

Interim Report on phosphate monitoring in the upper Bourn Brook and its tributaries



One of two bio-bubbles at Bourn Sewage Treatments Works

Dr Mike Foley, Cam Valley Forum 8th April 2022

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Summary

From 24 January to 3 Mar 2022, concentrations of soluble reactive phosphorus (orthophosphate–P) were generally from very low to low in samples taken from the upper Bourn Brook catchment downstream to just above the confluence with the Bourn Brook STW discharge stream, whereupon levels became markedly much higher. The phosphate concentration in the stream used for discharging effluent from Bourn STW was shown to be very low just above the Bourn STW outfall and very high below it. The last batch of samples taken on 3 March when watercourses were swelling after recent high rainfall had overall lower concentrations of phosphate than previously. This project showed that <u>during this</u> <u>current period of sampling</u> the vast majority of soluble, readily available phosphate measured in the Bourn Brook in the upper catchment originated from the discharged effluent from Bourn STW. To understand better the variation in phosphate concentrations over time continuous monitoring would be required at two selected key locations on the Bourn Brook, because effluent discharges from Bourn STW bio-bubble system are intermittent. Further samples will be taken in July from key locations.

Method

Hanna HI-713 hand-held phosphate checker

A checker with a digital reader was bought new from Hanna Instruments on September 2021. It measures soluble phosphate by the Ascorbic Acid 'Blue' Method and was checked for accuracy with the HI713-11 calibration Check Set. The precision of individual readings is reported by the manufacturer as ± 0.04 ppm $\pm 4\%$ of reading @ 25°C. A reading was 1.04 mg/l (ppm) orthophosphate was obtained, within the 1.0 ± 0.08 required to validate the instrument. A second calibration reading in January 2022 was 0.98. The maximum reading that can be used is 2.50 mg/l. If the concentration of phosphate is higher than this the readout flashes to indicate this, and the original sample has to be diluted with deionised water until a reading of less than 2.50 can be obtained. The Hanna readings were converted to concentrations of orthophosphate-phosphorus (also known as Soluble Reactive Phosphorus – SRP).

Selection of sampling sites

This casual, indicative monitoring started initially to obtain some current values of phosphate concentrations in the watercourse receiving discharged final-effluent from Bourn STW, and to estimate by how much the phosphate from the STW is contributing to levels in the Bourn Brook. This is part of a larger CVF Cam catchment project. The expansion of the number of sample sites to include header streams above Caxton and tributaries of Bourn Brook down to Caldecote was inspired by Elizabeth Raneleigh's FWAG-East farmer-based survey of phosphate levels in 2012. In addition, a site on the Bourn Brook at Haslingfield was sampled to provide samples in the lower section.

Sampling dates

Visits were made on 24 January [1], 6 [2], 9 [3], 11 February [4] and 3 March [5], the latter date deliberately chosen because water levels were the highest within the period and opportunities for phosphate pollution of the watercourses in the upper catchment due to run-off from fields and other agricultural sources were likely to be more frequent than prior to that date.

<u>Hydrology</u>

Rainfall: based on a Trumpington garden rain gauge, there was no rainfall for the 13 days prior to 24th Jan, and no measurable rainfall until 8.4mm on 4th Feb, then 2.4mm 6th Feb, and 1.7mm on 9th Feb. 15mm were recorded 28 Feb-2 March.

Data extracted from <u>Gaugemap</u> showed that there was a slight increase in water level in the Bourn Brook at Bourn of about 4cm during 4th Feb most of which persisted up to 6th Feb, with a slight decrease up to 9th Feb. The level was 0.29m on 11th Feb. It was rising by 3 March and was 0.52m at the time of sampling on that day.

Date (2022)	Level (m, Above Stage	
	Datum)	
24 Jan	0.29	
6 Feb	0.31	
9 Feb	0.31	
11 Feb	0.30	
3 Mar	0.52 (@1700; 0.68 @ 0400	

Table 1: Water level in the Bourn Brook over the period of sampling (Gauge
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On 3 March, the water level was nearly double the levels at the previous samplings. This was evident in all watercourses (see photos), and would have been linked to rainfall amounts of ~15mm over the previous 3 days.

