River Chess NOSES sampling survey

Investigating phosphate concentrations in the River Chess

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Executive Summary

Analysis of over ten years of Environment Agency revealed an increase in phosphate concentrations at Solesbridge Lane on the River Chess, suggesting an unknown source of phosphate between Solesbridge Lane and Valley Farm Road. To investigate this further, we organised Citizen Science survey days to collect and process water samples in-situ using portable equipment.

Our results confirmed that groundwater springs along the River Chess are characterised by low phosphate concentrations of c. 0.02 to 0.04 mg/L, whereas phosphate concentrations in the river water were ten times higher, ranging from 0.4 to 0.65 mg/L dependent on environmental factors. Previous analysis of phosphate concentrations by the Environment Agency indicates that 96% of the reactive phosphorus is currently from sewage treatment works (STW), but this should change after phosphorus stripping has been introduced to Chesham STW (by the end of 2024).

Our results did not identify the mystery phosphate source in the lower Chess, but we did measure several changes in phosphate concentration around Chenies and Sarratt. As a result of this first campaign we would also like to repeat sampling around Chenies STW to establish whether an increase in phosphate in this area is attributable to this small treatment works (population equivalent of 150). Phosphate concentrations did not change markedly between Chorleywood House Estate and Rickmansworth suggesting little by way of additional sources of phosphate during the time of surveying, right down into Rickmansworth. The town ditch in Rickmansworth showed no signs of urban sources of phosphate (such as due to mis-connections) during our survey. Consequently, we are hoping to run further citizen science survey days to look in finer detail at phosphate levels in the River Chess from Latimer to Chenies Bottom, and around Sarratt Bottom.

Critical findings

Key findings from each survey day are summarised in the Table below:

Reach name	Survey date	Critical finding	Further action (Y/N)
Chenies to Crossing	22/03/2023	c. 0.1 mg/L increase in phosphate observed in Chess due to Chenies STW Unexplained changes in phosphate concentration in channel network (location of some spring source and connection between spring-fed side channels and main river is unclear)	Y
Crossing to Marine	24/03/2023	Spring-fed channels have low phosphate concentration (c. 0.02 to 0.04 mg/L phosphate) Unexplained changes in phosphate concentration in channel network (location of some spring source and connection between spring-fed side channels and main river is unclear)	Y
Loudwater Estate	25/03/2023	No significant change in phosphate concentration through Loudwater Estate	N
Scotsbridge Mill	30/03/2023	No significant change in phosphate concentrations, but influence of springs seen in side-channels	N
Elms Lake	01/04/2023	Phosphate concentration are lower in Elms lake compared to main River Chess potentially due to plant uptake	N
Croxley Fisheries	18/05/2023	Very low (0.00 mg/L) phosphate concentrations in spring-fed lakes at Croxley fisheries Higher concentrations in R Chess compared to other surveys due to less dilution of treated effluent from Chesham STW by groundwater and runoff	N
Rickmansworth	23/03/2023	No evidence of higher phosphate concentrations from sewage mis-connections in town ditch Phosphate concentrations reflect combination of Chess, Gade and Colne	N
All sites	-	Phosphate concentrations may vary due to time of day in response to operation of Chesham STW	Y

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1.0 Introduction

NOSES (Nutrient Ongoing Scrutiny Evaluation Surveys) was named by one of our citizen scientists. It is a survey method designed to determine phosphate levels in the River Chess. The focus of the first campaign was to investigate a potential increase in phosphate levels occurring in the lower catchment between Sarratt Bottom and Solesbridge Lane, as captured by Environment Agency monitoring data (Fig. 1).

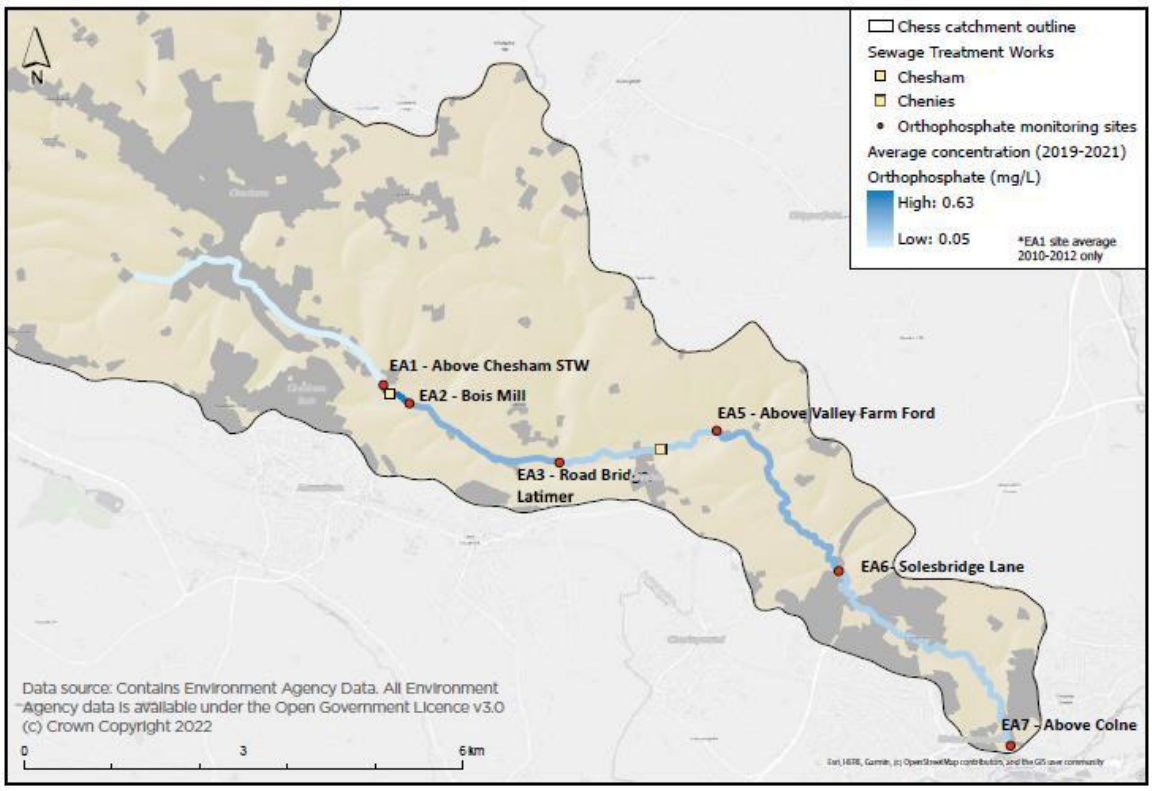

Figure 1 *Average orthophosphate concentrations as recorded monthly by the Environment Agency between 2019 and 2021 (EA1 showing 2010-2012 only). Darker colour identifies higher concentrations of orthophosphate occurring upstream of the sampled monitoring site. NOSES citizen science surveys were designed to investigate an increase in phosphate occurring between EA5 and EA6.*

1.1 Why is phosphate important?

Phosphorus is a critical nutrient for plants in the river, but too much of it can lead to a condition known as cultural eutrophication. This happens when nutrient enrichment changes the biodiversity of the river system, reducing the variety of plant species and encouraging the growth of algae (Fig. 2).

The River Chess is classified as having 'poor' phosphorus status under the Water Framework Directive. This means that the phosphorus concentrations in the river may be having a harmful effect on the river ecosystem. The Environment Agency estimate that 96% of the total reactive phosphorus (the proportion of phosphorus that is available to biota) currently originates from treated effluent entering the river from Chesham sewage treatment works (STW).

Figure 2 *River Chess with filamentous algae smothering aquatic plant species.*

To help improve the phosphorus status of the River Chess, the maximum reactive phosphorus concentration permitted in treated effluent from Chesham sewage treatment works will reduce from 2.00 to 0.25 mg P/L. Thames Water will be introducing additional treatment processes to achieve this aim by the end of 2024. This permit change is predicted (by Environment Agency SAGIS modelling) to change the watercourse status to 'moderate' phosphorous condition (Fig. 3).

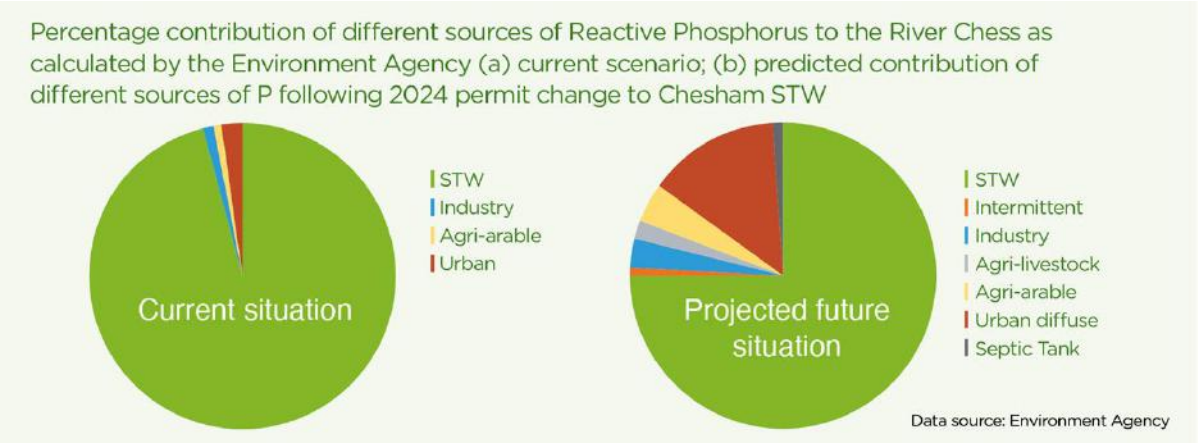

Figure 3 *Pie charts of a) current and b) proposed phosphate contribution to the River Chess as calculated by the Environment Agency. This figure was included within our 'State of the River Chess' report*[1].

2.0 NOSES survey design

Our focus was sampling the river between Sarratt and Solesbridge Lane (our river 'reach') where Environment Agency data had identified a potential input of phosphate to the river.

We sampled as far north as Chenies to understand what was happening to phosphate levels above the focal reach, to investigate the impact of effluent input from Chenies STW. Within the reach of interest, we hoped to be able to identify the location at which phosphate concentrations increased. We also sampled downstream of the focal reach to explore the impact of dilution from spring sources and artesian wells on phosphate concentrations.

To cover as much ground as possible, we co-ordinated seven separate public and privately organised citizen science survey days (Fig. 4) to include; 1) Chenies to Chess Crossing; 2) Chess Crossing to Tropical Marine Centre; 3) Loudwater Estate; 4) Loudwater Farm to Scotsbridge Mill; 5) Scotsbridge Mill to Elms Lake; 6) Croxley Hall Fisheries; and 7) Rickmansworth town centre.

For each of the survey days, we were based either at a host venue (Loudwater Farm, Rickmansworth Waterways Education Trust Centre, Elms Fishing Lake, Croxley Hall Fisheries), or under a gazebo in a more rural location (Fig. 5). We recruited citizen scientists for public survey days by setting up open Eventbrite pages for members of local communities to find the events and register their attendance, with a maximum capacity of 10 people per day. Although we advertised the survey days to our existing regular citizen science database, we also advertised the events through social media to engage new people to the project since the sampling methods were to be taught on the day. Our Loudwater Estate survey day was privately organised by one of our existing Chess citizen scientists, Kerry Rock, who is a resident of the estate. Kerry solely organised river access with landowners and recruited residents to assist with the sampling. Our final two privately organised survey days were held at fishing lakes in the Rickmansworth area, where the site managers had already expressed a strong interest in water quality and how it might impact the ecology within their lakes.

2.1 Daily setup

Before the day we carried out risk assessments of each reach. We began each survey day with an explanation of the survey purpose, followed by a demonstration of the water sampling method and a discussion about site-specific risk as identified through a risk assessment (see Appendix A). Then we allocated pairs/groups to pre-planned sampling sites.

Pairs/groups of three then left our 'base station' to collect their samples from their allocated sites, collecting two bottles of river water, recording the time of sample collection at each site and if necessary, the GPS/What Three Words location if these had not been provided. Recording time of water sample collection was important to understand the potential impacts of rainfall or possible pollution events that may have occurred before and between sampling events.

For our Elms Lake survey day on Saturday 1st April, recording the time of water sample collection was critical since the Chesham STW storm tank overflowed into the River Chess for 6.5 hours the previous evening until 00:30 on the morning of the survey.

