Summary of

Blue-Green Algae Monitoring in Northern Ireland Bathing Waters 2024

Department of
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An Roinn
Talmhaíochta, Comhshaoil agus Gnóthaí Tuaithe

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Summary

Blue-green algae also known as cyanobacteria, are microscopic, plant-like organisms that occur naturally in fresh, brackish and seawaters throughout the world. Blooms of blue-green algae often produce toxins (cyanotoxins), which can include neuro-(nerve) toxins, hepato-(liver) toxins, skin irritants, and inflammatory agents. This report provides a summary of blue-green algae water sample results taken to support management of risk to public health in Northern Ireland at relevant identified and candidate bathing waters in 2024.

The surveillance programme from the Interagency Blue-Green Algae Protocol was used by DAERA Bathing Waters Team at monitored sites. The Protocol operates on a Green, Amber and Red alert system, Red being the highest level and advice against bathing advised. Biovolume concentrations were the main reason for Red alerts at the monitored sites during the 2024 season. Toxicity was seldom detected throughout the monitoring period. However, when present it occurred around the same date as the high biovolume counts and concentrations were within the Red alert level.

Microcystin toxins were detected on one occasion at Rea's Wood on 2 August. Rea's Wood had the greatest number of Red alerts for biovolume, occurring between the 16 July - 16 September, with the largest occurrence on the 2 August. Toxicity was detected on two occasions at Seaton's Marina; on the 28 and 29 August. Red alerts for biovolume at Seaton's Marine occurred between 2 August - 11 September, the largest occurrence on the 28 and 29 August. The only other occurrence of toxins was at Portrush bathing water on the 29 August which had its highest biovolume, an Amber alert, on the 30 August. No toxins were detected or Red alerts occurred at Portstewart Strand, Castlerock, Downhill and Magilligan bathing waters.

1 Background

Blue-green algae also known as cyanobacteria, are microscopic, plant-like organisms that occur naturally in fresh, brackish and seawaters throughout the world. Usually green or blue-green in colour, cells may also be yellow-brown or red depending on the species. Normally, blue-green algae are not visible in the water. However, when suitable weather conditions combine with a ready supply of nutrients, high concentrations can occur to form algal blooms and scums which discolour the water.

Blooms of blue-green algae often produce toxins (cyanotoxins), which can include neuro-(nerve) toxins, hepato-(liver) toxins, skin irritants, and inflammatory agents. These toxins are largely retained within the blue-green algae cells during their development and growth and are released when the cells die. Algal blooms can occur throughout the year, but they are most common from May through to October. The duration of blooms may last for a few days to months until conditions change, and the blue-green algae die and decompose. The behaviour of blooms is unpredictable and their location within a water body can change quickly throughout the day. Blooms can float to the surface or move horizontally due to wind and currents. Therefore, a bloom that may be visible at one location one day may not be visible the next. The variability of bloom density is demonstrated in the cover picture of this report. Decaying blooms can also appear as scum or foam along the shoreline as a result of being carried by wind.

DAERA has worked with the Northern Ireland Environment Agency (NIEA), Agri-Food & Biosciences Institute (AFBI), NI Water, Food Standard Authority, and the Public Health Agency to develop an Inter-Agency Blue-Green Algae Monitoring Protocol which was published in May 2024. The Protocol details the DAERA response for surveillance and monitoring blue-green algae and describes the roles and responsibilities of the involved organisations and individuals, as well as how various types of waterways are monitored. The Protocol is available at Inter-Agency Blue-Green Algae Monitoring Protocol | Department of Agriculture, Environment and Rural Affairs.

This report provides a summary of blue-green algae water sample results taken to support management of risk to public health at relevant identified and candidate bathing waters in 2024.

2 Monitoring of Bathing Waters

Northern Ireland has 26 identified bathing waters, all of which are coastal, and 7 candidate bathing waters (1 inland, 6 coastal). Under The Quality of Bathing Water Regulations (Northern Ireland) 2008 identified or candidate bathing waters are monitored by DAERA Marine and Fisheries Division (MFD) through its Bathing Waters Programme during the bathing season (1st June - 15th September) each year.

Routine monitoring analyses for faecal indicator bacteria (E. coli and Intestinal enterococci) and includes water sampling and visual assessments. It is carried out up to 20 times each year at identified and candidate bathing water during the bathing season (pre-season testing is normally also carried out each May). During 2023 and 2024, additional sampling has been completed out of the bathing season and monitoring is also carried out in response to pollution incidents. When faecal indicator bacteria levels reach a set threshold then a 'poor bathing quality - advice against bathing notice' is issued by the Bathing Water Operator.

Unlike faecal indicator bacteria, there is not a specific methodology prescribed by the Bathing Water Regulations for assessing risk to public health from blue-green algae, beyond the visual assessment and the requirement to take action to minimise risk. Where there are concerns of risks to bathers' health from a visual assessment of blue-green algae, reference is made to guidelines provided by the World Health Organization (WHO) Guidelines (2021), which emphasises that if there is a dense scum visible, or risk of this developing (e.g. where scum is near the bathing site), advice against bathing should be issued. A range of water sample analyses for blue-green algae are possible to support assessment of potential risk to health, including cell counts, biovolume analysis and cyanotoxin analysis, which can then be used to compare against established 'guideline values' for safe levels for recreation. Toxin-based monitoring is necessary to allow adequate management measures to be put in place and for provision of accurate advice to bathing water operators, which is a statutory obligation for DAERA under the Bathing Water Regulations. The bathing water operator has a statutory obligation to post any 'advice against bathing' where deemed necessary following monitoring results.

In 2024 the surveillance programme from the Interagency Blue-Green Algae Monitoring Protocol was used by DAERA Bathing Waters Team to respond to suspected blue-green algae incidences at monitored sites. Depending on the monitored values of blue-green algae, each site was given the corresponding alert level and appropriate action taken (Figure 1).

Experience in the 2023 season has shown that account should be taken of prevailing wind conditions, which can transport blooms and scums into different locations and either concentrate them further or disperse them. Although a monitoring programme was

carried out in 2023 at the same sites, comparisons between 2023 and 2024 results are not drawn in this report as the dataset is still small, having only the two years of information.

	Green level - surveillance mode	**Amber level - alert mode**	**Red level - action mode**
Monitoring requirements:	Fortnightly visual assessment*, water sample ELISA analysis and/or biovolume analysis to establish a baseline.	Weekly visual assessment, water sample ELISA analysis and/or biovolume analysis. Cyanotoxin concentration corroboration at accredited laboratory.	Weekly visual assessment, water sample ELISA analysis and/or biovolume analysis. Cyanotoxin concentration corroboration at accredited laboratory.
Results:	No presence of microcystins. Biovolume of all cyanobacteria below 1mm^3/L.	Some visual evidence of patchy scum/mats/ potetial material. AND Presence of microcystin. Microystin concentration below 10 μg/L. AND/OR Biovolume of all cyanobacteria between 1 and 4mm^3/L.	A visible, thick scum covering most of the water surface. AND/OR Microcystin concentration at or above 10 μg/L. AND OR Biovolume of all cyanobacteria exceeds 4mm^3/L.
Advice to Bathing water operators:	Bathing water operators informed at surveillance mode.	Bathing water operator and public informed to watch out for scums and when in doubt, stay out (encourage vigilance).	Bathing water operator to issue '**advice against bathing**' and public warned of risk to public health.

