse		
20	Peat Bottom Wood	40	South of Turf Pits Covert		

4 Hydrological risk zone mapping

4.1 Methodology

4.1.1 Surface water catchment mapping

The surface water hydrology was characterised by determination of the contributing topographic catchment for each fen site. This was carried out as follows:

1) The LiDAR Composite Digital Terrain Model (DTM) with a 1 m resolution was downloaded from the service published by the Environment Agency.
2) The DTM was post-processed to 'burn in' watercourses where they pass through culverts under roads and other obstacles to surface flow, as these passages are not identified in the LiDAR DTM. The Ordnance Survey Open Rivers data set was used to do this. Small watercourses through fen sites shown on Ordnance Survey mapping as passing under roads but not included in the Open Rivers data were digitised manually.
3) The DTM was further corrected by filling sinks (depressions) that would otherwise prevent the accurate determination of flow pathways.
4) The final, hydrologically corrected DTM was processed to create a flow direction raster, using the D8 algorithm.
5) Polygon data of the fen sites were converted to a raster dataset at 1 m resolution.
6) The flow direction raster was used with the rasterised fen sites to generate contributing catchment areas for each site.
7) Catchment areas were converted to polygons.
8) Catchment polygons were merged into a single dataset.

All processing was carried out in ArcGIS Pro v3.3.0.

The LiDAR datasets are sufficiently accurate and of a very high resolution to produce reliable outputs, and the delineated surface water catchments are therefore considered robust. However, real world surface water flows may be modified by anthropogenic drainage, such as storm drains or culverts on small waterbodies, and by natural events such as flooding. It was not possible to account for these using the available data.

4.1.2 Hydrogeological mapping

For each fen site, a high-level assessment was made of the potential for hydraulic connection with groundwater and, where it had been determined to be significant, an indicative groundwater catchment. Where there was not considered to be a significant hydraulic connection with groundwater a default zone was determined which incorporated the fen site and 50 m buffer zone around it (see Section 4.1.3 for further information on derivation of zones).

In deriving groundwater zones, a distinction has been made between groundwater catchment for a fen site and the wider groundwater body / aquifer over which a fen site is located. The former represents a zone where groundwater travels to or beneath the fen site and is primarily used for the assessment of the risk posed by contamination of groundwater; the latter is an area which, although not flowing towards the fen site, is hydraulically connected, and can therefore impact the fen site as a result of activities that affect wider aquifer water balance (e.g. abstractions, changes to aquifer recharge).

For catchment zones, a further distinction is made between confined and unconfined areas. Confined areas are those where there is an intervening low hydraulic conductivity (permeability) layer between ground surface and the aquifer that feeds the fen site. Surface

contamination in confined areas represents a much lower contamination risk to the fen site compared to unconfined areas as the vertical downward movement of groundwater from the surface is restricted. The risk posed to fen sites by contamination reaching or directly introduced to the aquifer in confined areas would be the same as that posed by the same area as if it were unconfined, however.

To assess the potential hydraulic connection to groundwater, the following datasets were reviewed:

- British Geological Survey (BGS) 1:50,000 scale mapping of solid and superficial geology;
- 1 m resolution topographic data produced as output from the surface water catchment mapping undertaken for this project.
- Surface water catchments derived as part of the surface water catchment mapping undertaken for this project (subsection 4.1.1).
- Ordnance Survey (OS) 1:25,000 scale raster maps for hydrological and topographic information.
- Freely available online OS watercourse vector data.
- Environment Agency (EA) / BGS aquifer designation mapping.
- The EA's freely available online Groundwater Dependent Terrestrial Ecosystem dataset[5].

Where it was determined that there was a likely connection with groundwater then groundwater flow direction and catchment boundary delineation was undertaken through review of:

- BGS scanned 'Hydrogeological Map of South West Chilterns and Berkshire and Marlborough Downs'[6], for regional flow direction.
- Outcrop pattern from BGS 1:50,000 scale geological mapping.
- Surface water flow direction and catchment delineation (for local groundwater flow direction and/or where regional flow data are absent) derived as part of the surface water catchment mapping undertaken for this project.
- The morphology of EA Source Protection Zones (SPZs) where present.
- Local knowledge of sites (such as the position of spring lines) that provides additional information on the likely catchment extent

For Cothill Fen SSSI and Spartum Fen SSSI, the assessment used results of recent, detailed hydrogeological assessments carried out as part of proposed developments (Low, Meade and Pendleton, 2016; WSP, 2019; 2020; Milestone Environmental Ltd., 2021).

Each groundwater catchment included as a minimum a 50 m buffer around the fen site. For sites where it was considered that there was confined groundwater flow to the site, the catchment was extended to include the site and the inferred area of confined flow to the site[7].

[5] https://www.data.gov.uk/dataset/72a149a2-1be7-441f-bc37-94a77f261e27/groundwater-dependent-terrestrial-ecosystems-england-only
[6] https://largeimages.bgs.ac.uk/iip/hydromaps.html?id=south-west-chilterns.jp2
[7] See Appendix 1 for definition of confined groundwater and other technical terms

The assessment process followed to determine the groundwater catchment of each fen site was:

1) Determine if the site lies on productive bedrock aquifer (EA / BGS designation of Secondary or Principal).
2) If the answer to 1) is 'yes', then there is the potential for interaction with bedrock groundwater; if no, then bedrock groundwater can be ignored (skip to item 6).
3) Determine if any part of the site lies below regional groundwater level through estimation of depth to groundwater by comparison of LiDAR topographic data with groundwater elevation. Where there was no regional groundwater level information, it was assumed that there would be interaction between the site and bedrock groundwater.
4) If the answer to 3) above was 'yes' (or there was no regional groundwater level information), then there was the potential for interaction with bedrock groundwater; if 'no', then it was assumed that bedrock groundwater could be ignored (skip to item 6).
5) Use regional groundwater contours to determine flowlines that might intersect the site. Where there was no regional groundwater level information, it was assumed that groundwater flow was coincident with surface water flow direction and catchment.
6) Determine if the site lies on productive superficial aquifer (EA / BGS designation of Secondary).
7) If the answer to 6) was 'yes', then it was assumed that there would be an interaction between the site and superficial aquifer groundwater. Otherwise, there it was assumed that there would be no interaction and the total catchment for the site was defined as the bedrock groundwater catchment (and 50 m minimum buffer where applied) and the process was complete.
8) Superficial groundwater flow direction was assumed to be coincident with surface water flow direction, and catchment and flow were assumed to be towards watercourse but not across them. Where there were a number of different productive superficial units which were indicated to be contiguous then these were treated as one. Only those portions of superficial aquifers with an unbroken, continuous flowline to the site were considered to be part of the catchment (even where they may spring out at the surface and enter the site as surface water).
9) In some cases, there may be a link between a remote productive bedrock aquifer (i.e. one which does not directly underly the site) and the site via an overlying productive superficial aquifer. In this case, the bedrock groundwater catchment was adjusted as if the superficial aquifer groundwater catchment outcropped within the site.
10) Where more detailed local knowledge that provides additional information on the likely catchment extent is available, this has been applied. This is noted in the results for each site.
11) The final groundwater catchment was created by overlaying the bedrock and superficial catchments and the 50 m minimum buffer.

Due to the low resolution and indirect nature of data sources, the delineation of groundwater catchments was an interpretive exercise relying on expert judgement. As a result, the following assumptions and limitations apply (in addition to those already mentioned above):

- The potential for connection with bedrock groundwater is assumed to apply to the whole site where any part of the site has been determined to be below regional groundwater level.

- Regional groundwater level data were coarse and do not necessarily reflect the local variations that may exist. For example, the drawdown effect of local topographic lows (which are generally where the fens sites are located) and the potential expansion of the catchment that could result (compared with the catchment suggested by the regional contours) is not taken into account (however, where there is relevant additional information from local knowledge of the fen site, this has been used). To account for this would require a more detailed assessment of site-specific data such as groundwater level monitoring and locations of spring / seepage lines around the site. Point 2) above will be exacerbated where sites are in particularly deep local depressions and therefore potentially significantly lower than the regional groundwater level surface. In this assessment no account has been taken of the magnitude of the depth below regional groundwater level (including how that might vary within a site).

- The coarseness of the available groundwater level data means that there can be considerable uncertainty regarding the precise location of groundwater catchment boundaries in some places. This uncertainty increases with increasing distance (particularly relative to catchment width) from the site.

- Catchments can overlap. This is because, it is assumed that all sites that lie along the same flowline could be affected by contamination introduced over that flowline up hydraulic gradient of those sites. In reality, a single potential location may have a flow direction towards multiple fen sites.

- Catchments are shown to be continuous even in places where the aquifer to which they relate is overlain by unproductive strata. In this situation, contamination introduced at the surface may not represent a significant risk to the site; however, any contamination that was able to bypass the overlying strata would.

- In a small number of cases regional groundwater contours suggest that faults are acting as barriers to flow. In these cases, the truth of this assumption could have significant consequences for catchment morphology.

These assumptions and limitations reflect the precautionary nature of the assessment, which appropriately reflects the sensitive and irreplaceable biodiversity of the fen sites and the complex flow pathways supplying them with water.

Further information on the basis for the delineation of catchments is provided in the results for each site.

4.1.3 Hydrological risk zones

The risk zones for hydrological impacts mapped for each fen site are defined in Table 3. The zones are not ranked in order of importance but zones 1-4 are nested. Zone 2, the groundwater catchment, is divided into sub-zones 2a and 2b.

Hydrological impacts have been divided into two categories:

- Contamination impacts – The impact of contamination of a fen site's supporting groundwaters or surface waters by substances that may adversely affect the biodiversity and hydrological function of the site's fen habitat. Substances include for example nutrient pollution (e.g. nitrogen, phosphorus and potassium chemical species) and sediment, but contamination should include any event that elevates any chemical or other substance above natural background concentrations and total quantity within the water body.

- Water balance impacts – The impact of changes in levels and flows of water, and therefore volumes of water supplied to a fen site by individual sources, including seasonal fluctuations in these. Levels refer to the piezometric head in an aquifer, or

levels in surface waters, and their variation in space and time. Flows refer to the direction, speed and discharge water, determined by hydraulic gradients and the physical properties of catchments. Note that for groundwater, 'catchments' may not be physically defined as for the watershed of a surface water catchment, but by wider regional flow patterns within an aquifer. Impacts to groundwater levels and flows outside of the groundwater catchment can therefore have an impact within the catchment and therefore at a fen site.

For groundwater contamination risks, zones have been defined based on the following qualitative levels of risk: Negligible; Low; Medium; and High. These zones have been defined based on proximity, used as a proximity for the speed of transmission via groundwater. The risk levels used are relative to the site, i.e. levels cannot be compared between sites. See Table 3 for definitions of these risk zones.

For surface water contamination and water balance risks, the risk has simply been rated as 'possible' and further zones have not been differentiated. To do this would require detailed analysis of the configuration of sites (e.g. location of habitats, watercourses etc.) and data on flows, levels and chemistry across catchments, which is outside the scope of this report. Methods for more detailed studies to assess risks to sites are described in Section 5.

The hydrological impacts considered could result in a variety of effects to fen sites, depending on the site and its catchments, and impacts could be caused by many kinds of development. Guidance on the application of the zones to developments is provided in Section 5.

Table 3. Hydrological risk zone definitions

Risk zone	Definition	Description of zone	Risk
1	Groundwater body	A large regional zone defined by the aquifer unit in which the site is located, e.g. the Water Framework Directive (WFD) groundwater body. For sites on smaller bedrock aquifers or superficial aquifers, the extent of the groundwater body may not be included in the WFD and has been mapped from geological mapping, if possible. This zone covers the area where developments could impact on groundwater levels or flows, and developments that might alter the hydrogeological properties of the aquifer pathway to the site. As it extends outside the groundwater catchment, it is not a zone within which potentially contaminating activities pose a risk.	• Contamination risk – Negligible • Water balance risk – Possible
2a	Groundwater catchment – recharge	A sub-area of Zone 1, and of the groundwater catchment. For each fen site, this is the area of the groundwater catchment with unconfined groundwater flow to the site. It is equal to the area over which groundwater flows to the site are recharged by infiltration. As an area of recharge, potentially contaminating activities within this zone and activities impacting groundwater levels and flows could impact the site.	• Contamination risk – Low • Water balance risk – Possible
2b	Groundwater catchment – confined flow	A sub-area of Zone 1, and of the groundwater catchment. For each fen site, this is the area of confined groundwater flow to the site. No recharge occurs across this area, but the area has a hydraulic connection to areas of recharge (zone 2a). Confined zones were identified as areas outside of groundwater body (zone 1) overlain by mudstones and other low permeability strata shown on geological mapping. As there is no recharge, potentially contaminating activities within this zone are unlikely to propagate to the fen site. However, activities impacting groundwater levels and flows in this zone could impact the site.	• Contamination risk – Negligible • Water balance risk – Possible

Risk zone	Definition	Description of zone	Risk
3	Nearest 50 % of the groundwater catchment to the site	A sub-area of the groundwater catchment (zone 2). This zone is defined as the closest 50 % of the groundwater catchment area to the site. This area is delineated to represent a higher probability of risk for contamination impacts at the site than Zone 2. For each site, this has been delineated using an algorithm to estimate the buffer distance around the site that divides the groundwater catchment (zone 2), excluding the site itself, into two regions of equal area.	• Contamination risk – Medium • Water balance risk – Possible
4	Within 50 m of the site	A sub-area of Zone 3. This is a 50 m buffer zone around the site, including the site itself, which represents the highest risk from potentially contaminating activities, as well as risk of impacts to the site's water balance. 50 m is used by the Environment Agency as a minimum distance for determining Source Protection Zones (SPZ) and is also used by them elsewhere, e.g. minimum distance between abstraction boreholes and septic tanks.	• Contamination risk – High • Water balance risk – Possible
5	Surface water catchment	This zone comprises the whole surface water catchment. Differentiation into risk zones for contamination and water balance impacts is not possible within the scope of this report.	• Contamination risk – Possible • Water balance risk – Possible

4.2 Results

The mapped risk zones for each fen site are shown in the figures in Appendix 3. Information about the surface water and hydrogeology of each site is given in Appendix 2.

For sites on the Water Framework Directive (WFD) Corallian and Chalk groundwater bodies, risk zone 1 is not included in the maps in Appendix 3 as the groundwater bodies are too large to display. A plan of these groundwater bodies is shown in Figure 4.1 in Appendix 4.

Areas of the Corallian WFD groundwater bodies where the regional groundwater level from the BGS hydrogeological map is at or above the elevation of the ground surface are shown in Figure A4.2 in Appendix 4. Fen site boundaries are overlain for comparison.

The following general points should be noted about the groundwater catchments delineated:

- For the Corallian groundwater bodies, the general trend in groundwater flow is north to south, and for the Chalk waterbodies the flow is south to north. This is reflected in the groundwater catchments mapped, which are extended along the direction of regional flow. For some sites, this produced long 'tails'. For sites around the northern, eastern and western edges of the Corallian outcrop account has been taken of how the regional groundwater flow pattern is likely to be modified by topography.

- Using available hydrogeological data for the Corallian, it was generally not possible to truncate groundwater catchments along topographic watersheds; catchments have therefore been extend north to the edge of the outcrop, and catchments overlap. In other words, flow beneath or between sites could not be excluded.

- For some sites e.g. Almonds Farm Bank (site 52), it was difficult or not possible to determine a hydraulic connection to groundwater. While groundwater is likely to be a source based on knowledge of the site and habitats present (where known), it was not possible to determine the origin of groundwater using available geological and hydrogeological data. For these sites, zone 2 was mapped as a 50 m buffer around the site and zones 1, 3 and 4 were not mapped.

- For Abbey Fishponds (site 14) and Wytham Ditches and Flushes (site 7) it was considered that fen habitat was supported by groundwater in superficial deposits, but it was not possible to map the groundwater body (zone 1). This was because the superficial deposits were large (e.g. whole river floodplains) and could be connected to other strata, and it was not possible to determine these hydraulic connections.

Zone 2b was differentiated for 18 sites considered to have areas of confined groundwater flow within their catchment. For sites on the Corallian, this was where younger strata overlie the Corallian rocks in well-defined areas around hill tops. However, in the case of Spartum Fen SSSI, there is a zone of confined groundwater to the east of the site where the aquifer dips beneath the Gault Formation, and the extent of this confined zone could not be determined from available information. This area is important for the water balance of the site, and as such a precautionary distance of 1 km around the site has been used.

For the four sites in Oxford authority area, risk zones 2-5 did not lie within South Oxfordshire or Vale of White Horse. Risk zone 1 for three of the sites, including Lye Valley (site 51), consisting of the Headington Corallian groundwater body, does lie within South Oxfordshire, however. For Almonds Farm Bank (site 14), no hydraulic connection with either authority area could be established, though this was a site about which it was difficult to be certain about groundwater flows to the site. Also for this site, the northern boundary of its surface water catchment is the A40, and road drainage cannot be ruled out. The A40 is the boundary between Oxford and South Oxfordshire authorities.

For the site in Cherwell (site 31) and Buckinghamshire (site 54), small areas of their groundwater catchments (zone 2) were within South Oxfordshire.

5 Discussion

5.1 Fen sites in South Oxfordshire and Vale of White Horse

A total of 57 fen sites have been identified, 51 in South Oxfordshire and Vale of White Horse. This is a large number of sites, more than other authority areas in Oxfordshire (Freshwater Habitats Trust, unpublished data), and reflects the geology of the region and its place as a national hotspot for alkaline fens.

There may be more fen sites across the Corallian which were not possible to identify using the data sources used in this assessment. Field survey would be needed to identify these. It is likely that there were once more fen sites in South Oxfordshire and Vale of White Horse, but they were lost as land use has changed and intensified over the last two centuries.

Detailed, recent data on the location, extent and condition of fen habitat are mostly limited to sites notified as SSSI; LWS and undesignated sites have been investigated in much less detail. For some sites, habitat and other biological data were lacking and the presence of fen habitat has been inferred from records of tufa or peat deposits and from historic and modern aerial imagery. While based on limited data, the identification of these sites as fen sites is robust; their location correlates with environmental factors known to support fen habitat in Oxfordshire, such as geology and topography, and relation to groundwater.

Only slightly more than half of sites have any form of designation, with approximately only a fifth (12 sites) strictly protected as SSSI. The other 27 sites (47 %) have no protection at all.

The nationally important fen resource across South Oxfordshire and Vale of White Horse is generally in poor condition and in need of restoration, even at sites protected as SSSI. This damage has largely been caused by lack of management since the Second World War, leading to colonisation by scrub and trees (succession) and subsequent loss or deterioration in quality of fen habitat. Very few sites have been actively destroyed. Most sites are highly isolated, small, forgotten wetlands, surrounded by intensive agricultural land or other modern land uses; few sites sit within larger areas of semi-natural land managed for biodiversity. Even for fen sites with limited site-based information, aerial photographs in public archives and modern satellite imagery show this process of neglect, succession and isolation playing out across South Oxfordshire and Vale of White Horse from the 1940s to the present day.

To protect the nationally important and irreplaceable fen habitat in South Oxfordshire and Vale of White Horse, it will be necessary to both protect the catchments of sites using the tools developed in this work, and reverse succession and fragmentation to restore the many degraded sites across the region.

5.2 Using the hydrological risk zones

The risk zones provide a generic impact assessment tool for use by the councils and others in planning development across South Oxfordshire and Vale of White Horse. The zones are necessarily simplistic given the complexity of types of development and potential hydrological interactions with fens. However, they provide a robust and precautionary starting point for further assessment.

The risk zones have been mapped as areas of uniform risk of impacts to water chemistry (contamination) or levels and flows (water balance). However, in practice, the risk will depend on the specific development's activities, or series of cumulative developments, and the hydrological interaction between the development's location and the site. It has not been possible to assess this in this report. Nor will South Oxfordshire and Vale of White Horse as planning authority be able to conduct this assessment for every planning application.

For a development, or series of developments, the following will need to be considered:

1) The zone in which the development will take place.
2) The development activities and scales of activity.
3) The hydrology of the fen site and its catchment, and their sensitivities to the proposed development's activities, scale and location.

When assessing a proposed development, the planning authority should consider points 1) and 2), and determine, on a precautionary basis, whether to 'screen in' the development for hydro-ecological assessment as in point 3). The further assessment should be carried out by the developer. Methods of hydro-ecological assessment are outlined in Subsection 5.3.

Table 4 provides guidance on the types of development activity in each hydrological zone that would warrant, on a precautionary basis, further assessment.

For most fen sites, zones relating to groundwater (zones 1 to 4) are likely to carry higher risk from development, due to the generally greater importance of groundwater in fen sites' water balance and chemistry, and the inherent uncertainty in understanding below-ground flows. Surface water bodies will generally supply water only in wetter parts of the annual hydrological cycle, though they may have an important role in regulating the outfall of water from a site.

As a general principle, all development within risk zone 4 (i.e. within 50 m of the site) should be screened in for hydro-ecological assessment.

Risk zone 1 consists of a large area representing the extent of the aquifer connected to a fen site. The mapping of these large zones recognises that the whole aquifer unit is relevant to each fen site, not just the 'upstream' area where recharge and flow to the site occurs. Developments that could impact a fen site at the scale of zone 1 are likely to be larger developments such as those involving extensive excavations and dewatering, or large-scale land use changes. Such developments would likely be screened in for hydrogeological assessment following existing regulations and planning policy.

Finally, Sustainable Drainage Systems (SUDS) are likely to be commonly proposed by developers to mitigate hydrological impacts to fens, including to manage pollution from development, changes to surface water levels and flows, and groundwater recharge. However, it should be noted that:

- SUDS standards have not been developed to protect fens and the groundwater and surface water systems they depend on. Industry standards may not be stringent enough (e.g. in the amount of flow reduction or pollutant removal) to protect sensitive habitats such as fens.
- To be effective, SUDS must be maintained for the lifetime of the development, which may be indefinitely.

The onus is on the developer to demonstrate that proposed mitigation will work. Given the above points, for developments likely to impact fen sites, the planning authority should expect to be provided with justification that mitigation will be effective, going beyond existing standards. The maintenance of mitigation infrastructure and other measures, as well as mechanisms to repair damage caused by failures, should be guaranteed through planning conditions.

Table 4. Development activities relevant to each hydrological risk zone

Risk zone	Definition	Development activities affecting water chemistry	Development activities affecting water balance

5	Surface water catchment	• Activities generating pollutants that can run off to surface waterbodies, such as:
		  ○ Residential development and roads and other transport infrastructure.
		  ○ Sewage and water supply infrastructure from new residential developments, or upgrades to existing infrastructure, leaking to groundwater.
		• Other land use changes, including agricultural intensification and industry.
		• For sites with large surface water catchments, Impacts in risk zone 5 are more likely for larger developments, or from small developments closer to sites.
			• Construction of impermeable surfaces, without mitigation for storm flows.
			• Capture or diversion of surface flow pathways, or enlargement of surface catchments e.g. as part of drainage systems.
			• Discharge of water to surface waterbodies, e.g. for dewatering.
			• For sites with large surface water catchments, Impacts in risk zone 5 are more likely for larger developments, or from small developments closer to sites.
			• Given the near-surface nature of groundwater levels in many fen systems, changes in surface water balance may cause changes in groundwater balance. See zone 2.

4	Within 50 m of the site	• Any development should be screened in for further hydro-ecological assessment that potentially generates pollutants that can infiltrate to groundwater, such as:
		  ○ Residential development and roads and other transport infrastructure.
		  ○ Sewage and water supply infrastructure from new residential developments, or upgrades to
			NA – see zone 2

Risk zone	Definition	Development activities affecting water chemistry	Development activities affecting water balance
		existing infrastructure, leaking to groundwater. ○ Other land use changes, including agricultural intensification and industry. • All forms of contamination should be considered potentially relevant.	
3	Nearest 50 % of the groundwater catchment to the site	• Activities as above, but scale of groundwater pollution greater, such that attenuation in the saturated zone and during flow in the aquifer may not be sufficient to rule out an impact.	NA – see zone 2
2 or 2a	Groundwater catchment – recharge	• Activities as above, but scale of groundwater pollution even greater, such that attenuation in the saturated zone and during flow in the aquifer may not be sufficient to rule out an impact. • Likely to include large-scale land use changes, e.g. large residential developments, forestry plantations.	• Any development should be screened in for further hydro-ecological assessment where associated activities cause reduction in recharge or changes in flows. • Activities causing reduction in recharge: ○ Construction of impermeable surfaces, e.g. buildings, car parks, paving. ○ Temporary storage of surface water, e.g. in SUDS systems. ○ Woodland planting, increasing evapotranspiration and rainwater interception. • Activities causing changes in flows: ○ Any of the above, by reducing recharge.

Risk zone	Definition	Development activities affecting water chemistry	Development activities affecting water balance
			○ Any structures constructed in the saturated zone. ○ Groundwater abstractions e.g. for agriculture or industry. ○ Discharging to groundwater. • Given the near-surface nature of groundwater levels in many fen systems, changes in groundwater water balance may also be caused by changes in surface water levels and flows. See zone 5.
2b	Groundwater catchment – confined flow	• Any activity penetrating the confining geology, e.g. discharging contaminated water to groundwater.	• Any activity penetrating the confining geology, e.g.: ○ Quarrying. ○ Boreholes for discharging to or abstracting from groundwater. • Excavations that thin or remove the confining geology, providing a pathway for groundwater flow.
1	Groundwater body	NA	• Types of activity as above for zones 2-4, but only larger scale developments would be expected to impact a site in this zone, outside the groundwater catchment (zone 2). • Such developments would likely trigger a hydrogeological impact assessment for their impact on the aquifer. Impact to groundwater dependent habitats such as fens may carried out as part of this.

Risk zone	Definition	Development activities affecting water chemistry	Development activities affecting water balance
			• Developments include quarrying, residential or infrastructure developments, or other large-scale land use changes, e.g. solar farms, large new tree plantations, reservoirs.

5.3 Methods for hydro-ecological assessment

If a development is proposed in any of the risk zones and is screened in for detailed assessment of hydrological impacts to one or more fen sites, then the developer should first follow a process of data gathering and site conceptualisation. A competent, independent specialist in fen hydrology and ecology should be commissioned to carry out the following work.

- Map the location and extent of wetland habitats within the fen site(s), and map and classify vegetation using the National Vegetation Classification (Rodwell, 2006).
- Gather biological records from the fen site(s) and identify rare and threatened wetland species. Uncertainties or data deficiencies (e.g. in invertebrates) may need to be addressed by commissioning surveys or working with local experts to obtain data.
- Characterise the wetland vegetation and other biological communities in terms of their hydrological and ecological requirements. The UKTAG guidance can be used as a starting point (UKTAG, 2004; 2009; 2012).
- Map hydrological features within the fen site(s), around the development site and in areas that could potentially connect them hydrologically (e.g. surface water and groundwater catchments). Features include natural features such as rivers, streams, ponds, lakes, springs and wetland deposits (e.g. peat, tufa), as well as artificial features such as ditches, land drains, culverts and boreholes. Flow directions should be recorded, and ideally flows should be observed in a variety of conditions throughout the hydrological cycle.
- Record simple water chemical measurements from surface waters, e.g. pH, electrical conductivity. If required, laboratory analysis of water samples can be conducted.
- Gather information about the topography, geology and hydrogeology in and around the fen site(s) and catchments. Data on near-surface geology (e.g. soils, superficial deposits), which are critical to wetland function, are likely to be limited; this should be investigated by hand augering or by drilling shallow boreholes.
- Synthesise all data to develop a hydroecological conceptual site model, summarising the key elements and mechanisms in the water supply and other processes in the functioning of wetland habitats at the fen site(s) and across its surface water and groundwater catchments, as well as uncertainties in the conceptualisation (Low *et al.*, 2018).

Site-based data should be gathered through fieldwork carried out for the development. If pre-existing data are available, then they should be assessed for relevance and completeness, and verified through fieldwork.

Depending on the development activities, sensitivity of the site and uncertainties in understanding, the above process may be sufficient for the developer to confidently assess the risks of development and propose mitigation. However, if there are existing uncertainties then these may need to be addressed through more intrusive, intensive investigations and monitoring. As an example, quantitative data on groundwater levels and flows may be needed to understand whether excavations are likely to be within groundwater or whether the groundwater is likely to flow to a fen site. An array of boreholes and other water level monitoring equipment, recorded over time (at least one hydrological cycle), would be needed to gather these data. The need for further investigations and the design of these should be determined by a competent, independent specialist.

6 Conclusion

The fens of South Oxfordshire and Vale of White Horse support some of the rarest and most threatened biodiversity in the UK. However, as wetland ecosystems that receive water from their surroundings, fens and their special wildlife are highly sensitive to impacts of surrounding land use on the quality and quantity of this water.

This report has presented the results of an assessment to identify where irreplaceable fen habitat is present in South Oxfordshire and Vale of White Horse, and to map zones around these sites where development could have a risk of hydrological impacts to fen habitat.

South Oxfordshire and Vale of White Horse hold most of Oxfordshire's resource of irreplaceable fen habitat, with 13 sites identified in South Oxfordshire and 38 in Vale of White Horse. Only slightly more than half of the sites are designated and therefore afforded some kind of existing protection.

For all fen sites identified, risk zones were defined that characterise areas where development could result in impacts to water quality (contamination) or levels and flows (water balance), either of surface water or groundwater. The zones were based on delineation of surface water and groundwater catchment areas, and groundwater bodies. Guidance on applying the risk zones to the complexities of individual fen sites and developments has been provided.

The risk zones developed as part of this work provide a tool in planning development around fens to protect the hydrological processes they depend on. However, the sites themselves are often in poor ecological condition, and it is therefore imperative to restore and manage them. Only in this way, by protecting and enhancing fen habitat at both site and landscape scales, will the nationally important wetland heritage of South Oxfordshire and Vale of White Horse be preserved for the future.

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Appendix 1 Glossary

Term	Definition
Alkaline fen	A complex of vegetation types characteristic of sites where there is tufa and / or peat formation with a high water table and a calcareous base-rich water supply. In this report, this habitat includes a broader range of fen habitat than the Annex I habitat '7230 Alkaline fens', in order to reflect the degraded state of many sites in Oxfordshire, and their shared biodiversity.
Annex I habitat	Natural habitat types of European importance whose conservation requires the designation of special areas of conservation, listed on Annex I of Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.
Aquifer	A body of rock saturated with groundwater.
Bog	Mire where the predominant source of water is direct rainfall onto the wetland surface.
Brown mosses	A non-taxonomic group of mosses characteristic of rich-fen vegetation, mostly of a brown or reddish colour.
Confined aquifer	Confined aquifers are where thick deposits overly the aquifer and confine it from the Earth's surface or other rocks, preventing or slowing groundwater movement. Confining cover can cause groundwater to be under pressure.
Unconfined aquifer	Unconfined aquifers are those where the rock is directly open at the surface of the ground (outcrops) and groundwater is directly recharged, for example by rainfall or snow melt.
Fen	A minerotrophic mire. See Subsection 2.2.
Groundwater	Water that exists underground in saturated zones beneath the land surface.
Groundwater catchment	For a given site, surface extent of an aquifer over which groundwater flows toward the site. This includes the area of recharge, i.e. the area of land over which water from any form of precipitation will infiltrate to the underlying aquifer and flow to the site through it. If the aquifer includes areas of confined flow, then these will not be areas of recharge, though flow to a site may still originate from them. Groundwater catchments are determined by physical properties of the aquifer and the spatial and temporal variation in groundwater levels. As such, the limits of a groundwater catchment may change through time and catchments of different sites may overlap.

Term	Definition
Headwater	Headwater streams are at the higher points in a surface water catchment, where flow pathways converge to form wetlands and small streams that feed larger stream and river networks.
Irreplaceable habitat	In the National Planning Policy Framework (NPPF), defined as habitats which would be technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity. Lowland fens priority habitat is included as an example of irreplaceable habitat in the NPPF.
Lowland fens	The priority habitat encompassing the types of fen habitat found in lowland England.
Local Wildlife Site (LWS)	Local Wildlife Sits are areas of Oxfordshire identified as including rare habitats and species. LWS status does not confer legal protection but are protected from development in the planning system. For more information see https://www.tverc.org/data-hub/local-wildlife-sites-lws
Minerotrophic	Of a wetland, the predominance of sources of water that have been in contact with the mineral ground, such as surface run-off, flood water or groundwater.
Mire	Terrestrial habitats with a consistently high, but rarely above-surface, water table, including fens and bogs. Peat-forming wetlands are mires, though mires need not form peat
Peat	Peat is a partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions in wetlands.
Poor-fen	Fen where the chemistry experienced by vegetation is relatively poor in minerals and nutrients, generally with pH < 5.5.
Priority habitat	Types of semi-natural habitat of principal importance for the purpose of conserving biodiversity. The list of priority habitats is published by the UK government.
Reedbeds	Reedbeds are a type of swamp habitat dominated by stands of Common Reed (*Phragmites australis*), where the water table is at or above ground level for most of the year. They tend to incorporate areas of open water and ditches. Reedbeds are a priority habitat.
Rich-fen	Fen where the chemistry experienced by vegetation is relatively rich in minerals and nutrients, generally with pH > 5.5.
Seepage	An area where groundwater flows to the surface through the ground or soil, usually over an extended area without a discrete outflow.

Term	Definition
Site of Special Scientific Interest (SSSI)	A Site of Special Scientific Interest (SSSI)is the land notified as an SSSI under the Wildlife and Countryside Act (1981), as amended. SSSI are the finest sites for wildlife and natural features in England, supporting many characteristic, rare and endangered species, habitats and natural features. SSSI are strictly protected by law from development.
Special Area of Conservation (SAC)	A Special Area of Conservation (SAC) is the land designated under Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora. SAC are designated for supporting species and habitats identified as needing coordinated conservation action across Europe. SAC are strictly protected by law.
Spring	A place where groundwater flows directly out of the ground, more-or-less in a discrete area with visible surface flow.
Superficial deposits	Superficial deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 2.6 million years from the present. They rest on older deposits or rocks referred to as bedrock.
Surface water	Any water that is found above ground, such as in rivers, streams, lakes, ponds or wetlands.
Surface water catchment	For a given site, the land over which water from any form of precipitation drains to the site. Generally defined by topography, though may be changed by artificial drainage.
Swamp	Vegetation consisting of emergent species growing in shallow water, up to around 1 m depth. Swamp vegetation many occur within fens and other wetland habitats, e.g. ponds, lakes, rivers. Includes reedbeds priority habitat.
Tufa	Tufa is a terrestrial freshwater accumulation of calcium carbonate that forms when water saturated with calcium carbonate becomes supersaturated due to e.g. degassing of carbon dioxide, temperature changes, and microbial processes. Calcium carbonate precipitates from the water, forming a pale, flaky, mineral deposit, often as a coating on objects in the water.
Water balance	The totality of flows of water into and out of a wetland, and the water stored in it (e.g. in superficial deposits such as peat). Water inflows include surface water, groundwater and precipitation. Water outflows include discharge to rivers and evapotranspiration. The water balance of a wetland is generally a theoretical concept that is difficult to quantify and measure, though the relative of importance of different inflows and outflows can be identified through investigations.

Term	Definition
Wet woodland	A type of woodland occurring on poorly drained or seasonally wet soils, usually with alder, birch and willows as the predominant tree species. Wet woodland is a priority habitat.

Appendix 2 Site accounts

Site 1 - Cothill Fen

Site ID:	1	**Site name:**	Cothill Fen
Area (ha):	43.29	**Authority area:**	Vale of White Horse
Designation(s):	Cothill Fen SAC, Cothill Fen SSSI, Cothill NNR		
Site description:	Cothill Fen comprises several headwater valley systems converging on the Sandford Brook. Fen habitat is found at the northern end of the site, in the Lashford Lane Fen BBOWT nature reserve, and to the south in Parsonage Moor BBOWT nature reserve and Cothill Fen NNR. The connecting area consists of drained former fen, and woodland. The SAC supports one of the largest surviving examples of alkaline fen habitat in central England.		

Surface water

Site elevation range (mAOD):	74.2 to 94.1	**Surface water catchment area (ha):**	713.77	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	22.68	Secondary A
None	14.03	NA
Peat (peat)	6.58	Unproductive

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	43.22	Secondary A	High

Stanford Formation (limestone)	0.06	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	75 to 92	**Estimated depth to regional water table to nearest metre (m):**	0 to 5

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	160 to 180	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment: Catchment has been reproduced from that presented in Rigare's 2016 report "Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon" (Report Ref: Rigare 1605_r1) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 2 - Hinksey Heights

Site ID:	2	**Site name:**	Hinksey Heights
Area (ha):	23.54	**Authority area:**	Vale of White Horse
Designation(s):	Harcourt Hill Scrub and Fen LWS		
Site description:	Hinksey Heights is the largest in the series of fen sites along the escarpment of the Corallian west of Oxford, consisting of a pair of valleys between Hinksey Hill and Harcourt Hill, as well as extensive areas of seepage above the Thames floodplain. It is one of the largest fen sites in Oxfordshire, supporting some of the most extensive areas of open or formerly open fen habitat in the county, with only Cothill Fen supporting a larger area. The site supports many uncommon fen plants and invertebrates (e.g. Morris, 2019) and has been under restoration by Freshwater Habitats Trust since 2018. The site is privately owned and managed as a nature reserve with permissive public access.		

Surface water

Site elevation range (mAOD):	62.4 to 116.9	**Surface water catchment area (ha):**	200.57	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	23.55	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	10.97	Secondary A	High

Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	8.03	Unproductive
Stanford Formation (limestone)	4.55	Secondary A

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD): 76 to 112

Estimated depth to regional water table to nearest metre (m): 0 to 8

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: 135DegE

From SPZ: None close enough

Basis for delineation of groundwater catchment:

Most of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of eastern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the south and south-west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 3 - Barrow Farm Fen

Site ID:	3	**Site name:**	Barrow Farm Fen
Area (ha):	6.73	**Authority area:**	Vale of White Horse
Designation(s):	Barrow Farm Fen SSSI		
Site description:	Part of the Sandford Brook complex of fen sites, Barrow Farm Fen is located in a peat-filled basin along the west bank of the Brook, where several shallow valleys converge. Fen habitat is a feature of the SSSI, and the site formerly supported Annex 1 alkaline fen habitat (Fojt, 1991), but became degraded during the late twentieth century through invasion by trees and scrub. The site has been under restoration by Freshwater Habitats Trust since 2019.		

Surface water

Site elevation range (mAOD):	57.1 to 61.1	**Surface water catchment area (ha):**	962.01	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	6.46	Secondary A
None	0.27	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Stanford Formation (limestone)	6.29	Secondary A	High
Ampthill Clay Formation and Kimmeridge Clay Formation	0.44	Unproductive	High

(Undifferentiated)
(Mudstone)

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	60 to 60	**Estimated depth to regional water table to nearest metre (m):**	0 to 1
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	166DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 4 - Spartum Fen

Site ID:	4	**Site name:**	Spartum Fen
Area (ha):	7.62	**Authority area:**	South Oxfordshire
Designation(s):	Spartum Fen SSSI		
Site description:	An outlying site of the Corallian series, Spartum Fen is thought to be supplied by upwelling of groundwater from the Portland aquifer through a 'window' in the surrounding Cretaceous Gault Formation. Fen habitat is a feature of the SSSI, and the site formerly supported Annex 1 alkaline fen habitat (Fojt, 1991), but became degraded during the late twentieth century through invasion by trees and scrub. The site has been under restoration by Freshwater Habitats Trust since 2019.		

Surface water

Site elevation range (mAOD):	65.3 to 69.2	**Surface water catchment area (ha):**	991.79	**WFD operational catchment:**	Thame

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Peat (peat)	4.11	Unproductive
Alluvium (clay, silt, sand and gravel)	2.98	Secondary A
Head (clay, silt, sand and gravel)	0.60	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Gault Formation (mudstone)	7.62	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Catchment adapted from that presented in Figure 13 of WSP's 2019 report (2) to allow for groundwater flow beneath the Gault Formation between WSP's recharge area and the site and a 50 m buffer around the site.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. WSP (2019). Harrington New Settlement Proposal, Hydrological Review / Update of Spartum Fen SSSI, Report Ref: 70049563

Site 5 - Dry Sandford Pit

Site ID:	5	**Site name:**	Dry Sandford Pit
Area (ha):	4.21	**Authority area:**	Vale of White Horse
Designation(s):	Dry Sandford Pit SSSI		
Site description:	Part of the Sandford Brook complex of fen sites, Dry Sandford Pit is of recent origin, the fen habitat having formed at the bottom of a former limestone quarry following cessation of quarrying in the mid twentieth century. One of the few Oxfordshire fen sites still to support Annex 1 alkaline fen habitat, the site has a rich wetland flora and fauna, including many rare and endangered species. It is managed as a nature reserve by BBOWT.		

