THE STIFFKEY RIVER CATCHMENT
Links between geodiversity and landscape

- A resource for educational and outreach work -

Tim Holt-Wilson
Norfolk Geodiversity Partnership

CONTENTS

1.0 INTRODUCTION

The Stiffkey River is partly a chalk river, of which there are more in England than any other country in the world. Chalk rivers are fed from groundwater sources in chalk bedrock, producing clear waters. Most of them have 'winterbourne' stretches in their headwaters, with intermittent or absent flow in summer. They have characteristic plant communities, and their gravelly beds, clear waters and rich invertebrate life support important populations of brown trout, salmon and other fish. The Stiffkey is a notable example of a chalk river in north Norfolk.

This report explains the links between geodiversity and the biological and cultural character of the river catchment. It provides a digest of information for education and interpretive outreach about this precious natural resource. Some specialist words are marked in blue and appear in the Glossary (section 6).

2.0 LANDSCAPE PORTRAIT

2.1 Topography and geology

The Stiffkey River has the largest river catchment in north Norfolk (141 sq km), gathering its waters from springs and seeps in parishes as far afield as Field Dalling, Fulmodeston and Hindringham. Some 22.5 km (14 miles) out of a total length of 29 km (18 miles) are classified as a chalk river, being fed directly by groundwater from chalk bedrock of Cretaceous age. The chalk forms a vital local aquifer, holding massive quantities of water in its cracks, joints and pores and releasing it steadily into the valleys. By contrast, the upper reaches of the river and its tributaries are fed by water flowing over and through the glacial deposits which underlie tracts of upland. These include glacial tills of the Sheringham Cliffs Formation and glaciofluvial sands and gravels of the Briton's Lane Formation dating from the later phases of the Anglian glaciation, c.430,000 years ago. The tills were laid down beneath an ice sheet while the sands and gravels were deposited by its meltwaters. Because the ice sheet was eroding a land surface of chalk, the character of the till in the Stiffkey catchment is rich in chalk and flint, from which it was given the informal name 'Marly Drift', and this contributes lime-rich waters too. The Pleistocene deposits are overlain by a variety of more recent Holocene deposits, including alluvium and peat. While peat is a natural accumulation of plant matter, much alluvium has accumulated on the valley floor due to the impact of forest clearance and farming, as silt is washed into the valley from bare soils.

Thus the superficial deposits modify the chemistry of the river, making it more responsive to rainfall than a pure chalk stream and subtly influencing the character of the whole.

The drainage pattern of the catchment is distinctive. The main valley has a south-west to north-east orientation, and is fed by right-bank tributaries only. This pattern is likely to reflect the Pleistocene geological history of the area. During the Anglian glaciation, a major ice sheet was withdrawing north-westwards from a still-stand in the area of the Cromer Ridge. During its retreat phase it had several halts, and meltwater rivers were developed parallel to the ice front or beneath it at each of them. The orientation of the main valley of the Stiffkey suggests that it may have been incised by a proglacial river discharging its meltwaters southwards along the ice front, perhaps into the headwaters of the Wensum valley near Fakenham. The Stiffkey's tributaries were developed on the dipslope of a till plain lying between the Stiffkey and Glaven valleys.

2.2 Water in the catchment

The chalk bedrock is the most important aquifer in north Norfolk, holding massive quantities of water in its cracks, joints and pores. Rainwater percolates downwards to recharge the aquifer at different rates, according to the thickness of any overlying superficial deposits. Percolation is slowest through layers of glacial till capping the interfluves if they have a high clay content; in some parts of Norfolk the water underneath the till has been estimated to be over 10,000 years old. The Stiffkey catchment, however, has generally good aquifer recharge, as its chalk-rich tills, glaciofluvial sands and periglacial silts are quite permeable. A steady flow of groundwater is released into the valleys through springs and seeps, and also directly into the river bed. The contribution of baseflow to the river is estimated at 79%.

The river and its floodplain have been changed by human activity over many centuries. The channel has been diverted, straightened and deepened: dams, weirs and mills have been installed. The chemistry of the water has been altered by pesticides and fertilisers used in farming, and by excess nutrients such as phosphorus from sewage. The chalk aquifer and river flows have been depleted by pumped abstraction for homes, businesses and farms. These changes to the river's natural dynamics and water composition have led inevitably to impoverished biodiversity.

2.3 Soils

Soil types in the headwaters and upper reaches are strongly influenced by the glacial deposits, principally loamy and sandy soils over chalky till and glaciofluvial drift. Soil types developed directly on the Chalk itself are purely calcareous loamy soils.

