A MEETING OF THE NORFOLK RIVERS INTERNAL DRAINAGE BOARD WAS HELD IN THE ANGLIA ROOM CONFERENCE SUITE AT BRECKLAND DISTRICT COUNCIL, ELIZABETH HOUSE, WALPOLE LOKE, DEREHAM, NORFOLK ON THURSDAY, 17 OCTOBER 2019 AT 10.00 AM.

	Elected Members		**Appointed Members**
	H C Birkbeck		**Breckland DC**
	J Borthwick	*	S G Bambridge
*	J F Carrick	*	W Borrett
*	H G Cator		
*	N W D Foster		**Broadland DC**
	J P Labouchere	*	K Kelly
	M R Little	*	N Shaw
	D Mack	*	J Thomas
*	T Mutimer		
*	M J Sayer		**North Norfolk DC**
	S Shaw		H Blathwayt
	R Wilbourn		P Butikofer
	Vacancy	*	N Housden
	Vacancy		J Toye
	Vacancy		Vacancy
			South Norfolk DC
		*	T Holden
		*	Dr N Legg
		*	R Savage
			Joint Appointments
		*	Mrs L Monument – Breckland DC
			Mr I Devereux – King's Lynn & WN BC
			Vacancy

* Present (48%)

Mr J F Carrick in the Chair

In attendance:

Mr P Camamile (Chief Executive), Mr M Philpot (Project Engineer), Miss C Brady (Sustainable Development Manager), Miss J Nobbs (Senior Sustainable Development Officer), Mrs C Laburn (Environmental Manager) and Mrs C Cocks (Minutes)

ID	Minute	Action
65/19	**REMEMBRANCE**	
65/19/01	Members stood for a moment's silence in remembrance of Mr Alastair Borthwick who had passed away in September 2019. Mr Borthwick was well known to many locally, having previously served on the Norfolk Rivers IDB for many years.	
66/19	**APOLOGIES FOR ABSENCE**	
66/19/01	Apologies for absence were received on behalf of Messrs H C Birkbeck, J Borthwick, I Devereux, J P Labouchere, M R Little, D Mack, S Shaw and R Wilbourn.	
67/19	**WELCOME AND INTRODUCTIONS**	
67/19/01	The Chairman welcomed Mr N Shaw appointed by Broadland District Council to his first meeting of the Norfolk Rivers IDB. Mr Shaw replaced Mr G Everett.	
67/19/02	The Chief Executive introduced and welcomed Miss Cathryn Brady, Sustainable Development Manager and Miss Jessica Nobbs, Senior Sustainable Development Officer. He explained that Graham Brown, Flood and Water Manager was leaving the WMA Group on 1 November 2019 to take up a position with the National Trust and Miss Brady would replace Graham with immediate effect.	
68/19	**DECLARATIONS OF INTEREST**	
68/19/01	There were no declarations of interest other than those already disclosed and recorded in the Register of Member's Interests.	
69/19	**MINUTES OF THE LAST BOARD MEETING**	
69/19/01	The minutes of the last Board meeting held on 15 August 2019 were approved and signed as a true record, subject to the following amendments. <u>American Signal Crayfish (50/19/06)</u> The minute should read "…no evidence of native crayfish has been found." <u>ADA Eastern Branch AGM(58/19/02)</u> The date for the ADA Eastern Branch AGM should have read 12 October 2019, not 12 November 2019.	

There were no matters arising.

70/19 MINUTES OF THE LAST EXECUTIVE COMMITTEE MEETING

70/19/01 The minutes of the last Executive Committee meeting held on 15 August 2019 were considered in detail and approved. Arising therefrom:

70/19/02 Precept Monies (27/19/02)

The Chief Executive advised members that both he and the Project Engineer had met with Peta Denham and Graham Verrier from the Environment Agency (EA) on 26 September 2019 to discuss the Board's precept appeal for 2019/20. The EA's position had not changed and no compromise had been offered: the IDB's precept could not be used to fund work on low risk main-river systems that the Board benefitted from and the EA would not de-main those low risk systems so that the Board then had the opportunity to carryout the necessary maintenance works themselves. A further response was awaited from Peta Denham (EA) confirming this position, at which point the Board would need to decide whether or not to continue with its appeal and have it heard by Defra's Secretary of State. RESOLVED that this be noted.

71/19 OPERATIONS REPORT

71/19/01 The Operations Report (a copy of which is filed in the Report Book), was considered in detail and approved. Arising therefrom:

71/19/02 Silvergate: River Restoration (3.6)

It was noted that the Board had been working with the National Trust (NT) to deliver a Lottery funded river restoration project on an IDB adopted main drain at Silvergate (near Blickling Hall). Work had commenced 4 weeks ago which involved putting in silt traps and making the channel smaller. The work was expected to take 5 weeks to complete. RESOLVED that this be noted.

71/19/03 Camping Beck Natural Flood Management Scheme (3.8)

This project was completed last summer and the grass has now grown back and the bank has become stable. The scheme was designed to reduce the risk of flooding in Buxton by storing 7,000 m3 of surface water during flood events over a 20% Annual Exceedance Probability (1:5 return period) before releasing the water through a restricted outfall. Time lapse cameras had been installed, which enabled flood events to be recorded. The scheme was funded by Defra and delivered as part of a national natural flood management pilot. RESOLVED that this be noted.

71/19/04	**American Signal Crayfish (4.1.1)**	
	It was noted that Signal Crayfish have been found on a drain at Thuxton (River Yare), however no white clawed crayfish had been found. The Norfolk Crayfish Group were seeking out any potential sites to reintroduce native crayfish and five drains could potentially have suitable habitat. RESOLVED that this be noted.	
71/19/05	**Abstraction and Water Transfer Licences: Update**	
	The Environmental Manager had conducted a WMA wide audit on IDB abstraction and impoundment infrastructure during the summer period. It was thought that the Board had no water transfer/abstraction inlet points from EA main rivers and any installed impoundments found were thought to remain exempt due to the length of time in the past when they were installed. The Environmental Manager would keep the Board apprised of any further guidance and information. RESOLVED that this be noted.	**CL**
71/19/06	**Wensum Demonstration Test Catchment (DTC) Water Monitoring Equipment**	
	This project was being run by the UEA who had been using high resolution monitoring equipment since 2010 to monitor the water quality at 30 minute intervals. The DTC have had their funding cut and were offering the equipment to any projects which needed them. The cost of running the equipment was £500/year and the Board had been approached to take on these stations until such time as new projects were found. It was agreed and thereby RESOLVED to take on these stations which provided valuable data for the purposes of monitoring.	
72/19	**PLANNING REPORT**	
72/19/01	The Planning Report (a copy of which is filed in the Report Book) was considered in detail and approved. Arising therefrom:	
72/19/02	**Planning Comments (4.1)**	
	It was reported that the Planning Team had 5 consents being determined by officers on their books. There were no applications requiring consideration by the Board.	
72/19/03	The Sustainable Development Manager further reported that as a result of more liaison with the Local Planning Authorities, more applications were being received.	
73/19	**RE-CONSTITUTION OF NORFOLK RIVERS IDB**	
73/19/01	Members considered the map showing the new Electoral Divisions that the Chief Executive had been asked to propose at	

	the last Board meeting (a copy of which is filed in the Report Book). Ten new Electoral Divisions had been proposed (one for each directly elected member on the reconstituted Board, as had been requested). Arising therefrom:	
73/19/02	It was agreed that the Upper Nar area should form one Electoral Division. The new Electoral Division C should therefore include both Narborough and Litcham (and exclude Fakenham). The new Electoral Division B should just include Fakenham. RESOLVED that this be noted.	
73/19/03	It was agreed that members would send any other suggested changes to the Chief Executive as soon as possible, so that they could be considered by the Board at its next meeting in January 2020.	**ALL**
74/19	**FINANCIAL REPORT**	
74/19/01	The Financial Report for the period 1 April 2019 to 31 August 2019, was considered in detail and approved, (a copy of which is filed in the Report Book). There were no matters arising.	
75/19	**SCHEDULE OF PAID ACCOUNTS**	
75/19/01	The Schedule of Paid Accounts for the period 1 July 2019 to 31 August 2019, totalling £103,815.67 (a copy of which is filed in the Report Book), was considered in detail and approved. There were no matters arising.	
76/19	**MATERIAL CHANGES TO RISK REGISTER**	
76/19/01	The Risk Register showing those risks with a risk assessment matrix score of ≥6 was considered in detail and approved. No changes were recommended. RESOLVED that this be noted.	
77/19	**AUDITED ANNUAL GOVERNANCE AND ACCOUNTABILITY RETURN YEAR ENDING 31 MARCH 2019**	
77/19/01	The audited Annual Governance and Accountability Return for the year ended 31 March 2019, (a copy of which is filed in the Report Book), was considered in detail and approved. There were no matters arising.	
78/19	**CORRESPONDENCE**	
78/19/01	**Water Resources East (WRE)**	
	The letter from ADA proposing to take up a seat on the Water	

	Resources East (WRE) Board of Directors (a copy of which is filed in the Report Book) was considered in detail and approved.	
78/19/02	It was agreed and thereby RESOLVED to support ADAs proposal to appoint Mr David Thomas, Chief Executive/Engineer to the Middle Level Commissioners as its representative on the WRE Board of Directors. To facilitate this, it was further agreed to approve the annual cost to Norfolk Rivers IDB of approx. £127, which would be reviewed annually.	
78/19/03	It was agreed and thereby RESOLVED to apply to join the WRE Strategic Advisory Group as a member directly and to guarantee the debts of the company up to the value of £1 accordingly. Dr N Legg requested that the Chief Executive ask constituent councils to do the same.	**PJC**
78/19/04	It was agreed and thereby RESOLVED to appoint Matthew Philpot, Project Engineer (WMA Eastern) to represent the Board on the WRE Strategic Advisory Group. It was noted that the WRE Strategic Advisory Group were due to meet next on 14 January 2020 in New Market.	
79/19	**MEETING DATES 2020**	
79/19/01	The calendar of meetings for 2020 was considered and approved as set out below: 30 January 2020 11 June 2020 13 August 2020 15 October 2020 All Board meetings would start at 10.00 am in the Anglia Room Conference Suite at Breckland District Council, Elizabeth House, Walpole Loke, Dereham, NR19 1EE, subject to availability. All Executive Committee meetings would start at 9 am in the Dereham Room at Breckland District Council, Elizabeth House, Walpole Loke, Dereham, NR19 1EE, subject to availability.	
80/19	**NEXT MEETING DATE**	
80/19/01	The next Board meeting would take place on 30 January 2020 at 10.00 am, at Breckland District Council.	
81/19	**ANY OTHER BUSINESS**	
81/19/01	It was proposed by Mr S G Bambridge, seconded by Mr N Shaw and unanimously agreed to appoint Mr H G Cator to represent Norfolk Rivers IDB on the Consortium Management Committee	

	until 31 October 2021 (replacing Mrs E Watson).	
81/19/02	It was proposed by Ms J Thomas, seconded by Mr N Shaw and unanimously agreed to appoint Mr K Kelly to serve on the Board's Executive Committee until 31 October 2021 (replacing Mrs E Watson).	
81/19/03	Members were reminded that the ADA Conference and AGM was taking place on Wednesday, 13 November 2019 at 1 Great George Street in London and places were still available for those who wished to attend. Anyone who wished to attend should therefore contact Mrs C Cocks as soon as possible.	
81/19/04	Mr N Housden informed the Board that North Norfolk DC had recently considered a planning application for the construction of 90 new houses in Raynham and enquired if the Board was aware. The Sustainable Development Manager agreed to check on the IDB's involvement but did not believe that there would be any positive discharge of surface water into the district arising from this particular development.	**CB**
82/19	**OPEN FORUM: TO HEAR FROM ANY MEMBER OF THE PUBLIC, WITH LEAVE OF THE CHAIRMAN**	
82/19/01	There were no members of the public present at today's meeting.	
83/19	**CONSORTIUM MATTERS**	
83/19/01	**Unconfirmed Minutes**	
	The unconfirmed minutes of the last Consortium Management Committee meeting held on 27 September 2019 were considered in detail and approved. Arising therefrom:	
83/19/02	Mr K Kelly enquired if the plans were available regarding the new office build at King's Lynn. He was informed that the plans were available to view on the Borough Council's website. Once the land purchase had been completed, plans would be brought back to the Board to view. RESOLVED that this be noted.	
83/19/03	**Schedule of Paid Accounts**	
	The WMA Schedule of Paid Accounts for the period 1 April 2019 to 31 July 2019 totalling £713,429.03.19 as approved at the Consortium Management Committee meeting on 27 September 2019, was considered in detail and adopted by the Board. There were no matters arising.	
83/19/04	**WMA Financial Report**	
	The WMA Financial Report for the period 1 April 2019 to 31 July	

2019, as approved at the Consortium Management Committee meeting on 27 September 2019 was considered in detail and adopted by the Board. There were no matters arising.

83/19/05 **Issues for discussion at next CMC meeting**

There were no specific issues raised by members that would require discussion at the next Consortium Management Committee meeting on 13 December 2019. Should members wish any item to be discussed at the next meeting on 13 December 2019, they should raise the matter with any of the Board's representatives, or with the Chief Executive directly. Members were reminded that the Board's representatives on the CMC were Mr S G Bambridge, Mr J Carrick and Mr H G Cator.

84/19 **CONFIDENTIAL BUSINESS**

84/19/01 It was agreed and thereby RESOLVED to exclude the public from the next part of the meeting due to the confidential nature of the business to be transacted, in accordance with Section 2 of the Public Bodies (Admission to Meetings) Act 1960.

84/19/02 The confidential minutes of the last Board meeting held on 15 August 2019 were approved and signed as a true record. There were no matters arising.

84/19/03 The unconfirmed confidential minutes of the WMA Consortium Management Committee (CMC) meeting held on 27 September 2019 were considered in detail and approved. There were no matters arising.

Meeting closed at 12 noon

A MEETING OF THE NORFOLK RIVERS IDB EXECUTIVE COMMITTEE WAS HELD IN THE DEREHAM ROOM CONFERENCE SUITE, BRECKLAND DISTRICT COUNCIL, ELIZABETH HOUSE, WALPOLE LOKE, DEREHAM, NORFOLK ON THURSDAY, 17 OCTOBER 2019 AT 9.00 AM.

	Elected Members		Appointed Members
			Breckland DC
*	J F Carrick	*	S G Bambridge
	J P Labouchere		**South Norfolk DC**
	M R Little	*	Dr N Legg
			Jointly Appointed
			Vacancy

* Present (50%)

Mr S G Bambridge in the Chair

In attendance:

Mr P Camamile (Chief Executive), Mr M Philpot (Project Engineer), Miss C Brady (Sustainable Development Manager), Mrs C Cocks (Minutes)

ID	Norfolk Rivers IDB: Executive Committee, Minute	Action
33/19	**APOLOGIES FOR ABSENCE**	
33/19/01	Apologies for absence were received from Mr M R Little and Mr J P Labouchere.	
34/19	**MINUTES OF THE LAST EXECUTIVE COMMITTEE MEETING**	
34/19/01	The minutes of the last Executive Committee meeting held on 15 August 2019 were approved and signed as a true record. Arising therefrom:	
34/19/02	**Precept Monies (27/19/02)**	
	The Chief Executive advised members that both he and the Project Engineer had met with Peta Denham and Graham Verrier from the Environment Agency (EA) on 26 September 2019 to discuss the Board's precept appeal for 2019/20. The EA's position had not changed and no compromise had been offered: the IDB's precept could not be used to fund work on low risk main-river systems that the Board benefitted from and the EA would not de-main those low risk systems so that the Board then had the opportunity to carryout the necessary maintenance works themselves. A further response was awaited from Peta Denham (EA) confirming this position, at which point the Board would need to decide whether or not to continue with its appeal and have it heard by Defra's	

Secretary of State. RESOLVED that this be noted.

35/19 FINANCIAL REPORT

35/19/01 The Financial Report for the period 1 April 2019 to 31 August 2019 was considered in detail and approved (a copy of which is filed in the Report Book). Arising therefrom:

35/19/02 Highland Water Contributions Claim for 2019/20

The Chief Executive confirmed that the Board had received full payment of its Highland Water Contributions Claim for 2019/20 from the Environment Agency. RESOLVED that this be noted.

35/19/03 Precept Charges for 2019/20

The Chief Executive advised members that half the precept charge for 2019/20 had been paid to the Environment Agency in May 2019, with the balance due in November 2019. Although the Board had lodged an appeal, payment still had to be made. RESOLVED that this be noted.

36/19 SCHEDULE OF PAID ACCOUNTS

36/19/01 The Schedule of Paid Accounts for the period 1 July 2019 to 31 August 2019, totalling £103,815.67 (a copy of which is filed in the Report Book), was considered in detail and approved. There were no matters arising.

37/19 COLLECTION OF DRAINAGE RATES

37/19/01 It was reported that everything was on track, although the Chief Executive was disappointed by how few of the Board's ratepayers had signed up to use the new online rating system. Quite bizarrely none of the Board's members had signed up to use the new system.

38/19 DATE AND TIME OF NEXT MEETING

38/19/01 The next Executive Committee meeting would take place on Thursday, 30 January 2020 at 9.00 am, subject to the Board's approval of the meeting dates for 2020.

39/19 ANY OTHER BUSINESS

39/19/01 Water Resources East (WRE)

	The Committee supported ADAs proposal to take up a seat on the WRE Board of Directors to represent the IDB sector. It was agreed that the Executive Committee's Chairman would put this to the Board together with a recommendation that the Board joins the WRE Strategic Advisory Board as a member in its own right. RESOLVED that this be noted.	
39/19/02	**Consortium Management Committee (CMC) Membership**	
	It was noted that the Board had a vacancy on the CMC and it was agreed that Mr Henry Cator be asked if he would be prepared to represent the Board on this Committee (replacing Mrs E Watson), following his resignation as Chairman of Broads IDB.	
39/19/03	**Executive Committee Membership**	
	It was noted that the appointment of an additional member to the Executive Committee (replacing Mrs E Watson) was on the Agenda for the Board to consider at its next meeting.	
39/19/04	**Proposed Electoral Divisions**	
	Mr S G Bambridge advised members that he was comfortable with the proposed Electoral Divisions as presented and suggested that the IDB write to the elected members for their opinions on this matter and for the Board to then make a decision in January 2020. Proceedings to reconstitute the Board could then commence, if the members did not have any objections. It was agreed that this would be discussed at the next Board meeting.	

Meeting closed at 9:50 am

ENGINEERING, OPERATIONS AND ENVIRONMENTAL REPORT

October 2019

The Engineering and Operations teams continue to plan and manage maintenance and capital projects throughout the NRIDB catchment area, facilitated by the Environmental Team. The following information pertains to operations and schemes carried out for the Norfolk Rivers IDB, from the **24 July 2019 – 02 October 2019**:

1. HEALTH & SAFETY

No incidents or accidents this quarter.

Tool box talks delivered on;

- Water Primrose, invasive species.
- Wild Parsnip, potentially hazardous plant

Included in Appendix A and B to this report

2 REVENUE MAINTENANCE WORKS

2.1 Routine maintenance works were carried out on board main drains in the following districts:

Contractor's Machine: (GDR Ltd)

Bure:	Blickling, Burgh next Aylsham
Wensum:	Whitewater
Upper Yare and Tas:	Thuxton/Runhall
North Norfolk	Burnham Deepdale
Smallburgh	North Walsham Dilham Canal

Handwork: NRIDB Operatives

Numerous sites across the whole of the district & circa 3 weeks of secondment to the EA for one staff member.

2.2 Billingford

Further water vole surveys and control (cutting and pulling) of Himalayan Balsam has been undertaken. This will enable the planning of maintenance and improvement works to be undertaken on this section of drain, which has historically been maintained by the landowner.

2.3 North Walsham and Dilham Canal: Royston Bridge

A further survey of the drains around Royston Bridge has been undertaken in order to determine the maintenance works required here. It is planned to undertake vegetation cutting along the overgrown drains adjacent to the canal.

The board have been working with the Old Canal Company, who are restoring parts of the North Walsham Dilham Canal to repair a brick culvert which forms part of the adopted system. The board have assisted with a camera survey and materials for the repairs being undertaken by the Canal Company.

2.4 Burnham Norton: un-adopted watercourse maintenance

A Habitats Regulations Assessment is being prepared in order to gain assent from Natural England. This is to enable maintenance works to be undertaken on a section of drain, as agreed at the last board meeting, linking the existing main drain to the tidal sluice.

2. PLANT

Nothing to report this period.

3. CAPITAL SCHEMES

3.1 Fish Passage at Narborough

Works to retro-fit two fish passes at Narborough have been completed successfully. The pre-fabricated structures were installed by our in house Mechanical and Electrical team. This was a PSCA project with the Environment Agency as a partner.

Fish passage is now available from source to sea on the River Nar.

Fish and Eel pass in place (IDB Drain)

Fish and Eel pass in place (EA Main River)

3.2 Castle Acre River Restoration

River restoration works are ongoing at Castle Acre Common. Working with Five Rivers and river restoration designer Charles Rangeley-Wilson, the aim is to create 400m of new river channel through the common to bypass a section of the old channel.

The new channel is being excavated following a seam of gravel which will be an excellent bed material for the new channel. This will create a more natural and sustainable chalk river habitat that will allow indigenous species to prosper. Such habitats will include areas of clean gravel beds for invertebrates and spawning trout.

The Common is a SSSI site. Works are being carried out as sensitively as possible by using specialist wide tracked excavators with ground protection mats. Environmental mitigation works have been carried out to protect water voles and nesting birds.

Excavator with wide tracks constructing the new channel

Water vole mitigation works

3.4 Felthorpe Hall: Pond, Drain and Wetland Improvements

Plans are currently being developed in consultation with the landowner at Felthorpe Hall to discuss the NRIDB undertaking some improvement works, on his behalf, to a pond, wetland area and drain within his land. The project conveys water towards one of the NRIDB main drains.

As work will be undertaken to a number of trees that are protected, consultation on the plans is being undertaken with the Broadland District Council Tree Officer to gain permission for this work.

3.5 Scarrow Beck: River Restoration

The NRIDB is working with the National Trust to deliver a Water Environment Grant (WEG) funded river restoration project on Scarrow Beck. Initial plans are being discussed and refined. The work has been delayed until 2020 to allow the design to be finalised and for a water vole mitigation licence to be obtained.

3.6 Silvergate: River Restoration

NRIDB are working with the National Trust to deliver a Lottery funded river restoration project on our main drain at Silvergate (near Blickling Hall). This work will help to manage silt within the river as well as improving the hydromorphology, floodplain connectivity and habitats. Works are completely within the land ownership of the National Trust and NRIDB officers have been working closely with the National Trust on the design of the project.

Water vole mitigation works were undertaken under the IDB Class Licence.

Work started in September and is expected to take 5 weeks to complete.

3.8 Camping Beck Natural Flood Management scheme –

Following completion of the main construction works in March 2019, NRIDB operatives have completed the final phase of the Camping Beck NFM scheme at Buxton by connecting the project to the Camping Beck by means of a fixed spillway.

The scheme is designed to reduce the risk of flooding in Buxton by storing $7000m^3$ of water during flood events over a 20% Annual Exceedance Probability (1:5 return period) before releasing the water through a restricted outfall.

The site has developed well since the construction period last year and initial environmental surveys undertaken by the Norfolk Rivers Trust on behalf of the Environment Agency show a diverse variety of plant species have colonised the new channels.

Time-lapse cameras have been installed allowing flood events to be recorded. The scheme was funded by the DEFRA and delivered as part of a national natural flood management pilot.

Inlet spillway with geotextile and rock roll reinforcement

Section of new connecting channel through Dudwick part

3.9 2019 Environment Agency Maintenance Work

NRIDB officers have delivered a number of maintenance activities on behalf of the Environment Agency, assisting in the delivery of their 2019-20 routine maintenance programme. Completed to date -

- Truxor Weedcuts on 5 different river systems
- Footpath Works at Burnham Deepdale
- Secondment of hand operative to the EA

Further works for completion this financial year -

- Routine maintenance on the Hales Watercourse
- River Tudd Routine maintenance

Further Works in discussion

- De-silt works at Weybourne Beck
- Repairs to Morston outfall sluice

Further information available on request.

Footpath at Burnham Deepdale

4 OPERATIONAL MATTERS

4.1. Invasive Species

4.1.1 Invasive American Signal Crayfish

The NRIDB are continuing to fund crayfish surveys in NRIDB river systems again this year as part of their contribution toward benefiting White Clawed Crayfish and the NRIDB BAP. This is a valuable piece of work which is concentrating of tributaries of the River Yare and tributaries including the River Tiffey between now till the end of October 2018. The Norfolk Crayfish Group have undertaken surveys to find out the extent of the spread of American Signal Crayfish, whether there are or any evidence of our native White clawed Crayfish and also to seek out any potential arc sites to reintroduce native crayfish.

The results have shown that no white clawed crayfish have been found on the drains and the invasive American Signal Crayfish have been found on DRN067G0801 at Thuxton (River Yare).

