North Wyke Farm Platform

Fine Resolution (15-Minute) Hydrology and Water Quality Data

User Guide

Version 2.0

The North Wyke Farm Platform: Fine Resolution (15-Minute) Hydrology and Water Quality Data

DOI: https://doi.org/10.23637/rothamsted.98y34

Version: 2.0

Cite as: Hawkins, J.M.B., Griffith, B., and Harris, P. (2023). The North Wyke Farm Platform: Fine Resolution (15-Minute) Hydrology and Water Quality Data, *Rothamsted Research, Harpenden, UK.* 15pp. https://doi.org/10.23637/rothamsted.98y34

Published by: Rothamsted Research, Harpenden, UK

Date: 04 August 2025

Description: The North Wyke Farm Platform (NWFP) was established in 2010 to study and improve grassland livestock production at the farm-scale. The NWFP uses a combination of environmental sensors, routine field and lab-based measurements, and detailed management records to monitor livestock and crop production, emissions to water, emissions to air, soil health, and biodiversity. The rich NWFP datasets help researchers to evaluate the effectiveness of different grassland (and arable) farming systems, which in turn, contributes to the development of sustainable, resilient and net zero land management strategies. This document serves as a user guide to the hydrology and water quality data collected at a 15-minute temporal resolution from the NWFP. The guide gives details of the instrumentation, sensor calibration and data collection and is associated with other dedicated user guides that detail the design, establishment and development of the NWFP, field events, and the quality control process of datasets.

Site: North Wyke, Okehampton, Devon, UK. Geographic location: 50.76944, -3.90138; 50°46’10” N, 3°54’05” W.

Funding: Rothamsted Research receives strategic funding from the UK Biotechnology and Biological Sciences Research Council (BBSRC). The NWFP has been supported by grants BB/J004308/1, BBS/E/C/000J0100 and is currently supported by grant BBS/E/RH/23NB0008 (2023-28).

