Par River data review

Review of Environment Agency and citizen science data in the Upper and Lower Par WFDR waterbodies (GB108048002310 and GB108048002290), 2019 – 2023.

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Introduction

The River Par is an Environment Agency (EA) focus area under the St Austell Resilient Regeneration project. There are a number of environmental pressures in the waterbody, including china clay and sewage discharges, heavily modified sections and flood risk areas. Improvement actions are underway, including improving fish passage, flood resilience and river habitats.

The Upper Par Water waterbody (GB108048002310, as defined by the Water Environment (Water Framework Directive) Regulations 2017 (WFDR)) had Moderate ecological status in the 2022 WFDR classification, based on data 2019 to 2021 (next classification due in 2025). The Lower Par WFDR waterbody (GB108048002290) had Moderate ecological potential (because it is classed as a heavily modified waterbody) in the 2022 WFDR classification.

Par designated bathing water is currently classified as Sufficient (using 2019 and 2021 - 2023 data) under the Bathing Water Regulations 2013 (BWR). It has a planning class of Poor (the planning class includes all available bathing water data, not just data used for classification), and is considered 'at risk' by the Environment Agency.

The Environment Agency have been comprehensively monitoring the water quality of the Par River since 2019. Citizen scientists including the Friends of Par Beach and the Friends of Luxulyan Valley also regularly monitor the river, using Citizen Science Investigations (CSI) on-site water quality kits provided by Westcountry Rivers Trust, Riverfly invertebrate monitoring, and some bacteria monitoring using a field kit purchased online. These groups prepare a monthly report to present all the data collected.

This report aims to collate, analyse and interpret all available EA and citizen science data 2019 - 2023, to identify ongoing water quality concerns, recommend further monitoring to better understand these concerns, and recommend additional catchment actions that may help to improve waterbody status.

In addition, the report aims to assess how citizen science data can be effectively used to help achieve these aims, and how it could be further used in future to add value to ongoing investigations and fill gaps in EA understanding of the catchment.

Method

All available Environment Agency and citizen science data for the Upper and Lower Par WFDR waterbodies and Par Sands designated bathing water (2019 – 2023 inclusive) were collated. Table 1 and Figure 1 give details of monitoring points where data were available. Not all monitoring points were monitored for the same determinands. These data were compared with the most recent WFDR and BWR compliance assessments, catchment rainfall, regulated discharge permit information, pollution incident reports and previous catchment knowledge. Data were analysed for trends, patterns and relationships, to try to identify causes for non-compliances with the regulatory standards and risks to good water quality. Recommendations were made for further monitoring, and for actions that may improve catchment water

quality. An assessment was also made of the value of using citizen science data alongside EA data to enhance catchment knowledge, and of how this could be further enhanced.

Sample point number	Site name	NGR	EA/citizen science (CS)
	Criggan Moors, Par River	SX 01882 61133	CS
	South of Minorca Lane, Par River	SX 02657 59788	CS
	Carbis Stream	SX 02834 59401	CS
	Par Luxulyan allotments, Par River	SX 04732 58045	CS
	Cam Bridges, Par River	SX 05292 57454	CS
	Tributary Gatty's Bridge, Bokiddick Stream	SX 05531 57953	CS
	Treffry Viaduct, Par River	SX 05650 57179	CS
	Lady Rashleigh Mine, Par River	SX 06451 56509	CS
	Par Beach slipway	SX 0776 53261	CS
	Tributary Polmear Stream, Ship Inn	SX 08749 53417	CS
	Treskilling Stream upstream Innis Stream	SX0405856650	CS
	Treskilling Stream downstream Innis Stream	SX0411356670	CS
81610186	Par River d/s St Austell North STW	SX0451858074	EA
81610190	Par River u/s St Austell North STW	SX0431058219	EA
81610194	Par River at Luxulyan Bridge	SX0486058050	EA
81610210	Par River at Lavrean Bridge	SX0316159148	EA
81610221	Par River at Higher Menadew	SX0285259419	EA
81610559	Treskilling/Treverbyn Stream at Penrose	SX0428057200	EA
81611080	Rosevean Stream u/s Rocks Dryers Stream	SX0339058642	EA
81611085	Rosevean Stream d/s Bowling Green	SX0295058390	EA
81611044	Rocks Dryers Stream d/s Rocks Dryers CP 20/6	SX0292958554	EA
81611075	Rosevean Stream 75m d/s Rocks Dryers Stream	SX0340058730	EA
81611105	Carbis Stream prior to Par River	SX0283159402	EA
81611111	Carbis Stream u/s Wheal Henry	SX0260059360	EA
81611182	Carbis Stream d/s Wheal Prosper Mica Dam	SX0003059550	EA
81611270	Molinnis Stream at Molinnis	SX0248059280	EA
81610110	Par River at beach	SX0776953254	EA
81610134	Par River at St Blazey Bridge	SX0705055180	EA
81610603	Polmear Stream at Beach	SX0870053200	EA
81610303	Treesmill/Tywardreath stream at A3082 bridge	SX0754853581	EA
81610317	Treesmill/Tywardreath Stream u/s Emsleigh pond	SX0765054500	EA
81610329	Treesmill/Tywardreath Stream at Treesmill	SX0886155326	EA
81610320	Treesmill/Tywardreath Stream u/s Sluice at Footbridge	SX0817954912	EA

Table 1 EA and citizen scientist monitoring points. (u/s = upstream, d/s = downstream).