Figure 1 Summary of the surveillance programme used throughout 2024 to ascertain the severity of blue-green algae presence and accompanying action, established by the Inter-Agency Blue-Green Algae Monitoring Protocol.

Members of the public are encouraged to take personal responsibility for themselves, children and pets, and heed any signage at water bodies regarding risks of blue-green algae or specific signs with 'advice against bathing'. In addition, the general public health advice from the Public Health Agency is when in doubt, stay out, and do not let pets swim in, play in or drink water that looks discoloured or has scum on the surface.

Members of the public should report any suspected blue-green algal bloom via the Bloomin' Algae App or via the emergency pollution email: emergency-pollution@daera-ni.gov.uk

For further information and guidance on the Bloomin' Algae App scan below:

3 Water sample analysis

A range of water sample analyses for blue-green algae are possible to support assessment of potential risk to health, including cell counts, biovolume analysis and cyanotoxin analysis, which can then be used to compare against established 'guideline values' for safe levels for recreation.

Based on World Health Organization (WHO) Guidelines (2021), freshwater recreational water bodies where bathing occurs should not contain >24 μg/L total microcystin concentration and/or a biovolume equivalent of >4 mm^3/L for the combined total of all blue-green algae, and/or blue-green algae scums are consistently present.

3.1 Biovolume

In 2023, cell counts and cyanotoxin (microcystin) concentrations were used to help assess the nature of the blue-green algae in bathing waters (Summary of blue-green algae monitoring in bathing waters 2023 - v141223.pdf). However, in 2024 a different approach involving cyanobacterial biovolume was used instead of cell counts, in line with the recommendations within the Inter-Agency Blue Green Algae Monitoring Protocol. Cyanobacterial biovolume is preferred over cell counts as it provides a more accurate representation of the sample biomass. Cyanobacteria form different shapes like colonies (Microcystis) and filaments (Oscillatoria) and simply counting cells in colonies, which can contain thousands of cells, is difficult and misleading. Counting cells does not account for the differences between small single cells and large filaments or colonies. Biovolume is favoured as it standardizes differences in cyanobacteria to a single unit of measure which has regulatory thresholds and are used by World Health Organization (WHO) Guidelines (2021.

Biovolume analysis of water samples was conducted both by the environmental consultancy APEM Ltd and DAERA.

3.2 Toxicity

The parameters highlighted in the Interagency Blue-Green Algae Monitoring Protocol were the ones adopted for bathing water monitoring in 2024. Whilst the Protocol adopted the recommended WHO guideline of >4mm3/L biovolume, a more conservative microcystin concentration of 10 μg/L was used as a precautionary approach, given the paucity of information on cyanobacteria. The guideline value of 10 μg/L is based specifically on a particular toxin called microcystin-LR (MC-LR), as it is best understood and therefore its use can be supported by established scientific research. There are however, many other microcystin toxins with the ability to be potentially harmful. Therefore caution was exercised and the total microcystin concentration was still considered during bathing water monitoring. Results presented in this report are split between 'intracellular microcystin', i.e. toxins detected within blue-green algal cells, and 'extracellular microcystin' i.e. toxins found outside the cells and within the water.

Analysis of samples for cyanotoxins was progressed, as in 2023, so to better understand the possible toxicity of the bloom. The enzyme-linked immunosorbent assay (ELISA) techniques to enable DAERA to determine microcystin concentrations in-house are under development, therefore cyanotoxin analysis was outsourced to the suitably accredited laboratory, CEFAS Technology Ltd. CEFAS reported microcystin results with a minimum limit of reporting of 1 μg/L and with a measurement uncertainty envelope to allow for error; results presented in this report show the actual result from within the measurement uncertainty envelope.

In addition to the blue-green algae biovolume and toxicity testing, all identified, and candidate bathing waters, were visually assessed on a weekly basis during the bathing season (1st June - 15th September) under the DAERA bathing waters programme.

3.3 Monitored sites

Following the lessons learned in 2023 from Lough Neagh and the Lower Bann through to the north coast, the following bathing water sites were monitored as potentially impacted areas:

- Rea's Wood, Lough Neagh (inland candidate bathing water)
- Portrush Mill
- Portstewart Strand
- Castlerock beach
- Downhill beach
- Magilligan (Benone) beach

Samples were also collected within Seaton's Marina (which is 5.7km from the coast on the Lower Bann), as the site is a good indicator in identifying the flow/risk of blue-green algae movement from Lough Neagh onto the north coast.

The Northern Ireland Environment Agency (NIEA) also respond to reports of suspected blue-green algae, liaising with landowners to initiate actions as appropriate. As blooms are intermittent, they are also managed by NIEA as pollution incidents. Confirmed records of blue-green algae both in Lough Neagh and other sites throughout Northern Ireland are available via the DAERA blue green algae confirmed locations webmap available at: Blue-Green Algae - Confirmed Locations. Reports submitted via the 'Bloomin' Algae' app (created by the UK Centre for Hydrology and Ecology) are also available at: Bloomin' Algae maps | NI | UK Centre for Ecology & Hydrology.

4 Results and Discussion

4.1 Rea's Wood Antrim

Rea's Wood candidate bathing water is an inland site extending along part of the northeast shore of Lough Neagh (Figure 2).

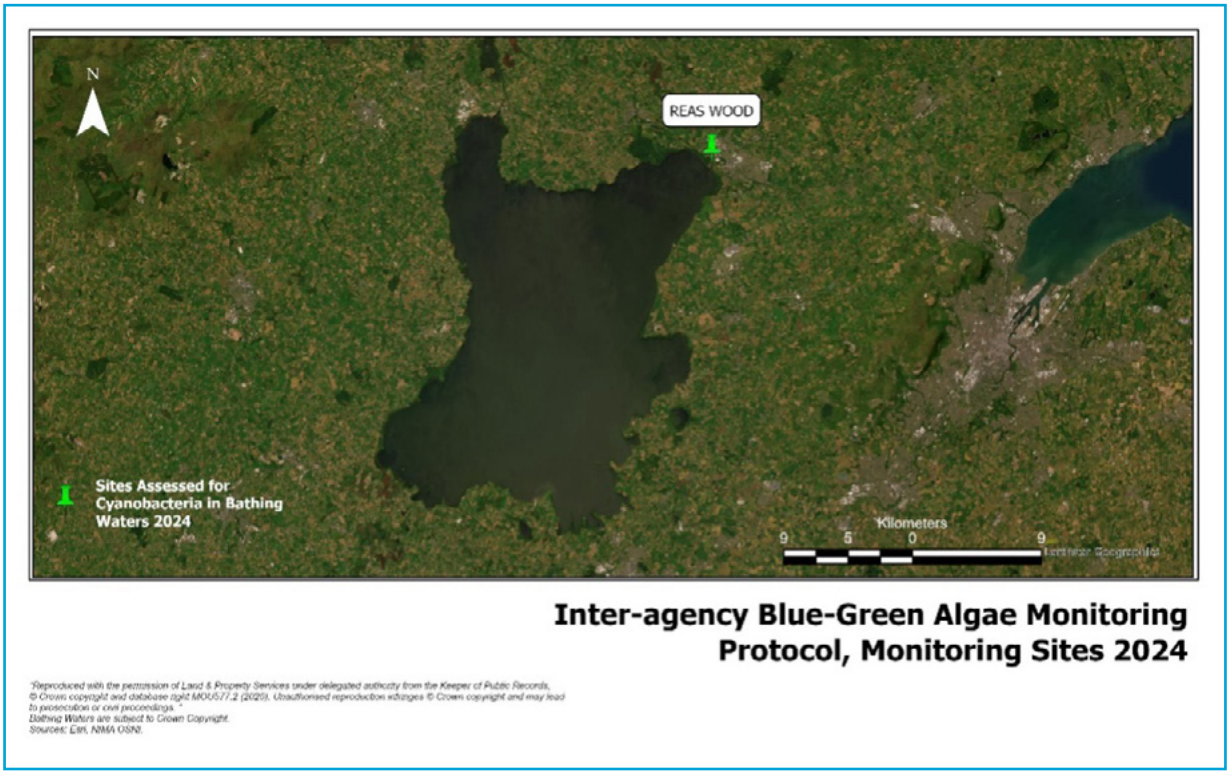


Figure 2 Location of the inland candidate bathing water Rea's Wood within Lough Neagh.