2.4 Geodiversity in the landscape

In terms of its geodiversity, the Stiffkey River can be divided into four thematic sections:

2.4.1 Upstream from Thorpeland Hall

The headwaters of the Stiffkey River lie in the uplands round Swanton Novers, Thursford and Fulmodeston. The river has a gravelly bottom, and is developed on beds of sandy alluvium and head derived from the glacial deposits of the valley sides. These superficial deposits contain much chalk gravel, so influencing the water's chemistry. Springs and wet flushes are present in the valley; these can best seen in their natural state in the Norfolk Wildlife Trust reserve at Thursford Wood, where the river is flanked by an extensive tract of boggy ground and alder carr woodland and feeds a Mediaeval fishpond.

The River Stiffkey in Thursford Wood, May 2013.

Grazing meadows are developed downstream of Great Snoring, mostly fed by baseflow from the valley floor. The clear water benefits aquatic species such as brook lamprey, caddis fly and white-clawed crayfish, which has one of its UK strongholds in this river catchment.

2.4.2 From Thorpland Hall to Warham

Downstream from Thorpland Hall the river becomes classified as a chalk river, fed directly from the aquifer via springs in the valley floor and sides. Springs are locally present: pilgrims to the famous shrine at Little Walsingham may fill their bottles from a natural spring on site, and there are two historic 'wishing wells' in the grounds of Walsingham Abbey. Water is abstracted from the river for public water supply at Houghton St Giles and Wighton, and in several places for agricultural use, mostly from groundwater sources. Unlike many chalk rivers in other parts of England, the Stiffkey River is unlikely to run critically low in summer, but over-abstraction is an ongoing concern throughout the catchment. The amount and quality of water are monitored at gauging stations at Little Walsingham and Warham, and abstraction licenses controlled accordingly. Nitrate pollution from agriculture is also a matter of ongoing concern.

Natural meanders on the floodplain at Houghton St Giles.

In many places the course

of the river has been artificially straightened, though a few natural meanders can be seen near Houghton St Giles. In its authentic, wild state a river is free to move at will over its floodplain in response to varying flows and obstructions such as fallen trees, and it tends to form meanders, braided channels and pool and riffle bedforms. In 2009, work was completed on restoring gravel riffles to the stretch between Wighton and Warham to benefit wild trout spawning. However, low river flows have meant that siltation has since become a problem.

Winter flood waters today may be considered a nuisance, but in past centuries they were turned to agricultural advantage in the valley. Evidence for water-meadow systems of early 19th century origin can be seen at Houghton St Giles. These water-meadows were an early form of agricultural intensification for raising sheep. Networks of channels directed a continual flow of water over the floodplain in winter to stimulate an early growth of grass in spring. Once the sheep had moved to summer pastures, the meadows could be irrigated again to promote the hay crop.

The energy of the river was harnessed by water mills. We have evidence of one at Great Snoring in the 17th century. Mills present in the 18th and 19th centuries include Little Walsingham, Wighton and Warham.

Downstream of Wighton, the floodplain becomes wider and the river becomes in most places an over-deepened, straight-sided drainage dyke. The Iron Age fort of Warham Camp demonstrates the impact of this drainage work; the ramparts in the south-west corner of the fort were demolished in the 18th century and the river was routed to cut off a corner of the site. The river may have been navigable upstream as far as the Camp in prehistoric times, but the water levels in the valley today are clearly much lower than they were then. A network of ditches now drains the meadows beyond.

The ramparts of Warham Camp, showing how their circuit was truncated when the river channel was rerouted in the early 19th century. Imagery © 2014 DigitalGlobe, Getmapping plc, Infoterra Ltd & Bluesky; Map data © 2014 Google

The valley floor west of Barsham is floored with layers of peat, alluvium, sand and gravel. Peat is an accumulation of partly rotted vegetation, and suggests that the floodplain once supported areas of wet fen. It may have been extensive elsewhere in the valley but drainage in recent centuries caused it to oxidise and waste away. The sand and gravel may be associated with a possible glacial Lake Stiffkey ponded up in the valley during the Devensian glaciation, c.20,000 year ago. An ice sheet is thought to have advanced from Wells-Next-The-Sea as far as Warham where it stopped, blocking the northern end of the valley. Meltwaters streaming from the glacier in summer may have built up in proglacial lake which backed up as far as Barsham and also extended up the lower reaches of the Binham and Hindringham valleys. The evidence may be seen today in beds of sand and gravel beneath the floodplain, and noticeable breaks of slope along the valley sides which suggest the likely margins of the former lake.

2.4.3 Hindringham Beck and Binham Beck

The River Stiffkey has two tributaries, Hindringham Beck and Binham Beck, strangely both right-bank. They have their sources in the uplands east of the main valley, developed mostly on chalk-rich glacial tills; these lend a predominantly chalky character to the water. The valley floors are lined with periglacial head deposits, the residue of material washed and soliflucted off surrounding slopes. In places this gives rise to marshy ground and springs with wildlife conservation value. There are County Wildlife Sites of wetland interest at Field Cottage Meadow and Bridge Marsh Meadows (Hindringham), Lower Green Meadow (Field Dalling), Langham Lane Meadow (Langham) and Binham Valley (Binham).