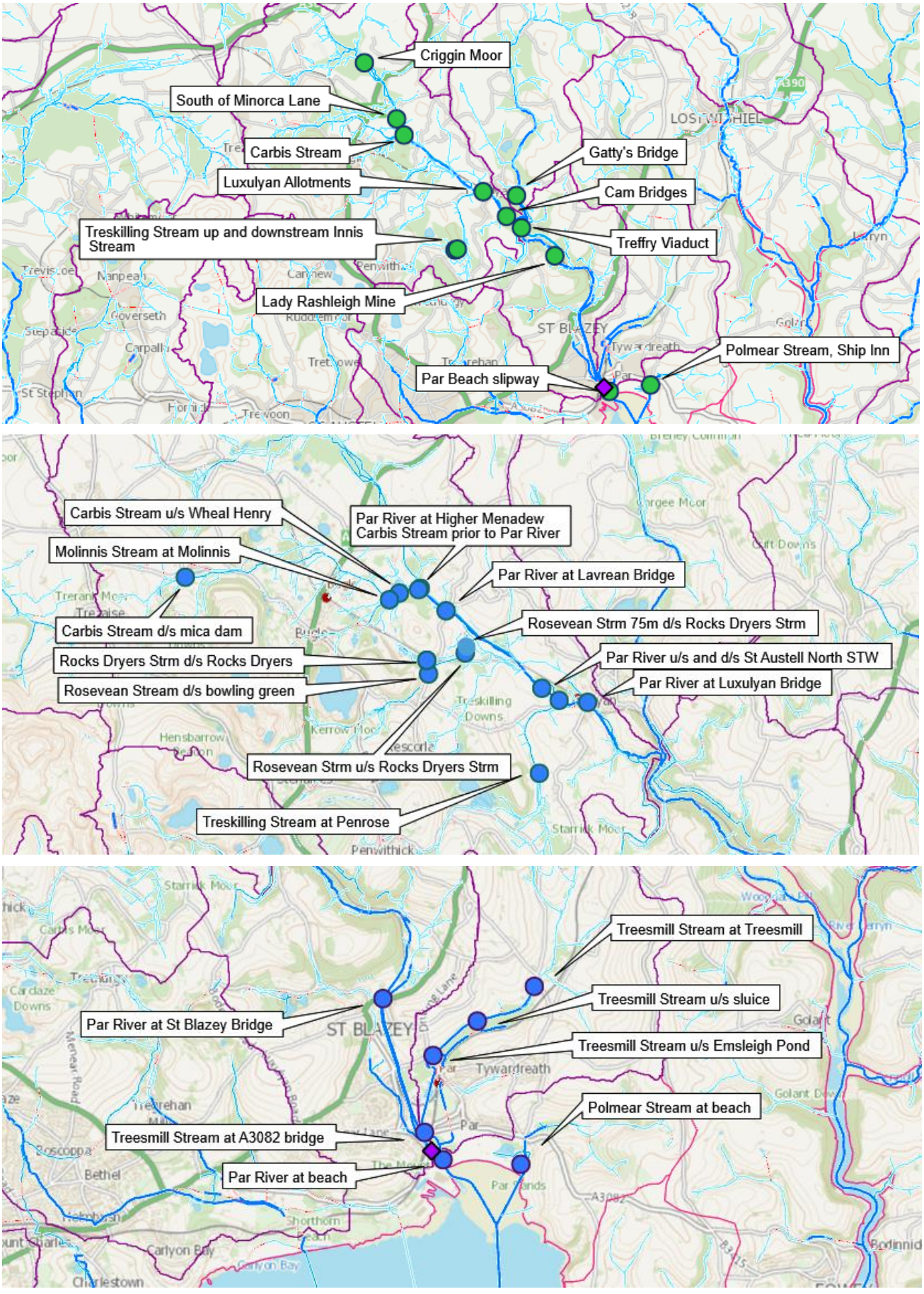


Figure 1 Citizen science (top) and EA monitoring points in Par River (purple lines are WFDR waterbodies). (Not all monitoring points are monitored for all determinands.)

Results and discussion

Upper Par

Orthophosphate and ammoniacal nitrogen

Elevated phosphate can cause elevated plant growth to the detriment of other river life, and elevated ammonia concentrations can be detrimental to fish and other river life. The 2022 Moderate WFDR classification in the Upper Par was driven by a Moderate classification for fish, but there were also sub-waterbody (site level) WFDR non compliances for ammoniacal nitrogen (NH4-N) and orthophosphate (PO4-P) at Luxulyan Bridge (Figure 1), which had Poor classifications for both these determinands.

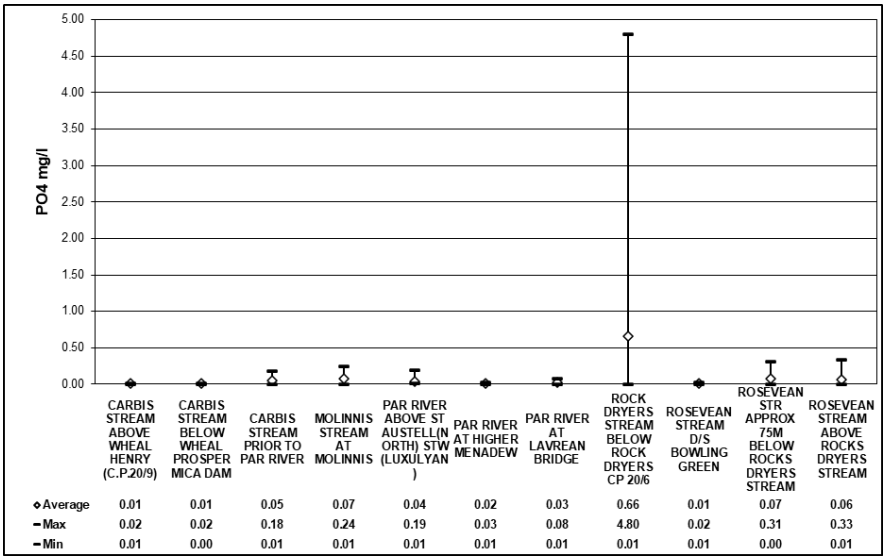
Data and investigations up and downstream St Austell North sewage treatment works (STW) (permit number SWWA146) have indicated that the site level non compliances were due to the final effluent and possibly storm discharges at this STW (Figure 2). The second WFDR classification site for the waterbody at Higher Menadew (upstream of the STW, Figure 1) had a High classification for NH4-N and Good for PO4-P.