Based on reports on blue-green algae blooms in Lough Neagh in 2023, surveillance monitoring at Rea's Wood commenced on the 19 March 2024 and continued to 25 November 2024. During this period a total of 37 water samples were lifted for toxin analysis and 24 water samples were lifted for biovolume, along with additional visual assessments and drone surveys. All water samples lifted between 19 March until the 3 June were tested for cyanotoxins and were below the limit of reporting.

Table 1 shows all sampling results for biovolume and microcystin concentrations from the 10 June - 25 November.

The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Rea's Wood bathing water are illustrated in Figure 3.

Table 1 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Rea's Wood candidate bathing water between the 10/06/24 - 25/11/24, with the corresponding alert level. <LOR is below the limit of reporting (<1μg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (μg/L)	Total extracellular microcystin (μg/L)	Intracellular microcystin-LR (μg/L)	Extracellular microcystin-LR (μg/L)	Alert level
10/06/24	0.002	<LOR	<LOR	<LOR	<LOR	Green
17/06/24	0.01	<LOR	<LOR	<LOR	<LOR	Green
24/06/24	0.178	<LOR	<LOR	<LOR	<LOR	Green
01/07/24	2.828	<LOR	<LOR	<LOR	<LOR	Amber
08/07/24	0.133	<LOR	<LOR	<LOR	<LOR	Green
16/07/24	333	<LOR	<LOR	<LOR	<LOR	Red
23/07/24	68.9	<LOR	<LOR	<LOR	<LOR	Red
29/07/24	356	<LOR	<LOR	<LOR	<LOR	Red
02/08/24	500	405.5	26.8	175	13	Red
05/08/24	187.27	<LOR	<LOR	<LOR	<LOR	Red
12/08/24	208	<LOR	<LOR	<LOR	<LOR	Red
19/08/24	34.95	<LOR	<LOR	<LOR	<LOR	Red
28/08/24	71.08	<LOR	<LOR	<LOR	<LOR	Red
02/09/24	9.28	<LOR	<LOR	<LOR	<LOR	Red
11/09/24	1.7	<LOR	<LOR	<LOR	<LOR	Amber
16/09/24	33.3	<LOR	<LOR	<LOR	<LOR	Red
23/09/24	0.11	<LOR	<LOR	<LOR	<LOR	Green
30/09/24	0.59	<LOR	<LOR	<LOR	<LOR	Green
07/10/24	0.13	<LOR	<LOR	<LOR	<LOR	Green
14/10/24	1	<LOR	<LOR	<LOR	<LOR	Green
21/10/24	0.35	<LOR	<LOR	<LOR	<LOR	Green
28/10/24	0.08	<LOR	<LOR	<LOR	<LOR	Green
11/11/24	0.33	<LOR	<LOR	<LOR	<LOR	Green
25/11/24	0.003	<LOR	<LOR	<LOR	<LOR	Green

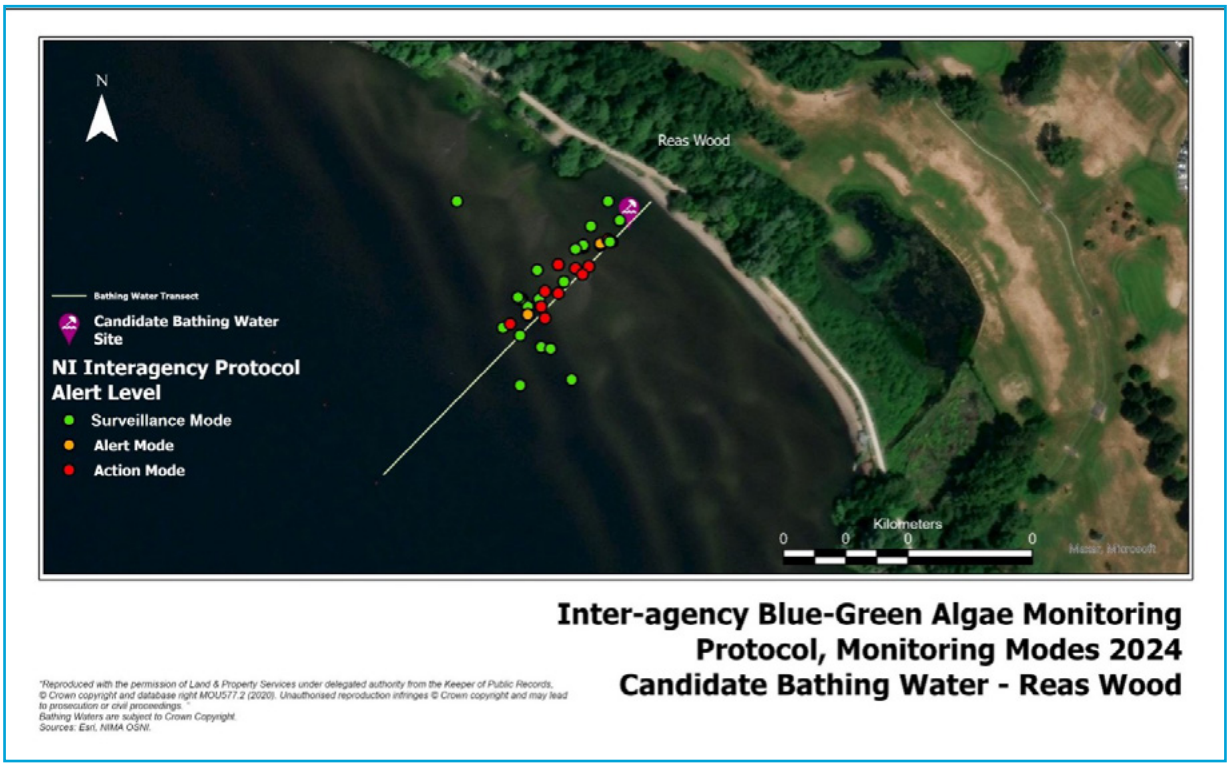


Figure 3 Sample locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Rea's Wood candidate bathing water in 2024.

The first sign of a potential blue-green increase occurred on the 1 July. By the 16 July a bloom was evident on the surface of the bathing water and biovolume had increased, with the highest recorded level on the 2 August.

The 2 August not only had the largest biovolume but was also the only time microcystin toxins were detectable for the whole monitoring period at Rea's Wood (Figure 4), with all other sampling results being below the limit of reporting. Total intracellular and extracellular microcystin concentrations on this date were well above the 10 μg/L guideline, as were the microcystin-LR values, adopted for Northern Ireland waters.