Table of Contents

List of Figures

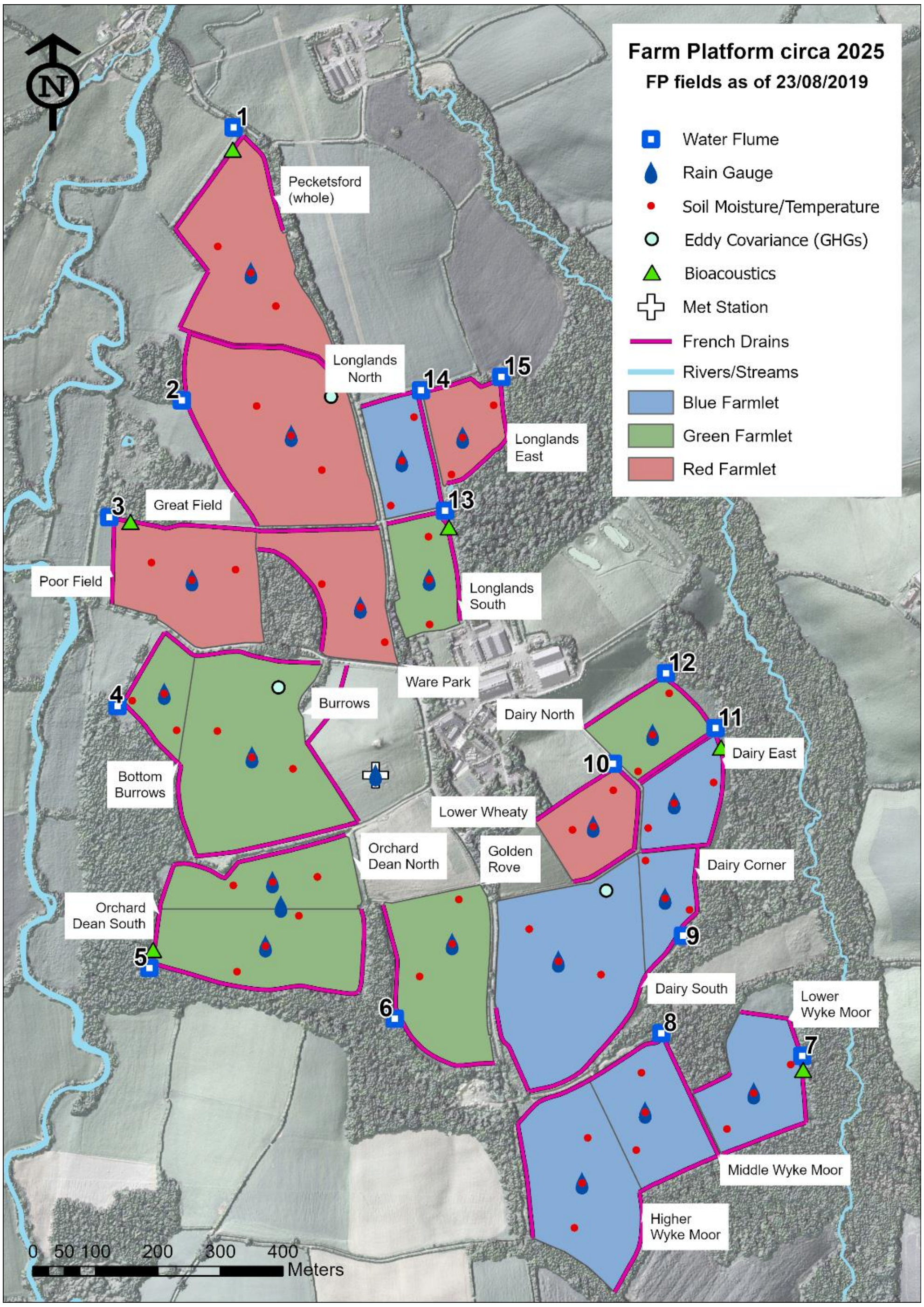
Appendices

1 Introduction

This document provides a guide to the instrumentation used to capture the hydrology and water quality data produced at a 15-minute temporal resolution on the NWFP (Figure 1). Information on the site characteristics, design and development of the NWFP, and the quality control (QC) system for the data can be found in the following User Guide documents available on the NWFP website:

- NWFP_UG_Design_Develop.pdf
- NWFP_UG_QC.pdf

Figure 1. Map of the NWFP.



2 Instrumentation

2.1 Monitoring Hydrology

Water from each of the catchments drains to a single monitoring station supplied by two branches of each French drain system which join in a confluence pit (see NWFP_UG_Design_Develop.pdf). The quantity of water discharging from each catchment is measured through a combination of primary and secondary flow devices. The primary devices are H Type flumes [TRACOM Inc., Georgia, USA] with capacity designed for a 1 in 50-year storm event (Figure 2). Flumes are fixed engineered structures that intercept and channel free-flowing liquids in such a way that flow rate can be determined by a known relationship (rating curve) between the height of the liquid at a single specific location in the flume and its flow rate. The specific design of the H flume facilitates the accurate measurement of both low and high flows and is relatively self-cleaning since it allows the ready passage of sediment and particulate matter [ISCO open channel flow measurement handbook, 2008]. The choice in size of the flumes installed on the NWFP was determined by size of the catchment they are servicing and are 1'6" (450 mm), 2'0" (600 mm) and 2'6" (750 mm) deep.

Figure 2. Example of an H-Flume with associated flume cabin.

Figure 3. Interior view of one of the flume laboratories.

Until 2015, the secondary devices used to measure water flow were bubble flow meters [4230, Teledyne ISCO, New England, USA], but during 2015 these were replaced with pressure level sensors [OTT Hydromet, Loveland, CO., USA]. These measure the depth of water by means of an integrated controller and ceramic pressure-measuring cell. The level sensors also measure the temperature of the flume water. The output level data are converted to flow (L s^{-1}) during the QC processing of the data using look-up tables based on the formulas given in Appendix A. Each catchment has a cabin or flume laboratory (Figure 2 & Figure 3) that houses telemetry devices, pumping equipment, and a by-pass flow cell that contains sensors to measure various water quality parameters, the specifications of which are described in Appendix B.

