Blue-green algae (Cyanobacteria) in inland waters: Assessment and control of risk to public health

Monitoring and action plan for NHS Greater Glasgow and Clyde

April 2008

REVISED DECEMBER 2009
1. Introduction

This plan is based on the Scottish Executive Blue-Green Algae Working Group's report Blue-Green Algae (Cyanobacteria) in Inland and Inshore Waters: Assessment and Minimisation of Risks to Public Health 2007 and should be read in conjunction with this document.

2. Rationale

Blue-green algae occur under certain conditions in fresh, brackish and sea water. Forty-five to 90% of blooms can produce toxins. These toxins are largely retained within the blue-green algal cells during their development and growth phases and are released, in the main, on cell death. Exposure to these toxins can affect human and animal health adversely, from direct exposure to contaminated recreational waters, ingestion or exposure of contaminated drinking water, the food chain (consumption of shellfish) and haemodialysis. Symptoms among humans include abdominal pains, vomiting, diarrhoea, skin rashes, blistering of the mouth and sore throats. Atypical pneumonia has been reported, as have neurological effects and acute hepatocellular damage. Haemodialysis patients are at risk of severe, potentially life threatening effects if water is inadequately treated (by reverse osmosis) prior to dialysis. Furthermore, blooms have been responsible for the deaths of cattle, sheep, dogs, birds, fish and aquatic animals. Accordingly, this document sets out the NHS Greater Glasgow and Clyde, its eight local authorities, the Scottish Environmental Protection Agency (SEPA) and Scottish Water (SW) plan to assess, investigate and implement measures to prevent and manage exposure to blue-green algae occurring in local waterbodies.

3. Area and time period covered

The Local Action Plan covers the NHS Greater Glasgow and Clyde area (Glasgow City, Renfrewshire, East Renfrewshire, East Dunbartonshire, West Dunbartonshire and Inverclyde) and applies all year round. A risk assessment of inland waters will be carried out on an annual basis (November of each year) and the appendices to this plan will be amended accordingly. Environmental Health Departments (EHDs) will consult with SEPA and SW to ensure that the list contains all waters that pose a risk to the public. All agencies should then ensure the updated information is passed to the Public Health Protection Unit (PHPU) of NHS Greater Glasgow and Clyde where the database will be updated and redistributed. The whole plan will be subject to a formal review by all the stakeholders every three years.

4. Water bodies prone to algal blooms, scum or mat formation

4.1 List of susceptible waterbodies

All local authorities will undertake risks assessments of their inland water bodies. Individual risk assessments for each of the susceptible waterbodies are not included; however, a list of those water bodies thought to be susceptible to algal blooms is included in Appendix 1. The template for individual risk assessments is included in Appendix 2.

4.2 Risk assessments

The risk to human health is determined by:

   a) Likelihood of exposure to the water
   b) Occurrence of blue-green algae in the water

   a) Likelihood of exposure

Categories of risk are related to the use of waters (and hence the probability and extent of exposure). Categorisation relates to how the waters are commonly rather than possibly used.
**High risk category**
Waters that are either consumed by people or animals or used for activities involving immersion or appreciable skin contact. These include:

(a) Immersion or appreciable skin contact or
(b) The supply of water for consumption by humans or animals,
(c) And in particular waters used for:
   i. Potable water supplies
   ii. Bathing
   iii. Paddling
   iv. Diving
   v. Sail-boarding
   vi. Water-skiing
   vii. Jet-skiing
   viii. Livestock watering
   ix. Immersion of domestic animals.
   x. Canoeing

**Medium risk category**
Waters for which the risk of ingestion of blue-green algal material or toxins is small and appreciable skin contact with blooms is unlikely. Standing waters that are used for spray irrigation of crops. These include waters used for:

i. Sailing
ii. Rowing
iii. Fish farming

**Low risk category**
Waters that are inaccessible or not used or are used only for angling or other non contact activities. These include waters used for:

i. Angling
ii. Pleasure cruising
iii. General amenity

This plan shall not apply to waters that do not fall into one of the above categories.

b) **Occurrence of blue-green algae**
The magnitude, and frequency and duration of occurrence of algal blooms will determine the need for inspection and or monitoring.
### Table 1: Categorisation of waters in terms of the frequency and intensity of algal blooms. Column 3 indicates the likely efficacy of monitoring and inspections.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description of algal blooms</th>
<th>Implications for planned regular monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waters that consistently contain large populations of blue-green algae for many months in every year</td>
<td>Not indicated. Will add little to what is already known</td>
</tr>
<tr>
<td>2</td>
<td>Waters that have algal blooms for short periods in most years</td>
<td>Of some value. However, the ability to detect short blooms will depend on the frequency of monitoring and some might be missed</td>
</tr>
<tr>
<td>3</td>
<td>Waters that have only intermittent algal blooms for short periods</td>
<td>Of less value than for category 2. Frequent sampling will yield many negatives and less frequent sampling might fail to detect short blooms</td>
</tr>
<tr>
<td>4</td>
<td>Waters that never have algal blooms</td>
<td>Not indicated. All samples likely to be negative</td>
</tr>
</tbody>
</table>

Category 1 or 2 and water used for recreational use - may be appropriate to provide permanent or semi-permanent warning notices and to undertake inspections or monitoring to determine the beginning and end of the hazard period.