Biovolume levels varied markedly from the 16 July to the 2 September, but all records remained within the red alert level. From the 23 September - 25 November biovolumes decreased to the Green alert level, with only one sample on the 14 October near the Amber alert level threshold.

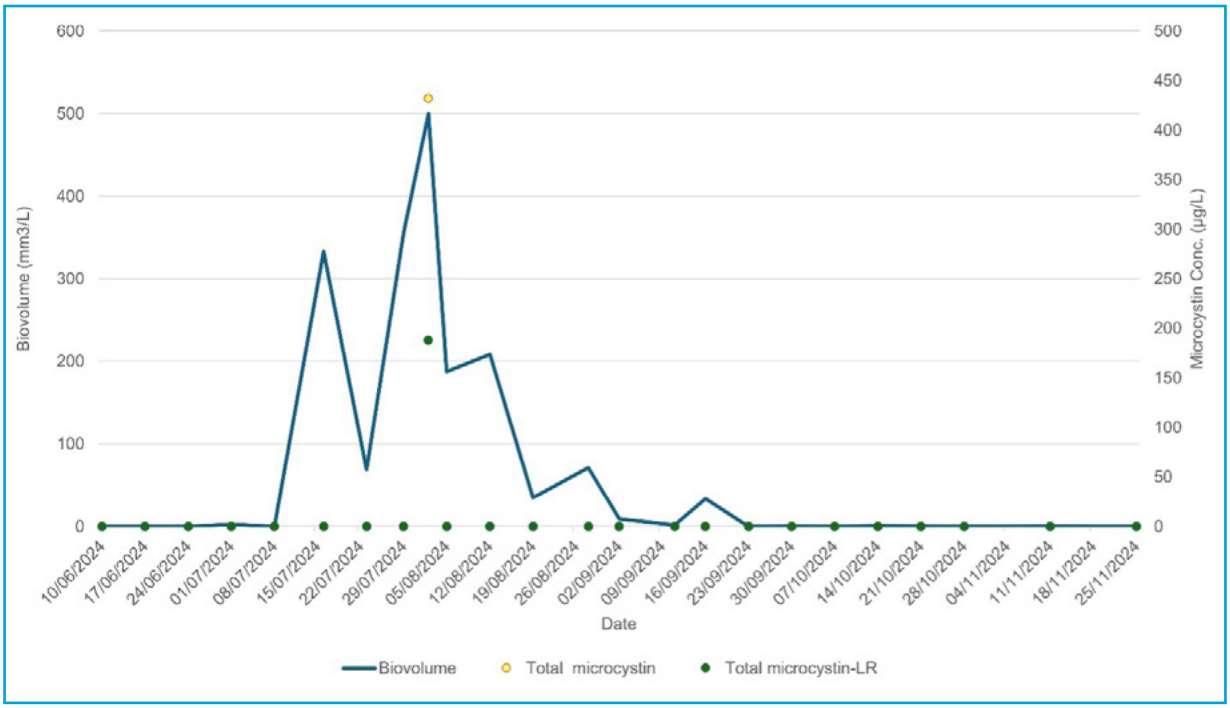


Figure 4 Graph illustrating the fluctuation in biovolume records and that the only recorded toxicity event occurred on the same date as the highest recorded biovolume at Rea's Wood candidate bathing water in 2024.

'Advice against bathing' was issued to Rea's Wood bathing water operators on the 16 July by DAERA staff and remained in place for the rest of the bathing season (Appendix 1).

4.2 Coastal sites

Lough Neagh drains via the floodgates at Toome (which help control water levels of Lough Neagh), into Lough Beg, past Newferry and into the Lower Bann. The estuarine section of the Lower Bann stretches from the Cutts upstream from Coleraine to the Barmouth, where sea walls separate the north coast beaches and sand dune systems of Portstewart Strand and Castlerock. The adjacent beach shorelines and their bathing waters may be impacted by the river water from the Bann, depending on wind and tidal conditions affecting mixing and flow. The coastal sites monitored for blue-green algae are illustrated in Figure 5.

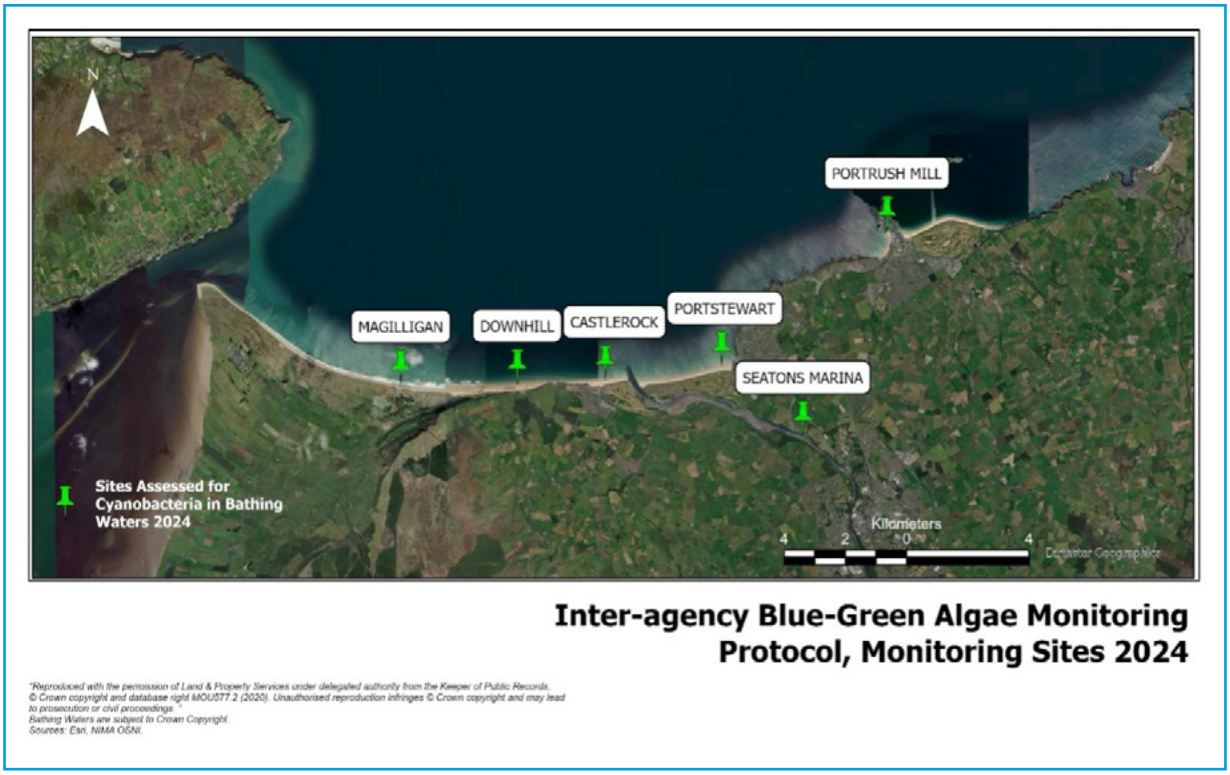


Figure 5 Location of the coastal sites monitored for blue-green algae (cyanobacteria) in 2024.

4.2.1 Seaton's Marina

Experience in the 2023 season showed that blooms/scums are transported into different locations and consequently either become more concentrated or disperse. Seaton's Marina was monitored as a sentinel surveillance programme, so to assist in identifying potential movements of blue-green algae to the North Coast.