Chalk outcrops in the valley floor of the Hindringham Beck downstream of Binham Bridge, and of the Binham Beck downstream of Binham. It contributes chalk-rich groundwater directly from the aquifer.

A floated water meadow system was created in the lower reaches of the valley of the Hindringham Beck in the early 19th century, including brick-built culverts and sluices to control water flow; there is no evidence of this to be seen now.

2.4.4 From Warham to the coast

Downstream of Warham, the Stiffkey River enters a meandering valley with steeper sides. This is thought to be an overspill channel created by meltwaters from glacial Lake Stiffkey. Once the glacier retreated from the Warham area, it unblocked the mouth of the valley, and the lake waters escaped energetically eastwards along the ice front, carving through the chalk bedrock to create an exit. Stiffkey village is attractively set in this glacial 'gorge'.

Upstream of Stiffkey, the valley has a dry, open aspect. The chalk does not hold surface water well, so the river can only pass through the landscape on a thin bed of alluvium. It is clearly a 'misfit' stream, though it is swelled when groundwater levels rise in winter. Faden's map of 1793 shows the river once flowed through a series of broad, looping meanders here, but these were removed in the early 19th century.

Part of the Stiffkey Valley SSSI, an area of former saltmarsh set in a glacial meltwater channel.

Downstream of Stiffkey village, the lower reaches of the valley is designated as a SSSI for its wetland biodiversity interest. The floodplain is floored with layers of freshwater alluvium and peat overlying layers of marine alluvium, showing that tidal flows formerly penetrated up the valley. There is a shallow freshwater lagoon downriver from the bridge on the A149, which is an important breeding ground for birds such as avocet. It is separated from the saltmarshes by an old seawall and a sluice. Tidal influences in the valley are controlled by a flap in the sluice. This acts to prevent natural interaction between freshwater and seawater

and hampers the migration of anadromous fish. A modified, fish-friendly flap has recently being installed in the sluice and its effectiveness is being evaluated.

2.5 Future scenario

Rising sea levels due to human-induced global warming may well see tidal influence extending up the Stiffkey valley once more. Norfolk County Council estimates that sea levels are likely to rise by up to 0.88 m this century, so the river could become tidal as far upstream as Wighton (located just below the 10 m contour). If so, the river will be grading to a rising base level, which could raise freshwater levels upstream in the catchment. Set against this, all future scenarios suggest that climate change is likely to lead to lower groundwater and river flows in summer. To add to the uncertainty, unstable weather patterns are likely to lead to episodes of more intense rainfall alternating with drought, all of which have implications for river, floodplain and water management, and biodiversity in the catchment. The Stiffkey River valley is clearly still evolving.

3.0 FEATURES TO VISIT

The following natural and cultural features have potential to communicate the contribution of geodiversity (geology, landforms and processes, soil and water) to the natural and cultural character of the Stiffkey River and its catchment. For details see section 4 below.

3.1 Thursford Wood

The headwaters of the River Stiffkey pass through Thursford Wood, a County Wildlife Site which is one of the best surviving remnants of Mediaeval wood pasture in Norfolk. It is an atmospheric place with massive, ancient trees and varied wildlife developed on sandy soils. The riverside is a tract of very boggy ground underlain by peat, with rivulets and springs, and a big spring-fed pond. This is a wonderful place to introduce people to the links between groundwater, soils and ecology. Archaeological evidence of prehistoric water boiling activity may be found. There is a car park with room for four vehicles. There are NWT interpretation panels, and access is free.

3.2 Warham Camp

This impressive Iron Age fort shows chalk in its circular double ramparts, and demonstrates the impact of river straightening where the circuit of the ramparts is truncated on the south-western side by river straightening work in C18th. Chalk is visible in the banks and ditches. The site is open to the public, but parking near the site is atrociously difficult for cars, so either arranged drop-off or walking from Warham village is advised.

3.3 River restoration

Stretches of river habitat restored by the Wild Trout Trust can be seen between Wighton and Warham, on Holkham Estate land. There are no public footpaths, however. Specialist input would be needed to explain beneficial changes to the river's ecology (before and after), and access permission from Holkham Estate.