2.2 Monitoring Water Quality

A complication with the in situ measurement of water quality of discharge from land is that flow is discontinuous since it is linked to soil moisture conditions and rainfall events. Some sensors require permanent submersion in a liquid to prevent them drying out. Thus, water from a sump in the conduit that supplies the flume from the confluence pit (Figure 4) is automatically pumped every 15 minutes into the cabin and into a bespoke stainless-steel by-pass flow cell that holds 13 litres and which houses the sensors (Figure 5). Water is pumped into and out of the base of the flow cell and this, coupled with the V shape design, ensures that there is no build-up of sediment or particulate matter either between samples or over time.

Figure 4. Water sampling point in conduit.

The cycle of filling and emptying the flow cell continues whilst flow conditions allow, but when flow drops below a critical threshold the pumping cycle stops and the volume of water in the flow cell is retained, thus keeping the sensors submerged. The pumping cycle is controlled through a combination of the data from the level sensor, a netDL 1000 data logger [OTT Hydromet, Loveland, CO., USA], a programmable logic controller (PLC) [PLC LOGO, Siemens AG, Munich, Germany] and a bi-directional peristaltic pump [621VI\R, Watson-Marlow Inc., Massachusetts, USA]. The PLC stores a programme that activates the pump as well as controlling its speed and direction via a 4-20 mA connection.

Figure 5. By-pass flow cell.

The level data is processed by the netDL logger, and a signal sent to the PLC according to the following conditions:

1. If a flow data point is equal to or greater than 0.2 L s^{-1} the PLC programme is activated.

2. If a flow data point is equal to or less than 0.18 L s^{-1} the PLC programme is de-activated by switching off the signal.

Flow conditions are checked every minute and the netDL 1000 outputs a signal to the PLC whenever the flow threshold is reached, triggering it to run its routine to switch the pump either on or off.

To prevent synchronization issues[1] with other instruments the PLC runs a sub-routine, containing a timer on a loop,

[1] *Until May 2016*

that only allows the main programme to be activated for a 1 minute period every 15 minutes. Once activated the main PLC programme runs on a 900 second cycle, first running the pump in reverse to empty the flow cell for 100 seconds, then holding for 10 seconds to allow previously sampled water to flow away before running forwards for a further 100 seconds to refill the flow cell. The programme then holds for 680 seconds before repeating. This cycle will continue until the PLC no longer receives a ‘switch on’ signal, which will result in the previous sample being held in the flow cell until flow conditions rise above the 0.2 L s^{-1} threshold.

Several sensors are sited within the flow cell (Figure 5), each synchronised with the pump filling cycle to take measurements every 15 minutes shortly after the fill has completed. The water quality variables and the sensors used to monitor them are described in the following sections.

2.2.1 Turbidity, ammoniacal nitrogen, fluorescent particulate dissolved organic matter, dissolved oxygen, specific conductivity, pH, and temperature

Originally, multi-parameter sondes [YSI 6600V2, Xylem Inc Rye Brook, New York, U.S] were used that hold five sensors measuring seven water quality parameters including turbidity and dissolved oxygen measured by self-cleaning optical sensors; ammoniacal nitrogen (NH_4^+, NH_3), specific conductivity, pH and temperature measured by ion selective electrodes (ISE).

During 2016, the YSI 6600V2 sondes were upgraded to YSI EXO 2 sondes that are fitted with smart sensors. In addition, fluorescent particulate dissolved organic matter (fDOM) sensors were added to the YSI sensor array as a proxy for dissolved organic carbon / total organic carbon. The sonde communicates directly with the netDL logger via a Serial Data Interface at 1200 baud (SDI-12). The NWFP has two complete sets of sensors for the YSI EXO2 sondes, allowing one set to be calibrated and stored in the lab while the other set is deployed in the field. This helps minimise downtime and ensures continuous high data quality. Information on the updates for sondes is given in Appendix B.