In total five drains could potentially have suitable habitat for White clawed crayfish. These include:

DRN062G0201 at Flordon, Tasburgh and Toprow (tributary of River Tas)
DRN069G1101 at Wymondham (River Tiffey)
DRN068G0902 at Deopham (tributary of the River Tiffey - Hackford Watercourse)
DRN062G0202 at Toprow (tributary of River Tas)
DRN064G301 at Keswick (tributary of Intwood stream)

4.2 Licence or assent applications made during this period:

License / Assent / Habitat Regulations Assessment	Applied	Granted
Update Natural England SSSI assent to carry out river restoration River Nar, Castle Acre Common.	03 September 2019	04 September 2019
Herbicide Spraying Burreed and F. Watercress up and down stream at Newton Mill. Contacted Natural England to inform them we are doing this using the Herbicide licence gained in 2018 (3 year licence).	03 September 2019	05 September 2019

5. OTHER MATTERS

5.1 Abstraction and Water Transfer Licences: Update

From the 1st January 2018, new regulations came into effect as the result of amendments to water resources legislation, by the implementation of the Water Act 2003. This new legislation, (superseding the Water Resources Act 1991) has removed many previously exempt activities to abstract water without a licence, such as the transfer or abstraction of water into Internal Drainage Districts. Many of these activities will now require an Environment Agency water resources abstraction/transfer licence depending on the location and definition of the Board's Boundary.

Special transitional arrangements are currently in place, which requires application to be made to the Environment Agency to legalise these transfer points and impoundments. Applications need to be with the EA and being processed by 31 December 2019.

ADA have been in consultation with the EA over the last 2 years, however, it is only in the recent couple of months that some clarification and guidance has been released.

The Environmental Manager has conducted a WMA wide audit on IDB abstraction and impoundment infrastructure. It is thought that the Norfolk Rivers IDD has no water transfer/abstraction inlet points from EA main rivers and any installed impoundments found are thought to remain exempt due to the length of time in the past when they were installed.

The Environmental Manager will continue to apprise the Board of any further guidance and information as it is released.

5.2 Wensum Demonstration Test Catchment (DTC) Water Monitoring Equipment

The Wensum DTC project has been using high resolution monitoring equipment since 2010 to monitor the following parameters at 30 minute intervals and the results are available in near real-time using a GPRS telemetry system:

- Nitrate *
- Total and reactive phosphorus
- Water temperature
- Conductivity
- Dissolved Oxygen
- pH
- Ammonium
- Turbidity
- Chlorophyll
- Battery Voltage (monitor the battery used to power the pump that collects the water samples – recharged by solar panels)

These have assisted in the assessment of different tillage systems, the benefits of cover crops, the benefits of roadside sediment traps, monitoring changes in river water quality and diel turbidity cycles looking at evidence of nocturnal bioturbation. Such a long term high resolution record of river water parameters is rare, and could be used in the future to assess long-term trends.

THE DTC have now had their funding cut and are offering the equipment to any projects which need them. The cost of running the equipment is £500/year and the board have been approached to take on these stations until such time as new projects are found.

The data benefits the board in that it monitors areas on our network and we have been a part of the DTC project in previous years, installing a number of silt traps which are being monitored by the equipment at Salle.

It is proposed that the boards BAP budget is used to fund this and our hand team clean the sensors as part of their routine works once every 3 weeks, a job which will take circa 1 hour. This will not only extend the data collection period but also prevent the stations being removed and placed in storage. If units fail it is not proposed the IDB pay for repairs but instead allow the units to be decommissioned at that point.

A detailed paper on the use of the data is also included as Appendix C to this report

Board Decision: Manage the DTC equipment as suggested.

6. COMPLAINTS/ENFORCEMENT

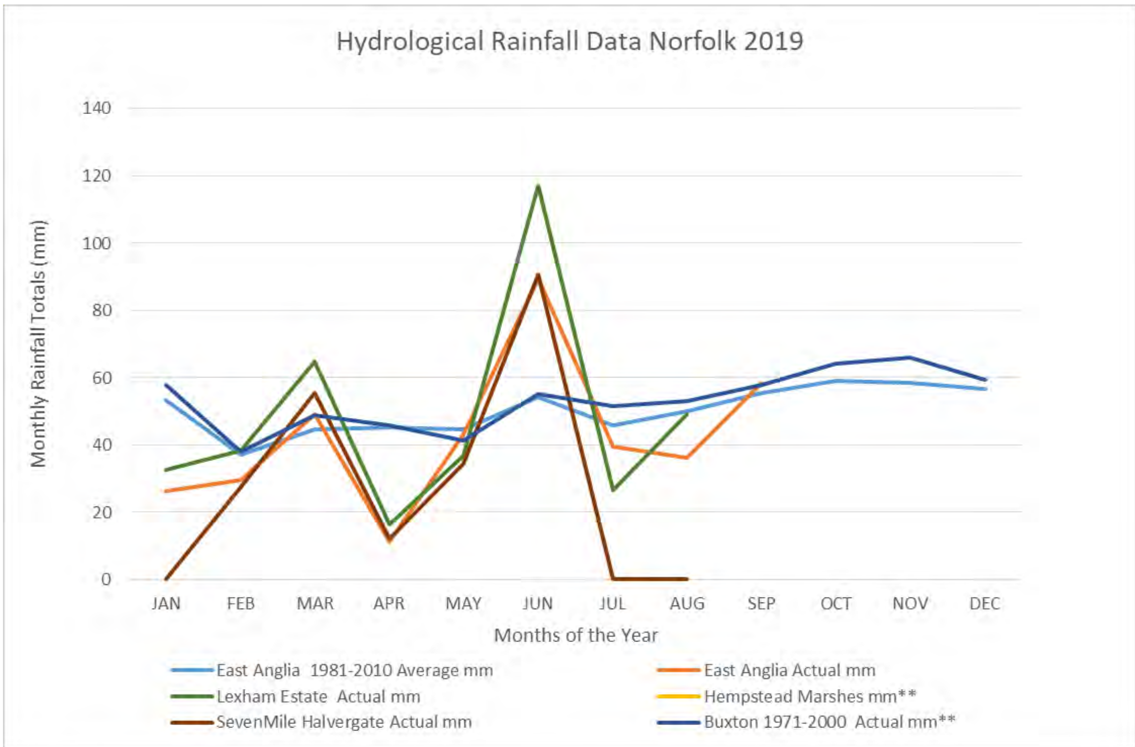
Nothing to report

7. HYDROLOGY – UK Overview

(extracts from http://www.metoffice.gov.uk/climate/uk/summaries/2019)

July started off rather cool with north-westerly winds, but with high pressure close to the south-west. The first half was mostly dry and settled but with unremarkable temperatures, and high pressure remained close to the south and west. The second half was much wetter, due largely to numerous thundery outbreaks, but with an exceptionally hot spell from the 22nd to 25th which saw record-breaking temperatures and plenty of sunshine. The mean temperature for July was provisionally 1.2 °C above the 1981-2010 long-term average, and the mean minimum temperature was the joint 6th highest in a series from 1910.

August opened with a weak ridge of high pressure, which brought some warm sunshine but also some scattered thundery showers in some places. The weather then turned more unsettled and breezier with some showers and longer spells of rain, and deep depressions brought bouts of wet and windy weather especially to Scotland on the 9th, 14th and 16th. There was a hot sunny spell in most central and southern areas between the 21st and 27th, which extended to most of the country between the 24th and 26th, setting new record temperatures for the late August bank holiday. A thundery breakdown followed, and the last few days were cooler with some heavy persistent rain over much of Scotland and Cumbria.



	East Anglia 1981-2010 Average mm	East Anglia Actual mm	Lexham Estate Actual mm	Hempstead Marshes mm**	SevenMile Halvergate Actual mm	Buxton 1971-2000 Actual mm**
JAN	53.4	26.2	32.5		0	57.8
FEB	37.2	29.6	38.4		27.4	38
MAR	44.8	49.1	64.8		55.6	49
APR	45.3	11.3	16.3		12.2	45.8
MAY	44.8	43	36.8		34.4	41.4
JUN	54.3	89.5	117		90.8	55.2
JUL	46	39.5	26.5		telemetry out	51.6
AUG	50.1	36.3	49.3		telemetry out	53.2
SEP	55.6	58.4				57.8
OCT	59					64.3
NOV	58.5					66.1
DEC	56.8					59.5

* http://www.metoffice.gov.uk/climate/uk/summaries/2019
** http://www.buxton-weather.co.uk/weather.htm#daily

Bibliography: Cooper, R J et al, 2018, Research Papers *Application of high-resolution telemetered sensor technology to develop conceptual models of catchment hydrogeological processes*, Journal of Hydrology X

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Water primrose Alert!

We need you to report any sightings of this plant.

If you think you have found water primrose, **'check the identification'** then send a photo and location details to: alertnonnative@ceh.ac.uk

- Water primrose *Ludwigia grandiflora* is an invasive non-native plant that is invading our ponds, lakes, wetlands, ditches and watercourses.
- It was introduced as an ornamental garden plant, but has now been banned from sale.
- It has already invaded many habitats in Western Europe and Japan, excluding native plants and animals, increasing flood risk, preventing fishing, navigation and reducing the amenity value.
- In the UK the Environment Agency is coordinating the eradication of water primrose, before it gets too established in the wild.
- If you have water primrose in your garden, it is a criminal offence to spread it into the wild. Follow the **'be plant wise'** campaign and dispose of it safely.

Help us eradicate water primrose from the UK:

- Read the ALERT information on the **'non-native species secretariat website'**
- Report any sightings of the plant to **alertnonnative@ceh.ac.uk**
- If you have the plant on your land, don't let it spread. Contact the Environment Agency for advice on how to remove it **03708 506 506**
- Always follow strict biosecurity and adopt the **'check-clean-dry'** campaign
- **Remember, spread the word, not the weed!**

Environmental Alert

Asset Delivery, September 2019

Wild Parsnip (*Pastinaca sativa*)

A pungent native species and the ancestor of the common vegetable.

Identification

Flowers: Small, yellow flowers form umbrella-shaped clusters 10 to 20 centimetres across. Flowers June - August.
Stems: Ridged, hairy and hollow. Up to 2m tall.
Leaves: Green. Serrated edges. Arranged in symmetrical sets of at least five on a single stem.

Images of Wild Parsnip's, flowers, stems and leaves. *Photo credits: Left and centre: Paul Ruddoch on Naturespot.org.uk, Right: Invadingspecies.com*

Habitat

Grows on rough, dry and often calcareous grassland. This species is often noted in numbers near the safety barriers on the network and is widespread in central and southern England.

Health Hazard

Like Giant Hogweed, the sap of Wild Parsnip contains photo-sensitive chemicals known as furanocoumarins. These chemicals can make the skin hyper-sensitive to sunlight and cause a reaction known as phytophotodermatitis. This reaction can occur up to 48 hours after contact and is not dissimilar to a chemical burn where reddening, itching, blistering or burning can occur.

Action

- DO NOT TOUCH this plant.
- If accidental contact is made with the plant's sap: wash the area immediately, cover the skin to prevent exposure to sunlight and seek medical advice if blistering occurs.

Severe blistering and burns caused by contact with Wild Parsnip sap. *Photo credit: SWNS.*

For further information please contact your local Environment Team on:
Area7Environment@highwaysengland.co.uk
Area10Environment@highwaysengland.co.uk
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Research papers

Application of high-resolution telemetered sensor technology to develop conceptual models of catchment hydrogeological processes

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ABSTRACT

Mitigating agricultural water pollution requires changes in land management practices and the implementation of on-farm measures to tackle the principal reasons for water quality failure. However, a paucity of robust empirical evidence on the hydrological functioning of river catchments can be a major constraint on the design of effective pollution mitigation strategies at the catchment-scale. In this regard, in 2010 the UK government established the Demonstration Test Catchment (DTC) initiative to evaluate the extent to which on-farm mitigation measures can cost-effectively reduce the impacts of agricultural water pollution on river ecology while maintaining food production capacity. A central component of the DTC platform has been the establishment of a comprehensive network of automated, web-based sensor technologies to generate high-temporal resolution empirical datasets of surface water, soil water, groundwater and meteorological parameters. In this paper, we demonstrate how this high-resolution telemetry can be used to improve our understanding of hydrological functioning and the dynamics of pollutant mobilisation and transport under a range of hydrometerological and hydrogeological conditions. Furthermore, we demonstrate how these data can be used to develop conceptual models of catchment hydrogeological processes and consider the implications of variable hydrological functioning on the performance of land management changes aimed at reducing agricultural water pollution.

1. Introduction

Diffuse pollution from agriculture is a major driver behind the degradation of freshwater systems, causing an array of detrimental economic (Färe et al., 2006; Popp et al., 2012; Pretty et al., 2003) and environmental (Hilton et al., 2006; Skinner et al., 1997; Smith et al., 1999) impacts that threaten the ability of these systems to provide ecosystem services (Némery and Garnier, 2016; Quinton et al., 2010). In the European Union, the response to this issue has been to implement the Water Framework Directive (WFD; 2000/60/EC) which requires member states to achieve good qualitative and quantitative status of all surface, subsurface and marine waterbodies up to 1 nautical mile offshore. These waterbodies are divided into River Basin Districts (RBDs) based on river catchment area. National governments within each RBD are required to produce a holistic river basin management plan to provide a clear strategy and timeframe for how the status of waterbodies within the RBD will be improved from source to mouth (Hering et al., 2010; Voulvoulis et al., 2017).

Achieving reductions in agricultural pollution within RBDs requires changes in land management and the implementation of mitigation measures to tackle the principal reasons for water quality failure. However, a paucity of robust empirical evidence on the hydrological functioning of individual river catchments, particularly in relation to the dynamics of pollutant mobilisation and transport under a range of hydrometerological and hydrogeological conditions, can be a major constraint on the design of effective pollution mitigation strategies at the catchment-scale (Allen et al., 2014; Harvey and Gooseff, 2015; Rode et al., 2016). For example, the porosity and permeability of catchment bedrock affects aquifer storage properties and the support of river baseflow (Cook, 2015); the type, thickness and hydraulic conductivity of superficial geological deposits affects shallow groundwater movement and the transport of leached pollutants (Nolan and Hitt, 2006); the composition of the hyporheic zone determines groundwater-surface

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water interactions and the movement and storage of pollutants across and within the riverbed (Gomez-Velez and Harvey, 2014; Rode et al., 2015; Newcomer et al., 2018); river channel morphology, sinuosity, gradient, stream order and connectivity impact upon hydrological functioning and the speed of pollutant transport (Garnier et al., 2002); within-channel processes such as the growth of macrophytes and bacterial communities impact upon the interception, utilisation and consumption of nutrients (Withers and Jarvie, 2008); whilst the climate regime controls the temporal dynamics (i.e. flushing) of dissolved and particulate pollutants through catchments (Halliday et al., 2012; Halliday et al., 2014).

Of particular interest here the hydrogeology of catchments affects both pollutant mobility within the environment and its delivery pathway from source to receptor and this consequently affects within-river pollutant behaviour (Dupas et al., 2015; Dupas et al., 2016). It is especially important to understand how the hydrogeology of a catchment impacts upon pollutant travel times, which can range from minutes for rapid surface flow paths to decades for slower subsurface routes (Bowes et al., 2015; King et al., 2015). Constructing a detailed understanding of pollutant transport is essential when it comes to assessing the effectiveness of targeted pollutant mitigation measures, as judgements made without the context of pollutant travel times could result in measures incorrectly being assessed as a success or failure before sufficient time has passed for the pollutant to reach the receptor (Allen et al., 2014).

Established in 2010, the Demonstration Test Catchment (DTC) platform is a UK government initiative funded by the Department for Environment, Food and Rural Affairs (Defra) working in four English catchments to evaluate the extent to which on-farm mitigation measures can cost-effectively reduce the impacts of agricultural water pollution on river ecology while maintaining food production capacity (McGonigle et al., 2014). Each DTC focuses on a different type of farming system, namely, intensive arable (River Wensum DTC, Norfolk), upland livestock (River Eden DTC, Cumbria) and mixed farming (River Avon DTC, Hampshire; River Tamar DTC, Devon/Cornwall). Research outputs from the DTCs have included assessments of the effectiveness of a biobed (Cooper et al., 2016a), cover crops and non-inversion tillage (Cooper et al., 2017), farm track resurfacing (Biddulph et al., 2017) and constructed wetlands (Cooper et al., 2019) as mitigation measures for reducing agricultural pollution. Research has also explored the factors controlling nutrient transfers to agricultural headwater streams (Lloyd et al., 2016a; Lloyd et al., 2016b; Outram et al., 2016; Perks et al., 2015), hydrochemical responses of rivers to extreme weather events (Cooper et al., 2015c; Ockenden et al., 2017; Outram et al., 2014), the impacts of invasive species on water quality (Cooper et al., 2016b) and the apportionment of sources of fluvial sediments to soils eroding under different land uses (Collins et al., 2013; Cooper et al., 2015a; Cooper et al., 2015b).

A central component of the DTC platform underlying this previous research has been the establishment of a comprehensive network of automated web-based sensor technologies to generate high-temporal resolution empirical datasets of surface water, soil water, groundwater and meteorological parameters. Whilst numerous catchment-scale environmental research programmes (e.g. Critical Zone Observatories) have been established across Europe (Garnier and Billen, 2016; Vuorenmaa et al., 2018) and the United States (Brantley et al., 2017; Kim et al., 2017) in recent years, only a few have managed to produce comprehensive datasets of environmental variables at the 15–30 min resolution of the DTC platform over timescales of >5 years. The near unprecedented level of detail generated by such an intensive monitoring network means the DTCs are uniquely placed to deliver advancements in our understanding of hydrological functioning at the catchment-scale (Covino, 2017).

Focusing on the River Wensum DTC, the aim of this paper is to demonstrate how such high-resolution data can be used to improve our understanding of hydrological functioning and pollutant pathways and, in turn, how this can be used to develop conceptual models of catchment hydrogeological processes (e.g. Harvey and Gooseff, 2015; Rode et al., 2016). This paper:

(i) presents the experimental design of the River Wensum DTC for generating high-resolution datasets of river water, groundwater, soil water and meteorological parameters;
(ii) contrasts the temporal and spatial dynamics of these hydrological parameters in areas with contrasting geology and soil type over six hydrological years (2011–2017);
(iii) develops conceptual models of catchment hydrogeological processes informed by high-resolution empirical datasets;
(iv) considers the implications of hydrogeological characteristics for the implementation of on-farm mitigation measures to reduce agricultural pollution

2. Material and methods

2.1. River Wensum

The River Wensum, Norfolk, is a 78 km length lowland, calcareous, river that rises near the village of South Raynham (52°46′N, 0°47′E) ~75 m above sea level and flows southeast before merging with the River Yare south of Norwich (52°37′16″ N, 1°19′22″ E) (Fig. 1). In total, it drains an area of 660 km^2 and has a mean annual discharge of 4.1 m^3 s^{-1} near its outlet (CEH, 2017) and annual baseflow indices (BFI) ranging from 0.5 to 0.9. In 1993, a 71 km stretch of the Wensum from South Raynham to Hellesdon Mill, Norwich, was designated a whole-river Site of Special Scientific Interest (SSSI) in recognition of it being one of the best examples of a lowland calcareous river system in the UK (Sear et al., 2006). In 2001, the Wensum was given further European Special Area of Conservation (SAC) status due to the diversity of its internationally important flora and invertebrate fauna. However, the ecological condition of the Wensum is in decline, with 99.4% of the protected habitat considered to be in an unfavourable or declining state due, primarily, to excessive sediment and nutrient loadings from agriculture and sewage treatment works (Grieve et al., 2002; Sear et al., 2006). Arable agriculture dominates land use across the catchment (63%) and it is due to the impact of agriculture on water quality that the River Wensum was chosen as one of four DTC study catchments by the UK government.

2.2. Blackwater Drain sub-catchment

The Wensum catchment comprises 20 sub-catchments, one of which, the 19.7 km^2 Blackwater Drain, represents the area intensively studied as part of the River Wensum DTC and provides the focus of this paper. For monitoring purposes, the Blackwater Drain is further divided into six mini-catchments named *A* to *F*, across which there is a pronounced contrast in the superficial geology and soil type (Fig. 1). The western section (mini-catchments A + B) is underlain by a complex sequence of Mid-Pleistocene chalky, flint-rich, argillaceous glacial tills of the Sheringham Cliffs (Bacton Green Till Member; 0.2–7 m depth) and Lowestoft (Lowestoft Till Member; 8–16 m depth) Formations, with interdigitated bands of glaciofluvial and glaciolacustrine sands and gravels (Table 1; Fig. 2). In turn, these are superimposed onto the quartzite-rich marine sands and gravels of the Lower Pleistocene Wroxham Crag Formation (16–22 m depth), which overlies the Cretaceous Chalk

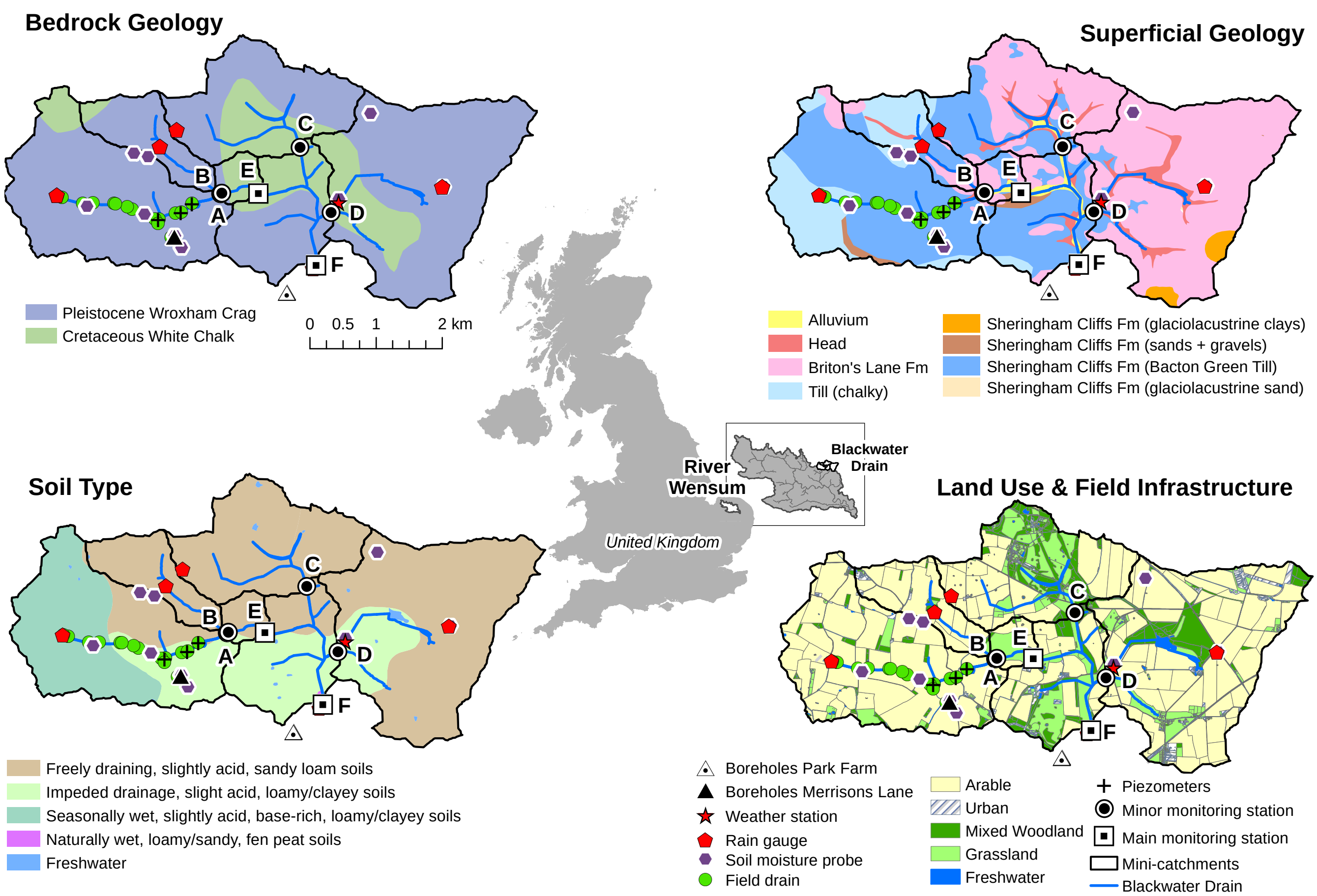

Fig. 1. Spatial variability in bedrock geology (BGS; 1:10,000), superficial geology (BGS; 1:10,000), land use (LCM2007) and soil type (LandIS) across the Blackwater Drain sub-catchment of the River Wensum, UK. Also showing the layout of field monitoring infrastructure and mini-catchment boundaries. Geological maps reproduced with the permission of the British Geological Survey, ©NERC; LCM2007© and database right NERC (CEH) 2011 (Morton et al., 2011). All rights reserved. Contains Ordnance Survey data © Crown copyright and database right 2007. © third party licensors.

Table 1
Hydrogeological succession of the Blackwater Drain sub-catchment.