3.4 Holy wells at Walsingham

The shrine to St Mary at Little Walsingham was built in the 11th century around a chalk spring, and today the spring there is a focus for pilgrim devotion along with the shrine; people can take home bottles of the water. There are two Mediaeval wishing wells in the grounds of nearby Walsingham Abbey, near the river. There is a fee for access as part of admittance to the Abbey, though not the shrine. Abundant parking is available in the village

The well at the Anglican shrine. Photo courtesy http://peregrinations.kenyon.edu/

3.5 Stiffkey Hall Farm

The Buxton family maintain the Farm for its nature conservation value as a SSSI, and will arrange tours if requested. There are areas of unimproved grassland which were formerly saltmarsh in the C18th. There are two chalk pits. The topography of the glacial meltwater channel can be seen here (best viewed west of the village near Home Hill) and a hanging valley truncated by the channel near Marlpit Plantation. The farm has a link to author Henry Williamson ('Tarka the Otter'). Adjacent Cockthorpe Common SSSI is a beautiful area of chalk grassland in a dry valley (part of the Stiffkey catchment) including a fine chalk pit; it is best reached by footpath from Cockthorpe village.

4.0 LOCAL DETAILS

Supporting in-depth information about environmental features of the Stiffkey River catchment.

Geology and soils
The area is underlain by Cretaceous Chalk bedrock. Chalky tills of the Pleistocene Sheringham Cliffs Formation occupy higher ground, formerly known as the Marly Drift (late Anglian age, perhaps 430,000 years BP). Rivers draining the post-Anglian till plateau have dissected it and cut down to reveal the underlying bedrock. Chalk is thus exposed along the lower valley sides and beneath the valley floors in the middle and lower reaches of the river and its tributaries.
Soil types in the headwaters and upper reaches are strongly influenced by the glacial deposits, principally 581f Barrow Association (loamy and sandy over chalky till and glaciofluvial drift), 711r Beccles 1 and 711s Beccles 2 (loamy over chalky till), and 572p (loamy over chalky till). Soil types developed directly on the Chalk itself are 343g Newmarket 2 soils, being calcareous loamy soils of rendzina type or 581f Barrow, depending on the thickness of any overlying superficial deposits.

Biodiversity
White-clawed crayfish present in 1990s. See: Rogers, WD and Holditch, DM (1997): Crayfish Surveys on the Rivers Wensum, Bure, and Gipping catchments, sections of the River Yare, and the Rivers Stiffkey and Glaven; EN and EA Research Report.
Reintroduction 2012. The transfer organised by Mike Sutton-Croft (Norfolk Non-native Species Initiative) supervised by Martin Pugh (Essex WT). Around 400 crayfish (carefully measured, sexed and checked for any signs of disease) from the Glaven and transferred them to two new sites on the Stiffkey. See also http://www.norfolkbiodiversity.org/actionplans/speciesactionplans/whiteclawedcrayfish.aspx

Fulmodeston
Headwater valley crossed by public footpath, with view of a boggy area with rushes revealing the presence of rising groundwater; a ditch was cut in the 20th century to drain it.

Thursford Wood
CWS 1294: Thursford Woods; area: 10.5 ha. A mixture of three distinct woodland types. Pasture woodland with very large oak (Quercus robur) pollards forms most of the site; alder (Alnus glutinosa) carr occurs on lower ground to the west; and a small woodland to the north-east contains mostly maiden trees. The river is flanked by an extensive tract of boggy ground with rivulets and seeps and feeds a Mediaeval fishpond.
NHER 49113: ancient medieval woodland. This ancient woodland contains some of the oldest oak trees in the county. The dead branches and partially rotten trunks provide refuge for a stunning array of wildlife, and there are 10 hectares of ancient pollarded wood pasture and ponds. The wood is managed as a nature reserve by Norfolk Wildlife Trust
NHER 35054: Prehistoric burnt flint, Brookhill Plantation. Burnt flints across this area. Perhaps a burnt mound within the vicinity, which is a mound of fire-cracked stones, normally accompanied by a trough or pit that could be locations where heated stones were used to boil water possibly for cooking purposes.
See NWT website http://www.norfolkwildlifetrust.org.uk/Wildlife-in-Norfolk/Reserves/Thursford-Wood.aspx

Little Snoring
Sewage works reached via lane from church over private land.
Strip of open access grassland, perhaps old parish land, reaching the river valley at TF948333.

Two County Wildlife Sites in the upper Stiffkey catchment
CWS 1300 Stiffkey Marshes (just upstream of Thorpland Hall) - low lying marshy neutral

grassland bordering the River Stiffkey. Some of the areas are moderately species-rich while others are fairly improved and heavily grazed. No public access, but partly visible from lane.
CWS 1296 Pond Meadows, Little Snoring - unimproved, marshy grassland with scattered scrub, divided by a network of defunct ditches. The River Stiffkey flows through the site. No public access.