2.2.2 Turbidity to sediment conversion

To convert turbidity data as NTU or FNU to sediment (g L^{-1}) refer to the calibration curves in following papers:

- *Peukert, S., Griffith, B. A., Murray, P. J., Macleod, C. J. A. and Brazier, R. E. (2014). Intensive Management in Grasslands Causes Diffuse Water Pollution at the Farm Scale. Journal of Environmental Quality, 43, 6, 2009-2023. (doi:10.2134/jeq2014.04.0193).*

- *Pulley, S. and Collins, A. L. (2019). Field-based determination of controls on runoff and fine sediment generation from lowland grazing livestock fields. Journal of Environmental Management, 249, 109365. (doi:10.1016/j.jenvman.2019.109365).*

2.2.3 Nitrate-N + nitrite-N

Combined nitrate-N and nitrite-N (NOx-N) are measured by a dedicated, self-cleaning, optical UV absorption sensor [NITRATAX Plus SC, Loveland, Colorado, USA]. Dissolved nitrate absorbs UV light at wavelengths below 250 nm. The NOx-N concentration is calculated by passing UV light through the water in the by-pass flow cell and measuring the absorption using a 2-beam turbidity compensated photometer.

2.2.4 Total phosphorus and inorganic phosphorus

Unlike the other water quality variables, the measurement of total phosphorus (Total-P) and/or inorganic P (Ortho-P) is independent of the flow cell process described above. Instead, a sample is collected directly from the sump using an associated device.

For data up until March 2021, Total-P and Ortho-P were measured only at flume cabins on Catchments 2, 3, 5 and 8. The instrumentation consisted of a SIGMATAX 2 [Hach, Loveland, Colorado, USA] which obtained a sample from the sump, homogenised it using ultra-sound before passing it to a PHOSPHAX sigma [Hach, Loveland, Colorado, USA] process photometer, to undergo digestion and colorimetric measurement using the Phosphomolybdenum Blue method. Since the instrument did not receive its samples from the flow cell, it did not have a reservoir from which to draw a sample. This meant that during periods where there was no flow through the sump, it was inoperable, since the instrument relies on a liquid passing through it. Therefore, the instrument was manually switched on and shutdown according to flow conditions. Since the automated process was not continuous, the instrument was typically used to monitor individual rainfall events or when base flow conditions were adequate to leave the instrument running for extended periods. The data were transferred via the same telemetry system as described for the other sensors, using a 4-20 mA current loop.

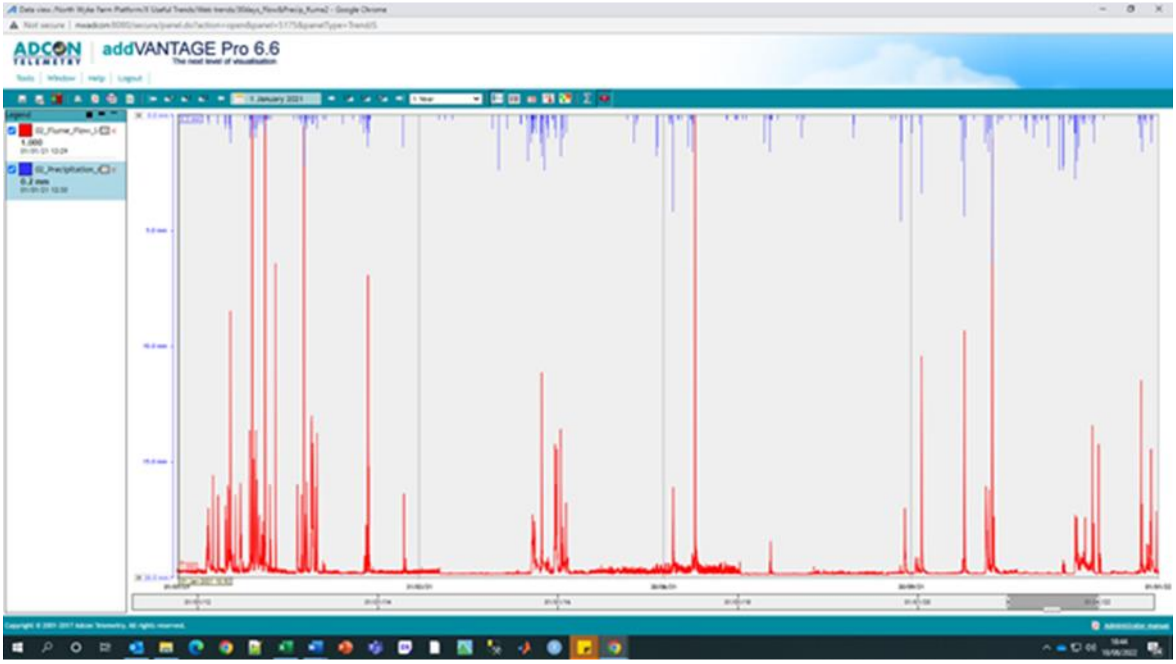
From autumn 2023, Total-P, Ortho-P, Total Carbon (Total-C) and Total Nitrogen (Total-N) are measured on all 15 catchments using a Bluemon Total P/Orth P Cabinet Analyser (Envitech Ltd, Cardiff, UK).