Between the 16 July and 14 October, seventeen water samples were analysed for biovolume and toxins analysis from Seaton's Marina and the results are displayed in Table 2. Visual assessments and drone surveys were also carried out. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Seaton's Marina are highlighted in Figure 6.

Table 2 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Seaton's Marina between the 16/07/24 - 14/10/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 µg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (µg/L)	Total extracellular microcystin (µg/L)	Intracellular microcystin-LR (µg/L)	Extracellular microcystin-LR (µg/L)	Alert level
16/07/24	0.13	<LOR	<LOR	<LOR	<LOR	Green
23/07/24	0.07	<LOR	<LOR	<LOR	<LOR	Green
29/07/24	0.07	<LOR	<LOR	<LOR	<LOR	Green
02/08/24	8.4	<LOR	<LOR	<LOR	<LOR	Red
05/08/24	0.78	<LOR	<LOR	<LOR	<LOR	Green
12/08/24	94	<LOR	<LOR	<LOR	<LOR	Red
19/08/24	1.26	<LOR	<LOR	<LOR	<LOR	Amber
28/08/24	100	11.8	<LOR	5.18	<LOR	Red
29/08/24	100	79.3	<LOR	31.25	<LOR	Red
30/08/24	26.6	<LOR	<LOR	<LOR	<LOR	Red
02/09/24	1.65	<LOR	<LOR	<LOR	<LOR	Amber
11/09/24	8.8	<LOR	<LOR	<LOR	<LOR	Red
16/09/24	0.13	<LOR	<LOR	<LOR	<LOR	Green
23/09/24	1.02	<LOR	<LOR	<LOR	<LOR	Amber
30/09/24	0.06	<LOR	<LOR	<LOR	<LOR	Green
07/10/24	0.01	<LOR	<LOR	<LOR	<LOR	Green
14/10/24	0.35	<LOR	<LOR	<LOR	<LOR	Green

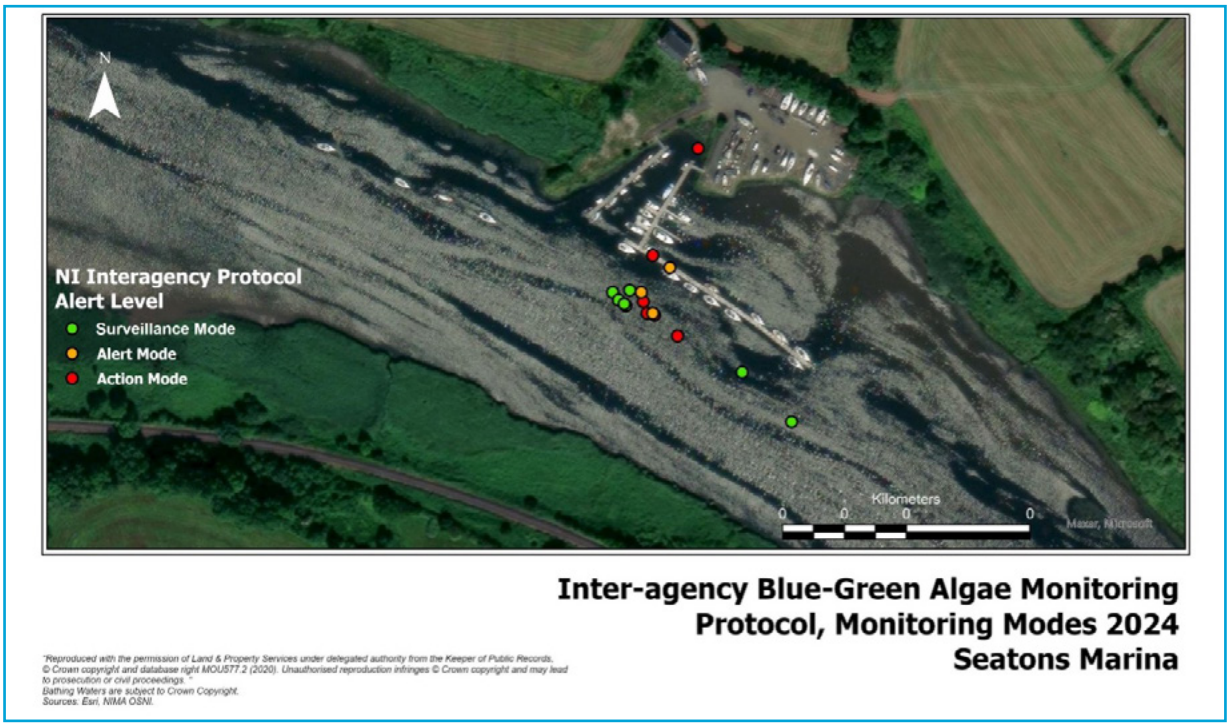


Figure 6 Sample locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Seaton's Marina in 2024.

Biovolume records varied markedly throughout the sampling period and were highest in August, with some recordings in September.

The 28 and 29 of August not only had the largest biovolumes but were also the only occasions when microcystin toxins were detected at Seaton's Marina (Figure 7). All other sampling results were below the limit of reporting.

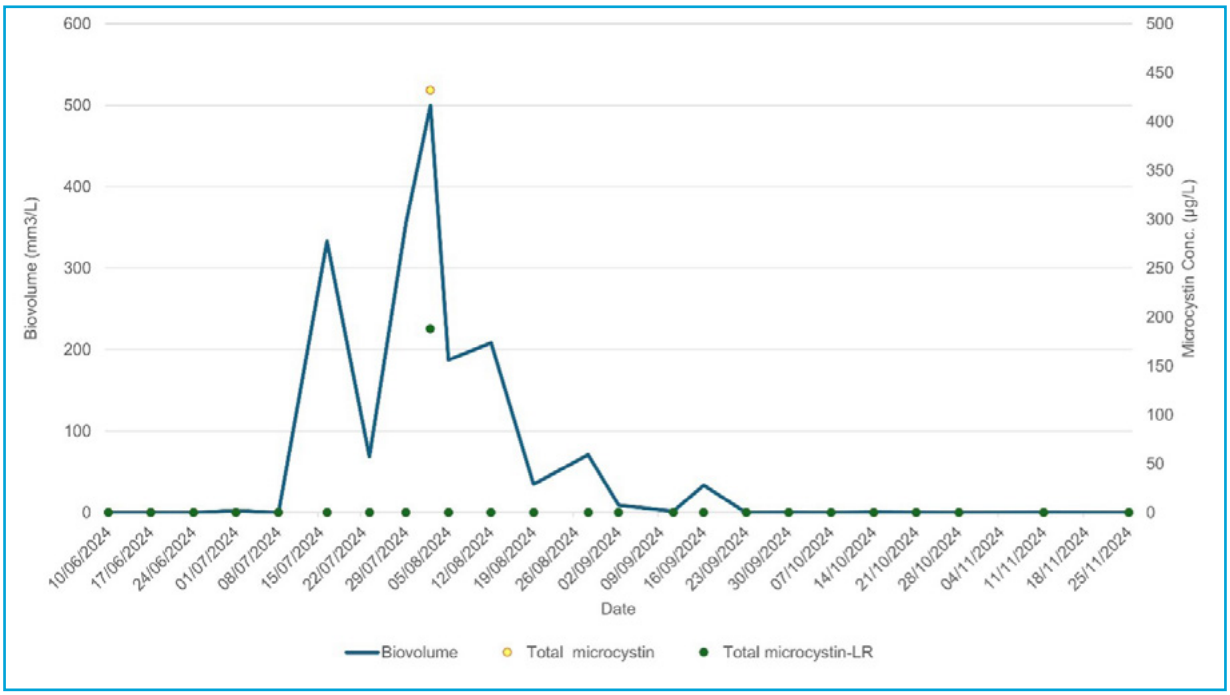


Figure 7 Graph illustrating the fluctuation in biovolume records and that recorded toxicity events occurred on the same dates as the highest recorded biovolume at Seaton's Marina in 2024.