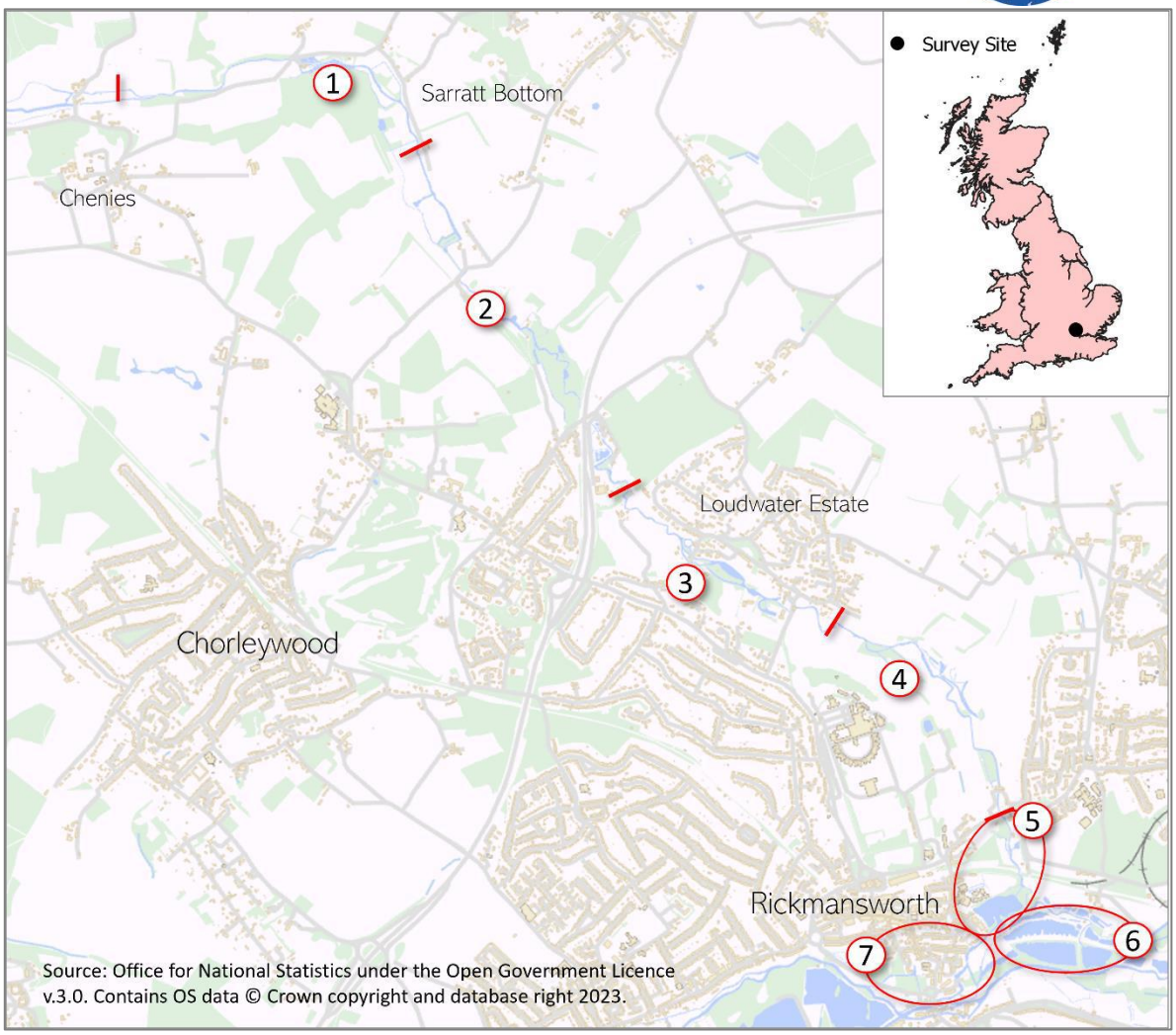

Figure 4 *Mid to lower River Chess, separated into seven reaches for public and private survey days. It should be noted that the survey days were not conducted in numbered order, nor on consecutive days.*

2.2 Sample processing

Once samples had been collected, they were returned to our 'base station' and handed over for processing. Each river water sample was processed for phosphate concentration using a Hanna HI-97713C low range portable photometer that uses a light emitting diode to determine colour of each sample once mixed with the phosphate reagent (Fig. 5 & 6). The instrument operates within a range of 0.00 to 2.50 mg/L as phosphate, with an accuracy (at 25°C) of ± 0.04 mg/L (hannainstruments.co.uk).

For quality assurance purposes, calibration of the Hanna HI-97713C was conducted and measurements recorded before the first river sample was processed on each survey day, using 0.00 mg/L and 1.00 mg/L phosphate standards provided with the Hanna HI-97713C kit. Calibration was then performed after intervals of 60-90 minutes, or after unexpected phosphate measurements were recorded from any of the river samples.

To determine phosphate concentrations, we transferred a sample of river water from one of the two bottles collected at each site into a glass cuvette (provided with the photometer kit), then placed it

into the holder of the photometer to zero the reading and account for any matrix effects from coloured material that absorbs at the same wavelength as phosphate reagents.

Following this, a Hanna HI-93713 phosphate LR reagent powder packet was carefully mixed into the glass cuvette with the river water sample. Due to the toxicity of the reagent in powder form, a face mask, safety glasses and nitrile gloves were always worn when processing these samples. This part of the process was only conducted by trained staff members Kate Heppell and/or Hannah Parry-Wilson and a COSHH and reagent safety data sheet were held on-site and identified to all event attendees should an incident occur. The cuvette was then sealed and gently shaken for 120 seconds, before being placed back into the photometer holder for a further 180 seconds before a phosphate reading was provided.

After recording the first phosphate reading, further readings to confirm stability of the result were read after increments of 20-30 seconds. If the phosphate result was unexpected or undetermined, a second sample would be processed for that site using the second sample bottle collected.

We kept the Hanna HI-97713C photometer out of direct sunlight so that sample temperatures did not fluctuate and samples were processed at fairly constant air temperatures underneath the gazebo or inside each of the indoor venues.

Figure 5 *Various locations of our survey days including a) in the gardens of Loudwater Farm, b) setup inside the gazebo where water samples pre-mixed with phosphate reagents were processed through the Hanna photometer.*

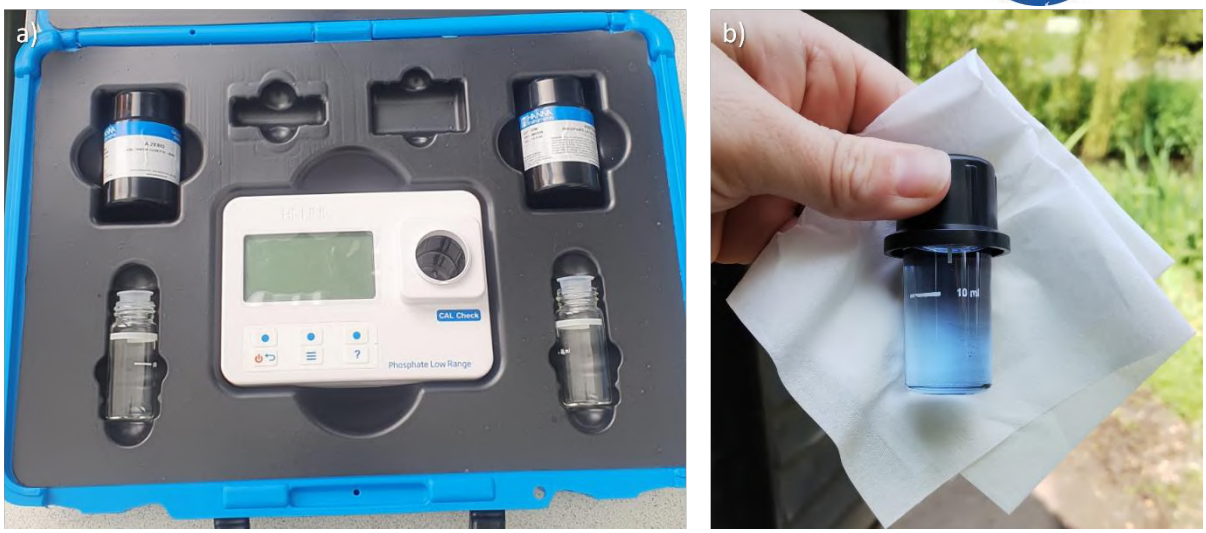

Figure 6 *a) Hanna HI-97713C low range portable photometer and b) River Chess water sample mixed with phosphate reagent in glass cuvette. The more intense the blue colour of the sample after full mixing with the phosphate reagent indicates a higher concentration of phosphate in the river water.*

2.3 Citizen scientist health & safety considerations

Sampling sites were visited before each day, and sites were assessed for safe access (firm bank, easy access). Sites would be sampled by volunteers at a distance from project staff, so extra care was needed. If a site was suitable for citizen scientist access, then a risk assessment was completed (Appendix A). As part of the Chilterns Chalk Streams Project public liability insurance, only individuals of 18 years of age could participate in this activity due to risks of working near to water.

All attendees were asked to sign in and out of the activity so that any missing persons could be identified quickly if problems were to occur. Next of kin details were collected on the day (destroyed following each event). These could also be added to a paper insert within a lanyard given to every individual. They could then carry these details on their person for use in event of any issue occurring during sample collection. Lanyards also provided contact details for the lead project organiser should an emergency occur, or should citizen scientists be approached by someone with queries that were better answered by a member of staff.

To ensure landowners could happily identify citizen scientists from the general public when accessing their land, high visibility jackets with ‘Volunteer’ were worn by all attendees. This was also crucial for sites with road crossings, car parks and busy roads (Fig. 7).

During the water sampling demonstration, all attendees were advised of the risks regarding handling of river water, such as Weil’s disease (leptospirosis), as well as the risk of soft bank edges and were advised under no circumstances to enter the water to collect samples.

Figure 7 *a) citizen scientists collecting a water sample at Sarratt and b) a group photo of citizen scientists at our privately organised Loudwater residents survey day, complete with family members learning about water sampling and the importance of river health.*

2.4 Limitations to survey method

These first survey days piloted our methods and enabled us to consider limitations to take in account during future surveys.

Our reaches were surveyed on separate days. Various parameters that fluctuate daily, both environmental and human, can influence phosphate levels. For example, rainfall can cause nutrients held in soils to flush into watercourses and can cause storm tank overflow events at sewage treatment works (such as on Friday 31st March from Chesham STW). Human use of domestic and agro-chemicals on land, such as fertilisers, can also cause significant changes to phosphate concentrations over a short amount of time.

To track phosphate sources within the lower catchment, all samples should have been collected on the same survey day. However, processing river samples through the Hanna HI-97713C photometer took ~2 hours per 8-10 samples in the field, so a single day of surveying was not feasible. In ideal circumstances, we would conduct these surveys after and during long periods of dry weather to more easily identify continuous, point sources to the river. Citizen science events, however, take time to organise, advertise and recruit for, therefore the dates that were set did not correspond to periods of dry weather. We have taken this into account when analysing the results. Now we have trained some volunteers in the technique then mobilisation for dry weather periods may become quicker.

The wet weather experienced during the surveying period also provided a further complication during sample processing. In ideal circumstances, these samples would be processed in laboratory conditions. We were, however, conducting these surveys in the field to provide live results for our citizen scientists, and the reagents were mixed with river water away from the base gazebo/venue to ensure no accidental contact with attendees (Fig. 8).

Figure 8 *Hannah Parry-Wilson mixing the phosphate powder reagent with a river water sample outside the 'base station' gazebo at Loudwater Farm on 30th March 2023, a good distance from all other staff and citizen scientists and in full PPE.*

2.5 Precision of analysis technique

Processing the samples away from a laboratory and under varying environmental conditions certainly introduced a suite of issues that should be noted.

Due to the flat design of the reagent packets that are intended to be cut open within laboratory settings, it was difficult to pour out all the reagent into the cuvette sample during wet and/or windy conditions. If the full reagent powder packet is not mixed with the river water sample, the concentration of phosphate may be under-estimated. When there were any issues mixing the powder reagent fully with the river water sample, a second sample was processed using the second sample bottle collected from that site.

In the long-term, adjustments to the reagent packet themselves into more 3D cone shapes could improve the process. When conducting further surveys, we will improve upon our processing methodology through use of a funnel and wash powder through with an aliquot of sample water. The reagent powder will continue to be added to the river sample cuvette away from the gazebo, but within a small pop-up tent (or similar).

During our survey days, river water was poured from the samples into a glass cuvette up to a 10 mL marked line on the outside of the glass, but these were not accurately measured out. Use of an adjustable volume pipette would add accuracy to the volume of river water sample placed into each cuvette, where pipette ends will need to be cleaned with deionised water between use.

Temperature was also a variable environmental factor that could not be controlled in an outdoor environment. It should be noted that the readings themselves are compensated for temperature variability by the Hanna HI-97713C photometer when processing each sample.

Calibrations were not routinely conducted at set intervals and were attempted every 60-90 minutes. For repeat survey days, a methodology will be designed to ensure calibrations are completed at set regular intervals to account for any drift in the readings.

3.0 NOSES overall survey results

A total of 85 sites were surveyed between 22nd March 2023 and 18th May 2023 (Fig. 9), including a small number that were repeated on separate days.

Phosphate concentrations ranged from 0.00 mg/L to 0.74 mg/L phosphate. The highest phosphate measurements of 0.74 mg/L were recorded on Thursday 18th May at the bottom of the River Chess, before the confluence with the River Gade/Colne/Canal, during our Croxley Hall Fisheries privately organised survey day. The lowest measurements of phosphate at 0.00 mg/L were recorded on the same survey day at Croxley Hall Fisheries from several of their spring-fed fishing lakes.

As discussed in section 2.3, it rained on most of our survey days (Fig. 10a). During rainfall events, phosphate can either be washed into the rivers from nearby soils, or rainfall can dilute phosphate concentrations, depending on the geomorphology and land use of each river catchment. Therefore, it is not possible to directly compare results from separate survey days. Only our survey day on Thursday 18th May at Croxley Hall Fisheries was conducted after a dry period (Fig. 10a & 10b).