The tributaries
"The vagaries of this river seem to have nothing to do with the incoming of tributaries, but rather the reverse, the only important tributaries, which are on the right or eastern side, not having any effect in preventing the eastward tendency of the stream." See Whitaker 1921: The water supply of Norfolk; HMSO, p.8

County Wildlife Sites in the catchment of the Hindringham Beck
Hindringham Field Cottage Meadow (CWS 1308) and Bridge Marsh Meadows (CWS 1305 and 1306) are areas of marshy ground in the headwaters of the Hindringham Beck and its tributaries. Field Cottage Meadow is a complex mosaic of unimproved, neutral and marshy grasslands together with an area of tall herb. The Bridge Marsh Meadows are basic marshy grassland sites subject to flooding from a stream which crosses the site; there are several springs. They are underlain by head and till deposits. These sites are not publicly accessible.

County Wildlife Sites in the catchment of the Binham Beck
Lower Green Meadow (CWS 1309 and 1310) is an area of damp woodland and basic marshy grassland with some tall fen vegetation. It is crossed by the Cake's Lane public footpath.
CWS 1314 Binham Sewage Works, Langham. An area of moderately species-rich, rank, marshy grassland, mainly dominated by rushes, which has formed on either side of a stream in a shallow valley. No public access.
CWS 1315 Binham Valley, Binham. An area of low lying marshy grassland either side of a stream, formed in a low lying valley, dominated by tall herbs and rushes. Some small areas of species-rich drier grassland and some areas of neutral grassland. No public access.
CWS 1108 Langham Lane Meadow. An unimproved neutral grassland with scattered scrub which lies in a shallow valley bottom. A small stream crosses the middle of the site, flowing in a south-north direction. Although there is some evidence of past efforts to drain the site, the whole remains essentially unimproved. No public access.

West Barsham
Peat on the valley floor marked on geological map, likely to be wasted remnant of formerly more extensive cover in Middle Ages and Saxon times.

Water mills
Great Snoring mill, present in C17th. See http://www.norfolkmills.co.uk/Watermills/gt-snoring.html
Wighton mill, demolished 1866. Much historical evidence. Only one low wall, some broken brickwork and part of the brick floor of the watercourse remain. Faden's map suggests the mill was 100 yards upstream of Wighton Common; see also 1st ed OS map. See http://www.norfolkmills.co.uk/Watermills/wighton.html
Little Walsingham Mill near the church. Visible walls and culvert. Demolished c.1900. See http://www.norfolkmills.co.uk/Watermills/lt-walsingham.html
A mill on the left bank of the river downstream of Wighton is visible on Faden's map.

Wighton Common
An area of publicly accessible common land adjoining the river. CWS 1304: an area of dense, tall grassland vegetation on an impeded to marshy, neutral substrate. The site is cut occasionally and is only moderately species-rich.

Navigable river

The river was navigable up to Little Walsingham in Mediaeval times, for bringing Barnack Stone upriver to build the Priory. Info from Norfolk Mills website says "Much of the stone to build the priory was brought in from Northamptonshire on flat bottomed barges towed up the River Stiffkey, which was navigable to Brooker's Dock on the opposite side of the priory to the mill".

Holy wells and springs

Our pagan and Christian ancestors revered springs and wells as sources of life-giving pure water. Natural spring at Anglican shrine at Little Walsingham supplies water to pilgrims and church visitors. "Water from the well has always played an important part in the worship at Walsingham. We are told that the original sign to the Lady Richeldis (11th century) as to the exact position she was to build the Holy House was the springing up of water from the ground. Fr Patten was thrilled when, as the foundations of the Shrine Church was being dug in 1931, the workman uncovered an old disused well. Cleaned out and repaired, the well has for more than 75 years gushed out water of beautiful quality." See http://www.walsinghamanglican.org.uk/the_shrine/index.htm.

However: "Recent scholarship suggests that the well belonged to either the 'White Hart' or 'Maidenhead' hostelries, or the Priory's Almonry, that once stood upon the site.". "Pilgrims visit the modern shrine on an annual basis and carry home with them small plastic bottles of water from the new 'Holy Well'. See http://peregrinations.kenyon.edu/vol3_1/photo_essays/Walsingham_photo_essay/Walsingham.html

Two historic 'wishing wells' in the grounds of St Mary's Priory (Walsingham Abbey). NHER 56856: two circular pools and a rectangular medicinal bath of later date; anecdotal evidence indicates that the wells are at least in part medieval in origin; now part of a small enclosed garden in Abbey Park (NHER 56859): see http://www.heritage.norfolk.gov.uk/record-details?MNF63267). St Mary's Priory is NHER 2029: http://www.heritage.norfolk.gov.uk/record-details?MNF2029).