System	Series	Formation	Member	Lithology	Approx. thickness (m)	Hydrogeological type
Quaternary	Holocene	Recent deposits	–	Head, alluvium, river terrace deposits	0–3	Minor aquifer
	Mid-Pleistocene (MIS 12)	Briton's Lane	–	Undifferentiated, glaciofluvial outwash sands and gravels	0–7	Minor aquifer
		Sheringham Cliffs	Bacton Green Till;	Undifferentiated, glacigenic chalk-rich, clays and sands;	0–10;	Aquitard;
			Sands + gravels	Glaciofluvial + glaciolacustrine sands and gravels	0–10 (patchy)	Minor aquifer
		Lowestoft	Lowestoft Till	Undifferentiated, glacigenic, argillaceous matrix with abundant chalk and flint clasts	0–10	Aquitard
		Happisburgh	Sands + gravels; Happisburgh Till	Glaciofluvial + glaciolacustrine sands and gravels; Undifferentiated, sandy grey matrix with flint and chalk clasts	0–5; 0–2	Minor aquifer
	Lower Pleistocene	Wroxham Crag	–	Marine, quartzite and flint-rich sands and gravels	0–5	Minor aquifer
Cretaceous	Upper Cretaceous	White Chalk Subgroup	–	Fine-grained fissured limestone with flints	350	Major aquifer

(>22 m depth). The Chalk, which has a mean storage coefficient of 0.064, transmissivity of 685 $m^2\ d^{-1}$ and effective fracture porosity of 1–2%, serves as the principal aquifer for this region, supplying ~40% of public water supply in East Anglia and up to 90% in some rural areas of north Norfolk (Hiscock et al., 2001; Toynton, 1983). Within the river valley, Holocene-age alluvium and river terrace deposits overlie this sequence (Hiscock et al., 1996). The soils in this western section are predominantly clay loams of the argillic brown earths (Freckenham series) and stagnogley (Beccles series) groups which, together with the argillaceous tills, result in moderately impeded drainage conditions in the western section of the sub-catchment.

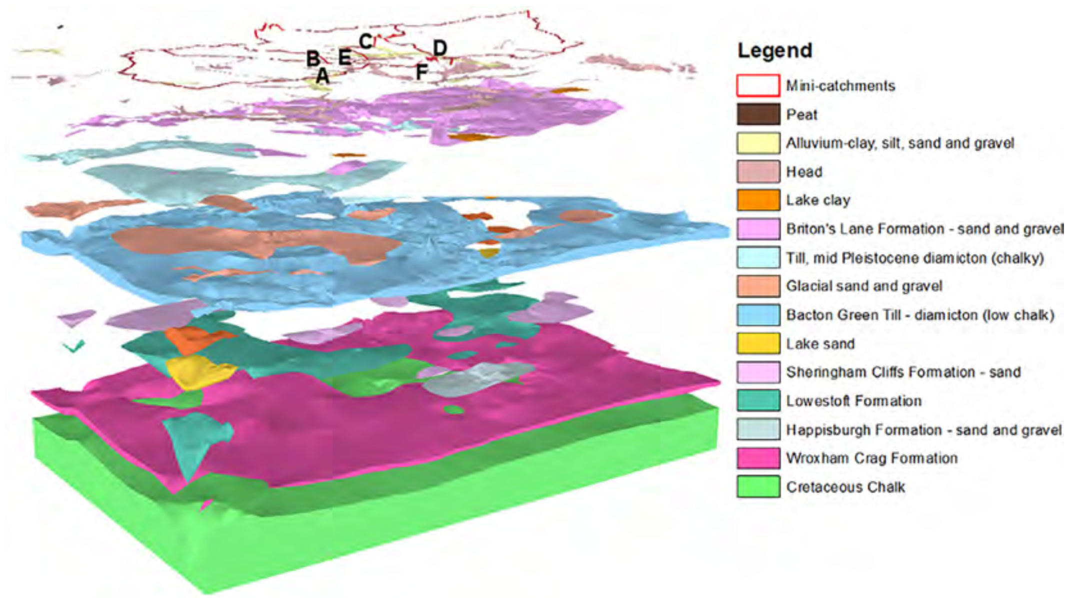

Fig. 2. An expanded 3-D geological model of the Blackwater Drain sub-catchment, Norfolk, UK. Letters refer to the locations of the bankside monitoring stations. BGS © UKRI 2018.

In contrast, the eastern section (mini-catchments C + D) is more freely draining with sheets of glacial outwash sands and gravels of the Mid-Pleistocene Briton's Lane Formation (0.2–7 m depth) overlying the clay-rich Bacton Green Till Member (6–10 m depth) (Table 1; Fig. 2). As with the western section, the Sheringham Cliffs Formation tills contain interdigitated higher permeability, glaciolacustrine sands (8–10 m). Underlying this is a comparatively thin layer of chalky, argillaceous till of the Lowestoft Formation (10–12 m depth), which in turn overlies glaciofluvial, glaciolacustrine and glaciogenic sands, gravels and tills of the Happisburgh Formation (12–17 m depth). Lastly, as in the western section, the Wroxham Crag Formation (17–22 m depth) overlies Cretaceous Chalk (>22 m depth) (Lewis, 2014). The soils in the eastern section are predominately freely draining, sandy loams of the brown sands (Hall series) and brown earth (Sheringham series) groups.

Topographically, the Blackwater Drain sub-catchment is ideally suited to arable farming, being 30–50 m above sea level and having gentle slopes that rarely exceed 0.5° of inclination. As such, land use is dominated by intensive arable cultivation, ranging from 60% on the lower fertility sandy loam soils of mini-catchment C, to 92% on the fertile clay loam soils of mini-catchment A. Winter wheat, winter and spring barley, sugar beet, oilseed rape and spring beans are the dominant crop types, with these being grown in a seven-year rotation across much of the western half of the sub-catchment. The remainder of the land use is comprised of improved grassland (12%), rough grassland (2%), mixed woodland (11%), freshwater (<1%) and rural settlements (1%).

2.3. Experimental design

2.3.1. Meteorological monitoring

Meteorological data at 15-min resolution are generated from two weather stations installed at sites A and D (Fig. 1). These record precipitation via tipping-bucking rain gauges, alongside measurements of temperature, wind speed, humidity and net solar radiation. In addition, five further tipping bucket rain gauges distributed across the sub-catchment also record precipitation at 15-min intervals and these data are compiled into a single master record based on the median of the five records. All weather station data are uploaded to web-based servers in near real-time via wireless telemetry (Meteor Communications Ltd.; Isodaq Technology). Precipitation and temperature records are compared against the UK Met Office 1981–2010 monthly averages for this area based on a weather station at Coltishall, Norfolk (Met Office, 2017).

2.3.2. Riverine monitoring

At the outlet of the six Blackwater Drain mini-catchments (A – F), a bankside monitoring station makes semi-continuous measurements of river water quality parameters at 30-min resolution (Figs. 1 and 3 & S4–S8). All monitoring stations measure temperature, conductivity, pH, turbidity, dissolved oxygen and ammonium via multi-parameter sondes (YSI 6600) mounted in flow-through cells. In addition, two larger monitoring stations at sites E and F measure nitrate-N (Hach Lange Nitratax SC optical probe), total phosphorus (TP) and total reactive phosphorus (TRP) (Hach Lange Sigmatax SC combined with Phosphax Sigma). River stage is measured using pressure transducers housed in stilling wells (Impress IMSL Submersible Level Transmitter) and this is converted into river discharge via stage-discharge rating curves constructed from manual flow gauging with an open-channel EM flow meter (Figs. S2 and S3). Discharge values are presented within 95% confidence intervals generated from the non-linear least-squares regression rating curve (Outram et al., 2014; 2016). As with the meteorological data, all data are uploaded to a web-based server in near real-time via wireless telemetry (Meteor Communications Ltd.).

2.3.3. Groundwater monitoring

Groundwater data are generated from two sets of boreholes which capture the influence of the different geologies between the eastern and western parts of the catchment. The western set of boreholes (Merrisons Lane MLBH1–4; 52°46′54″ N, 1°07′05″ E) are drilled to depths of 50 m (Chalk), 15 m (Lowestoft Formation), 12 m (Sheringham Cliffs Formation – sands and gravels) and 4 m (Sheringham Cliffs Formation – Bacton Green Till Member). The eastern set (Park Farm PFBH1–4; 52°46′25″ N, 1°08′33″ E) are drilled to depths of 48 m (Chalk), 17 m (Happisburgh Formation – sands and gravels), 10 m (Sheringham Cliffs Formation – sands and gravels) and 6 m (Britons Lane Formation). Each borehole is equipped with a pressure transducer (Mini-Diver, Schlumberger)

Fig. 3. Photographs of the River Wensum DTC study sites. Clockwise from top left: mini-catchment A (channel width ~2 m); site F (channel width ~4 m); mini-catchment C (channel width ~2 m); and a telemetered bankside monitoring station at site C.

which records temperature and pressure at 15-min resolution and is manually downloaded every 2–3 months and barometrically compensated by linear interpolation using the barometer located at each borehole set (BARO, Schlumberger).

2.3.4. Hyporheic zone monitoring

To provide an insight into catchment hydrological connectivity, groundwater-surface water interactions within the hyporheic zone were monitored via a network of 15 piezometers installed across five locations along a 1.6 km reach of the Blackwater Drain upstream of monitoring site E (Fig. 1). At each site, three drive-tip, galvanised steel piezometers with a screened tip section containing a filter membrane (Marton Geotechnical Services LTD) were installed to depths of 0.5, 1.0 and 1.5 m beneath the riverbed. At approximately monthly intervals between April 2016 and January 2017, the piezometers were evacuated using a hand siphon pump before being allowed to refill over a period of ~3 h. Following incubation, piezometer water column heights were measured to calculate infiltration rates and estimate the hydraulic conductivity of the subsurface sediments beneath the riverbed. Sediment coring was also undertaken at all piezometer sampling sites at the 0.5 m and 1.0 m depths to facilitate particle size analysis and measurements of bulk density and porosity to determine the nature of the hyporheic zone deposits.

2.3.5. Soil water monitoring

Soil moisture content data are generated at 15-min resolution through 10 capacitance-based soil moisture probes installed across the mini-catchments (Fig. 1), which measure percentage water content and temperature at 10 cm intervals at 10–90 cm depth. Wireless telemetry is used to upload the data in near real-time to a web server for utilisation (ADCON Telemetry). Furthermore, most of the arable land in the western Blackwater catchment on clay-rich soils is extensively under-drained by a dense network of plastic and concrete agricultural field drains installed in a herringbone layout at depths of 1.0–1.5 m during numerous phases of land drainage over past decades. Across mini-catchment A, 143 drains were identified discharging soil water directly into the river at a density of 43 outflows per km. A further 18 drain outflows were identified in mini-catchment B at a density of 16 per km. Grab samples (1 l) of this soil water were collected from a subset of 17 drains in mini-catchment A at approximately weekly intervals and the drain flow rate (L s^{-1}) recorded at the time of sampling. Of these 17 drains, 14 underdrain clay and clay loam soils, while just three underdrain sandy loam soils reflecting the reduced requirement for artificial drainage under higher permeability soils.

2.4. Data analysis

Hydrograph separation was conducted following application of the Boughton two-parameter algorithm approach (Chapman, 1999) to river discharge data in order to derive baseflow discharge (m^3 s^{-1}) for each location. The separation algorithm is as follows:

$$Q_b(i) = \frac{k}{1+C} Q_b(i-240) + \frac{C}{1+C} Q(i)$$

where Q_b is baseflow discharge; k (0.99) and C (0.1) are recession constants; i is the time-step; and 240 represents the 5 day integration period over which baseflow is calculated (i.e. 30 min data × 5 days = 240 half hour measurements). The baseflow index (BFI) was subsequently calculated as the ratio of baseflow discharge to total discharge. Annual rainfall runoff coefficients were calculated as the ratio of total discharge volume across the catchment area (mm) to annual precipitation totals (mm).

A catchment water balance equation was used to calculate evapotranspiration, E_T, as follows:

$$E_T = P - S_R - G_R \pm \Delta S$$

where P is precipitation; S_R is surface water runoff; G_R is groundwater discharge; and ΔS is the change in soil and groundwater storage. Groundwater storage coefficients (S) were calculated as follows:

$$S = \frac{G_R}{\Delta h}$$

where Δh is the amplitude of annual groundwater level change in the shallow borehole (i.e. MLBH4; PFBH4).

3. Results and discussion

3.1. Meteorological parameters

Annually, precipitation totals varied from a low of 632 mm during the 2016/17 hydrological year (October – September), 6% below the 1981–2010 average for this area (674 mm; (Met Office, 2017), to a high of 742 mm during the 2015/16 hydrological year, 10% above average (Table 2). July 2013 (11 mm) and May 2014 (120 mm) were the driest and wettest months, respectively, with these receiving 20% and 253% of the average monthly precipitation (Fig. 4). The highest recorded rainfall intensity was 60 mm h^{-1} observed during a heavy thunderstorm on the 20th June 2015. The longest near continuous period of wet conditions was between March 2012 and March 2013 when 11 of out 13 months recorded above average precipitation. This was immediately followed by the longest period of dry conditions between April and September 2013 when five out of six months recorded below average rainfall. However, the most significant winter recharge period deficit occurred from October 2011 – February 2012 when precipitation totals were 40% below average. In this period, just 33% of total annual rainfall in 2011/12 fell during the important October – March recharge season, compared with an average of 55% during the following five hydrological years.

With respect to temperature, the monitoring period started off relatively cold with temperatures below average for 19 out of 22 months between February 2012 and November 2013, with the mean temperature for this period 1.3 °C below the 1981–2010 average (10.2 °C) (Fig. 5). This was followed by 16 months of near average temperatures before a sustained warm period from April 2015 to June 2017 recorded 23 out of 27 months with above average temperatures. The mean temperature during this warm period was 1.2 °C above the long-term average. December 2015 was the warmest month relative to average with monthly mean temperatures 6.7 °C higher, whilst March 2013 was the coldest month relative to average with temperatures 4.3 °C lower. The highest maximum recorded temperature was 32.8 °C on the 1st July 2015, with the lowest minimum temperature of −16.6 °C recorded on the 16th January 2013.

3.2. Surface hydrology

Total annual river discharge volumes at the outlet of mini-catchment A (5.4 km^2), which drains the lower permeability Bacton Green Till Member deposits, ranged from 5.09×10^5 m^3 a^{-1}

Table 2
Annual hydrological summaries for sites A, C and F for the hydrological years 2011/12 to 2016/17. Numbers in parentheses represent one standard deviation.

Parameter	Type	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Meteorology	Mean total rainfall (mm)	694	638	724	715	742	632
	Mean air temperature (°C)	9.7	8.6	10.0	10.2	12.3	10.2
	Mean net solar radiation (W m^{-2})	40.6	42.2	38.5	41.3	41.5	45.3
Surface	Total discharge volume (m^3 a^{-1})	$6.97 \times 10^{5*}$	9.64×10^5	6.95×10^5	8.46×10^5	7.16×10^5	5.09×10^5
Hydrology	Total discharge volume (mm)	130*	180	129	158	133	95
Site A	Annual rainfall runoff coefficient	0.19	0.28	0.18	0.22	0.18	0.15
5.4 km^2	Baseflow volume (m^3)	3.22×10^5	4.54×10^5	3.99×10^5	4.73×10^5	3.39×10^5	2.64×10^5
	Baseflow volume (mm)	60	85	74	88	63	49
	Baseflow index (BFI)	0.46	0.47	0.57	0.56	0.47	0.52
Surface	Total discharge volume (m^3 a^{-1})	$4.35 \times 10^{5*}$	1.13×10^6	9.35×10^5	7.42×10^5	9.75×10^5	1.12×10^6
Hydrology	Total discharge volume (mm)	124*	321	266	211	278	318
Site C	Annual rainfall runoff coefficient	0.18	0.50	0.37	0.30	0.37	0.50
3.5 km^2	Baseflow volume (m^3)	3.22×10^5	8.35×10^5	7.40×10^5	6.01×10^5	7.60×10^5	9.23×10^5
	Baseflow volume (mm)	92	237	210	171	216	262
	Baseflow index (BFI)	0.74	0.74	0.79	0.81	0.78	0.82
Surface	Total discharge volume (m^3 a^{-1})	2.14×10^6	3.94×10^6	3.02×10^6	2.27×10^6	3.84×10^6	2.55×10^6
Hydrology	Total discharge volume (mm)	109	200	153	115	195	129
Site F	Annual rainfall runoff coefficient	0.16	0.31	0.21	0.16	0.26	0.20
19.7 km^2	Baseflow volume (m^3)	1.39×10^6	2.52×10^6	1.99×10^6	1.55×10^6	2.46×10^6	1.78×10^6
	Baseflow volume (mm)	71	128	101	79	125	90
	Baseflow index (BFI)	0.65	0.64	0.66	0.68	0.64	0.70
Groundwater	Mean level in borehole ML1 (m asl)	39.5 (0.3)	40.4 (0.5)	40.1 (0.3)	39.8 (0.4)	40.3 (0.5)	40.0 (0.4)
Merrisons Lane	Mean level in borehole ML2 (m asl)	39.8 (0.4)	41.3 (0.5)	40.8 (0.4)	40.6 (0.6)	40.7 (0.5)	40.7 (0.6)
	Mean level in borehole ML3 (m asl)	40.3 (0.6)	41.2 (0.5)	40.8 (0.4)	41.0 (0.3)	41.5 (0.3)	40.9 (0.6)
	Mean level in borehole ML4 (m asl)	41.1 (0.9)	41.7 (0.5)	41.5 (0.5)	41.2 (0.7)	41.5 (0.6)	41.1 (0.8)
Groundwater	Mean level in borehole PF1 (m asl)	31.2 (0.2)	31.8 (0.3)	31.6 (0.2)	31.5 (0.2)	31.7 (0.3)	31.6 (0.1)
Park Farm	Mean level in borehole PF2 (m asl)	31.4 (0.2)	32.1 (0.4)	31.8 (0.2)	31.7 (0.2)	32.0 (0.3)	31.7 (0.2)
	Mean level in borehole PF3 (m asl)	32.4 (0.3)	33.2 (0.4)	33.1 (0.2)	32.7 (0.2)	33.0 (0.4)	32.8 (0.1)
	Mean level in borehole PF4 (m asl)	33.4 (0.3)	34.0 (0.3)	33.8 (0.2)	33.6 (0.1)	33.9 (0.3)	33.7 (0.1)

* Missing data from October & November 2011.

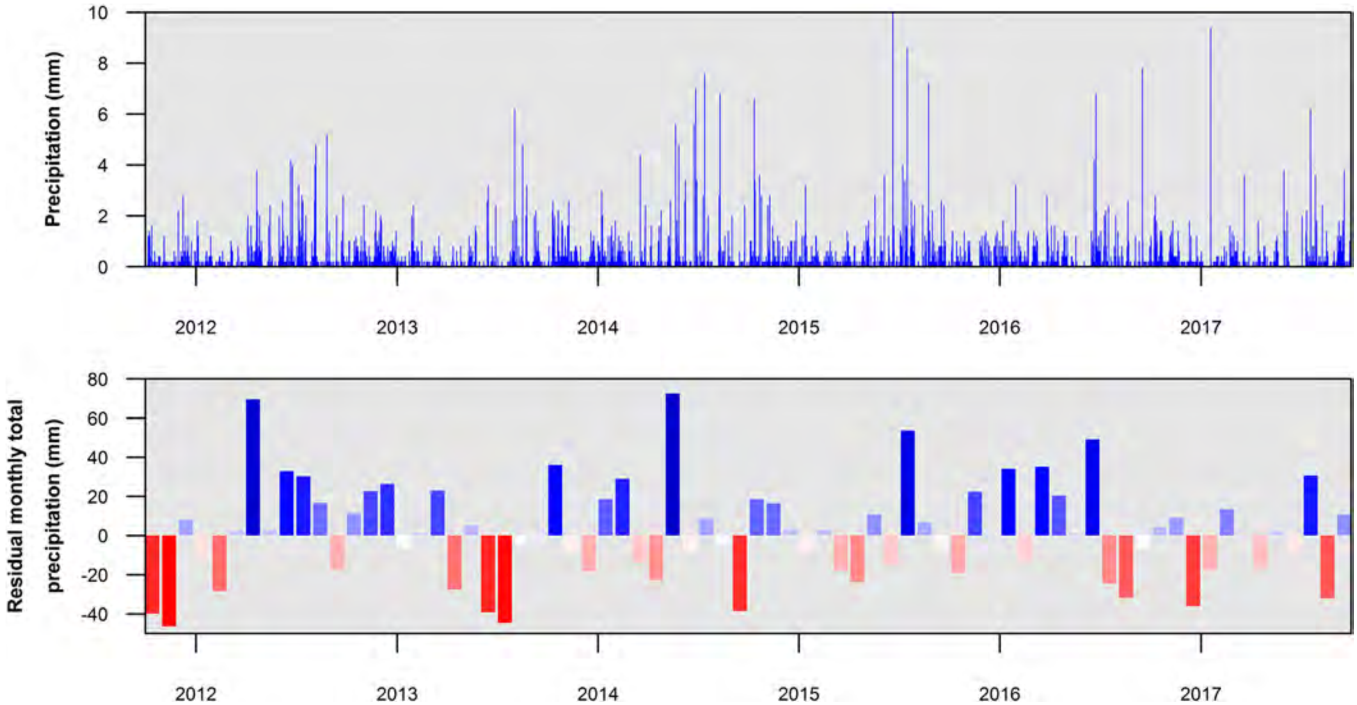

Fig. 4. Precipitation records for weather station A between October 2011 and September 2017 at 15-min resolution (top) and as monthly total residuals from the Met Office 1981–2010 average for Coltishall (bottom).

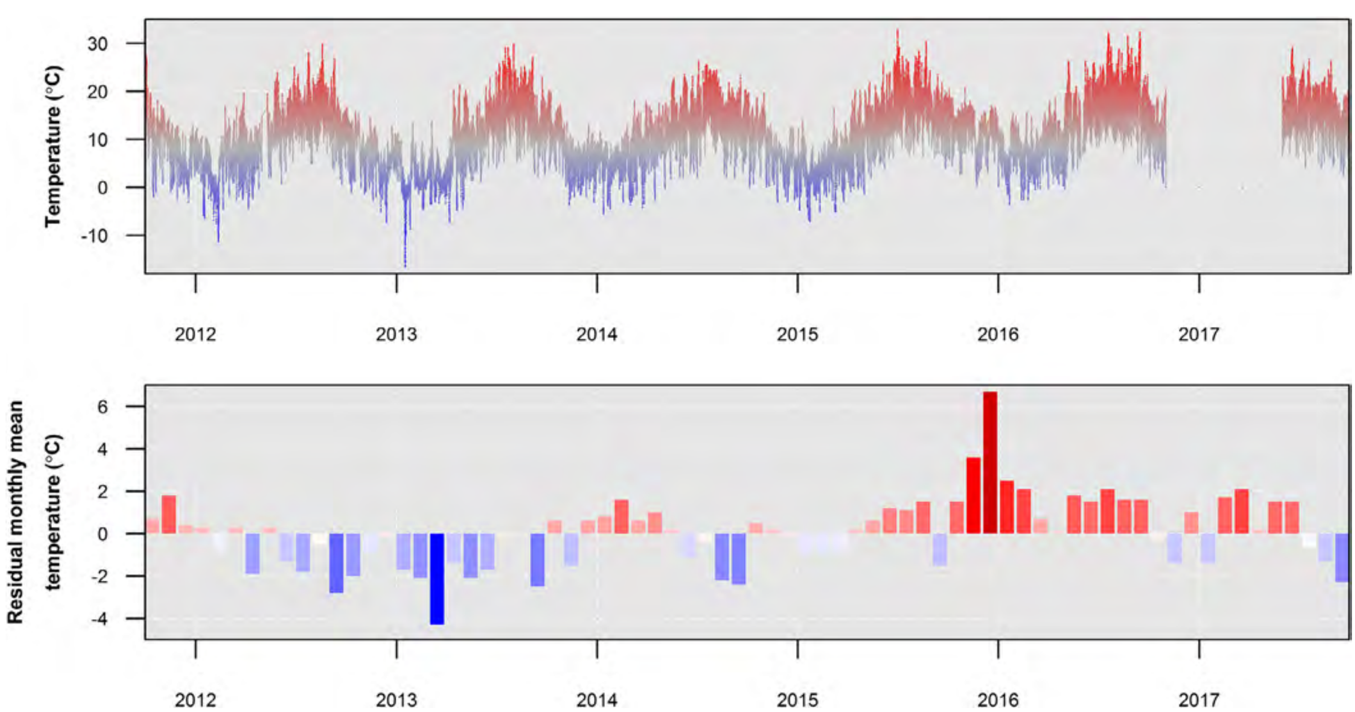

Fig. 5. Air temperature records for weather station A between October 2011 and September 2017 at 15-min resolution (top) and as monthly mean residuals from the Met Office 1981–2010 average for Coltishall (bottom). Missing 15-min resolution temperature data caused by instrument failure; substituted with data from a nearby station for monthly residuals.