Friends of Par Beach/Friends of Luxulyan Valley CSI data support this conclusion, with elevated PO4-P (>100 ppb or 0.1 mg/l) being consistently picked up at Luxulyan Allotments and Cam Bridges (Burrell, Farmer and Smith, December 2023).

EA data also suggested a source of PO4-P in Molinnis Stream at Molinnis. Potential sources include a china clay discharge and a combined sewer overflow (CSO). EA investigations (in situ water quality sondes and South West Water overflow spill reports) did not suggest a significant impact from the CSO, but found substantial evidence of an impact from the china clay discharge (Steward, 2019). A number of pollution reports also supported this conclusion.

There was also elevated PO4-P in Rocks Dryers Stream. This stream is almost entirely made up of a china clay discharge and drainage from the china clay works. Previously, a continuous water quality monitoring sonde showed that Rocks Dryers Stream often had elevated turbidity, although this did not always show up in spot samples. Spot sampling showed that Rosevean Stream downstream of Rocks Dryers Stream had elevated PO4-P compared with upstream, suggesting an impact from the latter. EA invertebrate surveys carried out in 2013 and 2019 also showed evidence of chronic impact in Rosevean Stream, probably from the china clay workings (Tim Geatches, personal communication).

China clay discharges to Molinnis and Rocks Dryers Streams are generally compliant with their permits to discharge. Further evidence of any ecological impact from the discharges (either from EA or citizen science monitoring) would be useful to assess whether the current permits are sufficient to protect the watercourse.



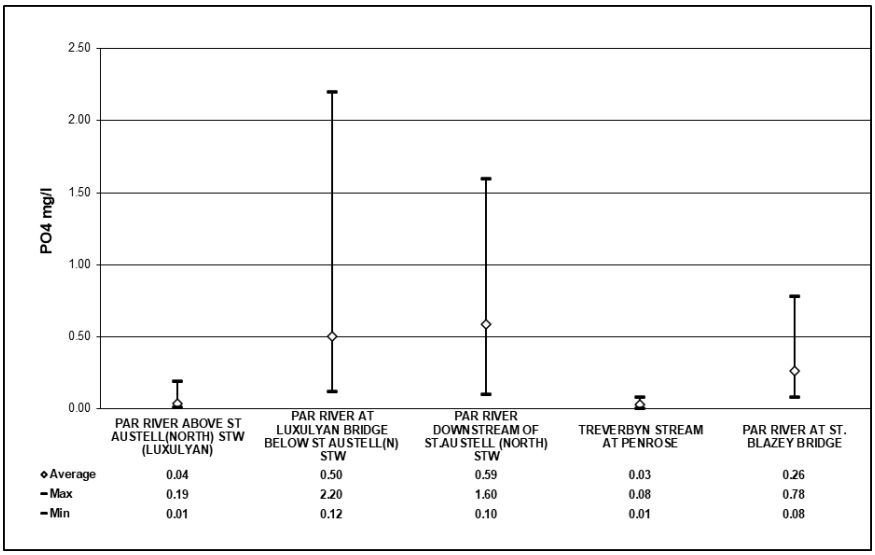
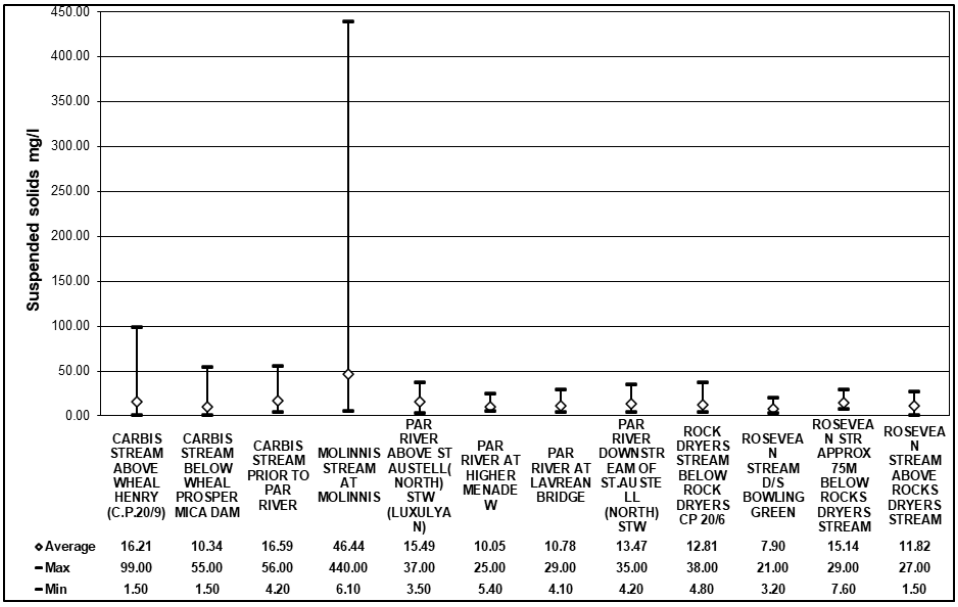


Figure 2 *EA PO4-P concentrations in Par River, July 2019 – Jan 2024*

Suspended solids

Although not a WFDR determinand, Natural England work to a standard of maximum 10 mg/l suspended solids for the protection of fish. Suspended solids can settle on riverbeds and adversely impact river flora and fauna (including fish), and can also affect fish gills at high concentrations. EA average suspended solids concentrations exceeded this target at most sites in the Upper Par watebody, but more so at sites in Carbis Stream, Molinnis Stream, Par River upstream St Austell North STW, and Rosevean Stream (Figure 3). All these streams drain, or are downstream of streams that drain, china clay areas. There are probably both diffuse and point sources (permitted discharges) of china clay pollution in these streams. Again it would be useful to gather more evidence of the ecological impact of elevated suspended solids in tributaries that drain china clay areas.