"These ancient wells have been venerated for over two thousand years and have produced evidence of ritual deposition that pre-dates the Roman occupation. It is perhaps the presence of these wells that prompted the erection of the original Holy House only a few dozen yards away. Between the two wells used to sit a stone that worshipers were required to kneel upon. They then dipped a hand in each well and silently asked for their boon." See http://peregrinations.kenyon.edu/vol3_1/photo_essays/Walsingham_photo_essay/Walsingham.html

"Of springs whose virtues are entirely legendary, may be mentioned the 4 Wishing Wells,' situated in the Abbey grounds at Walsingham There are two of these wells situated close together in the Alluvial ground bordering the Stiffkey stream, and whatsoever virtue they possess -is probably owned also by the little river which keeps up their supply. In the same enclosure of the Abbey grounds is a larger well, which may have been a baptistery, or a pool for healing the afflicted, or simply a bathing-place for dusty pilgrims; its original purpose has long been lost sight of. I am disposed, however, to take these as springs mainly derived from the Chalk". See Whitaker 1921: The water supply of Norfolk; HMSO

Public water supply

Water is abstracted from the river for public water supply at Houghton St Giles and Wighton, and in several places for agricultural use, mostly from groundwater sources. Over-abstraction is an ongoing concern throughout the catchment. The amount and quality of water are monitored at gauging stations at Little Walsingham and Warham, and abstraction licenses controlled accordingly. Nitrate pollution from agriculture is also a matter of ongoing concern.

Ref. Environment Agency 2005: The North Norfolk Catchment Abstraction Management Strategy, in particular the CAMS technical document. See http://www.environment-agency.gov.uk/business/topics/water/119931.aspx

River restoration work

Undertaken by the Wild Trout Trust as part of its Anglian Rivers Sea Trout Project, 2009, between Wighton and Warham. "Working with the landowner, Holkham Estate, the Wild Trout Trust installed ten gravel riffle areas, using approximately 700 tonnes of gravel and

creating 300 metres of shallow riffle habitat." See http://www.wildtrout.org/content/anglian-rivers-sea-trout-project#Stiffkey%20gravel
"Work has taken place between just downstream of Wighton (approx. TF944400) to opposite Swans Nest Plantation [below Warham] (approx. TF956426) – all Holkham Estate-owned land. As well as the gravel introduction detailed on our website, previous work (before I was involved) included re-profiling banks (on the downstream section) and three areas of gravel introduction at the upstream end near Wighton." – Tim Jacklin, WTT.
"In October 2002 the Estate installed three gravel riffles at Wighton. Nearly four years on and the riffles appear to be performing well, with good beds of starwort now present. Gravel appears to be fairly clean, however the low flows currently being experienced on the river are causing fine sediment deposition." See WTT document: 'Habitat Advisory Visit. Rivers Stiffkey & Burn. Holkham Estate, North Norfolk'. On behalf of Viscount Coke, Nick Zoll & Charles Rangeley-Wilson. (2006stiffkeyandburn_0.pdf)

Floated water meadows
Floated water meadows are an 18th century West Country invention designed to mitigate the impact of frost on floodplain meadows by directing flood water over the meadows through a network of channels, so promoting early growth of grass for sheep. The water could also be directed over the meadows in early summer to promote growth of grass for hay. There were such systems in place in the valley in the early C19th.
NHER 31607 Wighton post medieval water meadows: Earthworks of post medieval water meadows seen on 1946 aerial photograph. The brick culverts and sluices were created around 1802 and modified soon after. They have now been destroyed.
NHER 31890 Field Dalling post medieval water meadow: This is the site of a late 19th or early 20th century floated water meadow. It is thought that this was constructed by an owner of Manor Home Farm, Field Dalling. Part of the site is overgrown and a section has been destroyed by a modern pond.
NHER 33741 Barsham post medieval water meadows @ Houghton St Giles. Show up as earthworks to the west and cropmarks on 1946 aerial photograph to the east.
For historical information see Wade Martins and Williamson article at http://www.bahs.org.uk/AGHR/ARTICLES/42n1a2.pdf

Warham Camp
Iron Age fort with circular double ramparts. Chalk visible in upwarp and ditches. Circuit of ramparts truncated on the south-western side by river straightening work in C18th.
NHER 1828 Warham Camp: "Warham Camp is a large and very well-preserved Iron Age fort sitting within agricultural land, and is a scheduled monument. It is arguably the best earthwork of this period in the region. It has been repeatedly surveyed by aerial photography, and is a circular structure with an overall diameter of 212m. The course of a channel of the River Stiffkey cuts across the south western edge of the earthworks, but this is an 18th century alteration and the original river ran in a curve to the west… Like many earthwork sites, Warham Camp suffered due to changing landscape aesthetics in the middle of the 18th century, when the south-western side/curve of the monument was levelled to improve the view from the nearby Warham Grove House and to straighten the course of the river Stiffkey."
See http://www.heritage.norfolk.gov.uk/record-details?MNF1828
See Faden's map (1797) for former meandering river course.