Surface water

Site elevation range (mAOD):	70.0 to 80.3	**Surface water catchment area (ha):**	733.80	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	4.14	NA
Alluvium (clay, silt, sand and gravel)	0.07	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	2.63	Secondary A	High
Stanford Formation (limestone)	1.58	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	71 to 75	**Estimated depth to regional water table to nearest metre (m):**	0 to 7
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	153DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 6 - Sidling's Copse and College Pond

Site ID:	6	**Site name:**	Sidling's Copse and College Pond
Area (ha):	22.31	**Authority area:**	South Oxfordshire
Designation(s):	Sidlings Copse & College Pond SSSI		
Site description:	The largest of the fen sites formed around springs in the Stowood area, this was once one of the county's richest sites for fen plants and supported Annex 1 alkaline fen habitat. An open area of fen still remains in the central valley-bottom area of the Sidling's Copse part of the site, but it has lost many species. The College Pond part of the site was formerly open fen but has become degraded by invasion by scrub and trees. The north-eastern half of the site is managed as Sydlings Copse nature reserve by BBOWT.		

Surface water

Site elevation range (mAOD):	72.8 to 114.9	**Surface water catchment area (ha):**	174.58	**WFD operational catchment:**	Cherwell

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	16.09	NA
Peat (peat)	2.66	Unproductive
Alluvium (clay, silt, sand and gravel)	2.66	Secondary A
Head (clay, silt, sand and gravel)	0.90	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)

Temple Cowley Member (sandstone and siltstone, interbedded) Beckley Sand Member (sandstone)	12.27	Secondary A	High
West Walton Formation (mudstone) Weymouth Member (mudstone)	3.60	Unproductive	Low
Arngrove Spiculite Member (sandstone)	3.18	Secondary A	High
Wheatley Limestone Member (limestone)	2.45	Secondary A	High
Kimmeridge Clay Formation (mudstone)	0.81	Unproductive	Low

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	79 to 96	**Estimated depth to regional water table to nearest metre (m):**	0 to 26
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	Unclear, but possibly to south-east	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit; however, some of southern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and western part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978).

Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 7 - Wytham Ditches and Flushes

Site ID:	7	**Site name:**	Wytham Ditches and Flushes
Area (ha):	2.74	**Authority area:**	Vale of White Horse
Designation(s):	Wytham Ditches & Flushes SSSI		
Site description:	The eponymous flushes of this site north of Wytham are located around a series of springs on a terrace above the Thames floodplain. One of the few remaining populations of Common Cottongrass in the county is present, as well as a variety of other wetland plants. The site is included in Natural England's inventory of alkaline fen habitat.		

Surface water

Site elevation range (mAOD):	58.4 to 63.1	**Surface water catchment area (ha):**	125.02	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	2.18	Secondary A
None	0.56	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	2.74	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	0 to 0	**Estimated depth to regional water table to nearest metre (m):**	0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Springs in site suggest that River Terrace Deposits to the south may be more extensive than mapped by BGS and extend into the site. Downgradient (northern) boundary catchment defined as 50 m minimum buffer distance; upgradient (southern) boundary largely defined by superficials catchment. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 8 - Marley Fens

Site ID:	8	**Site name:**	Marley Fens
Area (ha):	2.16	**Authority area:**	Vale of White Horse
Designation(s):	Wytham Woods SSSI		
Site description:	The Marley fens consists of two parallel valleys in Marley Wood, on the eastern side of Wytham Hill, draining east toward the Seacourt Stream. The northern valley is open fen and is managed by Oxford University. The valley to the south has become degraded and invaded by scrub. Both valleys have peat deposits and are fed by tufa-forming springs.		

Surface water

Site elevation range (mAOD):	78.7 to 104.2	**Surface water catchment area (ha):**	11.19	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	2.16	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	1.39	Unproductive	Low
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	0.78	Secondary A	High

Groundwater

WFD groundwater body: NA

Estimated elevation of regional water table to nearest metre (mAOD):	91 to 132	**Estimated depth to regional water table to nearest metre (m):**	0 to 4

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	134degE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

North-eastern part of site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit; however, south-western part of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. Local knowledge indicates groundwater entering the site from the south and south-west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Most of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 9 - Tuckmill Meadows

Site ID:	9	**Site name:**	Tuckmill Meadows
Area (ha):	5.70	**Authority area:**	Vale of White Horse
Designation(s):	Tuckmill Meadows LNR, Tuckmill Meadows SSSI		
Site description:	Tuckmill Meadows SSSI is notified for its fen habitat. Fen habitat is found along the valley of the Pennyhooks Brook and a tributary valley to the south. Spring-fed fen habitat is found in the latter area. Tufa springs are present and peat is known from the site (Parker and Goudie, 1998). The site is currently managed as a nature reserve by Earth Trust on behalf of Vale of White Horse council, and by Friends of Tuckmill. The site has been surveyed in detail by Freshwater Habitats Trust (Morris, 2023).		

Surface water

Site elevation range (mAOD):	89.7 to 98.7	**Surface water catchment area (ha):**	1183.80	**WFD operational catchment:**	Upper Thames

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	2.97	NA
Alluvium (clay, silt, sand and gravel)	2.73	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation and Kingston Formation (Undifferentiated)	4.57	Secondary A	High

(sandstone, siltstone and mudstone)			
Stanford Formation (limestone)	1.13	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	98 to 102	**Estimated depth to regional water table to nearest metre (m):**	0

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	144DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Boundary extended to surface water catchment (minor adjustment) to the south. Most of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 10 - Gozzards Ford Fen

Site ID:	10	**Site name:**	Gozzards Ford Fen
Area (ha):	1.57	**Authority area:**	Vale of White Horse
Designation(s):	Gozzards Ford Fen LWS		
Site description:	This is a small site along the Sandford Brook at Gozzards Ford, much of which consists of secondary wet woodland. Open fen habitat is present around springs on the west bank of the brook, which is being restored by the landowners BBOWT. There is no public access.		

Surface water

Site elevation range (mAOD):	66.4 to 69.5	**Surface water catchment area (ha):**	822.13	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	1.18	Secondary A
None	0.39	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	1.55	Secondary A	High
Stanford Formation (limestone)	0.01	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	66 to 68	**Estimated depth to regional water table to nearest metre (m):**	0 to 2
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	161DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Local knowledge indicates groundwater entering the site from the north; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 11 - Limekiln Copse

Site ID:	11	**Site name:**	Limekiln Copse
Area (ha):	11.85	**Authority area:**	Vale of White Horse
Designation(s):	Limekiln Copse and Valley LWS		
Site description:	Limekilin Copse is the southern-most of the series of fen sites along the escarpment of the Corallian west of Oxford, consisting of a long valley cutting south-west to north-east into Hinksey Hill. Fen habitat is a feature of the LWS but the site has not been surveyed in detail.		

Surface water

Site elevation range (mAOD):	62.8 to 101.6	**Surface water catchment area (ha):**	205.56	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	11.86	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Stanford Formation (limestone)	5.40	Secondary A	High
Kingston Formation (sandstone)	4.45	Secondary A	High
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	2.00	Unproductive	Low

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	63 to 91	**Estimated depth to regional water table to nearest metre (m):**	0 to 12
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	121DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Most of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of eastern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the south and south-west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Tongue of unproductive aquifer along Chilswell Valley to the north assumed to act as barrier to any flow upgradient (north-west) of the tongue. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 12 - Louie Memorial Fields

Site ID:	12	**Site name:**	Louie Memorial Fields
Area (ha):	3.17	**Authority area:**	Vale of White Horse
Designation(s):	Louie Memorial Fields LWS		
Site description:	The smallest in the series of fen sites along the Corallian escarpment west of Oxford, Louie Memorial Field supports a small area of fen habitat along a headwater stream. The site is being restored by Botley Parish Council.		

Surface water

Site elevation range (mAOD):	85.4 to 118.4	**Surface water catchment area (ha):**	21.01	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	3.17	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	1.44	Secondary A	High
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	0.90	Unproductive	Low
Stanford Formation (limestone)	0.83	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	90 to 102	**Estimated depth to regional water table to nearest metre (m):**	0 to 15
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	137DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Most of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of northern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the east, south and west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 13 - Raleigh Park

Site ID:	13	**Site name:**	Raleigh Park
Area (ha):	9.69	**Authority area:**	Vale of White Horse
Designation(s):	Raleigh Park LWS		
Site description:	Raleigh Park is a headwater valley supporting a complex of habitats between Harcourt Hill and Yarnells Hill. Fen is formed around a zone of perched seepage on the south side of Yarnells Hill, and in the bottom of the steep valley cutting to the south-west into Harcourt Hill. Fen habitat has been under restoration since 2017, as a collaboration between Friends of Raleigh Park, Oxford City Council, BBOWT and Freshwater Habitats Trust.		

Surface water

Site elevation range (mAOD):	67.0 to 101.7	**Surface water catchment area (ha):**	38.21	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	9.69	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	6.09	Unproductive	Low
Kingston Formation (sandstone)	3.60	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	80 to 110	**Estimated depth to regional water table to nearest metre (m):**	0 to 3
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	128DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Most of site lies over unproductive (low hydraulic conductivity) aquifer and is unlikely to be supported by bedrock groundwater from this unit; however, some of southern part of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the south-east and south-west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 14 - Abbey Fishponds

Site ID:	14	**Site name:**	Abbey Fishponds
Area (ha):	5.65	**Authority area:**	Vale of White Horse
Designation(s):	Abbey Fishponds LWS, Abbey Fishponds LNR		
Site description:	Abbey Fishponds (or Daisybanks) is an urban site in Abingdon, consisting of a pair of convergent valleys fed by springs emerging as the valley cuts through the extensive river terrace deposits in this area. The site is unusual in Oxfordshire, having strongly tufa-forming springs supplied by a superficial aquifer, and it is only one of two sites in the county known to have spring domes, a rare morphological feature of spring-fed fens. The site is managed as a nature reserve by Earth Trust on behalf of Vale of White Horse council.		

Surface water

Site elevation range (mAOD):	53.6 to 60.0	**Surface water catchment area (ha):**	358.03	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	5.26	NA
Summertown-Radley Sand and Gravel Member (sand and gravel)	0.39	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Ampthill Clay Formation and Kimmeridge Clay Formation	5.65	Unproductive	Low

(Undifferentiated)
(Mudstone)

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. Northern and eastern margin of site lie on superficial deposits and may be supported by groundwater within them. Unclear how much of catchment immediately to north-west of site is contributing so it has been extended to the next topographic surface water divide to be conservative. Local knowledge suggests that there may also be connection with superficial deposits to the south (although not mapped as such). Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Much of catchment defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 15 - Chilswell Valley

Site ID:	15	**Site name:**	Chilswell Valley
Area (ha):	7.57	**Authority area:**	Vale of White Horse
Designation(s):	Chilswell Valley LWS		
Site description:	Part of the series of fen sites along the escarpment of the Corallian west of Oxford, Chilswell (or Happy) Valley consists of a long valley cutting south-west to north-east into Hinksey Hill. Fen habitat is located around an extensive area of groundwater seepage toward the north-eastern end of the site. The site is owned and managed by Oxford City Council, and the fen has been under restoration since 2016.		

Surface water

Site elevation range (mAOD):	66.2 to 102.9	**Surface water catchment area (ha):**	133.74	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	7.57	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	3.89	Unproductive	Low
Kingston Formation (sandstone)	2.92	Secondary A	High

Stanford Formation (limestone)	0.76	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	77 to 97	**Estimated depth to regional water table to nearest metre (m):**	0 to 11

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	125DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Around half of site (mostly in the east) lies over unproductive (low hydraulics conductivity) aquifer and is unlikely to be supported by bedrock groundwater from this unit; however, the remainder of the site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the south and south-west; however precise position of groundwater divide not know and therefore assumed to be surface water catchment. Tongue of unproductive aquifer along Hinksey Heights to the north assumed to act as barrier to any flow upgradient (north-west) of the tongue.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 16 - Easington Fen

Site ID:	16	**Site name:**	Easington Fen
Area (ha):	10.44	**Authority area:**	South Oxfordshire
Designation(s):	-		

Site description: Part of the series of fens along the foot of the Chalk escarpment and Upper Greensand outcrop, Easington Fen was known to nineteenth century botanists for a range of fen species. Peat is recorded from the site (Parker and Goudie, 1998). The site was formerly designated as a LWS for its fen habitat, but this has recently been lost due to invasion by trees and scrub. The site has not been investigated in detail recently.

Surface water

Site elevation range (mAOD):	79.0 to 85.7	**Surface water catchment area (ha):**	1975.47	**WFD operational catchment:**	Thame

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	10.26	Secondary A
None	0.18	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Gault Formation (mudstone)	9.59	Unproductive	Low
Upper Greensand Formation (siltstone and sandstone)	0.85	Principal	Medium to High

Groundwater

WFD groundwater body:	Chiltern Chalk Scarp		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	Broadly westwards	**From SPZ:**	Broadly westwards

Basis for delineation of groundwater catchment:	Most of site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit; however, a small area of the northern part of site lies over productive aquifer and may be supported by bedrock groundwater from this unit (indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Superficials to the south of the site may also be supported by bedrock groundwater in productive aquifer not directly underlying the site. Groundwater levels on regional hydrogeological map (1) not shown at site location obtained but it is assumed those which are can be extrapolated to the site which would result in bedrock groundwater levels at around 90 to 100 mAOD (i.e. limited to ground level). Down hydraulic gradient boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 17 - Wheatley Bog

Site ID:	17	**Site name:**	Wheatley Bog
Area (ha):	0.08	**Authority area:**	South Oxfordshire
Designation(s):	-		

Site description: Wheatley Bog is a small area of fen formed around a spring on the floodplain of the River Thame south of Wheatley. There are only two other spring-fed fen sites in Oxfordshire known to be located on a river floodplain (both Evenlode). The site supports a diversity of fen plants that are rare in the Thame catchment, including its only surviving population of Common Cottongrass, a scarce plant in Oxfordshire.

Surface water

Site elevation range (mAOD):	54.8 to 55.7	**Surface water catchment area (ha):**	6.40	**WFD operational catchment:**	Thame

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	0.08	Secondary A
River Terrace Deposits, 1 (sand and gravel)	0.00	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
West Walton Formation (mudstone)	0.08	Unproductive	Low

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials. A fault in the Portland Group crosses this are at almost exactly the location of the site. It is possible that the spring at this site is a result of upwelling through from bedrock through superficials, but this cannot be determined. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Much of catchment defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 18 - Pea Pits Copse

Site ID:	18	**Site name:**	Pea Pits Copse
Area (ha):	6.63	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Pea Pits Copse is a headwater valley north of Shrivenham and at the edge of the National Trust Coleshill Estate. Fen is present around extensive seepages along the valley, and tufa and peat deposits are present. Since 2021, the site has been under restoration by Freshwater Habitats Trust and the National Trust.

Surface water

Site elevation range (mAOD):	85.8 to 93.8	**Surface water catchment area (ha):**	107.44	**WFD operational catchment:**	Upper Thames

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	4.03	NA
Alluvium (clay, silt, sand and gravel)	2.60	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation (mudstone)	2.07	Unproductive	Low
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	4.56	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	88 to 110	**Estimated depth to regional water table to nearest metre (m):**	0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	134degE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Northern part of site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit; however, southern part of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Local knowledge indicates groundwater entering the site from the west, south, and east; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and groundwater upgradient of that catchment. Down hydraulic gradient boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 19 - Chawley Pastures

Site ID:	19	**Site name:**	Chawley Pastures
Area (ha):	3.22	**Authority area:**	Vale of White Horse
Designation(s):	Pasture near Chawley LWS, Chawley footpath LWS		
Site description:	Chawley Pastures consists of fen habitat around a series of springs and headwater streams on the north side of Cumnor Hill. These have been modified by drainage and construction of the A420, and degraded by lack of management. The site retains a small number of characteristic fen plant species. Peat is mapped for the western-most area (Parker and Goudie, 1998), and there are tufa deposits throughout.		

Surface water

Site elevation range (mAOD):	84.1 to 110.1	**Surface water catchment area (ha):**	31.99	**WFD operational catchment:**	Windrush

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	2.85	NA
Peat (peat)	0.37	Unproductive

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	1.81	Secondary A	High
Kingston Formation (sandstone)	0.73	Secondary A	High

Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	0.68	Unproductive	Low

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	89 to 107	**Estimated depth to regional water table to nearest metre (m):**	0 to 3

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	157DegW	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Most of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of northern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Boundary of site over unproductive aquifer defined as 50 m minimum buffer distance. Local knowledge indicates groundwater entering the site from the south; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 20 - Peat Bottom Wood

Site ID:	20	**Site name:**	Peat Bottom Wood
Area (ha):	5.37	**Authority area:**	Vale of White Horse
Designation(s):	Buckland Warren Woods LWS		

Site description: Peat Bottom Wood lies in a shallow valley along a headwater stream at the southern edge of Buckland Warren. Most of the site appears to have been wooded since at least the nineteenth century, but the western-most part was open and supported species-rich fen into the 1960s. It was then that Fen Sedge (Cladium mariscus) was last seen in the county, and a diversity of other species indicative of Annex 1 alkaline fen habitat were then present. No survey has been carried out recently, but trees and scrub appear to have invaded much of the former open area.

Surface water

Site elevation range (mAOD):	82.7 to 91.2	**Surface water catchment area (ha):**	165.48	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	4.92	Secondary A
None	0.45	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (limestone, ooidal)	5.22	Secondary A	High

Kingston Formation (sandstone)	0.15	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	86 to 90	**Estimated depth to regional water table to nearest metre (m):**	0 to 2
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	129DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 21 - Pennyhooks Brook Marsh

Site ID:	21	**Site name:**	Pennyhooks Brook Marsh
Area (ha):	9.92	**Authority area:**	Vale of White Horse
Designation(s):	Penny Hooks Brook and Marsh LWS		
Site description:	Lying on the Pennyhooks Brook just downstream from Tuckmill Meadows SSSI, this site is assumed to have a similar hydrology and range of wetland habitats. The LWS includes fen habitat as a feature of the site, but the type, extent and condition of fen habitat has not been investigated in detail.		

Surface water

Site elevation range (mAOD):	82.7 to 96.3	**Surface water catchment area (ha):**	100.84	**WFD operational catchment:**	Upper Thames

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	5.60	NA
Alluvium (clay, silt, sand and gravel)	4.32	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation and Kingston Formation (Undifferentiated) (sandstone, siltstone and mudstone)	9.38	Secondary A	High

Highworth Limestone Member (limestone)	0.54	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	103 to 110	**Estimated depth to regional water table to nearest metre (m):**	0

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	143DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Local knowledge indicates groundwater entering the site from the south; however precise position of groundwater divide not know and therefore assumed to be ridge line along south-eastern boundary as far as topographic high and groundwater upgradient of that. Most of north-eastern boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 22 - West Hagbourne Moor

Site ID:	22	**Site name:**	West Hagbourne Moor
Area (ha):	11.46	**Authority area:**	South Oxfordshire
Designation(s):	-		

Site description: In the nineteenth century West Hagbourne Moor supported many fen plant species that are now rare in the county. The site is private and has not been surveyed since the 1970s, but based on satellite imagery and survey from the public footpath, fen habitat is still present.

Surface water

Site elevation range (mAOD):	54.9 to 57.2	**Surface water catchment area (ha):**	1723.08	**WFD operational catchment:**	South Chilterns

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	11.46	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Upper Greensand Formation (siltstone and sandstone)	11.46	Principal	High

Groundwater

WFD groundwater body:	Vale of White Horse Chalk		
Estimated elevation of regional water table to nearest metre (mAOD):	c.55	**Estimated depth to regional water table to nearest metre (m):**	c.0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	33DegE	**From SPZ:**	Broadly west to east

Basis for delineation of groundwater catchment:	Unclear if bedrock groundwater levels at the site are coincident with those shown nearby for the chalk, but it is assumed that they are. Site lies over highly productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Upgradient extent of catchment truncated by SPZ. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Down hydraulic gradient boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 23 - Turfpit Copse

Site ID:	23	**Site name:**	Turfpit Copse
Area (ha):	2.26	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Turfpit Copse lies in a headwater valley on the edge of the National Trust Coleshill Estate at Great Coxwell. Nothing is known about the site except for the presence of peat deposits (Parker and Goudie, 1998). Aerial photograph indicate that in the mid-twentieth century the site was less wooded than today. The situation and geology are typical of fens on the Corallian ridge, so that given the presence of peat, the occurrence of fen at least in the recent past is likely.

Surface water

Site elevation range (mAOD):	99.3 to 110.0	**Surface water catchment area (ha):**	188.12	**WFD operational catchment:**	Upper Thames

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	1.24	Secondary A
None	1.02	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	2.26	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	106 to 110	**Estimated depth to regional water table to nearest metre (m):**	0 to 1

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	163DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Local knowledge indicates groundwater entering the site from the east; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and groundwater upgradient of that catchment. Southern part of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 24 - Lower Ash Bed

Site ID:	24	**Site name:**	Lower Ash Bed
Area (ha):	0.56	**Authority area:**	Vale of White Horse
Designation(s):	Buckland Warren Woods LWS		

Site description: Lower Ash Bed is a valley within Buckland Warren, along a headwater stream that rises from springs south of Buckland. The site boundary is delineated around an area where peat is recorded (Parker and Goudie, 1998). However, the site has not been investigated and existing or former fen habitat may extend across a larger area, including along the valley to the north. Aerial photographs from the mid-twentieth century suggest the valley had large open areas at that time, potentially fen.

Surface water

Site elevation range (mAOD):	81.6 to 84.9	**Surface water catchment area (ha):**	208.87	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	0.47	Secondary A
None	0.09	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (limestone, ooidal)	0.56	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	84 to 85	**Estimated depth to regional water table to nearest metre (m):**	0 to -1
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	133DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 25 - Turf Pits Covert

Site ID:	25	**Site name:**	Turf Pits Covert
Area (ha):	11.54	**Authority area:**	Vale of White Horse
Designation(s):	Turf Pits Covert LWS		

Site description: Turf Pits Covert is a woodland along the west side of Cherbury Camp where peat has been recorded (Parker and Goudie, 1998). Most of the site appears to have been wooded since the nineteenth century, but the site is not thought to be ancient woodland. There is limited recent information on the vegetation across the site, or the location and extent of peat deposits.

Surface water

Site elevation range (mAOD):	66.1 to 71.5	**Surface water catchment area (ha):**	671.54	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	8.86	Secondary A
None	2.68	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (limestone, ooidal)	10.46	Secondary A	High
Kingston Formation (sandstone)	1.07	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	68 to 71	**Estimated depth to regional water table to nearest metre (m):**	0 to 1
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	128DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 26 - Lovell's Court Wood

Site ID:	26	**Site name:**	Lovell's Court Wood
Area (ha):	2.83	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Lovell's Court Wood lies along one of the headwater streams rising at springs in the Pusey area. Peat is known from the site (Parker and Goudie, 1998) but otherwise there is no site-level information. Aerial photographs show that the site was largely open in the mid-twentieth century, but has since been colonised by scrub and trees.

Surface water

Site elevation range (mAOD):	70.3 to 73.4	**Surface water catchment area (ha):**	398.61	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	2.42	Secondary A
None	0.41	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	2.29	Secondary A	High
Kingston Formation (limestone, ooidal)	0.54	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	70 to 73	**Estimated depth to regional water table to nearest metre (m):**	0 to 2
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	140DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 27 - Vale Ground

Site ID:	27	**Site name:**	Vale Ground
Area (ha):	2.11	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Vale Ground is a mostly wooded site around the source of a stream between Longworth and Southmoor. There is very limited biological data for the site, but it is known to have peat deposits (Parker and Goudie, 1998). Aerial photography from the mid-twentieth century show the site as open habitat, likely fen. The location is typical of fens on the Corallian.

Surface water

Site elevation range (mAOD):	79.8 to 86.0	**Surface water catchment area (ha):**	66.21	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	1.21	NA
Alluvium (clay, silt, sand and gravel)	0.90	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	1.71	Secondary A	High
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	0.40	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	81 to 84	**Estimated depth to regional water table to nearest metre (m):**	0 to 2
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	163DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 28 - Marcham Bog South

Site ID:	28	**Site name:**	Marcham Bog South
Area (ha):	10.52	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Named after a name used for Barrow Farm Fen by botanists in the nineteenth and early twentieth century, this site extends wetland within Barrow Farm Fen SSSI to the south and west. The western area has an extensive peat deposit but was drained probably during the Second World War and then cultivated until around 1980. Part of this area has reverted to fen. The area to the south along the Sandford Brook is a mosaic of fen and grassland and has not been investigated in detail.

Surface water

Site elevation range (mAOD):	55.4 to 61.5	**Surface water catchment area (ha):**	1114.32	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	9.69	Secondary A
None	0.82	NA
Northmoor Sand and Gravel Member, Lower Facet (sand and gravel)	0.01	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)

Stanford Formation (limestone)	6.62	Secondary A	High
Ampthill Clay Formation and Kimmeridge Clay Formation (Undifferentiated) (Mudstone)	3.90	Unproductive	Low

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD): 60 to 60

Estimated depth to regional water table to nearest metre (m): 0 to 1

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: 166DegE

From SPZ: None close enough

Basis for delineation of groundwater catchment:

Most (northern part) of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site; however, some of southern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Local knowledge suggests that there in no significant flow from superficials to the west. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 29 - Roke Marsh

Site ID:	29	**Site name:**	Roke Marsh
Area (ha):	0.81	**Authority area:**	South Oxfordshire
Designation(s):	-		
Site description:	Formerly designated as an SSSI, Roke Marsh site was not renotified following the passing of the Wildlife and Countryside Act 1981 as the site had been severely damaged. It is not known what fen habitat or biodiversity the site currently supports.		

Surface water

Site elevation range (mAOD):	56.4 to 57.3	**Surface water catchment area (ha):**	8.75	**WFD operational catchment:**	South Chilterns

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	0.81	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Gault Formation (mudstone)	0.81	Unproductive	Low

Groundwater

WFD groundwater body:	NA

Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Much of catchment defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 30 - Henton Fen

Site ID:	30	**Site name:**	Henton Fen
Area (ha):	2.00	**Authority area:**	South Oxfordshire
Designation(s):	-		

Site description: Henton Fen lies north-east of Chinnor along a chalk stream that forms the boundary between Oxfordshire and Buckinghamshire. There is very limited recent information about the site and its habitats, but fen habitat is considered likely to have been present based on past botanical records. Aerial photographs show that the site was completely open in the mid-twentieth century, but began to become significantly colonised by scrub and trees from the early 1990s.

Surface water

Site elevation range (mAOD):	87.5 to 91.1	**Surface water catchment area (ha):**	97.53	**WFD operational catchment:**	Thame

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Tufa (tufa, calcareous)	1.81	Secondary A
None	0.19	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Gault Formation (mudstone)	2.00	Unproductive	Low

Groundwater

WFD groundwater body:	None		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA
Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Much of catchment defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs		

Site 31 - Noke Wood

Site ID:	31	**Site name:**	Noke Wood & Sling Copse
Area (ha):	22.13	**Authority area:**	Cherwell
Designation(s):	Noke Wood & Sling Copse LWS		
Site description:	Noke Wood & Sling Copse is an ancient woodland site that includes a series of tufa-forming springs. Peat deposits are also recorded from the site (Parker and Goudie, 1998). The site is currently completely wooded and the historic location and extent of fen habitat are unknown.		

Surface water

Site elevation range (mAOD):	60.9 to 93.9	**Surface water catchment area (ha):**	83.41	**WFD operational catchment:**	Oxon Ray

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	21.92	NA
Head (clay, silt, sand and gravel)	0.21	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Weymouth Member (mudstone)	18.70	Unproductive	Low
West Walton Formation (mudstone)	1.81	Unproductive	Low
Stewartby Member (mudstone)	1.62	Unproductive	Low

Groundwater

WFD groundwater body:	None		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials , but only in a small area in the south-west corner of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and northern part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 32 - Cookes Copse

Site ID:	32	**Site name:**	Cookes Copse
Area (ha):	2.49	**Authority area:**	South Oxfordshire
Designation(s):	Cookes Copse LWS		
Site description:	Cookes Copse is an ancient woodland site that includes a series of tufa-forming springs along the southern edge of the site. Aerial photographs from the mid-twentieth century show these areas as open habitat, but they are now largely covered in trees.		

Surface water

Site elevation range (mAOD):	88.5 to 113.7	**Surface water catchment area (ha):**	29.63	**WFD operational catchment:**	Oxon Ray

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	2.49	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
West Walton Formation (mudstone)	1.98	Unproductive	Low
Beckley Sand Member (sandstone)	0.52	Secondary A	High

Groundwater

WFD groundwater body:	Headington Corallian			
Estimated elevation of regional water table to nearest metre (mAOD):		98 to 114	**Estimated depth to regional water table to nearest metre (m):**	0 to 3
Regional groundwater flow direction (degrees)				
From BGS hydrogeological map:	Unclear, but probably southward	**From SPZ:**	None close enough	

Basis for delineation of groundwater catchment:	Most of site (incorporating northern and eastern parts) lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit; however, some of south-western part of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and northern part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 33 - The Osiers

Site ID:	33	**Site name:**	The Osiers
Area (ha):	2.37	**Authority area:**	South Oxfordshire
Designation(s):	-		
Site description:	The Osiers continues north the line of springs between Headington Wick and Elsfield. Unlike the nearby Sidlings Copse and College Pond SSSI, little is known about this site, but peat is recorded (Parker and Goudie, 1998).		

Surface water

Site elevation range (mAOD):	79.2 to 111.6	**Surface water catchment area (ha):**	40.13	**WFD operational catchment:**	Cherwell

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Peat (peat)	1.12	Unproductive
None	0.88	NA
Head (clay, silt, sand and gravel)	0.37	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Beckley Sand Member (sandstone)	2.09	Secondary A	High
West Walton Formation (mudstone)	0.27	Unproductive	Low

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	83 to 93	**Estimated depth to regional water table to nearest metre (m):**	0 to 20
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	Unclear, but possibly to south-east	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of southern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and south-western part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 34 - Simon's Land

Site ID:	34	**Site name:**	Simon's Land
Area (ha):	0.17	**Authority area:**	South Oxfordshire
Designation(s):	-		
Site description:	A small site around a spring on the Corallian above the River Thames west of Littlemore. The site is owned and managed by Oxford Preservation Trust who are restoring fen habitat.		

Surface water

Site elevation range (mAOD):	54.0 to 59.2	**Surface water catchment area (ha):**	1.42	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.17	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Beckley Sand Member (sandstone)	0.09	Secondary A	High
Temple Cowley Member (sandstone and siltstone, interbedded)	0.08	Secondary A	High

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	55 to 55	**Estimated depth to regional water table to nearest metre (m):**	0 to 4

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	150DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Upgradient parts of boundary extended to surface water catchment.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 35 - Bog Under Stow Wood

Site ID:	35	**Site name:**	Bog Under Stow Wood
Area (ha):	0.44	**Authority area:**	South Oxfordshire
Designation(s):	-		

Site description: The 'bog under Stow Wood' was well known to botanists during the 18th and 19th centuries as a locality for rare fen plants. However, trees and scrub colonised the site during the twentieth century and no open habitat remains. There are no biological data from the site since the mid-twentieth century. The site is included in Natural England's inventory of alkaline fen sites, although it is not precisely located.

Surface water

Site elevation range (mAOD):	109.3 to 119.9	**Surface water catchment area (ha):**	21.36	**WFD operational catchment:**	Cherwell

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.44	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Beckley Sand Member (sandstone)	0.44	Secondary A	High

Groundwater

WFD groundwater body:	Headington Corallian				
Estimated elevation of regional water table to nearest metre (mAOD):		99 to 102	**Estimated depth to regional water table to nearest metre (m):**	10 to 19	
Regional groundwater flow direction (degrees)					
From BGS hydrogeological map:	Unclear, but possibly south-eastward	**From SPZ:**	None close enough		

Basis for delineation of groundwater catchment:	Available data indicate that bedrock groundwater may be at several metres depth below the site and therefore not contributing to it; however, the mapped absence of superficials means that they are also not a source of groundwater for the site. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and southern part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 36 - Beckley Common

Site ID:	36	**Site name:**	Beckley Common
Area (ha):	7.48	**Authority area:**	South Oxfordshire
Designation(s):	-		
Site description:	This site consists of a series of partly drained tufa-forming springs on the hill south-west of Beckley. The site has not been surveyed in detail, and data on the current condition and biodiversity value of the site are limited.		

Surface water

Site elevation range (mAOD):	84.4 to 116.6	**Surface water catchment area (ha):**	51.08	**WFD operational catchment:**	Oxon Ray

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	7.48	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
West Walton Formation (mudstone)	6.33	Unproductive	Low
Beckley Sand Member (sandstone)	0.69	Secondary A	High
Weymouth Member (mudstone)	0.46	Unproductive	Low

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	95 to 114	**Estimated depth to regional water table to nearest metre (m):**	0 to 5
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	Unclear, but probably to the south	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Most of site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit; however, some of eastern and southern parts of site lie over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. There is some uncertainty regarding the direction of flow of groundwater and no information from the hydrogeological map (1). In the absence of detailed site-specific data, it is assumed that groundwater and surface water catchments are coincident. Downgradient and some of northern and north-western part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 37 - Frilford Heath, Ponds and Fens

Site ID:	37	**Site name:**	Frilford Heath, Ponds and Fens
Area (ha):	100.25	**Authority area:**	Vale of White Horse
Designation(s):	Frilford Heath, Ponds & Fens SSSI		
Site description:	Fen habitat within this large SSSI is found along the Blackwater Brook within the Frilford Heath Golf Course, and along the Marcham Brook to the south. The SSSI notification includes several ponds, created by damming the valley and flooding areas of former fen habitat. The site supports a small area of Annex 1 alkaline fen habitat. Areas of degraded fen habitat have been subject to restoration over the last decade but there remains much in a degraded state, having been drained or invaded by trees and scrub during the twentieth century. Parts of the SSSI have not been surveyed for decades; as recent comprehensive habitat survey data are not available, the whole SSSI boundary has been included in this fen site, except for unit 2 (Hitchcopse Pit) and the part of unit 1 east of Frilford Heath Golf Club, along Faringdon Road.		

Surface water

Site elevation range (mAOD):	60.7 to 80.6	**Surface water catchment area (ha):**	1770.35	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	93.30	NA
Alluvium (clay, silt, sand and gravel)	6.95	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)

Kingston Formation (sandstone)	84.60	Secondary A	High
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	15.65	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	60 to 76	**Estimated depth to regional water table to nearest metre (m):**	0 to 6

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	163DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Groundwater drainage into watercourse to the north-west of the site may result in groundwater divide close to surface water catchment divide; however underflow cannot be ruled out, and groundwater catchment has been extended northwards in line with hydrogeological map. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 38 - Shotover Hill

Site ID:	38	**Site name:**	Shotover Hill
Area (ha):	18.60	**Authority area:**	South Oxfordshire
Designation(s):	Brasenose Wood & Shotover Hill SSSI, Monks Wood Grassland LWS		
Site description:	There are many springs around Shotover Hill and the fen site delineated takes in the area known locally as Long Marsh within Shotover Hill SSSI, the Monks Wood Grassland LWS and an undesignated area of springs to the north of the SSSI. The LWS has not been surveyed in detail, so that the extent and condition of fen is not known, but fen habitat is referred to as a feature of the site. There is no information about the undesignated area of springs.		

Surface water

Site elevation range (mAOD):	114.5 to 158.4	**Surface water catchment area (ha):**	73.16	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	16.08	NA
Head (clay, silt, sand and gravel)	2.52	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kimmeridge Clay Formation (mudstone)	8.90	Unproductive	Low
Kimmeridge Clay Formation (siltstone and sandstone)	5.30	Secondary A	Medium to High

Whitchurch Sand Formation (sandstone)	4.40	Secondary A	Medium to High
Portland Group (limestone and calcareous sandstone)	3.53	Secondary A	Medium to High

Groundwater

WFD groundwater body: NA

Estimated elevation of regional water table to nearest metre (mAOD): NA **Estimated depth to regional water table to nearest metre (m):** NA

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: NA **From SPZ:** NA

Basis for delineation of groundwater catchment: Just over half of site lies on productive (high hydraulic conductivity) bedrock and could therefore be supported by groundwater from this unit; however, productive units at the site are expected to be hydraulically isolated from the underlying regional (Corallian) aquifer by intervening low hydraulic conductivity units and no data has been seen regarding bedrock groundwater levels. Groundwater catchment in productive units is assumed to follow surface water flow routes. The remainder of the site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported by groundwater from this unit. Some parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 39 - Birch Copse

Site ID:	39	**Site name:**	Birch Copse
Area (ha):	12.60	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Birch Copse on the north-east side of Boars Hill is believed to be the site that Druce describes as the bog above Childsey (i.e. Chilswell) and that was known as a rich locality for wetland plants to him and earlier botanists. It once supported a range of rich-fen and poor-fen species, indicating a mix of water chemistries. Druce describes it as having been partly destroyed in the late nineteenth century and there has been no investigation of the site since. The site now appears to be largely wooded, but much of it was open habitat in the mid-twentieth century.

Surface water

Site elevation range (mAOD):	110.2 to 159.1	**Surface water catchment area (ha):**	38.89	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	12.43	NA
Northern Drift Formation (sand and gravel)	0.17	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Lower Greensand Group (sandstone)	6.87	Secondary A	Medium to High

Ampthill Clay Formation and Kimmeridge Clay Formation (Undifferentiated) (Mudstone)	5.64	Unproductive	Low
Stanford Formation (limestone)	0.09	Secondary A	Low

Groundwater

WFD groundwater body: NA

Estimated elevation of regional water table to nearest metre (mAOD): 99 to 102

Estimated depth to regional water table to nearest metre (m): 12 to 59

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: NA

From SPZ: None close enough

Basis for delineation of groundwater catchment:

Around half of site lies over productive aquifer (to the west) and may be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, most of the remainder (eastern half) of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. A small part of the eastern end of the site lies over the Corallian aquifer, but groundwater level and depth (as quoted above) indicates no support from this aquifer. Productive aquifer in the western half of the site forms an outlier of relatively limited extent and hydraulically separated from the underlying Corallian aquifer by unproductive units. Regional hydrogeological map (1) does not show groundwater levels in this aquifer unit but it has been assumed that they may be close to surface. Groundwater flow is assumed to follow surface water flow directions. Downgradient part of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 40 - South of Turf Pits Covert

Site ID:	40	**Site name:**	South of Turf Pits Covert
Area (ha):	7.78	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: This site along an un-named headwater stream north of Charney Bassett was formerly arable farmland, but in the last 30 years fen has re-established in part of the site no longer cultivated. In the early 2000s a population of Fen Pondweed (Potamogeton coloratus) was discovered in the stream, one of only three sites in the county. The site has not been investigated in detail.

Surface water

Site elevation range (mAOD):	65.4 to 68.1	**Surface water catchment area (ha):**	959.43	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	6.49	Secondary A
None	1.29	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	7.78	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	67 to 70	**Estimated depth to regional water table to nearest metre (m):**	0

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	120DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Local knowledge indicates groundwater entering the site from the south; however precise position of groundwater divide not know and therefore assumed to be surface water catchment. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 41 - Chinham Copse

Site ID:	41	**Site name:**	Chinham Copse
Area (ha):	4.95	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Chinham Copse lies in a shallow valley near the source of the Frogmore Brook between Faringdon and Hatford. Part of the site is wooded and was formerly designated as a LWS for its wet woodland habitat fed by springs and associated plants. The open area on the south side of the site consists of fen around a seepage zone, apparently an area that was formerly cultivated. The site has not been investigated in detail.

Surface water

Site elevation range (mAOD):	93.0 to 100.6	**Surface water catchment area (ha):**	134.57	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	4.20	Secondary A
None	0.75	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (limestone, ooidal)	4.95	Secondary A	High

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	4.20	Secondary A
None	0.75	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (limestone, ooidal)	4.95	Secondary A	High

Site 42 - Old Pump House

Site ID:	42	**Site name:**	Old Pump House
Area (ha):	0.55	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Old Pump House is the name of the house west of this site, which lies on a slope above an un-named headwater stream that rises south-east of Farringdon around Wicklesham Copse. The site was not wooded until planted with trees in the latter part of the twentieth century, and before then aerial photographs indicate fen habitat along the valley. The site currently supports a small area of remaining fen but it has not been investigated in detail.