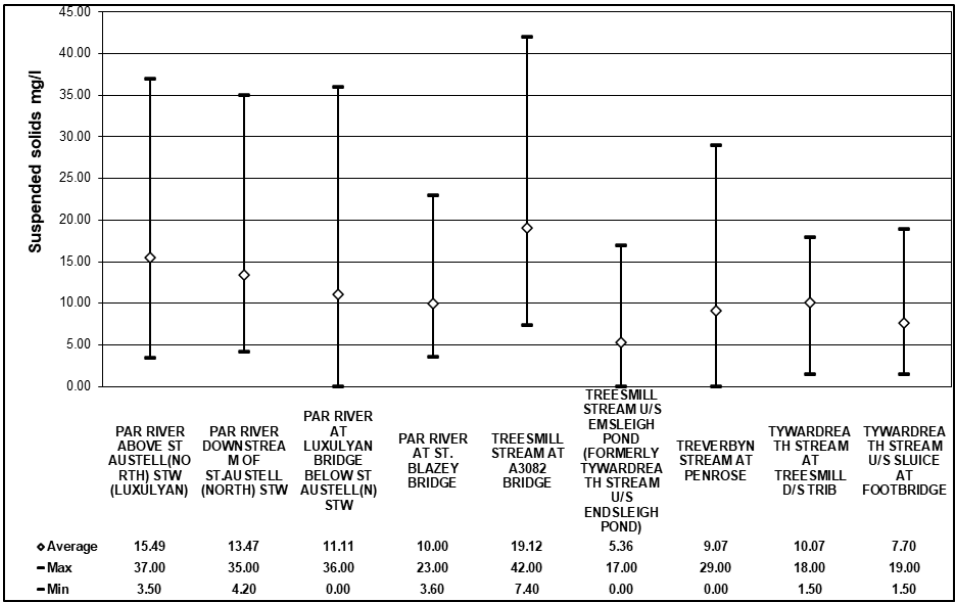


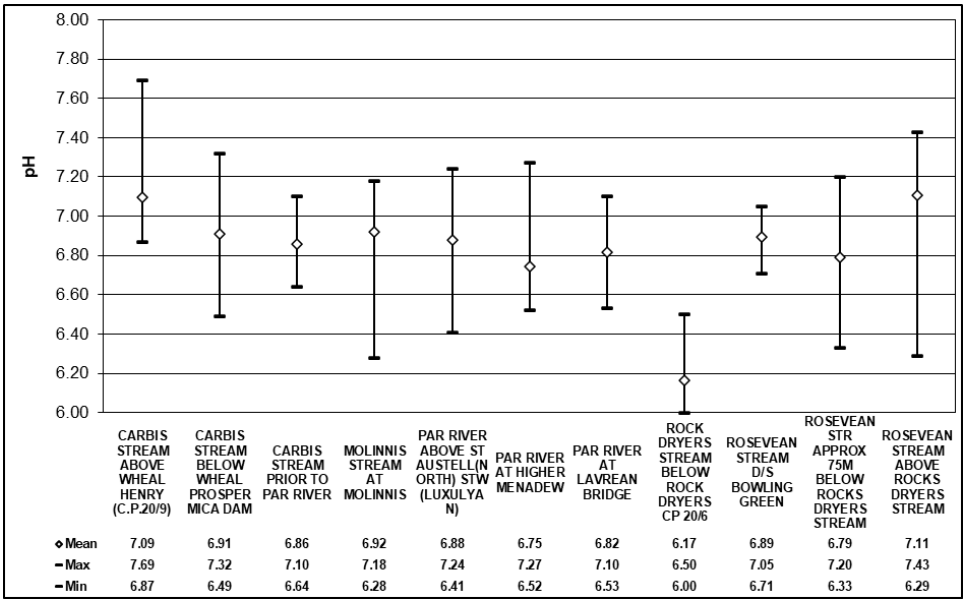
Figure 3 *EA suspended solids concentrations in Par River, July 2019 – Jan 2024*