Glacial Lake Stiffkey
Reconstructed ice margin reached Warham and Stiffkey in the Dimlington Stadial (the coldest period of the Devensian). Proglacial lakes inferred in lower reaches of the Stiffkey, Binham and Hindringham valleys. Ice retreat down Northgate Hall Farm valley allowing water to escape east towards Stiffkey, incising valley. See: Brand, D, Booth, SJ and Rose, J (2002: *Late Devensian glaciation, ice-dammed lake and river diversion, Stiffkey, north Norfolk*, England Proc Yorks Geol Soc vol.54, pt.1. See also Straw (1960): The limit of the 'last' glaciation in North Norfolk; Proc Geol Assoc 71.

Downstream of Warham
River is clearly a misfit in the glaciofluvial spillway. Former looping meanders marked on

Faden's map replaced by straightening and channelling before 1850s (see 1st ed OS map and [1840s] tithe map); poss pre-1826 (see Bryant's map).

Stiffkey Valley SSSI

Extends from area nr Marlpit Covert to saltmarsh margin, including the lake at Stiffkey Freshes. Formerly saltmarsh (see Faden's map) extending upstream as far as the 1st valley bend.

"A wetland habitat supporting nationally important populations of breeding avocet, an assemblage of breeding birds associated with lowland damp grasslands and an assemblage of breeding birds associated with lowland open waters and their margins.

Comprises a range of different wetland habitats created in the flood plain of the River Stiffkey. The majority of the site comprises areas of standing open water, grazing marsh and reedbed. Smaller areas of carr woodland and scrub are also present." (SSSI citation at http://www.sssi.naturalengland.org.uk/citation/citation_photo/2000464.pdf)

There is a chalk pit at TF978432 and a larger one close to the farmstead at TF975427.

There is a hanging dry valley north of Marlpit Plantation whose outlet was truncated by the glacial channel event.

Stiffkey Hall Farm is managed by Buxton Conservation Trust (Bidwell House, Trumpington Road, Cambridge, CB2 9LD; 01223 559 520). Author Henry Williamson (of 'Tarka the Otter' fame) farmed here in the 1930s. See http://en.wikipedia.org/wiki/Henry_Williamson

Cockthorpe Common, Stiffkey SSSI

"Cockthorpe Common is situated in the valley of the River Stiffkey where the steep slopes support a diverse chalk grassland flora. Unimproved chalk downland is now rare in Norfolk and Cockthorpe Common is considered to be one of the best remaining examples. The flora is extremely rich and includes a number of uncommon species."

Area includes a chalk pit with notable exposure where faulted chalk can be seen underlying glacial till.

Publicly accessible via footpath from Morston Road (no ready parking however) and from Cockthorpe village (Binham) (parking available).

Site managed by Michael Case (Manor Farm, Cockthorpe, NR23 1QS; 01328 830202)

Global warming impacts

See Norfolk Climate Change Strategy [2009] and also Local Climate Impacts Profile at http://www.norfolkambition.gov.uk/consumption/groups/public/documents/article/ncc095340.pdf -

- Increased winter rainfall, combined with a likely increase in the quantity of rainfall from intense events in winter, will result in a greater risk of flooding.
- Acute temperature events such as heat waves are extremely likely to increase. The longest summer heat wave duration is likely to grow by up to 10 days over the 21st century.
- Summers are also likely to be drier. Future summer average daily rainfall is likely to significantly decrease. In partnership with this summer dry periods are likely to ncrease in duration, more likely than not increasing by up to 10 days.
- Sea levels are likely to rise by up to 0.88m, rising at rates faster than present (IPCC, 2007), having a major impact on coastal erosion and coastal flooding. Recent scientific findings find this estimation to be very conservative.

Re. impact of climate change on groundwater and river flows, "almost all scenarios suggest lower summer flows" - see Prudhomme et al 2012 at http://nora.nerc.ac.uk/15039/

Saltmarsh

The Stiffkey discharges into the sea through a sluice in an old seawall at Freshes Creek, in an area of saltmarsh. The sea wall and sluice are marked on Faden's map (1797), and they now act to retain the waters of a lagoon which is important for breeding birds such as avocet (see SSSI citation). The map shows that saltmarsh once extended some 0.8 km upstream of White Bridge. The seawall and sluice permitted the valley floor upstream of the bridge to be reclaimed as grazing land.