Surface water

Site elevation range (mAOD):	87.3 to 90.7	**Surface water catchment area (ha):**	21.70	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.39	NA
Alluvium (clay, silt, sand and gravel)	0.16	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Stanford Formation (limestone)	0.53	Secondary A	High
Kimmeridge Clay Formation (mudstone)	0.02	Unproductive	Low

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	97 to 97	**Estimated depth to regional water table to nearest metre (m):**	0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	Variable/unclear	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Most of site (to the east) lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site; however, some of the eastern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Area is geologically and structurally complex and there is a high degree of uncertainty regarding groundwater flow directions in this area; the resultant catchment is therefore highly speculative. Contours shown on regional hydrogeological map (1) suggest that faults may be acting as barriers locally. Western boundary of catchment (where greater than 50 m away) therefore defined as BGS mapped linear feature. Linear feature coincident with watercourse also passes through western edge of site. Local knowledge indicates groundwater entering the site from the north; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and groundwater upgradient of that catchment. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Most of southern boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 43 - Fyfield

Site ID:	43	**Site name:**	Fyfield
Area (ha):	6.02	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Lying along the Marcham Brook, little is known about this site. Peat deposits are mapped for this area (Parker and Goudie, 1998), but otherwise there is no information from site-based surveys. From inspection of satellite imagery and the part of the site visible from the A420, it is considered to be likely that the site supports fen habitat.

Surface water

Site elevation range (mAOD):	65.9 to 70.7	**Surface water catchment area (ha):**	1294.08	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	4.75	Secondary A
None	1.27	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	6.02	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	71 to 75	**Estimated depth to regional water table to nearest metre (m):**	0

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	144DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Local knowledge indicates that groundwater may be entering the site from areas further to the west then suggested by the hydrogeological map (1) and it has therefore been extended westwards in line with the surface water catchment what is considered a reasonable distance but not so far as the western end of the surface water catchment (which is considered overly conservative). Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 44 - Wicklesham Copse

Site ID:	44	**Site name:**	Wicklesham Copse
Area (ha):	3.19	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Wicklesham Copse is the area around where an un-named headwater stream rises from springs south-east of Faringdon. In the mid-twentieth century, aerial photographs indicate the presence of fen in the shallow valley around the stream, but since then the site has been much modified by drainage, land use change and succession to scrub and woodland. The site has not been investigated in detail, but tufa and peat deposits have been identified within the site.

Surface water

Site elevation range (mAOD):	91.1 to 98.8	**Surface water catchment area (ha):**	176.41	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	2.53	Secondary A
None	0.66	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (mudstone and sandstone, interbedded)	1.99	Secondary A	High

Ampthill Clay Formation (mudstone)	0.82	Unproductive	Low
Kimmeridge Clay Formation (mudstone)	0.38	Unproductive	Low

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	100 to 100	**Estimated depth to regional water table to nearest metre (m):**	0

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	Variable/uncertain	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Most of site (to the west) lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site; however, some of eastern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Area is geologically and structurally complex and there is a high degree of uncertainty regarding groundwater flow directions in this area and resultant catchment is therefore highly speculative. Contours shown on regional hydrogeological map (1) suggest that faults may be acting as barriers locally. Northern boundary of catchment therefore defined as BGS mapped linear feature which also passes through the middle of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 45 - Tubney Wood

Site ID:	45	**Site name:**	Tubney Wood
Area (ha):	53.65	**Authority area:**	Vale of White Horse
Designation(s):	Tubney Woods LWS		
Site description:	Tubney Wood lies on the hill above Frilford Heath and takes in the headwaters of the Blackwater Brook, including three tributary streams. Most of the site is wooded, but there are open areas of fen around the ponds in the northern area of Frilford Heath, Ponds and Fens SSSI that projects into the site. The valley of the Blackwater also supports areas of seepage along its length, and aerial photographs indicate these were open in the mid-twentieth century, likely supporting fen habitat.		

Surface water

Site elevation range (mAOD):	73.1 to 92.6	**Surface water catchment area (ha):**	87.96	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	52.70	NA
Alluvium (clay, silt, sand and gravel)	0.95	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	48.67	Secondary A	High

Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	4.97	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	74 to 84	**Estimated depth to regional water table to nearest metre (m):**	0 to 11

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	179DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Groundwater drainage into watercourse to the west of the site may result in groundwater divide close to surface water catchment divide; however underflow cannot be ruled out, and groundwater catchment has been extended northwards in line with hydrogeological map. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 46 - Hydes Farm Fen

Site ID:	46	**Site name:**	Hydes Farm Fen
Area (ha):	1.10	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: This site lies in a small valley along a headwater tributary of the Sandford Brook that rises from springs in Marcham. There is no site-level information about the site but it is similar in elevation and geology to Barrow Farm Fen SSSI to the east, so that groundwater flow to the site and stream are likely. Satellite imagery strongly suggests the presence of fen habitat along the east side of the valley.

Surface water

Site elevation range (mAOD):	55.8 to 58.6	**Surface water catchment area (ha):**	84.16	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.66	NA
Alluvium (clay, silt, sand and gravel)	0.44	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Stanford Formation (limestone)	1.10	Secondary A	High

Groundwater

WFD groundwater body:	Shrivenham Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	60 to 60	**Estimated depth to regional water table to nearest metre (m):**	0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	158DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Local knowledge indicates groundwater entering the site from the north; however precise position of groundwater divide not know and therefore assumed to be surface water catchment and any groundwater upgradient of that catchment. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 47 - Lincombe Lane

Site ID:	47	**Site name:**	Lincombe Lane
Area (ha):	4.12	**Authority area:**	Vale of White Horse
Designation(s):	Lincombe Lane Field LWS		
Site description:	The LWS at Lincombe Lane includes wetland habitat fed by springs from the Lower Greensand toward the top of Boars Hill. The site was open in the mid-twentieth century but has been invaded by scrub and trees, so that little open fen remains. Peat is recorded from the site (Parker and Goudie, 1998). The site is owned by Oxford Preservation Trust.		

Surface water

Site elevation range (mAOD):	100.2 to 130.6	**Surface water catchment area (ha):**	4.46	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	4.12	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Lower Greensand Group (sandstone)	3.63	Secondary A	Medium to High
Ampthill Clay Formation and Kimmeridge Clay Formation (Undifferentiated) (Mudstone)	0.49	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Most of site lies over productive aquifer and may be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of southern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Productive aquifer forms an outlier of relatively limited extent and hydraulically separated from the underlying Corallian aquifer by unproductive units. Regional hydrogeological map (1) does not show groundwater levels in this aquifer unit but it has been assumed that they may be close to surface. Groundwater flow is assumed to follow surface water flow directions. All of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 48 - Matthew Arnold's Field

Site ID:	48	**Site name:**	Matthew Arnold's Field
Area (ha):	1.57	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: Matthew Arnold's Field is an area of fen fed by springs from the Lower Greensand toward the top of Boars Hill. The site was open in the mid-twentieth century but was invaded by scrub and trees. The site is owned by Oxford Preservation Trust who are restoring fen habitat.

Surface water

Site elevation range (mAOD):	124.5 to 142.4	**Surface water catchment area (ha):**	7.47	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	1.57	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Lower Greensand Group (sandstone)	1.37	Secondary A	Medium to High
Ampthill Clay Formation and Kimmeridge Clay Formation (Undifferentiated) (Mudstone)	0.21	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Most of site lies over productive aquifer and may be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of western part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Productive aquifer forms an outlier of relatively limited extent and hydraulically separated from the underlying Corallian aquifer by unproductive units. Regional hydrogeological map (1) does not show groundwater levels in this aquifer unit but it has been assumed that they may be close to surface. Groundwater flow is assumed to follow surface water flow directions. Downgradient and southern part of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 49 - Old Berkley Golf Course Springs

Site ID:	49	**Site name:**	Old Berkley Golf Course Springs
Area (ha):	2.29	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: A series of springs / flushes on the north side of Boars Hill support small areas of fen habitat. These are limited in botanical diversity, but support the county's only remaining populations of Ivy-leaved Watercrowfoot (Ranunculus hederaceus). The site is owned and managed by Oxford Preservation Trust.

Surface water

Site elevation range (mAOD):	113.1 to 130.4	**Surface water catchment area (ha):**	10.49	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	2.29	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Lower Greensand Group (sandstone)	1.36	Secondary A	Medium to High
Ampthill Clay Formation and Kimmeridge Clay Formation (Undifferentiated) (Mudstone)	0.93	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Most of site lies over productive aquifer and may be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of northern and western part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Productive aquifer forms an outlier of relatively limited extent and hydraulically separated from the underlying Corallian aquifer by unproductive units. Regional hydrogeological map (1) does not show groundwater levels in this aquifer unit but it has been assumed that they may be close to surface. Groundwater flow is assumed to follow surface water flow directions. Downgradient and northern part of boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 50 - Radbrook Common

Site ID:	50	**Site name:**	Radbrook Common
Area (ha):	1.41	**Authority area:**	Vale of White Horse
Designation(s):	Wytham Woods SSSI		
Site description:	Radbrook Common is a valley on the west side of Wytham Hill, draining west toward Farmoor. It consists of two ponds and surrounding areas of fen habitat, fed by springs.		

Surface water

Site elevation range (mAOD):	91.7 to 107.9	**Surface water catchment area (ha):**	48.75	**WFD operational catchment:**	Windrush

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	1.41	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Hazelbury Bryan Formation (sandstone, siltstone and mudstone)	0.71	Secondary A	High
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	0.40	Unproductive	Low
Kingston Formation (sandstone)	0.30	Secondary A	High

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	93 to 140	**Estimated depth to regional water table to nearest metre (m):**	0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	147DegW	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Most of site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site; however, some of southern part of site lies over unproductive aquifer and is unlikely to be supported by bedrock groundwater from this unit. Downgradient and southern part of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 51 - Lye Valley

Site ID:	51	**Site name:**	Lye Valley
Area (ha):	8.15	**Authority area:**	Oxford
Designation(s):	Lye Valley LNR, Lye Valley SSSI, Lye Valley and Cowley Marsh LWS		
Site description:	A valley in urban Headington along the Boundary Brook and a tributary, Lye Valley is biologically one of the richest fen sites in the county. The site is managed as a Nature Reserve by Oxford City Council and volunteers of the Friends of Lye Valley. There has been intensive restoration work at the site over the last decade, and the site now supports a large area of Annex 1 alkaline fen habitat, including many rare fen plants and invertebrates. As an urban site, Lye Valley suffers from many pressures, including erosion from storm drainage, groundwater pollution and recreational pressures.		

Surface water

Site elevation range (mAOD):	69.7 to 97.1	**Surface water catchment area (ha):**	347.96	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Peat (peat)	3.59	Unproductive
None	3.21	NA
Alluvium (clay, silt, sand and gravel)	1.19	Secondary A
Head (clay, silt, sand and gravel)	0.16	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)

Temple Cowley Member (sandstone and siltstone, interbedded)	7.95	Secondary A	Medium to High
Wheatley Limestone Member (limestone)	0.20	Secondary A	Medium to High

Groundwater

WFD groundwater body: Headington Corallian

Estimated elevation of regional water table to nearest metre (mAOD): 68 to 75

Estimated depth to regional water table to nearest metre (m): 1 to 22

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: 161DegE

From SPZ: None close enough

Basis for delineation of groundwater catchment: Catchment has been reproduced from that provided by Dr C Lamberth to Natural England following issue of his October 2007 report "Investigation of the possible hydrological effects on the Lye Valley Sites of Special Scientific Interest and the riparian zones of the Lye and Boundary Brooks as a result of development on Southfield Golf Course".

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 52 - Almonds Farm Bank

Site ID:	52	**Site name:**	Almonds Farm Bank
Area (ha):	0.87	**Authority area:**	Oxford
Designation(s):	Almonds Farm and Burnt Mill Fields LWS		
Site description:	Part of the larger Almonds Farm and Burnt Mill Fields LWS, fen habitat is formed around two springs along a terrace above the floodplain of the River Cherwell. The springs support fen vegetation and several wetland plants of conservation concern, including the only site in Oxfordshire for the priority species Flat Sedge (Blysmus compressus). Tufa deposits are present.		

Surface water

Site elevation range (mAOD):	56.2 to 59.9	**Surface water catchment area (ha):**	47.02	**WFD operational catchment:**	Cherwell

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	0.23	Secondary A
None	0.05	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Oxford Clay Formation and West Walton Formation (Undifferentiated) (Mudstone)	0.29	Unproductive	Low

Groundwater

WFD groundwater body:	NA		
Estimated elevation of regional water table to nearest metre (mAOD):	NA	**Estimated depth to regional water table to nearest metre (m):**	NA
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	NA	**From SPZ:**	NA

Basis for delineation of groundwater catchment:	Site lies on unproductive (low hydraulic conductivity) bedrock and therefore unlikely to be supported (directly) by bedrock groundwater. The site may be supported by groundwater in superficials where it lies at lower elevation. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Entire catchment defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 53 - Dunstan Park

Site ID:	53	**Site name:**	Dunstan Park
Area (ha):	0.13	**Authority area:**	Oxford
Designation(s):	-		
Site description:	Dunstan Park is an area with peat deposits around a tufa-forming spring on the Corallian in Headington. Currently degraded, with limited wetland biodiversity, the site is being restored by Oxford City Council and local experts.		

Surface water

Site elevation range (mAOD):	80.5 to 86.6	**Surface water catchment area (ha):**	1.34	**WFD operational catchment:**	Cherwell

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.08	NA
Peat (peat)	0.05	Unproductive

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Temple Cowley Member (sandstone and siltstone, interbedded)	0.13	Secondary A	High

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	82 to 85	**Estimated depth to regional water table to nearest metre (m):**	0 to 2
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	149degE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:	Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Most of boundary of site defined as 50 m minimum buffer distance. Upgradient parts of boundary extended to surface water catchment. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 54 - Bledlow Fen

Site ID:	54	**Site name:**	Bledlow Fen
Area (ha):	4.28	**Authority area:**	Buckinghamshire
Designation(s):	-		
Site description:	A small site in the North Buckinghamshire fen series (Wheeler, 1997) fed by Chalk springs. There has been no survey since the 1990s.		

Surface water

Site elevation range (mAOD):	104.1 to 116.5	**Surface water catchment area (ha):**	34.51	**WFD operational catchment:**	Thame

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Head (clay, silt, sand and gravel)	3.18	Secondary (undifferentiated)
None	1.03	NA
River Terrace Deposits, 1 (sand and gravel)	0.07	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
West Melbury Marly Chalk Formation (chalk)	4.04	Principal	High
Glauconitic Marl Member (sandstone, glauconitic)	0.24	Principal	High

Groundwater

WFD groundwater body: NA

Estimated elevation of regional water table to nearest metre (mAOD):	110	**Estimated depth to regional water table to nearest metre (m):**	0 to 6.5

Regional groundwater flow direction (degrees)

From BGS hydrogeological map: 27DegW **From SPZ:** Unclear

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Site 55 - Little Bradfield Farm

Site ID:	55	**Site name:**	Little Bradfield Farm
Area (ha):	1.57	**Authority area:**	Vale of White Horse
Designation(s):	-		

Site description: This site by Little Bradfield Farm forms part of the headwaters of the Sandford Brook, lying in a shallow valley on the west side of the Brook, with a tributary stream rising from a spring in the north-west of the site. Fen habitat lies on seasonally wet ground along the stream, and supports a range of fen plants. The site is unusual locally for a drier headwater area such as this to have survived agricultural improvement and to have retained a continuity of management, here by grazing.

Surface water

Site elevation range (mAOD):	94.4 to 98.2	**Surface water catchment area (ha):**	344.43	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	1.52	NA

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Kingston Formation (sandstone)	1.51	Secondary A	High
Stanford Formation (limestone)	0.02	Secondary A	High

Groundwater

WFD groundwater body: Shrivenham Corallian

Estimated elevation of regional water table to nearest metre (mAOD):	94 to 96	**Estimated depth to regional water table to nearest metre (m):**	0 to 3

Regional groundwater flow direction (degrees)

From BGS hydrogeological map:	180	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit at and up hydraulic gradient of the site. Catchment has been delineated taking into account groundwater contours presented in Rigare's 2016 report (2) which was derived using data presented on the regional hydrogeological map (1) and local groundwater level data. Downgradient parts of boundary of site defined as 50 m minimum buffer distance.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs
2. Rigare (2016). Eco-hydrological assessment of the risks to the long-term integrity of Cothill Fen SAC, Oxon, Report Ref: Rigare 1605_r1

Site 56 - Letcombe Fen

Site ID:	56	**Site name:**	Letcombe Fen
Area (ha):	1.72	**Authority area:**	Vale of White Horse
Designation(s):	Letcombe Reed Swamp LWS		
Site description:	The south-westerly most fen site of the series along the Chalk / Upper Greensand running across the south of Oxfordshire, Letcombe Fen is formed around a series of springs on the floodplain of the Letcombe Brook, a chalk stream. Tufa and peat deposits are present. The LWS identifies reedbeds priority habitat as a feature of the site, but the area of Common Reed dominated tall herb fen represents degraded fen rather than reedbeds priority habitat.		

Surface water

Site elevation range (mAOD):	91.0 to 94.3	**Surface water catchment area (ha):**	1298.80	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
Alluvium (clay, silt, sand and gravel)	1.49	Secondary A
Head (clay, silt, sand and gravel)	0.23	Secondary (undifferentiated)

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Upper Greensand Formation (siltstone and sandstone)	1.72	Principal	High

Groundwater

WFD groundwater body:	Vale of White Horse Chalk		
Estimated elevation of regional water table to nearest metre (mAOD):	c.95	**Estimated depth to regional water table to nearest metre (m):**	c.0
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	140DegW	**From SPZ:**	Broadly north to south
Basis for delineation of groundwater catchment:	Unclear if bedrock groundwater levels at the site are coincident with those shown nearby for the chalk, but it is assumed that they are. Site lies over highly productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Upgradient extent of catchment in line with southern extent of nearby SPZs. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Down hydraulic gradient boundary of site defined as 50 m minimum buffer distance. Footnotes/data sources: 1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs		

Site 57 - Rivermead

Site ID:	57	**Site name:**	Rivermead
Area (ha):	0.72	**Authority area:**	Oxford
Designation(s):	-		
Site description:	Rivermead is a small site on the spring line of the Corallian above the River Thames below Rose Hill. The site is owned and managed by Oxford City Council, who have been restoring fen habitat.		

Surface water

Site elevation range (mAOD):	55.1 to 64.2	**Surface water catchment area (ha):**	21.33	**WFD operational catchment:**	Ock

Geology

Superficial geology (in decreasing order of coverage):

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation
None	0.69	NA
Alluvium (clay, silt, sand and gravel)	0.03	Secondary A

Solid geology outcrop:

Description (lithology)	Approx. coverage (ha)	EA / BGS Aquifer designation	Potential for hydraulic connection to site (including through superficials)
Temple Cowley Member (sandstone and siltstone, interbedded)	0.39	Secondary A	High
Beckley Sand Member (sandstone)	0.33	Secondary A	High

Groundwater

WFD groundwater body:	Headington Corallian		
Estimated elevation of regional water table to nearest metre (mAOD):	55 to 57	**Estimated depth to regional water table to nearest metre (m):**	0 to 8
Regional groundwater flow direction (degrees)			
From BGS hydrogeological map:	150DegE	**From SPZ:**	None close enough

Basis for delineation of groundwater catchment:

Site lies over productive aquifer with groundwater levels close to / at surface and is likely to be supported by bedrock groundwater from this unit (both directly and indirectly through superficials) at and up hydraulic gradient of the site. Groundwater flow in superficials assumed to be broadly in line with surface topographic slope direction and perpendicular to watercourses / drainage features at point of discharge. Downgradient parts of boundary of site defined as 50 m minimum buffer distance. Upgradient parts of boundary extended to surface water catchment.

Footnotes/data sources:
1. Institute of Geological Sciences and Thames Water Authority (1978). Hydrogeological Map of the South West Chilterns and the Berkshire and Marlborough Downs

Appendix 3 Risk zone maps

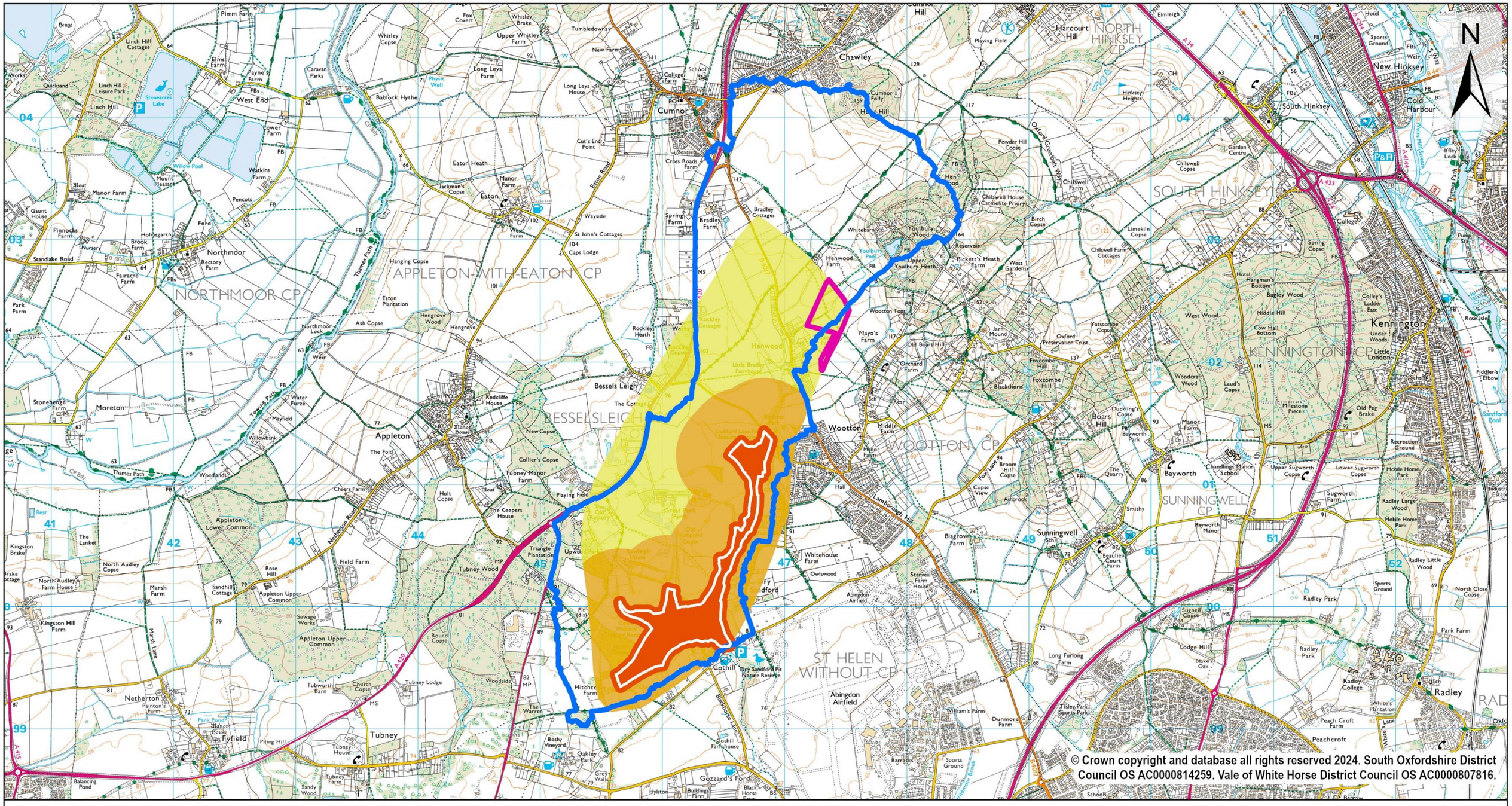


Figure A3.1 Risk zones mapped for Cothill Fen (site ref. 1)

Freshwater Habitats Trust

Scale:
1:30,000 @A3

0 0.75 1.5 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

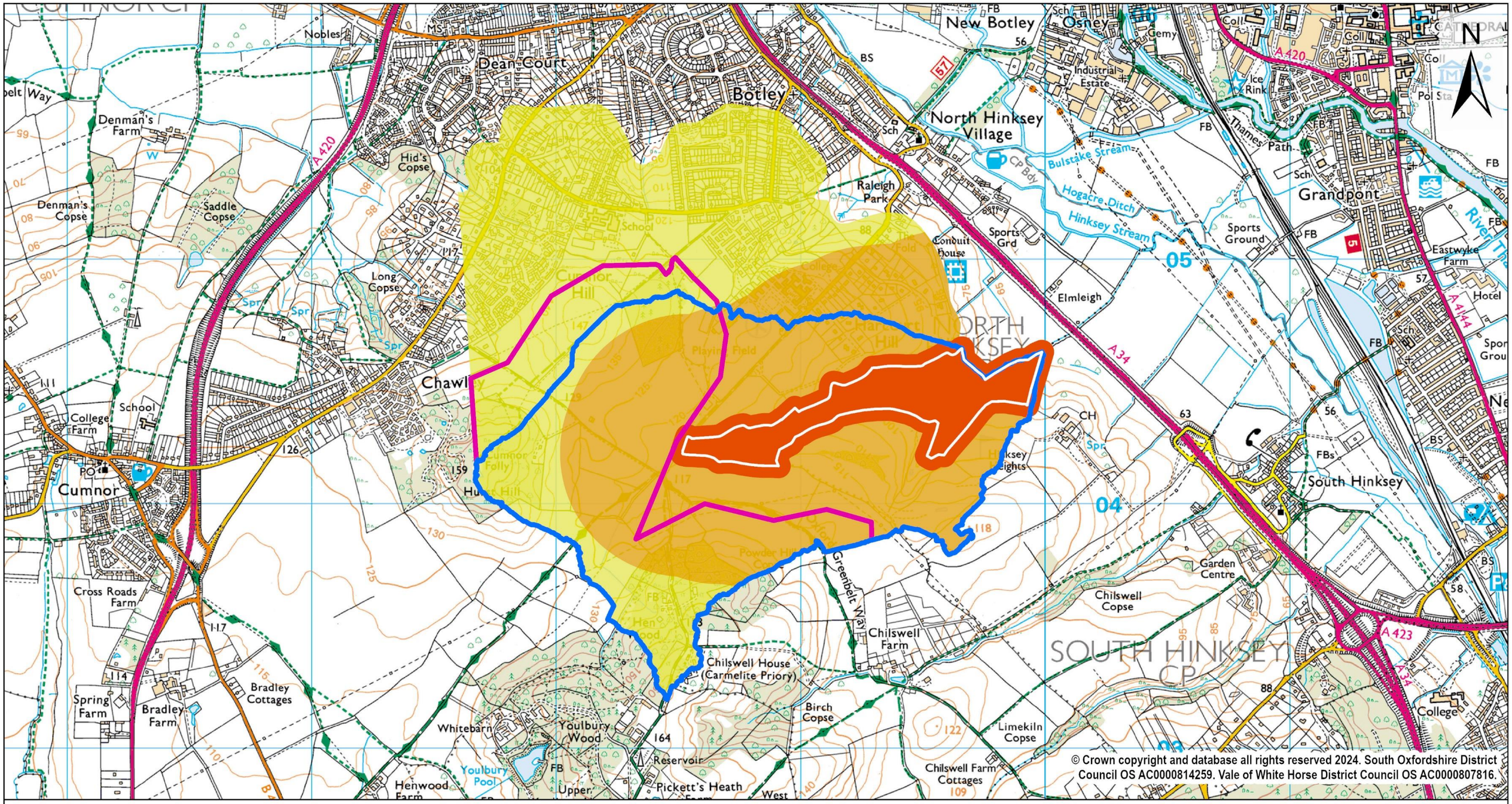


Figure A3.2 Risk zones mapped for Hinksey Heights (site ref. 2)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

Figure A3.3 Risk zones mapped for Barrow Farm Fen (site ref. 3)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:40,000 @A3

0 1 2 km

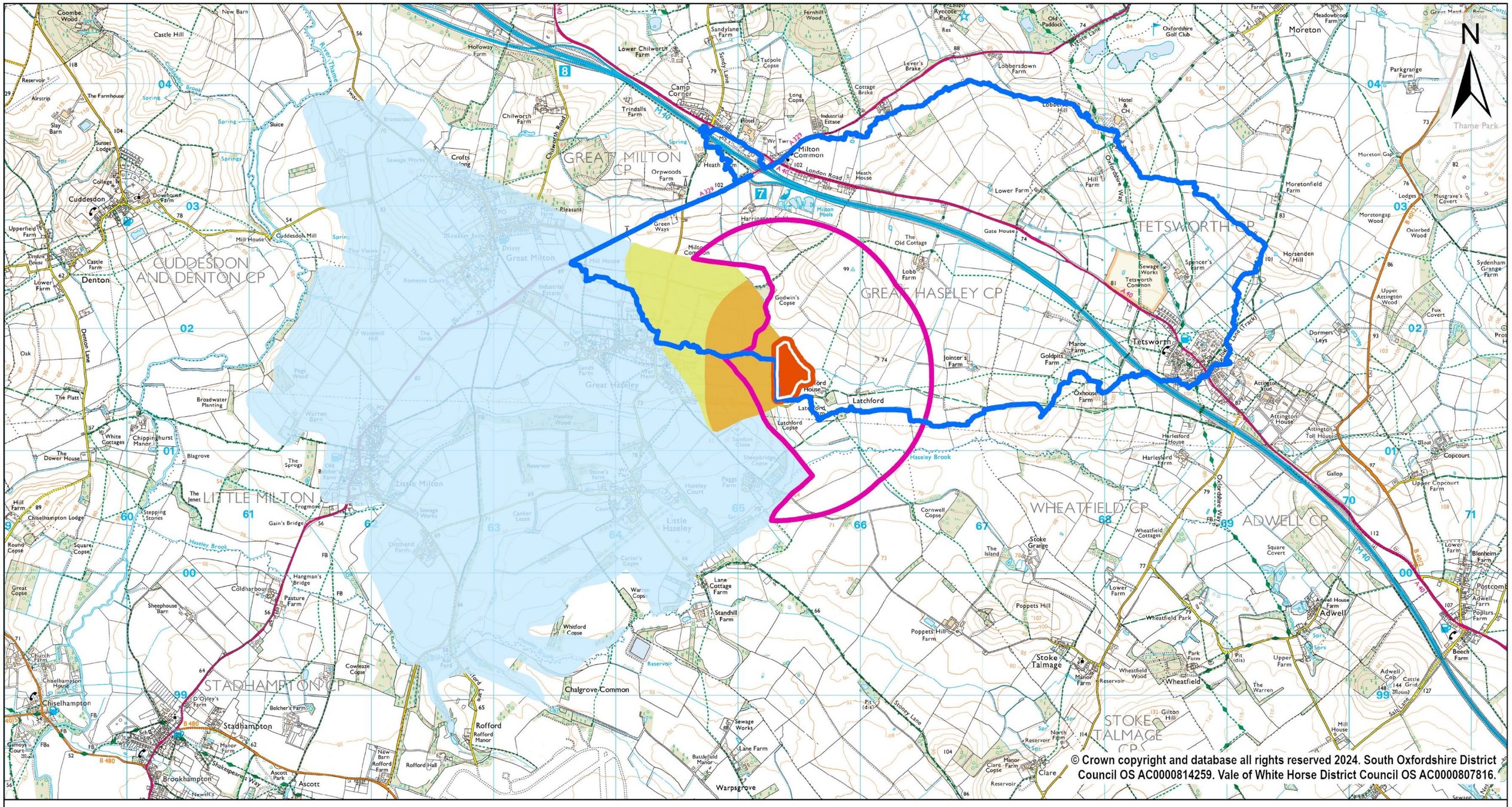


Figure A3.4 Risk zones mapped for Spartum Fen (site ref. 4)

Fen site

Hydrological risk zone

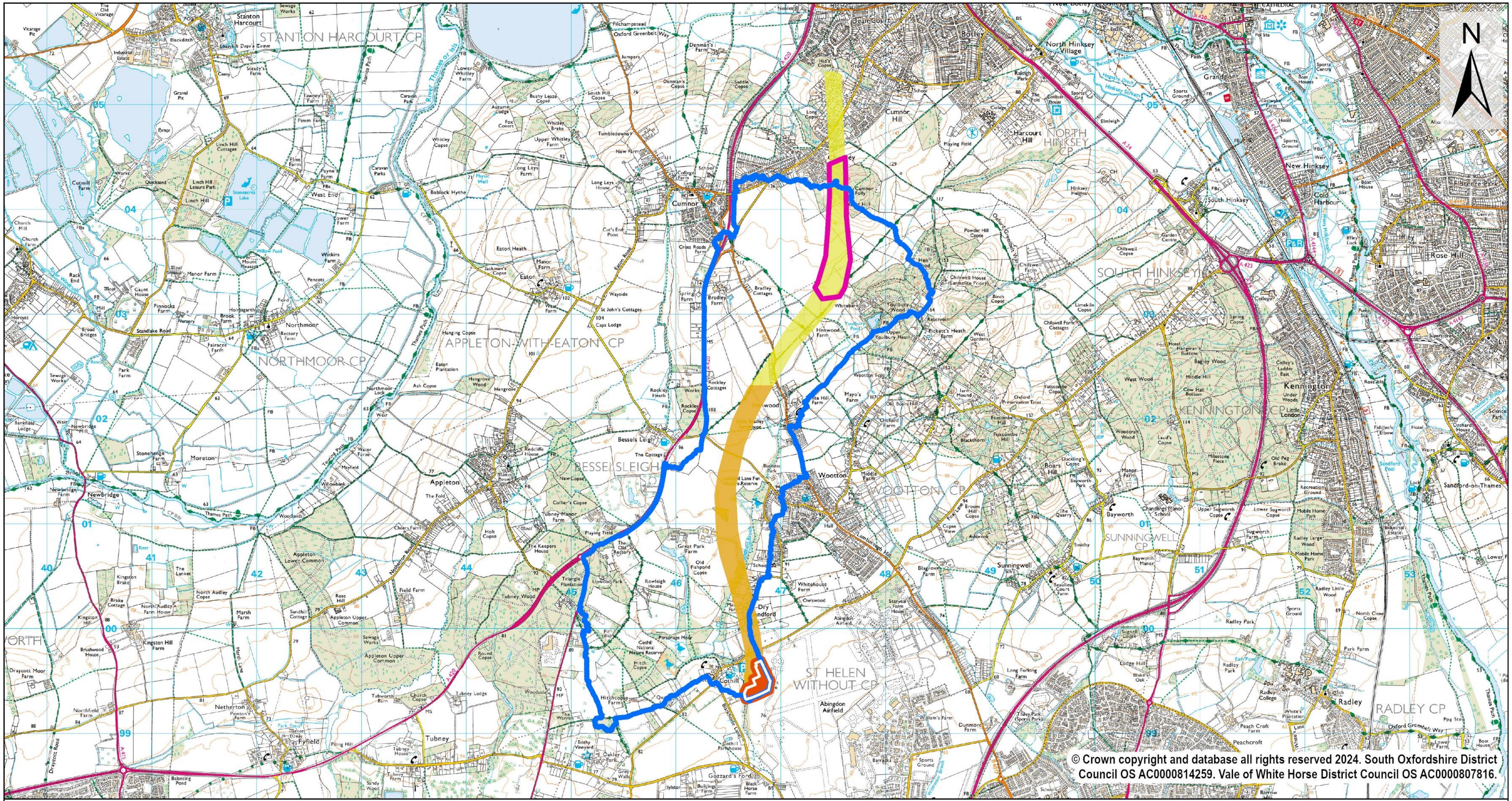
- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB the area of confined groundwater mapped east of the fen site has not been included in zone 2 to the west as this area has been delineated based on a precautionary distance of 1 km rather than based on knowledge of groundwater levels and flows.