2.3 Data Telemetry and Acquisition

The communication network that provides continuous data transfer from the in situ water sensors sited in the flume cabins is central to the NWFP. Currently, the telemetry network collects data every 15 minutes and transfer of data is facilitated using netDL1000 loggers [OTT Hydromet, Loveland, CO., USA], that transmit via file transfer protocol (FTP) over the fibre optic network.

The 15 minute raw data are hosted by Adcon addVANTAGE pro software, allowing for visualisation (Figure 6), data processing, automated control, event alarming and data export / distribution. An extension running within the software automatically creates and exports weekly CSV files for each parameter for archive and subsequent QC procedures.

Figure 6. Example of graphical display by the addVantage Pro software of hydrology and rainfall data for one of the catchments.



3 Sensor Calibration and Data Harmonisation

Many sensor calibrations or harmonisations directly relate to the QC of the 15-minute data. To see how this relates to the QC of the 15-minute data in detail, refer to the User Guide to the QC system entitled 'NWFP_UG_QC.pdf'.

3.1 Data Sondes

Until May 2016, the NWFP used two complete sets of YSI 6600V2 sondes (incorporating ammoniacal nitrogen (NH_4^+, NH_3), specific conductivity/temperature, dissolved oxygen, pH, and turbidity sensors), allowing one set to be calibrated in the lab while the other set was deployed in the field. The sets were rotated once every month, minimising downtime and ensuring continuous high data quality. When a set of sondes was returned from the field following a period of deployment, all sensors were checked in standards of known concentration and these data used to drift correct values during subsequent quality control procedures. Once drift checked the sondes were cleaned, the pH sensors removed and placed in a pH 4 buffer, and the NH_4 ISEs removed and allowed to dry to prolong their lifespan. The sondes were then stored in hydrated calibration cups for up to one month until they were calibrated prior to deployment.

From September 2016 onwards, water quality parameters are measured using YSI EXO 2 multi-parameter sondes. The different design of the sonde allows smart sensors to be plugged in and removed easily. Thus, two complete sets of sensors, rather than the whole sondes are now in use; one set deployed in the field whilst the other is calibrated and stored in the laboratory, ready for deployment. An additional advantage is that a sonde can be mounted with multiple smart sensors of the same type for calibration, thereby speeding up the process. Full details of the new calibration procedures are described in Appendix C.

3.2 Nitratax (NO_xN)

Nitratax UV absorption sensors remain in situ and are calibrated monthly in the field. Sensor drift that may be due to lens contamination is checked prior to cleaning the instrument lenses and wiper blades.

Calibration: 2-point: 0 (Reverse Osmosis (RO) water and 11.3 mg NO_{2+3} L^{-1}.

Frequency: Monthly.

Additional info: The instruments have an annual service including a 3-point factory calibration.

3.3 Phosphax (Total-P & Ortho-P)

The Phosphax analysers perform their own daily calibration checks using a 2 mg L^{-1} standard. The Phosphax takes about 15 minutes between sample collection and generation of a value. Furthermore, although the sampling interval is stated as 15 minutes by the manufacturers, in practice it is slightly more and so drifts from the point the machine is switched on. The time stamp assigned to data points is the time they were recorded by the logger and do not represent the sample time or the time the analysis completed. This will be at least 15 minutes after sample collection but could be as much as 30 minutes. For example, if a sample was collected at 00:01, following the analysis, a data point would be available at 00:16 (and held on the devices current loop output) but not recorded by the logger until the next 15-minute time period e.g. 00:30. The Phosphax has been set up so that every other analysis is either Total-P or Ortho-P, thus each of these is measured every 30 minutes.