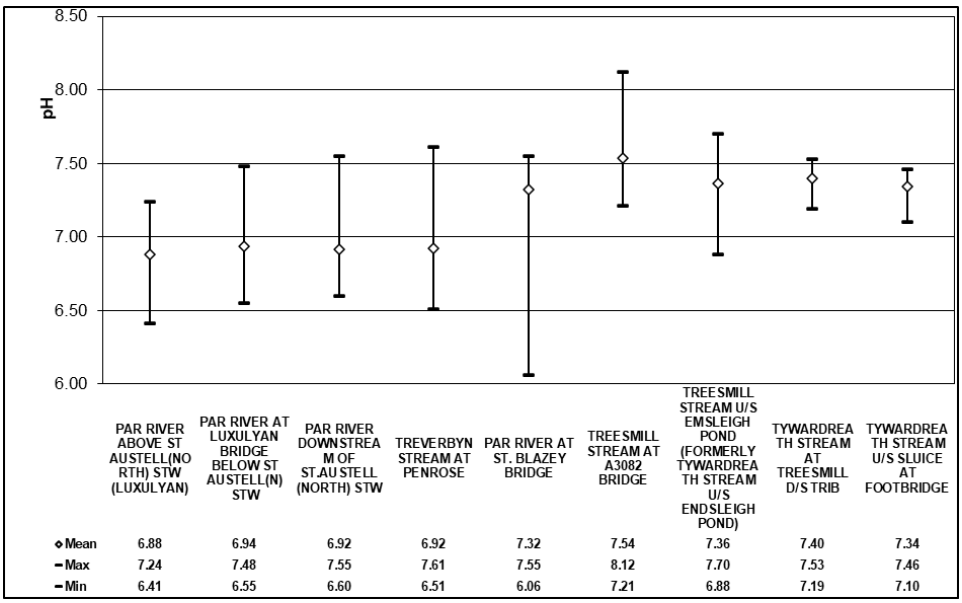
pH and conductivity

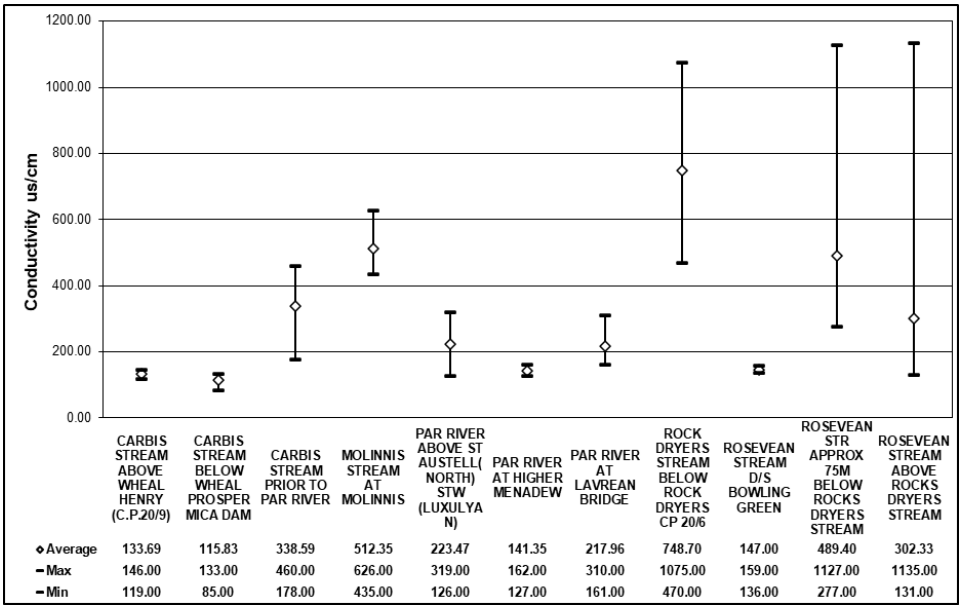
Low or High pH values can adversely affect river life and elevated conductivity indicates the presence of dissolved substances, possibly pollutants. Rocks Dryers Stream had a notably lower average pH than any other site, at 6.17 (Figure 4 – EA data). This site had a minimum pH of 6, which is the lower boundary of the 'Good' range for WFDR classification, again almost certainly due to the china clay discharge. As previously mentioned, it would be useful to assess whether these low pH values are impacting the invertebrate community downstream.

Conductivity was variable between sites, with several sites having average conductivity of < 200 us/cm, indicating unpolluted water. Again, Rocks Dryers Stream had the highest average conductivity, with the second highest being in Rosevean Stream downstream Rocks Dryers Stream. Molinnis Stream and Carbis Stream prior to Par River (downstream the inflow from Molinnis Stream) also had elevated conductivity values – again the likely source of this is the china clay discharge.

Citizen science data (Burrell, Farmer and Smith, December 2023) suggested more elevated total dissolved solids (TDS - a surrogate for conductivity) at sites in the main Par River than on its tributaries and headwaters. This is as expected, as there is more opportunity for rivers to 'pick up' dissolved solids (natural or anthropogenic) as they flow downstream. Carbis Stream showed more elevated TDS than other tributary sites. As discussed above, it is likely that the source was the clay discharge.







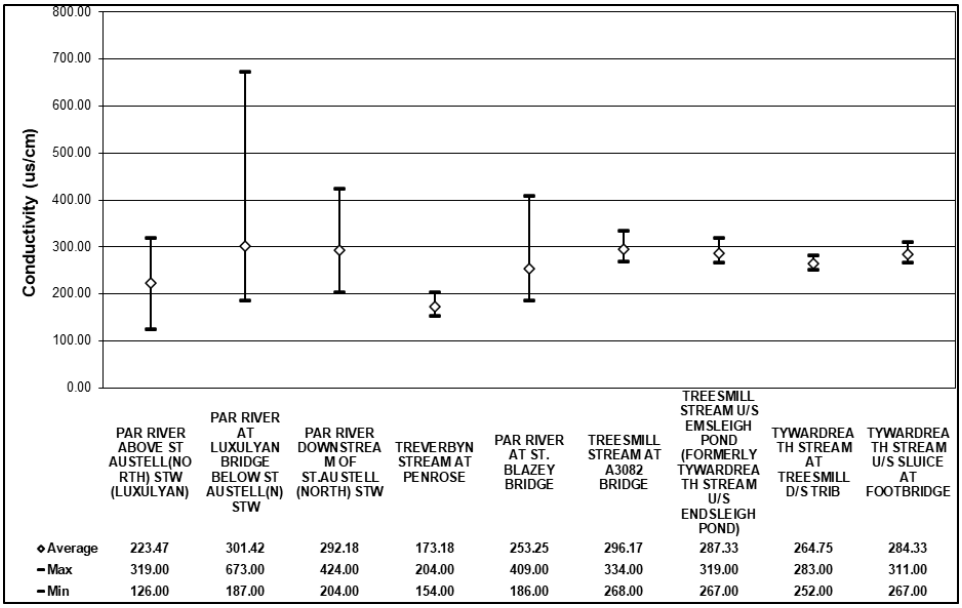


Figure 4 *EA pH and conductivity in Par River, July 2019 – Jan 2024*

Invertebrates

Friends of Luxulyan Valley/Friends of Par Beach have carried out ARMI Riverfly monitoring in Treverbyn/Treskilling Stream, up and downstream Innis Stream (Figure 1) (Burrell, Farmer, Jones and Smith, 2024). This showed a paucity of invertebrate species (3 or 4) at both sites, although there is no trigger level for these sites (for reference, the trigger level for Lady Rashleigh Mine is 6). There are a number of potential pollution sources upstream of these sites, including historic china clay mining, a sewage discharge and fishery. The EA has also identified other potential pollution sources further down this stream from our investigations. Further Riverfly and CSI monitoring at strategic locations in the stream would be beneficial.