Figure 10 shows the relationship between phosphate samples and (a) Chenies daily rainfall; (b) Chenies daily and previous days rainfall (using antecedent precipitation index method of Hill *et al.* (2014)[2]; and (c) maximum river level at Rickmansworth. These data show that, overall, site-specific factors have a greater control on phosphate concentrations in water samples than rainfall or river level. From a comparison of the data in all plots within Figure 10, we can clearly see that the range of phosphate concentrations remained comparable over the course of all survey days.

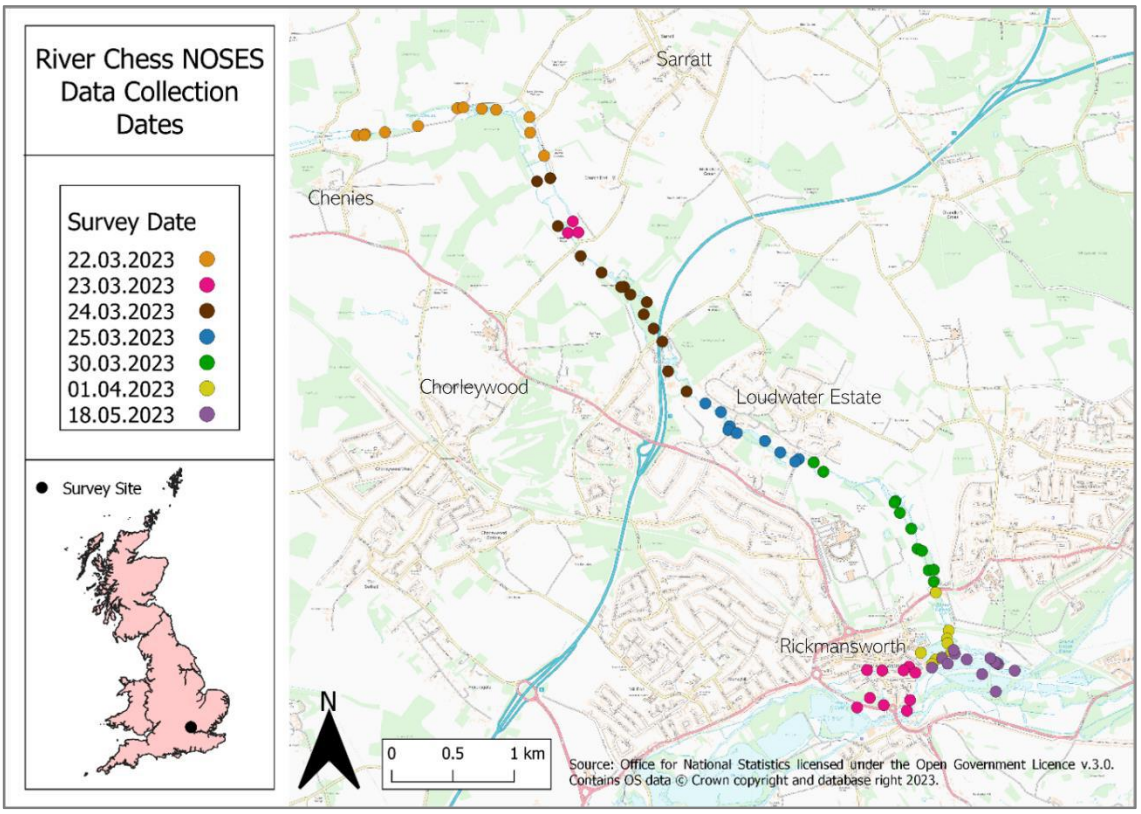

Figure 9 *Map of mid-lower River Chess showing locations of water sampling sites, colour-coded to the date of collection.*

River levels at Rickmansworth were also comparable during our earliest survey days, until 29th March 2023 (Fig. 10c), when high levels of rainfall on 30th and 31st March (Fig. 10a) caused a spike in water level. This intense rainfall event resulted in a storm overflow event at Chesham STW which began on Friday 31st March 2023 at 18:00 and lasted for 6.5 hours into the early hours of Saturday 1st April (data acquired via https://www.thameswater.co.uk/edm-map).

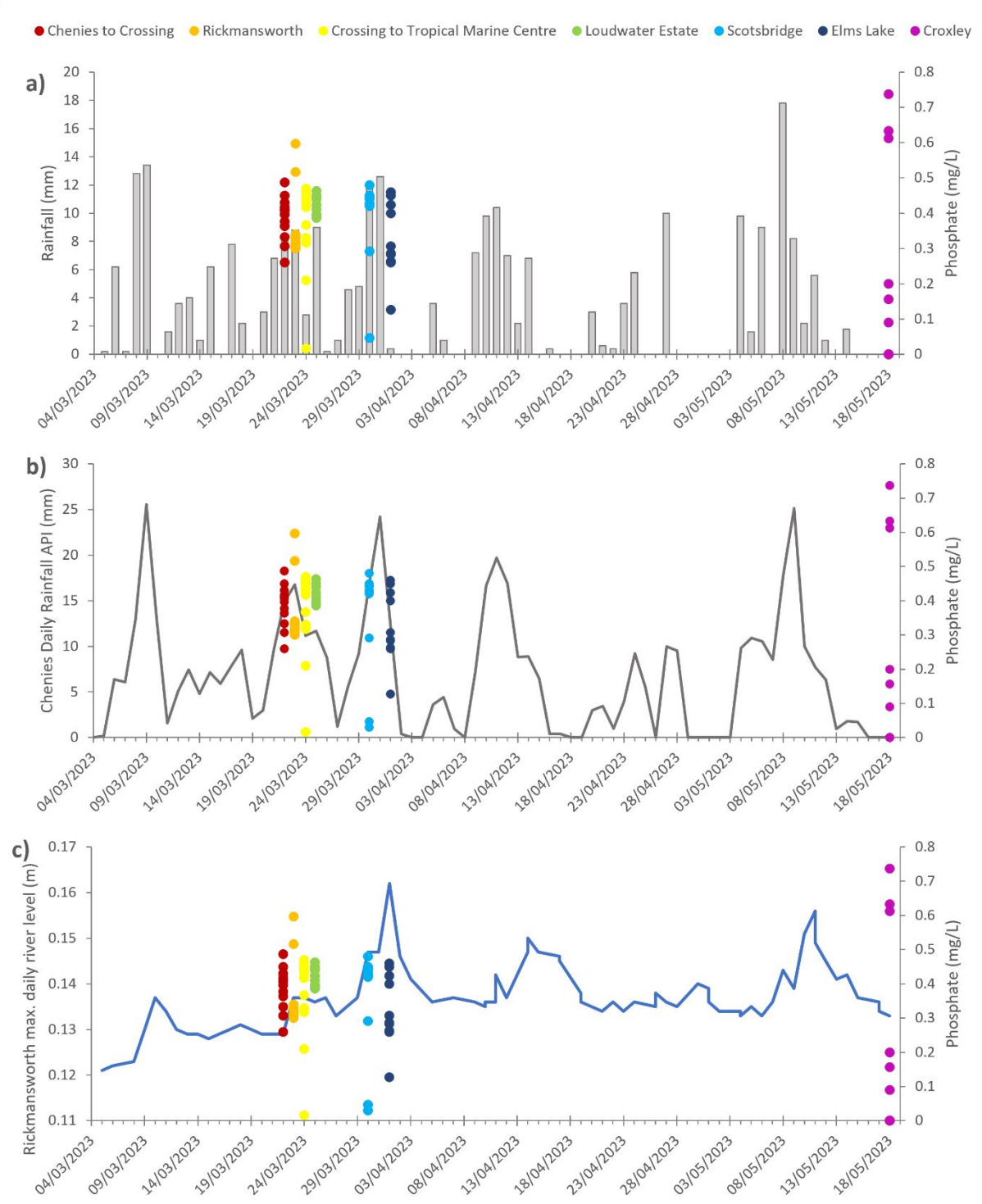

Figure 10 *a) Chenies rainfall (mm) data, b) Chenies daily antecedent precipitation index (API) (mm) data, and c) Rickmansworth maximum river level (m) data. The second axis of each plot shows phosphate concentrations (mg/L) in different colours according to location of the collected samples. Chenies rainfall and Rickmansworth maximum river level data acquired from environment.data.gov.uk/hydrology/explore via Open Government Licence v3.0, © Crown Copyright 2021. Chenies daily rainfall API data calculated from 1st November 2022, but plotted here from 4th March 2023 on the first occasion of a 0 mm API result prior to the commencement of the NOSES survey days.*

3.1 Individual survey day results

We present all the results below as separate survey days, moving from upstream to downstream.

3.1.1 Chenies to Chess Crossing, 22nd March 2023

We planned this survey day to look at phosphate concentrations both upstream and within the focal stretch of potential phosphate input, down to Chess Crossing downstream of Sarratt (Fig. 11). Our results from this survey day showed average levels of phosphate along the main river channel of between 0.33 and 0.45 mg/L.

We collected water samples both upstream and downstream of Chenies sewage treatment works (STW) (Fig. 11; Fig. 12a) to understand how the treated effluent from this small STW (population equivalent of 150) might be affecting phosphate concentrations. There was an increase of 0.11 mg/L phosphate (from to 0.31 to 0.42 mg/l) downstream of the effluent discharge point from Chenies STW (Fig 12a), but samples were collected four hours apart on a wet day, so these results need repeating during dry weather.

The side channel within Sarratt Bottom SSSI contained a lower phosphate concentration (0.20 mg/L) compared to the main channel. Whether this is because of dilution due to a spring, or due to uptake of phosphate by plants in the channel should be confirmed by a future sampling programme.

An average concentration of 0.49 mg/L phosphate was recorded in the channel parallel to Chenies STW (Fig 12b), which receives its water from both the main channel and a spring sourced near the Old Church of St Mary Magdelene's in Latimer Meadows. This high result was unexpected and further investigation is needed in this area.

Figure 12 *a) point source of effluent from Chenies sewage treatment works (STW) between a woodland and adjacent field on the opposite bank from where the photo was taken, and b) parallel channel of the River Chess not impacted by Chenies STW. Both channels join roughly 30-50 metres downstream from where these photographs were taken.*

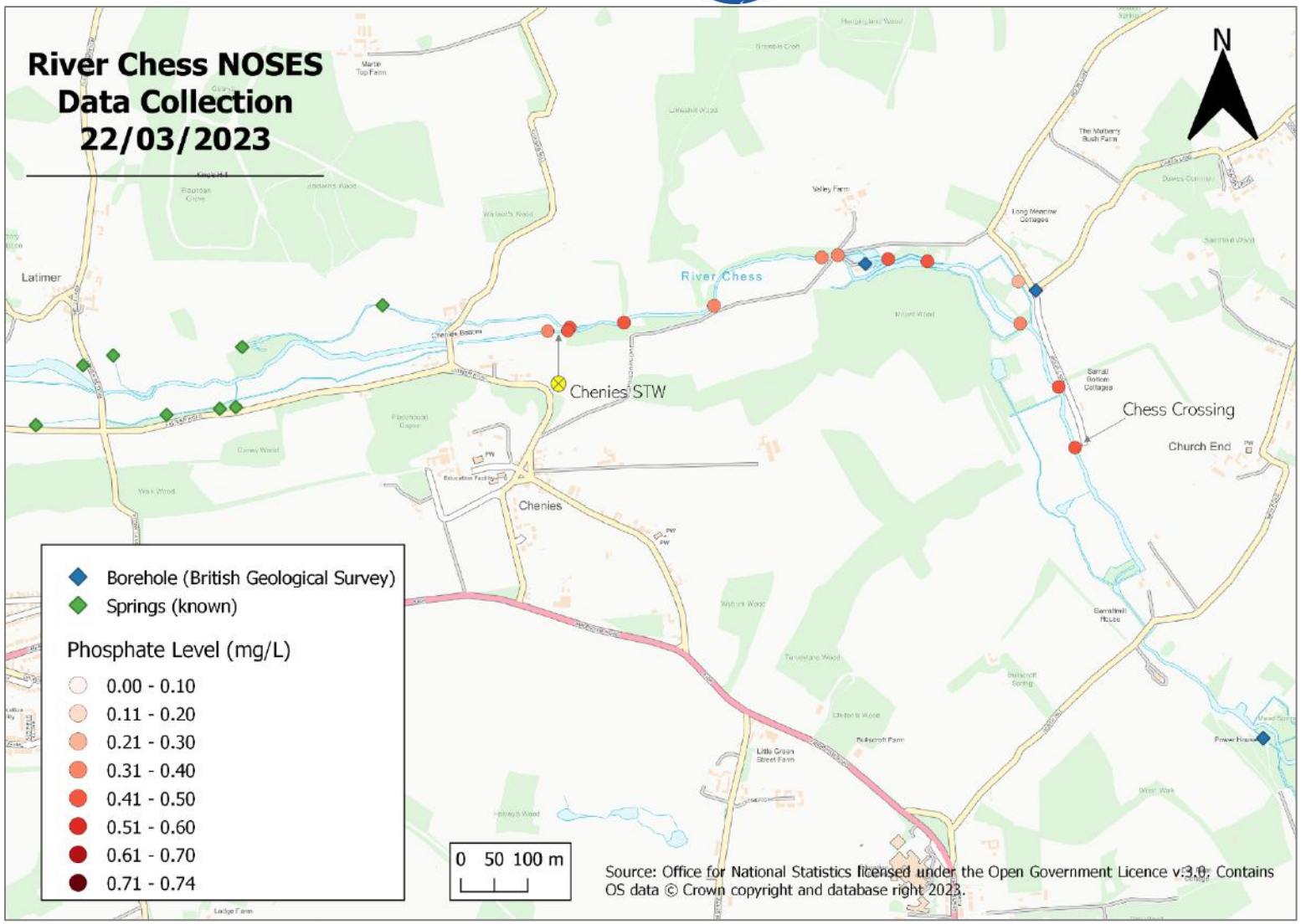

Figure 11 *Map of Chenies to Chess Crossing survey day water sampling locations, collected on Wednesday 22nd March 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend. Chenies sewage treatment works (STW) is shown as a yellow circle with cross symbol, with an arrow pointing at the discharge location into the River Chess. Contains British Geological Survey material © UKRI 2023.*

3.1.2 Chess Crossing to Tropical Marine Centre, 24th March 2023

For this survey day, our sampling sites reached as far upstream as Chess Crossing, down to the grounds of Micklefield Hall just before the River Chess runs below the M25 (Fig. 13). On the day, we welcomed many members of 'Friends of Chorleywood House Estate' to help collect our water samples.