<u>Turbidity</u>

The tributaries had low turbidity, but Bourn Brook itself did appear murkier than before, viewed at the sampling site east of the Bourn golf course. At Haslingfield the Brook was highly turbid and brown, the metal rake head invisible at 30cm depth.

Flow measurements were not attempted on any of the watercourses, one factor being that CVF does not possess the necessary equipment. It is not easy to look at a stream and judge its flow nevertheless flow is important in interpreting phosphate measurements. New Ditch and Dean Brook both had noticeably low flows prior to 3 March.

Quality control

A new bottle of Halfords deionised water was tested and was satisfactory. After a run of testing resulting in very low concentrations a sample of Trumpington cold tap water was tested to ensure a new batch of reagent was in good condition. The tap water reading was

>2.50 phosphate (>0.815 mg/l P), the highest yet after testing four samples, the average concentration of the previous three sample being 0.77. Thus, this test showed that the reagent was of sufficiently good quality to produce high readings. Throughout the testing, the intensity of the blue coloration after five minutes from the addition of the reagent to the sample matched the readings.

Costs of disposables

£25.00

Contact with farmers

No landowners or farmers were seen or talked to during this project.

Water Frame Directive, phosphate standards

Table 2: Water Frame Directive, standards for phosphate-phosphorus in lowland (<80m AOD above</th>Ordnance Datum, high alkalinity rivers (applies to sections of rivers rather than specific sites

	Status				
	High	Good	Moderate	Poor	Bad
Bands of Soluble Reactive Phosphorus (mg/l =ppm)	0.00 - 0.05	0.051- 0.089	0.090 - 0.211	0.212- 1.089	>1.089



Figure 1: Locations of all sampling sites, key locations (red-ringed), and direction of flow of watercourses

Table 3: Dates of sampling and location of all sites

Date	Site	Site details	Reason for site selection	Lat - long
09/02/2022	A. Gascote Dean 'above pig farm'	Opposite bridleway to road	Furthest site upstream, above the pig farm	52.203190, - 0.104499
09/02/2022	B. Gascote Dean 'below pig farm'	U/S confluence with Haydean just above confluence with Bourn Brook	Closest to confluence with Haydean and Bourn Brook	52.208033, - 0.103808
09/02/2022	C. Haydean U/S confluence with Gascote Dean	U/S confluence with Gascote Dean, just above confluence with Bourn Brook	End point, close to confluence with Gascote Dean and Bourn Brook	52.208053, - 0.104355
06/02/2022	D. Eastern Brook, above culvert	Footpath, above culvert	To check all of brook and ditchwork above this point	52.211986, - 0.107633
06/02/2022	E. Stream E. of Eastern Brook, U/S culvert	Eastern Brook, U/S Upstream of culvert/footpath		52.212041, - 0.105165
06/02/2022	2022 F. Stream E. Eastern Brook, D/S Downstream of confluence with Eastern Brook culvert/footpath		To re check the un- named ditch and Eastern Brook, below their confluence	52.211893, - 0.105085
06/02/2022	G. Bourn Brook, above St Peters Street ford	At ford, St Peters Street	First easy point on Bourn Brook to sample	52.207491, - 0.097923
09/02/2022	H. Bourn Brook, above Caxton End ford	U/S ford, above, entry points of Frog Hall stream and road stream	Bourn Brook above some significant field streams which at enter the ford	52.197428, - 0.073951

06/02/2022	I. Caxton End, field stream culverted S side, into road > Bourn Brook	Exit from culvert	One significant field stream that enters Bourn Brook after flooding across the road for ~100m	52.197388, - 0.073903
24/01/2022	J. Bourn Brook, western outskirts of Bourn	Caxton End footbridge near Meadow Rise	Above Bourn village and below the field stream near Bourn Brook ford above	52.194453, - 0.066317
06/02/2022	J. Bourn Brook, western outskirts of Bourn	Caxton End footbridge near Meadow Rise	Above Bourn village and below the field stream near Bourn Brook ford above	52.194453, - 0.066317
09/02/2022	J. Bourn Brook, western outskirts of Bourn	Caxton End footbridge near Meadow Rise	Above Bourn village and below the field stream near Bourn Brook ford above	52.194453, - 0.066317
11/02/2022	K. Dean Brook, Bourn	Toft-Bourn road, opposite side to golf course	Close to Bourn Brook	52.183799, -0.053521
11/02/2022	L. New Ditch, Kingston	Bourn Road bridge, Kingston	Further upstream from site L.	52.180889, -0.040139
11/02/2022	M. New Ditch	Toft-Bourn road, culvert	EA sampling site	52.184639, -0.031695
24/01/2022	N. Bourn Brook, east of Burn Golf Club	Footbridge, public footpath, east of Bourn Golf Club	Below Bourn village, below Bourn Golf Club	52.184655, - 0.045170