Category 3 and water used for recreational use - visual inspection at intervals determined by the use of the water, with or without sampling should be undertaken

Category 4 - regular monitoring is not indicated.

### 5. Planned monitoring of selected waters

#### 5.1 Inspection and monitoring methods

- **Proactive inspection and monitoring**
  Methods of inspection and monitoring of those water bodies found to require inspection and monitoring as a result of the above risk assessment are detailed in Appendix 3. (Annex E of national guidance).

- **Reactive inspection and monitoring**
  These methods will also be used when there is an allegation of occurrence of algal blooms in a water body, or allegations of adverse health effects from exposure to algal blooms. **In these circumstances there may be a need to implement immediate control measures while the investigation is undertaken.**

In the event of a human or animal health incident which may be associated with the occurrence of blue-green algae sample collection and analysis for toxins will be undertaken.

SEPA will be used for the analysis of water samples obtained from recreational waters.

Scottish Water will be used for the analysis of water samples obtained from potable supplies.
6. Analysis of samples

This should include identification of the dominant blue-green algae species. Toxicity assessment and toxin analysis testing may also be undertaken. SEPA ecology labs provide an analytical algal service and do not charge. Contact the lab first so they are able to accept and deal with the sample promptly. (See Annex C of national guidance for sources of advice and contact details.)

7. Thresholds for action

7.1 Drinking water

The WHO (2004) Guidelines for Drinking Water Quality define a provision value of 1 microgram/litre of microcystin-LR (one of the commonly found hepatotoxins) in drinking water that is intended for life long consumption.

7.2 Recreational water

The guideline levels and related typical actions derived from current recreational water WHO guidance are presented in table 2 below.

When there is an allegation of occurrence of algal blooms in a water body, or allegations of adverse health effects from exposure to algal blooms and inspection reveals algal scum immediate control measures should be implemented pending further investigation.

8. Recording of information

Each EHD shall keep a record in manual or electronic form of individual waters categorised in the terms of this plan.

That record shall include, as far as is reasonably practicable, a list of all owners, sporting or leisure interests, private water supplies and users thereof, public water supplies and farmers or crofters who require to be notified in terms of this protocol. It may well be impracticable to record all owners etc for large stretches of water.

The record shall include the category of the water and its Ordnance Survey map reference and any bloom/scum history and sampling records.

The record form for individual risk assessments is contained at Appendix 2.

9. Reporting arrangements (Appendix 4)

All agencies shall advise their counterparts of:

- Any report received regarding blooms/scums in any water and the immediate control measures being implemented

- The results of any inspection and/or monitoring or sampling which indicates or confirms the presence of blooms/scums in such waters.

Where there is a high risk that people or animals will be exposed to the water the CPHM should always be informed by telephone. (Dr Gillian Penrice (CPHM) or CPHM on call, NHS Greater Glasgow and Clyde, 0141 201 4917)

The incident will be reported to Health Protection Scotland (HPS) via the Scottish Environmental Incident Surveillance System (SEISS).
10. Control measures to be taken

Rationale

Actions are intended to reduce the possibility of acute or delayed effects of algal toxins on people and animals via:

- Reduced skin contact or ingestion of algae from direct exposure to the water.
- Reduced ingestion of drinking water containing algae or algal toxins and exposure to such water during bathing and showering.
- Reduced exposure to toxins by eating fish or shellfish from algal rich waters.
- Reduced delivery of contaminated water to patients undergoing haemodialysis.

Table 2: Recreational water guideline levels and related “typical actions” derived from current WHO guidance.

<table>
<thead>
<tr>
<th>Guidance level or situation</th>
<th>Typical actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanobacterial scum formation in bathing waters</td>
<td>• Immediate action to control contact with scums; possible prohibition of swimming and other water contact activities</td>
</tr>
<tr>
<td></td>
<td>• Public health follow up investigation</td>
</tr>
<tr>
<td></td>
<td>• Inform public and relevant authorities</td>
</tr>
<tr>
<td>20,000 cells cyanobacteria/ml or 10 micrograms chlorophyll-a/l with dominance of cyanobacteria</td>
<td>• Watch for scums or conditions conducive to scums</td>
</tr>
<tr>
<td></td>
<td>• Discourage bathing and further investigate hazard</td>
</tr>
<tr>
<td></td>
<td>• Post on site risk advisory signs</td>
</tr>
<tr>
<td></td>
<td>• Inform relevant authorities</td>
</tr>
</tbody>
</table>

10.2 Pro-active interventions

For some lochs where the risk to health is higher due to the frequency of blooms or the use of the loch, a number of measures may be taken. These may include:

- The use of permanent/semi-permanent signs
- Measures to reduce the frequency of blooms (see the national guidance for further details)
- Flexible plans for recreational use.

When monitoring reveals the occurrence of cyanobacterial scum, the following are advised:

- Give information via leaflets, warning notices, letters to stakeholders, or public announcements
- Give advice to dog owners to protect dogs from ingestion of blue-green algal material or on the shoreline
- Give advice to farmers to protect stock.

SW will take appropriate action to ensure the safety of supplies where algal blooms are identified. Algal toxins are removed by reverse osmosis units that are used to treat the water supply to dialysis units. Contingency measures should be put in place for the event of failure of this system.