Freshwater Habitats Trust

Scale:
1:30,000 @A3

0 0.75 1.5 km



Scale:
1:35,000 @A3

0 0.75 1.5 km

Figure A3.5 Risk zones mapped for Dry Sandford Pit (site ref. 5)

Fen site

Hydrological risk zone

- **Zone 2 - Groundwater catchment**
- **Zone 2b - Groundwater catchment – confined flow**
- **Zone 3 - Sub-groundwater catchment**
- **Zone 4 - 50 m site buffer**
- **Zone 5 - Surface water catchment**

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

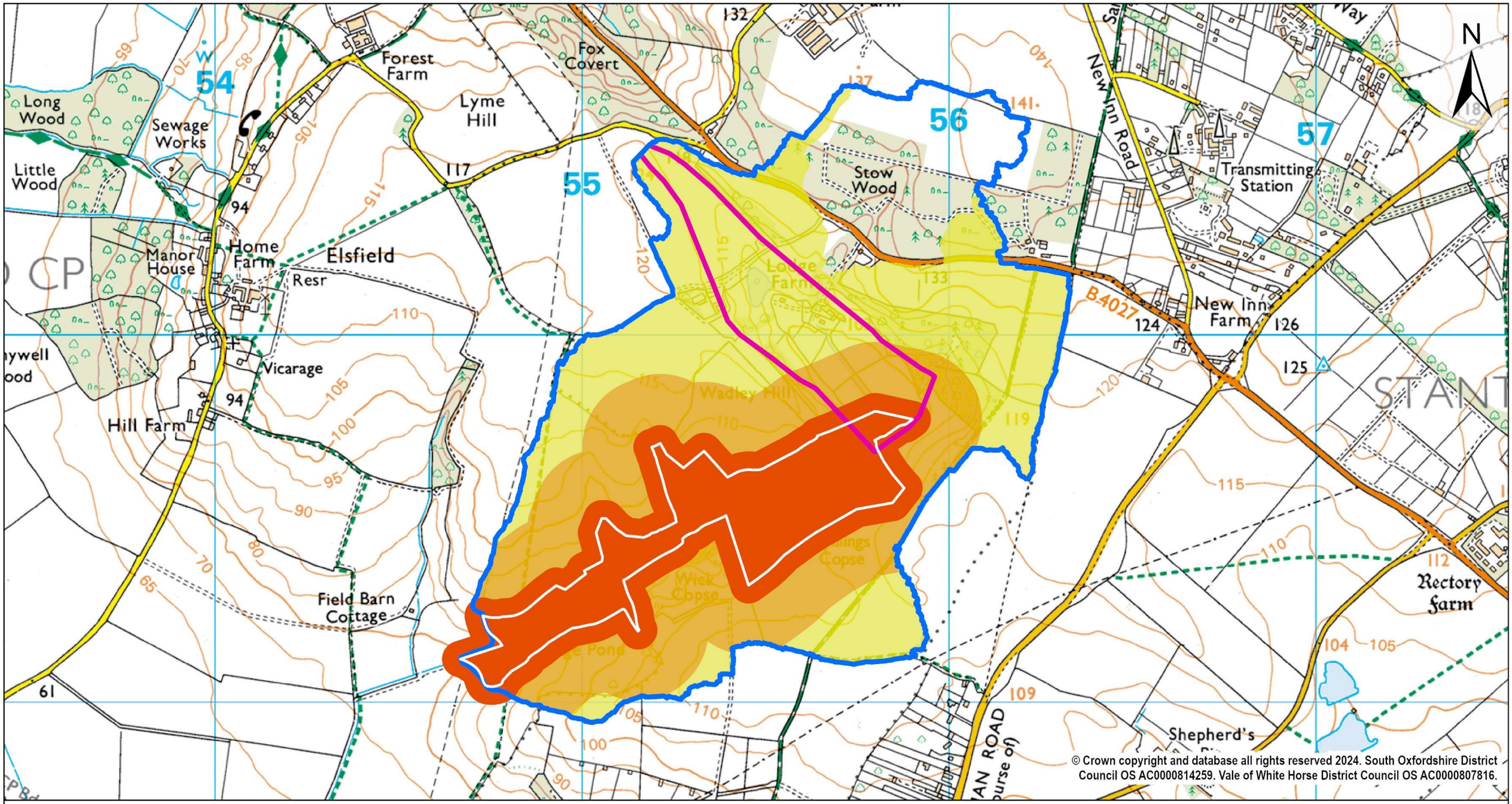


Figure A3.6 Risk zones mapped for Sidling's Copse and College Pond (site ref. 6)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

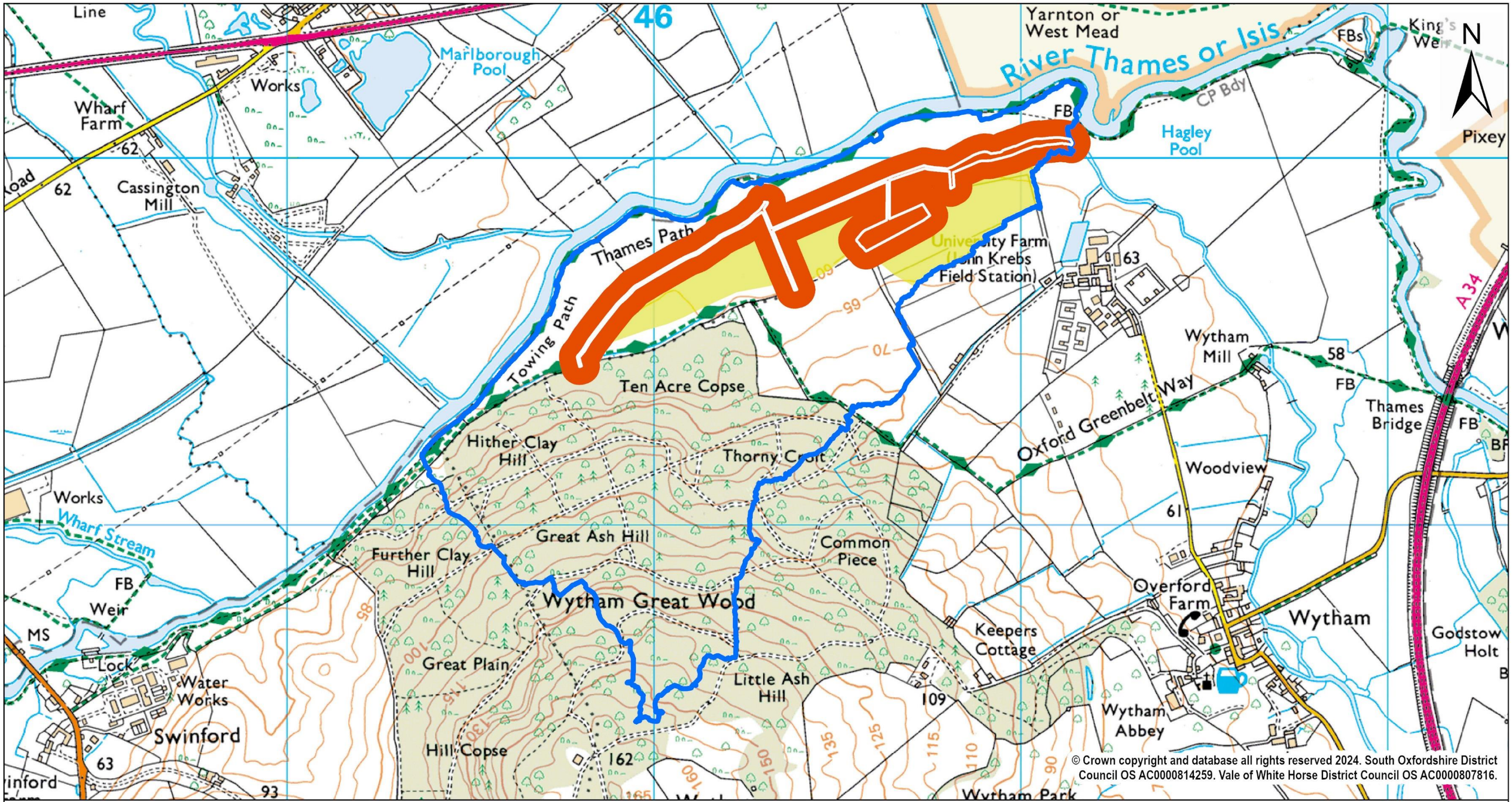


Figure A3.7 Risk zones mapped for Wytham Ditches and Flushes (site ref. 7)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this site lies over a superficial groundwater body - Zone 1 not mapped.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

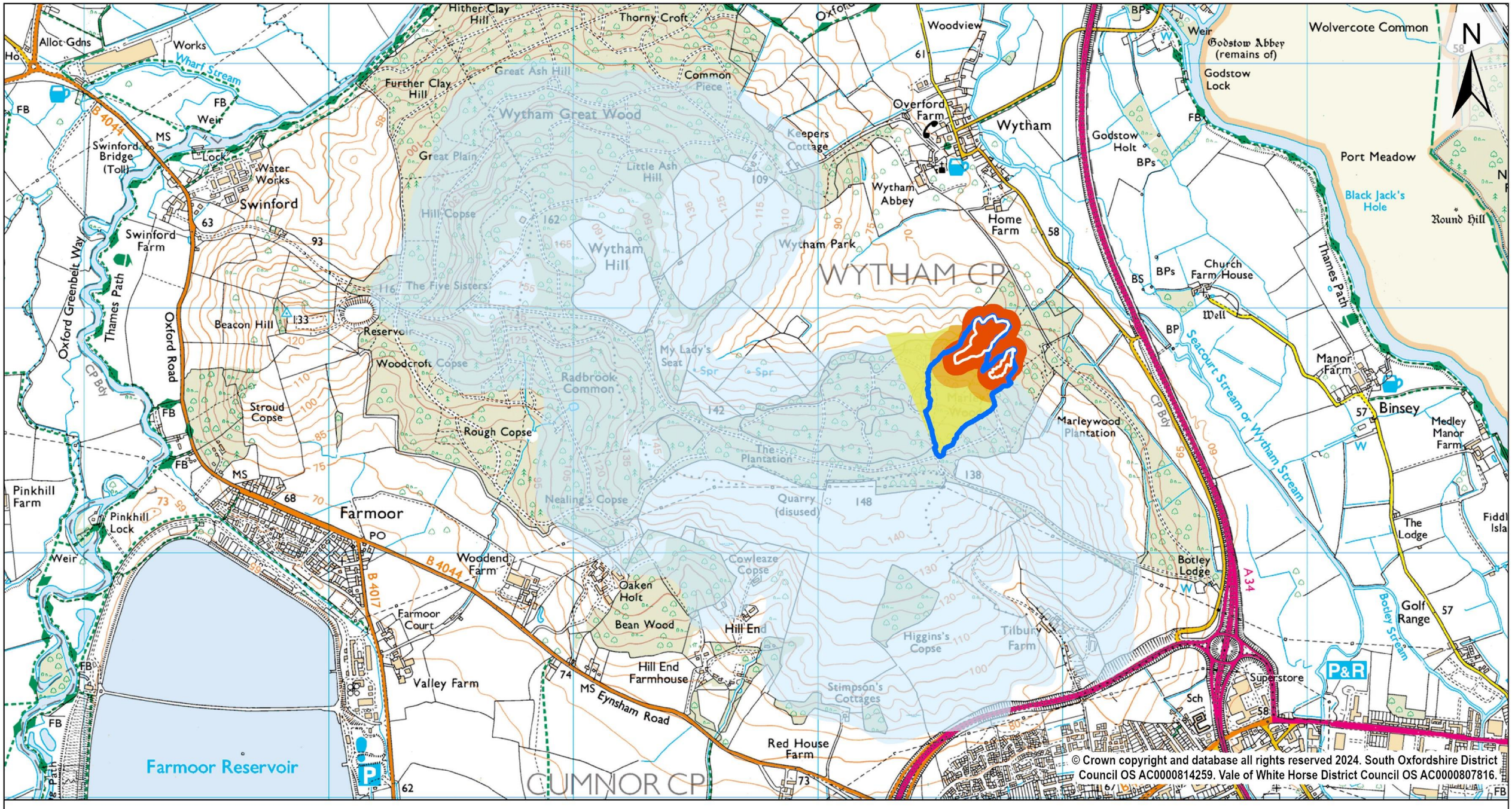


Figure A3.8 Risk zones mapped for Marley Fens (site ref. 8)

Fen site

Hydrological risk zone

- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

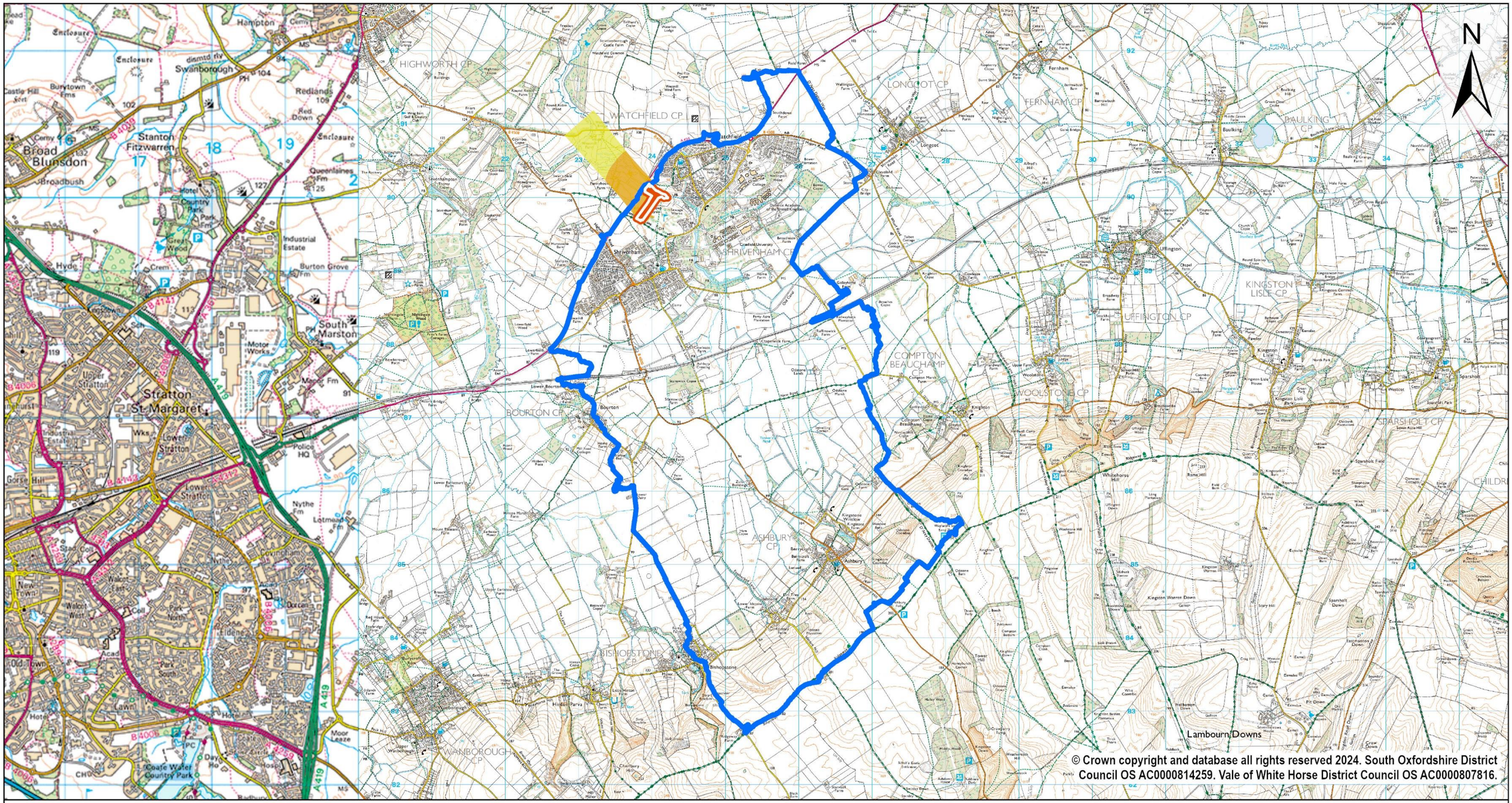


Figure A3.9 Risk zones mapped for Tuckmill Meadows (site ref. 9)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:50,000 @A3

0 1.25 2.5 km

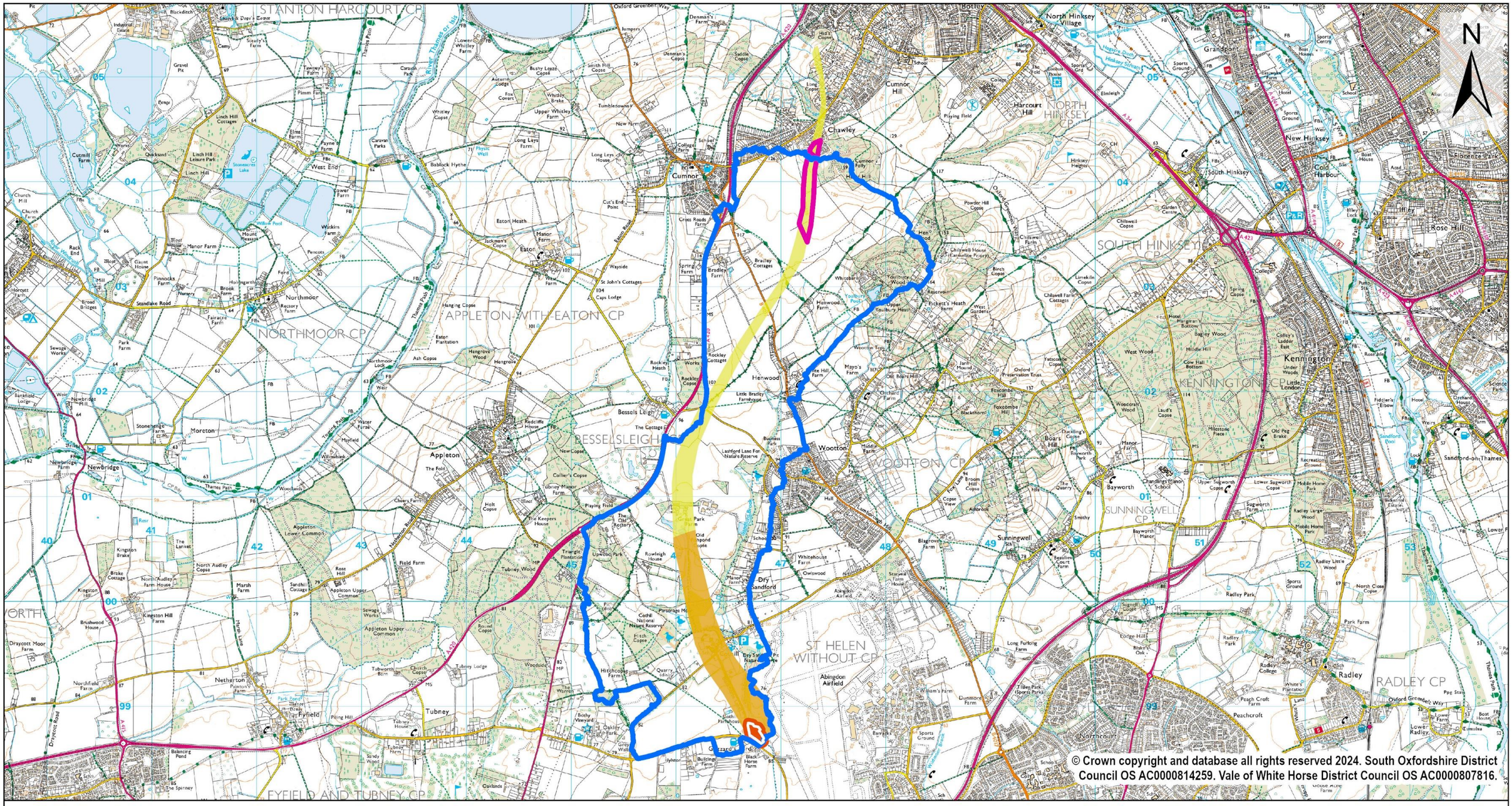


Figure A3.10 Risk zones mapped for Gozzards Ford Fen (site ref. 10)

Freshwater Habitats Trust

Scale:
1:35,000 @A3

0 0.75 1.5 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

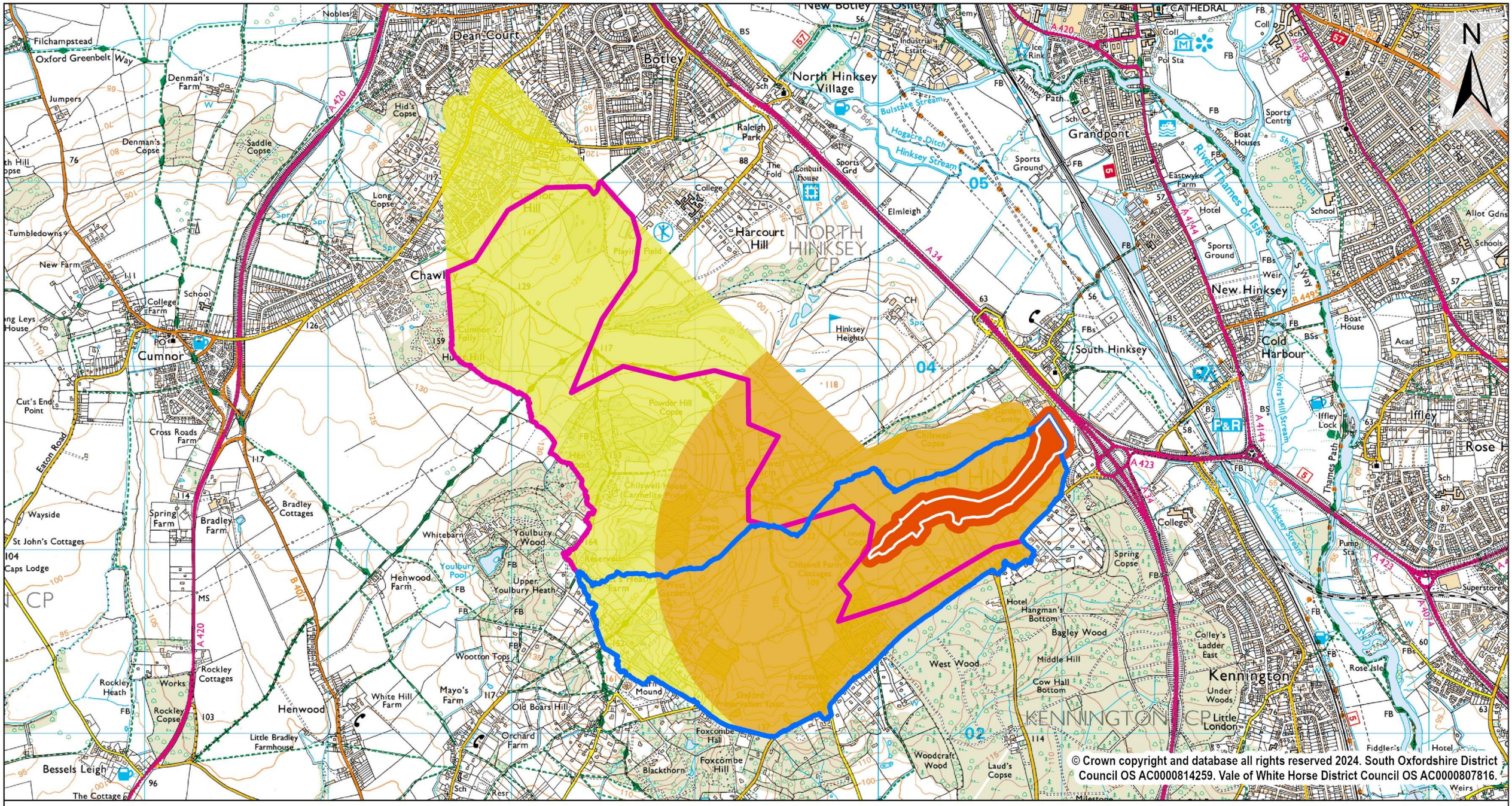


Figure A3.11 Risk zones mapped for Limekiln Copse and Valley (site ref. 11)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

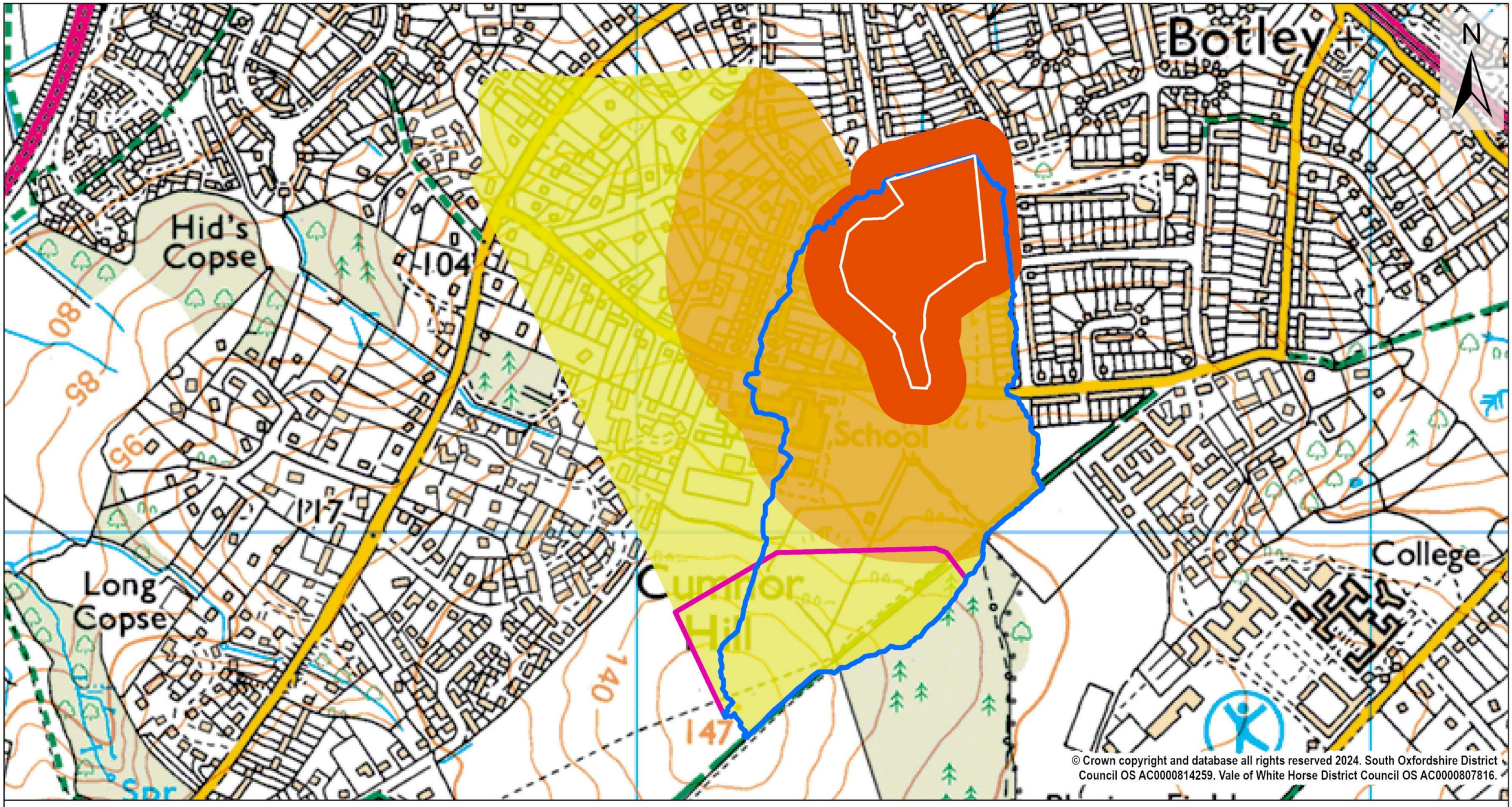


Figure A3.12 Risk zones mapped for Louie Memorial Fields (site ref. 12)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

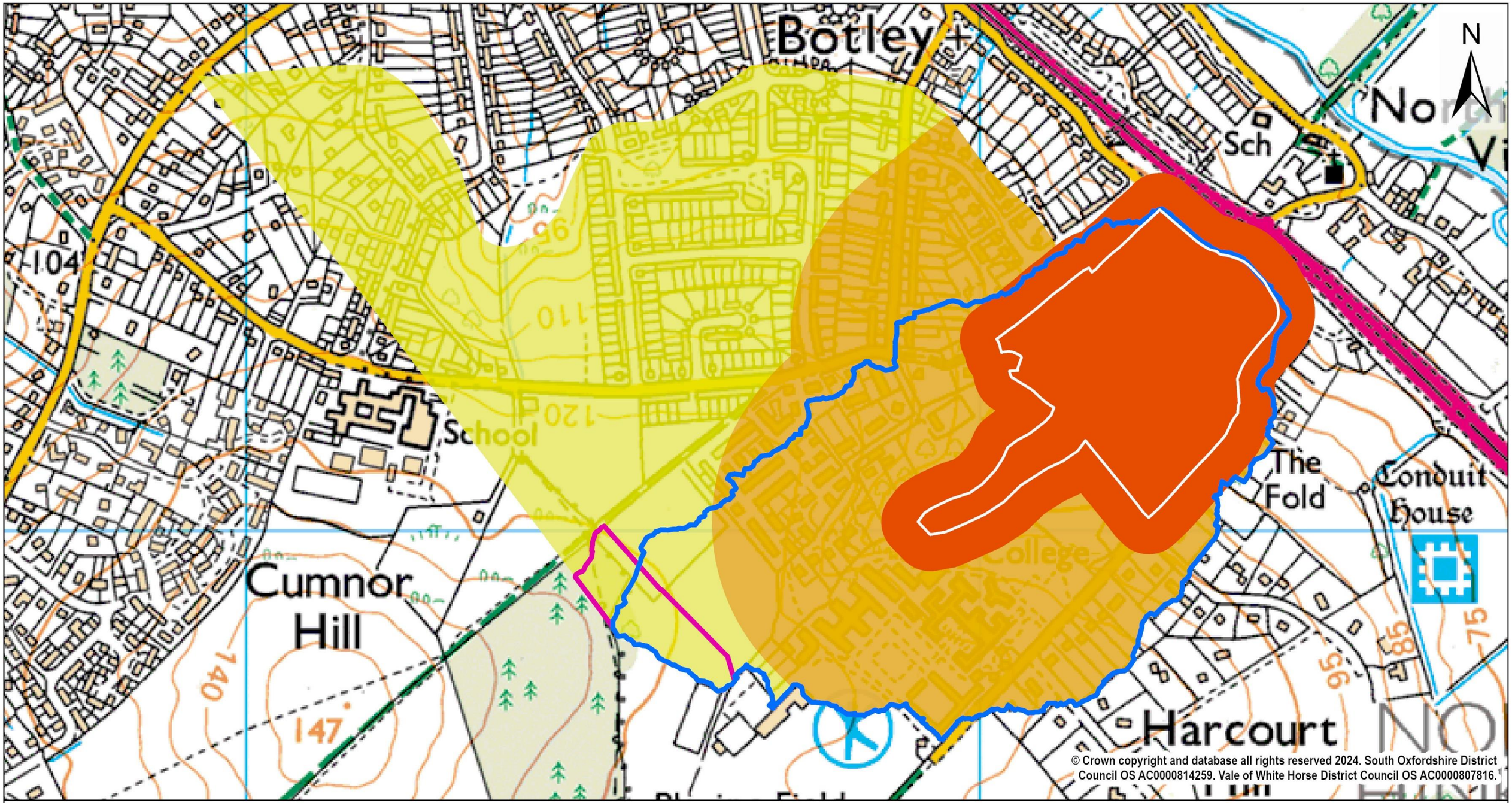


Figure A3.13 Risk zones mapped for Raleigh Park (site ref. 13)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

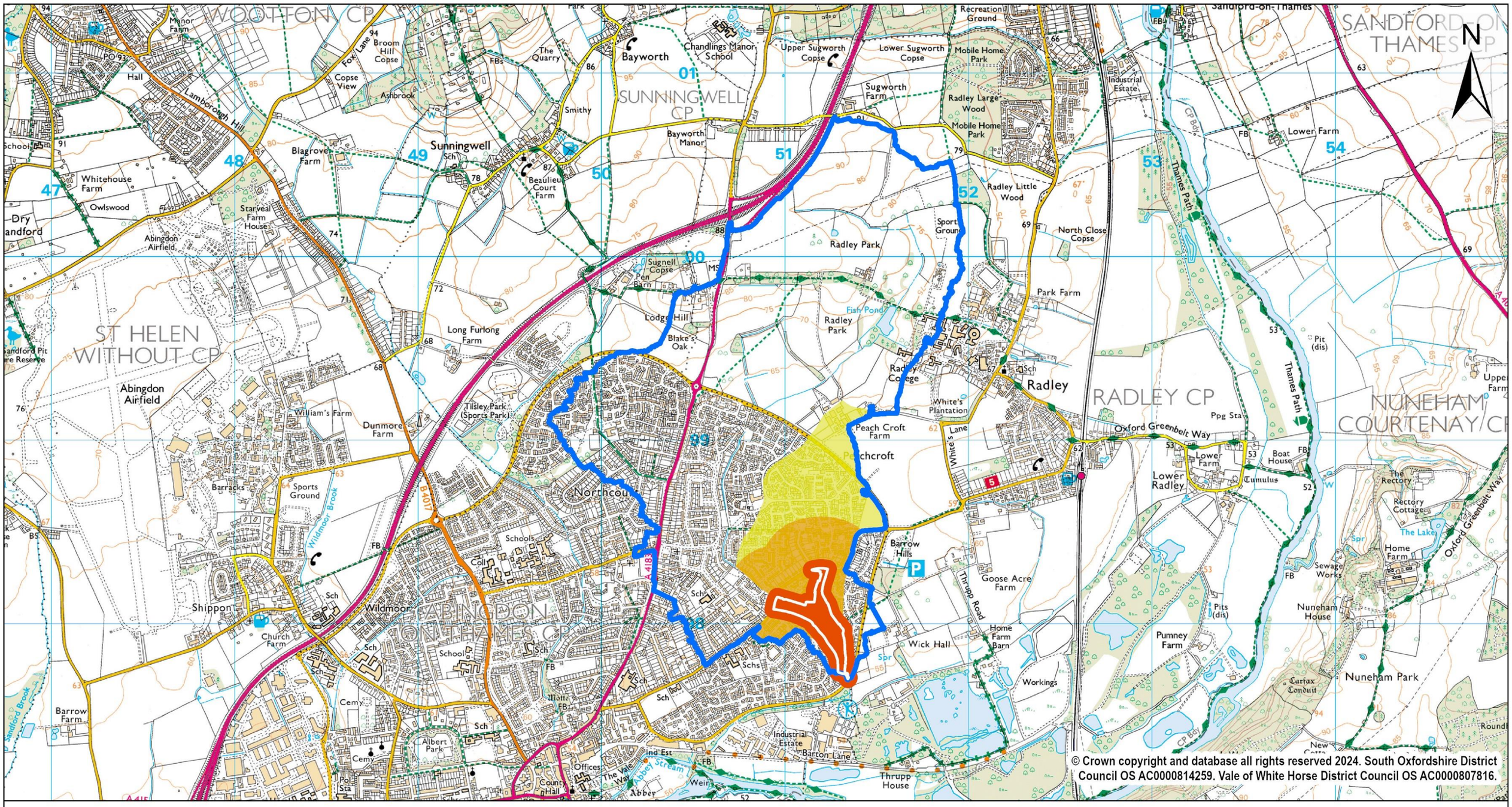


Figure A3.14 Risk zones mapped for Abbey Fishponds (site ref. 14)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this site lies over a superficial groundwater body - Zone 1 not mapped.

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

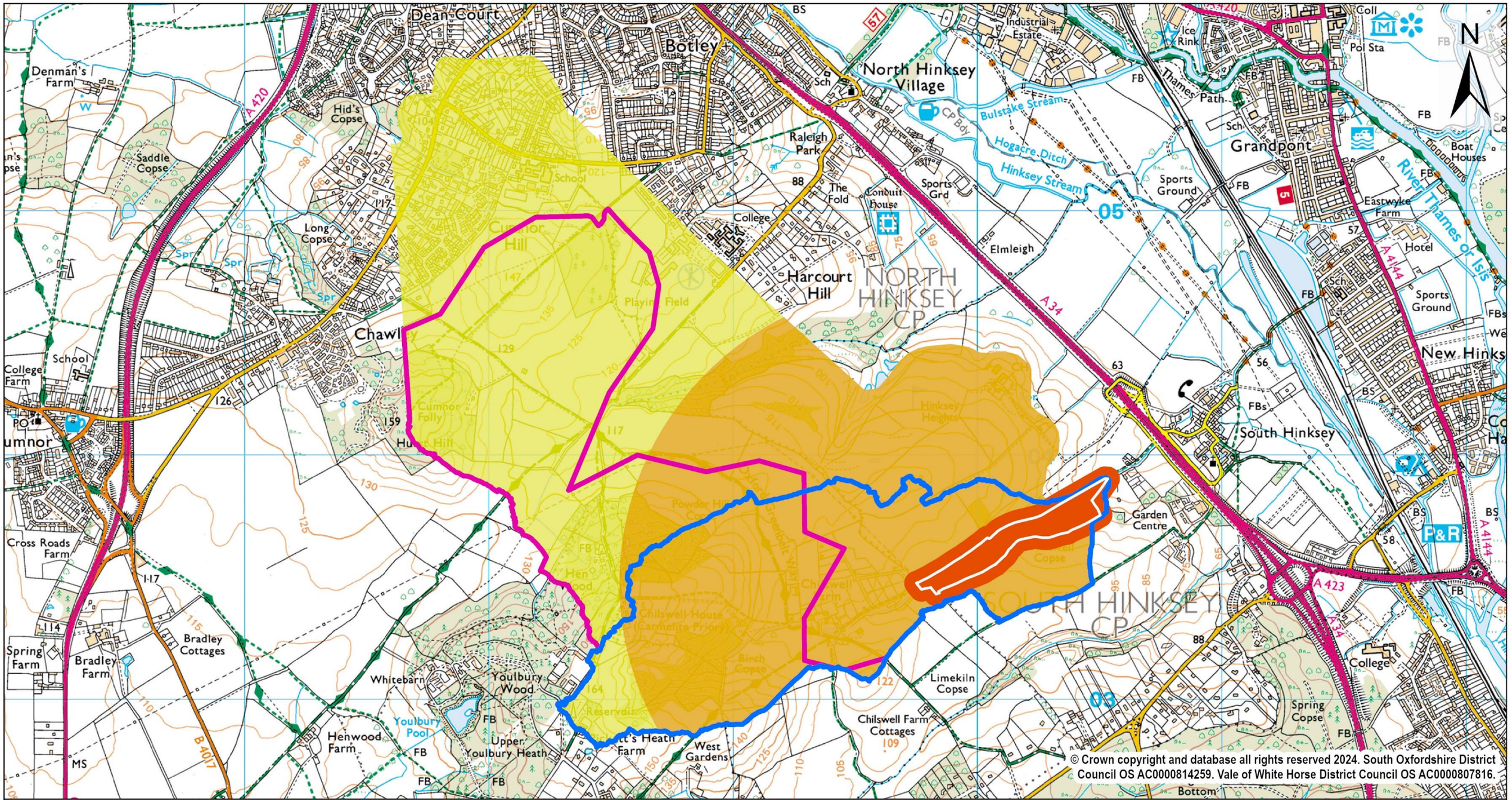


Figure A3.15 Risk zones mapped for Chilswell Valley (site ref. 15)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

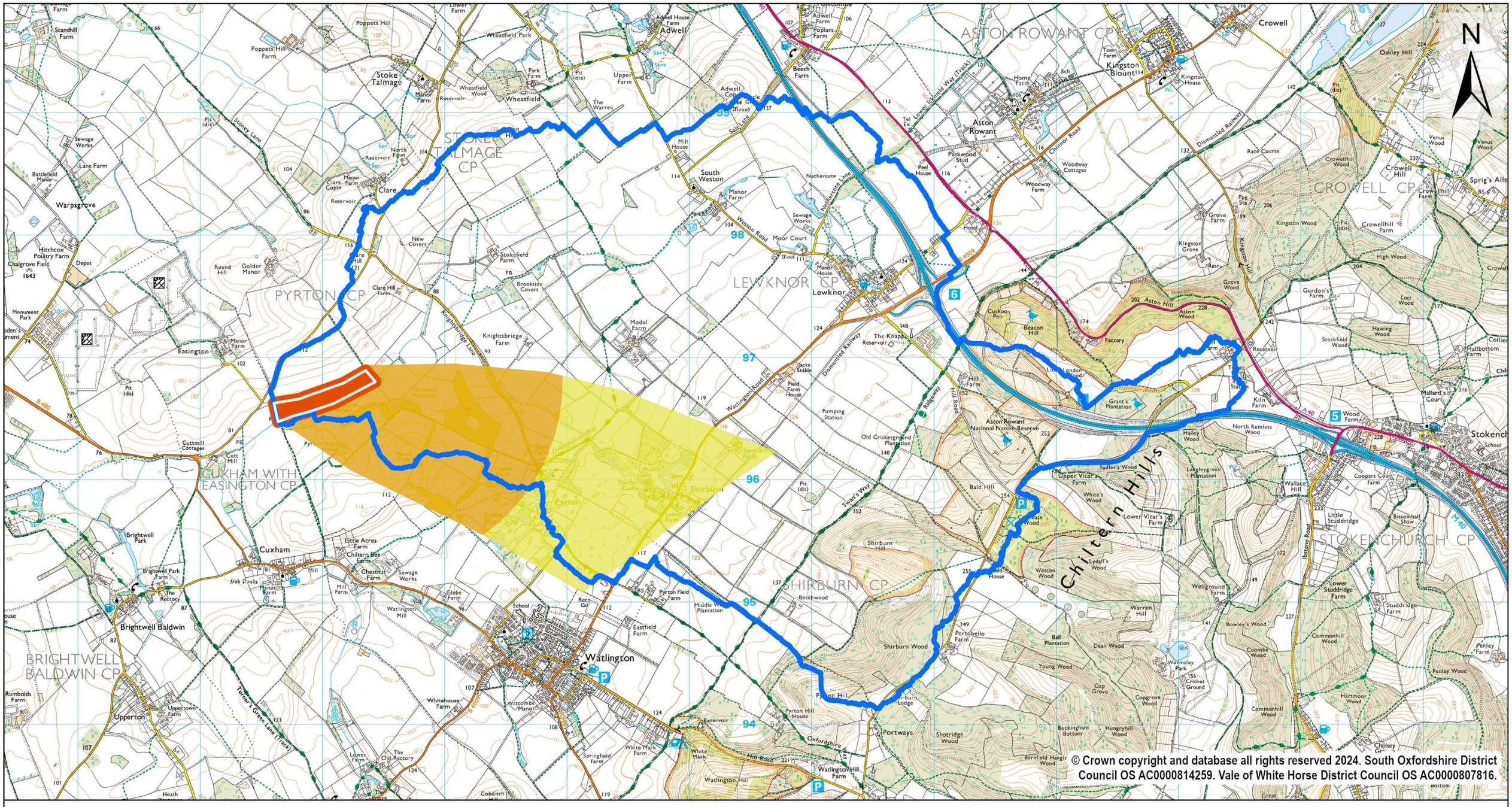


Figure A3.16 Risk zones mapped for Easington Fen (site ref. 16)

Freshwater Habitats Trust

Scale:
1:30,000 @A3

0 0.75 1.5 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Chiltern Chalk Scarp groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

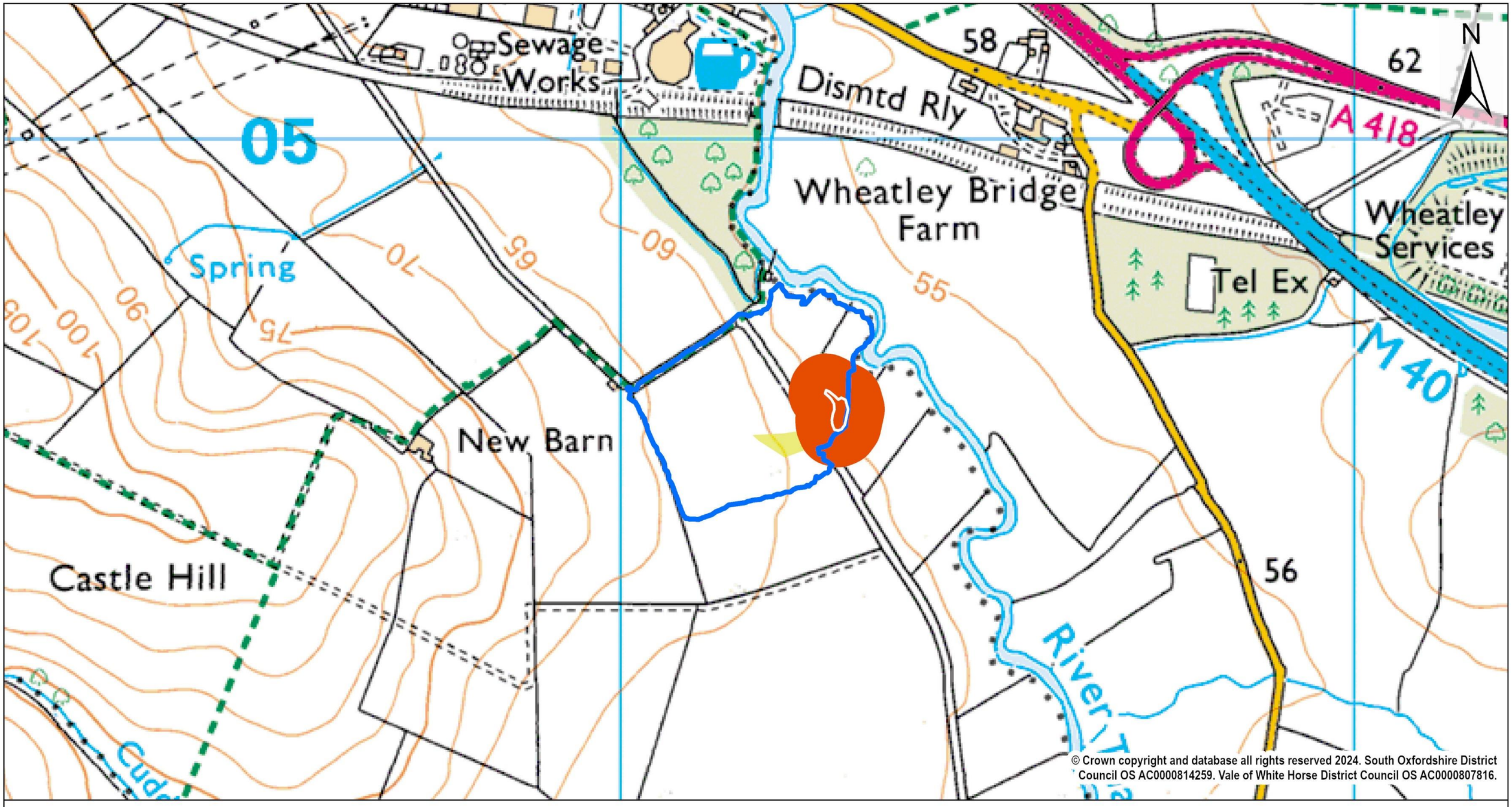


Figure A3.17 Risk zones mapped for Wheatley Bog (site ref. 17)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