				<u>.</u>		
				and above 'Bourn STW		
				discharge stream'		
				Below Bourn village,		
	06/02/2022	N. Bourn Brook, east of Burn Golf	Footbridge, public footpath,	below Bourn Golf Club		
	00/02/2022	Club	east of Bourn Golf Club	and above 'Bourn STW	52.184655,	
				discharge stream'	-0.045170	
				Below Bourn village,		
	00/02/2022	N. Bourn Brook, east of Burn Golf	Footbridge, public footpath,	below Bourn Golf Club	52.184655 <i>,</i> -	
	09/02/2022	Club	east of Bourn Golf Club	and above 'Bourn STW	0.045170	
				discharge stream'		
	24/01/2022	O "Bourn STM stream' U/S outfall	Unstroom of STM outfall	Field stream above the	52.203366, -	
	24/01/2022	O. "Bourn STW stream" U/S outfall	Opstream of STW outrain	STW	0.045041	
		D. 'Pourn STW stroom' D/S outfalls	Downstroom of STM outfall	After discharge outfall	E2 20264E	
	24/01/2022	P. Bourn STW Stream D/S outlan,	and just below track / cultort	point of STW at time of	52.202045,-	
				no discharging	0.044342	
		P. 'Bourn STW stream' D/S outfall; discharging	Downstream of STW outfall	After discharge outfall	52 202645 -	
	24/01/2022		and just below track / culvert	point of STW at time of	0 044542	
				discharging	0.044342	
	09/02/2022	P. 'Bourn STW stream' D/S outfall;	Downstream of STW outfall	After discharge outfall	52.202645, -	
	05/02/2022	unsure if discharging	and just below track / culvert	point of STW;	0.044542	
				At point immediately		
		Q. 'Bourn STW stream', U/S		above confluence with	F2 10F224	
	24/01/2022	confluence with Bourn Brook;	Desire an of confidence with	Bourn Brook, includes	52.185224, -	
		<u>discharging</u>	Bourn Brook	all field ditches further	0.043456	
				above		
				At point immediately		
		Q. 'Bourn STW stream', U/S confluence with Bourn Brook;	Unstream of confluence with	above confluence with	52.185224, - 0.043456	
	09/02/2022		Pourp Prook	Bourn Brook, includes		
		unsure if discharging		all field ditches further		
				above		

	24/01/2022	R. Bourn Brook, Main Street to Caldecote	Road bridge	First easy point to sample after confluence with 'STW discharge stream',	52.186637, - 0.031623
	09/02/2022	R. Bourn Brook, Main Street to Caldecote	Bourn Brook, Main Street to Idecote	First easy point to sample after confluence with 'STW discharge stream',	52.186637, - 0.031623
	03/03/22	R. Bourn Brook, Main Street to Caldecote	Road bridge	First easy point to sample after confluence with 'STW discharge stream',	52.186637, - 0.031623
	24/01/2022	S. Bourn Brook, Cantelupe Farm road bridge	From west bank	Near confluence with Rhee; EA and CVF reference sampling point	52.17252, 0.09255
03/03/22	03/03/22	S. Bourn Brook, Cantelupe Farm road bridge	From west bank	Near confluence with Rhee; EA and CVF reference sampling point	52.17252, 0.09255

Results

None of the samples from Bourn Brook itself down to the east side of Bourn Golf & Country Club or its tributaries showed any indication of poor phosphate 'status' (Table 4). A few streams were omitted from in these batches of sampling – including a tributary which flows from Cambourne to Caxton, but historic EA sampling of the latter stream indicated that it has had low phosphate in samples taken during the months of February in the past (Table 5).