(95 mm) in 2016/17 to 9.64×10^5 m^3 a^{-1} (180 mm) in 2012/13, yielding annual rainfall runoff coefficients from 0.15 to 0.28 (Table 2; Fig. 6). Annual baseflow volumes ranged from 2.64×10^5 m^3 a^{-1} (49 mm) in 2016/17 to 4.73×10^5 m^3 a^{-1} (88 mm) in 2014/15, with baseflow indices of 0.46–0.57. The lowest and highest total discharges recorded were 0.0004 m^3 s^{-1} (May 2013) and 0.572 m^3 s^{-1} (June 2016), respectively, meaning the highest peak discharge was 1430 times greater than the minimum flow.

Conversely, at the outlet to mini-catchment C (3.5 km^2), which drains the higher permeability sands and gravels of the Briton's Lane Formation, mean annual river discharge was 20% higher than

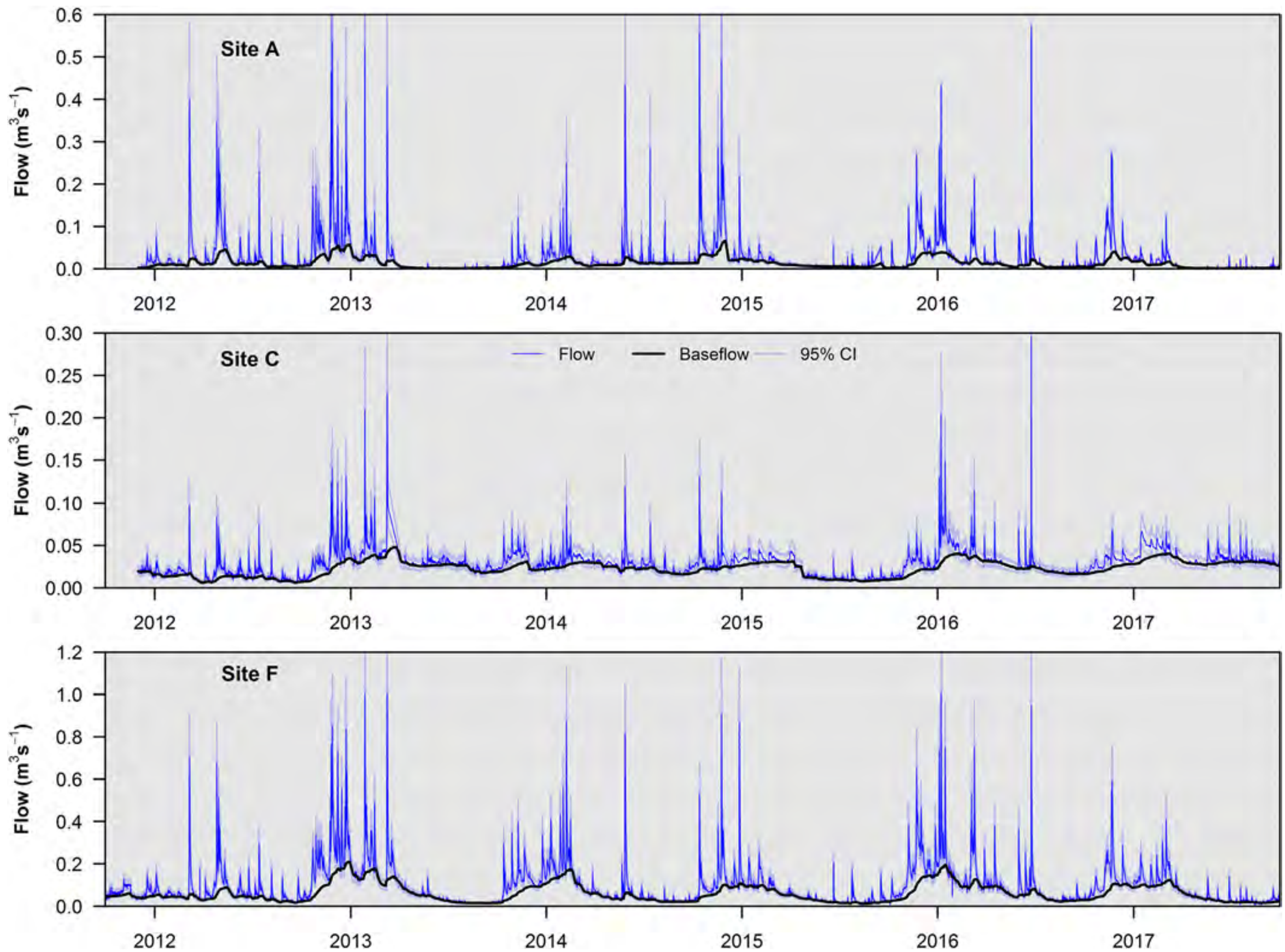

Fig. 6. River flow records (30-min resolution) derived from stage-discharge relationships at three sites in the Blackwater Drain sub-catchment between October 2011 and September 2017. Confidence intervals reflect uncertainty in the rating curves.

recorded at site A, this despite the catchment area being 35% smaller. Total discharge volumes ranged from 7.42×10^5 m^3 a^{-1} (211 mm) in 2014/15 (excluding 2011/12 due to missing data) to 1.13×10^6 m^3 a^{-1} (321 mm) in 2012/13, with annual rainfall runoff coefficients of 0.30–0.50. The lowest and highest total discharges recorded were 0.0049 m^3 s^{-1} (September 2012) and 0.296 m^3 s^{-1} (June 2016), respectively, revealing the maximum peak discharge was just 60 times greater than the minimum recorded flow. This reduced variability in flow range compared to site A reflects a fluvial system with greater baseflow input at site C, with baseflow volumes ranging from 6.01×10^5 m^3 a^{-1} (171 mm) to 9.23×10^5 m^3 a^{-1} (262 mm) and yielding much higher baseflow indices of 0.74–0.82. The permeable sandy glacial deposits within mini-catchment C result in lower surface water runoff during winter due to greater direct recharge to groundwater, and higher flows during the summer due to greater baseflow input to total runoff. This contrasts with mini-catchment A, where river flows are higher during winter due to increased surface water runoff from the less permeable argillaceous glacial deposits, and lower during the summer due to a lower baseflow input to total runoff.

At the Blackwater Drain sub-catchment outlet (site F; 19.7 km^2), total annual river discharge ranged from a low of 2.14×10^6 m^3 a^{-1} in 2011/12 to a high of 3.94×10^6 m^3 a^{-1} in the following hydrological year 2012/13. This equates to a total discharge depth across the whole sub-catchment of 109–200 mm, respectively, and annual rainfall runoff coefficients of 0.16–0.31. The low flows in 2011/12 can be attributed to low precipitation totals during the winter recharge period (Fig. 7) which resulted in total discharge volumes during October – March accounting for just 48% of the annual flow compared to an average of 78% during the following five years. The maximum recorded total discharge (1.009 m^3 s^{-1}) was 136 times greater than the lowest recorded discharge (0.0074 m^3 s^{-1}). Baseflow volumes similarly varied from a low of 1.39×10^6 m^3 a^{-1} (71 mm) in 2011/12 to 2.52×10^6 m^3 a^{-1} (128 mm) in 2012/13, with baseflow indices of 0.64–0.70. These BFI values are intermediate to those observed at sites A and C and reflect the combination of both low permeability Bacton Green Till Member deposits (53% spatial coverage) and high permeability Briton's Lane Formation deposits (47% spatial coverage) across the catchment.

3.3. Groundwater hydrology

Mean annual groundwater levels recorded at both the Merrisons Lane and Park Farm sites (Fig. 8) were lowest at all depths (4–50 m) during 2011/12 and highest during the following hydrological year (2012/13). Additionally, groundwater levels at both sites were always 2.6–7.2 m above the river water level and thus the Blackwater Drain was gaining water from either upwelling through the riverbed or through groundwater discharging into the river at field drain outflows (e.g. Brunner et al., 2011). However, the degree of temporal variability observed in groundwater levels

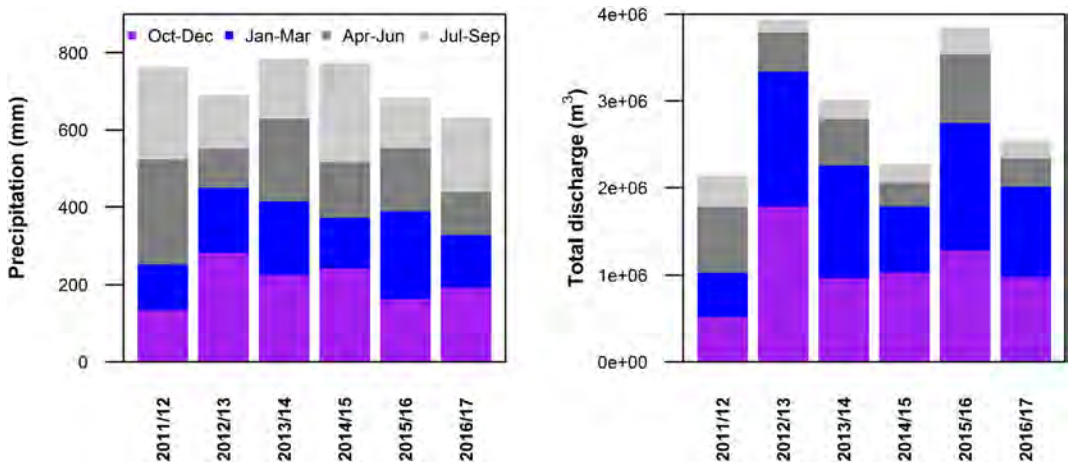

Fig. 7. Stacked bar charts of quarterly precipitation (left) and total discharge at site F (right) for hydrological years 2011/12 to 2016/17.

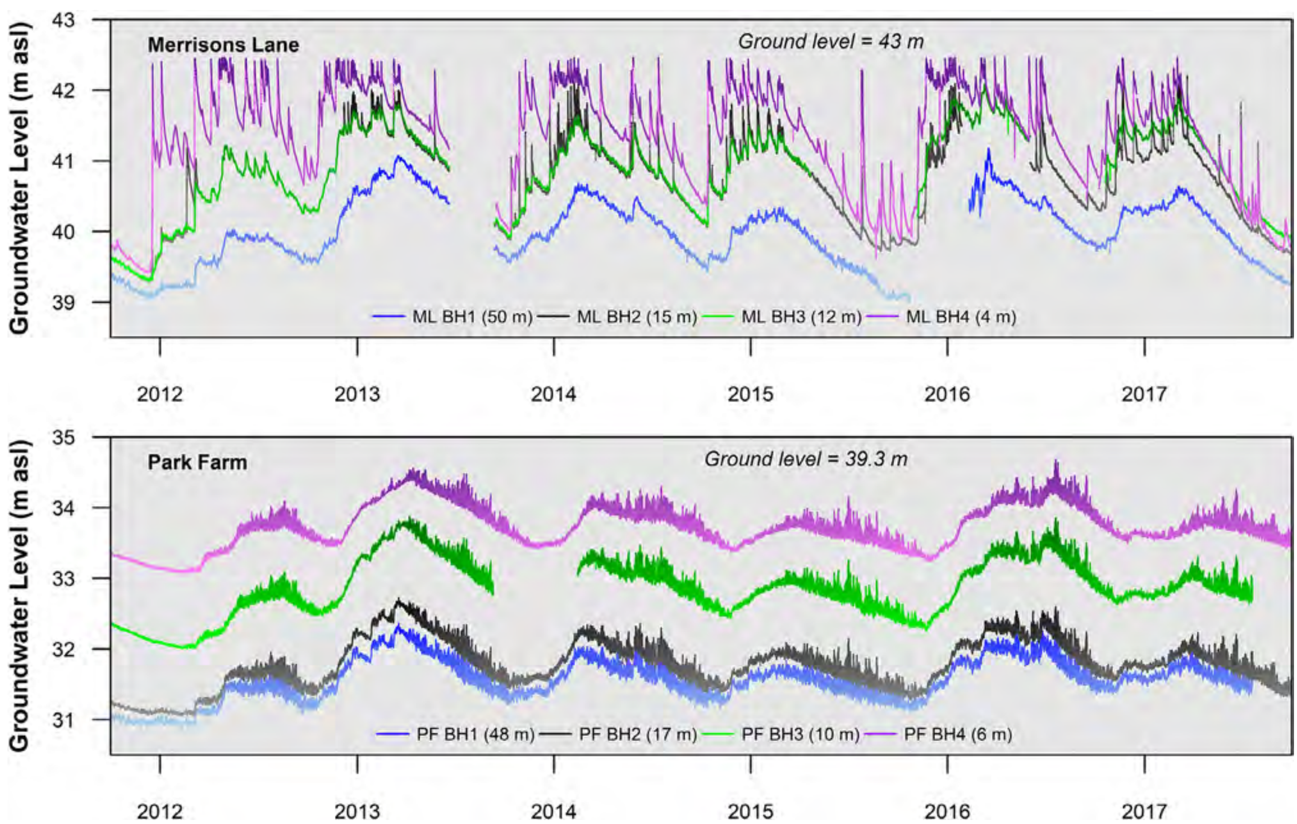

Fig. 8. Groundwater levels recorded (15-min resolution) in boreholes at two locations in the Blackwater Drain sub-catchment between October 2011 and September 2017. Superficial Quaternary geology is dominantly clay-rich glacial till at Merrisons Lane and glaciofluvial/glaciolacustrine sands and gravels at Park Farm.

differed considerably depending upon the superficial Quaternary geology. Beneath the argillaceous, lower permeability glacial deposits at Merrisons Lane there was considerable temporal variability at monthly to annual timescales, with the 50 m depth Chalk borehole recording a 2.20 m range in hydraulic head between the lowest (38.99 m a.s.l.) and highest (41.19 m a.s.l.) values. Similarly, in the shallow (4 m) Bacton Green Till borehole at this site a 3.06 m range in hydraulic head was recorded between the lowest (39.41 m a.s.l.) and highest levels (42.47 m a.s.l.). These values contrast strongly with groundwater levels recorded under the higher permeability sandy deposits at the Park Farm boreholes where a more muted response was observed. At Park Farm, a 1.49 m range in hydraulic head was observed between the lowest (30.88 m a.s.l.) and highest (32.37 m a.s.l.) levels in the 48 m depth Chalk borehole, whilst a 1.60 m head range was recorded in the 6 m depth Briton's Lane Formation borehole between the lowest (33.08 m a.s.l.) and highest (34.68 m a.s.l.) recorded levels.

These observations reflect the lower storage coefficient of the argillaceous Bacton Green Till Member and Lowestoft Formation at Merrisons Lane (see Section 3.6) which make groundwater levels here more responsive to antecedent conditions (i.e. wetting and drying) at monthly to annual timescales as there is a smaller volume of effective water stored within these superficial deposits (Allen et al., 1997; Jones et al., 2000). Conversely, the higher

Table 3
Water strikes recorded during the drilling of the Merrisons Lane (ML) and Park Farm (PF) boreholes in February 2011. SCF-SG = Sheringham Cliffs Formation – sands + gravels; SCF-BGT = Sheringham Cliffs Formation – Bacton Green Till Member; BLF = Briton's Lane Formation; WCF = Wroxham Crag Formation; LF = Lowestoft Formation; HF = Happisburgh Formation.

Strike	Parameter	ML BH1	ML BH2	ML BH3	PF BH1	PF BH2	PF BH3	PF BH4
1	Depth (m)	5.1	4.5	4.8	4.8	5.1	4.8	4.7
	Formation	SCF-SG	SCF-BGT	SCF-SG	BLF	BLF	BLF	BLF
	Inflow rate	Slow	Very slow	Moderate	Very slow	Very slow	Slow	Slow
2	Depth (m)	16.3	14.7		11.6			
	Formation	WCF	LF		HF			
	Inflow rate	Fast	slow		Moderate			
3	Depth (m)	21.5			17.2			
	Formation	Chalk			Chalk			
	Inflow rate	–			Moderate			

storage coefficient of the sandy Briton's Lane, Sheringham Cliffs and Happisburgh Formations result in greater effective water storage and thereby lower sensitivity to antecedent conditions at these medium timescales. At hourly-to-daily timescales, however, groundwater levels at Park Farm respond much faster to precipitation events due to the higher permeability of the sands, thus resulting in greater high-frequency variability within the Park Farm record.

Water strike depths recorded during the drilling of the boreholes in February 2011 revealed the top of the saturated aquifer formations at this time (Table 3). At Merrisons Lane, water strikes were recorded at ~5 m depth in both the Sheringham Cliffs Formation glacial sands and Bacton Green Till Member, where inflow rates were slow–moderate and very slow, respectively. Deeper water strikes occurred at 14.7 m in the Lowestoft Formation (slow inflow rate), 16.3 m in the Wroxham Crag Formation (fast inflow rate) and at 21.5 m in the regional Chalk aquifer. At the Park Farm boreholes, water strikes were recorded at ~ 5 m in the Briton's Lane Formation (slow – very slow inflow rates), at 11.6 m in the Happisburgh Formation (moderate inflow rate) and at 17.2 m in the Chalk (moderate inflow rate).

3.4. Hyporheic zone

The physical properties of the hyporheic zone sediments recorded at the five piezometer locations are summarised in Table 4. All locations were in the western section of the Blackwater Drain associated with the lower permeability glacial deposits and the majority of sites at 0.5 and 1.0 m depth were comprised of either sandy clay loam or clay sediments. Bulk densities across the sites ranged from 0.19 to 2.36 g cm^{-3} and porosities from 2.6 to 34.8%, whilst hydraulic conductivities ranged from a low of 5.2×10^{-6} m s^{-1} to a high of 6.2×10^{-3} m s^{-1}, but there was no evidence of seasonality during the April 2016 to January 2017 monitoring period. Piezometer recharge rate also remained fairly consistent with depth across the 0.5–1.5 m profile, although mean conductivities were significantly higher at site 5 lower down the catchment, indicating higher rates of groundwater movement at this site. Piezometer recharge rates are usually related to the antecedent conditions within the catchment, thus explaining the greater than two orders of magnitude range of values recorded at individual sites and depths. Nevertheless, most of the values recorded here fall within the range expected (10^{-4}–10^{-5} m s^{-1}) for sediments with clay contents of 9–58%, based on a previous study by Shevnin et al. (2006) who modelled hydraulic conductivity using resistivity data for sediments with increasing clay content. Some of the lower hydraulic conductivities (i.e. 10^{-6} m s^{-1}) could possibly be caused by smearing of the piezometer tip during installation and may not be an accurate reflection of groundwater-surface water interactions.

3.5. Soil water

Soil moisture content recorded in the sandy loam soils and sandy deposits developed on the Briton's Lane Formation at site F display a pronounced seasonal cycle of spring/summer drying and autumn/winter wetting throughout the 90 cm depth profile (Fig. 9a). Mean soil moisture content for the entire monitoring period steadily increased with depth from 49.0% at 10 cm depth to 56.6% at 90 cm depth, with the shallower depths exhibiting greater seasonal variability. At 10 cm depth, mean monthly soil moisture contents ranged from a low of 42.9% in August when evapotranspiration rates are high, to a maximum of 54.3% in December following autumn rewetting. This compares with mean monthly soil moisture contents at 90 cm depth of 55.9% in August and 57.7% in December, reflecting reduced evapotranspiration losses during the summer at deeper depths.

During storm events, distinct differences arise in the rewetting profile of clay loam (Fig. 9b) and sandy loam (Fig. 9c) soils, which reflect the impact of soil structure upon subsurface flow paths. The example presented here for the 7–13th March 2013 following 53 mm of rainfall, reveals that on the freely draining, light, sandy loam soils in the eastern Blackwater Drain sub-catchment, rainwater readily infiltrates down through the top 90 cm, with soil moisture content increasing from 36.8 to 41.7% at 10 cm depth and from 43.5 to 49.5% at 90 cm depth. In contrast, on the heavier clay-loam soils in the western part of the catchment, infiltration is severely impeded below 20 cm depth by the clay-rich Bacton Green Till Member deposits, such that there is no discernible increase in soil moisture content below this depth. It is also noted that the top 20 cm in clay loam soil exhibits a substantially larger response (~23% increase in moisture content) to the rainfall event than the sandy loam soil (~5% increase) indicating an increased risk of soil saturation and surface runoff generation. Similarly, the moisture peak at 20 cm occurs ~10 h earlier on the sandy loam soil reflecting a faster infiltration rate and thus a reduced risk of initiating surface flows.

For the subsurface agricultural field drains (Fig. 10), soil water discharges into the Blackwater Drain varied depending upon season and antecedent moisture conditions. Most drains dried up completely between April and September as groundwater levels across the catchment fell below the depth of the drains; this depth being below ~41.5 m a.s.l. at the Merrisons Lane boreholes. The highest drain discharge (2.96 l s^{-1}) was recorded under clay soil in November 2015 following heavy rainfall (32 mm) over the preceding 7 days. Over the whole monitoring period, mean discharges were significantly ($p < 0.05$) higher under clay/clay loam soils (0.22 l s^{-1}; $\sigma = 0.33$ l s^{-1}) than sandy loam soils (0.07 l s^{-1}; $\sigma = 0.06$ l s^{-1}), revealing increased potential for the direct quickflow transport of pollutants into the river through this preferential pathway. The mean drain catchment area was also significantly ($p < 0.05$) higher under clay/clay loam soils (2.0 ha; $\sigma = 1.9$ ha)

Table 4
Physical properties of the hyporheic zone sediments recorded at the five piezometer locations. Hydraulic conductivity presented as the mean with the range in parentheses.

Site	Depth (m)	Porosity (%)	Bulk Density (g cm^{-3})	Sand (%)	Silt (%)	Clay (%)	Sediment Type	Hydraulic Conductivity (m s^{-1})
1	0.5	2.6	2.36	30	19	51	Clay	1.1×10^{-4} (8.6×10^{-6} – 4.2×10^{-4})
1	1.0	22.4	1.00	17	26	57	Clay	2.2×10^{-4} (8.1×10^{-5} – 6.9×10^{-4})
1	1.5	–	–	–	–	–	–	3.6×10^{-4} (2.0×10^{-5} – 9.5×10^{-4})
2	0.5	12.6	0.19	85	6	9	Loamy sand	2.0×10^{-4} (6.1×10^{-5} – 9.5×10^{-4})
2	1.0	17.5	1.20	36	21	43	Clay	8.7×10^{-5} (1.8×10^{-5} – 2.5×10^{-4})
2	1.5	–	–	–	–	–	–	7.3×10^{-4} (2.0×10^{-4} – 2.3×10^{-3})
3	0.5	17.8	1.10	61	13	26	Sandy clay loam	5.5×10^{-5} (3.0×10^{-5} – 8.0×10^{-5})
3	1.0	16.7	1.44	35	18	47	Clay	6.5×10^{-5} (1.9×10^{-5} – 2.4×10^{-4})
3	1.5	–	–	–	–	–	–	7.4×10^{-5} (2.4×10^{-5} – 1.9×10^{-4})
4	0.5	22.3	1.15	46	20	34	Sandy clay loam	3.9×10^{-5} (1.3×10^{-5} – 1.2×10^{-4})
4	1.0	19.9	0.94	62	16	22	Sandy clay loam	2.8×10^{-5} (2.0×10^{-5} – 9.5×10^{-5})
4	1.5	–	–	–	–	–	–	1.4×10^{-5} (5.2×10^{-6} – 2.7×10^{-5})
5	0.5	34.8	0.86	50	19	31	Sandy clay loam	1.7×10^{-3} (6.7×10^{-4} – 2.1×10^{-3})
5	1.0	24.6	1.19	26	16	58	Clay	1.7×10^{-3} (1.2×10^{-3} – 2.2×10^{-3})
5	1.5	–	–	–	–	–	–	4.0×10^{-3} (3.2×10^{-3} – 6.2×10^{-3})

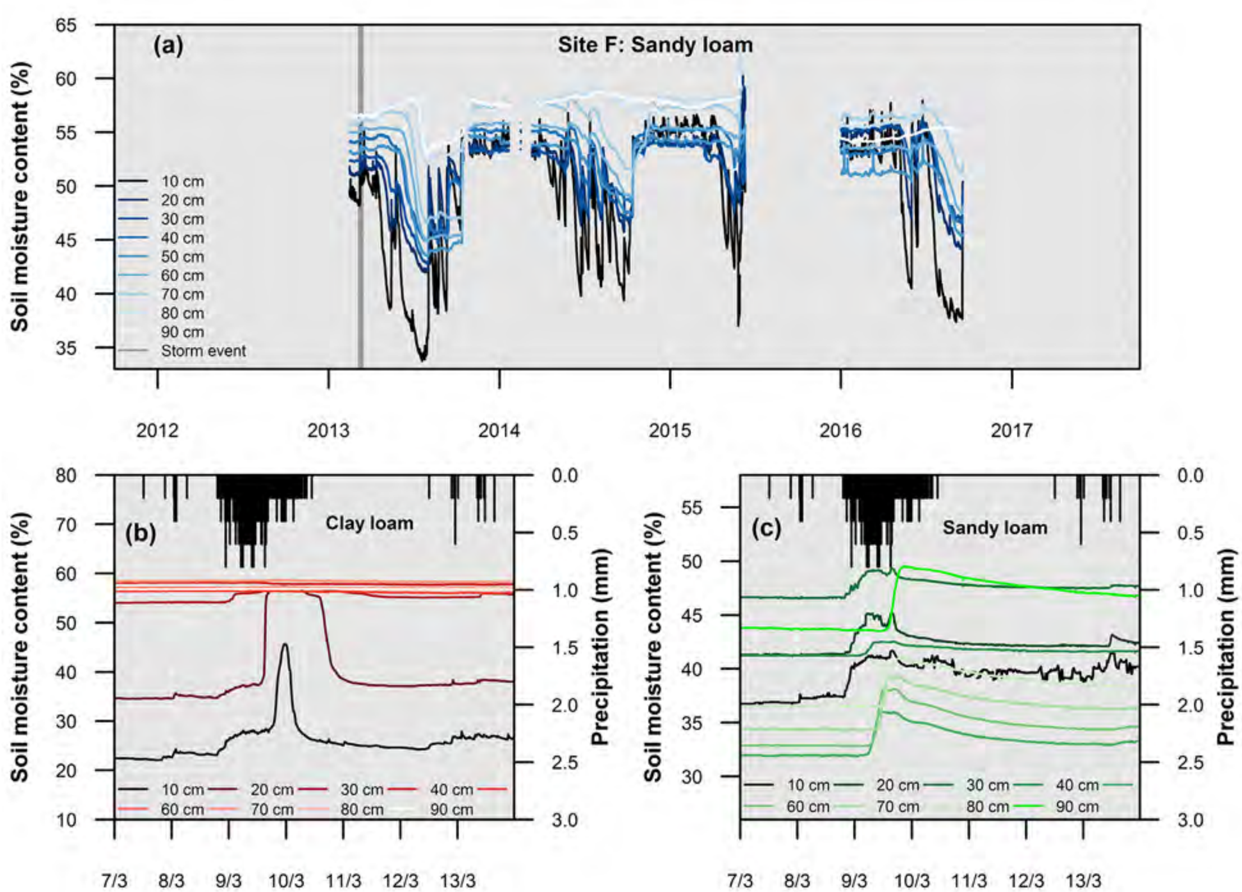

Fig. 9. Soil moisture content recorded at 10–90 cm depth in: (a) site F sandy loam soils between 2013 and 2016; and during a storm event (53 mm precipitation) in March 2013 on (b) clay loam soils in mini-catchment A and (c) sandy loam soils in mini-catchment D.

than sandy loam soils (0.4 ha; σ = 0.4 ha), which intuitively suggests that this difference was responsible for the greater discharge observed under heavier textured soils. However, drain discharge and drain catchment area were weakly and insignificantly correlated ($R^2 = 0.07$; $p = 0.40$) implying causality is unlikely. Instead, it is probable that the lower drain flows observed under sandy soils are a result of infiltrating precipitation bypassing the drain network as it percolates freely down to the shallow groundwater. Under clay soils, infiltrating precipitation is impeded from reaching the shallow groundwater table, meaning more water remains in the surface soils where it can enter into field drainage and be exported via quickflow into the river network bypassing the deeper geology (Deasy et al., 2009; King et al., 2015; Kronvang et al., 2007).