4.2.2 Portrush Mill

Between the 16 July - 16 September, at Portrush bathing water 11 water samples were taken for biovolume and 6 water samples were taken for toxin analysis (Table 3), along with additional visual assessments and drone surveys. Due to the nature of the samples, on occasion only extracellular toxins could be analysed. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Portrush Mill bathing water are highlighted in Figure 8.

Table 3 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Portrush Mill bathing water between the 16/07/24 - 14/10/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 µg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (µg/L)	Total extracellular microcystin (µg/L)	Intracellular microcystin-LR (µg/L)	Extracellular microcystin-LR (µg/L)	Alert level
16/07/24	0	N/A	N/A	N/A	N/A	Green
02/08/24	0.003	N/A	N/A	N/A	N/A	Green
05/08/24	0	N/A	N/A	N/A	N/A	Green
12/08/24	0	N/A	N/A	N/A	N/A	Green
19/08/24	0	N/A	N/A	N/A	N/A	Green
28/08/24	0.01	<LOR	<LOR	<LOR	<LOR	Green
29/08/24	0.23	24	<LOR	10.5	<LOR	Red
30/08/24	1.2	Tested for extracellular toxins only	<LOR	<LOR	<LOR	Amber
02/09/24	0	<LOR	<LOR	<LOR	<LOR	Green
11/09/24	0.02	<LOR	<LOR	<LOR	<LOR	Green
16/09/24	0	Tested for extracellular toxins only	<LOR	<LOR	<LOR	Green

Figure 8 Samples locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Portrush Mill bathing water in 2024.

The highest biovolume at Portrush bathing water occurred on the 30 August. There was no visible evidence of blue-green algae on the bathing water surface but a few visible patches were identified in the harbour on the 29 and 30 August.

Microcystin toxins were detected on one occasion, the 29 August, all other sampling results being below the limit of reporting (Figure 9). Only intracellular microcystin concentrations were detected and were above the 10 μg/L guideline, as was the microcystin-LR value. A high intracellular microcystin concentration was also recorded on the same date at Seaton's Marina, though Portrush had a much lower biovolume.

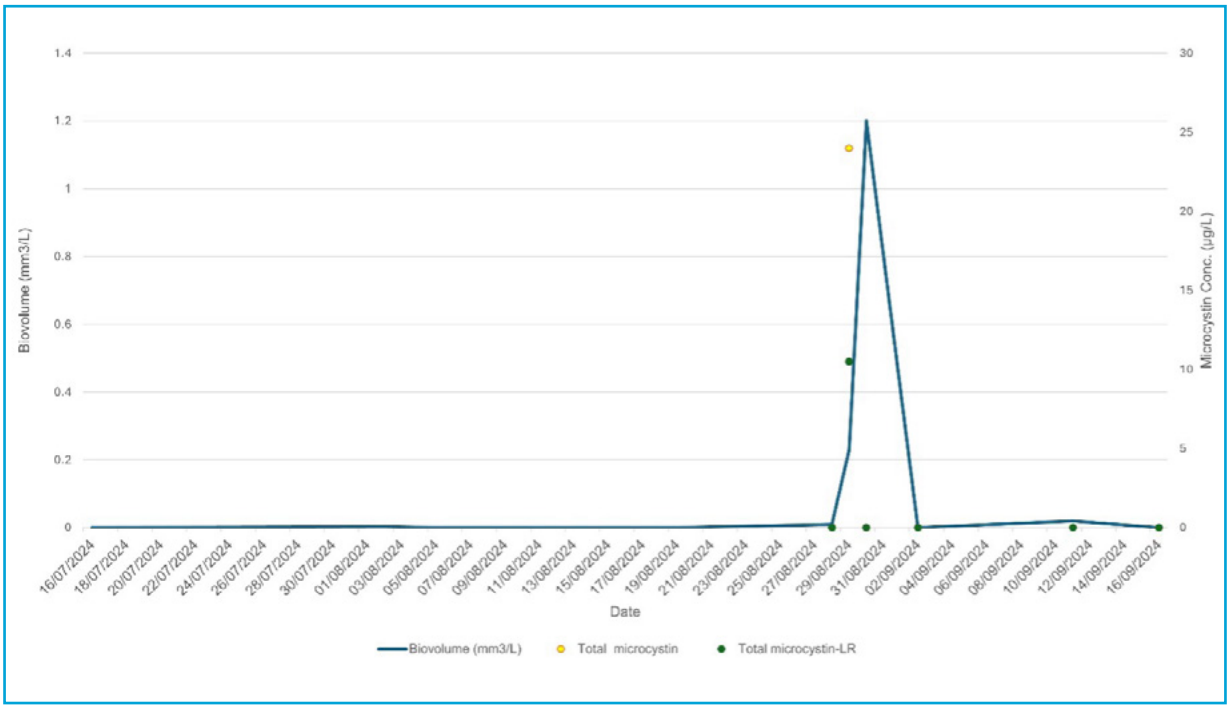


Figure 9 Graph illustrating biovolume records and that the only recorded toxicity event occurred around the same date as the highest recorded biovolume at Portrush Bathing Water in 2024.

On the 29 August bathing water operator at Portrush was advised that the DAERA assessment had indicated blue-green algae was present in low volumes, to be vigilant and to issue a Water Safety Notice as a precautionary measure.

4.2.3 Portstewart Strand

Between the 16 July - 16 September, at Portstewart bathing water 12 water samples were taken for biovolume and 6 water samples taken for toxin analysis (Table 4), along with additional visual assessments and drone surveys. Due to the nature of the sample, on occasion only extracellular toxins could be analysed. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Portstewart bathing water are highlighted in Figure 10.

Table 4 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Portstewart bathing water between the 16/07/24 - 16/09/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 μg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (μg/L)	Total extracellular microcystin (μg/L)	Intracellular microcystin-LR (μg/L)	Extracellular microcystin-LR (μg/L)	Alert level
16/07/24	0	N/A	N/A	N/A	N/A	Green
23/07/24	0	N/A	N/A	N/A	N/A	Green
02/08/24	0.01	N/A	N/A	N/A	N/A	Green
05/08/24	0	N/A	N/A	N/A	N/A	Green
12/08/24	0	N/A	N/A	N/A	N/A	Green
19/08/24	0	N/A	N/A	N/A	N/A	Green
28/08/24	0.08	<LOR	<LOR	<LOR	<LOR	Green
29/08/24	0.02	<LOR	<LOR	<LOR	<LOR	Green
30/08/24	1.2	Tested for extracellular toxins only	<LOR	Tested for dissolved toxins only	<LOR	Amber
02/09/24	0.06	Tested for extracellular toxins only	<LOR	Tested for dissolved toxins only	<LOR	Green
11/09/24	0	<LOR	<LOR	<LOR	<LOR	Green
16/09/24	0	Tested for extracellular toxins only	<LOR	Tested for dissolved toxins only	<LOR	Green

Figure 10 Sample locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Portstewart bathing water in 2024.