Other existing Riverfly monitoring in the catchment did not indicate cause for concern.

Other evidence

The River Par has been the focus of Environment Agency and Westcountry Rivers Trust catchment walkovers and farm visits, to identify potential sources of pollution and provide advice (and regulation where appropriate) on how farmers can mitigate these. The Environment Agency have also worked with South West Water to identify and rectify pollution issues from their discharges in the catchment. Continuation of this work would be beneficial to follow up on previously identified pollution sources and continue to identify and mitigate others.

Lower Par

Orthophosphate

The Lower Par WFDR waterbody was Moderate for fish and Poor for PO4-P in the 2022 classification, with the PO4-P classification being based on data for the WFDR site at St Blazey bridge (Figure 1). Data and investigations have indicated that St Austell North STW FE was a significant source of PO4-P to this site (Figure 2). Limited spot sampling did not indicate any other notable PO4-P sources in the waterbody.

Friends of Par Beach/Friends of Luxulyan Valley reports, based on CSI data, suggest consistently elevated PO4-P (> 100ppb or 0.1 mg/l) at Treffry Viaduct, Lady Rashleigh Mine and Par Beach (Burrell, Farmer and Smith, December 2023). It is likely that at least the first two sites are impacted by St Austell North STW, and possibly also Par Beach. The CSI total dissolved solids data indicate that there may be other pollution sources impacting Par Beach (see below). Further investigation (sampling and catchment walkover) of the lower River Par upstream Par beach would be beneficial to confirm these sources.

pH and conductivity

Average pH values at all sites were generally in the 6.5-7.5 range, which did not indicate cause for concern (Figure 3). Average conductivities were slightly higher than for Upper Par unpolluted sites (to be expected in lower waterbodies) but did not indicate significant cause for concern.

Friends of Par Beach/Friends of Luxulyan Valley CSI investigations have shown consistently and significantly elevated readings (compared with other sites) for TDS in Par River at Par Beach since April 2023. There are known historic metal mine sources of dissolved metals in the Treesmill/Tywardreath Stream, which enters the Par just upstream of this sampling point. Tywardreath Stream (waterbody ID GB108048002291) was Moderate for zinc in the 2022 WFDR classification. This may be the source of the elevated TDS, and/or there may be other pollutant sources in this tributary or in the Par River upstream. Further sampling in and upstream of this tributary would be needed to investigate these potential sources further.

Suspended solids

Suspended solids were generally low in the Lower Par waterbody, but elevated at Treesmill Stream at A3082 Bridge (average 19.12 mg/l). They were not notably elevated at the next upstream site at Treesmill Stream upstream Emsleigh Pond (Figure 4). The source of the elevated suspended solids has not been

investigated, but may warrant a catchment walkover or further sampling. There are some online ponds, an industrial estate and caravan park in this section of river. EA investigations have also found evidence of potential sediment sources further up this tributary. EA walkover and CSI/Riverfly monitoring at strategic locations would be beneficial to investigate this further.

Par Sands designated bathing water

Par Sands designated bathing water (Defra ID 27300) has fluctuated between Bathing Water Regulations classifications of Good (2019, 2022) and Sufficient (2021, 2023) in the last 5 years (no classification was produced in 2020 due to the Covid 19 pandemic). It is currently considered 'at risk' of a Poor classification due to a number of elevated bacterial results in that time (Figure 5). As such Par is a priority bathing water for the Environment Agency.

Data indicated that the 'at risk' status was due to elevated Intestinal Enterococci (IE) results in 2019-2023, particularly in 2019 and 2021 (Figure 5). E Coli data alone suggested a Good classification. Microbial source tracking (MST) analysis of elevated bathing water samples suggested the presence of both human and ruminant bacterial markers. On one occasion when measured, seabird markers were also present. Markers for dog faeces were also present in lower numbers than the other sources (quantitative analysis is indicative only).

The Pollution Risk Forecasting model for Par bathing water (derived from comparing a long dataset of bathing water bacteria against environmental factors that may influence it), indicates that rainfall and wind were both significant factors influencing bathing water quality.

There was a strong relationship between IE in Par River at Par Beach and in Par bathing water (Figure 7), indicating that the Par River is a significant source of bacteria to the bathing water. However, IE concentrations in Par River at Par Beach were relatively low compared with some other rivers impacting bathing waters in Cornwall, except on a few days when there was high rainfall in the catchment (Figure 5). IE concentrations in Par River at Beach had a strong relationship with rainfall (Figure 6).

Elevated bathing water IE occurred in both wet and dry weather. Every elevated result in Par bathing water was associated with river IE concentrations in the highest 25% of river IE samples *and* some of the lowest salinities in the dataset (indicating relatively high river influence on the bathing water). This suggests that a combination of these factors influenced bathing water quality in both wet and dry weather. (Rivers generally have higher bacteria concentrations than coastal bathing waters, due to lower dilution of natural and anthropogenic sources of bacteria).

The relatively low dry weather river bacteria makes it difficult to trace sources. Given other evidence (eg elevated suspended solids in Treesmill/Tywardreath Stream, elevated TDS and PO4-P in Par River at the beach), it would be prudent to target the lower, urbanised areas of the catchment closest to the bathing water first, in addition to known historic pollution sources from previous investigations.