Although the upper detection limit of the analyser for Total-P and Ortho-P is 5 mg L^{-1} the relationship between the maximum mV output from the instrument and maximum concentration was adjusted for Total-P and Ortho-P to 1.8 mg L^{-1} and 0.8 mg L^{-1}, respectively, to increase the resolution of small concentrations. However, for data up to 13th January 2020, this has led to some capping and therefore loss of data where concentrations of Total-P in particular, exceeded 1.8 mg L^{-1} during some rainfall events. Consequently, the range was changed back to 5 mg L^{-1} on 13th January 2020 to avoid further loss of data. These data collections were ceased in March 2021, in preparation for a new suite of collections using

Bluemon sensors [GO Systemelektronik GmbH, Kiel, Germany]. Calibration details for these new sensors (measuring Total-P, Ortho-P, Total-C and Total-N) will appear once operational.

4 Sensor Downtime Log

A log of all sensor downtime issues is maintained in MS Access where input forms and restricted fields are used to ensure that the correct and required data is recorded. The information includes details on the location, the sensor, the start and end times the sensor was not functioning correctly, information about the problem and the required QC action (e.g., set recorded data as missing or add a ‘unreliable’ flag to the data). Exports from this worksheet are automatically used as part of the QC process. The sensor downtime log also serves as a useful reference when trouble shooting current sensor issues. Many sensor calibrations or harmonisations directly relate to the QC processing of the 15-minute data. To see how this relates to the QC of the 15-minute data in detail, refer to the User Guide to the QC system - ‘NWFP_UG_QC.pdf’.

5 Data Portal

The NWFP Data Portal (https://nwfp.rothamsted.ac.uk/) allows accessibility to the core NWFP datasets to not only Rothamsted Research but also the wider research community. The data are open access and free to download but users are required to register their interest.

For information on the latest version of the 15-minute datasets and the changes since the last version, please refer to the User Guide entitled ‘NWFP_UG_QC.pdf’ available on the NWFP website:

https://nw-farmplatform.rothamsted.ac.uk/nw-guides

or here:

https://repository.rothamsted.ac.uk/item/98y4y/the-north-wyke-farm-platform-quality-control-system-data-version-3-released-on-01-12-2018

In addition, the website offers a wealth of online, and regularly updated information to complement the data.

6 Citing the Data

If you choose to use any of datasets provided by the NWFP in a publication, please cite:

- *Orr, R. J., Murray, P. J., Eyles, C. J., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Goulding, K. W. T., Griffith, B. A., Gurr, S. J., Harris, P., Hawkins, J. M. B., Misselbrook, T. H., Rawlings, C., Shepherd, A., Sint, H., Takahashi, T., Tozer, K. N., Whitmore, A. P., Wu, L. and Lee, M. R. F. (2016). The North Wyke Farm Platform: effect of temperate grassland farming systems on soil moisture contents, runoff and associated water quality dynamics. European Journal of Soil Science, 67, 4, 374-385. (doi:10.1111/ejss.12350).*

In addition, if using data from the baseline period please cite:

- *Takahashi, T., Harris, P., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Hawkins, J. M. B., Misselbrook, T. H., McAuliffe, G. A., McFadzean, J. N., Murray, P. J., Orr, R. J., Rivero, M. J., Wu, L. and Lee, M. R. F. (2018). Roles of instrumented farm-scale trials in trade-off assessments of pasture-based ruminant production systems. Animal, 12, 8, 1766-1776. (doi:10.1017/S1751731118000502).*

- *Orr, R. J., Griffith, B. A., Rivero, M. J. and Lee, M. R. F. (2019). Livestock Performance for Sheep and Cattle Grazing Lowland Permanent Pasture: Benchmarking Potential of Forage-Based Systems. 9, 2, 101-118. (doi:10.3390/agronomy9020101).*

For the datasets used, please cite the latest version of the relevant User Guide PDF document(s), listed in the table below, that describe the establishment and development of the NWFP, and the various datasets produced in detail. The link to these can be downloaded from the NWFP website. Note that the User Guide entitled 'NWFP_UG_Design_Develop.pdf' should be cited irrespective of the dataset used.