Phosphate concentrations averaged 0.46 mg/L across the reach, dropping to 0.33 mg/L phosphate on both the main river and side channel around Fisheries Cottage in Chorleywood House Estate, and then returning to 0.42 mg/L thereafter; potentially due to inputs of groundwater with low phosphate concentration. A similar decrease in concentration (to 0.32 mg/L phosphate) was seen in the grounds of the Tropical Marine Centre at a confluence with a side stream that we think may be spring-fed, just before entry to the Loudwater Estate.

The lowest phosphate levels of 0.02 mg/L were recorded on a side channel running parallel to the main river channel which we believe is fed by a groundwater spring, on the western side of the valley across from Chess Crossing (Fig. 13; Fig. 14). Interestingly, concentrations increased in this channel to 0.21 mg/L phosphate at its lower end, so this a site worth re-investigating to see if river water from the main channel is entering this side stream via the central pond. We would like to explore phosphate concentrations in more detail, both on the main river and the side stream, to better understand variations in phosphate concentration around Sarratt Bottom.

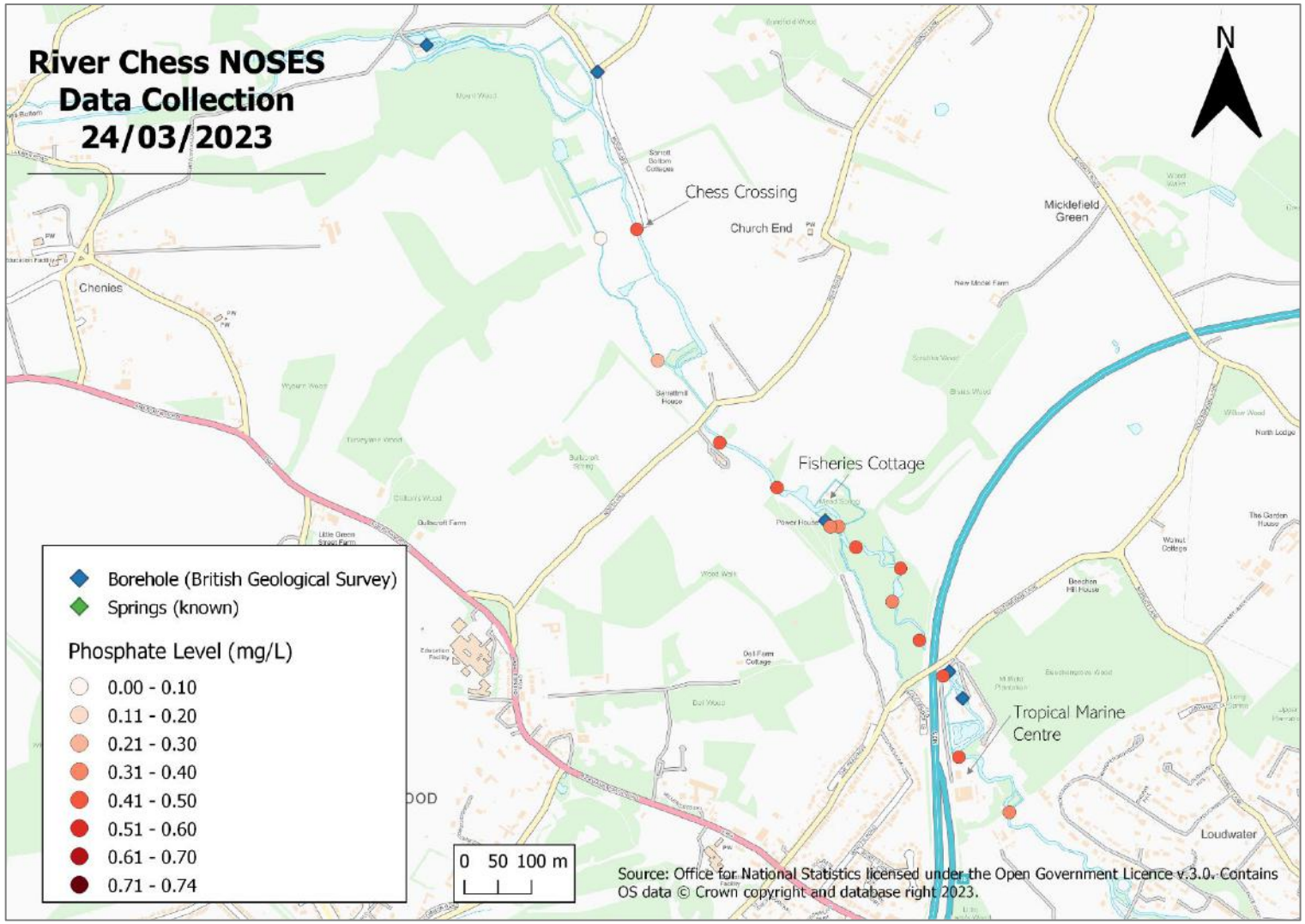

Figure 13 *Map of Chess Crossing to Tropical Marine Centre survey day water sampling locations, collected on Friday 24th March 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend. Spring source locations were unknown for this stretch of river and therefore could not be plotted. Contains British Geological Survey material © UKRI 2023.*

Figure 14 *Photos showing a) site of side channel where lowest phosphate concentration was recorded on 24th March 2023 on the western side of the valley, and b) Chess Crossing bridge where repeat water samples were collected on both 22nd March and 24th March 2023 on the eastern side of the valley below Sarratt.*

3.1.3 Loudwater Estate, 25th March 2023

Phosphate concentrations were similar at all sites sampled on this day (between 0.39 and 0.46 mg/L phosphate), suggesting that there was no input of phosphate into the River Chess within Loudwater Estate, nor are there spring sources in this location (Fig 15). We won't need to re-survey Loudwater Estate for phosphate concentrations using NOSES surveys in the near future.

3.1.4 Scotsbridge Mill, 30th March 2023

For this survey day, we were based in the gardens of Loudwater Farm, and citizen scientists walked downstream of the Loudwater Estate to collect samples as far as the grounds of the Miller and Carter Steakhouse (Fig. 16).

We repeated the water sampling at Loudwater Farm to compare results from two sites with a 5-day difference. The upstream Loudwater Farm site measured 0.40 mg/L on 25th March, then 0.45 mg/L on 30th March. The downstream Loudwater Farm site measured 0.42 mg/L on 25th March, then 0.43 mg/L on the 30th March. So, there was no significant difference in phosphate concentrations over the course of a few days.

The contrast between phosphate concentrations in the main Chess and in channels fed by groundwater sources was most starkly observed at the footbridge within this reach. Here, average phosphate levels measured 0.43 and 0.03 mg/L respectively in samples taken just a few metres apart, from separate channels (Fig 16; Fig 17). This area was historically used for watercress beds adjacent to the main river channel.

A further point of interest from this survey day presented itself when sampling the side channel that emerges from twin culverts on the southern edge of the main river channel, before the bend that leads directly to the Scotsbridge Mill restaurant (Fig. 16; Fig. 18). This side stream is not perennial and is culverted directly underneath the main River Chess from the field on the eastern side of the river. Phosphate concentrations at the northern start of the side channel were 0.45 mg/L and dropped to 0.05 mg/L before the confluence with the River Chess, potentially due to uptake by vegetation in this slow-moving channel, and/or due to dilution by groundwater.

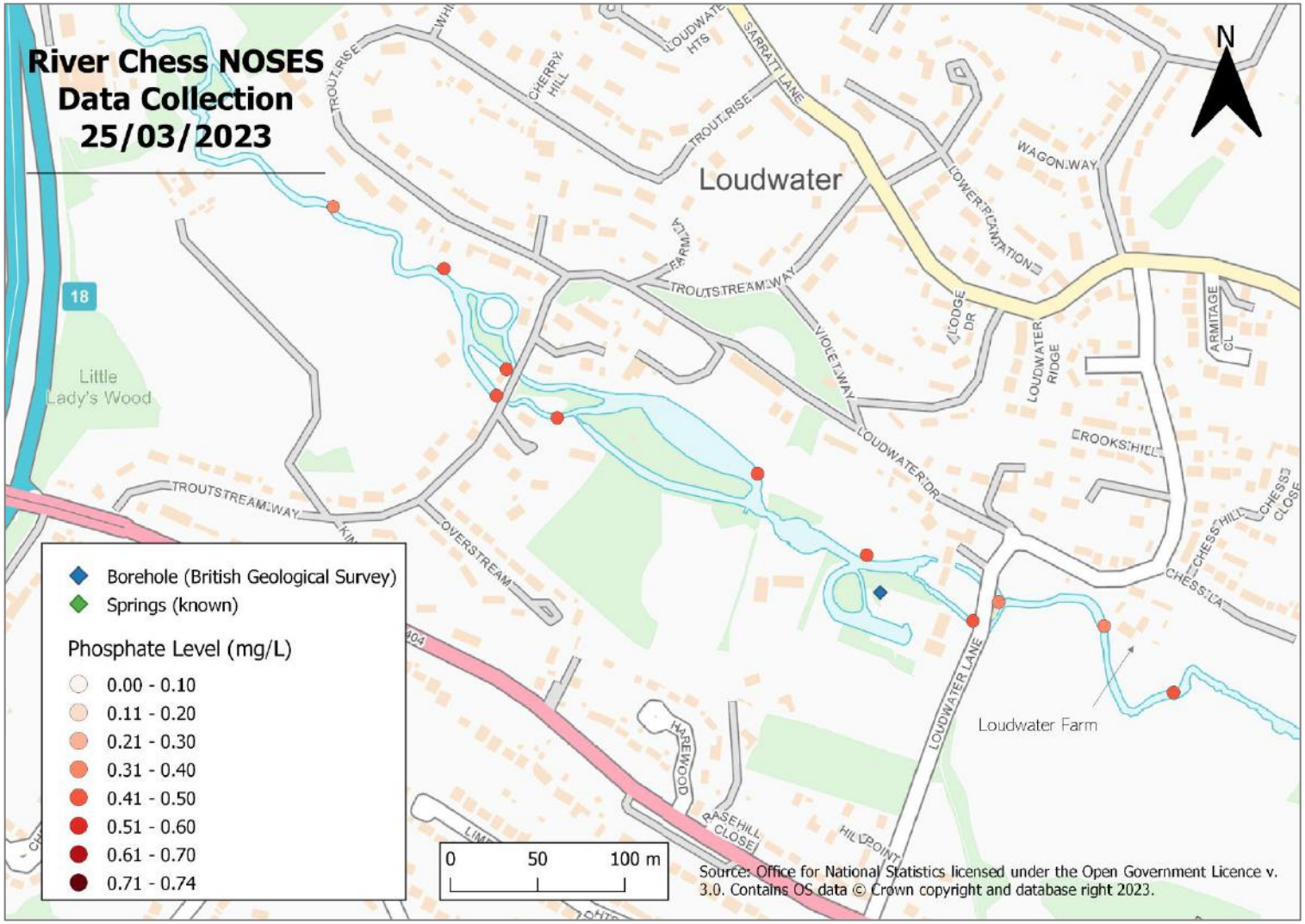

Figure 15 *Map of Loudwater Estate survey day water sampling locations, collected on Saturday 25th March 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend. Spring sources are unknown, if any occur, within this stretch of the River Chess. Contains British Geological Survey material © UKRI 2023.*