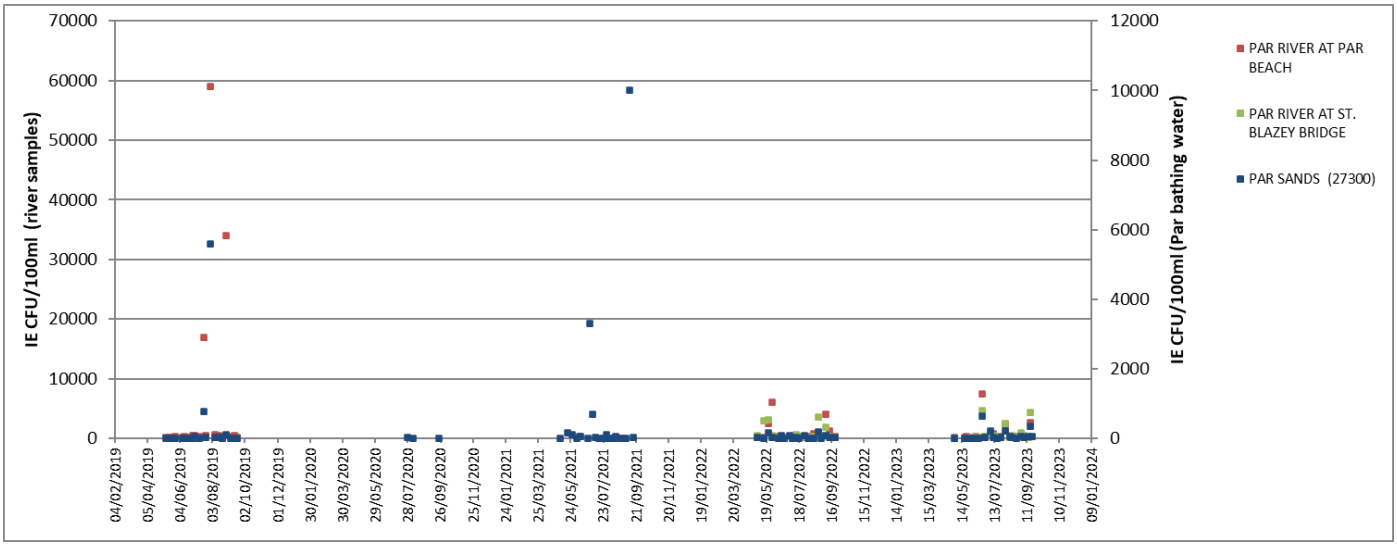


Figure 5 *Par bathing water and river bacteria samples, 2019-2023*

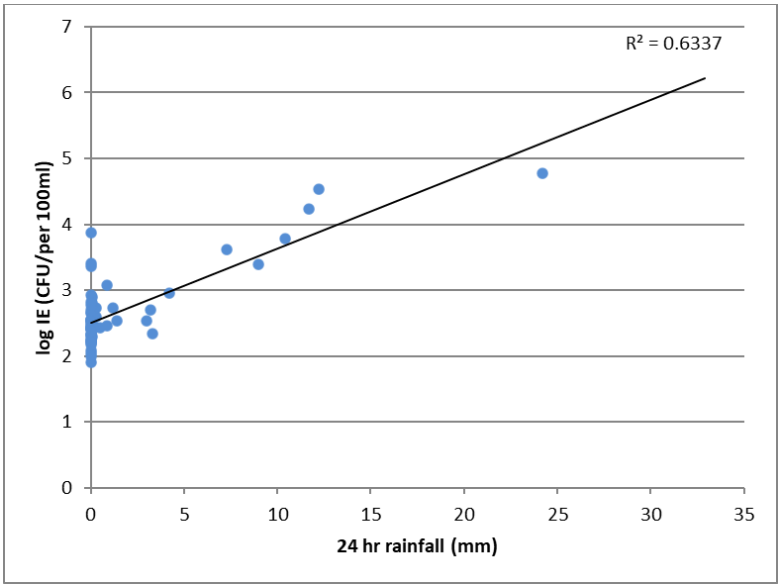


Figure 6 *Relationship between IE concentrations and 24 hour rainfall in Par River at Beach, 2019-2023*

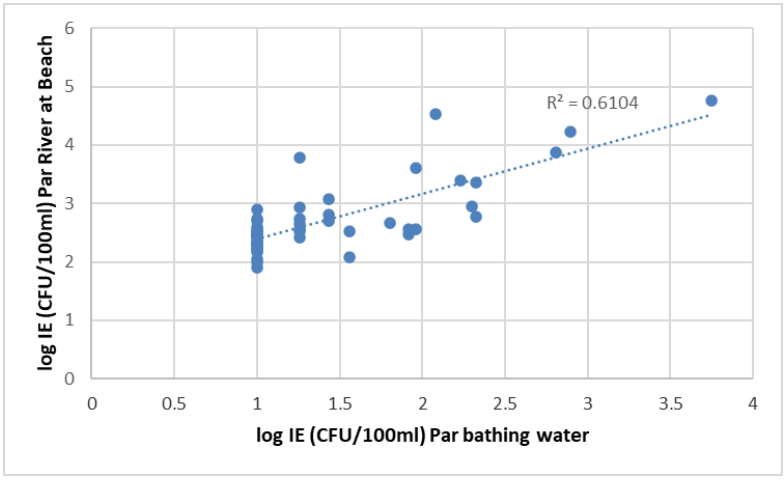


Figure 7 *Relationship between IE concentrations in Par bathing water and Par River at Beach, 2019 - 2023*

Bacterial citizen science data

The EA's interest in river bacteria concentrations is in relation to designated bathing waters, either coastal or inland (rivers and lakes). Bacteria are not generally a concern for the ecological health of a river, and form part of a natural river ecosystem. However, the EA will seek to investigate and reduce anthropogenic sources of E Coli and IE where they are likely to negatively impact the quality of a designated bathing water, either inland or coastal. It is difficult to achieve bathing water standards in rivers, as bacteria sources (natural and anthropogenic) are not subject to the same level of dilution as for coastal bathing waters.