The possible health effects from ingestion of blue-green algal toxins in affected foods should be considered. These include:

- Whether the muscle tissue of fish from heavily affected waters should be eaten. Fish should not be consumed if fish mortalities, or behavioural abnormalities, are observed at waterbodies containing mass populations of blue-green algae. In the event of blue-green algal scum being present, or blue-green algal cell numbers exceeding 20,000 per ml, toxin analysis of fish intended for consumption should be carried out.
- The liver and guts of fish from affected waters should not be fed to pets.
- The possibility of accumulation of microcystins on or in plants irrigated with contaminated water.
• The possible accumulation of toxins on the external surface of salad plants.

10.3 Reactive actions

Immediate control measures may be required if inspection reveals algal scum (table 2)

Where significant risk or potential risk exists the CPHM may convene an incident management team to ensure consistency of control measures and communications.

Reactive measures may include:
• Permanent/semi-permanent signs
• Informing users by other means
• Restriction/modification of recreational use
• Banning of any recreational use.

Public health follow up of exposed individuals:
• NO follow up is required in cases of exposure to skin
• Following ingestion of toxic bloom or scum, medical or veterinary monitoring may be required; expert advice should be sought (Sources of expert advice are found in Annex C of the national guidance). Clinical samples should be taken.

When animals have been affected by blue-green algae, particularly where deaths of livestock, wildlife and pets have occurred the owner should be asked to consult with his or her veterinary surgeon who will decide whether to submit carcasses and samples to the local veterinary centre of the Scottish Agricultural College Veterinary Science Division (SACVSD) for post mortem examination and further testing. The SACVSD will report the findings to the veterinary surgeon and if positive the EHD.

10.4 Blue-green algae in public drinking water supplies

On being notified of a potential bloom/scum in waters that are a source of a public water supply, the Scottish Waterborne Hazard Plan (SWHP) shall be activated by SW in consultation with the CPHM (Appendix 5). Toxin analysis is required.

10.5 Blue-green algae in private drinking water supplies

On being notified of a potential bloom/scum in waters that serve a private water supply, EHD or SEPA officers shall advise their respective counterparts by fax and shall also advise the CPHM and SW in like manner.

It is the responsibility of EHD to inform the users of the PWS as a matter of urgency. A sample of the notice to private water supply users is shown in Appendix 6b.

11. Arrangements for providing information

11.1 Informing the public and the owners of waterbodies

This should form part of the individual risk assessment/action plan agreed with the owner/operator of high-risk waters. These will usually include:

i. Arrangements for the standard warning/advice a type 1 notice, shown in Appendices 6a-6c to be erected at waters designated by the CPHM.

ii. Notification of all appropriate landowners, tenant farmers, angling clubs or leisure/sport operators etc by standard letter (Appendix 7).
Depending on the circumstances of each individual incident, information may be provided as appropriate to some, or all of the following organisations and interested parties:

1. Water-owners
2. Other official bodies, including SW, SEPA, EHD, Scottish Agricultural College, Regional Veterinary officer, Health and Safety Executive, Scottish Government Environment and Rural Affairs Department, Scottish Government Health Department, other NHS Boards, HPS or the Food Standards Agency.
3. Those engaged in healthcare – in particular, those providing haemodialysis services
4. General Practitioners and Veterinary Surgeons
5. Those with identifiable interests – for example, those receiving haemodialysis, farmers
6. Members of canoe and angling clubs and recreational associations
7. The news media
8. The public

Appendices 10 and 11 have information that may be used to inform these various groups with some amendment according to the specific circumstances.

Where a landowner objects to the posting of warning notices of type one, he should be encouraged to devise a suitable warning notice of his own making. When appropriate he should be advised, in writing, that he might have responsibilities in terms of the Health and Safety at Work Act 1974. (Note: The owner of the water has the primary responsibility for restricting public access or leisure activities. The local authority has no legal power to erect notices of this type without the permission of a landowner).

11.2 Dealing with the media

There should be a presumption of openness in sharing information about the management of any BGA event which may pose health risks. The press release shown in Appendix 8 may be issued in appropriate circumstances in response to a blue-green algae event. Appendix 11 contains general information that could be modified to be used as a general informative press release during BGA season. Both should be adapted as required.

11.3 Removal of warning notices and giving the all clear

Restriction of recreational and other uses of waters and warning notices erected in terms of this plan (other than those erected permanently) shall remain in place for the normal period of bloom/scum activity expected at those waters, or for such lesser period as may be determined following consultation with the CPHM.
APPENDICES

Appendix 1  High risk waters in NHS Greater Glasgow and Clyde

Appendix 2  Blue-green algae (Cyanobacteria) in inland waters: risk assessment forms (Blank)

Appendix 3  Sampling blue-green algae

Appendix 4  Flow chart of the dissemination of information and the reporting arrangements upon the discovery of an algal bloom

Appendix 5  Scottish Waterborne Hazard Plan – Algal Toxins

Appendix 6  Sample text of warning notices blue-green algal blooms
   6a  Water body (general)
   6b  Private water source
   6c  Water sports/recreational water
   6d  Scottish water owned

Appendix 7  Draft letter to owners of waters identified as likely to develop/or having developed potentially toxic algal blooms (Letter type BGA1)