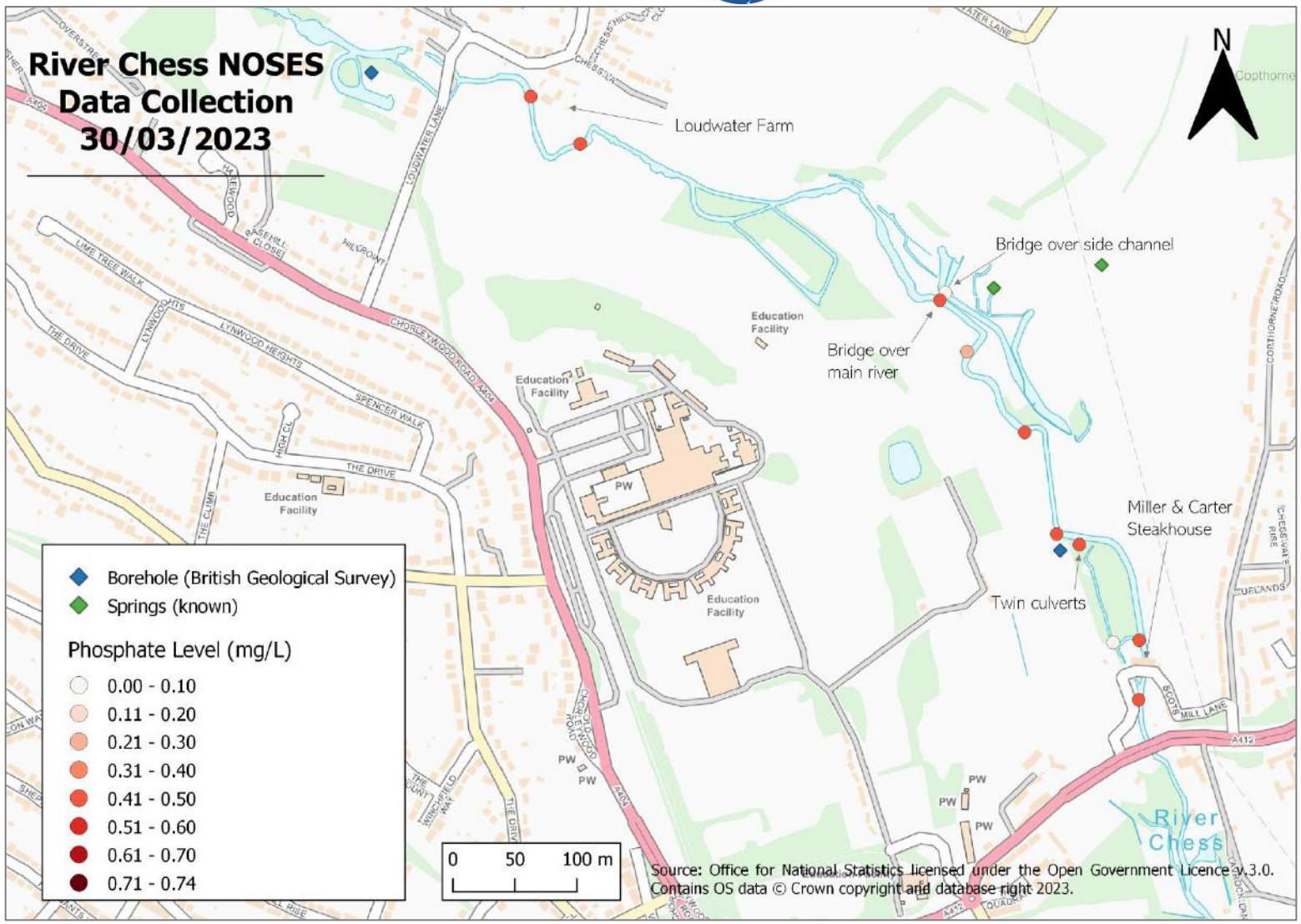

Figure 16 *Map of Scotsbridge Mill survey day water sampling locations, collected on Thursday 30th March 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend. Some spring sources are known (as shown) but it is believed that more occur within this stretch of the River Chess. Contains British Geological Survey material © UKRI 2023.*

Figure 17 *Photos showing a) site of side channel where lowest phosphate concentration was recorded on 30th March 2023, and b) bridge crossing main River Chess channel where phosphate concentrations measured more than 14 times that of the side channel.*

Figure 18 *Photos showing a) site of side channel emerging from twin culverts, following the green stretches of grass to converge where the surveyor is standing at water sampling location. Phosphate concentrations here matched those of the main River Chess. Photo b) shows southern end of the culverted side channel. Water samples were here collected upstream of the concrete bridge before the confluence with the main river offshoot.*

3.1.5 Elms Lake, 1st April 2023

Samples collected from the lower Chess around Elms Lake on Saturday 1st April (Fig. 19) were impacted by heavy rainfall which caused a peak in river levels (Fig. 10) and a storm overflow event at Chesham STW from 18:00 on 31st March 2023 for 6.5 hours. This resulted in untreated sewage effluent in the main River Chess.

Our water quality sensor at Loudwater detected a peak in ammonium around 06:00 on Saturday 1st April on our Loudwater Estate sonde (Fig. 20). This coincided with a drop in pH and spike in turbidity, the latter being a measure of cloudiness of water. It would take a few hours for water to flow from Loudwater to Elms Lake, so samples were most likely taken on the recession limb of the storm tank overflow event. We decided to persist with our sampling, with extra precautions taken to ensure our volunteers were not in contact with contaminated water.

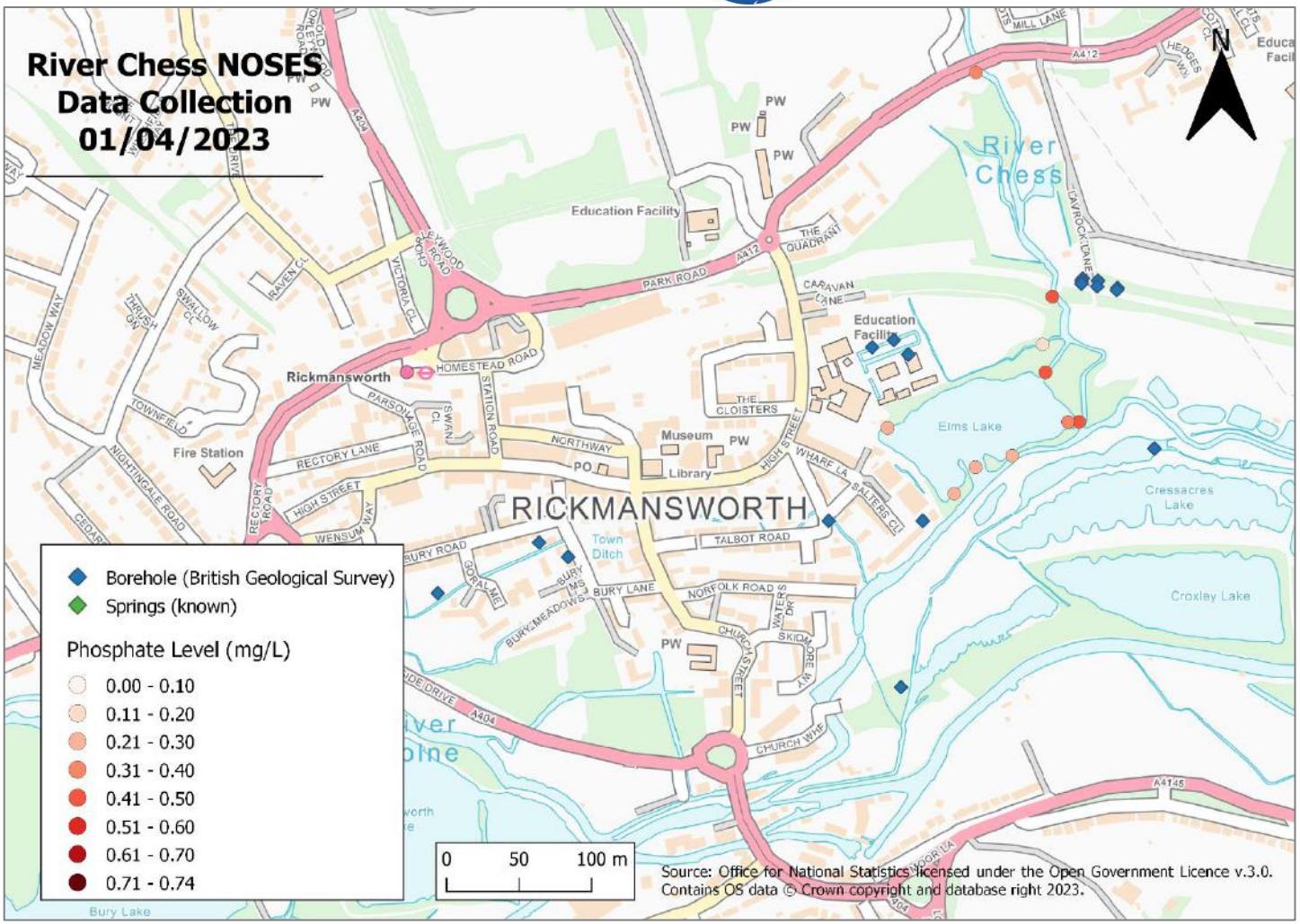

Figure 19 *Map of Elms Lake survey day water sampling locations, collected on Saturday 1st April 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend*. *Contains British Geological Survey material © UKRI 2023.*

At the Elms Lake intake point, average phosphate levels measured 0.42 mg/L, whereas sampling points from corners of the lake measured between 0.26 and 0.31 mg/L, all significantly lower than the intake point. Slow water flow and aquatic vegetation are likely taking up phosphate for plant growth, thereby lowering phosphate levels. We won't need to resurvey phosphate levels around Elms Lake in the near future due to the consistency of results around the lake.

Highest phosphate concentrations were found on the main River Chess channel (0.40 to 0.46 mg/L phosphate) with no significant differences between consecutive sampling sites. At the end of the River Chess, the river meets the Gade/Colne/Canal having passed through Croxley Hall Fisheries. A further sample was taken on the Chess/Gade/Colne/Canal just before the Elms Lake outflow, measuring 0.26 mg/L. This suggests that the Gade/Colne/Canal is diluting phosphate from the River Chess. We explored this in a bit more depth during our Croxley Hall Fisheries survey day (see section 3.1.6).

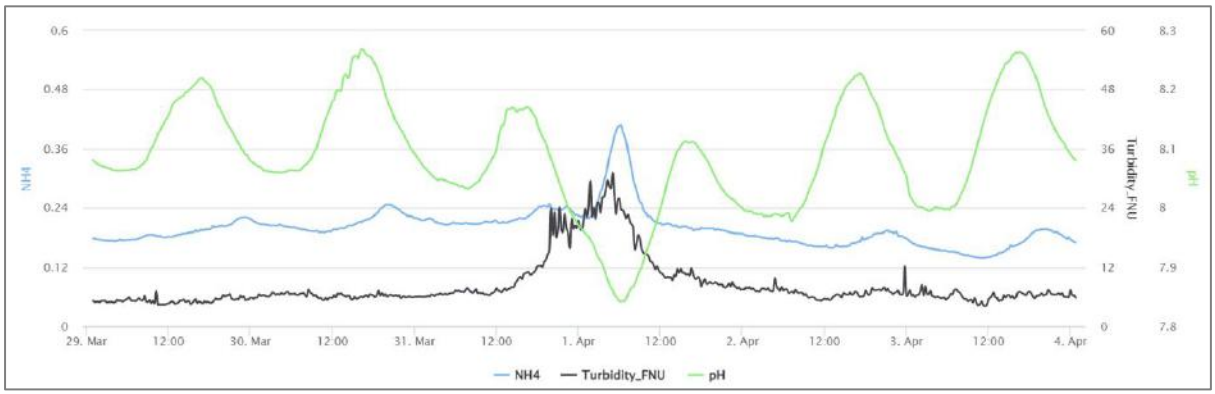

Figure 20 *Line graph showing levels of Ammonium (NH4 = blue) against turbidity (FNU = black) and pH (green) from 00:00 on 29th March to 00:00 on 4th April 2023, recorded by our water quality sonde in Loudwater Estate, Rickmansworth. Peak of Ammonium and lowest pH were recorded at 06:00 on Saturday 1st April 2023.*

3.1.6 Croxley Hall Fisheries, 18th May 2023

Reasonably dry weather preceded this survey day (Fig. 10), where we collected samples from each of six lakes at Croxley Hall Fisheries, from the River Chess, the Gade/Canal, the Gade/Colne/Canal, and after the confluence of the Chess/Gade/Colne/Canal (Fig. 21).

From this survey day, we found that phosphate concentrations were below levels of detection at seven locations, including all sampled spring-fed lakes that each resulted in levels of 0.00 mg/L. These results were repeated, and similar results were obtained during the second set of tests.

River water entering Croxley Hall Fisheries, both into the Gade/Canal tributary on the eastern side of the estate and into Broadacres Lake at the southern border, resulted in similar average phosphate concentrations of 0.20 mg/L and 0.16 mg/L respectively. After leaving Broadacres Lake, river water then heads north very slowly and phosphate concentrations drop to 0.00 mg/L, suggesting uptake by aquatic vegetation. This cleaner water then joins the Gade/Colne beside Longwater (lake), which dilutes concentrations down to 0.09 mg/L as the stream runs towards the River Chess (Fig. 21).