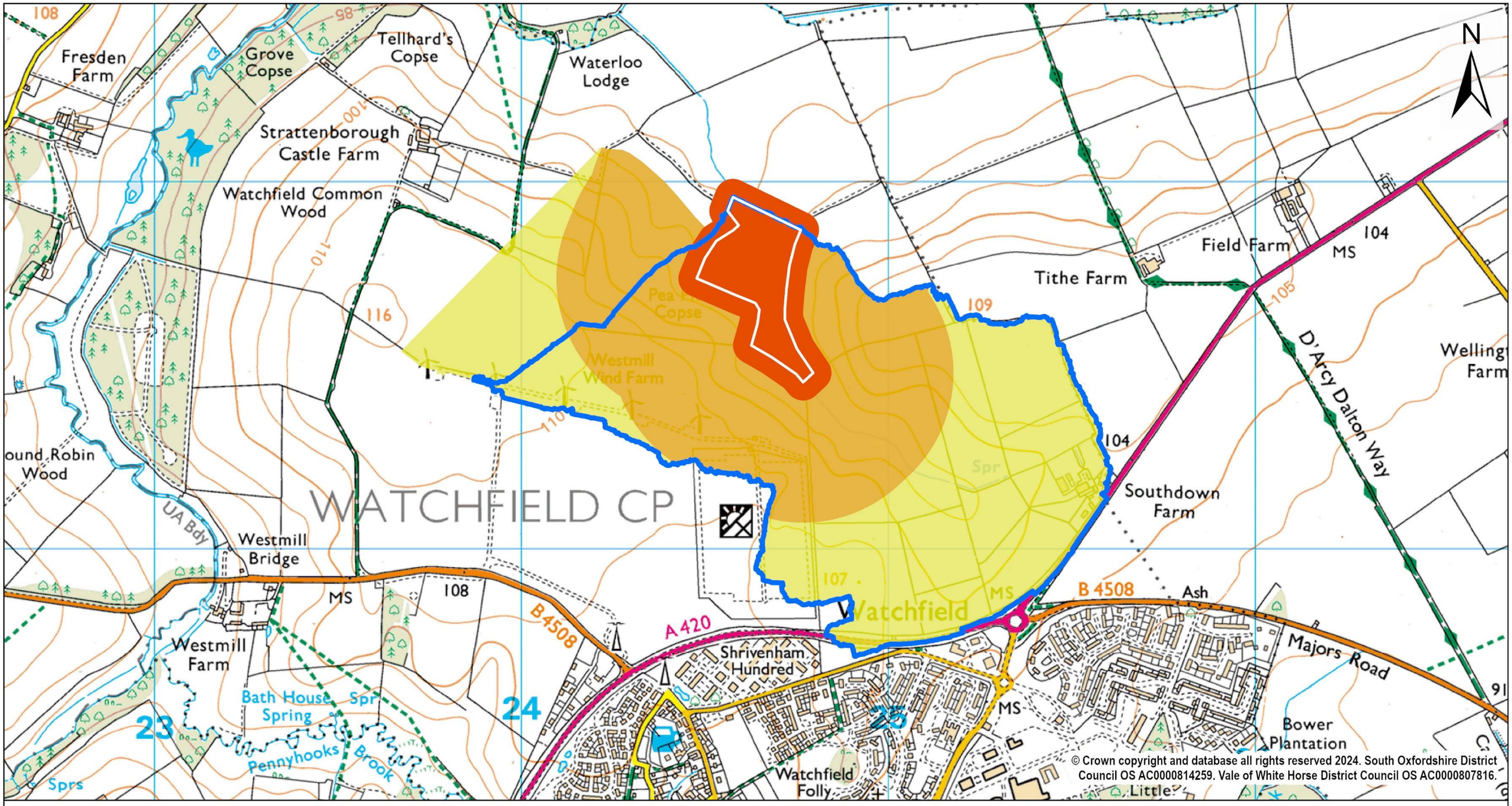


Figure A3.18 Risk zones mapped for Pea Pits Copse (site ref. 18)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

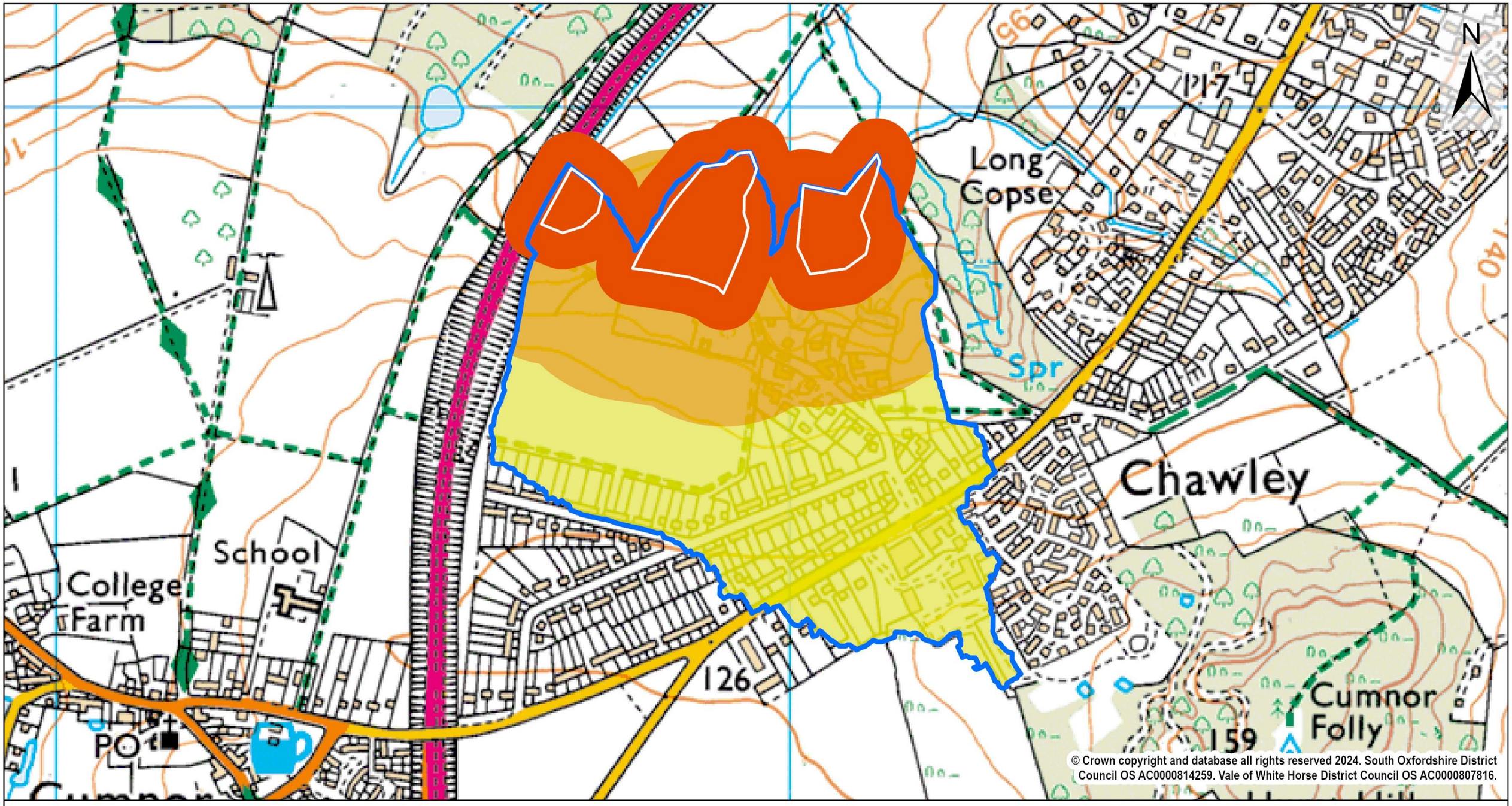


Figure A3.19 Risk zones mapped for Chawley Pastures (site ref. 19)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

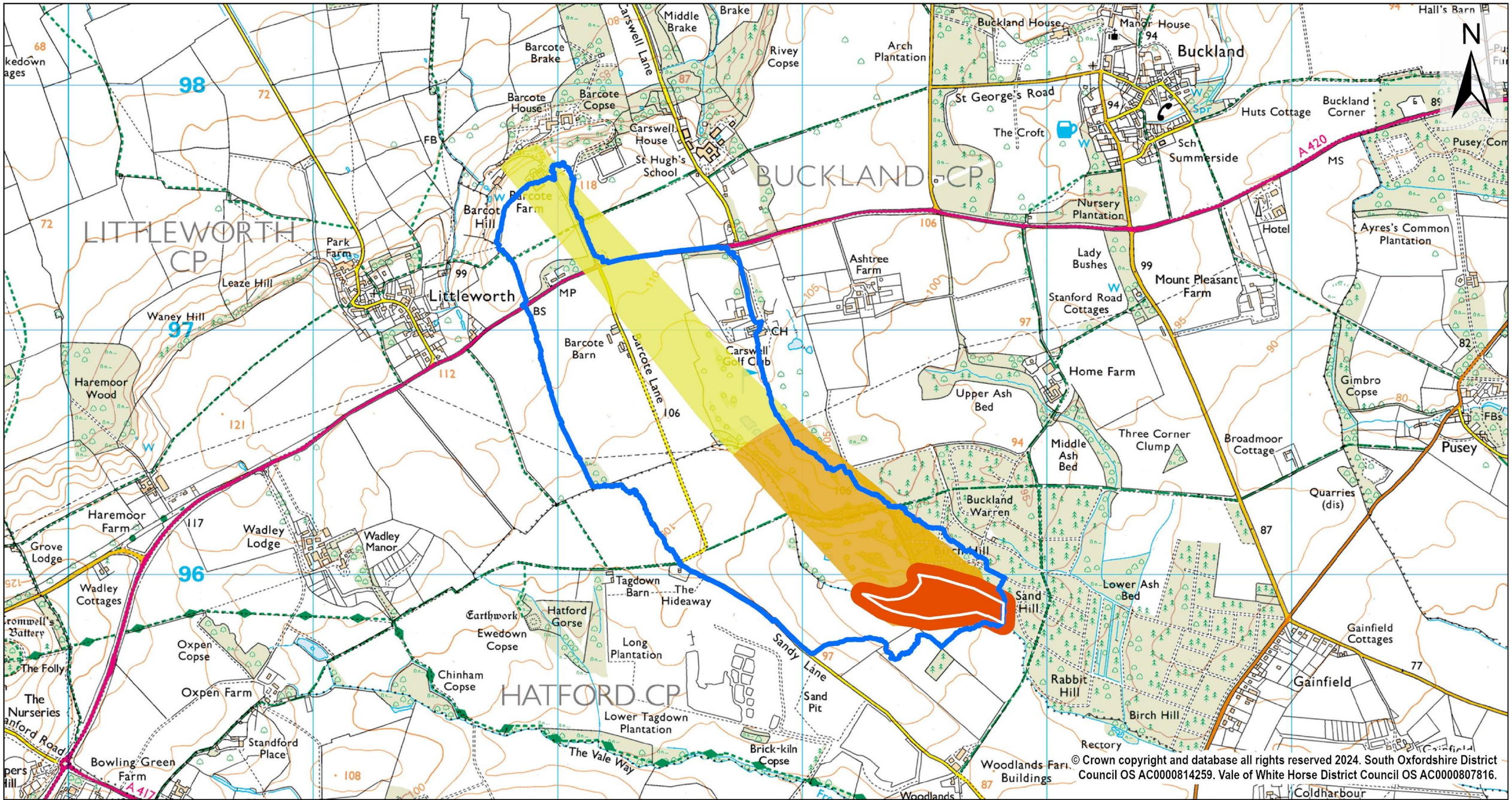


Figure A3.20 Risk zones mapped for Peat Bottom Wood (site ref. 20)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

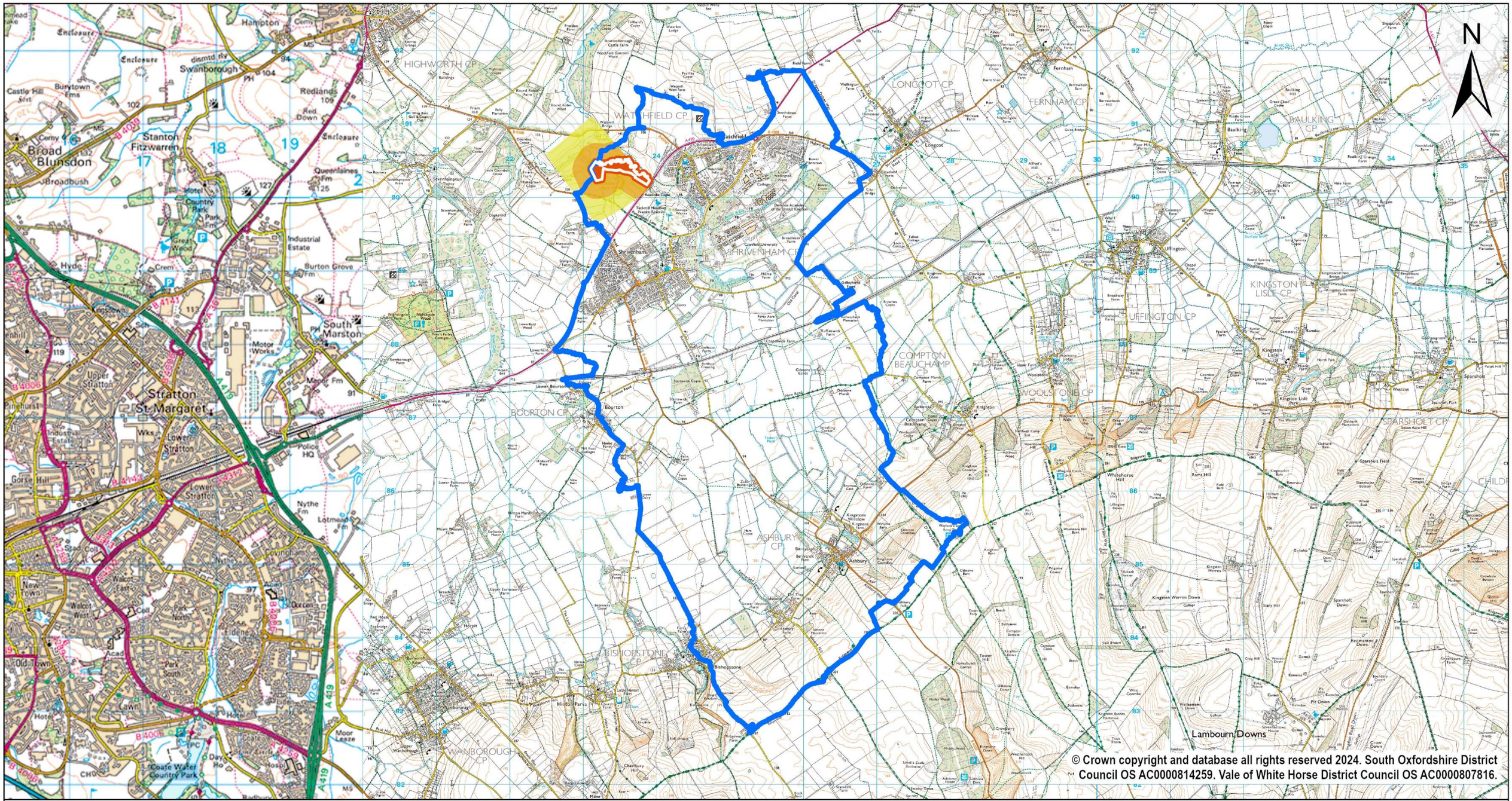


Figure A3.21 Risk zones mapped for Pennyhooks Brook Marsh (site ref. 21)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:50,000 @A3

0 1.25 2.5 km

Figure A3.22 Risk zones mapped for West Hagbourne Moor (site ref. 22)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Berkshire Downs Chalk groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:25,000 @A3

0 0.5 1 km

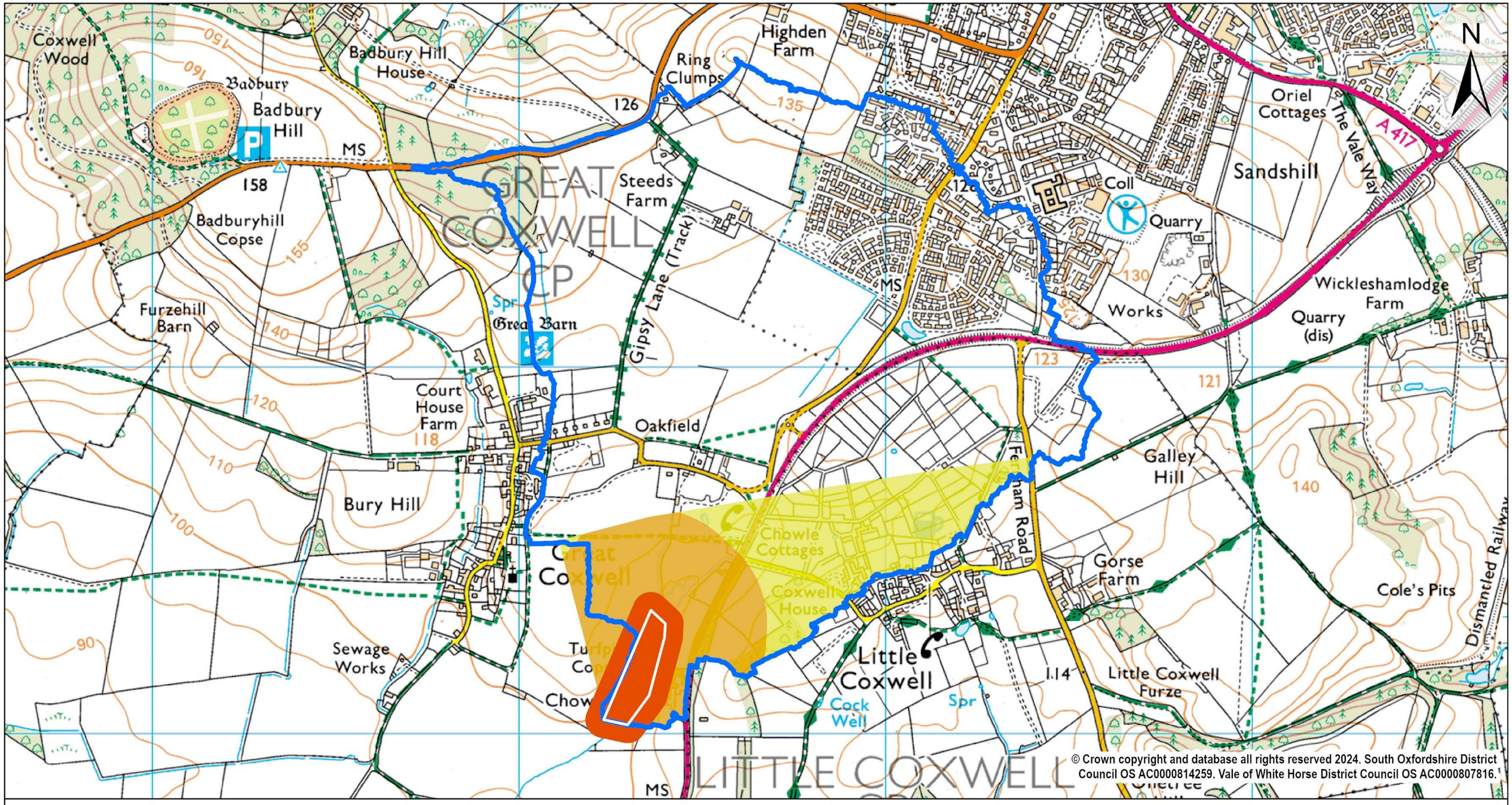


Figure A3.23 Risk zones mapped for Turfpit Copse (site ref. 23)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

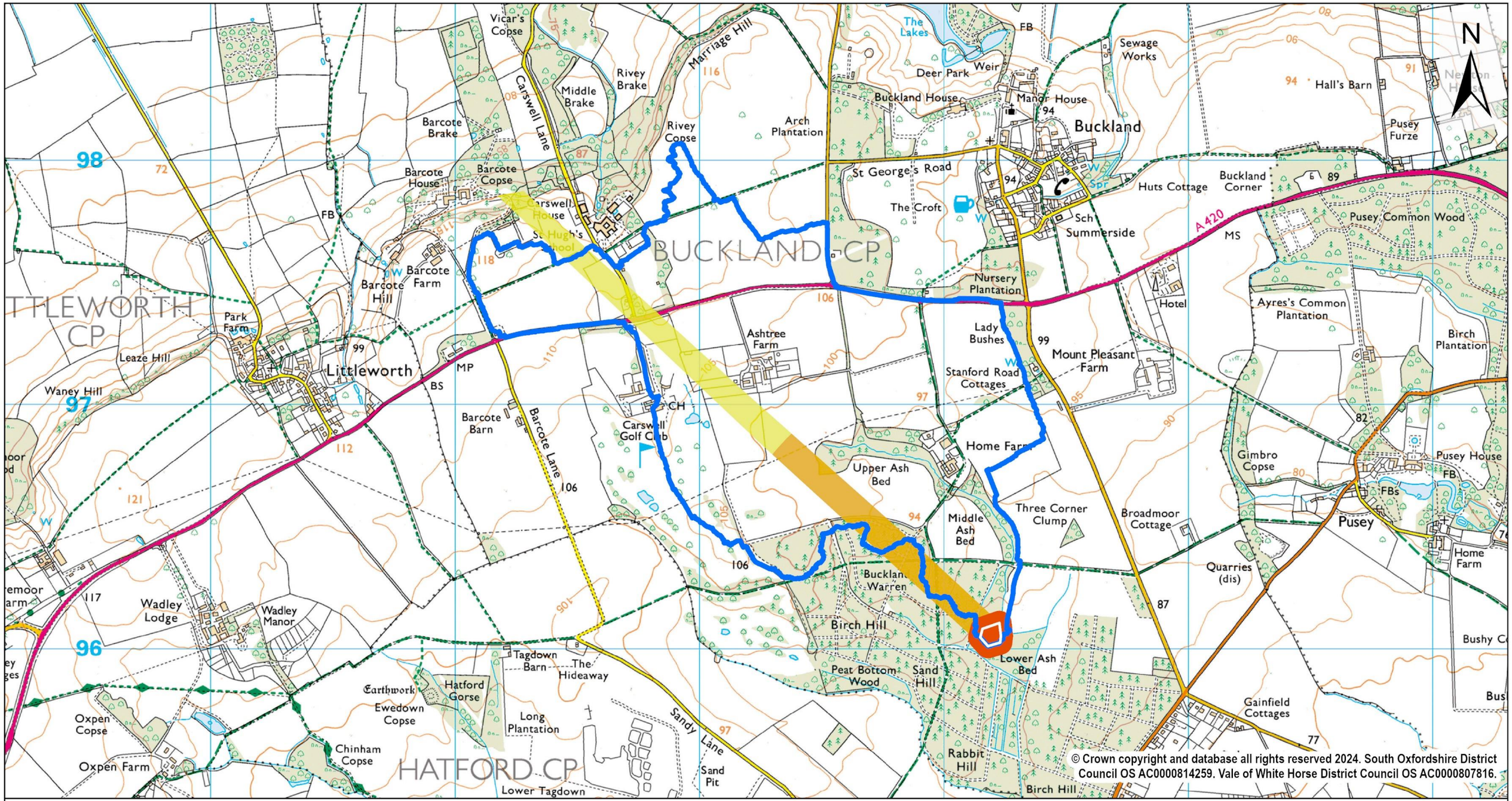


Figure A3.24 Risk zones mapped for Lower Ash Bed (site ref. 24)

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

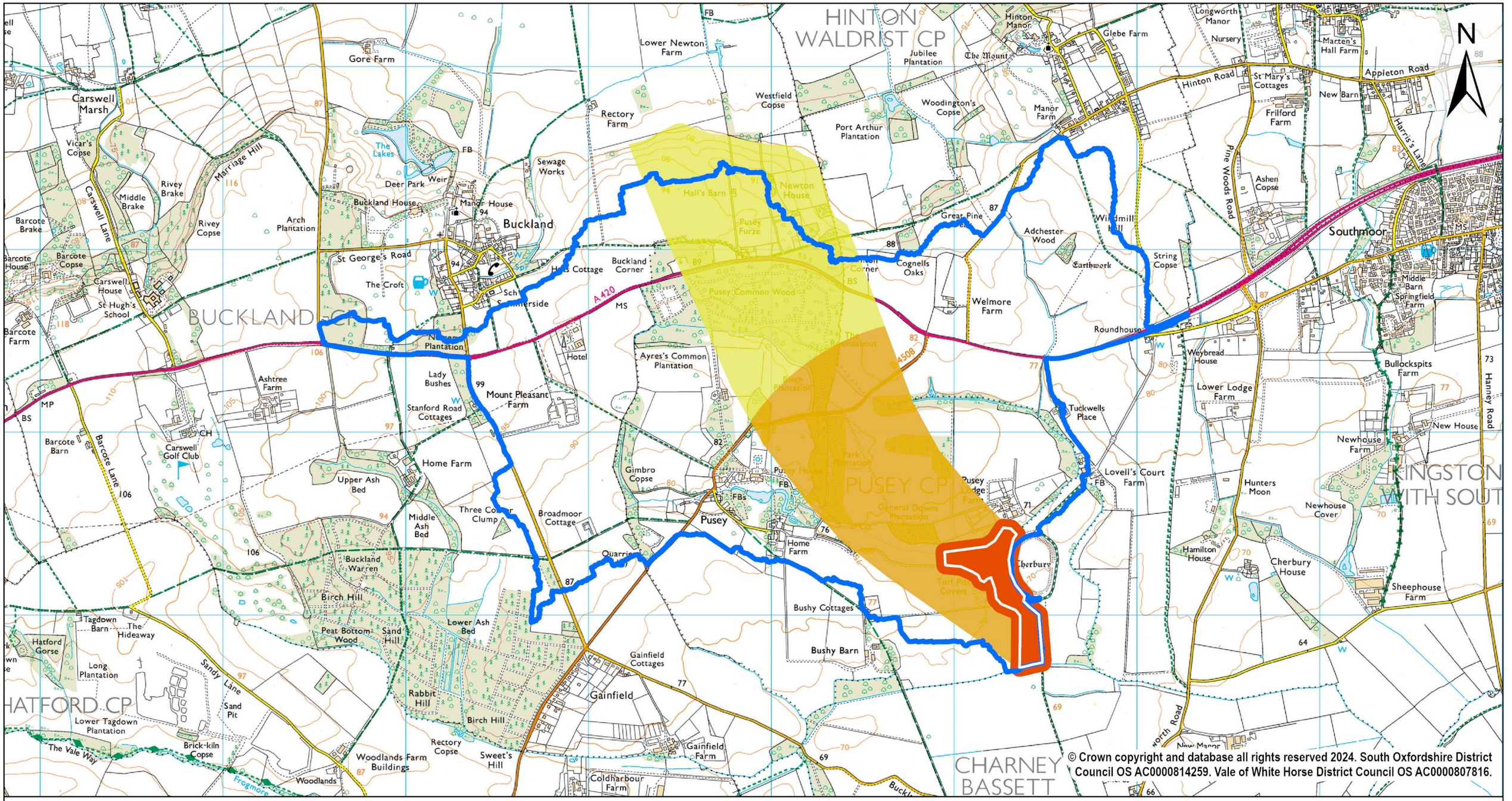


Figure A3.25 Risk zones mapped for Turf Pits Covert (site ref. 25)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

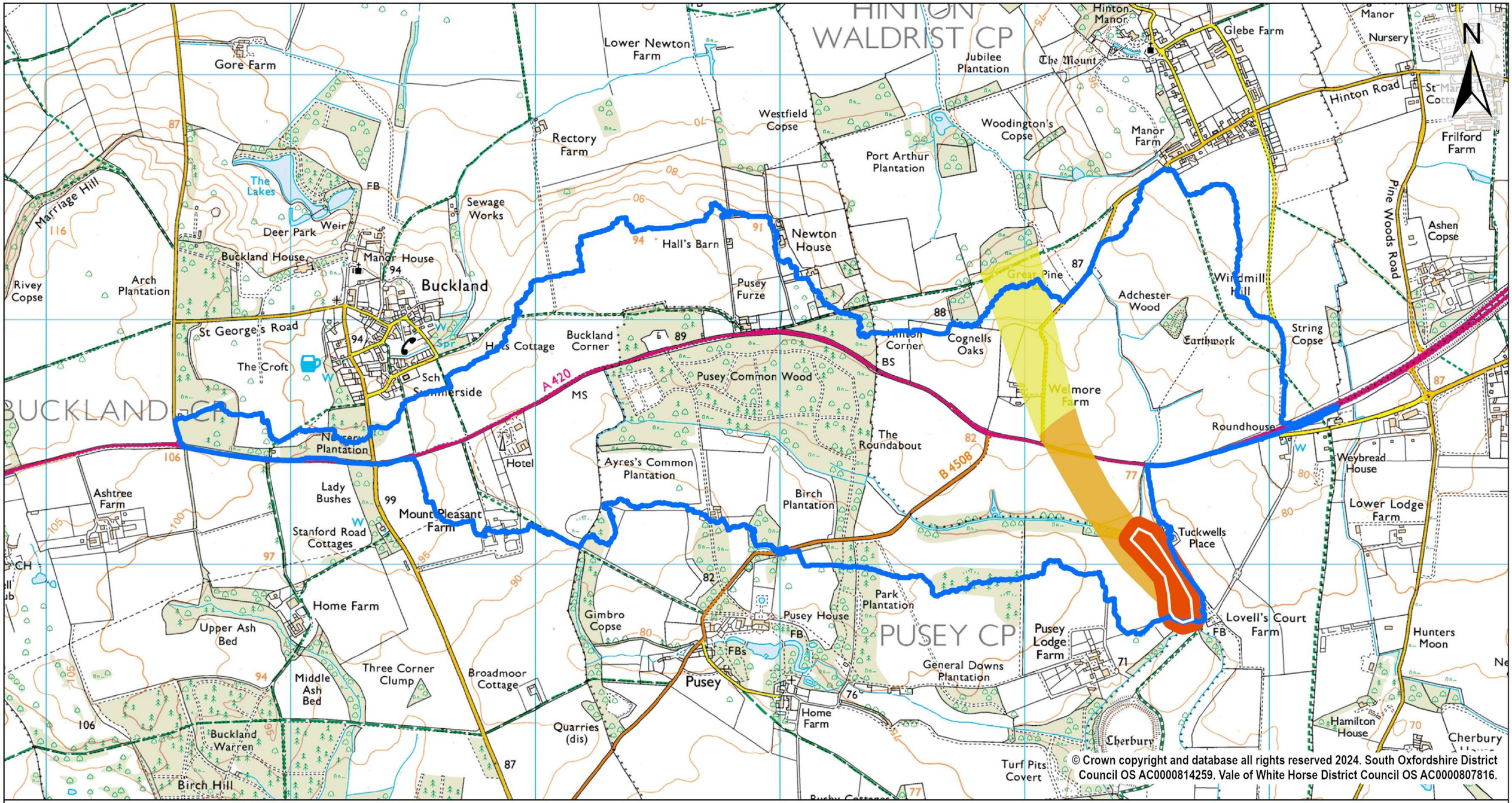


Figure A3.26 Risk zones mapped for Lovell's Court Wood (site ref. 26)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

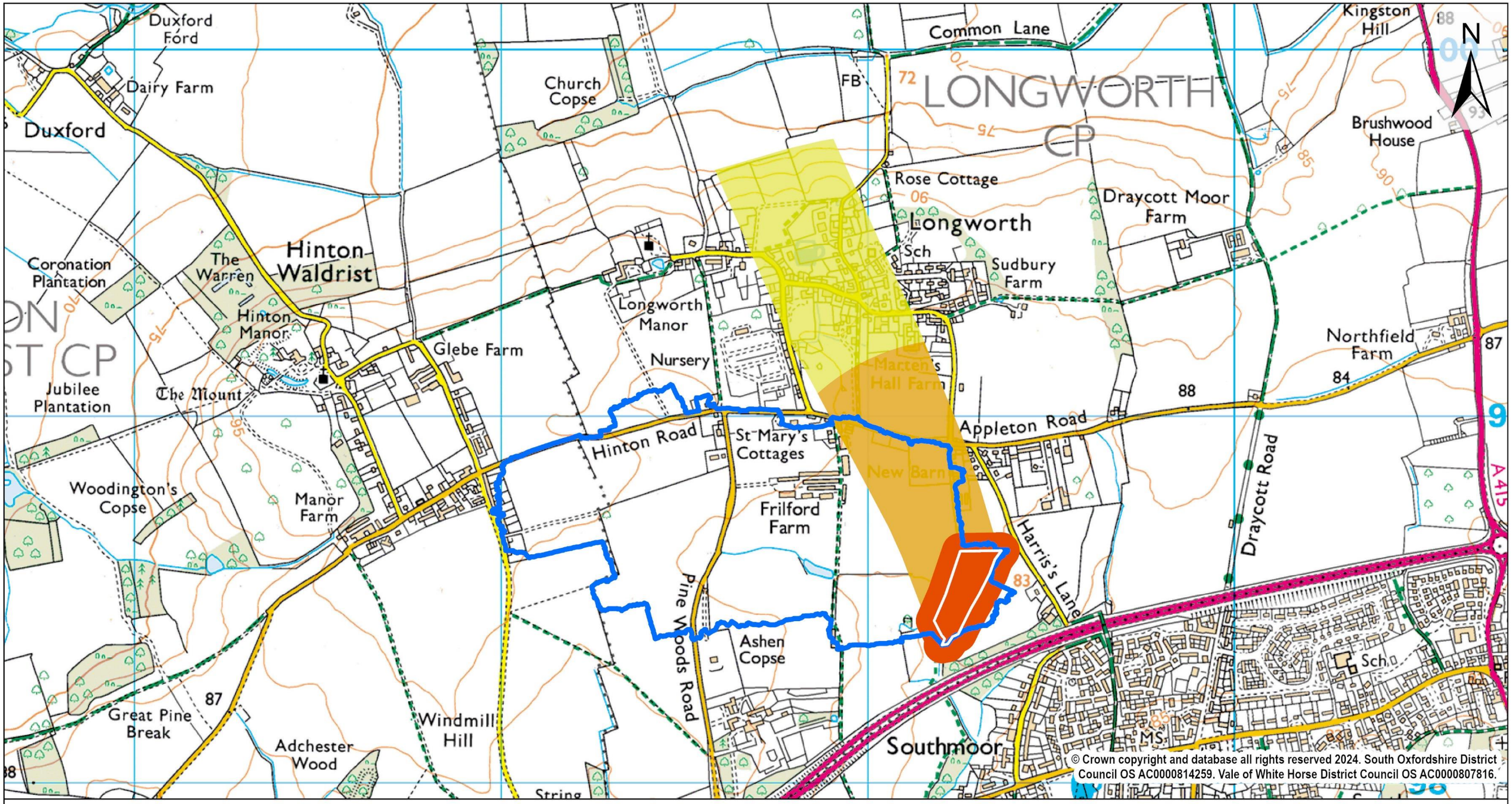


Figure A3.27 Risk zones mapped for Vale Ground (site ref. 27)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

Figure A3.28 Risk zones mapped for Marcham Bog South (site ref. 28)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:45,000 @A3

0 1 2 km

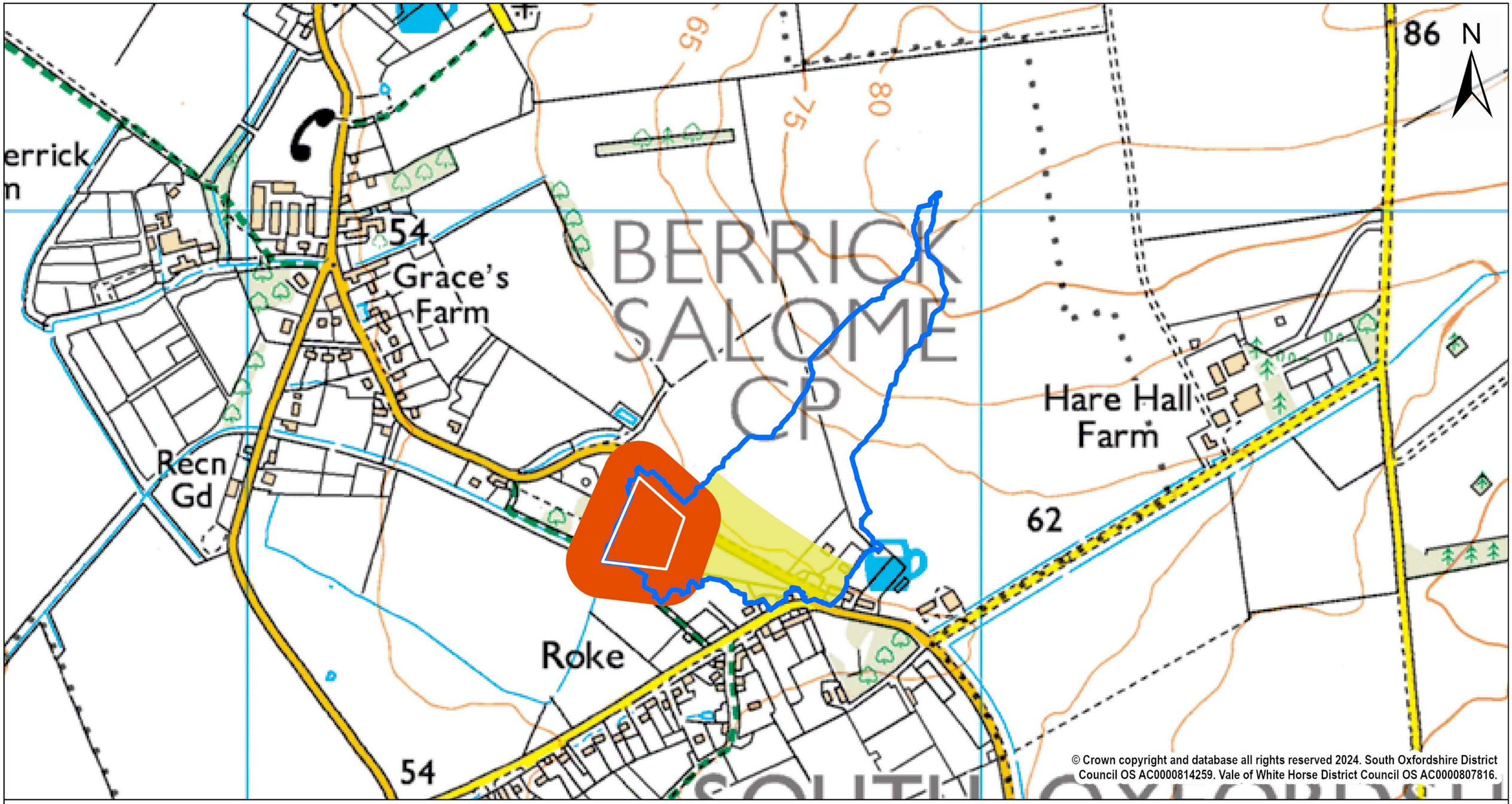


Figure A3.29 Risk zones mapped for Roke Marsh (site ref. 29)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Chiltern Chalk Scarp groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