Appendix 8  Algal bloom press release on initial discovery

Appendix 9  NHS Greater Glasgow and Clyde blue-green algae event reporting form

Appendix 10  Medical/treatment information

Appendix 11  Blue-green algae – frequently asked questions
## Appendix 1: High risk waters – Glasgow City

<table>
<thead>
<tr>
<th>Area</th>
<th>Waters</th>
<th>Map Ref. (easting &amp; northing)</th>
<th>Category of Risk</th>
<th>Occurrence Category</th>
<th>Permanent/ Semi-Permanent Signage</th>
<th>Water Supply</th>
<th>Sampling Frequency</th>
<th>Visual Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inland waters known to Environmental Health</strong></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dennistoun</td>
<td>Alexandra Park Boating Pond</td>
<td>NS 623 654</td>
<td>High</td>
<td>2</td>
<td>no</td>
<td>Recreational</td>
<td>Sampling is only carried out as required</td>
<td>Monthly</td>
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<td>Dennistoun</td>
<td>Alexandra Park Duck Pond</td>
<td>NS 620 656</td>
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<td>4</td>
<td>no</td>
<td>No</td>
<td>Monthly</td>
<td></td>
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<td>Auchinlea Park Pond</td>
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<td>4</td>
<td>no</td>
<td>Recreational</td>
<td>Monthly</td>
<td></td>
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<td>Carmyle</td>
<td>Baggie Minnie Pool</td>
<td>NS 645 615</td>
<td>Medium</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Annually</td>
<td></td>
</tr>
<tr>
<td>Kelvinside</td>
<td>Bingham’s Pond</td>
<td>NS 554</td>
<td>High</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Fortnightly</td>
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<td>Bishop Loch</td>
<td>NS 669 668</td>
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<td>Fortnightly if Hogganfield Loch has an algal bloom</td>
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<td>Kelvinside</td>
<td>Botanic Gardens Pond</td>
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<td>High</td>
<td>4</td>
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<td></td>
<td>Monthly</td>
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<td>Castlemilk</td>
<td>Castlemilk Pond</td>
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<td>4</td>
<td>no</td>
<td>No</td>
<td>Annually</td>
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<tr>
<td>Location</td>
<td>Location Details</td>
<td>NS Grid Ref</td>
<td>Algal Growth</td>
<td>Tests Per Year</td>
<td>Use</td>
<td>Monitoring Frequency</td>
<td></td>
<td></td>
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<tr>
<td>------------------</td>
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<td>Maryhill</td>
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<td>Elder Park Pond</td>
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<td>No</td>
<td>Monthly</td>
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<td>Easterhouse</td>
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<td>NS 655 678</td>
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<td>no</td>
<td>No</td>
<td>Monthly</td>
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<td>Gartloch</td>
<td>Gartloch Pool</td>
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<td>no</td>
<td>No</td>
<td>Monthly</td>
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<td>Robroyston</td>
<td>Hogganfield Loch</td>
<td>NS 642 672</td>
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<td>no</td>
<td>Recreational</td>
<td>Fortnightly</td>
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<td>Robroyston</td>
<td>Hogganfield Marsh Ponds</td>
<td>NS 647 672</td>
<td>Medium</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Monthly</td>
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<td>Kelvingrove</td>
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<td>No</td>
<td>Monthly</td>
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<td>Knightswood Park Pond</td>
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<td>Fortnightly</td>
<td></td>
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<td>Pollokshields</td>
<td>Maxwell Park Pond</td>
<td>NS 565 629</td>
<td>Medium</td>
<td>4</td>
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<td>Millerston</td>
<td>Millerston Pond</td>
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<td>4</td>
<td>no</td>
<td>No</td>
<td>Annually</td>
<td></td>
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<td>Newlands</td>
<td>Newlands Park Pond</td>
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<td>Medium</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Monthly</td>
<td></td>
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<tr>
<td>Pollokshaws</td>
<td>Pollok Park Pond</td>
<td>NS 555 625</td>
<td>Medium</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Monthly</td>
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<td>Possil Loch</td>
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<td>NS 585 700</td>
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<td>Annually</td>
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<td>Queens Park</td>
<td>Queens Park Boating Pond</td>
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<td>Springburn</td>
<td>Red Road Pond and disused railway</td>
<td>NS 621 672</td>
<td>Medium</td>
<td>4</td>
<td>no</td>
<td>No</td>
<td>Monthly</td>
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<td>Shawfield</td>
<td>Richmond Boating Pond</td>
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<td>Recreational</td>
<td>Fortnightly</td>
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<tr>
<td>Location</td>
<td>Pond Description</td>
<td>NS Coord</td>
<td>Water Quality</td>
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<td>Aquatic Plants</td>
<td>Sampling Frequency</td>
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<td>Springburn</td>
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<td>no</td>
<td>Annually</td>
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<td>No</td>
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Note - Sampling is during Summer months May – October
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Note - Sampling is during Summer months May – October
## High risk waters - East Dunbartonshire

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Note - Sampling is during Summer months May - October
### High risk waters - West Dunbartonshire

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Note - Sampling is during Summer months May - October
## High risk waters – Inverclyde