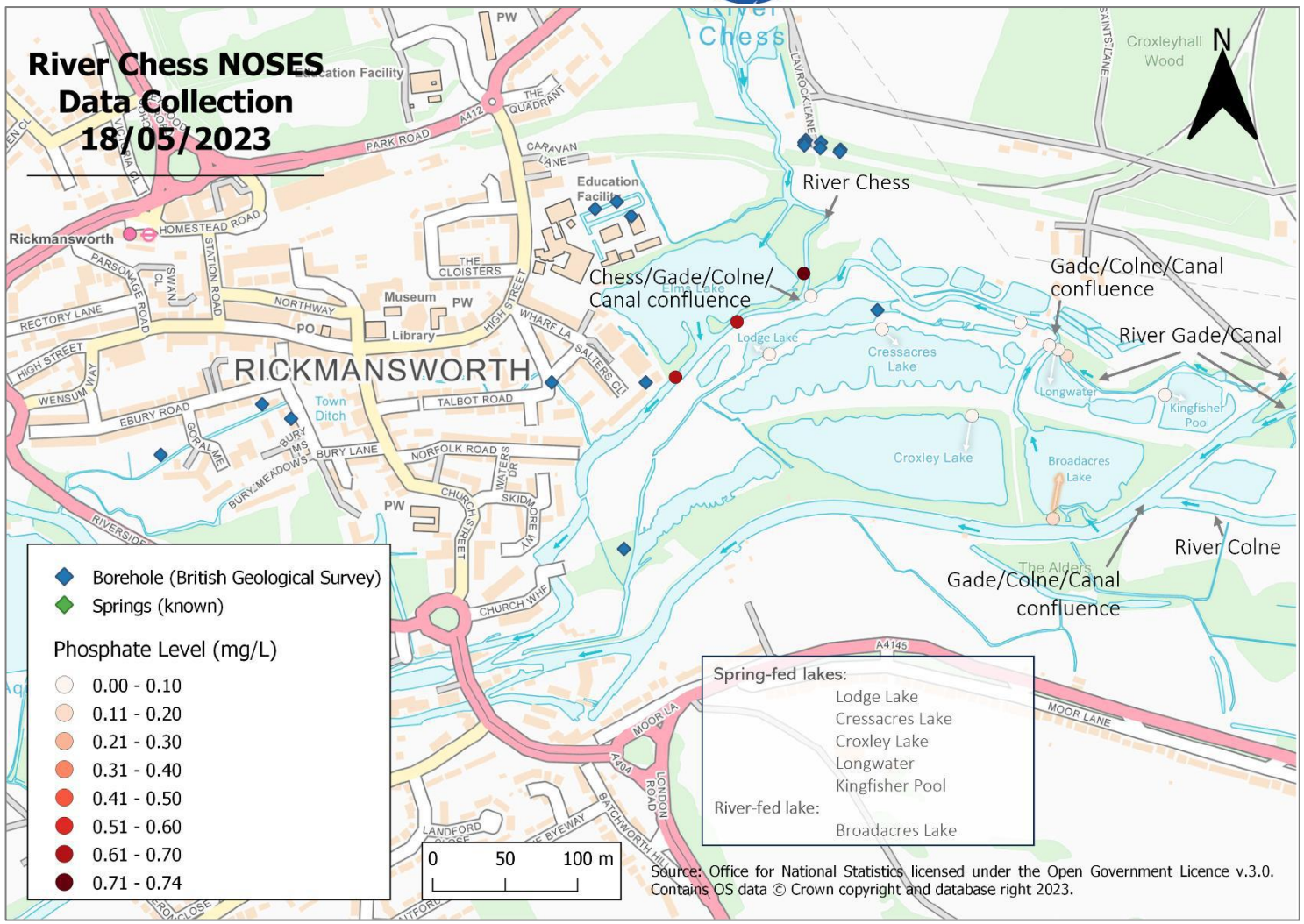

Figure 21 *Map of Croxley Hall Fisheries water sampling locations, collected on Thursday 18th May 2023. Phosphate levels are identified by circles using the colour ranges within the legend. Phosphate levels from samples taken on lakes have been identified with a white/orange arrow pointing to each respective lake name. River names and confluences have been identified on the map to assist with understanding of dilution effects; the Gade/Canal waterways include several rivers on the western side of the map and are therefore named as such due to repeated mixing of both waterways much further upstream of Croxley. Contains British Geological Survey material © UKRI 2023.*

We recorded the highest phosphate concentrations of 0.74 mg/L in the lower River Chess on this survey day. Phosphate levels dropped significantly to 0.63 mg/L downstream of the confluence between the River Chess and the Gade/Colne/Canal, highlighting that at this time the Gade/Colne/Canal waters were diluting phosphate-rich water from the Chess. Previously, the River Chess had recorded significantly lower phosphate concentrations of 0.46 mg/L on 1st April at our Elms Lake survey day, following heavy rain and during a period of storm tank overflow from Chesham STW. We hypothesised that higher concentrations on the Chess on the later survey day (18th May 2023) could be due to (i) the effects of seasonality on phosphate concentrations; (ii) lower groundwater levels in May thus less dilution of treated effluent; and/or (iii) dry conditions resulting in less dilution of treated effluent by runoff caused by rainfall.

Analysis of monthly grab samples collected by the Environment Agency from Solesbridge Lane to determine phosphate concentrations, allows us to discount the effect of seasonality (Fig. 22). Note that the Environment Agency measured phosphate concentrations in the main river channel on 3rd March 2023 of 0.62 mg/L and on 5th April 2023 of 0.37 mg/L, where we measured 0.43 – 0.45 mg/L at a similar location on the 24th March; our results fit the general trend of the Environment Agency's plotted data (Fig. 22).

Water flow rate (Fig 23a) dropped substantially between the surveys conducted on 1st April and 18th May 2023. Furthermore, groundwater levels begin a downward trend after annual peaks generally occur in April (Fig 23b) which started to become apparent in the Rickmansworth maximum river level data (Fig. 10c), so we cannot distinguish between the effects of the two factors in this instance.

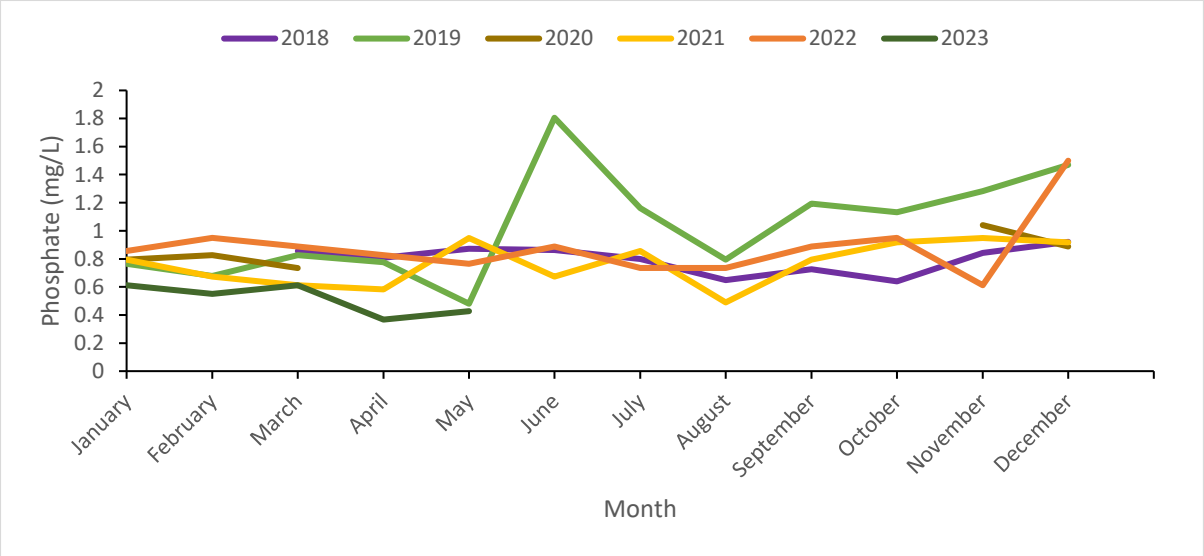

Figure 22 *Phosphate, unfiltered (mg/L) recorded monthly at Solesbridge Lane on the River Chess by the Environment Agency. Colours show data recorded per year from 2018 to 2023. Data downloaded from Environment Agency Open Water Quality Archive Dataset; environment.data.gov.uk/water-quality/ via Open Government Licence v3.0, © Crown Copyright 2021.*

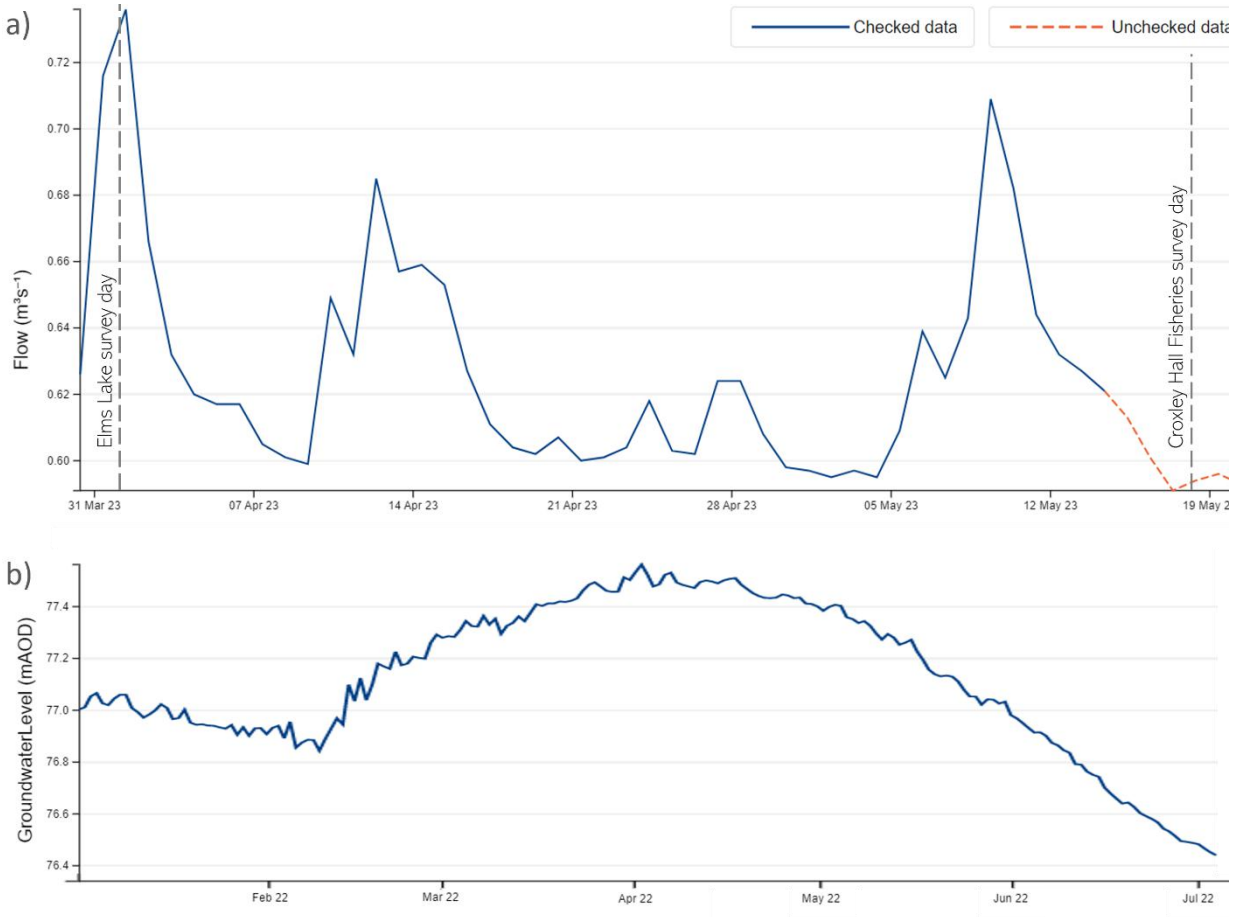

Figure 23 *Data showing a) mean daily water flow rates (m^3s^{-1}) for the lower River Chess in Rickmansworth, recorded at the Rickmansworth gauging station upstream of Elms Lake. Data for b) daily logger groundwater level (mAOD) between 1st January and 14th July 2022, as recorded by the Environment Agency at Amersham Road, Little Chalfont. Please note the differing x-axis timelines. Data obtained from Environment Agency Open Water Quality Archive Dataset; environment.data.gov.uk/water-quality/ via Open Government Licence v3.0, © Crown Copyright 2021.*

3.1.7 Rickmansworth, 23rd March 2023

This Rickmansworth survey day focussed mainly on the collection of water samples from Rickmansworth town ditch, the Chess/Gade/Colne/Canal confluence leading into the canal and a side channel running through Bury Park (Fig. 24). All surveyed sites throughout the town centre, canals and side streams recorded phosphate concentrations of 0.30 – 0.34 mg/L, highlighting that on the day of our survey there were no sewage pipe misconnections occurring in the area. Phosphate concentrations reflected those in the main river channel which comprises water from the Chess, Gade, Colne and Grand Union Canal.

We do not feel the need to repeat our phosphate water sampling in Rickmansworth in the near future due to these consistent levels recorded.

Samples were also collected on this day from the River Chess just above North Hill/New Road in Sarratt Bottom. We believe the higher phosphate concentrations recorded are a result of treated effluent from the Chesham and/or Chenies STW further upstream. We are therefore keen to further explore the importance of groundwater dilution from spring sources in the Sarratt Bottom area.