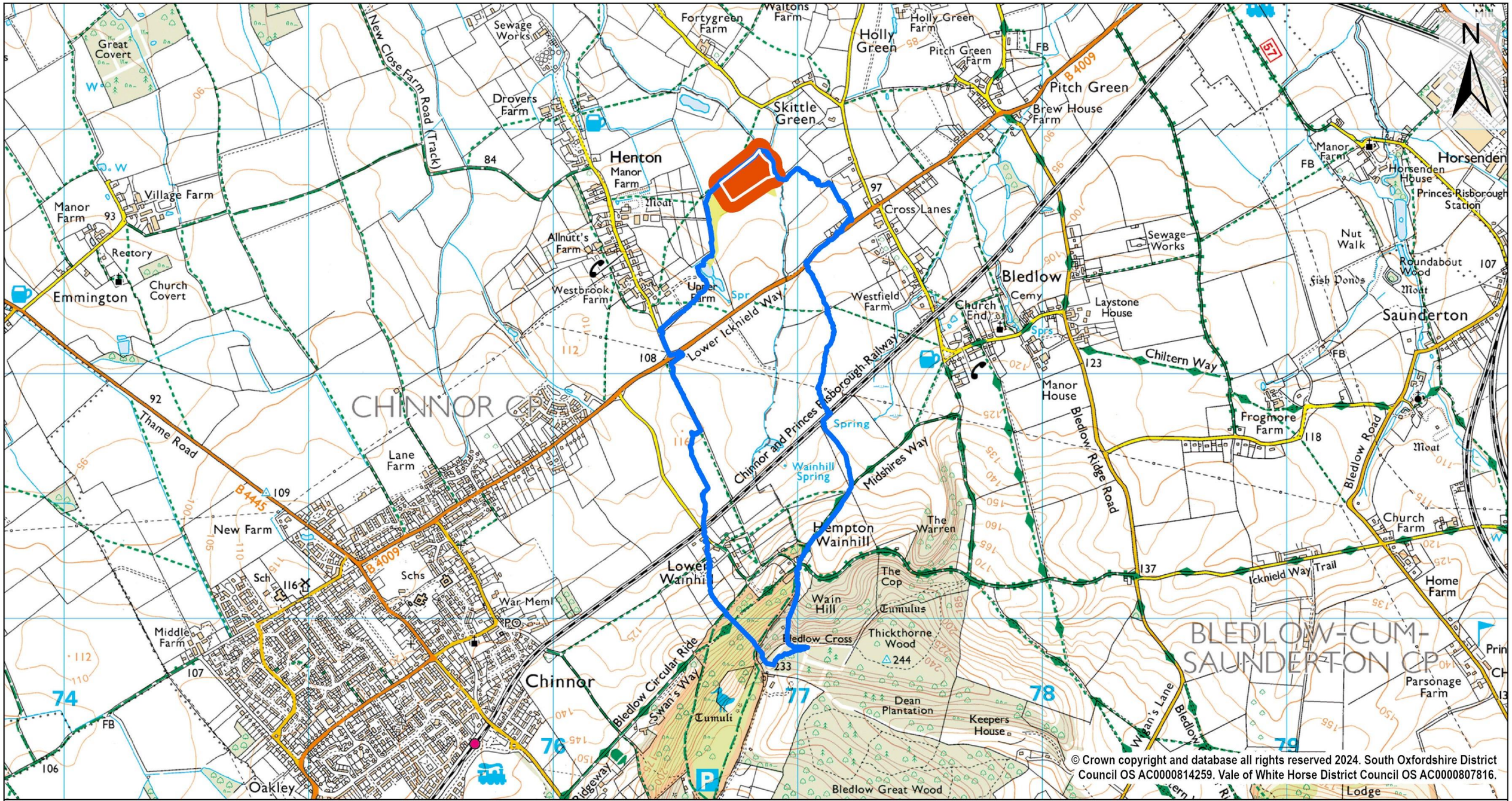


Figure A3.30 Risk zones mapped for Henton Fen (site ref. 30)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Chiltern Chalk Scarp groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

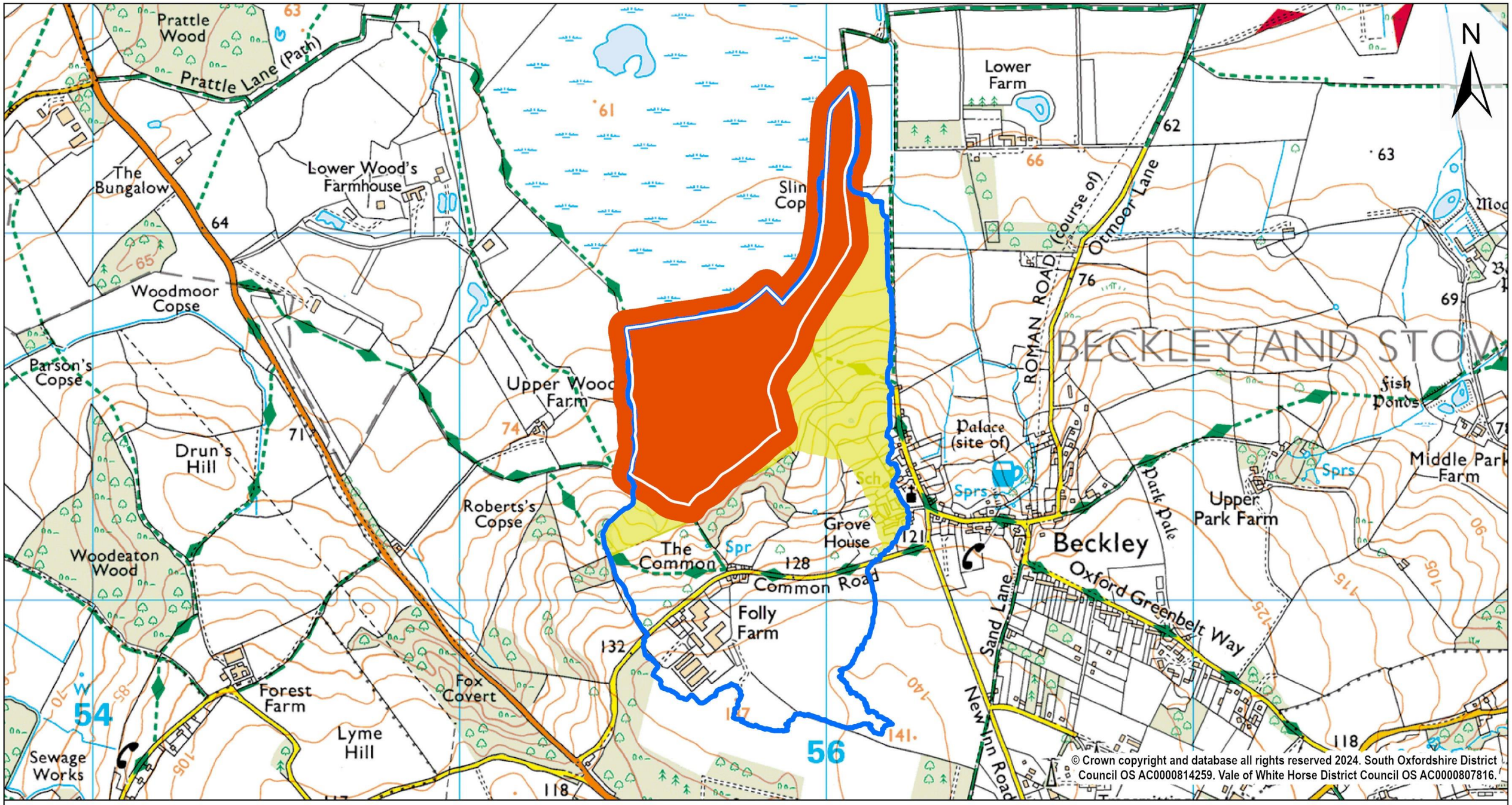


Figure A3.31 Risk zones mapped for Noke Wood (site ref. 31)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

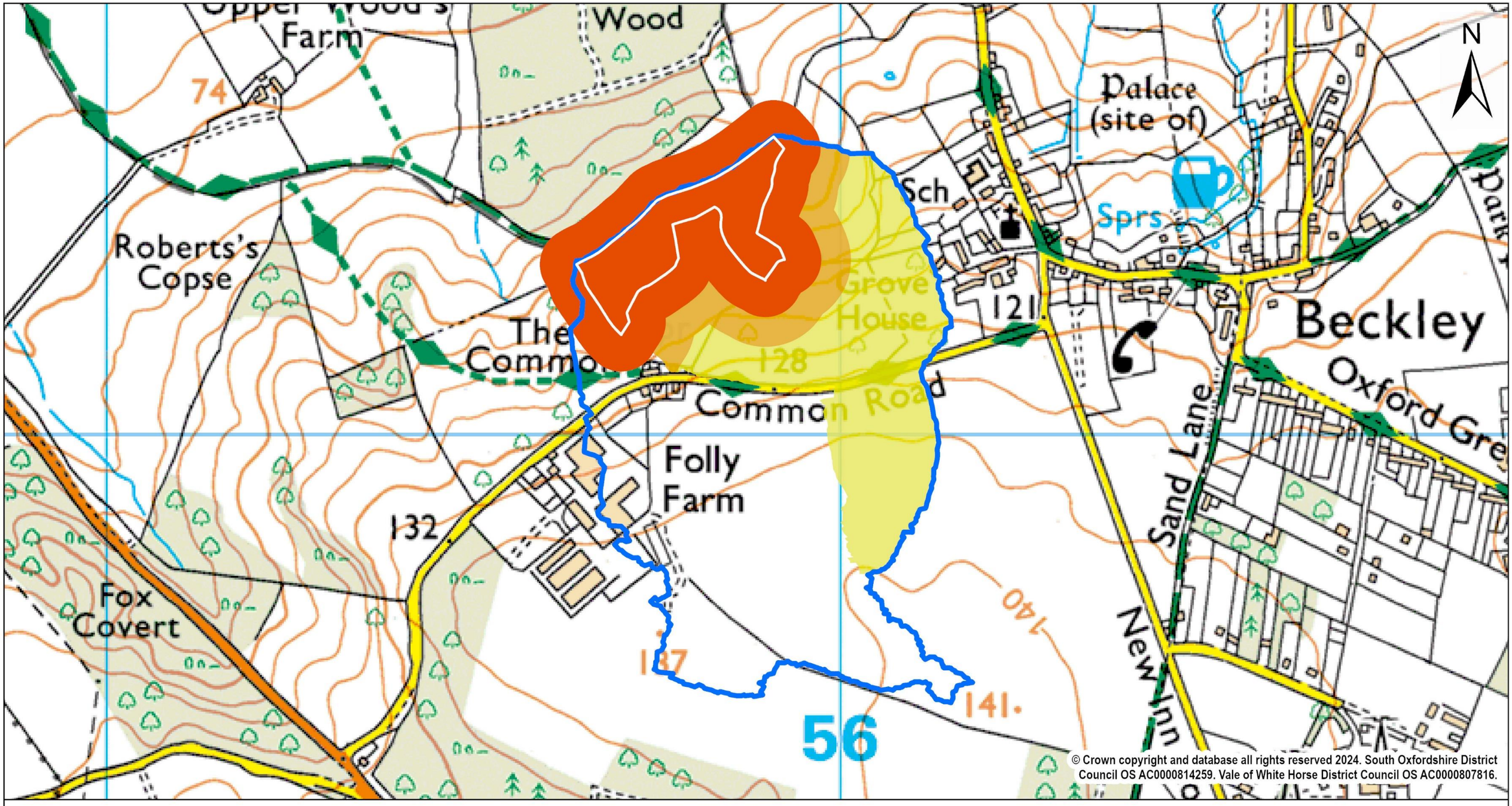


Figure A3.32 Risk zones mapped for Cookes Copse (site ref. 32)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

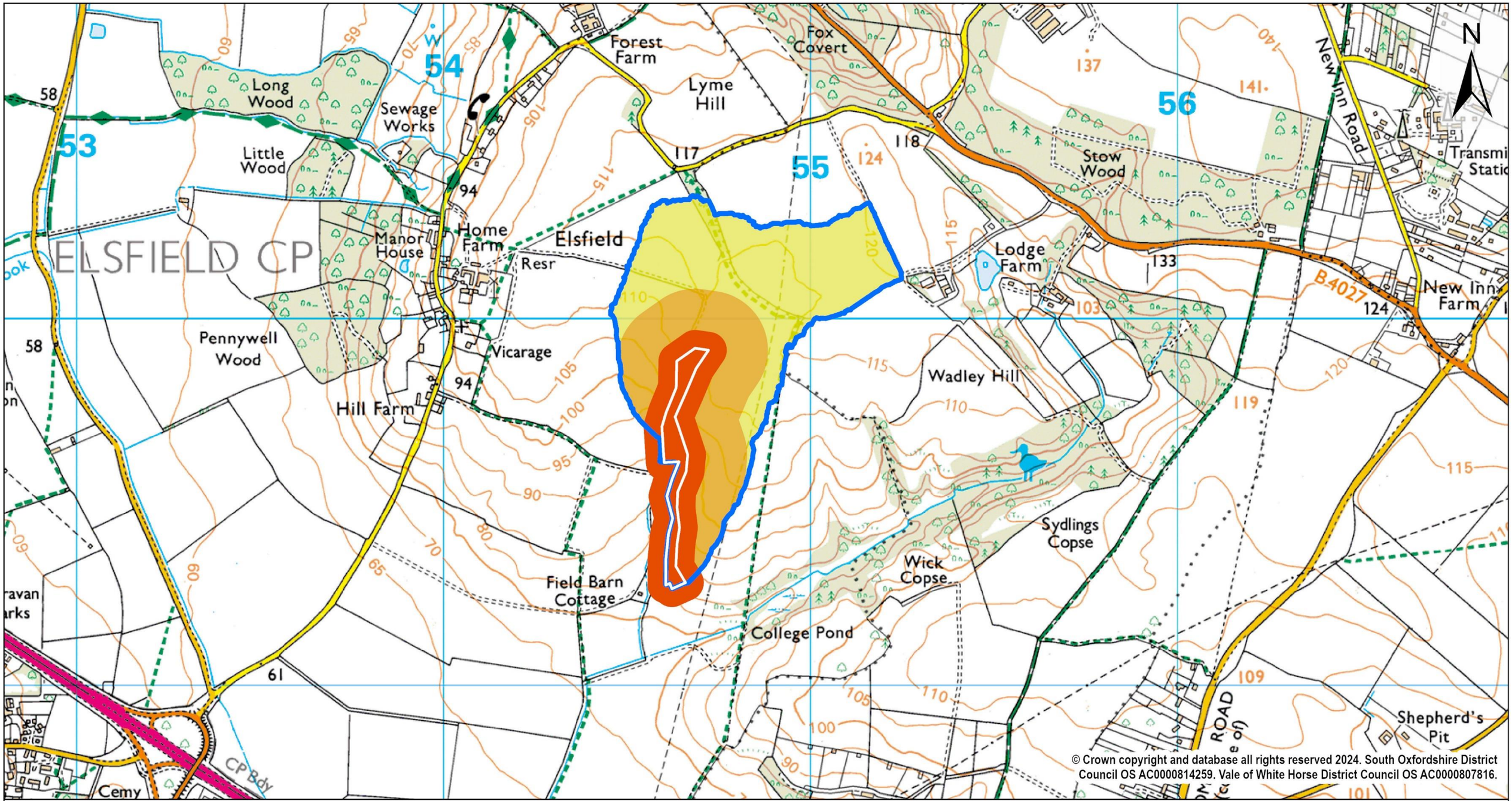


Figure A3.33 Risk zones mapped for The Osiers (site ref. 33)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

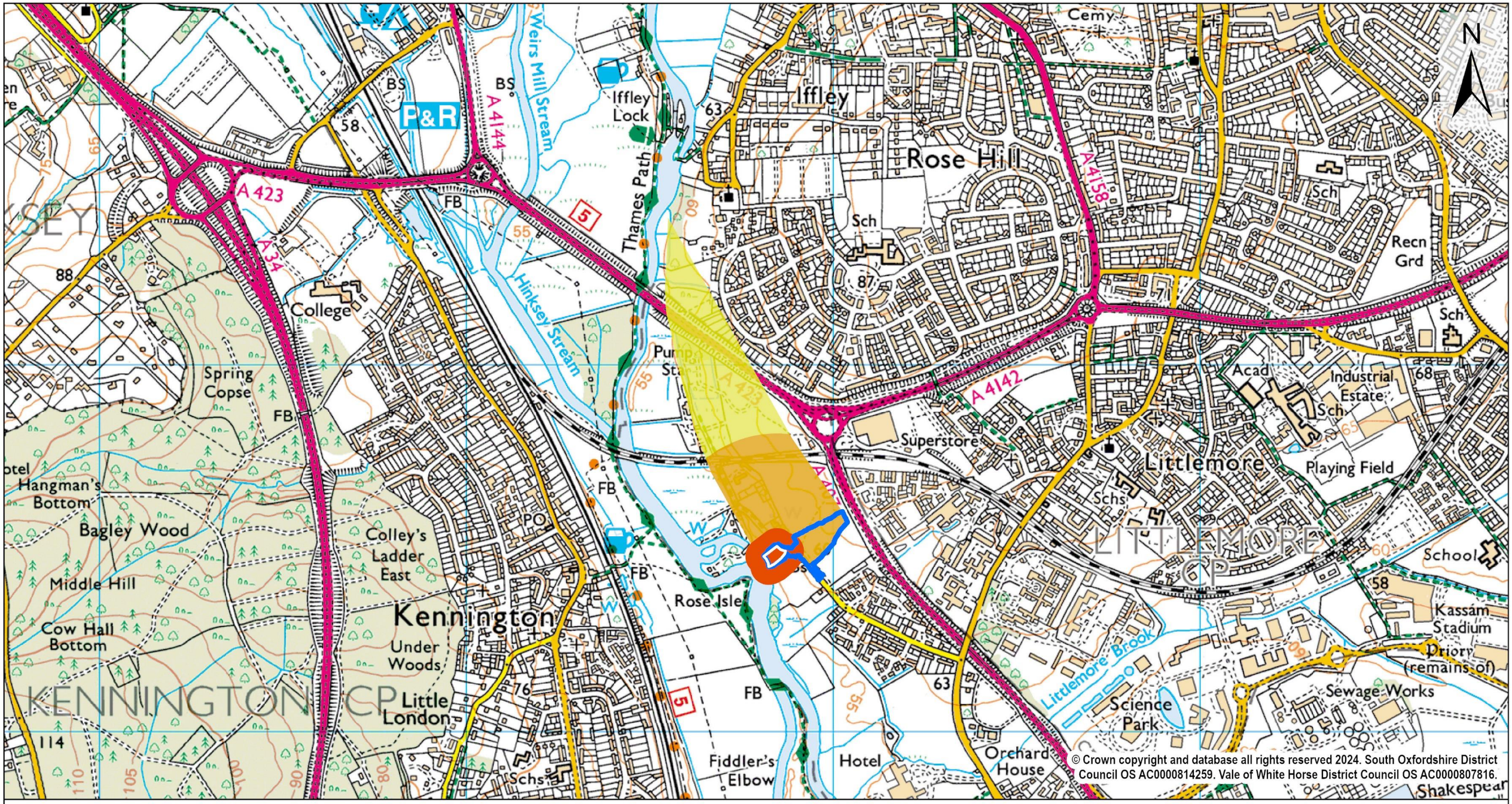


Figure A3.34 Risk zones mapped for Simon's Land (site ref. 34)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:10,000 @A3

0 0.25 0.5 km

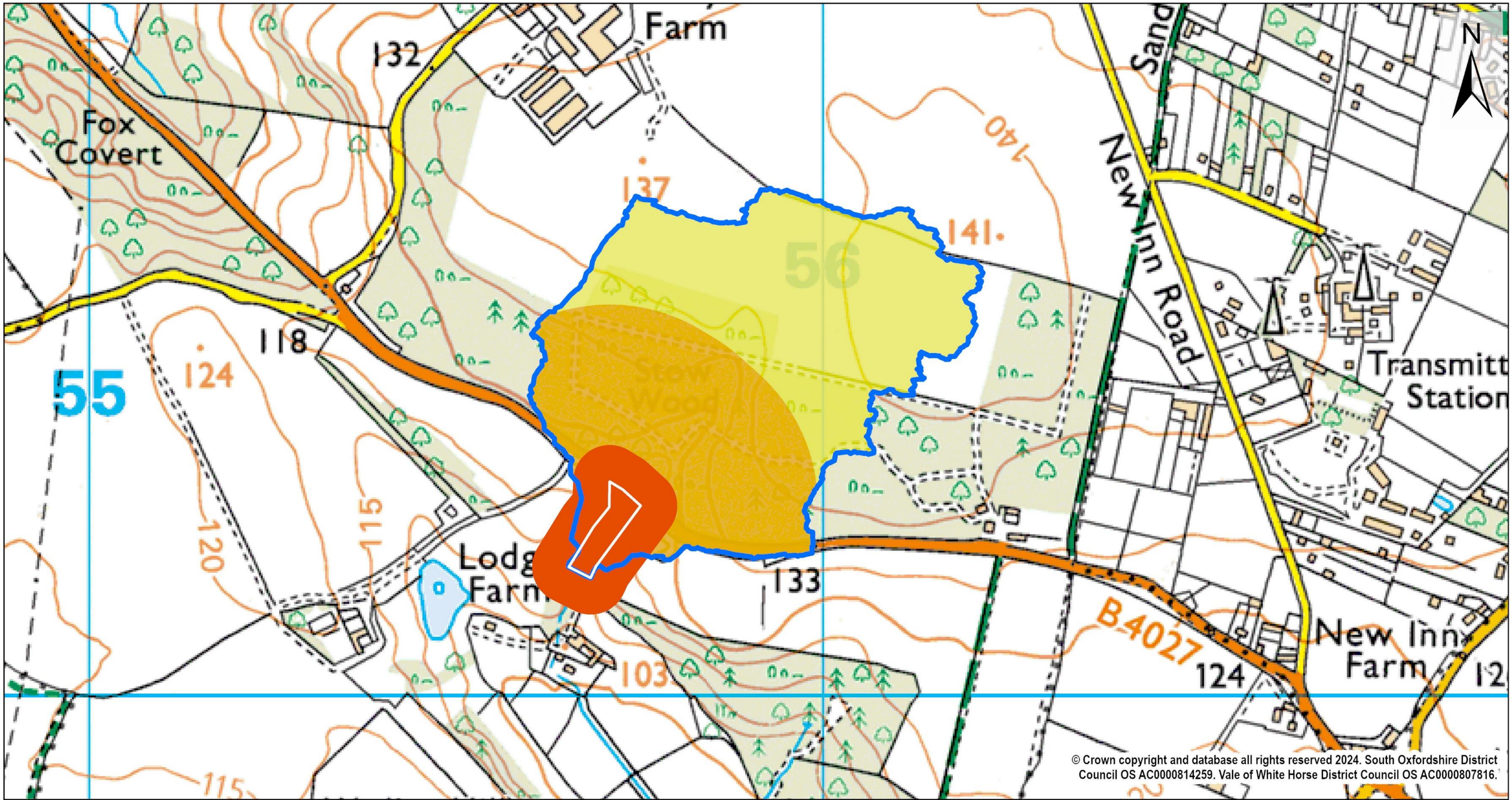


Figure A3.35 Risk zones mapped for Bog Under Stow Wood (site ref. 35)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

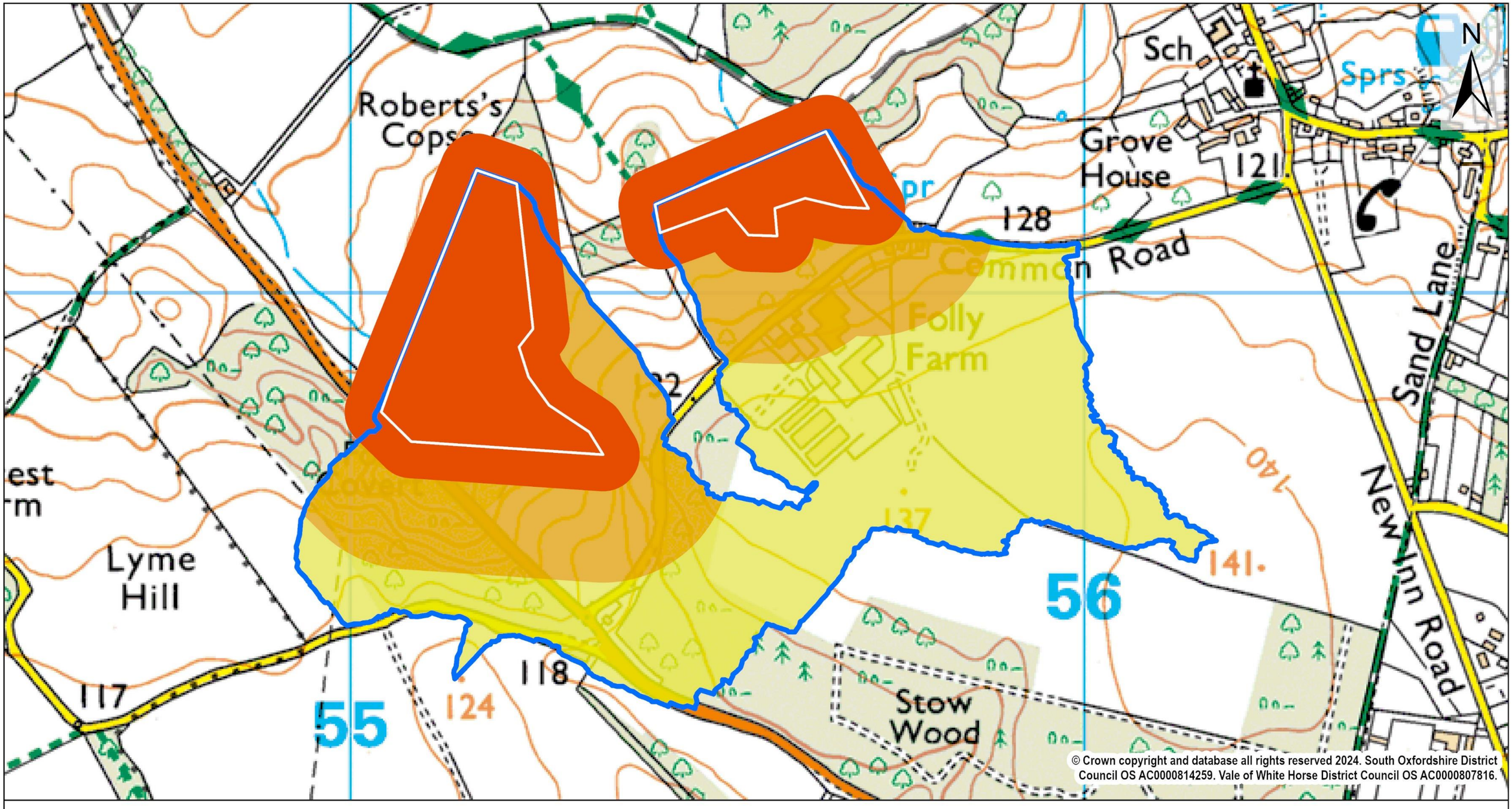


Figure A3.36 Risk zones mapped for Beckley Common (site ref. 36)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

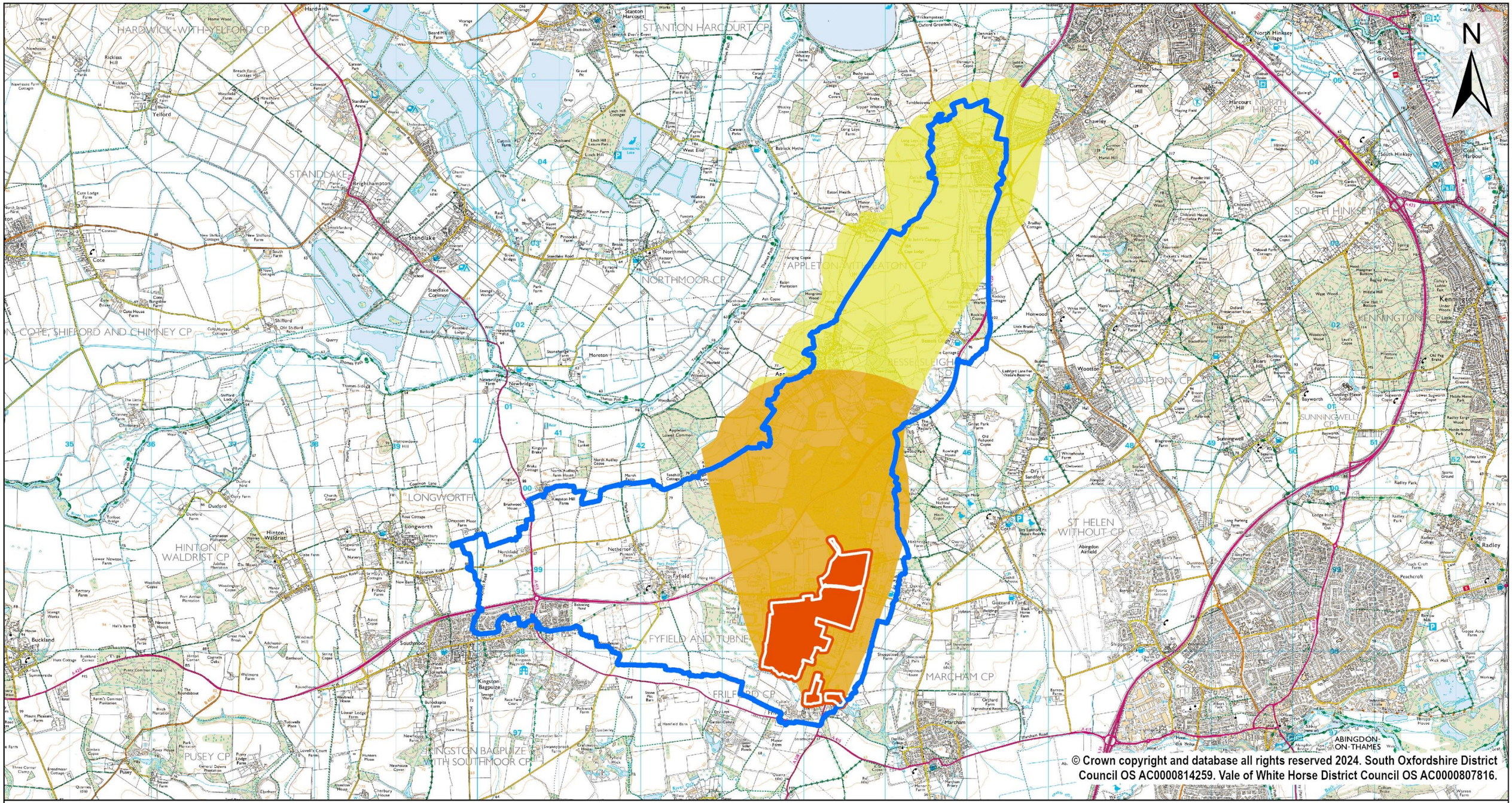


Figure A3.37 Risk zones mapped for Frilford Heath, Ponds and Fens (site ref. 37)

Freshwater Habitats Trust

Scale:
1:45,000 @A3

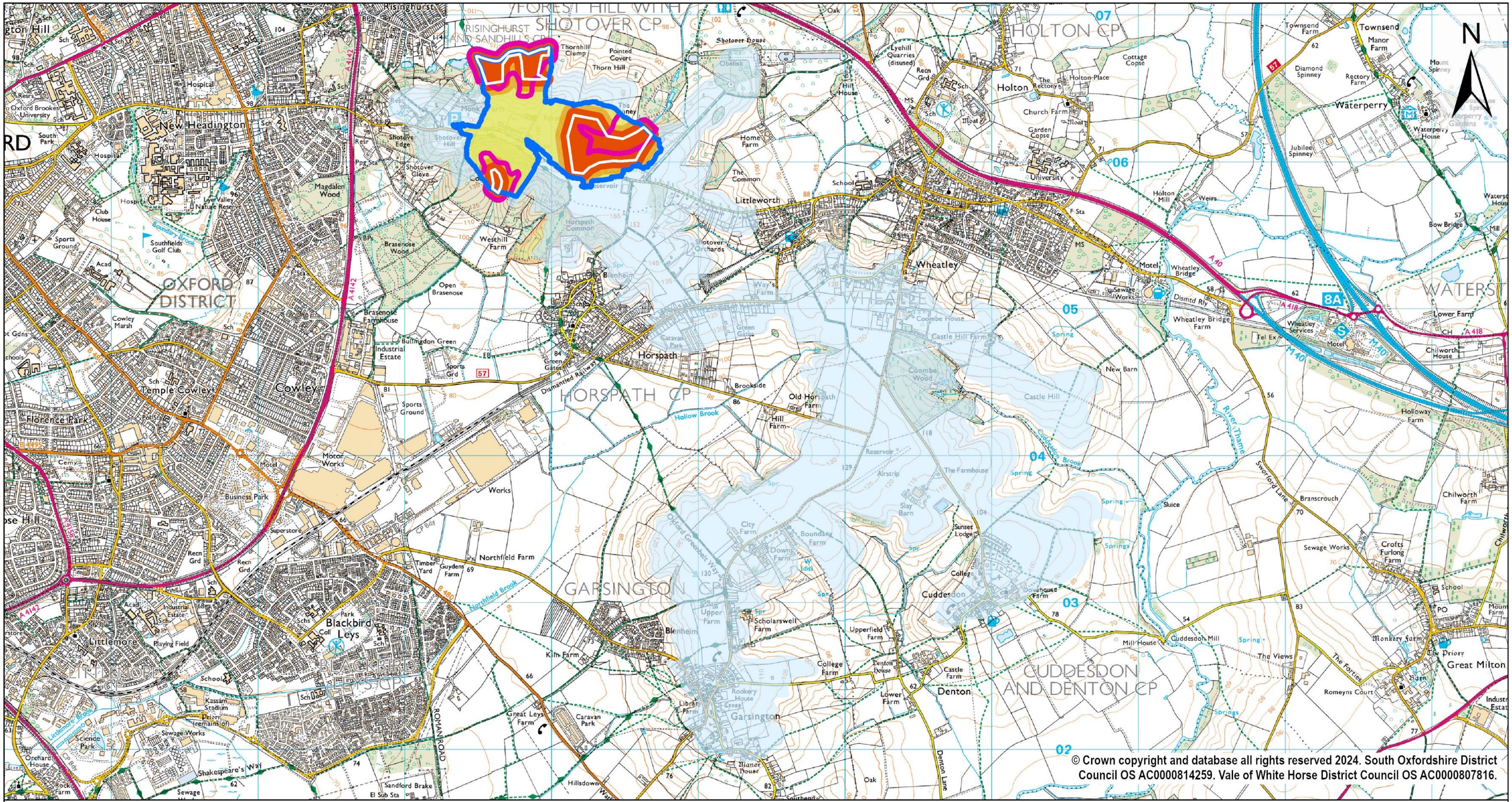
0 1 2 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.



Freshwater Habitats Trust

Scale:
1:25,000 @A3

0 0.5 1 km

Figure A3.38 Risk zones mapped for Shotover Hill (site ref. 38)

Fen site

Hydrological risk zone

- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

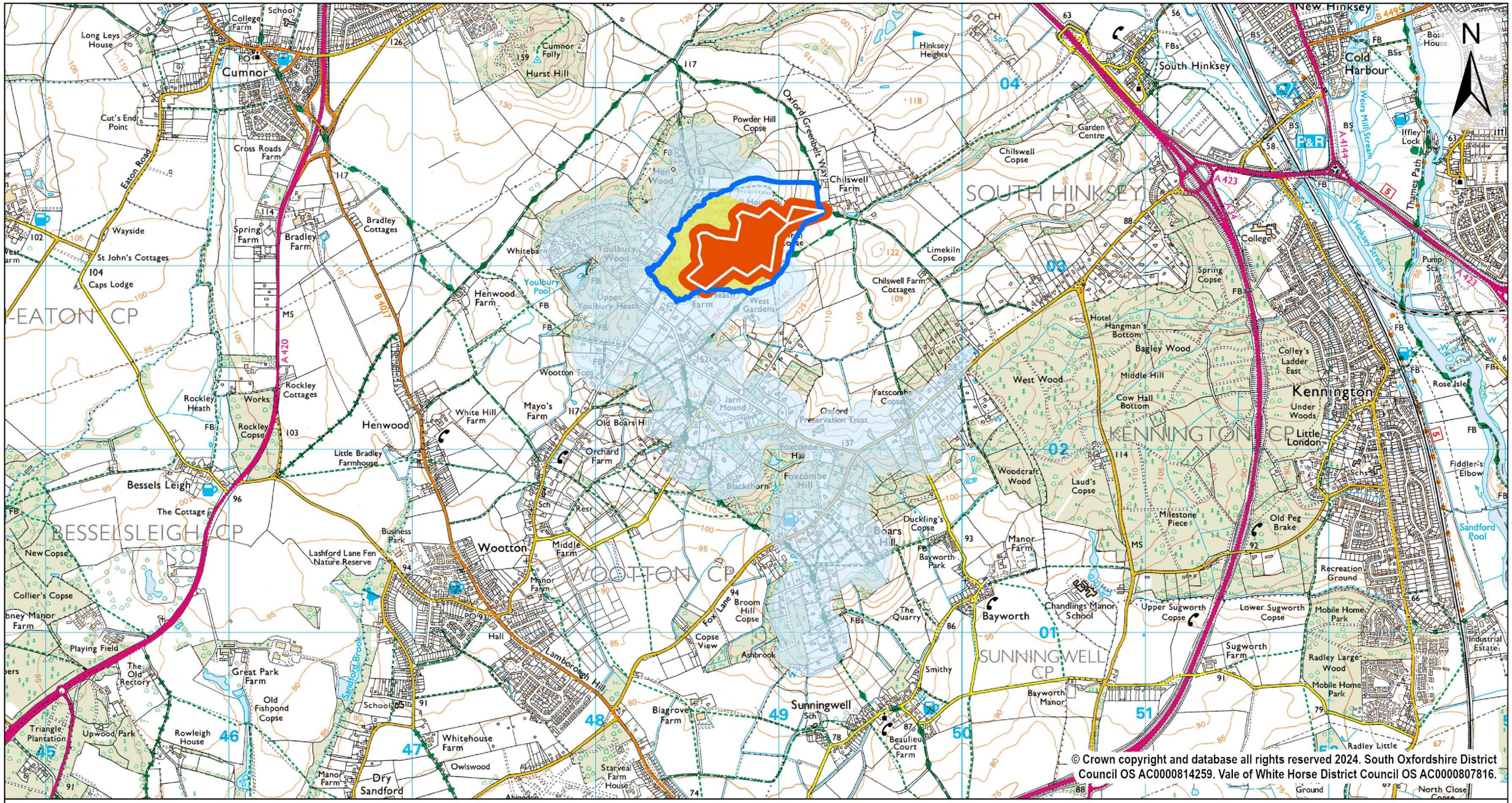


Figure A3.39 Risk zones mapped for Birch Copse (site ref. 39)

Fen site

Hydrological risk zone

- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

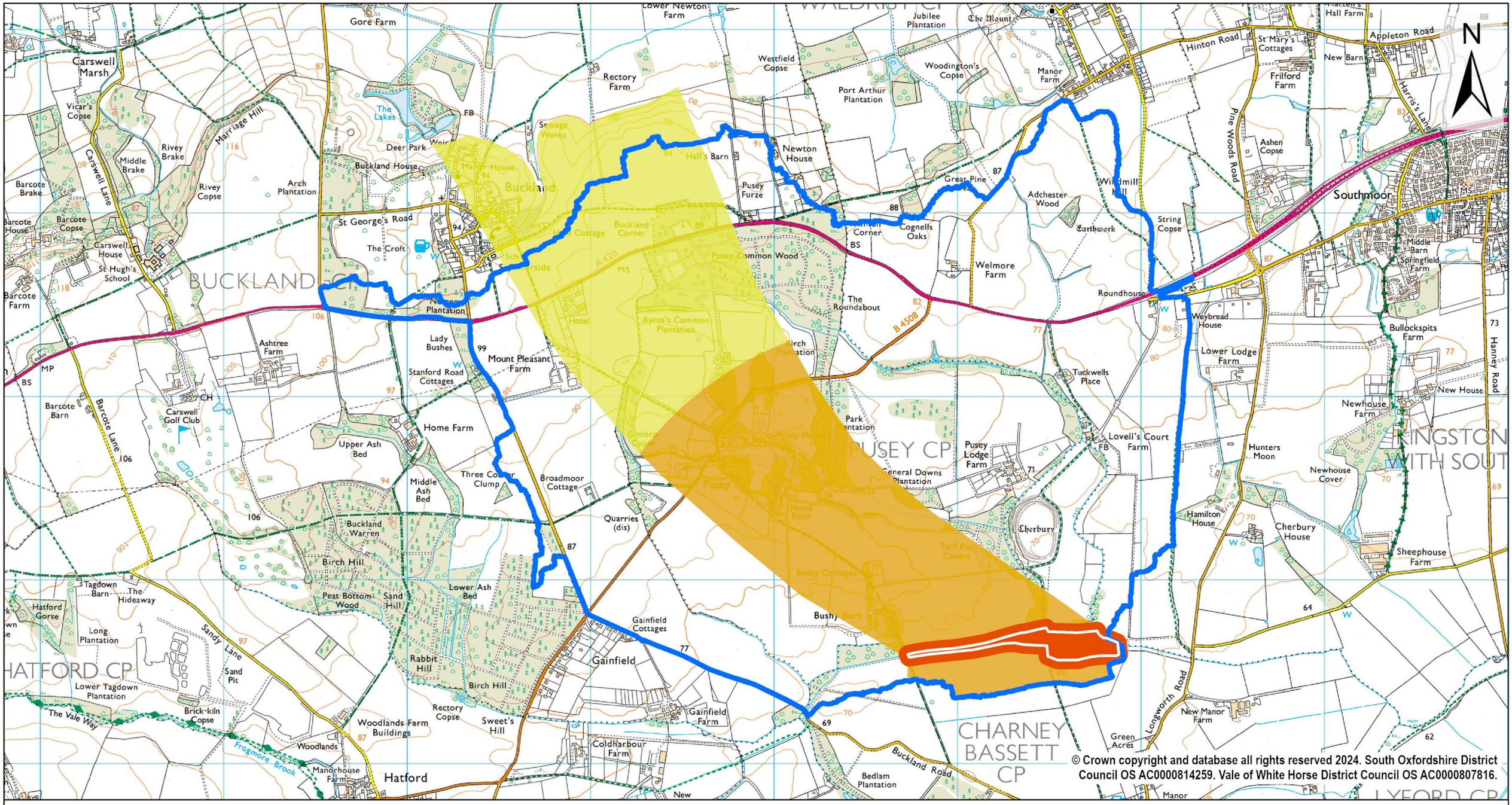


Figure A3.40 Risk zones mapped for South of Turf Pits Covert (site ref. 40)