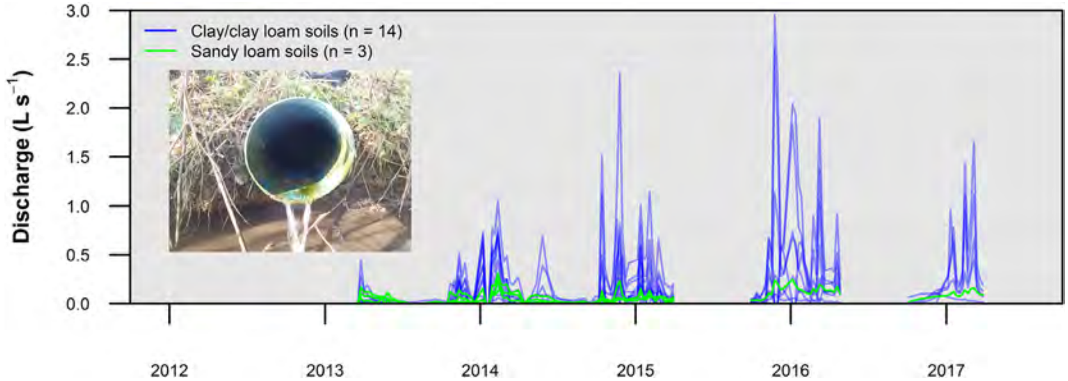

Fig. 10. Soil water discharge rates from subsurface agricultural field drains recorded under contrasting soil types during 2013–2017.

3.6. Storm event responses

Fluvial hydrographs displaying typical storm event responses at sites A, C and F are shown in Fig. 11 for example summer (June 2016) and winter (November 2012) events. During the summer storm event on the 23 June 2016, 29.6 mm of rainfall fell in just 4 h with a total of 48 mm of rainfall falling over the whole seven day period shown (23–29 June). In response, river discharge increased 30-fold at site A, 12-fold at site C and 10-fold at site F between pre-event conditions and peak flow conditions. The larger, flashier response at site A reflects the greater proportion of surface runoff in mini-catchment A (lower BFI) compared to mini-catchment C (higher BFI), where a more permeable superficial geology allows for greater infiltration and groundwater recharge. Furthermore, the time between precipitation onset and peak discharge was 6 h 45 min at site A, 3 h 15 min at site C and 5 h 15 min at site F. This slower response time in mini-catchment A reflects the lower permeability of the clay-rich soils and glacial deposits, which correspondingly slows the flow of event water (i.e. soil through-flow) into the river.

During the winter storm event in late-November 2012, three main bands of precipitation delivered a total of 48 mm of rainfall over 7 days (24–30 November) resulting in three distinct peaks in the hydrograph at sites A, F and, to a lesser extent, site C. As with the summer event, site A displayed the largest, flashy response with discharge increasing 5-fold between pre-event conditions and peak discharge of the first event, compared to 3-fold increases observed at sites C and F. Unlike the summer event, however, the response times between precipitation onset and peak discharge were very similar at sites A and C for the first (~18 h), second (~7h) and third (~12 h) winter events. This comparatively faster response time at site A, relative to site C, than observed during the summer event can be explained by the activation of the subsurface field drains in mini-catchment A, which by late-November are flowing continuously due to the rise in groundwater levels and so providing a preferential pathway for the transport of event water into the river.

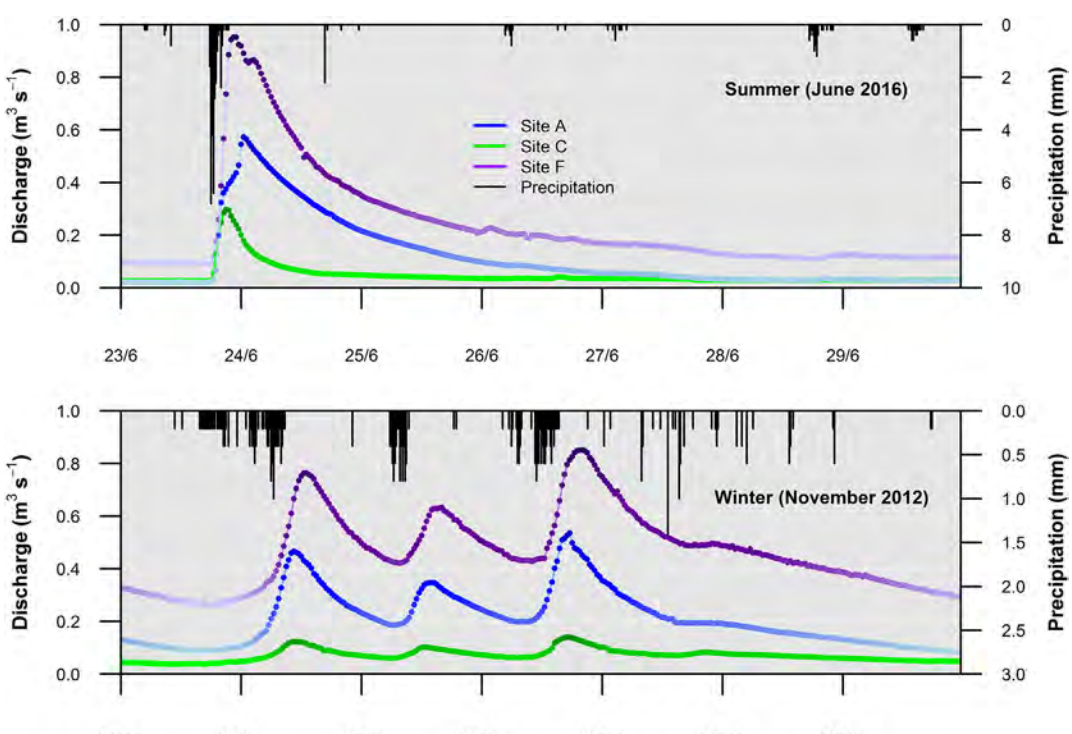

Fig. 11. Fluvial hydrographs displaying typical storm event responses during example summer (June 2016) and winter (November 2012) periods at sites A, C and F.

3.7. Catchment water balance

Annual evapotranspiration (E_T) estimates for mini-catchments A, C and F were derived using a simple catchment water balance approach (Table 5). The surface runoff (S_R) and groundwater discharge (G_R) components of total river flow (Q), calculated using hydrograph separation, were subtracted from annual precipitation totals to yield evapotranspiration estimates over the mini-catchment areas.

Mini-catchment A experienced the highest mean annual evapotranspiration rate (548 mm), accounting for ~ 80% of total precipitation and yielding a mean annual effective precipitation total of 139 mm. This compares with mini-catchment C which had a significantly ($p < 0.05$) lower mean annual evapotranspiration rate of 408 mm, accounting for 59% of total precipitation and yielding a mean annual effective precipitation total of 279 mm. This difference can be explained by the lower permeability of the argillaceous deposits underlying mini-catchment A, which reduce infiltration rates and leave more water available near the soil surface for evapotranspiration. In mini-catchment C, the high permeability sandy Briton's Lane Formation deposits readily allow infiltration down to the shallow groundwater, which then supplies greater groundwater discharge in support of river baseflow. A direct consequence of the lower effective precipitation totals in mini-catchment A is that this area is more susceptible to drought and increases the risk of the river in this part of the catchment drying up completely during the summer months. Evidence for this can be seen in Fig. 6, where the minimum summer flow recorded at site A (0.0004 $m^3 s^{-1}$) was an order of magnitude lower than observed at site C (0.0049 $m^3 s^{-1}$), despite the area of mini-catchment A being 54% larger than mini-catchment C.

Groundwater storage coefficients were also estimated using the borehole hydrograph method (Hiscock and Bense, 2014). This was achieved by dividing the annual groundwater discharge (G_R) found by stream hydrograph separation by the change in amplitude of groundwater (Δh) in the shallowest borehole (Table 5). This yielded mean groundwater storage coefficients of 0.027 for the Bacton Green Till Member and 0.216 for the Briton's Lane Formation, values comparable with those reported previously for Quaternary glaciogenic deposits (Morris and Johnson, 1967).

3.8. Conceptual models

Interpreting these high-resolution monitoring data, it is possible to construct conceptual models of hydrological processes across areas of contrasting hydrogeological conditions (e.g. Rozemeijer and Broers, 2007) within the Blackwater Drain sub-catchment (Figs. 12 and 13).

In the western section, the low permeability, argillaceous superficial deposits of the Sheringham Cliffs Formation Bacton Green Till Member and Lowestoft Formation restrict rainwater infiltration and inhibit recharge to the underlying confined Wroxham Crag and Cretaceous Chalk aquifers. This reduced downward movement of water leads to increased risk of soil saturation – as detected by soil moisture probe monitoring down to 90 cm depth – and consequent activation of surface runoff pathways during heavy precipitation events as infiltration capacity is exceeded – as determined by river discharge monitoring with pressure transducers. This produces a river with a comparatively low groundwater/surface water ratio (BFI = 0.50) – as determined by hydrograph separation – where river levels vary widely from low in summer to high in winter. Agricultural field drains artificially lower the water table in the Bacton Green Till Member during the winter months to prevent waterlogging in the root zone, providing a quickflow pathway for the export of water into the surface watercourse – as determined by measuring field drain discharges and borehole monitoring of groundwater levels. The Holocene alluvium and river terrace deposits are usually in hydraulic continuity with the associated river – as determined by piezometer monitoring of hydraulic conductivity within the hyporheic zone down to 1.5 m depth. Within the Bacton Green Till, frequent bands of oxidised iron reveal evidence of water flow through lateral and vertical fissures, as inferred by Hiscock and Tabatabai Najafi (2011), within these otherwise low permeability deposits (Table S1). At greater depth the glaciolacustrine and glaciofluvial sands of the Sheringham Cliffs Formation provide a zone of increased permeability and can become saturated forming a shallow aquifer, as determined through borehole monitoring of groundwater levels and water strike depths.

In contrast, in the eastern section the high permeability sands of the Briton's Lane Formation allow for rapid infiltration of precipitation (derived from 15-min resolution rain gauge measurements)

Table 5
Annual catchment water balance for mini-catchments A, C and F in the Blackwater Drain sub-catchment. *P* = precipitation; S_R = surface water runoff; G_R = groundwater discharge; E_T = evapotranspiration; Δh = amplitude of groundwater level change; *S* = groundwater storage coefficient.

Site	Year	P (mm)	Stream hydrograph separation			Borehole hydrograph storage estimation	
			S_R (mm)	G_R (mm)	E_T (mm)	Δh BH4 (mm)	S
A	2011/12	694	70*	60*	564*	2530	–
	2012/13	638	95	85	458	2705*	0.031
	2013/14	724	55	74	595	2290	0.032
	2014/15	715	70	88	557	3075	0.029
	2015/16	724	70	63	591	2156	0.032
	2016/17	632	46	49	537	3256	0.015
C	2011/12	694	32*	92*	570*	879	–
	2012/13	638	84	237	317	1091	0.217
	2013/14	724	56	210	458	888	0.236
	2014/15	715	40	171	504	906	0.189
	2015/16	724	62	216	446	1236	0.175
	2016/17	632	56	262	314	989	0.265
F	2011/12	694	38	71	585	1705	0.042
	2012/13	638	72	128	438	1898*	0.067
	2013/14	724	52	101	571	1589	0.064
	2014/15	715	36	79	600	1991	0.040
	2015/16	724	70	125	529	1696	0.074
	2016/17	632	39	90	503	2123	0.042

* Calculation affected by missing data.

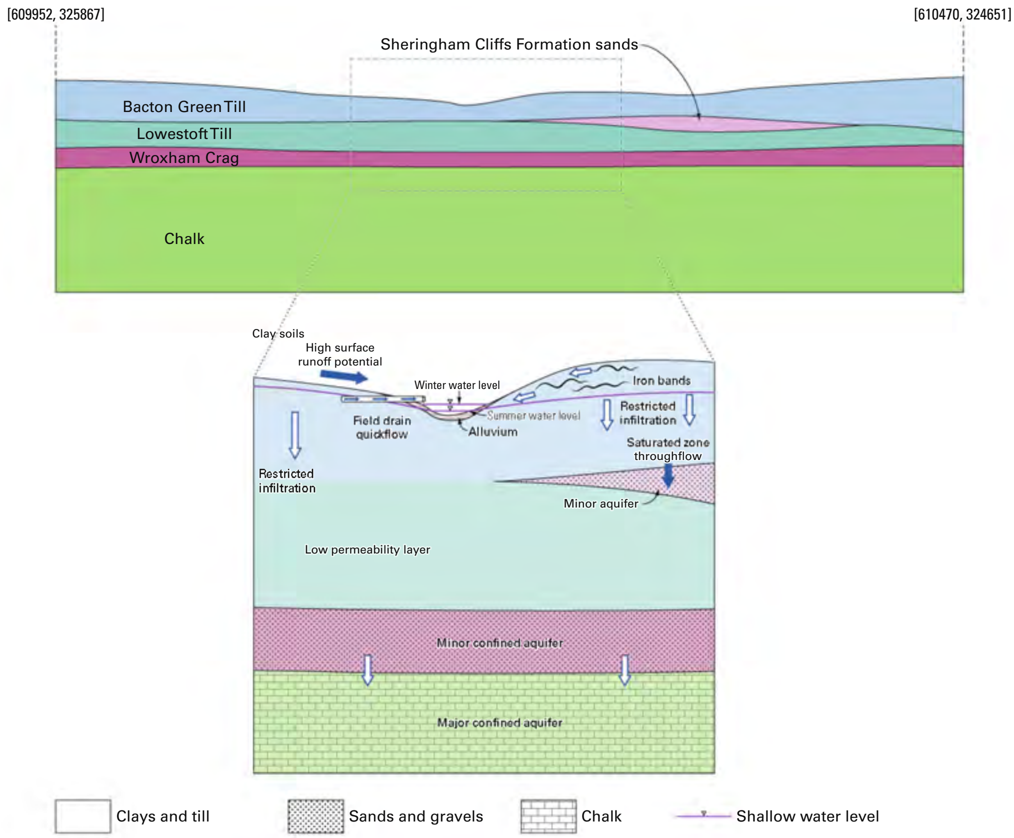

Fig. 12a. Simplified 2-D conceptual model of hydrogeological processes in the western section of the Blackwater Drain sub-catchment. Blue arrows represent the dominant water flow paths; white arrows the minor flow pathways. BGS © UKRI 2018. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

away from the soil surface. This reduces the potential for soil saturation – as determined from soil moisture probes – and the initiation of surface runoff as determined by monitoring of river discharge storm event response. This negates the requirement for artificial field drainage – reducing the availability of artificial quickflow pathways in this part of the catchment – and produces a river with a comparatively high groundwater/surface water ratio (BFI = 0.78) and stable year round water levels – as determined by pressure transducer river stage monitoring. Saturation of the Briton's Lane sands forms a shallow aquifer that rests above lower permeability deposits of the Sheringham Cliffs Formation glaciolacustrine clay – as determined from borehole groundwater level monitoring. As presented by Hiscock et al. (2011), interdigitation of the glacial tills with glaciofluvial and glaciolacustrine sands provides a zone of saturated throughflow that sits above the confining layer of the low-permeability Lowestoft Formation. The Lowestoft Till Member inhibits recharge to the underlying Happisburgh Formation and Cretaceous Chalk aquifers, which are largely in hydraulic continuity.

In both the eastern and western sections of the Blackwater Drain catchment, the channel morphology (e.g. sinuosity, gradient, connectivity, pools, riffles) and within-channel processes (e.g. density of emergent and submergent macrophyte growth), will impact upon the hydrological functioning of these river systems (e.g. storm event response times), although these are not currently monitored as part of the Wensum DTC research project.

3.9. Implications for agricultural management practices

The hydrogeological characteristics of this region have a number of important implications for land management practices, particularly in relation to the implementation of on-farm mitigation measures to reduce agricultural water pollution. Some example measures are considered below:

(i) **Winter cover crops** – evidence from the high-resolution soil moisture probe data demonstrates that the sandy soils and sandy deposits of the Briton's Lane Formation in the east of the catchment are highly vulnerable to nutrient (principally nitrate) and pesticide leaching into the shallow groundwater. The use of cover crops to provide overwinter soil cover has been shown to significantly reduce nutrient leaching losses by taking up both excess fertiliser and excess soil moisture (Dabney et al., 2001; Stevens and Quinton, 2009) and would therefore be recommended as an on-farm pollution mitigation measure in this area. The soil moisture probe data also reveal that the western section of the catchment under clay-rich soils suffers from restricted infiltration below 20 cm depth and is therefore at increased risk of soil saturation and the generation of erosive surface runoff. The use of deep-rooting cover crop varieties, such as oilseed radish (Cooper et al., 2017), would be recommended for these conditions as they can help to break up compacted soil and create larger pores and fissures which increase permeability and infiltration rates and help to transport water away from the soil surface.

(ii) **Reduced tillage** – the short response times observed in river flow, soil moisture content and groundwater levels to precipitation events in the sandy mini-catchment C reflect the limited capability of these soils and superficial deposits to retain water. This rapid transport of event water into surface

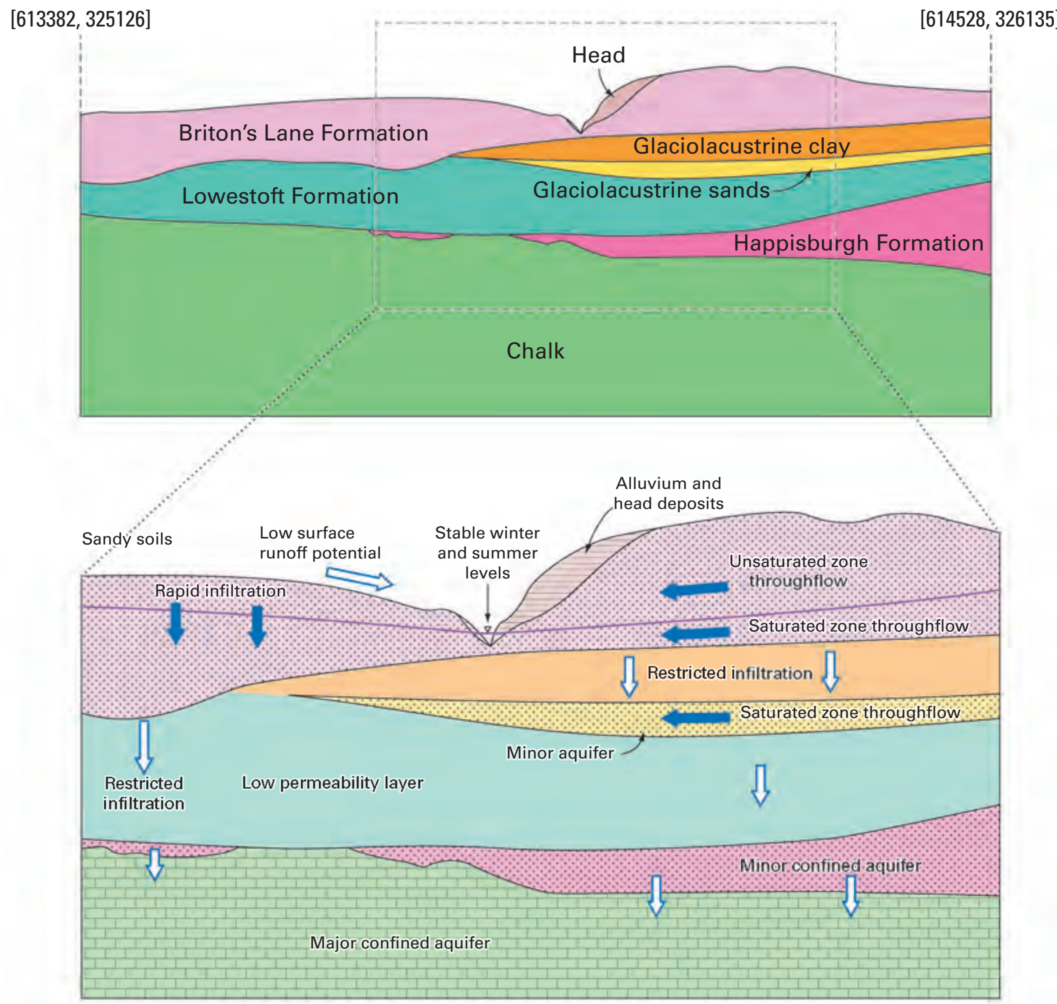

Fig. 12b. Simplified 2-D conceptual model of hydrogeological processes in the eastern section of the Blackwater Drain sub-catchment. Blue arrows represent the dominant water flow paths; white arrows the minor flow pathways. BGS © UKRI 2018. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

watercourses provides reduced opportunities for pollutant attenuation and thereby elevates water pollution risk. Reduced tillage practiced over several years has been shown to increase soil organic carbon contents, which in turn can improve both the structural stability and water holding capacity of the soil, thus helping to slow storm event response times in sandy catchments (Holland, 2004; Soane et al., 2012).

(iii) **Application timing** – agricultural field drains have been shown to act as important preferential pathways for the export of soil water into the river network under clay-rich soils. This pathway is most active between October and March when drain flows are high and thus application of agrochemicals during this period will carry increased water pollution risk. Where possible, applications outside of this period would be recommended to reduce pollutant mobility within the environment. However, it should also be noted that river discharge was very low during the summer months where argillaceous deposits predominated and this carries with it the risk of concentrating riverine pollutants during the most ecologically sensitive season if measures are not put in place to reduce agrochemical input at this time. Whilst it will not always be agronomically feasible to cease agrochemical applications, the high-temporal resolution water quality monitoring presented here can at least assist in demonstrating the scale and timing of water and nutrient losses out of agricultural areas and make farmers aware of the need to consider best practices for how and when to make fertiliser and pesticide applications.

The interpretations made here are applicable not just to southeast England, but also more widely across northwest Europe (Eissmann, 2002; Kasse, 2002) and North America (Fortin et al., 1991; Gleeson et al., 2014; Ross et al., 2004), where similar Quaternary glaciogenic geology can be found. In Denmark, for example, Tertiary and Cretaceous Limestone in the east of the country is overlain by complex sequences of sandy/clayey tills and sandy/gravelly glacial outwash deposits, resulting in a very similar hydrogeological setting to the Blackwater Drain sub-catchment (Jørgensen and Stockmarr, 2008). Denmark's rivers are also largely groundwater fed, as in southeast England, and the landscape is similarly dominated by agriculture (62%; European Environment Agency, 2018) and thus experiences many of the same issues with diffuse water pollution raised here which necessitate the adoption of on-farm mitigation measures (Jørgensen and Stockmarr, 2008; Thomsen et al., 2004).