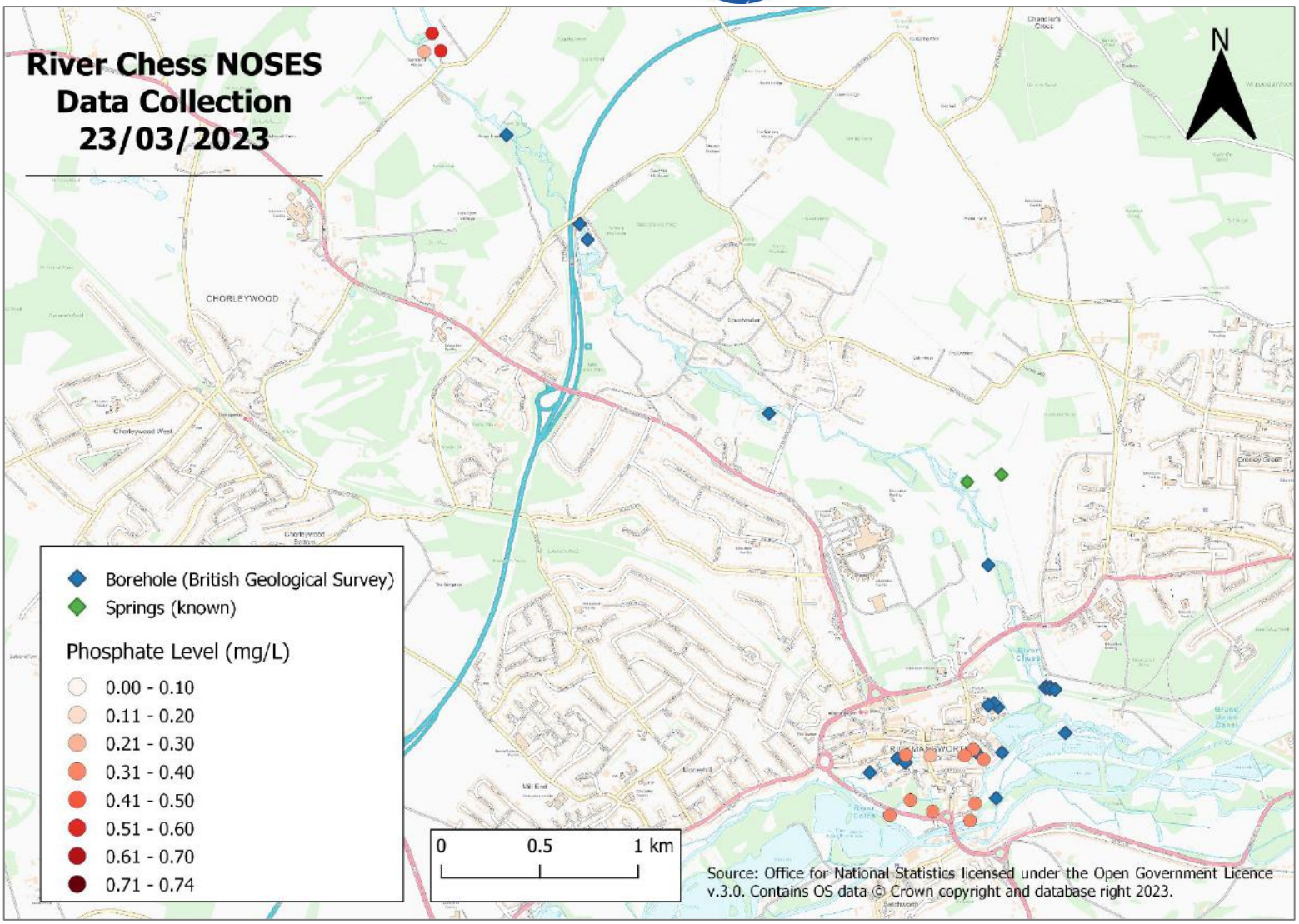

Figure 24 *Map of lower Chess, between Sarratt Mill House and Rickmansworth. This survey day was based in Rickmansworth, but shows all water sampling locations collected on Thursday 23rd March 2023. Phosphate levels at each location are identified by circles using the colour ranges within the legend. Contains British Geological Survey material © UKRI 2023.*

3.2 Importance of time of day for phosphate sampling

We cannot rule out time of day as a reason for some variability in phosphate concentrations in the River Chess. For example, our upstream water quality sensors show daily variations in ammonium consistent with the daily operation of Chesham STW with peaks at 13:00 and 00:30 each day corresponding to peak usage time plus the time it takes to treat domestic sewage in the morning and evening respectively (Fig. 25).

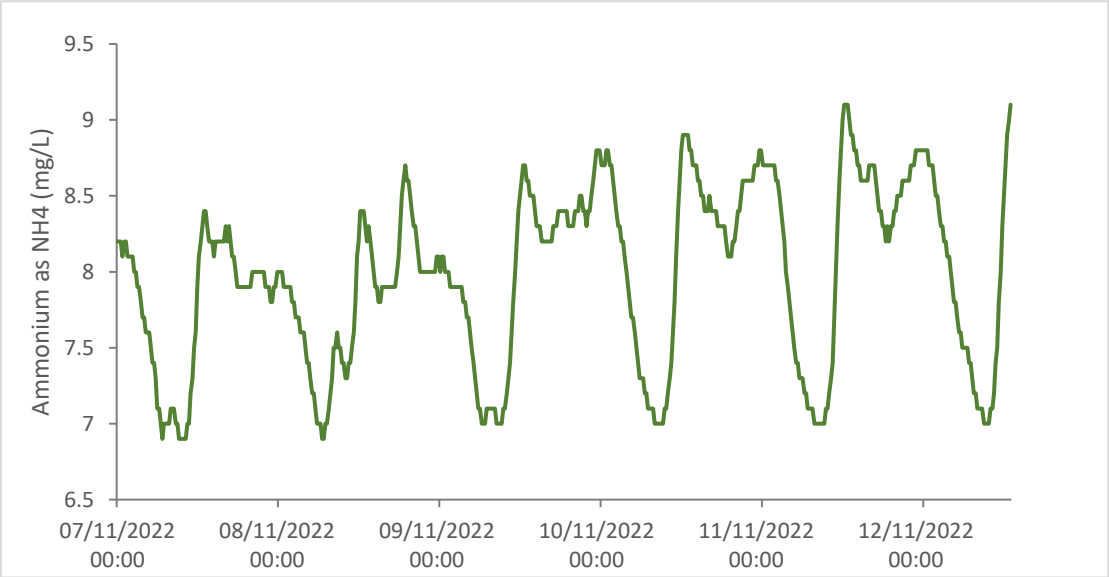

Figure 25 *Ammonium (mg/L) concentrations recorded by a water quality sensor downstream of Chesham Sewage Treatment Works. The data shows ammonium levels recorded over the course of six days between Monday 7th and Saturday 12th November 2022. Due to the technology currently available to record ammonium levels, only patterns in the data can be observed, where accurate measurements cannot be obtained due to upwards drifts in the data over short spaces of time. This distribution shows a bimodal daily pattern of increased ammonium levels, coinciding with increased treated effluent output as a result of heightened domestic water usage. Data available to view online: https://rhysh.shinyapps.io/ChessWatch/.*

3.3 Critical findings

Key findings from each survey day are summarised in the Table below:

Reach name	Survey date	Critical finding	Further action (Y/N)
Chenies to Crossing	22/03/2023	c. 0.1 mg/L increase in phosphate observed in Chess due to Chenies STW (measure upstream and downstream at same time of day) Unexplained changes in phosphate concentration in channel network (location of some spring source and connection between spring-fed side channels and main river is unclear)	Y
Crossing to Marine	24/03/2023	Spring-fed channels have low phosphate concentration (c. 0.02 to 0.04 mg/L phosphate) Unexplained changes in phosphate concentration in channel network (location of some spring source and connection between spring-fed side channels and main river is unclear)	Y
Loudwater Estate	25/03/2023	No significant change in phosphate concentration through Loudwater Estate	N
Scotsbridge Mill	30/03/2023	No significant change in phosphate concentrations, but influence of springs seen in side-channels	N
Elms Lake	01/04/2023	Phosphate concentration are lower in Elms lake compared to main River Chess potentially due to plant uptake	N
Croxley Fisheries	18/05/2023	Very low (0.00 mg/L) phosphate concentrations in spring-fed lakes at Croxley fisheries Higher concentrations in R Chess compared to other surveys due to less dilution of treated effluent from Chesham STW by groundwater and runoff	N
Rickmansworth	23/03/2023	No evidence of higher phosphate concentrations from sewage mis-connections in town ditch Phosphate concentrations reflect combination of Chess, Gade and Colne	N
All sites	-	Phosphate concentrations may vary due to time of day in response to operation of Chesham STW	Y

3.4 Citizen science engagement

Although these surveys could be completed with research staff collecting and processing the data, this citizen science initiative aimed to engage the local community, help enhance their knowledge of environmental issues, and develop their skillset through various surveying methods.

We were delighted that 51 citizen scientists, both existing and new to the project, joined us during our NOSES phosphate sampling days (Fig. 26). We were in contact with 12 different landowners (not including individual residents with river access in the Loudwater Estate) who all graciously gave their permission for either our staff or citizen scientists to access their land to collect water samples from the River Chess and various side channels. We would also like to offer many thanks to another citizen scientist, Sian Hows, for her wonderful production of maps and data plots for this report.

Figure 26 *Photos of citizen scientists and their furry friends involved in our NOSES phosphate sampling days taken at a) Croxley Fisheries, b) Elms Lake, c) Scotsbridge Mill (based at Loudwater Farm) and d) Elms Lake.*

4.0 Plans for further citizen science surveys

We are keen to repeat a survey day with sampling sites around Sarratt Bottom, including a couple of sites slightly south of North Hill/New Road, due to slightly higher concentrations of phosphate found upstream of Sarratt Mill House (Fig. 27).

We have also found an area of interest in the mid-Chess at the most upstream part of our surveys, around the Chenies Bottom area. Here we are keen to understand the importance of dilution on the split channels from spring sources (Fig. 28), and re-measure phosphate concentrations upstream and downstream of Chenies STW.

We hope to survey these two areas of interest (Chenies Bottom and Sarratt Bottom) on two separate survey days, following a period of dry weather. Initial survey days will be organised with a back-up date in mind for both should wet weather ensue. We currently have plans to carry out these survey days in July/August 2023.

With any repeat surveys conducted as part of the NOSES method, we are now aiming for more scientific accuracy and therefore triplicate (three) water samples will be collected and processed for each of the water sampling sites following our revised methodology described in Section 2.5.

Figure 27 *Maps of suggested water sampling sites pending landowner contact and permission, including sites a) upstream of Chess Crossing, and b) downstream of Chess Crossing including one site below North Hill/New Road and two sites along the spring-fed side channel to see whether river water from the main river channel is entering the side channel below the connected pond. Ordnance Survey maps produced using Digimap OS Roam online, accessed and annotated on 7th June 2023; https://digimap.edina.ac.uk/.*

Figure 31 *Maps of suggested water sampling sites pending landowner contact and permission, including sites a) upstream of Chenies Bottom through Latimer meadows, and b) downstream of Chenies Bottom. Ordnance Survey maps produced using Digimap OS Roam online, accessed and annotated on 7th June 2023; https://digimap.edina.ac.uk/.*

Acknowledgements

We would like to extend our thanks to all the landowners who granted us access to collect water samples for this survey, to those who provided us nearby parking spots for the day, and to those who additionally offered locations to for our gazebo as a 'base station' for each of our rural survey days.

We would also like to thank everyone who got involved in collecting water samples for these surveys, including those that stayed for the full day and helped us record the data, tidy up and even pack up our equipment.

Furthermore, we would like to give huge thanks to Sian Hows, a new citizen scientist to the project who volunteered much of her time outside of her full-time job to map our NOSES data.

Most especially, we would like to thank volunteer Kerry Rock from the Loudwater Estate, for single-handedly organising both sampling locations and recruiting citizen scientists to help with us with water sampling during our survey day for Loudwater Estate residents.

We very much look forward to the next stage of our NOSES sampling in the coming months. Please do get in touch if you have any questions, comments, data or interest in these surveys chesscs@chilternsaonb.org.

Glossary of terms

mg/L	Milligrams per litre
mm	Millimetres
Artesian wells	A well that brings groundwater to the surface without pumping because the water is under pressure
Boreholes	A deep narrow hole in the ground to measure water depth
SAGIS	A mathematical model used by the Environment Agency for calculating the different sources of phosphate (in this instance) in a river
Spring sources	A natural point at which groundwater exits the ground and flows into stream channel

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Explanation of different forms of phosphorus

Orthophosphate means only one phosphate (PO_4^{3-}) unit. Phosphate is often used interchangeably with orthophosphate when describing water quality, but a full definition would include molecules that comprise more than one phosphate unit.

Phosphorus is the element P, but the legislation also refers to 'reactive phosphorus' which is a method-based term to explain that when you carry out the test for orthophosphate you also get a small fraction of other forms of phosphorus.

Units of measurement

Converting between ortho-phosphate (PO_4^{3-}) and orthophosphate expressed as phosphorus (PO_4-P) requires multiplication or division by 3.06. To convert a result from orthophosphate expressed as phosphorus (PO_4-P) to phosphate (PO_4^{3-}), you multiply by 3.06. To convert from phosphate (PO_4^{3-}) to orthophosphate expressed as phosphorus (PO_4-P) you divide by 3.06.

References

[1] River Chess Smarter Water Catchment initiative. (2022) Background: Water Quality. The State of the River Chess Catchment. March 2022.

[2] Hill, P. I., Graszkiewicz, Z., Taylor, M. and Nathan, R. J. (2014) Loss models for catchment simulation. State 4 Analysis of rural catchments. May 2014. ARR Revision project 6.