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

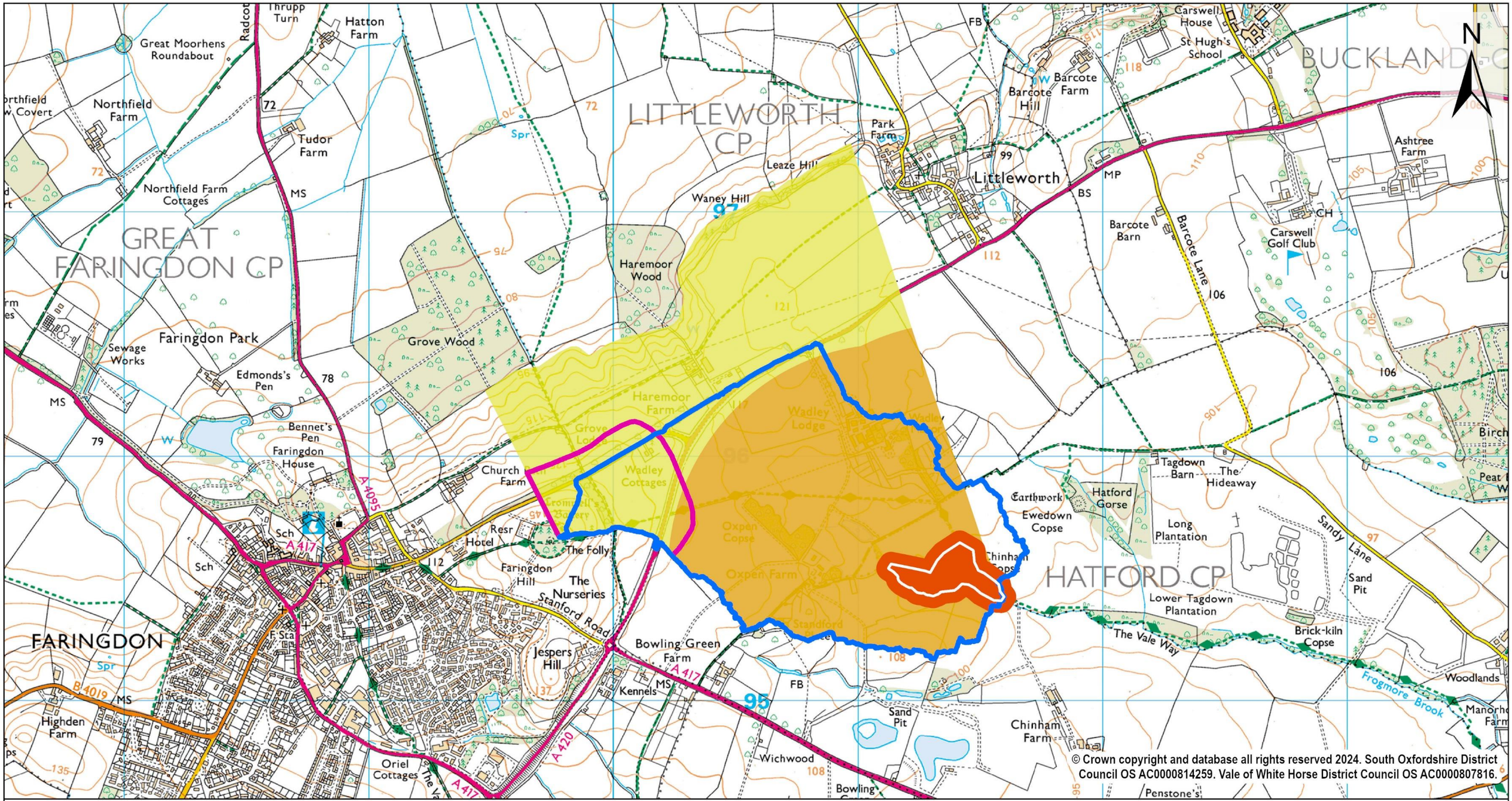


Figure A3.41 Risk zones mapped for Chinham Copse (site ref. 41)

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

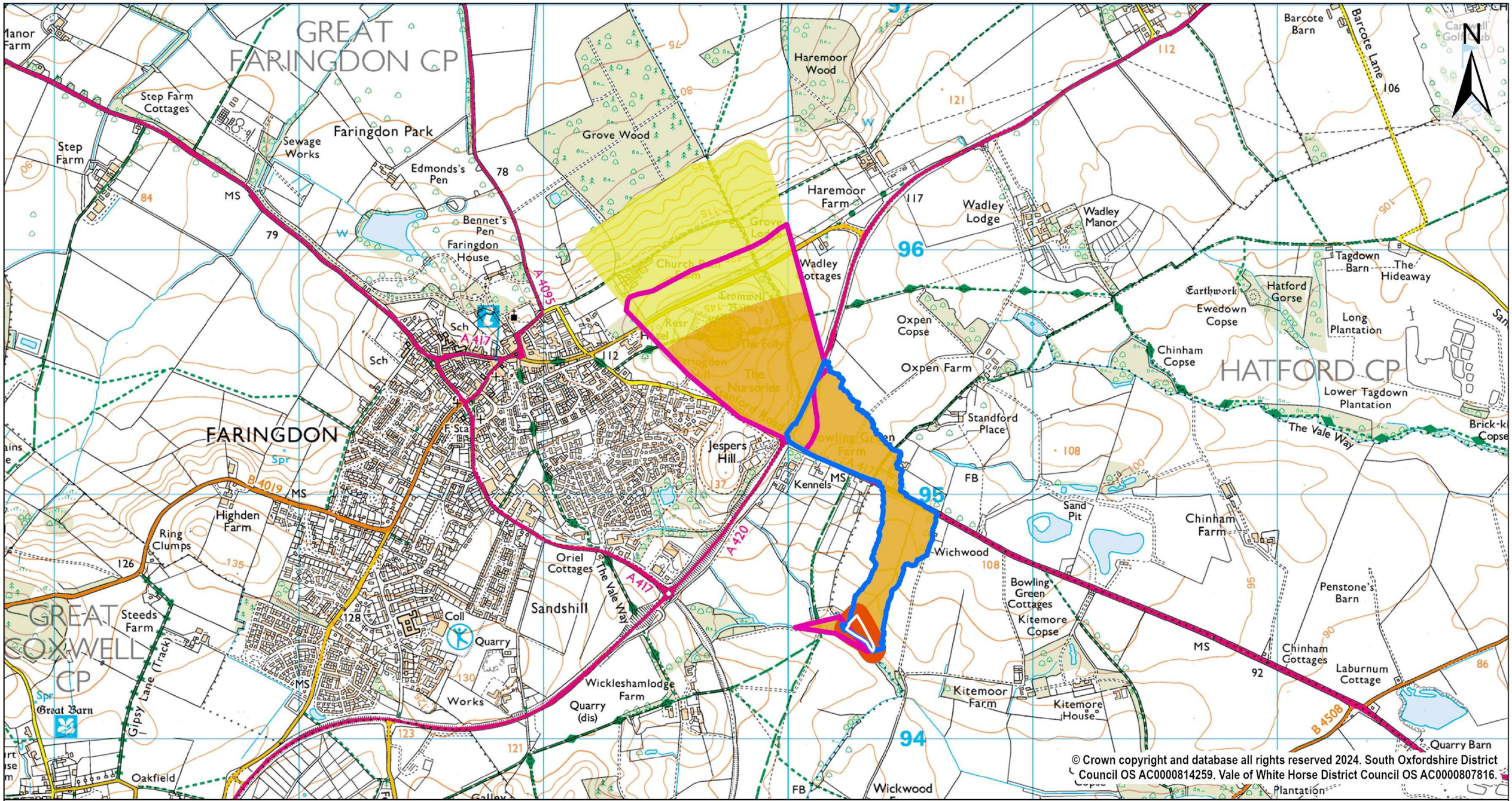


Figure A3.42 Risk zones mapped for Old Pump House (site ref. 42)

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

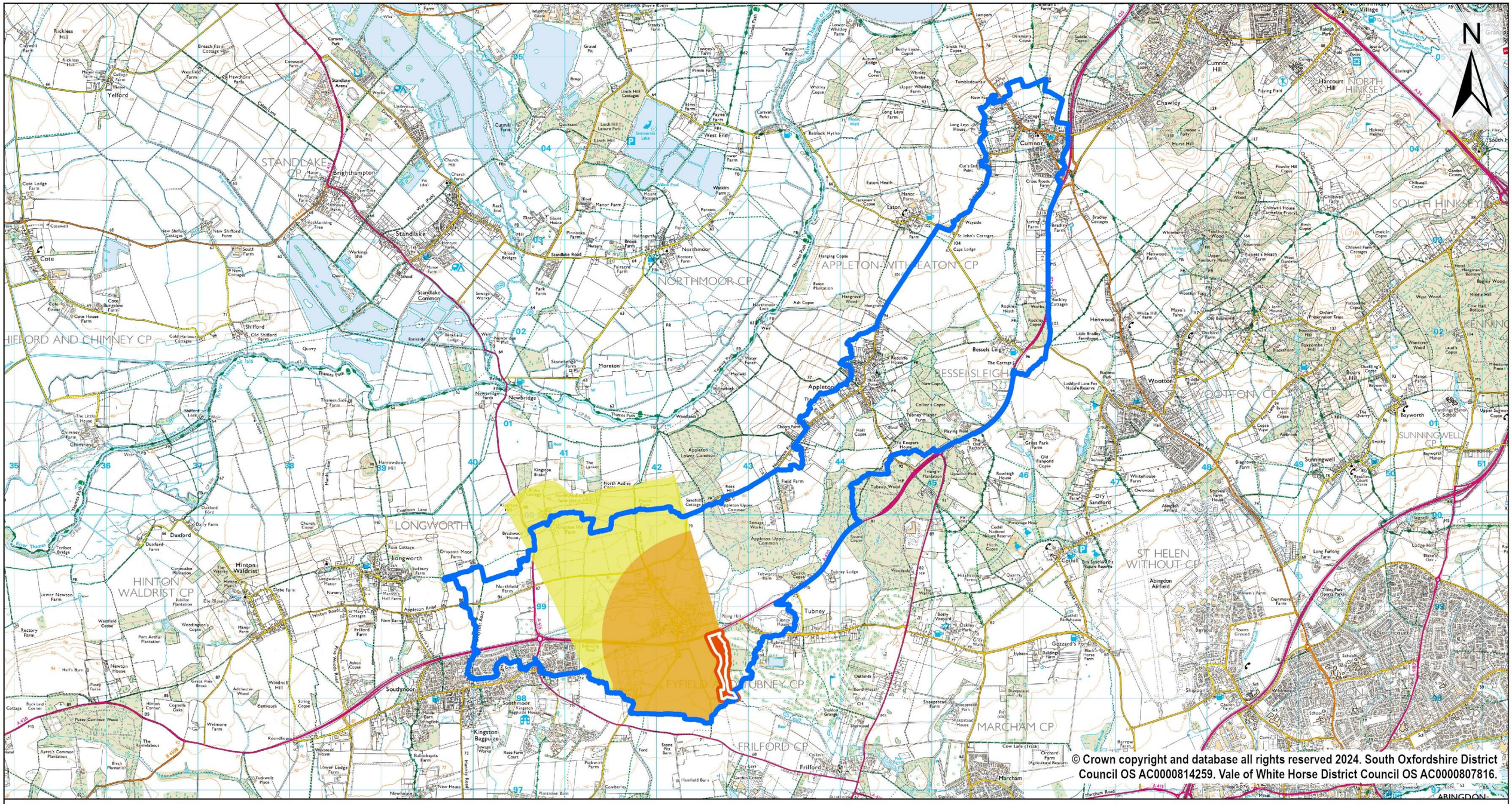


Figure A3.43 Risk zones mapped for Fyfield (site ref. 43)

Freshwater Habitats Trust

Scale:
1:40,000 @A3

0 1 2 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

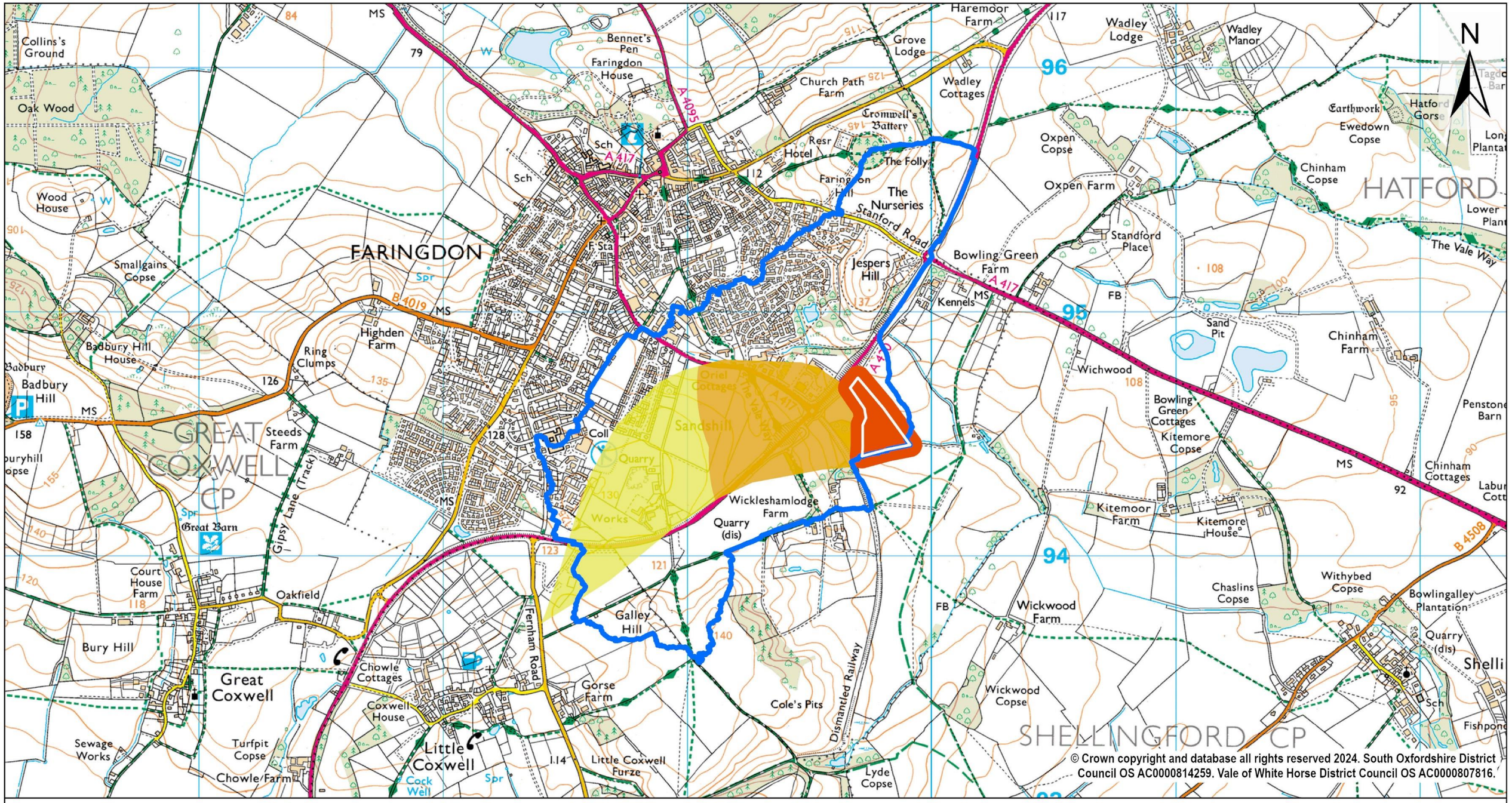


Figure A3.44 Risk zones mapped for Wicklesham Copse (site ref. 44)

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

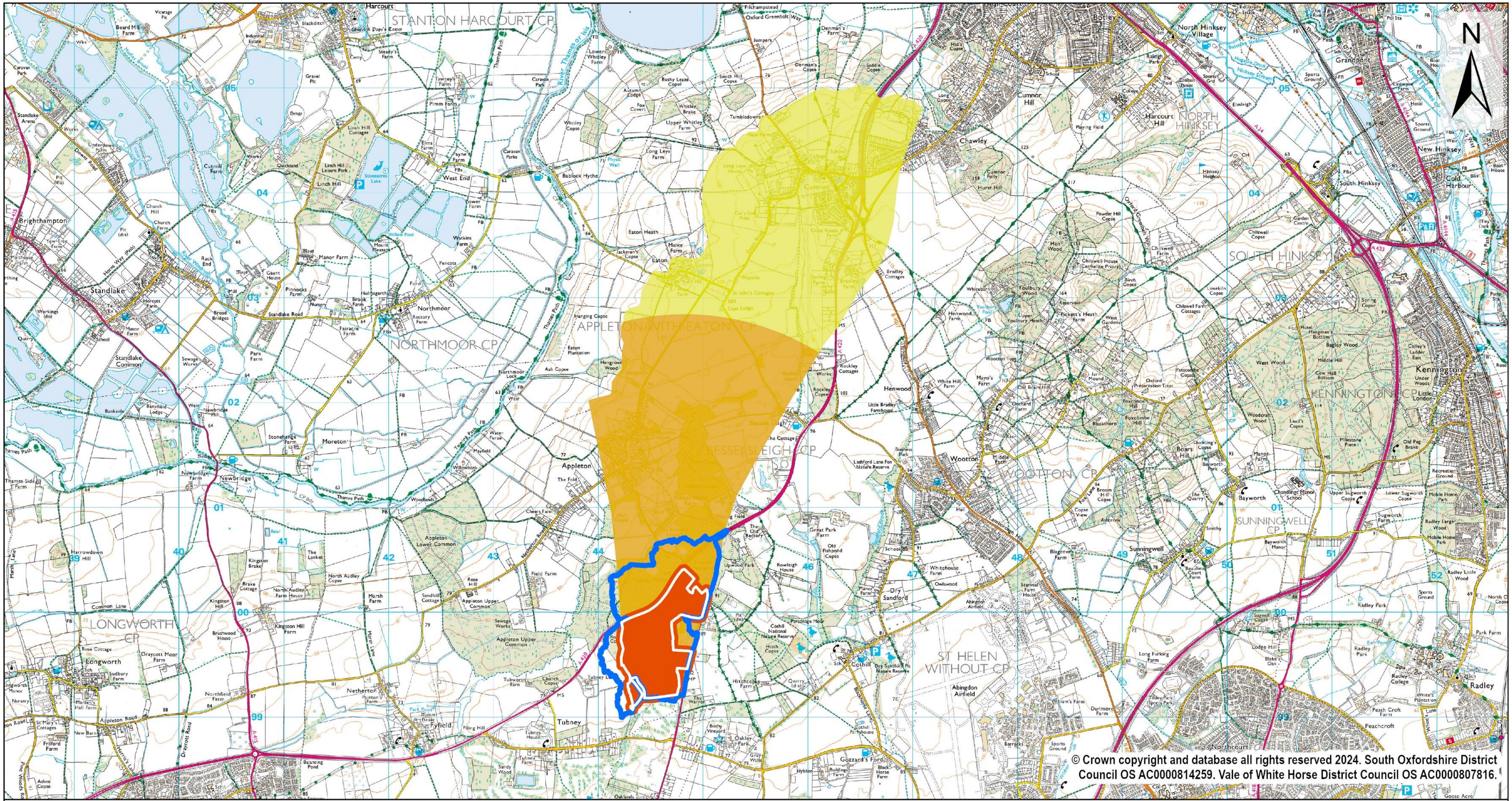


Figure A3.45 Risk zones mapped for Tubney Wood (site ref. 45)

Freshwater Habitats Trust

Scale:
1:35,000 @A3

0 0.75 1.5 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

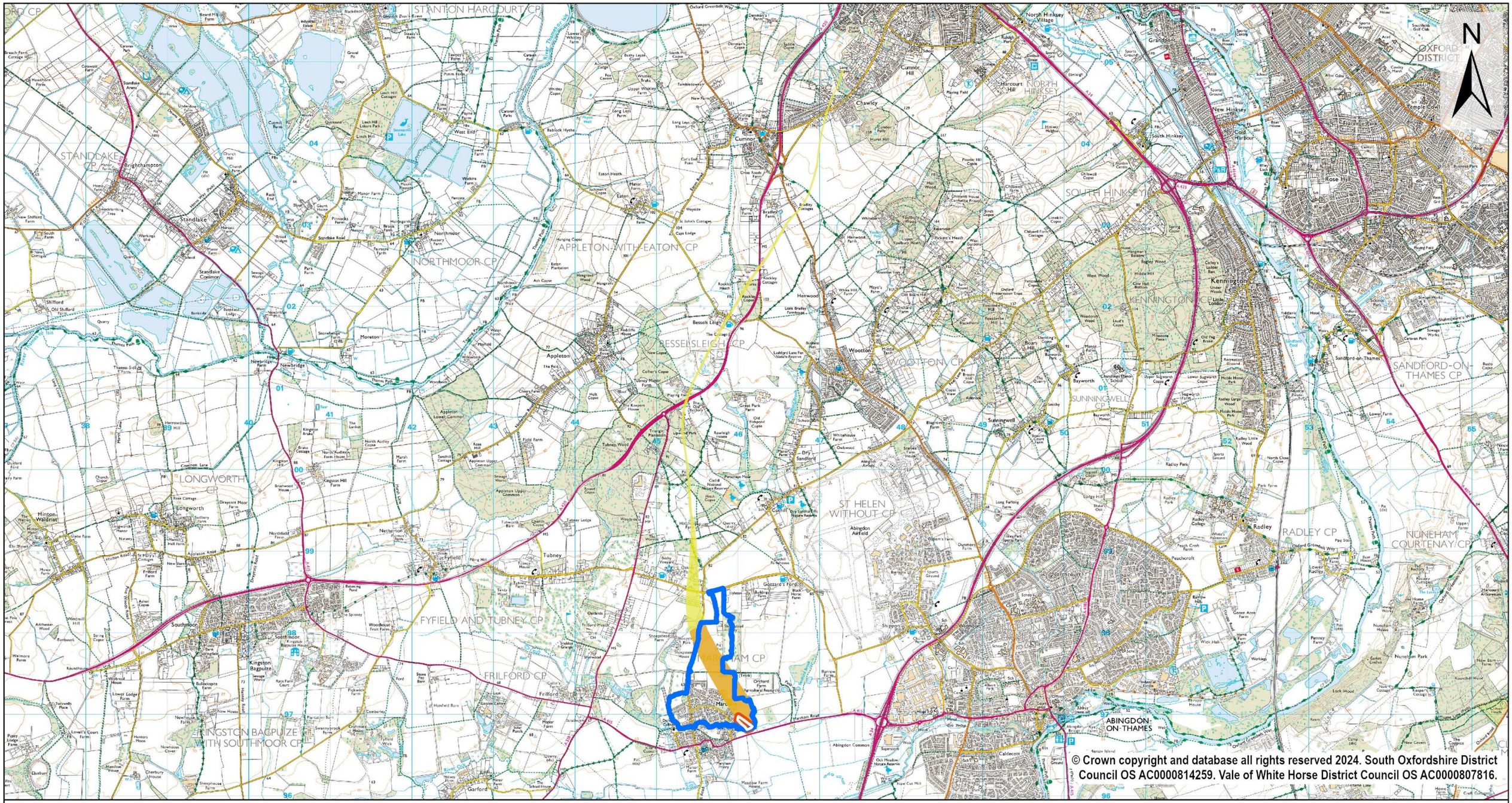


Figure A3.46 Risk zones mapped for Hydes Farm Fen (site ref. 46)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Shrivenham Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:45,000 @A3

0 1 2 km

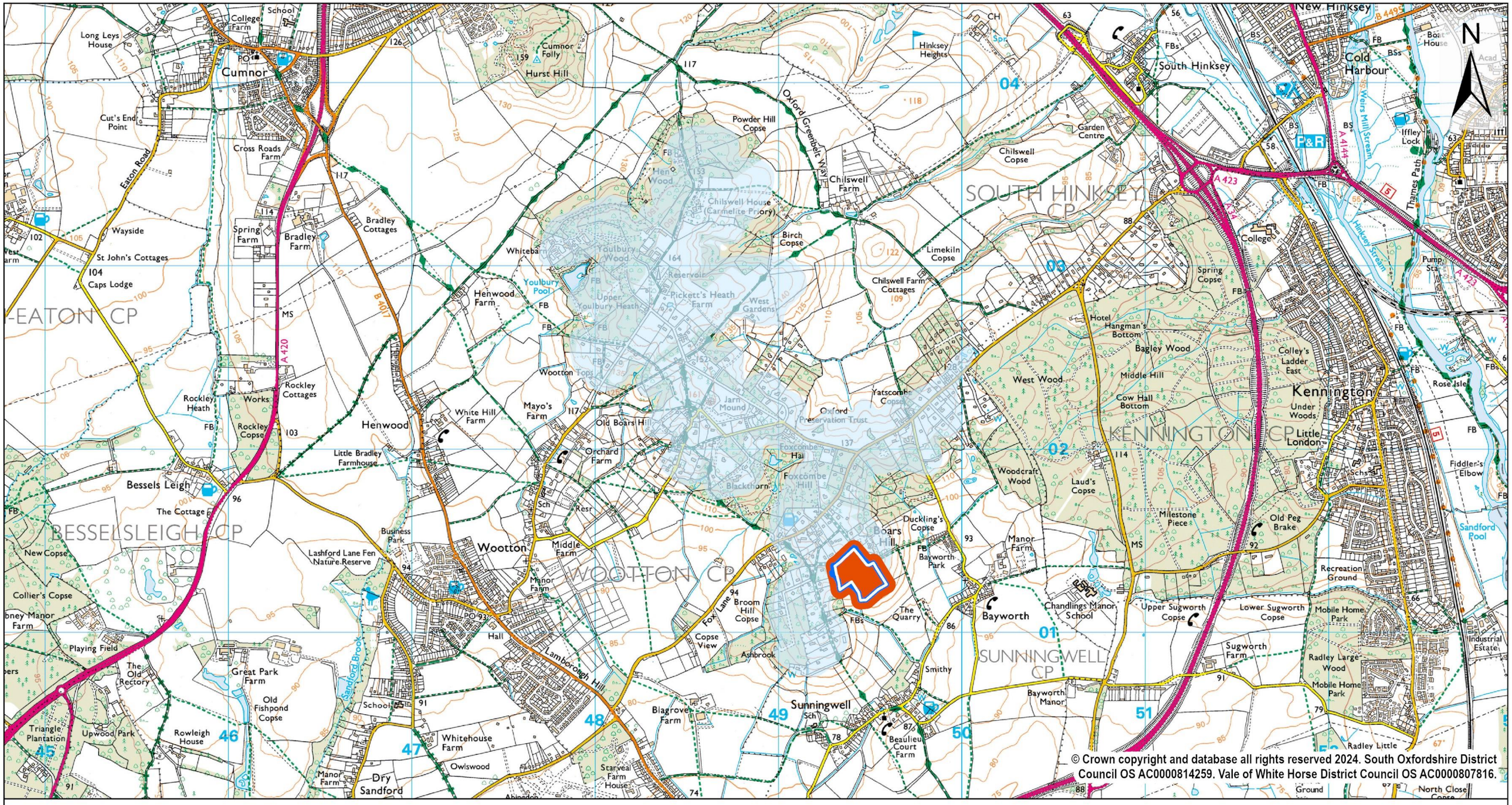


Figure A3.47 Risk zones mapped for Lincombe Lane (site ref. 47)

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

Fen site

Hydrological risk zone

- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

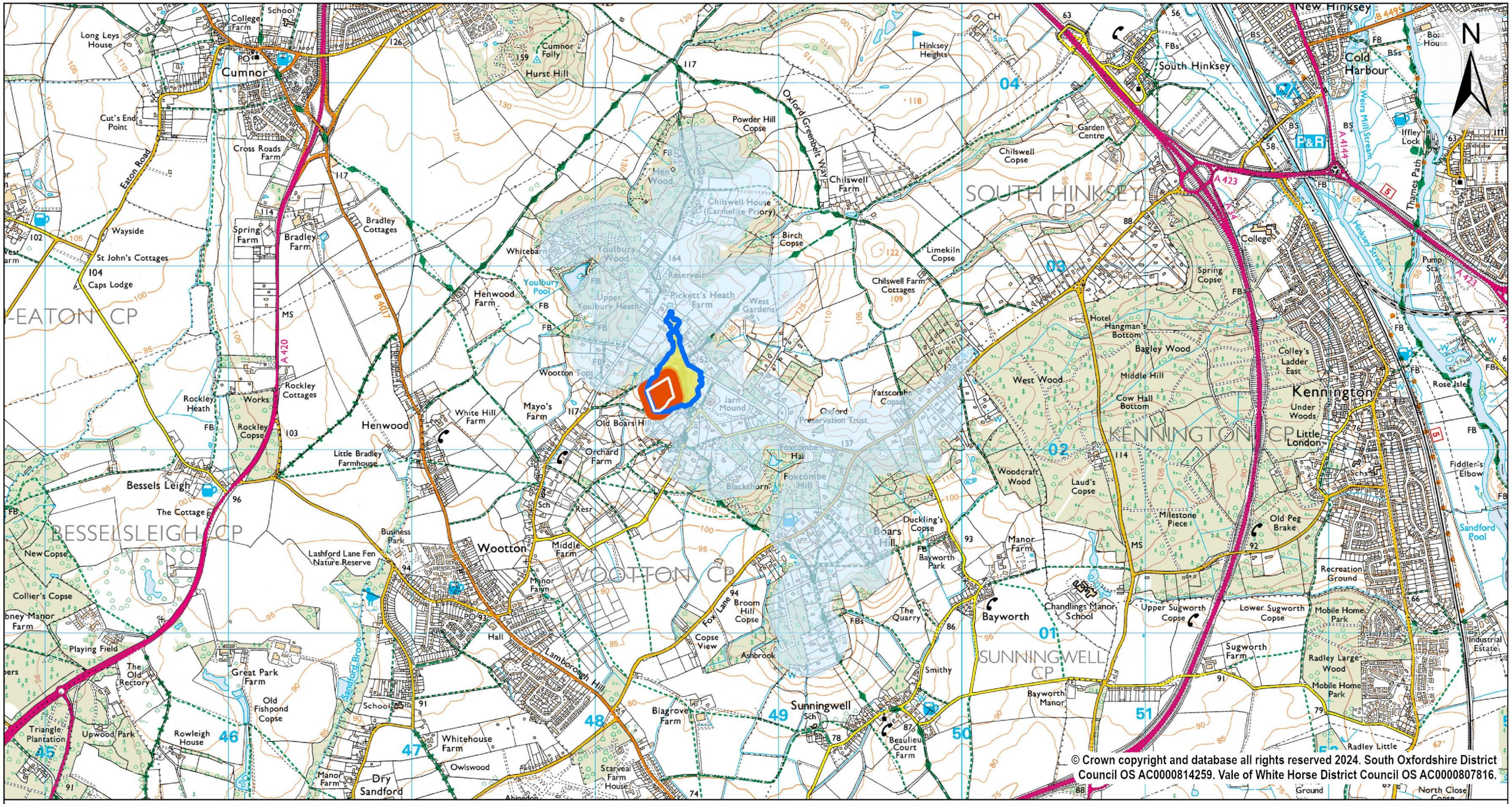


Figure A3.48 Risk zones mapped for Matthew Arnold's Field (site ref. 48)

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

Fen site

Hydrological risk zone

- **Zone 1 - Groundwater body**
- **Zone 2 - Groundwater catchment**
- **Zone 3 - Sub-groundwater catchment**
- **Zone 4 - 50 m site buffer**
- **Zone 5 - Surface water catchment**

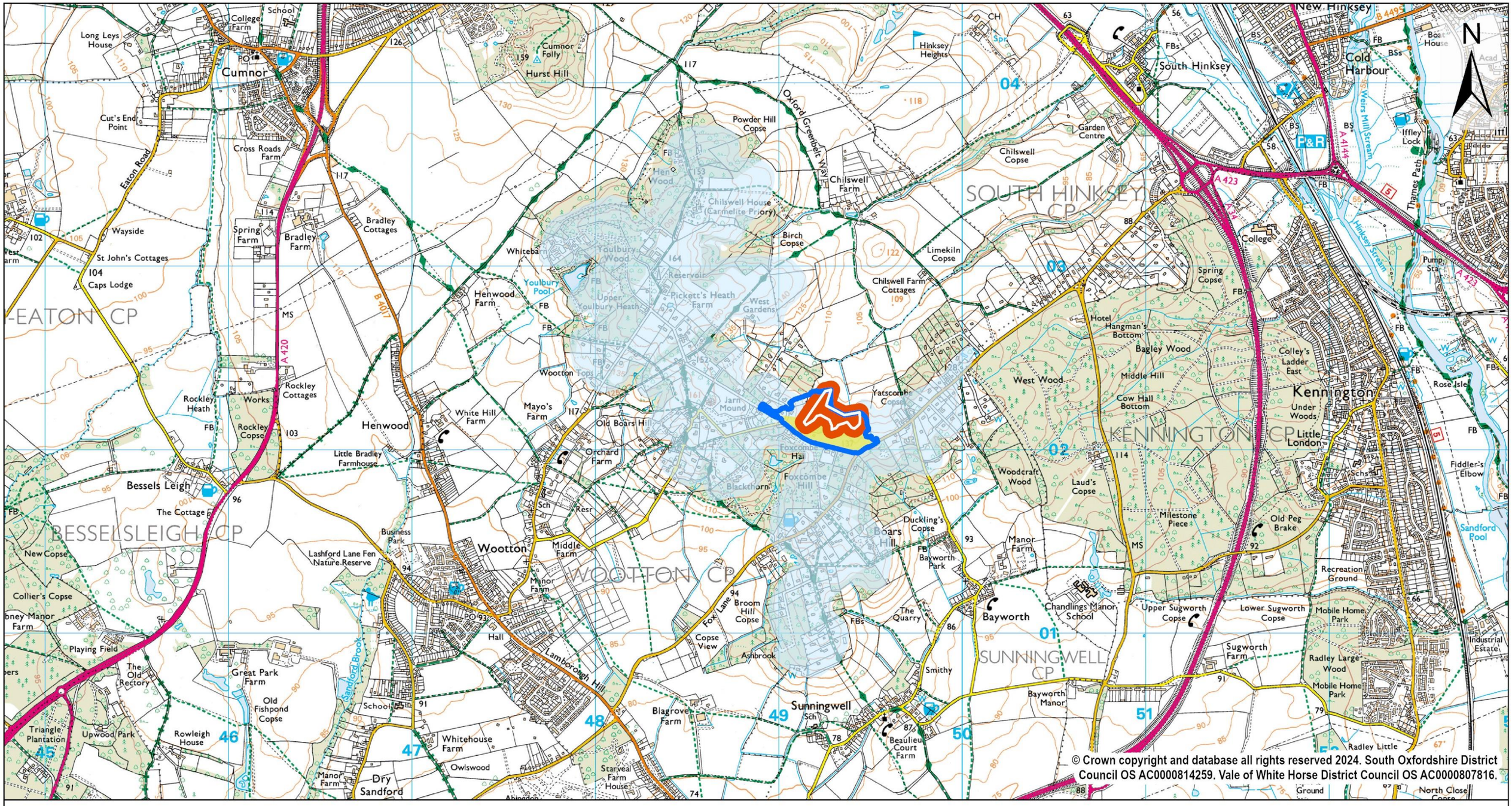


Figure A3.49 Risk zones mapped for Old Berkley Golf Course Springs (site ref. 49)

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

- Fen site
- Hydrological risk zone
  - Zone 1 - Groundwater body
  - Zone 2 - Groundwater catchment
  - Zone 4 - 50 m site buffer
  - Zone 5 - Surface water catchment

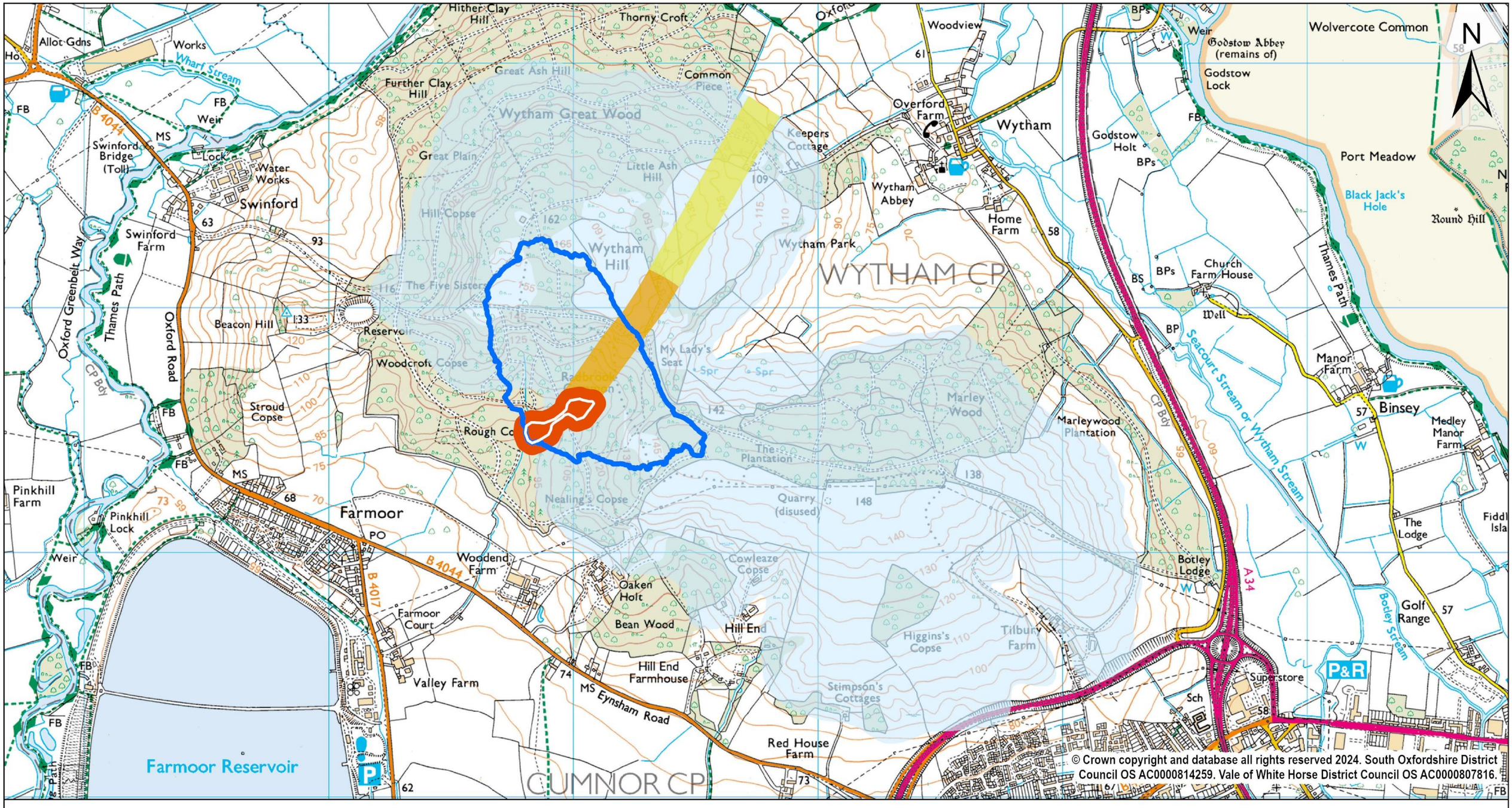


Figure A3.50 Risk zones mapped for Radbrook Common (site ref. 50)