Friends of Par Beach/Friends of Luxulyan Valley did some bacteria monitoring of the freshwater catchment in February 2022 to July 2023 inclusive, using the Aquagenx field test kit (Burrell, Farmer and Smith, July 2023). E Coli concentrations at Lady Rashleigh Mine and occasional other sites (Criggan Moor, Minorca Lane, Gatty's trib) were generally lower than 500 MPN (Most Probable Number - equivalent to Colony Forming Units per 100ml (CFU/100ml), the EA standard measurement unit). The exception was two samples in March and June 2023 at Lady Rashleigh Mine, which returned results of > 1000 MPN. One of these was taken in wet weather.

It is not clear how accurate the Aquagenx bacterial measurements are. For EA E Coli samples taken at the same time as Aquagenx at Minorca Lane and Lady Rashleigh Mine, EA samples returned significantly higher results than Aquagenx (Aquagenx readings 483 MPN for both, EA readings 2200 and 860 CFU/100ml respectively). On the wet weather day at Lady Rashleigh Mine, when the Aquagenx kit gave an E Coli result of > 1000 MPN, EA data returned a concentration of 6600 CFU/100ml at St Blazey Bridge.

It may be that the Aquagenx kit is best used to compare readings at different sites, or at one site at different times, to give a relative indication of contamination at different sites or over time, rather than the concentrations being taken as absolute. As Par River generally has relatively low (< 1000 CFU/100ml) bacteria, the kit could potentially be used to identify 'low' (<1000 CFU/100ml) and 'high' (>1000 CFU/100ml) bacterial concentrations, with the latter being more likely to be associated with elevated bathing water bacteria. However, more data would be needed to confirm this.

Given the generally relatively low concentrations of IE in Par River in dry weather, investigating and reducing sources will be challenging. Agile citizen science monitoring could supplement EA monitoring and add value to the investigation. This would require a reliable and user-friendly field based method of measuring bacteria. The EA are currently trialling a field monitoring kit from Fluidion called the ALERT One (Fluidion ALERT One), which claims high accuracy and repeatability comparable with laboratory methods. We may be able to lend this out to citizen science groups in the future, depending on the results of these trials and our own use of these kits.

Usefulness of citizen science data

The data provided by Friends of Par River and Friends of Luxulyan Valley citizen science groups was very useful to supplement that collected by the Environment Agency. In particular, the reports they produced were very helpful to enable us to see their findings 'at a glance' and saved valuable staff time (which may

not otherwise have been found) spent analysing the raw data. The charts of long term data using different timeframes (from April 2022 and from April 2023) were particularly useful, to allow us to identify long term and more recent patterns in the data.

A number of water quality issues were highlighted by the CS reports (as described in other sections of this report), that the EA might not otherwise have been aware of. In other cases, the citizen science reports added valuable supporting evidence to existing EA knowledge of specific water quality issues, raised awareness of these issues among citizen scientists and thereby increased public pressure on polluters to reduce pollution from their activities.

Consistency of the citizen science data was key – for the most part data were collected monthly, giving confidence that they were giving a consistent picture over time. Comparison of different sites with each other (eg up and downstream of suspected pollution sources or in different tributaries of the river) were more useful than absolute values given by the field test kits, which have a bigger margin for error than EA laboratory samples and are therefore difficult to compare with existing standards for water quality. However, more information on the accuracy of values produced by these kits, from the current Catchment Systems Thinking Cooperative methods audit, will be useful in assessing the usefulness of the values themselves.

The value of the citizen science data could be enhanced in a number of ways. As a general principle and for surveillance purposes, the more data collected the better, both spatially and temporally. These data allow the EA and citizen scientists to recognise and celebrate good water quality, as well as to highlight developing issues. Citizen science data collection could also be used in a more targeted way where the EA would like more evidence of an existing or suspected water quality issue (see recommendations below). This is most useful where citizen scientists are happy to collect these data independently, based on general discussions with the EA, to reduce the support burden on the EA.

Conclusion

EA and citizen science data have highlighted a number of water quality issues and concerns in the Upper and Lower Par waterbodies. These waterbodies have shown elevated nutrients, suspended solids and bacteria which may be detrimental to river ecology and bathing water quality. These issues are associated with various catchment activities, some known, some suspected and some not yet identified. This report has demonstrated these concerns, identified where further evidence is required and made recommendations on where to target further investigations in order to provide this.

Recommendations

Monitoring of ecological impacts of china clay discharges in Carbis and Rosevean Streams would be beneficial to assess whether the current discharge permits are sufficient to protect the watercourse. This could be achieved through EA monitoring if resources allow or CSI and ARMI Riverfly/enhanced Riverfly monitoring.

CSI and Riverfly monitoring at strategic locations in and upstream Treesmill/Tywardreath Stream would be useful, to investigate potential sources of TDS, PO4-P and sediment highlighted by citizen science and EA monitoring.

CSI and Riverfly monitoring at strategic locations in Treskilling/Treverbyn Stream would be useful, to investigate potential reasons for the paucity of invertebrates and potential pollution sources identified by citizen science monitoring and EA investigations.

An EA wet weather sampling survey Par River is needed, to identify wet weather sources of bacteria. This is planned for summer 2024.

An EA walkover of Par River and Treesmill/Tywardreath Stream in the urban area of Par immediate to the bathing water, and any other area identified by the wet weather survey or other catchment knowledge, is needed to follow up on previously identified issues and further identify potential sources of bacteria and other pollutants to the river and bathing water. This is planned for summer 2024.

Increased dry weather bacteria monitoring of Par River would be useful to better understand dry weather bacteria sources, either through laboratory samples or field based bacteria testing kits.

Continued Environment Agency and Westcountry Rivers Trust farm advisory and regulatory visits, targeted according to current knowledge of potential pollution sources, would be beneficial. (EA farm visits are planned for 2024 – 2025).

References

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