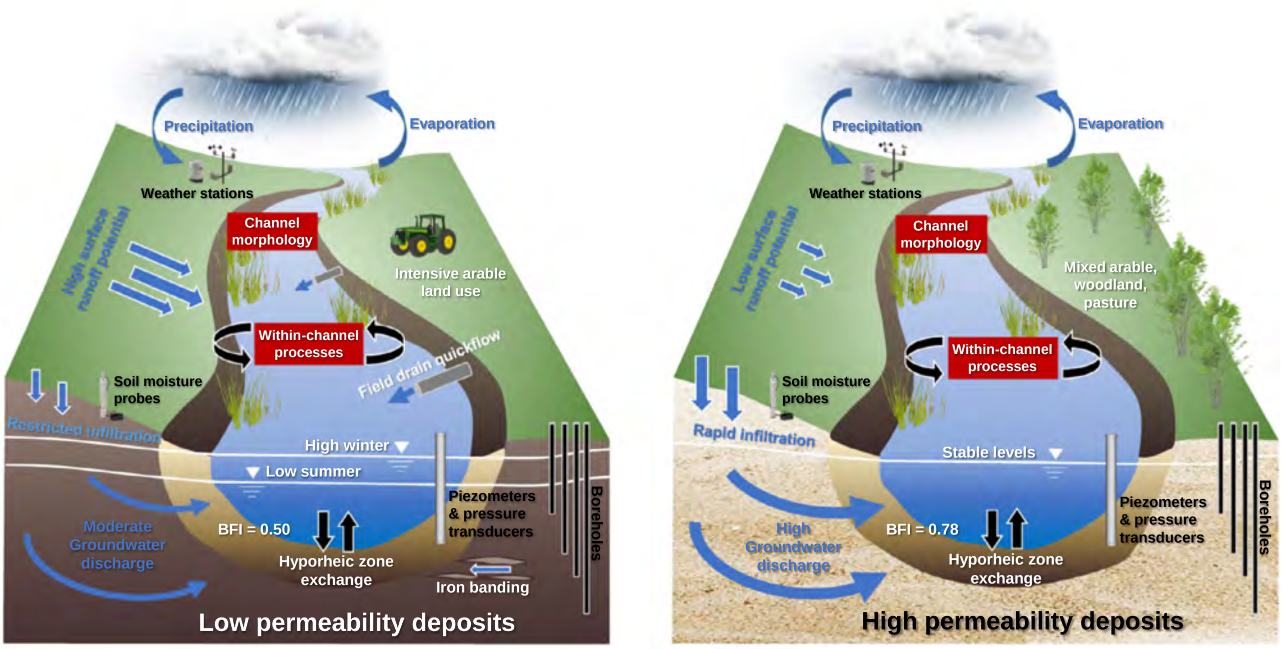

Fig. 13. 3-D conceptual models of hydrogeological processes in the western (left) and eastern (right) sections of the Blackwater Drain sub-catchment. Blue arrows denote the major flow paths monitored as part of the Wensum DTC platform; black labels highlight the Wensum DTC monitoring infrastructure; red boxes denote processes not currently monitored, but which likely impact upon fluvial dynamics. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4. Conclusions

This study has demonstrated how automated telemetered sensor technology can be applied to generate high-temporal resolution empirical datasets of hydrological and meteorological parameters from which conceptual models of catchment hydrogeological processes can be developed. The importance of improving our understanding of hydrogeological processes cannot be emphasised strongly enough, as ultimately it is the catchment hydrogeology which determines pollutant mobility within the environment as well as within-river pollutant behaviour. Gathering of such detailed datasets enables a more robust assessment to be made of the likely effectiveness of deploying on-farm mitigation measures to reduce agricultural water pollution, and this enhanced knowledge can help underpin the development of more effective, integrated and holistic river basin management plans incorporating groundwater – surface water interactions.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hydroa.2018.100007.

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PLANNING REPORT

1. SUMMARY OF ACTIVITY IN REPORTING PERIOD

1.1 This planning report covers the reporting period 25 July to 3 October 2019. There are currently 5 consent applications being processed. The most common types of consent that the Board receive and determine in its regulatory capacity are set out in the table below alongside the current breakdown of cases.

Application Type	*Number*
Byelaw 3 (B3) – Discharge of Treated Foul Water (TFW):	1
Byelaw 3 (B3) – Discharge of Surface Water (SW):	3
Byelaw 4 (B4) / Section 23 (S23), LDA 1991 – Alteration of watercourse	0
Byelaw 10 (B10)– Works within 9 m of a Board's maintained watercourse:	1
Total:	5

1.2 The current status of these applications are;

Application Type	*B3 - TFW*	*B3 - SW*	*B4/S23*	*B10*	*Total*
Awaiting further information from the applicant:	1	0	0	0	1
Awaiting applicants acceptance of conditions:	0	1	0	0	1
Being processed by officers:	0	2	0	1	3
To be determined by the Board in this report:	0	0	0	0	0
Total:	1	3	0	1	5

1.3 As is highlighted by the table immediately above there are no applications requiring consideration by the Board in this report.

1.4 During this reporting period there were no consents determined by the Chief Executives Management Committee in accordance with the Board's delegated authority under the Land Drainage Act 1991 and Board's Byelaws.

2. ENQUIRIES

2.1. Officers have responded to 9 enquires during the reporting period, outlined below;

Case. Ref.	**Case File Sub-type**	**Parish**	**Description**
18_00957_Q	QR - About Regulation	Hevingham	Enquiry regarding works to culvert
19_01607_Q	QR - About Regulation	East Ruston	Enquiry regarding filled watercourse

Case. Ref.	Case File Sub-type	Parish	Description
19_01715_Q	QI - About Infrastructure	Mattishall	Enquiry regarding riparian maintenance
19_01783_Q	QR - About Regulation	Bawdeswell	Enquiry regarding replacement footbridge
19_01787_Q	QR - About Regulation	Roughton	Enquiry regarding blockage of watercourse upstream of fishing lake
19_01846_Q	QR - About Regulation	Wroxham	Enquiry regarding works to bridge
19_01848_Q	QW - About works	Norwich	Enquiry regarding stopping up consultation
19_01853_Q	QR - About Regulation	Ryburgh	Enquiry regarding surface water discharge
19_01859_Q	QR - About Regulation	North Tuddenham to Easton	Enquiry regarding FRA requirements

3. PLANNING COMMENTS

3.1. Officers have provided comments on 12 applications that are either in or could impact on the Boards Internal Drainage District.

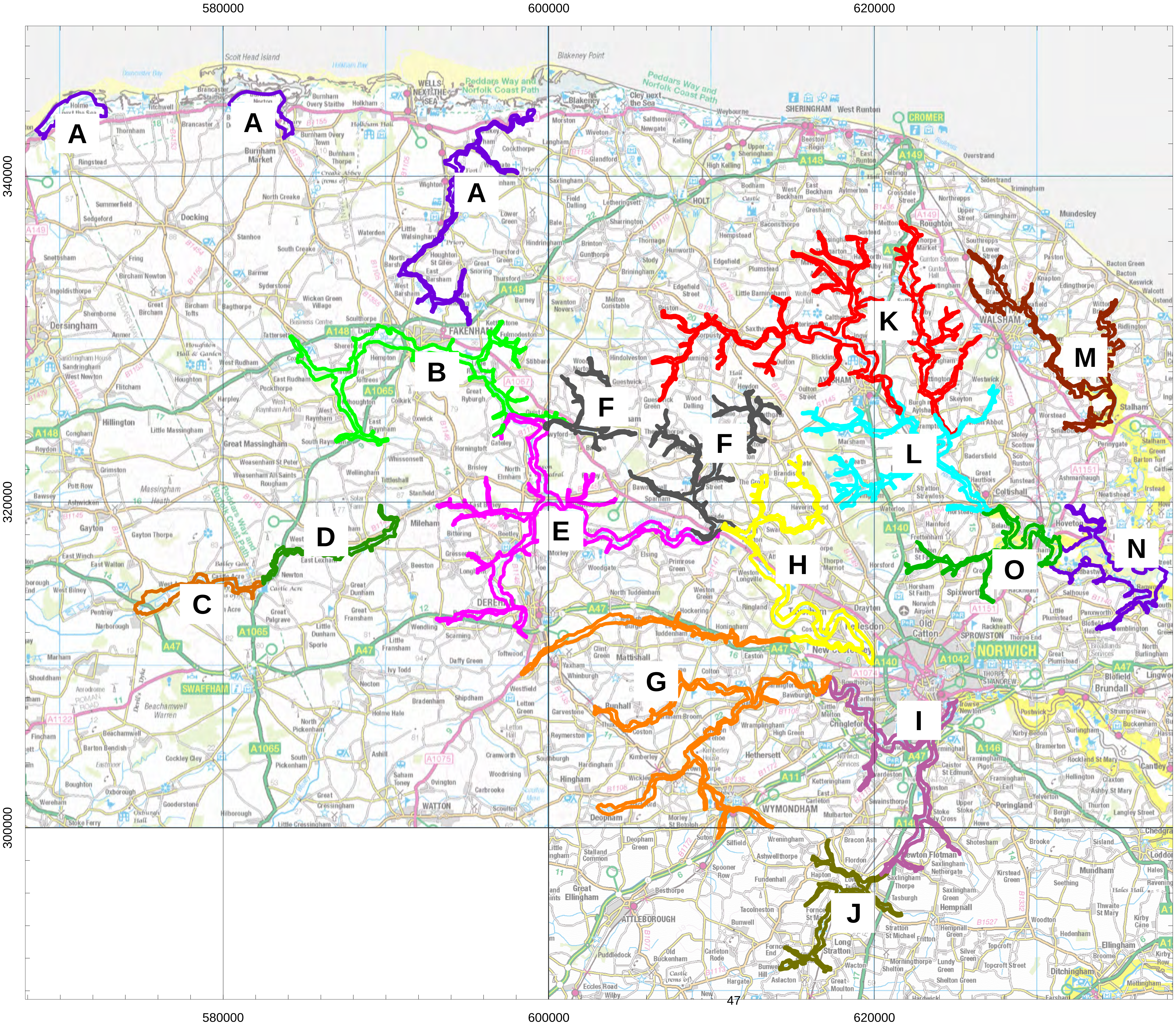
Planning App. Ref.	Parish	Location / Site Name	Stage of Planning	Description
20182036	Weston Longville	Weston Hall Road	Full	Development of 8 dwellings
3PL/2019/0798/O	Whissonsett	Rectory Road	Outline	Development of 5 dwellings
2019/1464	Barnham Broom	Rush Green	Full	Relocation of self-storage and agricultural facilities

Planning App. Ref.	Parish	Location / Site Name	Stage of Planning	Description
3PL/2015/1487/O	Dereham	Swanton Road	Outline	Development of 216 dwellings
3PN/2019/0038/UC	Litcham	Dereham Road	Change of Use	Development 1 dwelling
3PL/2019/0874/F	North Elmham	Holt Road	Full	Development of 25 dwellings
3PL/2017/1574/O	Hockering	Heath Road	Outline	Development of 28 dwellings
3PL/2019/0858/O	Beetley	Church Road	Outline	Development of 2 dwellings
PF/19/1028	Roughton	Back Lane	Full	Development of 30 dwellings
EN010087	N/A	Norfolk Boreas Onshore Route	Local Development Order	Section 56 Consultation
3PL/2019/1034/O	Gressenhall	Bridge Street	Outline	Development of 1 dwelling
3PL/2019/0869/F	Yaxham	Dereham Road	Full	Stationing of holiday lodges to Model Standards

4. FEES ASSOCIATED WITH CONSENTS GRANTED

4.1. There have been no fees invoiced during the reporting period.

C.H. BRADY – FLOOD AND WATER OFFICER
G.R. BROWN – FLOOD AND WATER MANAGER
J.F. NOBBS – FLOOD AND WATER OFFICER



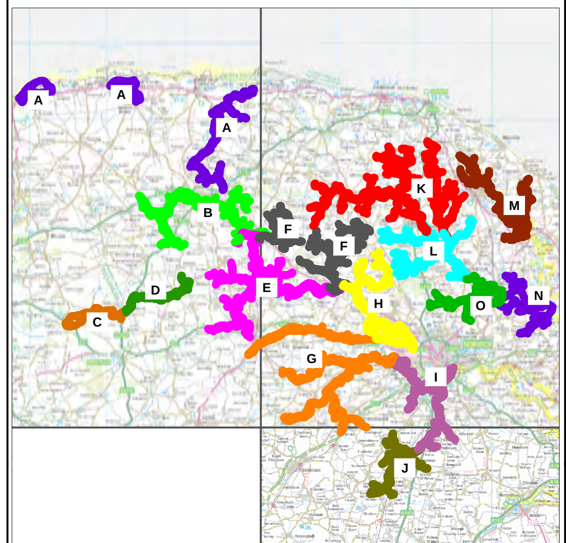
ELECTORAL DISTRICTS

Norfolk Rivers Drainage Board

LEGEND

A - Northern
B - Fakenham
C - Narborough
D - Litcham
E - Dereham
F - Reepham
G - Wymondham
H - Drayton
I - Newton Flotman
J - Tasburgh
K - Alysham
L - Coltishall
M - North Walsham
N - South Walsham
O - Wroxham

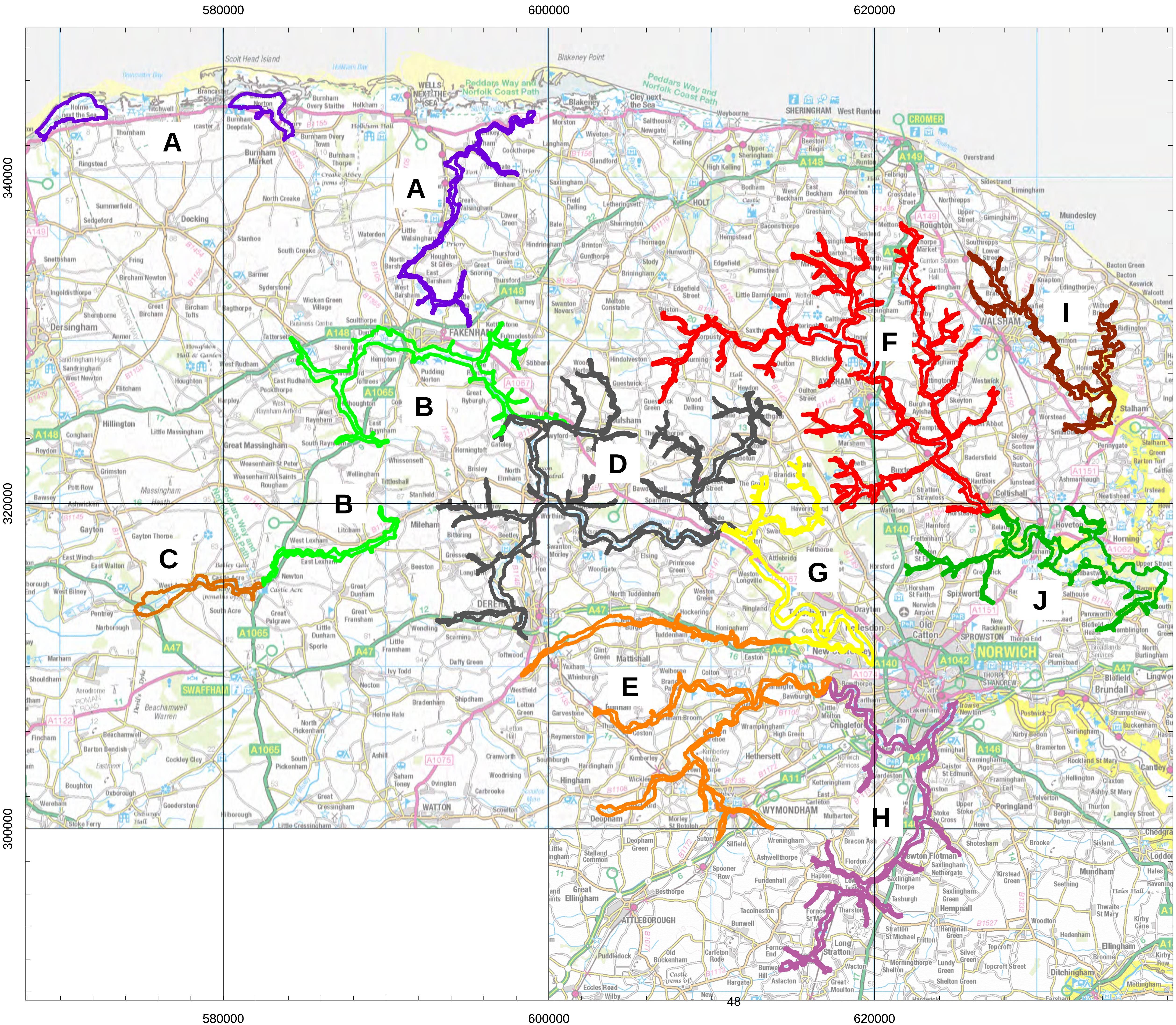
KEY MAP



SCALE	SHEET NUMBER
Best Fit	All Districts
PLOT DATE	
09/10/2019	

FILE NAME

Electoral_Bnd_NRIDB



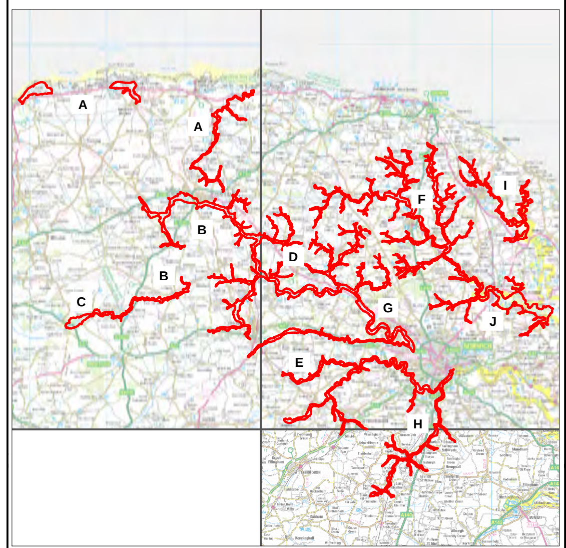
PROPOSED ELECTORAL DISTRICTS

Norfolk Rivers Drainage Board

LEGEND

A. Northern
B. Fakenham & Litcham
C. Narborough
D. Dereham & Reepham
E. Wymondham
F. Alysham & Coltishall
G. Drayton
H. Newton Flotman & Tasburgh
I. North Walsham
J. South Walsham & Wroxham

KEY MAP



N

SCALE	SHEET NUMBER
Best Fit	All Districts
PLOT DATE	
09/10/2019	
FILE NAME	
Electoral_Bnd_NRIDB	

Elected Board Members
From 1 November 2018 to 31 October 2021

Photo	Name/Contact Info.	Electoral Division	Registered Interests
	Mr Henry C Birkbeck e: NRIDB-Member@wlma.org.uk	C: Narborough	Download
No Photo	Mr Jason M Borthwick e: NRIDB-Member@wlma.org.uk	A: Northern	Download
	Mr John F Carrick **(Chairman)** e: NRIDB-Chair@wlma.org.uk	E: Dereham	Download
	Mr Henry G Cator OBE, FRICS, DL e: NRIDB-Member@wlma.org.uk	N: South Walsham	Download

DRS ®
Please click on the Electoral Division to identify the areas.
Please click on the Register of Interests to view the declarations made by your members.

Please note that if you send an email to a Board member who has a registered email address that uses either the WLMA or another corporate domain, your message may also be read by someone other than the intended recipient or made public under a Freedom of Information request.

Norfolk Rivers Drainage Board

Elected Board Members
From 1 November 2018 to 31 October 2021

Photo	Name/Contact Info.	Electoral Division	Registered Interests
	Mr Neil W D Foster e: NRIDB-Member@wlma.org.uk	D: Litcham	Download
N/A	Vacancy	I: Newton Flotman	N/A
	Mr John P Labouchere e: NRIDB-Member@wlma.org.uk	F: Reepham	Download
	Mr Mark R Little e: NRIDB-Member@wlma.org.uk	L: Coltishall	Download
No Photo	Mr Desmond Mack e: NRIDB-Member@wlma.org.uk	G: Wymondham	Not Filed

DRS ®

Please click on the Electoral Division to identify the areas.

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Elected Board Members
From 1 November 2018 to 31 October 2021

Photo	Name/Contact Info.	Electoral Division	Registered Interests
	Mr G Tom Mutimer e: NRIDB-Member@wlma.org.uk	M: North Walsham	Download
N/A	Vacancy	B: Fakenham	N/A
N/A	Vacancy	K: Aylsham	N/A
	Mr Michael J Sayer e: NRIDB-Member@wlma.org.uk	H: Drayton	Download

DRS ®

Please click on the Electoral Division to identify the areas.

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Norfolk Rivers Drainage Board

Elected Board Members
From 1 November 2018 to 31 October 2021

Photo	Name/Contact Info.	Electoral Division	Registered Interests
	Mr Simon Shaw e: NRIDB-Member@wlma.org.uk	O: Wroxham	Download
	Mr Richard Wilbourn e: NRIDB-Member@wlma.org.uk	J: Tasburgh	Download

15	**Elected Members**

Last Updated: July 2019

DRS ®
Please click on the Electoral Division to identify the areas.
Please click on the Register of Interests to view the declarations made by your members.

Please note that if you send an email to a Board member who has a registered email address that uses either the WLMA or another corporate domain, your message may also be read by someone other than the intended recipient or made public under a Freedom of Information request.

Norfolk Rivers
Drainage Board

From: 01 April 2019 **Period To:** 5
To: 31 August 2019 **Year Ended:** 31 March 2020

NOTES	INCOME AND EXPENDITURE ACCOUNT	Y-T-D BUDGET £	Y-T-D ACTUAL £	Y-T-D VARIANCE £	ANNUAL BUDGET £	PROJECTED OUT-TURN £	PROJECTED VARIANCE £
	Income						
	Occupiers Drainage Rates	81,586	81,586	0	81,586	81,586	0
1	Special Levies issued by the Board	315,784	315,784	0	315,784	315,784	0
2	Highland Water Contributions from EA	91,057	100,602	9,545	91,057	100,602	9,545
	Grants Applied	41,925	36,763	-5,162	100,620	95,458	-5,162
3	Income from Rechargeable Works	2,083	25,216	23,133	5,000	25,216	20,216
	Investment Interest	0	1,034	1,034	0	2,482	2,482
	Development Contributions	0	0	0	0	0	0
5	Other Income	110,033	86,903	-23,130	264,079	240,949	-23,130
	Total Income	**£642,468**	**£647,888**	**£5,420**	**£858,126**	**£862,078**	**£3,951**
	Less Expenditure						
6	Capital Works	41,925	36,763	5,162	100,620	95,458	5,162
7	Precept Contributions to EA	74,026	72,693	1,333	74,026	72,693	1,333
8	Maintenance Works	245,170	222,880	22,290	588,407	566,118	22,289
	Development Expenditure	2,500	0	2,500	6,000	6,000	0
9	Administration Charges	70,952	61,214	9,738	170,785	160,839	9,946
3	Cost of Rechargeable Works	0	31,941	-31,941	0	31,941	-31,941
4	Net Deficit/(Surplus) on Operating Accounts	0	-28,304	28,304	0	0	0
	Total Expenditure	**£434,573**	**£397,188**	**£37,386**	**£939,838**	**£933,050**	**£6,789**
	Profit/(Loss) on disposal of Fixed Assets	£0	£17,000	£17,000	£0	£17,000	£17,000
	Net Surplus/(Deficit)	**£207,895**	**£267,700**	**£59,805**	**-£81,712**	**-£53,972**	**£27,739**

Norfolk Rivers Drainage Board

From:	01 April 2019	Period To:	5
To:	31 August 2019	Year Ended:	31 March 2020

NOTES	BALANCE SHEET AS AT 31-8-2019	OPENING BALANCE £	MOVEMENT THIS YEAR £	CLOSING BALANCE £
10	**Fixed Assets**			
	Land and Buildings	38,961	-416	38,545
	Plant and Equipment	16,738	-1,475	15,263
	Shared Consortium Assets	0	0	0
		55,699	**-1,891**	**53,808**
	Current Assets			
11	Bank Account	31,875	61,474	93,349
12	Trade Debtors	64,324	35,313	99,637
13	Work in Progress	2,877	51,455	54,332
14	Term Deposits	900,000	0	900,000
15,16	Drainage Ratepayers and Special Levies Due	314	125,028	125,342
	Prepayments	0	0	0
17	Prepayments to WMA	22,728	-45,523	-22,795
	VAT Due	-3,947	17,527	13,580
	Grants Due	0	0	0
		1,018,170	**245,275**	**1,263,446**
	Less Current Liabilities			
	Trade Creditors	52	53,913	53,965
	Accruals	44,450	-40,783	3,667
	Drainage Rates/Special Levies paid in advance	16,853	-683	16,170
	Finance Leases	0	0	0
	Payroll Controls	0	0	0
		61,355	**12,448**	**73,803**
	Net Current Assets	**956,815**	**232,827**	**1,189,643**
	Less Long Term Liabilities			
19	Pension Liability	169,000	7,000	176,000
	Net Assets	**£843,514**	**£223,936**	**£1,067,451**
20	**Reserves**			
	Earmarked			
	General Reserve	545,862	267,701	813,563
18	Grants Reserve	150,658	-36,763	113,895
21	Development Reserve	210,035	0	210,035
22	Plant Reserve	65,000	0	65,000
		971,555	**230,937**	**1,202,492**
	Non-Distributable			
23	Revaluation Reserve	40,959	0	40,959
19	Pension Reserve	-169,000	-7,000	-176,000
		-128,041	**-7,000**	**-135,041**
	Total Reserves	**£843,514**	**£223,937**	**£1,067,451**

P J CAMAMILE MA FCIS
CHIEF EXECUTIVE

S JEFFREY BSc (Hons) FCCA
FINANCE & RATING MANAGER

Norfolk Rivers Drainage Board

From:	**01 April 2019**		**Period To:**	**5**
To:	**31 August 2019**		**Year Ended:**	**31 March 2020**

Note **Notes to the Accounts**

1 Special Levies due from constituent Billing Authorities are as follows:

	Y-T-D BUDGET	Y-T-D 2019/20
Breckland District Council	50,561	50,561
Broadland District Council	75,499	75,499
King's Lynn and West Norfolk Borough Council	19,204	19,204
North Norfolk District Council	100,751	100,751
Norwich City Council	5,638	5,638
South Norfolk District Council	64,131	64,131
	315,784	**315,784**

2 The EA Highland Water Claim for 2019/20 is due to be paid by the Environment Agency (EA) to the Board in September, following the changes made to the timetable in 2015 (previously the payment was made in two installments - one in May and one in December).