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<tr>
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<th>Waters</th>
<th>Map Ref. (easting &amp; northing)</th>
<th>Category of Risk</th>
<th>Occurrence Category</th>
<th>Permanent/Semi-Permanent Signage</th>
<th>Water Supply</th>
<th>Sampling Frequency</th>
<th>Visual Inspection</th>
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<tr>
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<td>PINeWooD FISHERY</td>
<td>NS 358 687</td>
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<td>DAFF RESERVOIR</td>
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<tr>
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Note - Sampling is during Summer months May - October
High risk waters - Renfrewshire

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<th>Waters</th>
<th>Map Ref. (easting&amp; northing)</th>
<th>Category of Risk</th>
<th>Occurrence Category</th>
<th>Permanent/Semi-Permanent Signage</th>
<th>Water Supply</th>
<th>Sampling Frequency</th>
<th>Visual Inspection</th>
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<td>NO</td>
<td>Randon sampling, no set frequency</td>
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</table>

Note - Sampling is during Summer months May - October

High-risk waters - Canals

British Waterways Scotland (BWS) is a public corporation which owns and manages five canals, their water supply reservoirs and feeder streams in Scotland. They are the Forth & Clyde, Monkland and Union Canals in the Central Belt, the Caledonian Canal in Highland and the Crinan Canal in Argyll. (Please note that short sections of the canals, parts of the feeder streams and a number of water supply reservoirs are not owned by BWS). More details about our canals can be found on: [http://www.scottishcanals.co.uk/](http://www.scottishcanals.co.uk/)

British Waterways canal bank staff report incidents of blue green algae to the ecology team and to the local SEPA environmental protection team. SEPA takes samples as required and BWS arranges for warning signs to be put in place as appropriate. The Environment Agency will inform Local Authority Environmental Health Departments and DEFRA in addition to informing British Waterways.
Appendix 2: Blue-Green Algae (Cyanobacteria) in Inland Waters: Risk Assessment Forms (Blank)

<table>
<thead>
<tr>
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</table>

**Occurrence** (Typical pattern of frequency and occurrence of algal blooms)

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<table>
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<th>Risk category:</th>
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<tbody>
<tr>
<td>Monitoring and control of risks</td>
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</table>

<table>
<thead>
<tr>
<th>Signed</th>
<th>Date</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Print name</th>
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</tr>
</thead>
</table>
Appendix 3: Sampling Blue-Green Algae

Source: SEPA Leaflet and Highland NHS Board BGA Action Plan

1. Introduction
Scottish inland waters can support numerous different species of algae which can “bloom”, either as individual species or in combination, when suitable ecological conditions occur. Some (“planktonic”) species exist as single cells or colonies of cells suspended in the water, whereas other (“benthic”) species grow on the bed of a waterbody and occasionally form thick gelatinous mats.

When blooms of planktonic blue-green algae occur, it is often possible to see colonies of algal cells in the water column with the naked eye. These may resemble fine grass cuttings or take the form of small irregular clumps or pinhead-sized spheres. These colonies will concentrate on a downwind shore and sometimes accumulate to such an extent as to form a “scum” which is a thick (often many centimetres) layer of colonies. They may also be seen in rivers or streams downstream of lochs.

When the blue-green algal cells start to die and break up, any toxins that may be present are released into the surrounding water. Cell pigments are also released resulting in a scum resembling turquoise emulsion paint spilt along the shore. However, it is important to note that not all blue-green algae are this typical colour and can range from black through dark greens to blues, reds and pinks.

There are only a few other types of algae (e.g. *Euglena*, *Botryococcus*) that will occasionally form scums which can be confused with blue-green algal scums. Growths of some aquatic macrophytes, particularly duckweed (*Lemna*), and filamentous algae are also commonly mistaken for blue-green algal scum by inexperienced observers.

Benthic blue-green algae can be found in both standing and running waters. The algal mats that these occasionally form can become a problem if the water level drops and exposes the mat, or in some cases, they may detach from the bed, rise to the surface and may then be washed up on the shore. These detached mats are often very different in appearance to planktonic forms. They are usually very dark in colour (black, dark brown or green) and are much more cohesive in nature than planktonic scums. For example, a planktonic scum will flow into a bottle as a liquid whereas benthic scum will be lumpy and often have to be scooped into a bottle or jar.

2. Sampling equipment
Blue-green algae can be sampled easily and cheaply using simple equipment comprising:
- Sample bottles of suitable size e.g. 1 litre plastic bottle for planktonic forms; vials or jars minimum size 30 ml for benthic forms.
- Plastic bucket tied to a rope (optional).
- Wellington boots.
- Rubber gloves.
- Field data sheets or notebook.
- Self-adhesive labels or waterproof marker.
- Preservative (Lugol’s iodine). Note that this is necessary only if it is likely that the samples will not be analysed within 24 hours. Lugol’s iodine should not be added to samples if these are required for toxin analysis.

3. Sampling health and safety
Blue-green algae may produce toxins hazardous to human health. Care should be taken to avoid ingesting or coming into direct skin contact with blue-green algal scum. Wear rubber gloves when sampling and wash hands before eating or drinking.
Lugol’s iodine is a skin irritant and is harmful if ingested in quantity. Eye protection and rubber gloves must be worn when handling this chemical.

Normal health and safety precautions should be taken for working in or near water.