Many locations above the confluence with the Bourn STW discharge stream had high to good 'status' (25 samples in total, 0.00 to 0.11 mg/l P, mean 0.06). The values for 3 March samples from five of these sites varied from 0.01 to 0.08, mean 0.04.

A marked increase occurred in the Bourn Brook sampled downstream of the STW discharge stream, measured at Main Street, Caldecote (two readings, mean 0.75). The value at Haslingfield on 3 March was half that on 24 Jan despite recent rainfall and raised levels of soil in the Bourn Brook there.

The values from the discharge stream immediately above its confluence with the Bourn Brook were 2.32, 2.71 and 0.63 – the lower value of the latter was presumably due to low or no flow of effluent (the effluent outflow from the STW bio-bubble system is intermittent). A STW final-effluent sample was not taken. EA samples at site 'P' taken in 2015 varied from 0.19 to 5.9, compared to this project's sample values of 0.7, 2.3 and 3.2 at the same site.

On 11 Feb a leaking sewer pipe was seen to be gushing sewage into the Bourn Brook at Main Street, Caldecote. Its position would not have affected the samples taken for phosphate, except at Haslingfield.

It was calculated by a soils scientist colleague the soils were almost at field capacity at the end of February and had probable attained field capacity by early March so that any rain would quickly run-off the fields. Thus, 3 March seemed a suitable day to contrast phosphate levels in samples taken on that day with samples taken early when flows were noticeably lower. Values at five comparable sites were generally lower on 3 March, from an already low baseline. It should be noted that the Bourn Brook flow on 3 March was higher than on the previous sampling occasions.

Although phosphate levels were mostly very low in the upper catchment between 24 January and 3 March, historic EA data for summer or early autumn in the Bourn Brook at Bourn (Figure. 6) shows that higher levels could occur. EA data for their Haslingfield sampling site (Figure 7) showed much higher levels overall – however Haslingfield is downstream of the Bourn STW. Furthermore, higher concentrations of P from any source will inevitably occur in summer when there is <u>less flow</u> to dilute the pollution.

Orthophosphate is a readily soluble nutrient present in fertilisers, sewage and organic manures, but is readily bound by iron III complexes in soils, where it is stored'. Thus, the majority of phosphates bound to soil particles, especially clay particles – less so silt particles – entering the watercourses during run-off events may be insoluble phosphate.

Conclusions

1.Bourn STW was the main and significant source of high phosphate concentrations measured in the Bourn Brook at Main Street, Caldecote.

2.Concentrations were very low to low at most of the other upper catchment sites visited.

3.At the time of sampling, concentrations found in Gascote Dean did not indicate any pollution from the Firs Farm piggery located in an adjacent field, or from the pig breeding unit at Redwood Farm.

4. There is no evidence of substantial phosphate inputs from other agricultural sources during the rainfall 28 February - 2 March levels, even after discounting increased dilutive flows on 3 March.

5. The intermittent discharge of effluent from Bourn STW is problematic if interpretation is attempted in the future of test results of samples taken further downstream, probably even as far as to Haslingfield.

Site (uppermost watercourses listed first)	Phosphate-P mg/I (rounded to two decir			vo decimal	nal places)	
	24 Jan	6 Feb	9 Feb	11 Feb	3 March	
A. Gascote Dean 'above pig farm'			0.08			
B. Gascote Dean 'below pig farm'			0.11			
C. Haydean U/S confluence with Gascote Dean			0.05			
D. Bourn Brook /Eastern Brook, above culvert under footpath		0.08				
E. Unnamed stream east of Eastern Brook, upstream of culvert		0.00				
F. Unnamed stream east of Eastern Brook, below confluence with Eastern Brook		0.09				
G. Bourn Brook, above St Peters Street ford		0.07			0.03	
H. Bourn Brook, above Caxton End ford			0.07			
I. Caxton End, field stream through culvert south side, enters into Bourn Brook		0.09			0.03	
J. Bourn Brook, western side of Bourn (Meadow Rise)	0.05	0.08	0.08		0.01	
K. Dean Brook, Toft-Bourn road				0.08	0.03	
L. New Ditch, Kingston-Bourn road				0.04		
M. New Ditch, Toft-Bourn road				0.05		
N. Bourn Brook, east of Bourn Golf Club	0.06	0.11	0.10	0.08	0.08	
O. 'Bourn STW discharge stream' U/S outfall	0.07					