Data used	Main title of User Guide PDF document	DOI
All datasets	NWFP_UG_Design_Develop.pdf	https://doi.org/10.23637/rothamsted.98y1x
All datasets	NWFP_UG_Data_Guide.pdf	https://doi.org/10.23637/rothamsted.99440
15-minute time-series datasets (water, soil moisture, meteorology)	NWFP_UG_Hydrology&WaterQuality_Data.pdf	https://doi.org/10.23637/rothamsted.98y34
	NWFP_UG_SMS_Data.pdf	https://doi.org/10.23637/rothamsted.98y4x
	NWFP_UG_MET_Data.pdf	https://doi.org/10.23637/rothamsted.98y4w
Greenhouse gases	NWFP_UG_GHG_Data.pdf	https://doi.org/10.23637/rothamsted.98y52
	NWFP_UG_GreenFeed_Data.pdf	https://doi.org/10.23637/rothamsted.98y53
Field surveys	NWFP_UG_FieldSurvey_Data.pdf	https://doi.org/10.23637/rothamsted.98y51
Livestock	NWFP_UG_Livestock_Data.pdf	https://doi.org/10.23637/rothamsted.98y50
Field events	NWFP_UG_FieldEvents_Data.pdf	https://doi.org/10.23637/rothamsted.98y4z
Forage quantity and quality	NWFP_UG_Forage_Quantity&Quality_Data.pdf	https://doi.org/10.23637/rothamsted.992wy
Biodiversity	NWFP_UG_Biodiversity_Data.pdf	https://doi.org/10.23637/rothamsted.993x2

Also, please include the following sentences in the acknowledgments section:

"The North Wyke Farm Platform is a UK National Capability supported by the Biotechnology and Biological Sciences Research Council (BBS/E/RH/23NB0008)."

"We acknowledge the interests of the Ecological Continuity Trust (ECT), whose national network of LTEs includes the experiment on which this research was conducted."

7 Appendices

Appendix A. Formulae for conversion of water height to discharge rate for different sized flumes.

Catchment Number	Flume size (ft)	Formulae (H in metres) †
1, 7, 10, 11, 12, 13, 14, 15	1.5	L^{-s} = -0.00396436 – (0.07231968 * $H^{0.5}$) + (79.89379128 * $H^{1.5}$) + (900.3765227 * $H^{2.5}$)
2, 3, 5, 6, 8, 9	2.0	L^{-s} = 0.022285358 – (0.55496382 * $H^{0.5}$) + (125.5275778 * $H^{1.5}$) + (939.5717311 * $H^{2.5}$)
4	2.5	L^{-s} = 0.042446953 – (0.90725263 * $H^{0.4}$) + (108.676075 * $H^{1.4}$) + (937.5943603 * $H^{2.5}$)

† *Taken from Field Manual for Research in Agricultural Hydrology, Agriculture Handbook No. 224, U.S. Department of Agriculture, February 1972*

Appendix B. Water properties monitored at each of the 15 catchments on the NWFP.