The tidal sluice has been modified by the Wild Trout Trust as part of its Anglian Rivers Sea

Trout Project, 2009. "Many East Anglian rivers enter the sea through a gate or sluice which closes at high tide to protect reclaimed or defended land from flooding. Such flow control structures can be significant barriers to the free movement of fish which migrate for feeding, breeding or shelter at different times or seasons. On the River Stiffkey, a 'pet door' type aperture was installed in the main tidal flap gate… Research on the effectiveness of the fish pass is being carried out by Gill Wright, a PhD student at Southampton University.." See http://www.wildtrout.org/content/anglian-rivers-sea-trout-project#Stiffkey%20gravel

---

5.0 RESOURCES

5.1 BOOKS, MAPS AND REPORTS

- Moorlock, BSP, et al: *Geology of the Wells-next-the-Sea District*; British Geological Survey, 2008.
- Purseglove, J.: *Taming the Flood: History and Natural History of Rivers and Wetlands*; Oxford University Press, 1988.
- Raven, PJ, et al: *River Habitat Quality: the physical character of rivers and streams in the UK and Isle of Man*; Report No.2, Environment Agency 1998. See http://www.riverhabitatsurvey.org/wp-content/uploads/2012/07/RHS.pdf
- *The State of England's Chalk Rivers – A report by the UK Biodiversity Action Plan for Chalk Rivers*; Environment Agency, 2004.

5.2 ONLINE RESOURCES

- Anglian River Basin Management Plan - http://www.environment-agency.gov.uk/research/planning/124725.aspx
- British Geological Survey Borehole Scans - http://mapapps.bgs.ac.uk/boreholescans/boreholescans.html.
- British Geological Survey Lexicon of Named Rock Units - http://www.bgs.ac.uk/lexicon/.
- Information about Walsingham history - http://peregrinations.kenyon.edu/vol3_1/photo_essays/Walsingham_photo_essay/Walsingham.html and http://www.walsinghamvillage.org/about/history-of-walsingham/
- Norfolk Historic Environment Record, via Norfolk Heritage Explorer – http://www.heritage.norfolk.gov.uk/simple-search.
- Soil Associations in England and Wales, via The Soils Guide (Cranfield University, 2014) – http://www.landis.org.uk/services/soilsguide/mapunit_list.cfm.
- UK Biodiversity Action Plan: Rivers Habitat Action Plan – http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-45-Rivers2011.pdf.

5.3 GLOSSARY

Alluvium	Unconsolidated, water-lain sediments of terrestrial origin deposited in a non-marine setting, for example a floodplain or an estuary.
Anglian	A major glacial period during the middle Pleistocene Epoch, about 450,000 years ago. Norfolk was covered by ice sheets from the north and north-west, one of which extended as far south as Hornchurch in Essex. When it retreated it left behind thick deposits of till or 'boulder clay', and also beds of outwash sands and gravels deposited by meltwater.
Aquifer	A water-bearing geological formation.
Association	A term used for classifying and mapping soils. Associations are composed of several soil types (series), and each is named after its principal series and these bear the location name from where they were first described (e.g. Isleham).

Biodiversity	The variety / diversity of life forms; the totality of genes, species, and ecosystems of a region.
Catchment	The land area from which a river or stream gathers its water.
Cretaceous	A period of Earth history between 145 and 65 million years ago; it followed the Jurassic period. It was characterised by widespread shallow shelf seas in which calcareous planktonic organisms were abundant; their remains were deposited to form chalk and the silica mineral flint.
Devensian	A stage (time period) of the late Pleistocene Epoch, between about 115,000 and 10,000 years ago. It is a predominantly cold period culminating in a major glaciation about 20,000 years ago when ice sheets reached north Norfolk, and Suffolk was part of the tundra zone.
Geodiversity	Tthe natural range (diversity) of geological features (rocks, minerals, fossils, structures), geomorphological features (landforms and processes), soil and hydrological features that shape the landscape. It is the non-biological aspect of nature.
Head	Mixed superficial deposits of periglacial origin on slopes, mobilised by solifluction.
Periglacial	In the vicinity of a glacial environment, with conditions dominated by freeze-thaw processes.
Pleistocene	An Epoch of Earth history, between about 2.5 million and 10,000 years ago. Its ending corresponds with the end of the last glacial period (the Devensian Stage). It is characterised by cyclical shifts in the Earth's climate between cold (glacial) and warm (interglacial) periods, driven by variations in planetary orbit round the sun.
Proglacial	A term referring to deposits or landforms situated at or beyond the margins of an ice sheet or glacier, for example a meltwater lake.
Saltmarsh	An area of marshy ground periodically inundated with seawater, and often having creeks and pools of salt or brackish water; it has characteristic salt-resistant vegetation.
Solifluction	The slow movement of an active layer of waterlogged sediment down-slope, over impermeable material such as permanently frozen ground (permafrost). It occurs in periglacial environments where surface layers melt in summer.
Till	Unsorted, unstratified material deposited directly by glacial ice; sometimes called boulder clay.

Written by Tim Holt-Wilson
Norfolk Geodiversity Partnership
timholtwilson@onetel.com
Version 1, January 2014

The Norfolk Geodiversity Partnership is a forum for conserving Norfolk's Earth heritage
https://sites.google.com/site/norfolkgeodiversity/