Table 4: Measurements of phosphate-P mg/l on various dates at all sites [<0.089 for a</th>section of a watercourse, measured regularly over three years, indicates 'good' status]

P. 'Bourn STW discharge stream' D/S outfall, during discharging	3.18		
P. 'Bourn STW discharge stream' D/S outfall, not discharging	0.74		
P. 'Bourn STW discharge stream' D/S outfall, discharging		2.80	
Q. 'Bourn STW discharge stream', U/S confluence with Bourn Brook	2.32	2.71	0.63
R. Bourn Brook, Main Street to Caldecote	0.99	0.51	0.18
S. Bourn Brook, Cantelupe Farm road bridge	0.45		0.24

Key sampling sites are emboldened







Figure 3: Sampling sites and P values 24th Jan

Figure 4: Sampling sites and results 6th Feb





Figure 5: Sampling sites and results above Bourn only, 9th Feb

Table 5: Environment Agency site monitoring

Environment Agency site monitoring

- Dean Brook (mapped as starting east of Hayley Wood, west of A1198, culvert under Toft Road B1046, joins Bourn Brook within the Bourn Golf Club).
- Bourn Brook (Manor Farm, Bourn).
- Bourn Brook (Gransden Road, Caxton).
- Bourn Brook, Main Street, Caldecote.
- Bourn Brook tributary, from Cambourne, joining below St Peters Street, Caxton.
- Discharge stream downstream of Bourn STW.

EA sample results						
Site	Last EA sample date	Spread in concs (mg/l) for samples taken in	Feb values	CVF values (or nearest CVF site)		
Dean Brook	28/07/15	2014–2015 0.04–0.50	0.05, 0.05	0.03, 0.08		
Bourn Brook	3/01/19	2014–2019	0.03, 0.05	Not sampled		
tributary,		0.01–0.88				
Cambourne to						
Caxton						
Bourn Brook,	28/07/15	31/1/12–28/7/15	0.03, 0.04, 0.04	0.07		
Gransden Road,		0.03-0.469				
Caxton						
Bourn Brook,	6/12/21	11/12/18-6/12/20	0.08, 0.05, 0.05	0.01, 0.05		
Manor Farm Bourn		0.05-0.270				
Bourn Brook,	14/1/22	2019–2022	0.30, 0.31	0.18-0.99		
Caldecote, Main		0.12-5.00				
Street						

Figure 6: EA historic data on phosphate-P concentrations, extracted data from 2015 to date, for samples taken at Manor Farm footbridge, Bourn. Red markers show 1 January for each year.



Figure 7: EA historic data on phosphate-P concentrations, extracted data from 2015 to date, for samples taken at Cantelupe Farm road bridge, Haslingfield. Red markers show 1 January for each year.



One of two bio-bubbles at Bourn STW



Outfall at Bourn STW





Eastern Brook (Bourn Brook) west of Caxton, above culvert under footpath - 6 February

Firs Farm pig farm, Caxton, now repositioned in field adjacent to Gascote Dean – 6 February



Bourn Brook, St Peters Street, Caxton, ford - 6 February (upper) and 3 March (lower)



Bourn Brook, Caxton End ford, field stream using road to enter it (LHS) - 6 February (upper) and 3 March (lower)



New Ditch, Kingston-Bourn road – 11 February



Dean Brook – 11 February (upper) and 3 March (lower)

Bourn Brook – 24 January (upper) and 3 March (lower), downstream of Bourn Golf & Country Club





Cantelupe Farm road bridge, Haslingfield, 3 March – high turbidity

PX Farms field, Caldecote sewage pipe leakage adjacent to Bourn Brook - 11 February

Passage of sewage into Bourn Brook from a broken sewer pipe between the pumping station nearby and Bourn STW, just upstream from Main Street road bridge. The flow was considerably less at the time when this photo was taken. Liquid was pouring into the brook, with a rapid slowing down before the photo could be taken as the pump shot down. Prompt action was taken by Anglian Water.