The highest biovolume at Portstewart occurred on the 30 August. Portrush bathing waters and Seaton's Marina also had their highest biovolume recorded around the same date. Microcystin sampling results were all below the limit of reporting. There was no visible evidence of blue-green algae in the bathing water, but a few visible patches were identified in the harbour on the 2 September.

No 'advice against bathing' was issued for Portstewart bathing water in 2024.

4.2.4 Castlerock

Between the 16 July - 16 September, at Castlerock bathing water 11 water samples were taken for biovolume and 6 water samples taken for toxin analysis (Table 5), along with additional visual assessments and drone surveys. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Castlerock bathing water are highlighted in Figure 11.

Table 5 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Castlerock bathing water between the 16/07/24 - 16/09/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 µg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (µg/L)	Total extracellular microcystin (µg/L)	Intracellular microcystin-LR (µg/L)	Extracellular microcystin-LR (µg/L)	Alert level
16/07/24	0	N/A	N/A	N/A	N/A	Green
23/07/24	0	N/A	N/A	N/A	N/A	Green
02/08/24	0.003	N/A	N/A	N/A	N/A	Green
05/08/24	0	N/A	N/A	N/A	N/A	Green
12/08/24	0.1	N/A	N/A	N/A	N/A	Green
28/08/24	0.05	<LOR	<LOR	<LOR	<LOR	Green
29/08/24	1.03	<LOR	<LOR	<LOR	<LOR	Amber
30/08/24	1	<LOR	<LOR	<LOR	<LOR	Green
02/09/24	0	<LOR	<LOR	<LOR	<LOR	Green
11/09/24	0.005	<LOR	<LOR	<LOR	<LOR	Green
16/09/24	0	<LOR	<LOR	<LOR	<LOR	Green

Figure 11 Sample locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Castlerock bathing water in 2024.

The highest biovolume at Castlerock bathing water occurred on the 29 August. Portrush and Portstewart bathing waters and Seaton's Marina also had their highest biovolume recorded around this date. Microcystin sampling results were all below the limit of reporting. There was no visible evidence of blue-green algae on the bathing water surface and no 'advice against bathing' was issued for Castlerock bathing water in 2024.

4.2.5 Downhill

Between the 16 July - 16 September, at Downhill bathing water 11 water samples were taken for biovolume and 6 water samples taken for toxin analysis (Table 6), along with additional visual assessments and drone surveys. Due to the nature of the sample, on occasion only extracellular toxins could be analysed. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Downhill bathing water are highlighted in Figure 12.

Table 6 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Downhill bathing water between the 16/07/24 - 16/09/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 µg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (µg/L)	Total extracellular microcystin (µg/L)	Intracellular microcystin-LR (µg/L)	Extracellular microcystin-LR (µg/L)	Alert level
16/07/24	0	N/A	N/A	N/A	N/A	Green
02/08/24	0.01	N/A	N/A	N/A	N/A	Green
05/08/24	0	N/A	N/A	N/A	N/A	Green
12/08/24	0.01	N/A	N/A	N/A	N/A	Green
19/08/24	0	N/A	N/A	N/A	N/A	Green
28/08/24	0	<LOR	<LOR	<LOR	<LOR	Green
29/08/24	0.03	Tested for dissolved toxins only	<LOR	<LOR	<LOR	Green
30/08/24	0.6	Tested for dissolved toxins only	<LOR	<LOR	<LOR	Green
02/09/24	0.13	<LOR	<LOR	<LOR	<LOR	Green
11/09/24	0	<LOR	<LOR	<LOR	<LOR	Green
16/09/24	0	Tested for dissolved toxins only	<LOR	<LOR	<LOR	Green

Figure 12 Sample locations during the different periods of alert mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Downhill bathing water in 2024.

The highest biovolume at Downhill bathing water occurred on the 30 August. Microcystin sampling results were all below the limit of reporting. There was also no visible evidence of blue-green algae on the bathing water surface and no ‘advice against bathing’ was issued for Downhill bathing water in 2024.

4.2.6 Magilligan (Benone)

Between the 28 August - 16 September, at Magilligan bathing water 6 water samples were taken for biovolume and 6 water samples taken for toxin analysis (Table 7), along with additional visual assessments and drone surveys. Due to the nature of the sample, on occasion only extracellular toxins could be analysed. The location of samples lifted during the different alert modes under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Magilligan (Benone) bathing water are highlighted in Figure 13.

Table 7 Blue-green algae biovolume and microcystin concentrations from water sampling results taken at Magilligan (Benone) bathing waters between the 28/08/24 - 16/09/24, with the corresponding alert level. <LOR is below the limit of reporting (<1 µg/L).

Date	Biovolume (mm^3/L)	Total intracellular microcystin (µg/L)	Total extracellular microcystin (µg/L)	Intracellular microcystin-LR (µg/L)	Extracellular microcystin-LR (µg/L)	Alert level
28/08/24	0.49	<LOR	<LOR	<LOR	<LOR	Green
29/08/24	0.09	<LOR	<LOR	<LOR	<LOR	Green
30/08/24	0.18	<LOR	<LOR	<LOR	<LOR	Green
02/09/24	0.04	<LOR	<LOR	<LOR	<LOR	Green
11/09/24	0	<LOR	<LOR	<LOR	<LOR	Green
16/09/24	0	Tested for dissolved toxins only	<LOR	<LOR	<LOR	Green