4. **Sampling procedure**
   a) Samples are normally collected from a point on the downwind shore of a waterbody where the concentration of blue-green algae is greatest. This may not be obvious to the naked eye, in which case any suitable site on the downwind shore can be selected. Bear in mind that blue-green algae will often collect in sheltered bays and inlets. If the downwind shore is inaccessible, then the waterbody should be sampled at the nearest accessible point to the downwind shore and this should be noted on the field data sheet or in a notebook.
   b) In large lochs it is usually impractical to examine the whole downwind shore, in which case one or more samples should be taken at selected points.
   c) Planktonic blue-green algae or floating benthic scums are sampled at or just below the water surface by directly immersing a pre-labelled bottle and filling it completely. Occasionally it may be difficult to reach open water, for example, because of dense emergent vegetation. In such cases a bucket on a rope may be a useful aid. Benthic blue-green algae may need to be scooped into a wide-mouthed jar.
   d) The following information should be recorded on the sample bottle label:
      - Name of waterbody.
      - Sample identifier (site name or number).
      - National grid reference of sampling site.
      - Date of sampling.
      - Name or initials of sampler.
   e) Additional information useful to the analyst should be recorded on a field data sheet or in a notebook. This should include:
      - Sampling location. For waterbodies which are sampled regularly, it may be more convenient to include an outline map on the field sheet so that the position of the sampling site can be marked on.
      - The presence and extent of any blue-green algal scum. For small easily surveyed waterbodies an estimate of percentage cover of the surface could be made or the position of any scum could be drawn on an outline map.
      - The presence of any visible blue-green algal colonies in the water column.
      - The direction and strength of the wind.

5. **Sample handling**
   a) Samples should be kept in a cool, dark place and transported to the laboratory as quickly as possible. If this cannot be achieved within 24 hours then the samples should be preserved for microscopy by adding Lugol’s iodine solution. Sufficient should be added to turn the sample a dark straw colour.
   b) Samples for toxin analysis should be stored in a cool box after collection and transferred to a refrigerator at about 4°C, but not frozen, if analysis is possible within 48 hours. If not possible within this period, samples for toxin analysis should be deep-frozen.

6. **Sample analyses**
   a) An analytical service to identify and quantify algal blooms in samples can be carried out by SEPA (or Scottish Water if it is a public water supply)
   b) The general analytical procedure is as follows. The water/algal sample is thoroughly mixed in the sample bottle and a small quantity is pipetted into a calibrated Lund counting chamber or Sedgewick Rafter cell. This sub-sample is then scanned for blue-green algae, which are identified, and colonies and filaments counted. The count is then multiplied up to give the number of cells or units per ml of original sample. The identification of dominant algae will be to species level wherever possible.
Appendix 4: Flow chart of the dissemination of information and the reporting arrangements upon the discovery of an algal bloom

1. **Member of the Public**  
   **Routine discovery**  
   **Algal bloom/scum**  
   **Notified to either**  
   **SEPA**  
   **EH**  
   **CPHM**  
   **Dissemination of information**  
   **Referral to GGC Action Plan**  
   **Appropriate sampling**  
   **Dissemination of results**  
   **Control measures**  
   **Notification of other interested bodies**  
   **Removal of control measures**

*HPS can be informed through the contribution of any of the agencies through SEISS (Scottish Environmental Incident Surveillance System) unless urgent specialist support is required.*
Appendix 5:

Scottish Waterborne Hazard Plan - Appendix 9 - Algal Toxins

5.1 Background

Algal Toxins - In addition to the Treatment problems algae can cause such as blocking of filters, taste and odour complaints and encouraging mains infestation.

The blue-green algae (Cyanobacteria) are capable of producing highly poisonous Algal toxins. Several blooms of blue-green algae have occurred on water supply reservoirs in recent years, posing a potential source of contamination to waters abstracted for potable water treatment. Algal toxins can be stored within the Algal cells until they die and lyse. If healthy Algal cells enter a treatment works, they may pass through intact to the customers tap.

There is also the possibility that they will be destroyed by the physical or chemical environments associated with different water treatment processes. This may cause cell lysis and consequently release toxins into the water. Ozone treatment or potassium permanganate, and absorption or biological degradation on granular activated carbon beds can remove dissolved toxins. Little is known about the fate of intracellular toxins.

There are three groups of toxin produced by the various species of Cyanobacteria.

1. Hepatoxins which are toxic to liver (Microcystins)
2. Neurotoxins which affect the nervous system (Anatoxins)
3. Lipopolysaccharides which are reported to cause skin rashes and gastrointestinal upsets

The incidence of humans being poisoned with toxins has most often been associated with the recreational use of water, leading to skin rashes eye irritation, vomiting, diarrhoea, and fever and joint and muscle pains.

Although Algal scum is not always harmful it is a sensible precaution to avoid contact with the scum and the water close to it.

In contrast to humans, animals may eat or swallow large quantities of Algal scum.

5.2 Problem Identification

- Microcystins- S.N.A.R.L (suggested no adverse response level) of 1ug/l
- Anatoxin - a – S.N.A.R.L of 1ug/l

5.3 Problem Investigation

5.3.1 Treatment Works

- Check records of water leaving works for any history of Algal problems.
- Algae may disrupt treatment due to pH changes, clogging of filters etc.