3 Rechargeable work includes professional supervision and contracting services to the Broads and East Suffolk IDBs.

4 Net Deficit/(Surplus) on Operating Accounts is made up as follows:

	Y-T-D BUDGET	Y-T-D 2019/20
Labour Operations Account	0	-18,417
Mobile Plant Operations Account	0	-9,887
	0	**-28,304**

Detailed operating surpluses/(deficits) for the Labour Operations Account and each item of mobile plant are shown in the Labour and Mobile Plant Operations Reports, which can be made available to members on request.

5 Other income is made up as follows:

	Y-T-D BUDGET	Y-T-D 2019/20
Shared Income from WMA	110,033	86,903
Insurance Claims	0	0
Sundry Income	0	0
Summons Costs	0	0
	110,033	**86,903**

6 The gross cost of each capital scheme is approved by the Board annually and detailed on the schedule of capital works as managed by the Project Engineer, which can be made available to members on request. The Grants Due/(Unapplied) also correspond with the figures shown on the Balance Sheet. The Executive Committee scrutinise this Report every year.

7 The EA Precept due for 2019/20 is payable to the EA on 31 May and the other half is payable to them on 30 November. The Board has no idea where or how this money is spent.

8 Detailed maintenance operations are approved by the Board annually and shown on the Operations map, together with the schedule of maintenance works for each catchment, which can be made available to members on request. Expenditure is analysed as follows:

	Y-T-D BUDGET	Y-T-D 2019/20
Labour Charges	33,625	30,973
Plant Charges	1,856	1,710
Materials	3,348	3,084
Contractors	69,648	64,153
Plant Hire & Transport	3,854	3,550
Direct Works	**112,332**	**103,469**
Technical Support Staff Costs	127,907	115,983
Other Technical Support Costs	833	3,428
Biodiversity Action Plan Costs	4,098	0
Maintenance Works	**245,170**	**222,880**

9 Administration charges reflect the Board's share of consortium expenditure (excluding technical support costs). Detailed expenditure is monitored by the Consortium Management Committee and the Board every three months:

Norfolk Rivers Drainage Board

From:	01 April 2019	Period To:	5
To:	31 August 2019	Year Ended:	31 March 2020

Note **Notes to the Accounts**

	Y-T-D BUDGET	Y-T-D 2019/20
Administration Staff Costs	53,225	43,402
Other Administration Costs	17,103	16,984
Development Expenditure	2,500	0
Drainage Rates AV Increases/(Decreases)	208	16
Depreciation Kettlewell House	416	416
Sundry Debtors written off	0	0
Sundry Expenses	0	0
Settlement Discount	209	396
	73,452	**61,214**

10 **TANGIBLE FIXED ASSETS**

Cost	Land and Buildings	Plant and Equipment	Total
Opening Balance as at 1-4-2019 b/fwd	49,950	78,344	128,294
(+) Additions	0	0	0
(-) Disposals	0	-39,847	-39,847
(=) Closing Balance as at 31-8-2019 c/fwd	**49,950**	**38,497**	**88,447**
Depreciation			
Opening Balance as at 1-4-2019 b/fwd	10,989	61,581	72,570
(+) Depreciation Charge for year	416	1,500	1,916
(-) Accumulated Depreciation written out on disposal	0	-39,847	-39,847
(=) Closing Balance as at 31-8-2019 c/fwd	**11,405**	**23,233**	**34,639**
Net Book Value as at 31-3-2019	**38,961**	**16,763**	**55,724**
Net Book Value as at 31-8-2019	**38,545**	**15,263**	**53,808**

Full details of all movements during this year are recorded in the Board's Fixed Assets Register, which can be made available to members on request. The Board also shares ownership of a proportion of the WMAs Shared Fixed Assets, which were last valued by Cruso & Wilkin, Chartered Surveyors, as at 31 March 2018. Such assets have a Net Book Value of zero.

11 Additional sums are now being invested on the short term money market to maximise the return on the working balances, in accordance with the Board's Investment Policy. The Bank Account is reconciled as follows:

	2018/19	2019/20
Opening Balance as at 1-4 b/fwd	240,663	31,875
(+) Receipts	1,259,168	404,236
(-) Payments	-1,467,956	-342,761
(=) Closing Balance as at 31-8-2019 c/fwd	**31,875**	**93,349**
Balance on Statement as at 31-8-2019	75,227	93,349
Less: Unpresented payments	-43,352	0
Add: Unpresented receipts	0	0
Closing Balance as at 31-8-2019 c/fwd	**31,875**	**93,349**

12 Aged Debtor profile is currently as follows:

Debt period	**Amount**	**Number of Debtors**
<=30 days	95,916	3
>30 days and <=60 days	3,721	1
>60 days and <=90 days	0	0
>90 days (£21,000 Paid August 2019)	0	0
	99,637	**4**

>90 days	**Amount**	**Inv. Date**	**Originator**

Norfolk Rivers
Drainage Board

From:	01 April 2019	Period To:	5
To:	31 August 2019	Year Ended:	31 March 2020

Note **Notes to the Accounts**

0

13 Work in Progress is currently made up of the following jobs:

Customer	Amount	Comp. Date	Originator
RBR0003 Brown & Co	35	Ongoing	Operations Engineer PG
RBA0003 EA Badley Moor Restoration	99	Ongoing	Operations Engineer TJ
RBI0001 Billingford EA WEIF Project	2,376	Ongoing	Project Engineer MP
RIMNR01 EA Integrated Maintenance Programme	873	Ongoing	Operations Engineer TJ
RLA0002 Langor Brook Restoration	3,222	Ongoing	Operations Engineer PG
RNA0001 Narborough Fish Passes	37,307	Ongoing	Operations Engineer PG
RNA0002 NT WEG Scarrow Beck Downstream	1,894	Ongoing	Operations Engineer TJ
RNM0001 New Mills Canoe Portage	1,234	Ongoing	Operations Engineer TJ
RNM0002 Neil Marshall Secondment	1,925	Ongoing	Project Engineer MP
RNO0001 Norfolk Ornithologists Association	611	Ongoing	Project Engineer MP
RSI0002 Silt Trap Development Fund	420	Ongoing	Project Engineer MP
RSI0003 Silt Trap Scoping Staff Time	198	Ongoing	Project Engineer MP
RTR0003 Truxor Works 2019	1,470	Ongoing	Project Engineer MP
RWA0002 Walcott NFM	690	Ongoing	Operations Engineer TJ
RWEG257-2018-4555	1,980	Ongoing	Operations Engineer PG
	54,332		

14 Term Deposits are currently as follows:

Financial Institution	Capital	Investment Date	Maturity Date	Variable Interest Rate
Natwest Treasury Reserve Deposit	400,000	26/10/2018	28/10/2019	0.88%
West Bromwich Building Society	500,000	28/06/2019	30/09/2019	0.81%
	900,000			

15 Special Levies are due to be paid by Constituent Councils in two halves on 1 May and 1 November every year.

16 There are currently 63 Ratepayers that have not paid their Drainage Rates for 2019/20, as compared to 87 Ratepayers this time last year. Summarised transactions for Drainage Rates and Special Levies during the year are as follows:

	2018/19	2019/20
Arrears b/fwd	2,190	314
Drainage Rates for the year	78,978	81,586
Special Levies for the year	305,690	315,783
New Assessments	216	212
Value Decreases	-1,018	-420
Value Increases	802	208
Payments Received	-386,928	-272,052
Settlement Discount	-310	-398
Returned/(Represented) amounts	20	79
Irrecoverables and write offs	-908	-14
Summons collection costs	1,500	0
Adjustments	82	45
Arrears c/fwd	**314**	**125,342**

17 Prepayments represent the amount that has been paid to the WMA in advance, which will be used by the WMA to pay the Board's share of consortium expenditure during the next reporting period.

18 **Grants Reserve**
Movements on the Grants Reserve are made up as follows:

	2019/20
Opening Balance at 1-4-2019	-150,658
Add: Grant Received	0
Less: Grant Applied	36,763
Closing Balance as at 31-8-2019	**-113,895**

Norfolk Rivers
Drainage Board

From:	**01 April 2019**	**Period To:**	**5**
To:	**31 August 2019**	**Year Ended:**	**31 March 2020**

Note **Notes to the Accounts**

		2018/19	2019/20
SCH03	Giant Hogweed Project	3,792	3,792
SCH02	River Wensum Restoration Project WLMP	1,233	1,233
SCH07	River Nar Litcham to Lexham Hall Lakes	760	760
SCH04	River Nar East Lexham Lakes Bypass	0	0
SCH12	River Wensum Resoration Scheme	52,447	35,090
SCH13	River Nar Restoration Scheme 4 Year	88,783	69,377
SCH15	Strategic Modelling and Restoration Project	0	0
SCH25	WFD Maintenance Improvements PSCA	3,643	3,643
		150,658	**113,895**

19(i) The Board provides its employees with access to the Local Government Pension Scheme but does not need to Account for this as a defined benefit pension scheme to comply with the limited assurance audit regime. However the Board has chosen to do so because it does have a pension liability, which has been calculated by the LGPS Fund Actuary as at 31 March 2019.

19(ii) The Board is a member of the Water Management Alliance Consortium and as such also has a proportion of the pension liability for the shared staff that are employed by King's Lynn IDB, t/a the Water Management Alliance. The Fund Actuary for Norfolk County Council has prepared a separate Report for the Water Management Alliance, which identifies a notional net pension liability of £2,496,000 as at 31 March 2019 that is shared by all 5 Member Boards. The Board's share of this pension liability is set out every year in the WMAs Basis of Apportionment, which was approved by the Board on 31 January 2019.

20 The Reserves are managed in accordance with the Capital Financing and Reserves Policy, as approved by the Board on 21 January 2015. This policy is available for viewing on the Board's website.

21 The purpose of the Development Reserve is to reduce the impact on drainage rates and special levies from development that takes place in the area. The Board charges developers a standard rate per impermeable hectare for agricultural land which is developed and becomes a hard standing area, such as housing, roadways etc. The money is credited to this Reserve and then used to reduce the gross cost of capital work needed to cater for the additional flows arising from such development. The income for this Reserve therefore comes exclusively from developers and is used to fund in part improvement works that are necessary because of development.

22 The purpose of this Reserve is to reduce the impact on drainage rates and special levies as and when equipment is bought and sold, in accordance with the plant renewals programme. Depreciation is its primary source of income, which largely comes from drainage rates/special levies in the form of plant charges included within the maintenance budget, together with any profits on disposal. Changes in hourly charge out rates are determined by the Operations Manager and the Chief Executive. Expenditure is determined by the Board, following recommendations made by the Chief Executive and Operations Manager.

23 This Revaluation Reserve has arisen from the revaluation of the Board's share of Kettlewell House on 31 March 2009 (approx. 10%).

Related Party Transactions

24 Mr J F Carrick is the Chairman of the Norfolk Rivers IDB. He has been paid £0 Chairman's Allowance during the year.

25 The Board uses Rating Software for the collection of Drainage Rates known as DRS. The software was developed by Mr P J Camamile, the Chief Executive, and is supported by Byzantine Ltd. Mr P J Camamile is the Company Secretary of Byzantine Ltd, and his wife, Mrs P Camamile is a Director. Both are shareholders.

Recommended Actions:

1. To approve the Financial Report for the period ending 31-8-2019.

P J CAMAMILE MA FCIS
CHIEF EXECUTIVE

S JEFFREY BSc (Hons) FCCA
FINANCE & RATING MANAGER

NORFOLK RIVERS IDB

SCHEDULE OF PAID ACCOUNTS

Payment Date from: 01/07/2019

Payment Date to: 31/08/2019

NAME	DETAILS	% COST RECOVERABLE	AMOUNT PAID THIS PERIOD
Anglia Farmers Ltd	Materials/Equipment	100	8,115.05
Broads (2006) IDB	Supervision/materials	94	8,743.89
DIY Tool Hire Ltd	Pump Hire	100	725.40
E A Fasteners Ltd	Galvanised throughbolts	100	90.00
FibreGrid Ltd	Gratings	100	572.57
Fishtek Ltd	Support Frame Rework	100	1,591.48
GDR Sales Ltd	Plant/Labour Hire	24	54,222.74
Hubble	Nuts & Bolts	100	55.06
Inland Revenue	PAYE	0	1,469.92
Meteor Communications	Pillar Camera	0	3,054.00
Middleton Aggregates	Clay	100	117.94
Norfolk Pension Fund	Superannuation	0	1,821.06
NTD	Tracked Dumper Hire	0	4,260.00
Vodafone Ltd	Mobile Phone Charges	0	108.80
WMA	Staff Recharges	100	18,867.76

Please note that the amounts shown above include VAT **£103,815.67**

STRATEGIC OBJECTIVES	RISK	IMPACT	LIKELIHOOD SCORE (1 – 3)	IMPACT SCORE (1 – 3)	RISK RATING (HIGH, MEDIUM, LOW)	RESPONSE (ACTIONS PLANNED/TAKEN)
To reduce the flood risk to people, property, public infrastructure and the natural environment by providing and maintaining technically, environmentally and economically sustainable flood defences within the Internal Drainage District (IDD)	(1a) Reduction in, or insufficient finance, grant and income (1b) EA may cease to pay highland water contributions to IDBs	Erosion of Board's capital and general reserves Reduction in FCERM service the Board is able to provide Unable to replace assets as scheduled in asset management plan	3	3	9 →	Explore alternative funding streams
	(1c) EA is no longer willing or able to carry out work on sea defences that protects the Internal Drainage District, or the works are undertaken to a reduced specification	Potential overtopping into IDD in severe weather events and cost implications of managing the increase in water	2	3	8 ↑	Develop Investment Plan with key stakeholders
	(1d) EA is no longer willing or able to carry out work on Main Rivers	Will limit the Board's ability to fulfil its statutory function	2	3	8 ↑	PSCA in place between IDB/EA, effective 2017/18 to undertake maintenance works on some sections of main river identified by the

STRATEGIC OBJECTIVES	RISK	IMPACT	LIKELIHOOD SCORE (1 – 3)	IMPACT SCORE (1 – 3)	RISK RATING (HIGH, MEDIUM, LOW)	RESPONSE (ACTIONS PLANNED/TAKEN)
						IDB's Project Engineer that will provide benefit to IDB watercourses, however EA has halted these works in 2018/19. The IDB has appealed the precept. Continue to encourage the EA to de-main lengths of less strategically important main river for the IDB to adopt and maintain
	(1m) Maintenance works constrained by the Water Framework Directive legislation and Habitat Regulations Assessment and onus of proof sits with IDBs	IDB could incur penalties/fines	2	3	. High 6 ↓	Work with EA, NE and voluntary sector orgs to meet WFD requirements. Agree interpretation of Habitat Regulations Assessments with NE. SMO regularly updated to remain WFD compliant Regular SMO update training for employees Pursue funding from all available sources
To liaise with EA to en-main sections of main river that will be de-listed by the EA.	(3a) EA may not provide funding to the IDB for this additional maintenance.	Lack of maintenance on these sections of main rivers could adversely affect	3	2	High 6 ↑	Continue to liaise with EA to bring proposal to Board. De-maining of low

STRATEGIC OBJECTIVES	RISK	IMPACT	LIKELIHOOD SCORE (1 – 3)	IMPACT SCORE (1 – 3)	RISK RATING (HIGH, MEDIUM, LOW)	RESPONSE (ACTIONS PLANNED/TAKEN)
	(3b) EA will not de-main the rivers if the IDB refuses to adopt them.	the IDB's watercourses and reduce the IDB's ability to fulfil its statutory function				consequence main river remains under consideration by EA. Public consultation during Autumn 2017 for national de-maining pilot study in Norfolk/Suffolk, but the pilot study is currently on hold in Norfolk Board has agreed to adopt de-mained rivers Prioritise maintenance programme
To enable and facilitate land use for residential, commercial, recreational and environmental purposes by guiding and regulating activities, which have the potential to increase flood risk	(4a) Planning Authorities ignore advice provided by Board, which leads to increased flood risk (4b) Potential for developers to allow SUDs to be managed by private companies who may allow them to fall into disrepair through lack of long term maintenance	Potential for increased flood risk Lost income from SWDCs and commuted sums Inadequate or total lack of maintenance of SUDs could have an adverse impact on the IDB infrastructure and subsequently	2	3	High 6 ↓	Planning/Enforcement is undertaken by the Board's Flood and Water Officers and issues are raised at Board meetings. Officers' comments on planning applications are available on Local Authority website. Updated Planning and Byelaw Strategy Document approved by the WMA on 7 December 2018 for consultation with LPAs and approved by the Norfolk Rivers IDB on 13 June 2019. A SUDs adoption and

STRATEGIC OBJECTIVES	RISK	IMPACT	LIKELIHOOD SCORE (1 – 3)	IMPACT SCORE (1 – 3)	RISK RATING (HIGH, MEDIUM, LOW)	RESPONSE (ACTIONS PLANNED/TAKEN)
		increase the risk of flooding				charging policy was adopted by the Board at its 26 January 2017 meeting to promote IDB services for adoption of SUDs to ensure these are properly maintained in perpetuity. At its 16 August 2018 meeting the Board adopted the variable SWDC rate and banding arising from the 2018 review undertaken by the WMA Flood and Water Manager and the South Holland IDB Engineer. New rates and banding introduced 1 October 2018.

Risk Assessment Matrix (From the Risk Management Strategy and Policy as approved 26 January 2017)

Risk Assessment Matrix

Likelihood			
Highly Likely	**Medium (3)**	**High (6)**	**High (9)**
Possible	**Low (2)**	**Medium (4)**	**High (6)**
Unlikely	**Low (1)**	**Low (2)**	**Medium (3)**
	Negligible	Moderate	Severe
	Impact		

The categories for impact and likelihood are defined as follows:

IMPACT

- Severe – will have a catastrophic effect on the operation/service delivery. May result in major financial loss (over £100,000) and/or major service disruption (+5 days) or impact on the public. Death of an individual or several people. Complete failure of project or extreme delay (over 2 months). Many individual personal details compromised/revealed. Adverse publicity in national press.

- Moderate – will have a noticeable effect on the operation/service delivery. May result in significant financial loss (over £25,000). Will cause a degree of disruption (2 – 5 days) or impact on the public. Severe injury to an individual or several people. Adverse effect on project/significant slippage. Some individual personal details compromised/revealed. Adverse publicity in local press.

- Negligible – where the consequences will not be severe and any associated losses and or financial implications will be low (up to £10,000). Negligible effect on service delivery (1 day). Minor injury or discomfort to an individual or several people. Isolated individual personal detail compromised/revealed. NB A number of low incidents may have a significant cumulative effect and require attention.

LIKELIHOOD

- Highly likely: very likely to happen
- Possible: likely to happen infrequently
- Unlikely: unlikely to happen.

Annual Governance and Accountability Return 2018/19 Part 3

To be completed by Local Councils, Internal Drainage Boards and other Smaller Authorities*:

- **where the higher of gross income or gross expenditure exceeded £25,000 but did not exceed £6.5 million; or**
- **where the higher of gross income or gross expenditure was £25,000 or less but:**
  - **are unable to certify themselves as exempt (fee payable); or**
  - **have requested a limited assurance review (fee payable)**

Guidance notes on completing Part 3 of the Annual Governance and Accountability Return 2018/19

1. Every smaller authority in England that either received gross income or incurred gross expenditure exceeding £25,000 **must** complete Part 3 of the Annual Governance and Accountability Return at the end of each financial year in accordance with Proper Practices.
2. **The Annual Governance and Accountability Return is made up of three parts, pages 3 to 6:**
   - The **annual internal audit report** is completed by the authority's internal auditor.
   - **Sections 1 and 2** are to be completed and approved by the authority.
   - **Section 3** is completed by the external auditor and will be returned to the authority.
3. The authority **must** approve Section 1, Annual Governance Statement, before approving Section 2, Accounting Statements, and both **must** be approved and published **before 1 July 2019.**
4. An authority with either gross income or gross expenditure exceeding £25,000 or an authority with neither income nor expenditure exceeding £25,000, but which is unable to certify itself as exempt, or is requesting a limited assurance review, **must** return to the external auditor by email or post (not both):
   - the Annual Governance and Accountability Return Sections 1 and 2, together with
   - a bank reconciliation as at 31 March 2019
   - an explanation of any significant year on year variances in the accounting statements
   - notification of the commencement date of the period for the exercise of public rights
   - Annual Internal Audit Report 2018/19

Unless requested, do not send any additional documents to your external auditor. Your external auditor will ask for any additional documents needed.

Once the external auditor has completed the review and is able to give an opinion on the limited assurance review, the Annual Governance and Accountability **Section1, Section 2 and Section 3 – External Auditor Report and Certificate** will be returned to the authority by email or post.

Publication Requirements

Under the Accounts and Audit Regulations 2015, authorities must publish the following information on a publicly accessible website:

Before 1 July 2019 authorities **must** publish:

- Notice of the period for the exercise of public rights and a declaration that the accounting statements are as yet unaudited;
- **Section 1 - Annual Governance Statement 2018/19**, approved and signed, page 4
- **Section 2 - Accounting Statements 2018/19**, approved and signed, page 5

Not later than 30 September 2019 authorities **must** publish:

- Notice of conclusion of audit
- **Section 3 - External Auditor Report and Certificate**
- **Sections 1 & 2 of AGAR** including any amendments as a result of the limited assurance review.

It is recommended as best practice, to avoid any potential confusion by local electors and interested parties, that you also publish the Annual Internal Audit Report, page 3.

The Annual Governance and Accountability Return constitutes the annual return referred to in the Accounts and Audit Regulations 2015. Throughout, the words 'external auditor' have the same meaning as the words 'local auditor' in the Accounts and Audit Regulations 2015.