Water properties	Method	Units	Range	Resolution	Accuracy
Stage Height (Data not released)	Bubbler flow meter	m	0.006 - 1.6		0.006 - 1.5m: ±0.003; 0.03 – 1.6m: ±0.006
	Pressure Probe	m	0 - 4	0.001	<± 0.05% full scale
Discharge	Equation	$L\ s^{-1}$			
Pump	Peristaltic Pump	On/Off	n/a	n/a	n/a
Nitrate and Nitrite-N	UV absorption sensor (Nitratax)	$mg\ L^{-1}$	0.1 - 100	0.1	±3% of the measured value ±1.0 mg L-1
Fluorescent Dissolved Organic Matter	UV fluorescence †	QSU	0 - 300	0.01	Linearity: R2 > 0.999 for serial dilution of 300 $\mu g\ L^{-1}$ QS solution
Ammonia-N & Ammonium-N	Ion selective electrode (YSI 6600V2)	$mg\ L^{-1}$	0 - 200	0.001 - 1	±10% or 2mg N L^{-1}, whichever is greater
	Ion selective electrode (YSI EXO 2)	$mg\ L^{-1}$	0 - 200	0.01	±10% or 2mg N L^{-1}, whichever is greater
Specific Conductivity	Ion selective electrode (YSI 6600V2)	$mS\ cm^{-1}$	0 - 100	0.0001 – 0.1	±0.5% + 0.0001
	Ion selective electrode (YSI EXO 2)	$mS\ cm^{-1}$	0 - 200	0.001, 0.01, 0.1	±0.5% of reading or 0.001 $mS\ cm^{-1}$, whichever is greater
pH	Ion selective electrode (YSI 6600V2)	n/a	1 - 14	0.01	±0.2
	Ion selective electrode (YSI EXO 2)	n/a	1 - 14	0.01	±0.1 pH units within ±10˚C of calibration temp or ±0.2 pH units for entire temp range
Dissolved Oxygen	Optical Sensor (YSI 6600V2)	%	0 - 500	0.1	0-200: ±2%; 200-500%: ±6%
	Optical Sensor (YSI EXO 2)	%	0 - 500	0.1	0 to 200%: ±1% of reading or 1% saturation, whichever is greater. 200 to 500%: ±5% of reading
Turbidity	Optical Sensor (YSI 6600V2)	FNU	0 - 1000	0.1	±2% or 0.3 FNU, whichever is greater
	Optical Sensor (YSI EXO 2)	FNU	0 - 4000	0 - 999: 0.01 FNU 1000 - 4000: 0.1 FNU	0-999: 0.3 FNU or +/- 2% of reading, whichever is greater. 1000-4000 FNU: +/- 5% of reading
Temperature	Thermistor (YSI 6600V2)	°C	-5 - 50	0.01	±0.15
	Thermistor (YSI EXO 2)	°C	-5 - 50	0.001	-5 to 35: ±0.01°C 35 to 50: ±0.05°C
Total Phosphorus (in 4 catchments only)	Reduction method, IR-LED photometer	$mg\ L^{-1}$	0-5	0.1	±2.0%+0.05mg L-1
Ortho-Phosphate in 4 catchments only)	Reduction method, IR-LED photometer	$mg\ L^{-1}$	0-5	0.1	±2.0%+0.05mg L-1

Appendix C. Details of data sonde sensor calibrations.

Sensor	Calibration	Frequency	Replacement	Additional Information
Ammonium/Ammonia ISE	2-point: 1mg L^{-1} 100 mg L^{-1}	Monthly	Sensor modules replaced every 12 months.	3-point calibrations are performed when new ISEs are used that includes a 1mg L^{-1} chilled standard. Following storage periods ISEs are re-hydrated by soaking for 24 hours in a 100 mg L^{-1} NH_4 standard prior to calibration.
Specific Conductivity	1-point: 1413 µs cm^{-1} (potassium chloride 0.01 mol L^{-1} solution)	Quarterly (previously monthly)	N/A	Specific conductivity sensors also include a temperature sensor. This is checked as part of the calibration.
Dissolved Oxygen	1-point: 100% saturated air in a hydrated and aerated calibration cup	Quarterly (previously monthly)	Membranes replaced every 18 months.	None
pH	2-point: pH 7 pH 4	Monthly	Sensor modules replaced every 18 months.	The pH sensor is integral to the performance of the Ammonium ISEs as the reference junction is shared by both sensors. pH sensors are replaced as soon as raw mV values drift outside the recommended manufacturers specification and decontamination following deployment is thorough.
Turbidity	2-point: 0 FNU[2] (RO[3] water) 124 FNU (RO water)		NA	Previously 0 NTU and 126 NTU
Fluorescent Dissolved Organic Matter (fDOM)	2-point: 0 (RO water) 300 QSU (Quinine sulphate units)	Quarterly	NA	None

[2] Formazin Nephelometric Units – changed from Nephelometric Turbidity Units (NTU). No conversion of the data values is necessary since the units are comparable. A full explanation for the change in unit of measurement can be found here:
https://www.ysi.com/ysi-blog/water-blogged-blog/2016/01/turbidity-measurements-tips-and-precautions

[3] Reverse Osmosis