Freshwater Habitats Trust

Fen site

Hydrological risk zone

- Zone 1 - Groundwater body
- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

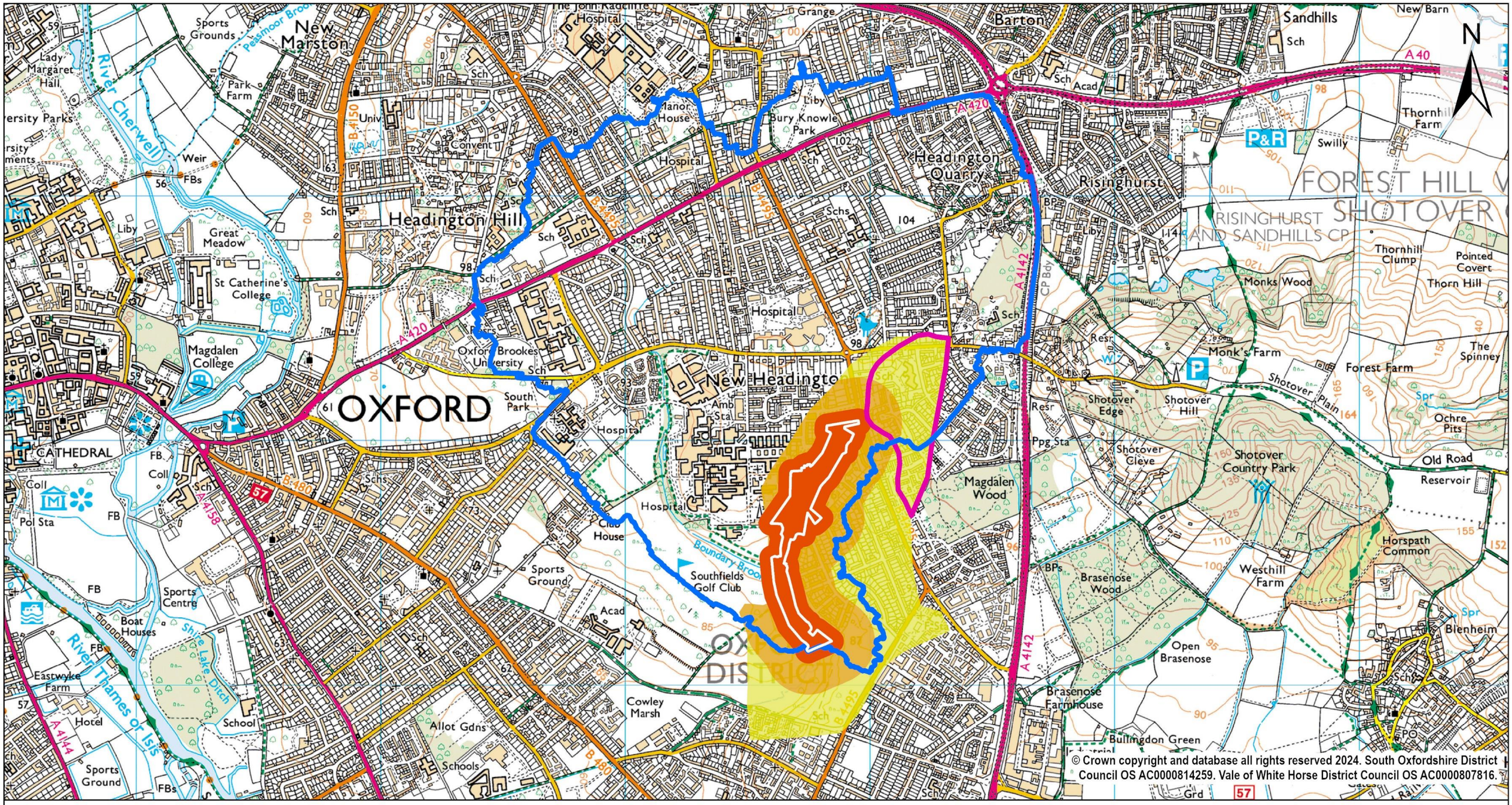


Figure A3.51 Risk zones mapped for Lye Valley (site ref. 51)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:15,000 @A3

0 0.38 0.75 km

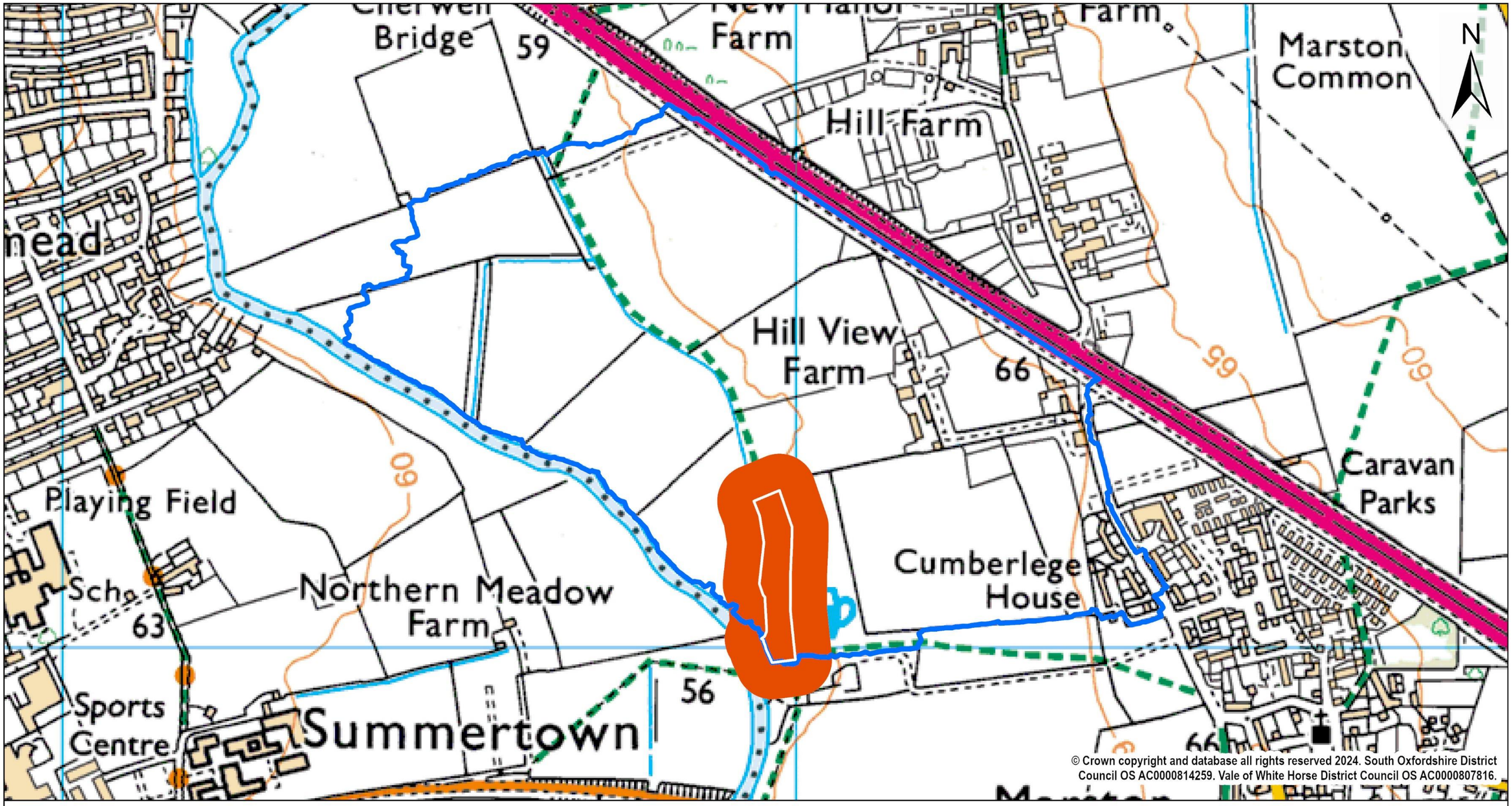


Figure A3.52 Risk zones mapped for Almonds Farm Bank (site ref. 52)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

Figure A3.53 Risk zones mapped for Dunstan Park (site ref. 53)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Headington Corallian groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

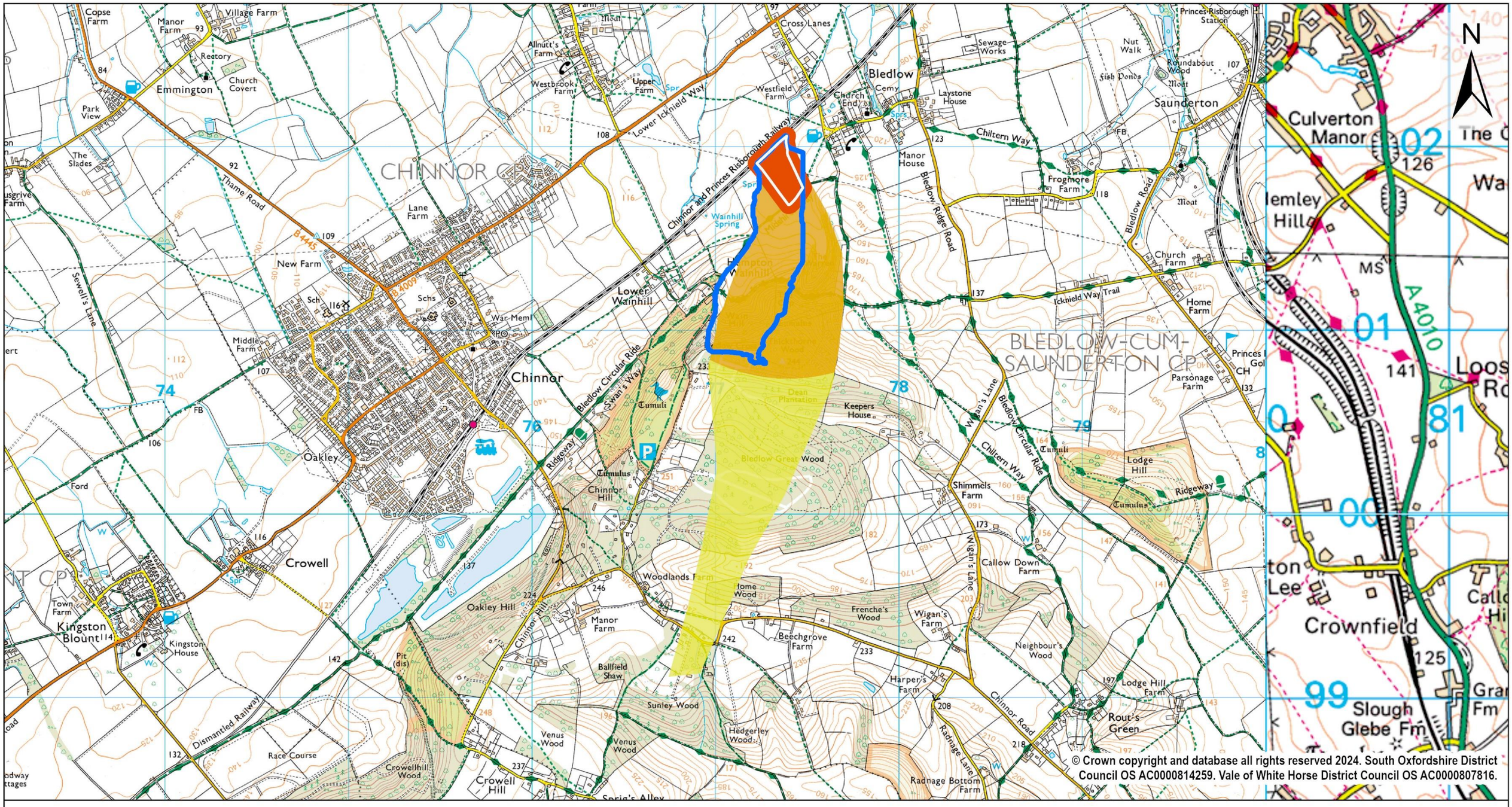


Figure A3.54 Risk zones mapped for Bledlow Fen (site ref. 54)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

NB this fen site lies over the Chiltern Chalk Scarp groundwater body, which is too large to show as Zone 1 in this figure. Please see Figure A4.1.

Freshwater Habitats Trust

Scale:
1:20,000 @A3

0 0.5 1 km

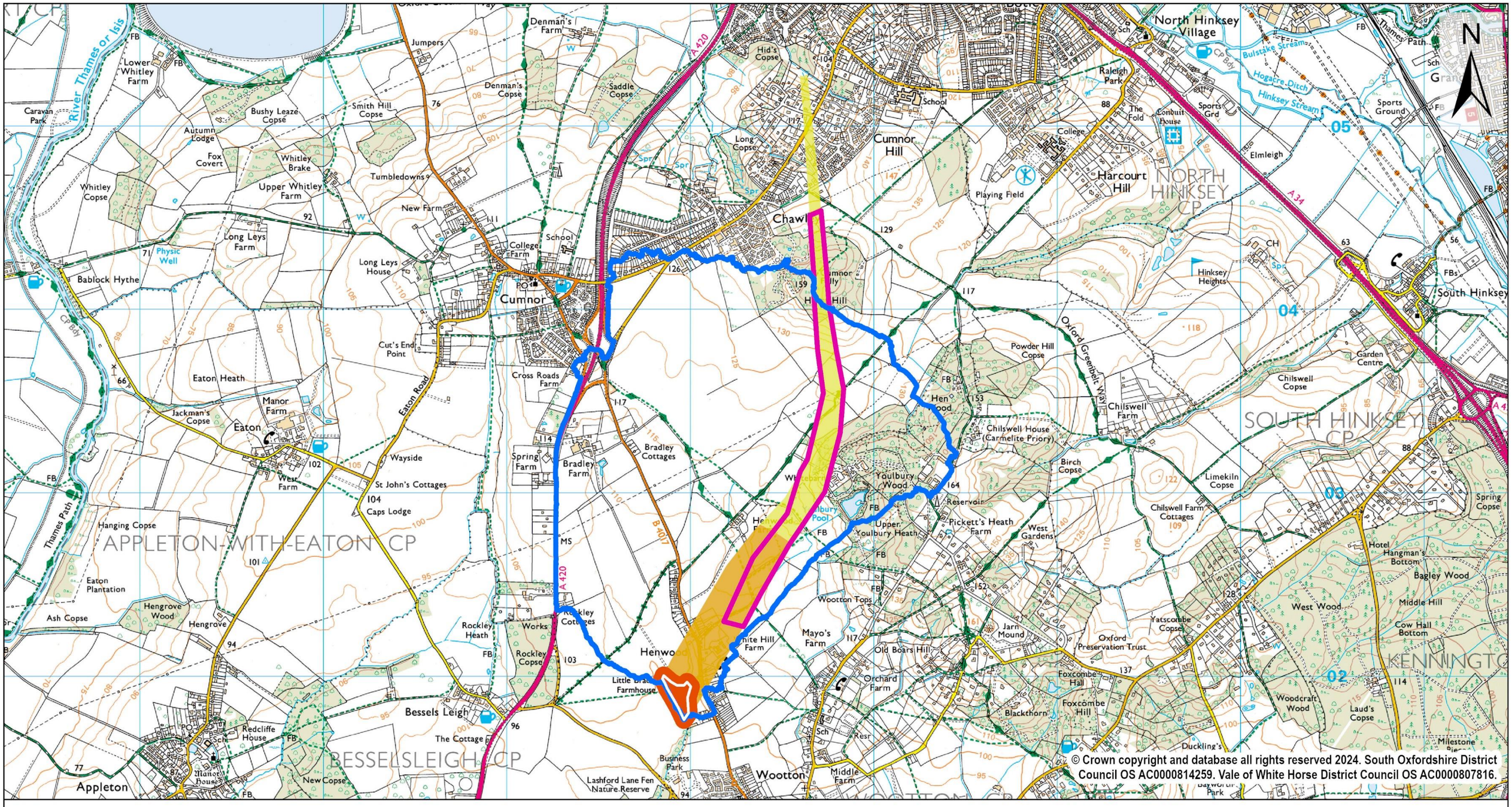


Figure A3.55 Risk zones mapped for Little Bradfield Farm (site ref. 55)

Freshwater Habitats Trust

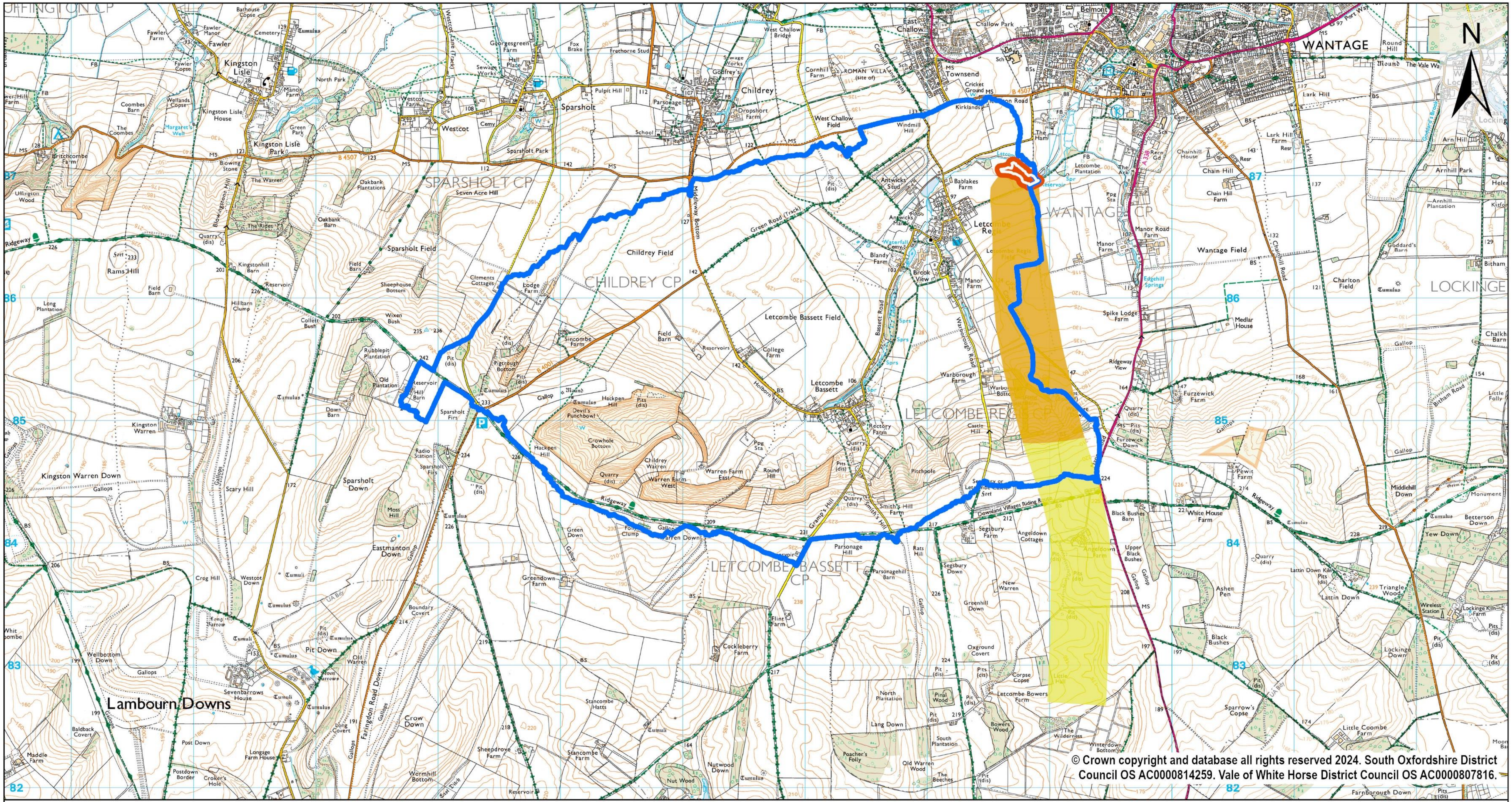
Scale:
1:20,000 @A3

0 0.5 1 km

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment



Freshwater Habitats Trust

Scale:
1:30,000 @A3

0 0.75 1.5 km

Figure A3.56 Risk zones mapped for Letcombe Fen (site ref. 56)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

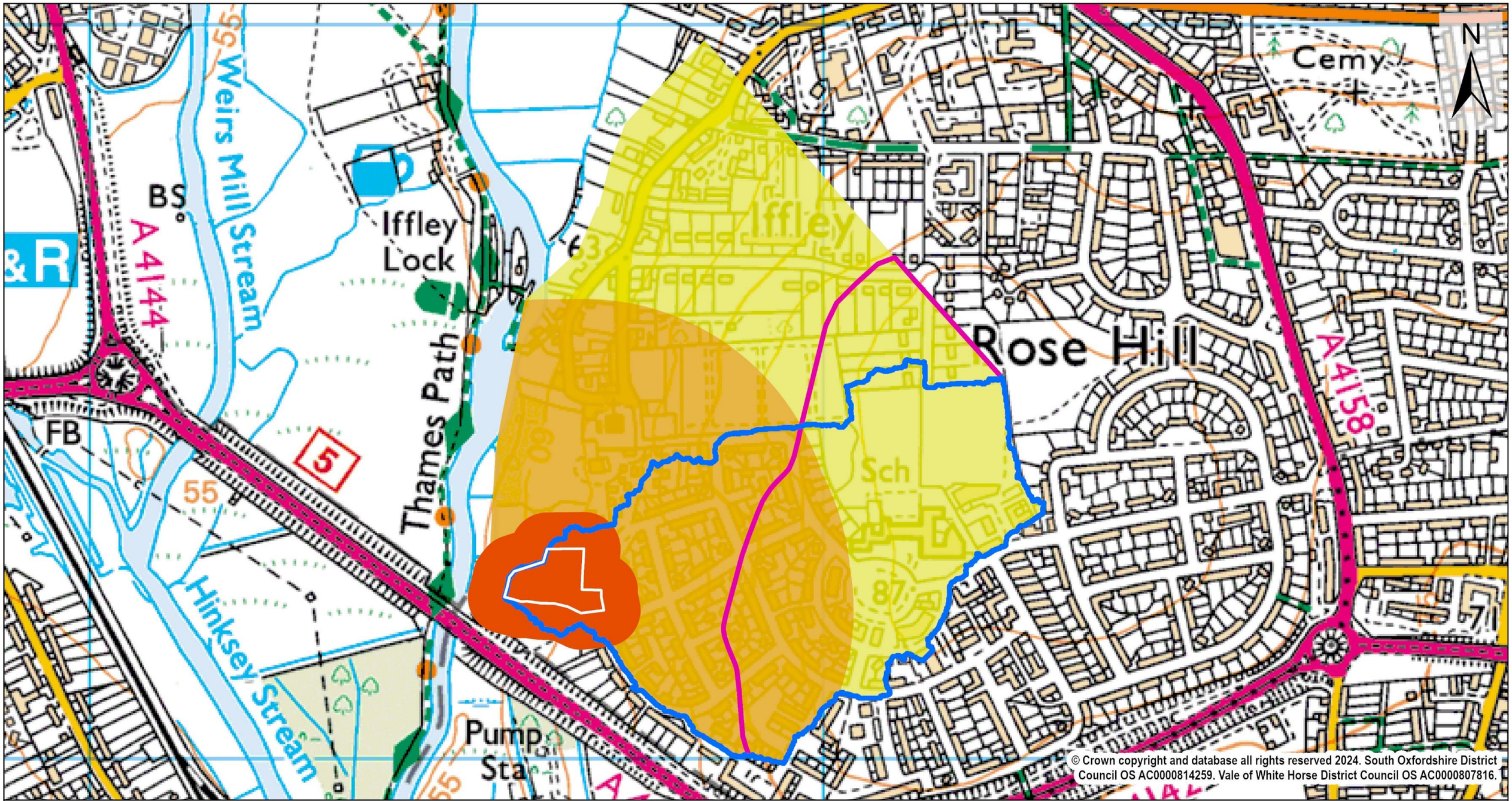


Figure A3.57 Risk zones mapped for Rivermead (site ref. 57)

Fen site

Hydrological risk zone

- Zone 2 - Groundwater catchment
- Zone 2b - Groundwater catchment – confined flow
- Zone 3 - Sub-groundwater catchment
- Zone 4 - 50 m site buffer
- Zone 5 - Surface water catchment

Freshwater Habitats Trust

Scale:
1:5,000 @A3

0 0.13 0.25 km

Appendix 4 Additional figures

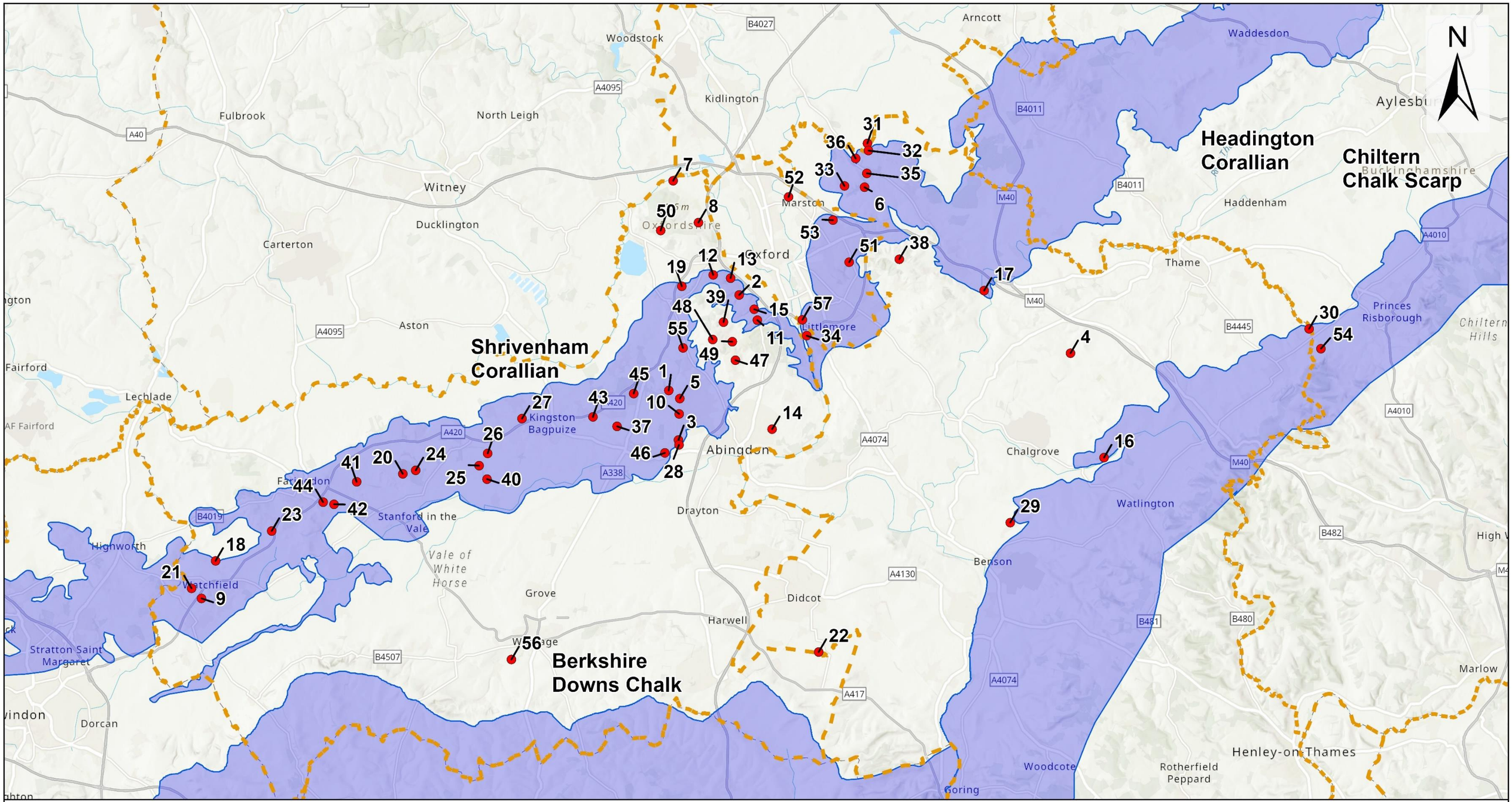


Figure A4.1 WFD groundwater bodies with potential hydraulic connection to fen sites

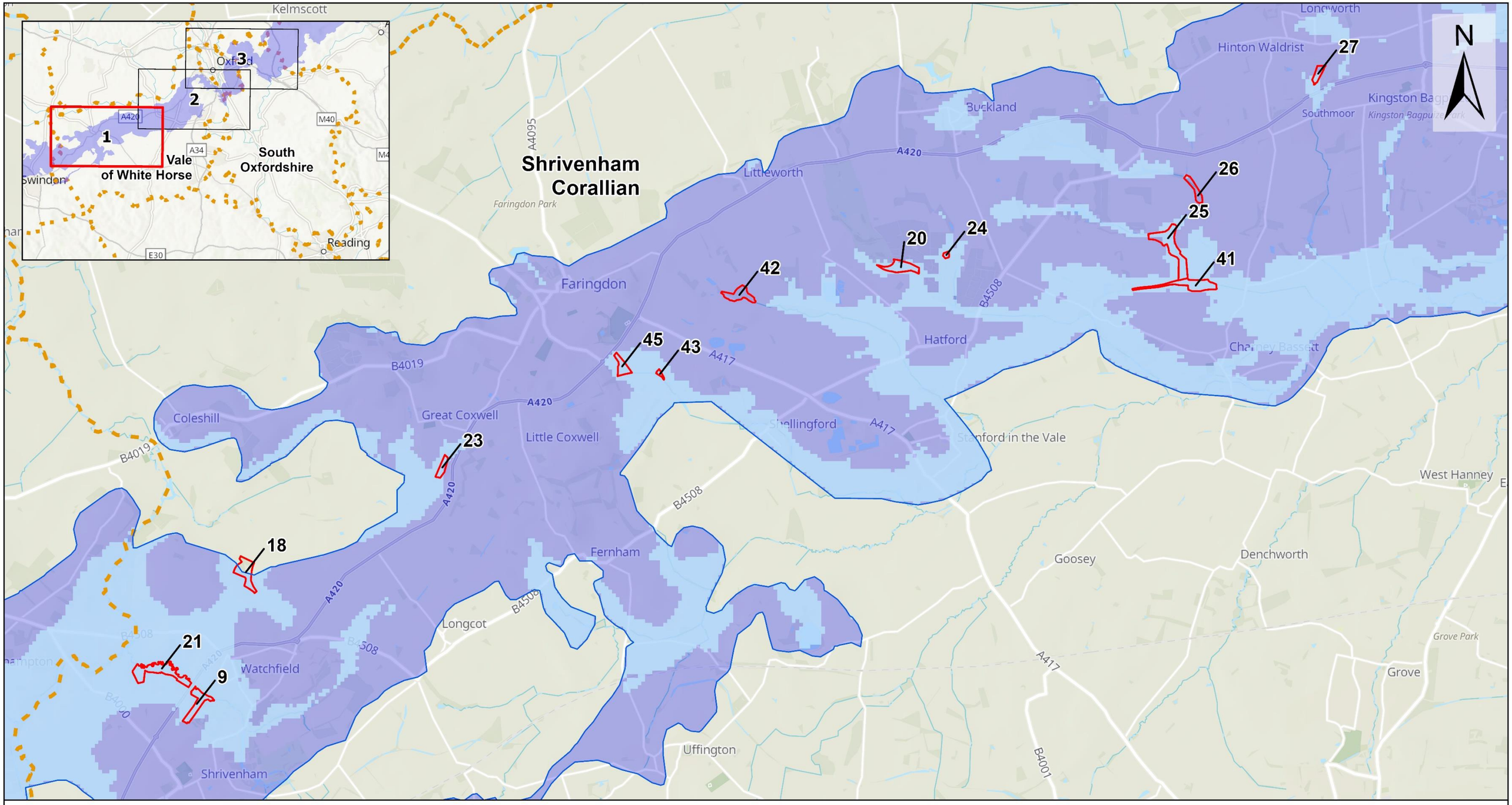


Figure A4.2 Depth to groundwater across the Corallian groundwater bodies (Sheet 1 of 3)

Freshwater Habitats Trust

Scale:
1:50,000 @A3

km
0 1.25 2.5

- Local authority area
- Fen site
- WFD groundwater body
- Regional groundwater level at or above ground surface

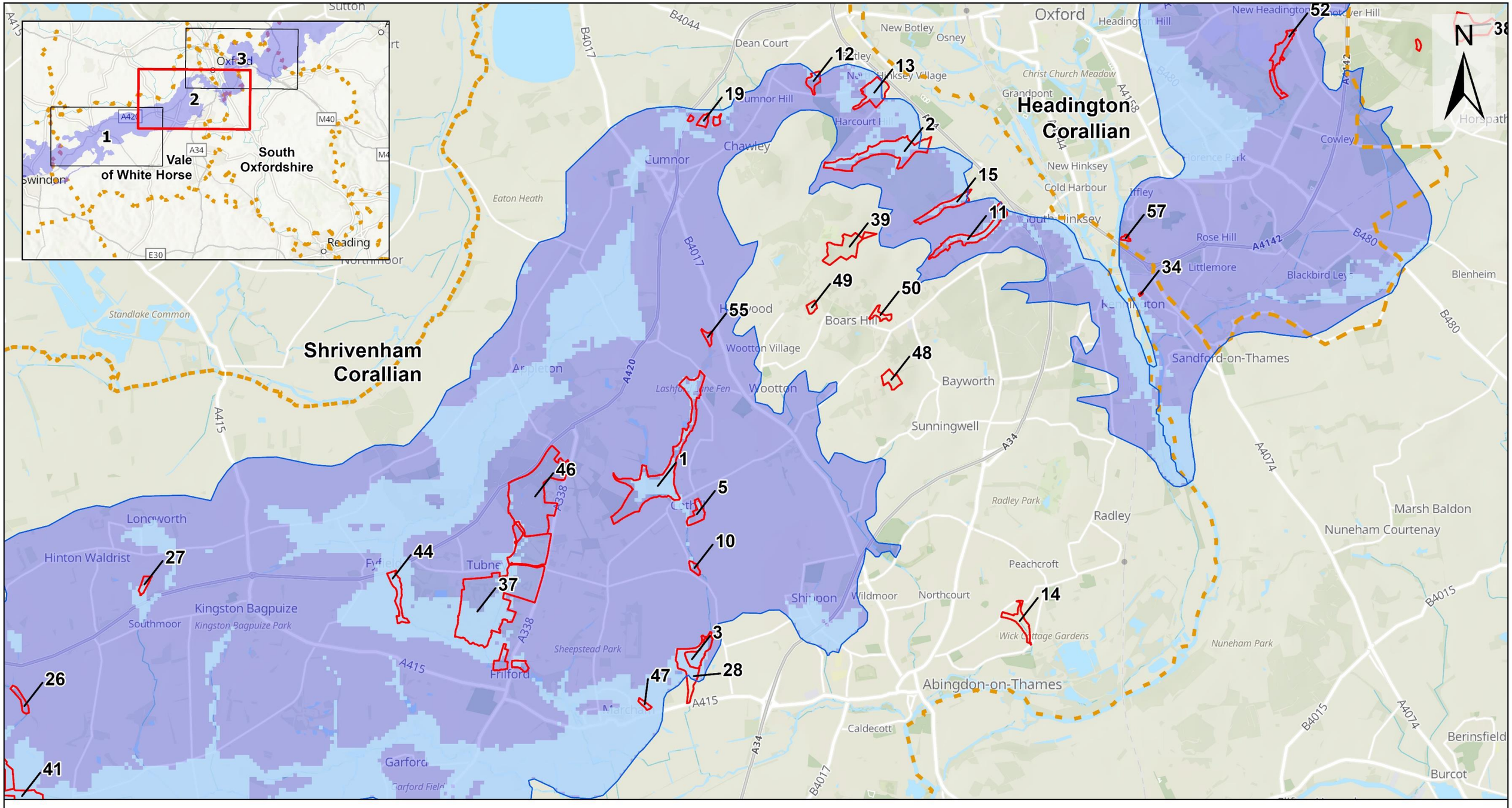


Figure A4.2 Depth to groundwater across the Corallian groundwater bodies (Sheet 2 of 3)

Freshwater Habitats Trust

Scale:
1:50,000 @A3

0 1.25 2.5 km

- Local authority area
- Fen site
- WFD groundwater body
- Regional groundwater level at or above ground surface

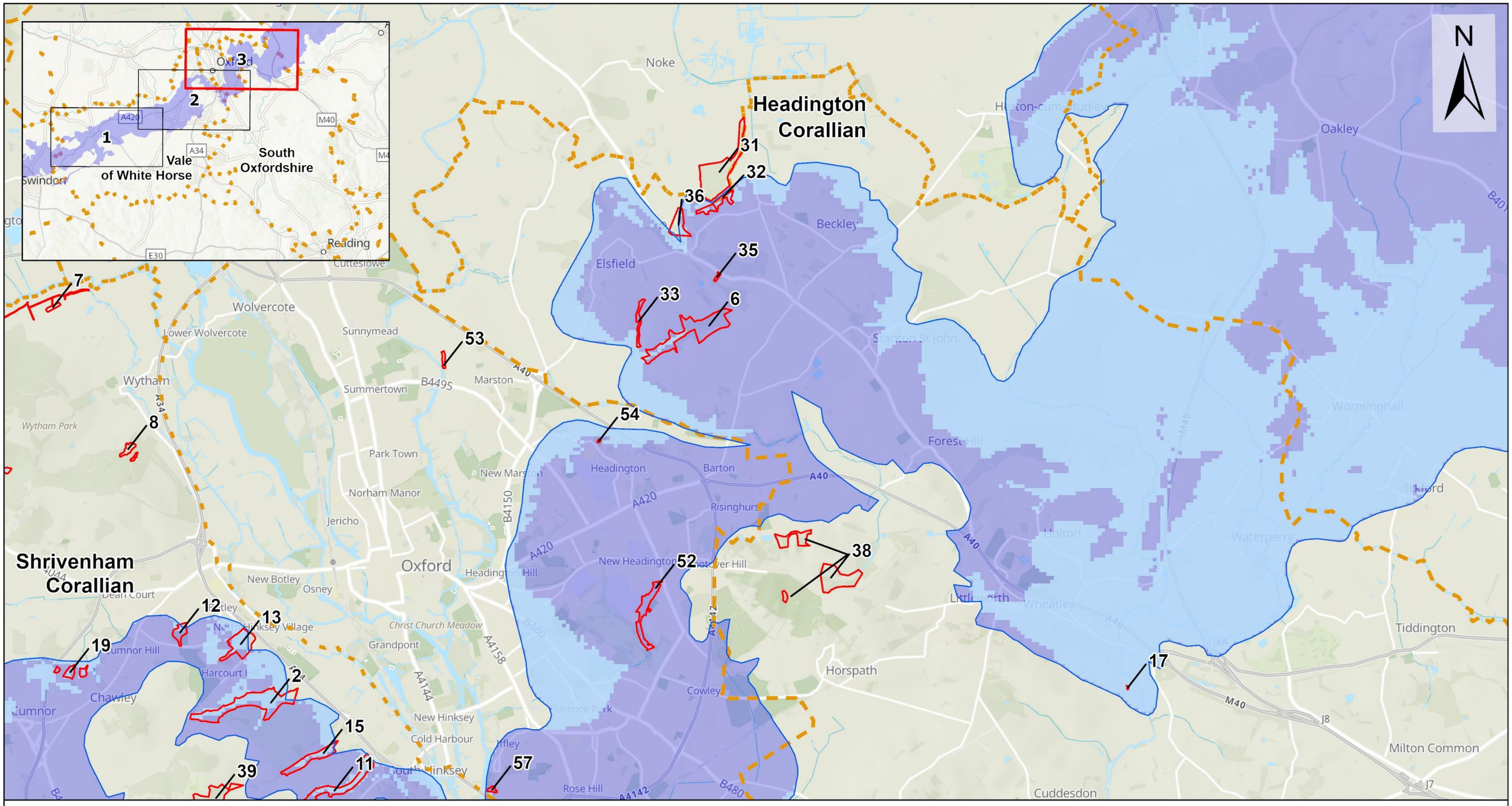


Figure A4.2 Depth to groundwater across the Corallian groundwater bodies (Sheet 3 of 3)

Local authority area

Fen site

WFD groundwater body

Regional groundwater level at or above ground surface

Freshwater Habitats Trust

Scale:
1:50,000 @A3

0 1.25 2.5 km