Appendices

Appendix A: Site-specific citizen science survey risk assessment

TITLE:	**NOSES Site: Chenies to Chess Crossing**	**RISK ASSESSOR:**	**Hannah Parry-Wilson**
RA NUMBER:	**RA/2023/Noses002/Sarratt**	**DATE OF ASSESSMENT:**	**21st March 2023**
LOCATION:	**United Kingdom**	**SIGNED (APPROVER)**	**H.M.Parry-Wilson**
DATE OF REVIEW:	**20th March 2024**		

DESCRIPTION OF TASK

NOSES (Nutrient Ongoing Scrutiny Evaluation Surveys) water sampling surveys to take place on the River Chess between Chenies and Sarratt Mill House. Maps below identify areas of bankside risk assessed for suitable access to the river to collect water samples using long-length dippers for this activity.

Nearest Accident & Emergency Hospitals from 'base' station on Moor Lane, Sarratt Bottom:

- *Watford General Hospital (WD18 0HB) – 6.5 miles (20 minutes drive)*
- *Hemel Hempstead Hospital (HP2 4AD) – 7.3 miles (22 minutes drive)*

The NOSES method includes:

- *Walking a distance of up to 1 mile away from 'base station' to collect water samples on route, returning via the same path to base station after collection of the samples.*
- *Printed maps will be provided to the citizen scientists to identify locations most suitable and safe to easily reach the river with the long-length dipper sticks with low risk of falling into the river. No volunteer is to enter the water during these surveys.*
- *Lanyards will be provided to each of the citizen scientists with contact details for project leads, nearest hospital details, and space to write their next of kin details and any medical issues should an emergency occur when away from each 'base station'.*
- *Citizen scientists are provided with equipment and PPE suitable for water sampling:*
    - *Long-length plastic dipper*
    - *Plastic sampling bottles*
    - *Plastic bags for keeping site-specific samples separate*
    - *Black marker pen to write on bags*
    - *Pencils to write any necessary notes on printed maps*
    - *Clipboards for paperwork*
    - *Large transparent bag to go over paperwork in case of wet weather*

- *Nitrile gloves to collect water samples*
- *Anti-bacterial gel (to be used after every sampling instance)*
- *Plastic bag for used gloves to be collected (to be recycled by project staff)*
- *High visibility jackets with 'Volunteer' written on to ensure visibility to both vehicles (where collision risks are possible) and for landowners/the general public*

The survey is to be conducted is pairs or groups of 3. Water sampling sites will be allocated to each group beforehand with a sensible route between the sites provided with photographs and detailed maps where internet and phone signal is very low in Sarratt Bottom.

Citizen scientists are advised to bring:

- *Suitable footwear for wet/unstable ground*
- *Layered clothing*
- *Waterproofs*
- *Hat*
- *Food and drinks*
- *Fully charged mobile phone*

Citizen scientists will be required to sign-in to each survey day on arrival and sign-out of each survey day when leaving to return home, to ensure that project leads are aware of who is still participating in the activity at all times.

During Sample processing on return to 'base station', only trained project leads, Hannah Parry-Wilson & Kate Heppell, will handle chemical reagents to process the water samples. A COSHH chemical datasheet will be held on site if required.

Hannah Parry-Wilson will be the designated First Aider for the survey day and a first aid box will be available at the 'base station'.

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Hazard: Plant toxins e.g. nettle stings **Reasonably Foreseeable Accident:** Sap from plant comes into contact with skin **Reasonably Foreseeable Worst Case Injury:** Dermatitis, localised allergic reaction	**LOW(1)**	• Citizen scientists advised to wear long trousers and socks to cover skin. • Citizen scientists told to stick to paths where possible, or well trodden dirt tracks leading to river edges to conduct their surveys.	**LOW (1)**	**LOW (1)**
Hazard: Uneven paths or ground **Reasonably Foreseeable Accident:** Trips, slips and falls **Reasonably Foreseeable Worst Case Injury:** Musculoskeletal injury	**MEDIUM (2)**	• Citizen scientists will be advised to wear appropriate footwear in advance. • Citizen scientists will be provided with this risk assessment covering all sampling locations that will be visited on the survey day, and advised of all hazards to avoid. • Citizen scientists will be advised to walk at the pace of the slowest member of their group and take their time travelling to and from surveys, as well as when moving around each survey site.	**MEDIUM (2)**	**MEDIUM (4)**
Hazard: Traffic **Reasonably Foreseeable Accident:** Collision with vehicle	**MEDIUM (2)**	• Citizen scientists will be advised to take care when walking along Moor Road where traffic is minimal, although cars can swing around the corner quickly where road hedges are high and visibility is lower.	**MEDIUM (2)**	**MEDIUM (4)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Reasonably Foreseeable Worst Case Injury: Musculoskeletal injury		• Citizen scientists will agree their access routes with project leads before leaving the base station and this is to be followed without deviations. If expected return times exceed 30 minutes, a project lead will walk out to meet delayed groups/pairs by following the agreed path. • Citizen scientists have also been provided with maps of parking locations and suggested routes to reach the base station on the day of the survey, including where traffic hazards may occur.		
Hazard: Anti-social behaviour **Reasonably Foreseeable Accident:** Trip, slip and fall **Reasonably Foreseeable Worst Case Injury:** Head injury	**MEDIUM (2)**	• Citizen scientists are advised to work in groups of two or more. • Citizen scientists have been advised to take a fully charged mobile phone out on survey work with them, which they can use to contact emergency services if necessary. If working in areas of low phone reception, they have been advised to end survey work in instances where they feel their safety is at risk for any reason and leave the area immediately.	**LOW (1)**	**LOW (2)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Hazard: Sharp refuse in the form of cans, needles, broken glass bottles, barbed wire on the ground **Reasonably Foreseeable Accident:** Deep cuts or scratches, needles penetrating the skin, sharp objects embedded in the body **Reasonably Foreseeable Worst Case injury:** Infection or deep cuts causing extreme blood loss	**MEDIUM (2)**	• Citizen scientists are advised to wear appropriate footwear for unstable terrain, which should avoid direct contact with skin should sharp refuse be stood on during survey work. • For this area of Sarratt Bottom, sharp refuse has only been found on the ground through the access route to SarSouth 3a & 3b when bypassing the gate.	**LOW (1)**	**LOW (2)**
Hazard: Dog faeces **Reasonably Foreseeable Accident:** Dog faeces coming into contact with the skin **Reasonably Foreseeable Worst Case injury:** Infection of existing cuts caused by contact with dog faeces	**LOW (1)**	• Citizen scientists will be made aware of any locations where encounters with dog faeces are more likely along the Chess Valley Walk, so that these can be avoided. • Citizen scientists are advised to watch their step, check their shoes and the floor beneath then before sitting down.	**LOW (1|)**	**LOW (1)**
Hazard: Brambles/vegetation/low hanging trees **Reasonably Foreseeable Accident:** Cuts or scratches **Reasonably Foreseeable Worst Case Injury**: Cut or scratch becoming infected	**LOW (1)**	• Where possible areas of bramble or thick vegetation will have been identified beforehand for this risk assessment, and the citizen scientist made aware of the potential hazards. • If scratches occur recipient will be advised to cover wounds with plasters from the first aid kit that will be held at base station.	**MEDIUM (2)**	**LOW (2)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Hazard: Stinging or biting insects **Reasonably Foreseeable Accident:** Insect bites or stings **Reasonably Foreseeable Worst Case Injury**: Severe allergic reaction	**MEDIUM (2)**	• Citizen scientists have been asked to declare any relevant medical conditions (incl. allergies) they suffer from, which could affect their ability to conduct survey work. If working in citizen scientist pairs without a project lead present, they should advise their survey partner if serious allergies exist. • Charged mobile phone will be carried at all times. • Citizen scientists suffering allergies will be advised to ensure they have any medication (e.g. epi-pens) with them.	**MEDIUM (2)**	**MEDIUM (4)**
Hazard: Ticks **Reasonably Foreseeable Accident:** Tick bite **Reasonably Foreseeable Worst Case Injury**: Lymes Disease	**LOW(1)**	• Citizen scientists have been made aware of the risks arising from tick bites and advised as to how to recognise ticks, bites and bullseye rash. They have been advised to check for ticks after each survey and visit GP if a bullseye rash, swelling or pain develops as a result of a tick bite.	**MEDIUM (2)**	**LOW (2)**
Hazard: Livestock **Reasonably Foreseeable Accident:** physical injury, bruising, cuts,	**LOW(1)**	• Citizen scientists will be advised of the likely presence of livestock (sheep, cows, horses, llamas, etc.) as per a pre-determined site-specific risk assessment. They will have been given appropriate advice such as avoiding	**LOW (1)**	**LOW (1)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Reasonably Foreseeable Worst Case Injury: Musculoskeletal injury		cornering animals inadvertently or approaching directly animals.		
Hazard: Adverse weather conditions **Reasonably Foreseeable Accident:** Slipping and falling **Reasonably Foreseeable Worst Case Injury:** Musculoskeletal injury including hips and backs	**MEDIUM(2)**	• Citizen scientists have been advised to check the weather before leaving home to conduct a survey (ideally the day before). If extreme weather conditions are forecast (e.g. thunderstorm with lightning, snow, hail) the survey should be cancelled and both the project leads will arrange a new date for the survey day to take place. • Project leads will communicate any changes in plan to all attendees before the survey day commences. • If the weather deteriorates during the survey to include thunderstorms, snow and/or hail, the survey is to be abandoned and all group surveyors are to return to base station immediately to return equipment, sign-out and leave for home.	**LOW(1)**	**LOW (2)**
Hazard: Terrain too difficult for some attendees	**MEDIUM(2)**	• Hazards and precautions will be communicated to those conducting surveys and a site-specific risk assessment will be done in advance to determine the accessibility of each survey site.	**LOW(1)**	**LOW(2)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Reasonably Foreseeable Accident: Slipping and falling **Reasonably Foreseeable Worst Case Injury:** Musculoskeletal injury including hips and backs		• Citizen scientists will be advised of closer sampling sites to the base station that they can collect from that are easier access points to the river.		
Hazard: Illness of or injury to attendees **Reasonably Foreseeable Accident:** Variable **Reasonably Foreseeable Worst Case Injury:** Highly variable.	**MEDIUM (2)**	• Citizen scientists have been advised to be aware of and monitor their own health during survey work, as well as that of their group members, especially during very hot or cold weather. • If a citizen scientist becomes unwell or injures themselves during survey work, the group members have been advised to seek appropriate help and abandon the survey work. • Citizen scientists have been advised to disclose possible life-threatening conditions to members of their survey group and the lead survey/project person so that better preparations can be made in instances of related injury. • If their condition is such that they cannot move, emergency services should be called	**LOW (1)**	**MEDIUM(2)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
		and the casualty is to be cared for until they arrive. Citizen scientists will be supplied with a leaflet detailing how to ensure breathing is maintained for casualties in emergency situations.		
Hazard: River **Reasonably Foreseeable Accident:** Falling into the river due to slippery and steep ground **Reasonably Foreseeable Worst Case Injury:** Drowning	**HIGH (3)**	• No one will be left alone – citizen scientists will work in pairs or groups of three. • Take fully charged mobile phone and have this available on the bank in case of emergency. • Very slippery and steep banks should be avoided; citizen scientists will be advised to find a more accessible bankside location than the one suggested if changes have occurred since sites visits were originally conducted, or abandon the sampling at that location if necessary. • Citizen scientists have been advised to carry additional warm clothing with them for any field survey work. • This survey is a bankside survey only and citizen scientists will not be permitted to enter any stretch of water to avoid any additional risk.	**LOW (1)**	**MEDIUM (3)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
Hazard: Cold water. **Reasonably Foreseeable Accident:** Exposure to cold due to falling into water **Reasonably Foreseeable Worst Case Injury:** Hypothermia	**MEDIUM (2)**	• Ensure a foil blanket is available in the first aid kit. • Citizen scientists have been advised to carry additional warm clothing with them for any field survey work.	**LOW (1)**	**LOW (2)**
Hazard: Potentially contaminated water **Reasonably Foreseeable Accident:** Ingestion of contaminated water via mouth, eyes or via open cuts. **Reasonably Foreseeable Worst Case Injury:** Leptospirosis	**MEDIUM (2)**	• Any cuts likely to come in to contact with water e.g. on hands/arms should be covered with a waterproof plaster before collecting samples from the river, even where nitrile gloves are to be worn over hands. • If any cuts are received whilst sampling, these should be cleaned and covered with a waterproof dressing immediately. • Clean hands before eating, drinking or smoking (anti-bacterial gel will be provided to every pair/group). • Citizen scientists should familiarise themselves with the symptoms of Leptospirosis (Weil's disease) and ensure that if any symptoms are recognised within days	**LOW (1)**	**MEDIUM (2)**

HAZARD & CONSEQUENCE		CONTROLS	RISK	
HAZARD & POTENTIAL FOR HARM	**RATING LOW(1), MEDIUM(2) or HIGH(3)**	**EXISTING & *REQUIRED* CONTROLS**	**LIKELIHOOD OF HARM LOW(1), MEDIUM(2) or HIGH(3)**	**CONSEQUENCE X LIKELIHOOD**
		or weeks of exposure to river water, they seek medical advice from a GP immediately.		

EXPLANATION OF RATING SYSTEM			
CONSEQUENCE	LOW(1) – Minor injury requiring no more than First Aid	HIGH(3) – Death or major injury with life changing consequences	MEDIUM(2) – All other injuries
LIKELIHOOD	LOW(1) – Would be extremely surprised if this occurred	HIGH(3) – Could reasonably expect this to occur in the foreseeable future	MEDIUM(2) - Other
RISK	LOW(1), L0W(2)	HIGH(6), HIGH(9)	MEDIUM(3), MEDIUM(4)