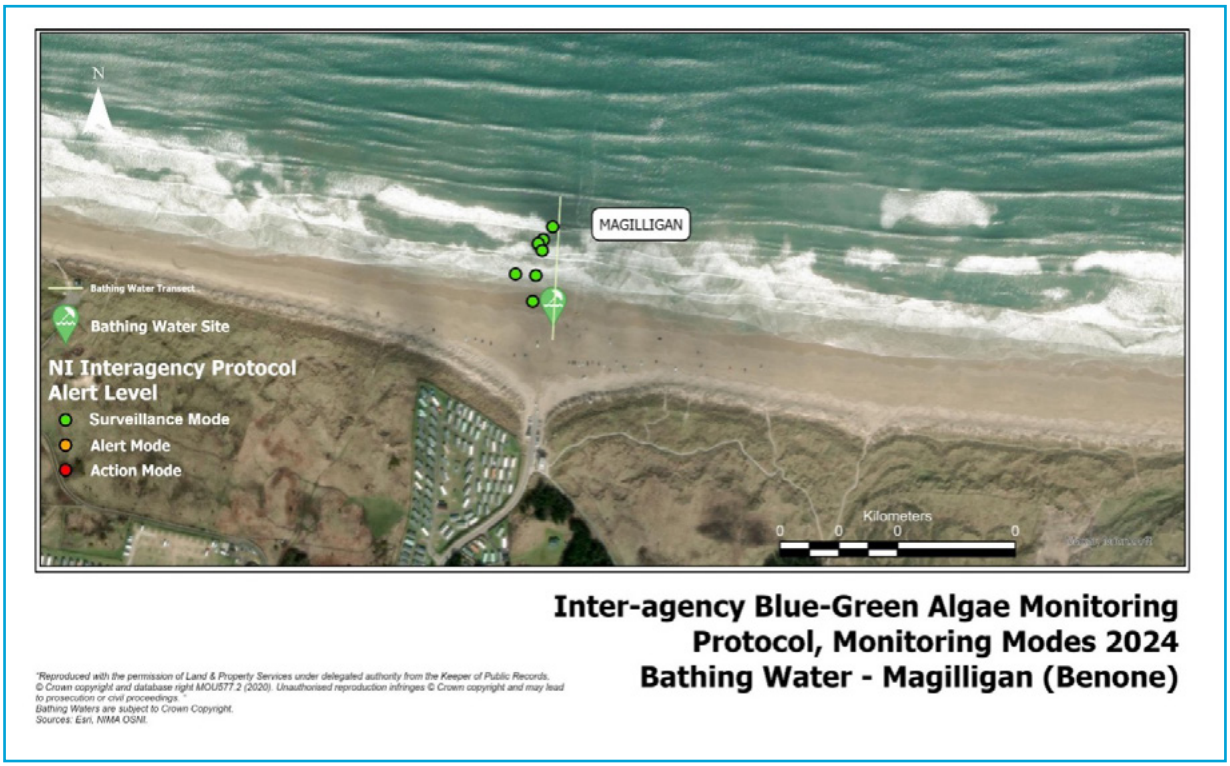


Figure 13 Sample locations during surveillance mode under the Inter-Agency Blue-Green Algae Monitoring Protocol (2024) at Magilligan (Benone) bathing water in 2024.

The highest biovolume at Magilligan bathing water occurred on the 30 August. Microcystin sampling results were all below the limit of reporting. There was also no visible evidence of blue-green algae on the bathing water surface and no 'advice against bathing' was issued for Magilligan bathing water in 2024.

5 Conclusions

- Biovolume concentrations were the main reason for Red alerts at the monitored sites. Toxins were seldom detected throughout the monitoring period. However, when present, it occurred around the same date as the site's highest biovolume, indicating that biovolume is a useful indicator of potential toxin presence.
- Rea's Wood had the greatest number of Red alerts for biovolume, occurring between the 16 July - 16 September, the largest occurrence on the 2 August which was also the only date toxins were detected. The 2 August at Rea's wood had the highest biovolume and toxin concentration for the whole monitoring period at all sites.
- Red alerts for biovolume at Seaton's Marine occurred between 2 August - 11 September. The largest occurrence was on the 28 and 29 August and these dates were also the only two occasions where microcystins were detected.
- Microcystins occurred at Portrush bathing water around the same date as the highest biovolume, resulting in an Amber alert on the 30 August.
- No microcystins were detected or Red alerts occurred at Portstewart Strand, Castlerock, Downhill and Magilligan bathing waters.
- Seaton's Marina and all monitored coastal bathing waters exhibited the highest biovolumes around the 29 - 30 August.

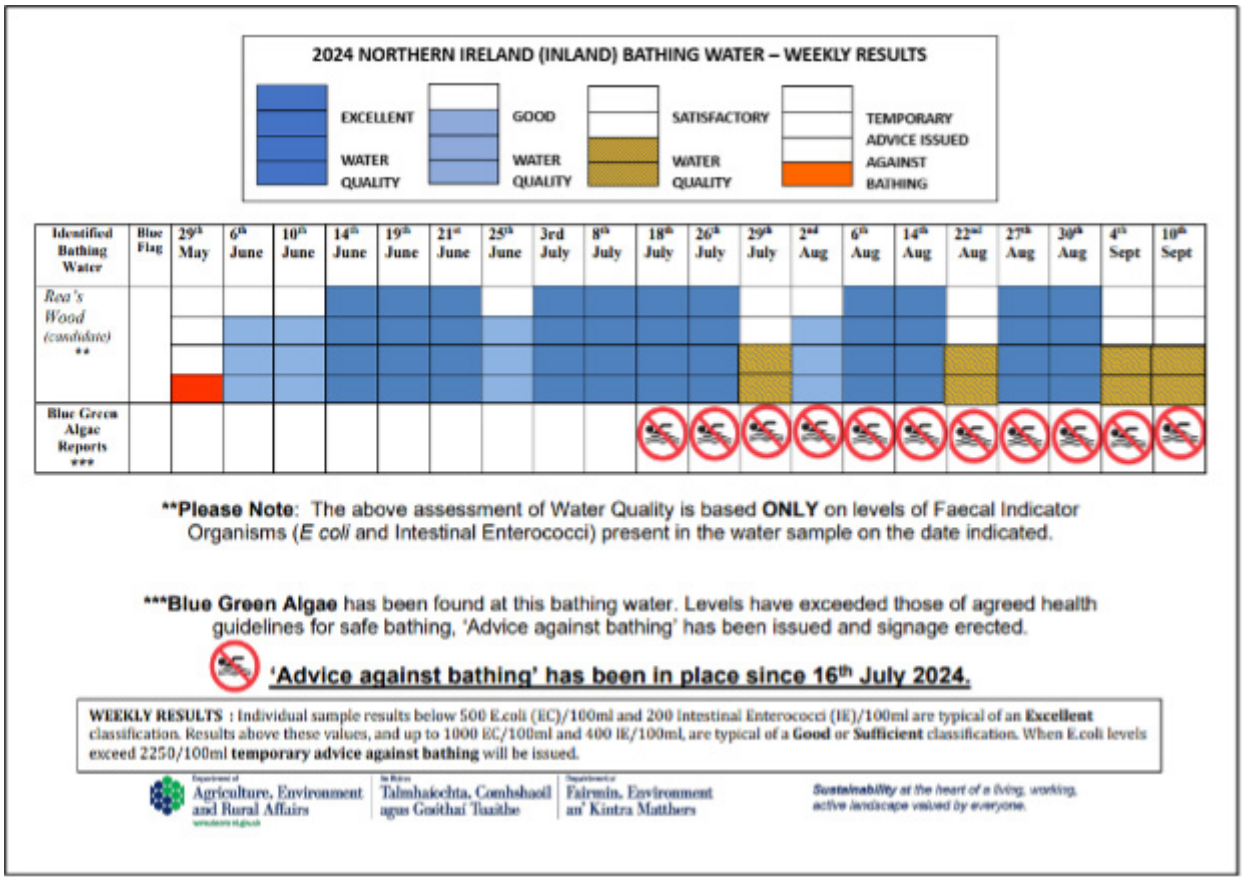
6 Next Steps

DAERA will continue to develop and refine the enzyme-linked immunosorbent assay (ELISA) techniques to enable DAERA to internally determine microcystin concentrations, and hence the potential toxicity of blooms. It is hoped that the development of these techniques in-house will not only reduce the cost of analysis but may also enable quicker turnaround and response times for advice.

The Interagency Blue-Green Algae Monitoring Protocol has served as a useful guide in unifying the approach to blue-green algae monitoring and alerts throughout Northern Ireland. The lessons learned from 2024 will be reviewed and, if necessary, the Protocol will be updated to reflect the increasing knowledge and understanding of blue-green algae blooms in Northern Ireland.

From 2025, NIEA will commence a Lough Neagh Priority Catchment monitoring programme with phytoplankton and chemistry samples being collected monthly at 9 locations around Lough Neagh.

7 Appendices



Appendix 1 'Advice against bathing' was issued to Rea's Wood bathing water operators on the 16th of July by DAERA staff.

Appendix 2 Blue-green algae (cyanobacteria) bloom Rea's Wood 16th July 2024.

Appendix 3 Blue-green algae (cyanobacteria) on shoreline Rea's Wood 2nd August 2024.

Appendix 4 Blue-green algae (cyanobacteria) on shoreline Seaton's Marina 29th July 2024.

Appendix 5 Blue-green algae (cyanobacteria) at Seaton's Marina 12th August 2024.

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