5.3.2 In distribution

Check records of final water for any taste and odour problems.
Appendix 5 - continued

Scottish Waterborne Hazard Plan - Appendix 9 - Algal Toxins

9.3.3 Sampling

**Treatment Works** – A **25 litre** sample should be collected to represent the maximum possible toxin available this will normally be the most downwind point of the water body.

- A **1 litre** sample of any scum or bloom should be taken and a **25 litre** sample from the upwind point to establish the minimum toxin concentration.
- Samples from the surface of the reservoir are best.
- A **25 litre** sample of the water leaving the works should also be taken.

**In distribution** – samples should be taken to check for ingress of algae to the distribution. There may be complaints of Taste and Odour.

9.3.4 Analysis

**Toxins**, Chlorophyll `a`, Algal species identification and cell counts, Colour, Turbidity, pH, Coliforms and E.coli, Taste and Odour.
Check with the Scientific Services Team.

9.4 Risk Assessment

On notification of an Algal problem Scientific Services will contact the relevant Operational staff. Operations require to provide all relevant operational data (**A priority response is required**.) Discussions should establish:

- Severity of Bloom
- The area affected (% coverage of the waterbody)
- Depth of algae in the water column
- The direction and strength of the wind
- Treatment options available
- The population affected
- Special Needs Premises

DWQ Managers nominated deputes require to consult with CPHM, EHO & SE once all information is obtained or expeditiously report to CPHM if there is an unusually high result, even in the absence of supporting operational data and/or where previous Algal blooms have occurred. If this occurs senior managers require to be informed.

All discussions require to be logged by all parties and backed up by Emails.

(Out of hours contact Scientific Services). The DWQ Manager or nominated depute will report the event to the appropriate operational staff, Unitary Authorities, Health Boards and Scottish Government when necessary.

9.5 Risk Management

- Determine action plan to protect public health and alternative supply arrangements
9.6 Risk Communication

The Communications Sub-group would manage the risk communications process. See Annex D for membership, roles and responsibilities.

The draft scripts for the Risk Communication can be found in Annex I. The particular scripts to be used for this type of incident would be the following:

<table>
<thead>
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<th>Qs &amp; As</th>
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<tbody>
<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>I 2.3</td>
</tr>
<tr>
<td></td>
<td>I 3.2 – Level dependant, or</td>
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<td>I 4.3 Holding Statement</td>
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</tr>
<tr>
<td>I 4.6 Press Statement – Level /Type dependant, or</td>
<td></td>
</tr>
<tr>
<td>I 4.7 Press Statement – Level /Type dependant</td>
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</tr>
<tr>
<td>I 4.8 All clear</td>
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<td>I 5.3 Holding Statement</td>
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<td>I 5.7 Press Statement – Level /Type dependant</td>
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<td>I 6.6 Blank notice for additional info throughout an incident</td>
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<tr>
<td>I 6.5 Return to service</td>
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</table>

9.7 Criteria for Standing Down the Incident

The IMT will determine the criteria to stand down the incident. This will specify as appropriate,

- The concentration of the contamination which will be deemed to no longer present a risk to public health
- The timescale over which concentration is to be achieved

The criteria should take into consideration the balance of risk associated with continuing any restrictions against the health risk associated with the waterborne hazard.

9.8 Issues for Returning to Normal Service

The WH-IMT will determine the strategy for dealing with issues for returning to normal service. The issues considered should at least include:

- Cleaning out tanks
- Residual issues in plumbing

The strategy should not be overly prescriptive.
Appendix 6A: Sample Text of Notice – Water body

TEMPORARY WARNING NOTICE
BLUE-GREEN ALGAL BLOOMS

HIGH CONCENTRATIONS OF BLUE-GREEN ALGAE HAVE BEEN FOUND IN THIS WATER.
or
WATER LIABLE TO CONTAMINATION WITH BLUE-GREEN ALGAE

ALGAL SCUM CAN BE HARMFUL TO HEALTH.

IT IS A SENSIBLE PRECAUTION FOR YOU, YOUR CHILDREN AND YOUR ANIMALS TO AVOID CONTACT WITH THE SCUM AND THE WATER CLOSE TO IT.

- NO BATHING
- NO PADDLING
- NO FISHING
- NO DOGS IN, OR DRINKING FROM THE WATER
- DO NOT DRINK THE WATER

NOTICE POSTED ON: <DATE>
NOTICE POSTED BY: <ORGANISATION>
<ADDRESS>

FOR FURTHER INFORMATION TELEPHONE XXXXXXXX
Temporary Warning Notice
Blue-Green Algal Blooms

High concentrations of blue-green algae have been found in the source of this water supply.

Algal scum can be harmful to health due to toxins released into the water.

As a precaution for you, your children and your animals, do not drink or wash in water from this supply until further notice.

You will be provided with an alternative source of water.

Notice Issued On: <Date>
Notice Issued By: <Organisation>
<Address>

For further information telephone XXXXXXXX
Appendix 6c: Sample Text of Notice – Water Sports/Recreational Water

TEMPORARY WARNING NOTICE
BLUE-GREEN ALGAL BLOOMS

HIGH CONCENTRATIONS OF BLUE-GREEN ALGAE HAVE BEEN FOUND IN THIS LOCH/RESERVOIR.