**for a complete list of bodies that may be smaller authorities refer to schedule 2 to the Local Audit and Accountability Act 2014.*

Guidance notes on completing Part 3 of the Annual Governance and Accountability Return 2018/19

- The authority **must** comply with *Proper Practices* in completing Sections 1 and 2 of this Annual Governance and Accountability Return. *Proper Practices* are found in the *Practitioners' Guide** which is updated from time to time and contains everything needed to prepare successfully for the financial year-end and the subsequent work by the external auditor.
- Make sure that the Annual Governance and Accountability Return is complete (i.e. no empty highlighted boxes), and is properly signed and dated. Where amendments are made by the authority to the AGAR after it has been approved by the authority and before it has been reviewed by the external auditor, the Chairman and RFO should initial the amendments and if necessary republish the amended AGAR and recommence the period for the exercise of public rights. If the Annual Governance and Accountability Return contains unapproved or unexplained amendments, it may be returned and additional costs will be incurred.
- The authority **should** receive and note the annual internal audit report if possible prior to approving the annual governance statement and before approving the accounts.
- Use the checklist provided below to review the Annual Governance and Accountability Return for completeness before returning it to the external auditor by email or post (not both).
- Do not send the external auditor any information not specifically requested. However, **you must inform your external auditor about any change of Clerk, Responsible Financial Officer or Chairman, and provide relevant email addresses and telephone numbers.**
- Make sure that the copy of the bank reconciliation to be sent to your external auditor with the Annual Governance and Accountability Return covers all the bank accounts. If the authority holds any short-term investments, note their value on the bank reconciliation. The external auditor must be able to agree the bank reconciliation to Box 8 on the accounting statements **(Section 2, page 5)**. An explanation **must** be provided of any difference between Box 7 and Box 8. More help on bank reconciliation is available in the *Practitioners' Guide**.
- Explain fully significant variances in the accounting statements on **page 5**. Do not just send a copy of the detailed accounting records instead of this explanation. The external auditor wants to know that you understand the reasons for all variances. Include complete numerical and narrative analysis to support the full variance.
- If the external auditor has to review unsolicited information, or receives an incomplete bank reconciliation, or variances are not fully explained, additional costs may be incurred.
- Make sure that the accounting statements add up and that the balance carried forward from the previous year (Box 7 of 2018) equals the balance brought forward in the current year (Box 1 of 2019).
- The Responsible Financial Officer (RFO), on behalf of the authority, **must** set the period for the exercise of public rights. From the commencement date for a single period of 30 consecutive working days, the approved accounts and accounting records can be inspected. Whatever period the RFO sets it **must** include a common inspection period – during which the accounts and accounting records of all smaller authorities must be available for public inspection – of the first ten working days of July.
- The authority **must** publish the information required by Regulation 15 (2), Accounts and Audit Regulations 2015, including the period for the exercise of public rights and the name and address of the external auditor **before 1 July 2019.**

Completion checklist – 'No' answers mean you may not have met requirements		Yes	No
All sections	Have all highlighted boxes have been completed?		
	Has all additional information requested, including **the dates set for the period for the exercise of public rights**, been provided for the external auditor?		
Internal Audit Report	Have all highlighted boxes been completed by the internal auditor and explanations provided?		
Section 1	For any statement to which the response is 'no', is an explanation provided?		
Section 2	Has the authority's approval of the accounting statements been confirmed by the signature of the Chairman of the approval meeting?		
	Has an explanation of significant variations from last year to this year been provided?		
	Has the bank reconciliation as at **31 March 2019** been reconciled to Box 8?		
	Has an explanation of any difference between Box 7 and Box 8 been provided?		
Sections 1 and 2	Trust funds – have all disclosures been made if the authority as a body corporate is a sole managing trustee? **NB:** do not send trust accounting statements unless requested.		

***Governance and Accountability for Smaller Authorities in England – a Practitioners' Guide to Proper Practices**,*
can be downloaded from **www.nalc.gov.uk** or from **www.ada.org.uk**

Annual Internal Audit Report 2018/19

NORFOLK RIVERS INTERNAL DRAINAGE BOARD

This authority's internal auditor, acting independently and on the basis of an assessment of risk, carried out a selective assessment of compliance with relevant procedures and controls to be in operation **during** the financial year ended 31 March 2019.

The internal audit for 2018/19 has been carried out in accordance with this authority's needs and planned coverage. On the basis of the findings in the areas examined, the internal audit conclusions are summarised in this table. Set out below are the objectives of internal control and alongside are the internal audit conclusions on whether, in all significant respects, the control objectives were being achieved throughout the financial year to a standard adequate to meet the needs of this authority.

Internal control objective	Agreed? Please choose one of the following		
	Yes	No*	Not covered**
A. Appropriate accounting records have been properly kept throughout the financial year.	✓		
B. This authority complied with its financial regulations, payments were supported by invoices, all expenditure was approved and VAT was appropriately accounted for.	✓		
C. This authority assessed the significant risks to achieving its objectives and reviewed the adequacy of arrangements to manage these.	✓		
D. The precept or rates requirement resulted from an adequate budgetary process; progress against the budget was regularly monitored; and reserves were appropriate.			✓
E. Expected income was fully received, based on correct prices, properly recorded and promptly banked; and VAT was appropriately accounted for.	✓		
F. Petty cash payments were properly supported by receipts, all petty cash expenditure was approved and VAT appropriately accounted for.			✓
G. Salaries to employees and allowances to members were paid in accordance with this authority's approvals, and PAYE and NI requirements were properly applied.	✓		
H. Asset and investments registers were complete and accurate and properly maintained.	✓		
I. Periodic and year-end bank account reconciliations were properly carried out.			✓
J. Accounting statements prepared during the year were prepared on the correct accounting basis (receipts and payments or income and expenditure), agreed to the cash book, supported by an adequate audit trail from underlying records and where appropriate debtors and creditors were properly recorded.	✓		
K. IF the authority certified itself as exempt from a limited assurance review in 2017/18, it met the exemption criteria and correctly declared itself exempt. *("Not Covered" should only be ticked where the authority had a limited assurance review of its 2017/18 AGAR)*			
L. During summer 2018 this authority has correctly provided the proper opportunity for the exercise of public rights in accordance with the requirements of the Accounts and Audit Regulations.			Not applicable ✓

	Yes	No	Not applicable
M. **(For local councils only)** Trust funds (including charitable) – The council met its responsibilities as a trustee.			✓

For any other risk areas identified by this authority adequate controls existed (list any other risk areas on separate sheets if needed).

Date(s) internal audit undertaken: 25/03/19 – 18/04/19

Name of person who carried out the internal audit: Kathy Woodward

Signature of person who carried out the internal audit: K Woodward.

Date: 29/04/19

*If the response is 'no' you must include a note to state the implications and action being taken to address any weakness in control identified (add separate sheets if needed).

**Note: If the response is 'not covered' please state when the most recent internal audit work was done in this area and when it is next planned, or, if coverage is not required, the annual internal audit report must explain why not (add separate sheets if needed).

Annual Governance and Accountability Return 2018/19

Annual Internal Audit Report 2018/19 – additional sheet

Following on from three years of Internal Audits providing substantial assurance on the level of controls identified for:

East Suffolk Internal Draining Board

The Internal Auditor agreed with the Management to rotate the frequency of the standard internal control objective audits and include additional governance related audits.

The audit areas not covered in 2018/19 were:

D. The precept or rates requirement resulted from an adequate budgetary process; progress against the budget was regularly monitored; and reserves were appropriate.

F. Petty cash payments were properly supported by receipts, all petty cash expenditure was approved and VAT was appropriately accounted for.

I. Periodic and year-end bank account reconciliations were properly carried out.

These audits were previously covered in the 2017/18 audit and will be included within the 2019/20 audit.

Additional internal control objectives audited during the 2018/19 audit were:

- *GDPR – robustness of the policy and procedural documents, and adequacy of training provided to staff and members.*
- *Board Members' declarations of interest – review of the process for members declaring interests.*
- *Write-offs – review of the process for the write-off of debts.*
- *Succession Planning – review of the succession planning process.*

Section 1 – Annual Governance Statement 2018/19

We acknowledge as the members of:

NORFOLK RIVERS INTERNAL DRAINAGE BOARD

our responsibility for ensuring that there is a sound system of internal control, including arrangements for the preparation of the Accounting Statements. We confirm, to the best of our knowledge and belief, with respect to the Accounting Statements for the year ended 31 March 2019, that:

	Agreed Yes	Agreed No*		'Yes' means that this authority:
1. We have put in place arrangements for effective financial management during the year, and for the preparation of the accounting statements.	✓			*prepared its accounting statements in accordance with the Accounts and Audit Regulations.*
2. We maintained an adequate system of internal control including measures designed to prevent and detect fraud and corruption and reviewed its effectiveness.	✓			*made proper arrangements and accepted responsibility for safeguarding the public money and resources in its charge.*
3. We took all reasonable steps to assure ourselves that there are no matters of actual or potential non-compliance with laws, regulations and Proper Practices that could have a significant financial effect on the ability of this authority to conduct its business or manage its finances.	✓			*has only done what it has the legal power to do and has complied with Proper Practices in doing so.*
4. We provided proper opportunity during the year for the exercise of electors' rights in accordance with the requirements of the Accounts and Audit Regulations.	✓			*during the year gave all persons interested the opportunity to inspect and ask questions about this authority's accounts.*
5. We carried out an assessment of the risks facing this authority and took appropriate steps to manage those risks, including the introduction of internal controls and/or external insurance cover where required.	✓			*considered and documented the financial and other risks it faces and dealt with them properly.*
6. We maintained throughout the year an adequate and effective system of internal audit of the accounting records and control systems.	✓			*arranged for a competent person, independent of the financial controls and procedures, to give an objective view on whether internal controls meet the needs of this smaller authority.*
7. We took appropriate action on all matters raised in reports from internal and external audit.	✓			*responded to matters brought to its attention by internal and external audit.*
8. We considered whether any litigation, liabilities or commitments, events or transactions, occurring either during or after the year-end, have a financial impact on this authority and, where appropriate, have included them in the accounting statements.	✓			*disclosed everything it should have about its business activity during the year including events taking place after the year end if relevant.*
9. (For local councils only) Trust funds including charitable. In our capacity as the sole managing trustee we discharged our accountability responsibilities for the fund(s)/assets, including financial reporting and, if required, independent examination or audit.	Yes	No	N/A	*has met all of its responsibilities where, as a body corporate, it is a sole managing trustee of a local trust or trusts.*
		H	✓	

*Please provide explanations to the external auditor on a separate sheet for each 'No' response and describe how the authority will address the weaknesses identified. These sheets should be published with the Annual Governance Statement.

This Annual Governance Statement was approved at a meeting of the authority on:

13/06/19

and recorded as minute reference:

32/19/01

Signed by the Chairman and Clerk of the meeting where approval was given:

Chairman [signature]

Clerk P. Canamile

Other information required by the Transparency Codes (not part of Annual Governance Statement)
Authority web address

WWW.WLMA.ORG.UK/NORFOLK-IDB/HOME/

Section 2 – Accounting Statements 2018/19 for

NORFOLK RIVERS INTERNAL DRAINAGE BOARD

	Year ending		Notes and guidance
	31 March 2018 £	31 March 2019 £	*Please round all figures to nearest £1. Do not leave any boxes blank and report £0 or Nil balances. All figures must agree to underlying financial records.*
1. Balances brought forward	1,062,076	1,003,467	*Total balances and reserves at the beginning of the year as recorded in the financial records. Value must agree to Box 7 of previous year.*
2. (+) Precept or Rates and Levies	373,454	384,686	*Total amount of precept (or for IDBs rates and levies) received or receivable in the year. Exclude any grants received.*
3. (+) Total other receipts	621,079	817,020	*Total income or receipts as recorded in the cashbook less the precept or rates/levies received (line 2). Include any grants received.*
4. (-) Staff costs	464,381	485,794	*Total expenditure or payments made to and on behalf of all employees. Include salaries and wages, PAYE and NI (employees and employers), pension contributions and employment expenses.*
5. (-) Loan interest/capital repayments	0	0	*Total expenditure or payments of capital and interest made during the year on the authority's borrowings (if any).*
6. (-) All other payments	588,761	762,564	*Total expenditure or payments as recorded in the cash-book less staff costs (line 4) and loan interest/capital repayments (line 5).*
7. (=) Balances carried forward	1,003,467	956,815	*Total balances and reserves at the end of the year. Must equal (1+2+3) - (4+5+6).*

8. Total value of cash and short term investments	940,663	931,875	*The sum of all current and deposit bank accounts, cash holdings and short term investments held as at 31 March –* ***To agree with bank reconciliation.***
9. Total fixed assets plus long term investments and assets	63,348	55,699	*The value of all the property the authority owns – it is made up of all its fixed assets and long term investments as at 31 March.*
10. Total borrowings	0	0	*The outstanding capital balance as at 31 March of all loans from third parties (including PWLB).*

11. (For Local Councils Only) Disclosure note re Trust funds (including charitable)	Yes	No	*The Council, as a body corporate, acts as sole trustee for and is responsible for managing Trust funds or assets.*
			N.B. The figures in the accounting statements above do not include any Trust transactions.

I certify that for the year ended 31 March 2019 the Accounting Statements in this Annual Governance and Accountability Return have been prepared on either a receipts and payments or income and expenditure basis following the guidance in Governance and Accountability for Smaller Authorities – a Practitioners' Guide to Proper Practices and present fairly the financial position of this authority.

Signed by Responsible Financial Officer before being presented to the authority for approval

P Camamile

Date 25/04/19

I confirm that these Accounting Statements were approved by this authority on this date:

13/06/19

as recorded in minute reference:

33/19/01

Signed by Chairman of the meeting where the Accounting Statements were approved

[signature]

Section 3 – External Auditor Report and Certificate 2018/19

In respect of **Norfolk Rivers Internal Drainage Board – DB0061**

1 Respective responsibilities of the body and the auditor

This authority is responsible for ensuring that its financial management is adequate and effective and that it has a sound system of internal control. The authority prepares an Annual Governance and Accountability Return in accordance with *Proper Practices* which:

- summarises the accounting records for the year ended 31 March 2019; and
- confirms and provides assurance on those matters that are relevant to our duties and responsibilities as external auditors.

Our responsibility is to review Sections 1 and 2 of the Annual Governance and Accountability Return in accordance with guidance issued by the National Audit Office (NAO) on behalf of the Comptroller and Auditor General (see note below). Our work **does not** constitute an audit carried out in accordance with International Standards on Auditing (UK & Ireland) and **does not** provide the same level of assurance that such an audit would do.

2 External auditor report 2018/19

On the basis of our review of Sections 1 and 2 of the Annual Governance and Accountability Return (AGAR), in our opinion the information in Sections 1 and 2 of the AGAR is in accordance with Proper Practices and no other matters have come to our attention giving cause for concern that relevant legislation and regulatory requirements have not been met.

Other matters not affecting our opinion which we draw to the attention of the authority:

- The annual internal audit report focuses on a series of internal control objectives covering an authority's key financial and accounting systems and concludes whether, in all significant respects, the internal control objectives were being achieved throughout the financial year to a standard adequate to meet the needs of the authority. We note that the internal auditor has not provided a conclusion on the following internal control objectives: D and I. The annual internal audit report will inform the authority's response to assertions 2 and 6 in the annual governance statement. As a result, the authority must ensure that assurance that has not been provided via these control objectives has been sought elsewhere

3 External auditor certificate 2018/19

We certify that we have completed our review of Sections 1 and 2 of the Annual Governance and Accountability Return, and discharged our responsibilities under the Local Audit and Accountability Act 2014, for the year ended 31 March 2019.

External Auditor Name

PKF LITTLEJOHN LLP

External Auditor Signature PKF Littlejohn LLP   Date 23/08/2019

* Note: the NAO issued guidance applicable to external auditors' work on limited assurance reviews for 2018/19 in Auditor Guidance Note AGN/02. The AGN is available from the NAO website (www.nao.org.uk)

To IDB Chairs, Clerks & CEOs 25th September 2019

by e-mail:

Dear Chair,

IDBs' invited to take a seat on the Board of Water Resources East

We are writing to you in connection with the invitation ADA has received from Water Resources East (WRE) to take a seat on WRE's Board of Directors as a representative of Internal Drainage Boards in the East of England. The seat is linked with an annual funding contribution, estimated by WRE for the first year.

What is WRE?

Water Resources East (WRE) was formed by Anglian Water in 2014 as a pioneering collaborative approach to water resources planning across eastern England. Instead of the traditional approach, in which water companies look at water resource planning for their respective areas in isolation, WRE has brought together regulators, companies, retailers and individuals in the water, agriculture, power and environmental sector. It has looked at the needs and potential trade-offs across all these organisations and balanced considerations of customers, agriculture, the economy and the environment.

In 2019 WRE became an independent company, and WRE have made it clear that they seek a Board of Directors with as wide a membership as possible to reflect the collaborative nature of the project. To date, they have received commitments from County Councils in Lincolnshire, Norfolk & Suffolk, the NFU, RWE Energy, and a number of directly affected water companies.

WRE is rooted in the principle that there isn't a lack of water, but a lack of sustainable and resilient water management. Given the climate change and economic growth challenges we are facing, WRE's overall role will be to develop a plan to secure long-term resilience in water resources which enhances the social, economic and natural environment in Eastern England. I attached a copy of WRE's Business Plan 2019/2020.

ADA's position on WRE

ADA's own Board of Directors discussed the invitation from WRE at their last Board meeting on 3 July 2019. ADA's position is that ADA clearly supports the pioneering and innovative thinking of WRE in their collaborative work to make the connection between flood and drought risk and the long-term sustainability of water supplies for all sectors that need it. Many of our members' activities involve draining freshwater to sea and it is clear that local IDBs are unanimous in their wish to help explore and evaluate all solutions that could store or retain water for re-use at times of higher demand or shortage of supply. ADA believes that IDBs will benefit from the positive PR of being an active and integral part of the solution to potential water shortages.

Representation by ADA on WRE and similar regional organisations

ADA's Board concluded that ADA's Branch structure is best suited to supporting WRE's invitation, and other similar invitations that may come to bear in the near future in other regions of England and Wales.

In the case of WRE, their area covers several of ADA's Branches, including: Lincolnshire, Welland & Nene, Eastern and Great Ouse, and borders onto the Trent Branch also. As a member of one of these ADA Branches, your IDB is directly affected by WRE's future plans. ADA would therefore very much welcome your support, and in so doing play a key role in leading the future decisions of water management in your area.

Proposal for ADA representation

To do that, we are proposing that the seat at WRE's Board of Directors is branded as an ADA Branch seat, representing IDBs from the five relevant Branches. We already have a willing volunteer to represent ADA on the WRE Board, through David Thomas, who is Chief Executive of the Middle Level Commissioners and Honorary Secretary of ADA's Great Ouse Branch. David would feedback to ADA after each WRE Board meeting to include minutes of the meeting and any relevant commentary, as well as trying to attend a meeting of each of the involved ADA Branches over a 12 month period. ADA would pass on the information supplied by David to all relevant IDBs.

Funding for WRE

The condition of ADA taking a seat is linked to us providing some financial support for the continued administration of WRE's technical and managerial staff. WRE's technical projects are being separately funded.

WRE have intimated that they are looking for a contribution from ADA of £15,000 for the first year of operation of WRE's Board. This would be reviewed for the second and subsequent years by the WRE Board of Directors. It would not be expected to change markedly, and the ADA position on the WRE Board is otherwise unconstrained. It is suggested that, subject to reasonable review of the financial commitment in years 2 and 3, that ADA should indicate its support for an initial three year term.

ADA is keen to attract the funding for the WRE Board seat from those IDBs that are directly affected by WRE's plans and activities. Several IDBs have already intimated that they would be willing to contribute to the overall sum requested by WRE.WRE have indicated that their vision includes for a future payment mechanism for the use of stored water which may in turn reduce drainage rates paid.

Proposal for contributions

ADA therefore proposes that the £15,000 sum asked for by WRE is funded by contributions from all IDBs involved across WRE's area, through a fair and proportionate system. We propose that contributions are directly linked to the banded scale of subscription (Area Annual Value Factor) used to define the membership fee IDBs pay annually to ADA.

This is calculated as the area of the Internal Drainage District (in hectares), multiplied by the total annual value of all property within the Internal Drainage District (in pounds sterling). The result is then divided by 1 million to give you the IDB's Area Annual Value Factor.

The table attached sets out the proposed subscription scale and in the second tab the IDBs that ADA believes fall within WRE's area of interest, as well as the proportional contribution that each IDB would contribute in year one if all IDBs were to contribute[1]. A minimum contribution of £50 has been set per IDB,

[1] *Note regarding the Middle Level: In this calculation ADA has assumed that the Middle Level Commissioners will have oversight of strategic water resources management across its district. ADA has therefore excluded contributions from IDBs within the Middle Level Commissioners' District to prevent duplicate contributions from the same area.*

plus a contribution directly proportionate to the Area Annual Value Factor. IDBs should be aware that the variable component would have to increase proportionately if some IDBs opt not to contribute.

ADA proposes that the IDB that provides the representative from ADA's Branches on WRE's Board of Directors would be responsible for administering and collecting this system of contribution. In recognition of the time spent on WRE matters by that IDB and the Director, it is proposed that that IDB would not make a financial contribution. For this reason the Middle Level Commissioners' contribution has been set at zero in the table attached.

As you can see from this table, if everyone plays their part, the contributions per IDB remain very reasonable and we estimate that the IDBs will amply benefit from the resulting projects for the small investment made. The IDB's we understand to part of our Branch are highlighted in blue.

We hope that your IDB will be able to favourably consider this proposal and that we can indicate ADA's position to WRE by Friday 1st November 2019.

If you have any further questions, please do not hesitate to contact me, Robert or ADA's offices.

Yours sincerely,

Duncan Worth
ADA Director
ADA Welland & Nene Branch

Robert Caudwell
ADA Chair

	2019 December	2020 January	February	March	April	May	June	July	August	September	October	November	December	
M							1							M
Tu							2			1			1	Tu
W		1 Bhol			1		3	1		2			2	W
Th		2			2		4	2		3	1		3	Th
F		3			3	1	5	3		4	2		4	F
Sa	**1**	4	**1**		**4**	**2**	**6**	**4**	**1**	**5**	**3**		**5**	**Sa**
Su	**2**	**5**	**2**	**1**	**5**	**3**	**7**	**5**	**2**	**6**	**4**	**1**	**6**	**Su**
M	3	6	**3**	2	6	4	8	6	3	7	5	2	7	M
Tu	4	7	4	**3**	7	5 SHIDB	9	7	4 SHIDB	8	6 PCWLMB	3 SHIDB	8	Tu
W	5	8	5	4	8	6	10	8	5	9	7	4	9	W
Th	6	9	6	5	9	7	11	9	6	10	8	5	10	Th
F	7	10	7	6 WMA Pay	10 Bhol	8 Bhol	12	10 KLIDB	7	11	9	6	11 WMA	F
Sa	**8**	**11**	**8**	**7**	**11**	**9**	**13**	**11**	**8**	**12**	**10**	**7**	**12**	**Sa**
Su	**9**	**12**	**9**	**8**	**12**	**10**	**14**	**12**	**9**	**13**	**11**	**8**	**13**	**Su**
M	10 Deben Con	13 ESIDB	10	9	13 Bhol	11	15	13	10 BIDB	14	12	9	14	M
Tu	11	14	11 SHIDB	10	14	12	16 PCWLMB	14	11	15	13	10	15	Tu
W	12	15	12	11	15	13	17 ESIDB	15	12	16	14	11	16	W
Th	13 WMA	16	13	12	16	14	18 NRIDB	16	13 NRIDB	17	15 NRIDB	12	17	Th
F	14	17 KLIDB	14 AOCom	13 KLIDB	17	15	19	17	14	18 KLIDB	16	13 KLIDB	18	F
Sa	**15**	**18**	**15**	**14**	**18**	**16**	**20**	**18**	**15**	**19**	**17**	**14**	**19**	**Sa**
Su	**16**	**19**	**16**	**15**	**19**	**17**	**21**	**19**	**16**	**20**	**18**	**15**	**20**	**Su**
M	17	20 SH Per/Ch	17	16	20	18 BIDB	22 SH Cons	20	17	21	19	16	21	M
Tu	18	21	18	17	21	19 Deben Co	23	21	18	22	20 SHH&S/PD	17	22	Tu
W	19	22	19	18	22	20	24	22	19	23	21	18	23	W
Th	20	23	20 ADAWN/Li	19	23	21	25	23	20	24	22	19	24	Th
F	21	24 BIDB	21	20	24	22 KLIDB	26 WMA	24	21	25 WMA	23	20	25 Bhol	F
Sa	**22**	**25**	**22**	**21**	**25**	**23**	**27**	**25**	**22**	**26**	**24**	**21**	**26**	**Sa**
Su	**23**	**26**	**23**	**22**	**26**	**24**	**28**	**26**	**23**	**27**	**25**	**22**	**27**	**Su**
M	24	27	24	23	27	25 Bhol	29	27	24	28	26 BIDB	23	28	M
Tu	25 Bhol	28 PCWLMB	25	24	28	26	30	28	25	29	27	24	29	Tu
W	26 Bhol	29	26	25	29	27		29	26	30	28 ESIDB	25	30	W
Th	27	30 NRIDB	27	26	30	28		30	27		29	26	31	Th
F	28	31	28	27 WMA		29		31	28		30	27	1 Bhol	F
Sa	**29**		**29**	**28**		**30**			**29**		**31**	**28**		**Sa**
Su	**30**			**29**		**31**			**30**			**29**		**Su**
M	31			30					31 Bhol			30		M
Tu				31										Tu
W														W
Th														Th

Kettlewell House (lilac) — Breckland DC (green) — Hickling Barn/Village Hall (cyan) — Marsh Reeves (yellow)

Full Board Venue East Suffolk DC Offices, Melton (magenta)
Deben Com. Kirton or Bromeswell
AO Com Orford Town Hall

Saffrons Sports Centre (red)

Norfolk Rivers IDB

Distributed to:

Members

Bambridge S G (Vice-Chairman)
Birkbeck H C
Borrett W
Borthwick J
Carrick J F (Chairman)
Cator H G
Devereux I
Foster N W D
Holden, T
Housden, N
Kelly, K
Labouchere J P
Legg N
Little M R
Mack D
Monument L Mrs
Mutimer G T
Savage, R
Sayer M J
Shaw N
Shaw S
Thomas, Ms J
Wilbourn R

Officers

Bloomfield G
Brown G
Camamile P J
George P
Jeffrey Miss S
Jones T
Laburn Ms C
Mandley Miss H
Philpot M

Norfolk Rivers IDB
Meeting 16 October 2019