ALGAL SCUM CAN BE HARMFUL TO HEALTH DUE TO TOXINS RELEASED INTO THE WATER.

AS A PRECAUTION FOR YOU, YOUR CHILDREN AND YOUR ANIMALS, AVOID CONTACT WITH THE SCUM AND THE WATER CLOSE TO IT.

- No bathing
- No paddling
- No fishing
- No dogs in, or drinking from, the water
- Keep boats well away from the scum
- Wind-surfing, canoeing, jet skiing, water skiing or other immersion sports that may lead to skin contact or drinking of water are not advisable

NOTICE ISSUED ON: <DATE>
NOTICE ISSUED BY: <ORGANISATION>
<ADDRESS>

FOR FURTHER INFORMATION TELEPHONE XXXXXXX
Appendix 6d: Sample Text of Notice – Scottish Water owned

suggested text for warning notices:

TEMPORARY / PERMANENT* WARNING NOTICE
BLUE-GREEN ALGAL BLOOMS

HIGH CONCENTRATIONS OF BLUE-GREEN ALGAE HAVE BEEN FOUND IN THIS WATER.

SWALLOWING THE WATER OR ALGAL SCUM CAN CAUSE STOMACH UPSETS OR MORE SERIOUS HEALTH EFFECTS.

CONTACT WITH THE WATER OR WITH ALGAL SCUM CAN CAUSE SKIN PROBLEMS.

IT IS A SENSIBLE PRECAUTION FOR YOU, YOUR CHILDREN AND YOUR ANIMALS TO AVOID CONTACT WITH THE SCUM AND THE WATER CLOSE TO IT.

NOTICE POSTED ON: <DATE>

EFFECTIVE UNTIL**: <DATE>

NOTICE POSTED BY: SCOTTISH WATER
<ADDRESS>

FOR FURTHER INFORMATION TELEPHONE: <NUMBER>

* AS APPROPRIATE ** FOR TEMPORARY NOTICES ONLY
Letter type BGA1

To: Owners of waters identified as likely to develop/or having developed potentially toxic algal blooms.

Dear

TOXIC BLUE-GREEN ALGAE: LOCH ....................;/...................RESERVOIR

Recent monitoring (inspection) of water in your ownership by ........... (has shown that concentrations of blue-green algae in the above loch/reservoir waters are at levels with the potential to cause toxic blooms and surface scums)(has indicated the presence of an algal bloom/scum). Information on the site and date of monitoring and the algal species present, where identified, is appended to this letter.

Blue-green algae occur naturally and, especially during warm weather, can multiply sufficiently rapidly to discolor the water so that it appears green, blue-green or greenish-brown. During calm weather, many of these algae can further aggregate by rising to the surface to form a scum which may look like blue-green paint or jelly (but it may equally be black, brown, grey-white, blue or even red on occasions). With changes in the direction and strength of the wind, the scum can be blown around the surface of the water and may thus appear at different places at different times. It may disappear and reappear quickly and accumulate on the shoreline.

These algae may produce toxins, but, because of the fluctuations in concentration and in toxicity at a single site, it is not practicable to assess toxicity on a routine basis. Assessment of risks to human and animal health should take account of the following statements of the Department of Health and of the Chief Veterinary Officer; both statements are endorsed by the Scottish Government. The statements differ because animals, in contrast to people, may eat or swallow large quantities of algal scum.

Human Health
‘Illnesses including skin rashes, eye irritation, vomiting, diarrhoea, fever and pains in muscles and joints have occurred in some recreational users of water who swallowed or swam through algal scum. There have been no reports of long-term effects or deaths in humans, but in some cases the illnesses were severe. ALTHOUGH ALGAL SCUM IS NOT ALWAYS HARMFUL, IT IS A SENSIBLE PRECAUTION TO AVOID CONTACT WITH THE SCUM AND WATER CLOSE TO IT.’

Animal Health
‘The toxins, which may be produced by the algae, are also poisonous to animals and can cause severe illness and death. FARMERS AND PET-OWNERS SHOULD THEREFORE ENSURE THAT THEIR ANIMALS DO NOT HAVE ACCESS TO AFFECTED WATER.’

You are therefore encouraged:
1. to make regular inspections of the water to check for evidence of bloom and scum formation, and
2. to take any steps you consider necessary to inform users of your water of the above statements by notices or other means. (Our officers will be erecting warning notices on the approach to the affected waters - a copy of the notice is enclosed for your information)

If you require further information on blue-green algae, please contact me.

As part of the standing arrangements for response to incidents of high blue-green algae concentrations, I am copying this letter to those listed below.

Yours sincerely

<Name>
<Organisation>

Copied to: CPHM, Public Health Protection Unit, NHS Greater Glasgow & Clyde; Scottish Water; Water Quality and Regulation Group, Glasgow; SEERAD; SEPA West; Relevant persons - private water supply users; farmers; water leisure or sports bodies; angling clubs;
Appendix 8: Algal bloom Press release on initial discovery

<Date, Month, Year>

<Time>

For Immediate Release

BLUE-GREEN ALGAE
Recent samples taken at <name of water body> have indicated the presence of blue-green algae. As a precautionary measure, notices have been posted next to the reservoir warning that contact with the algal scum should be avoided. Adjoining landowners and fishing interests have been advised of the situation as have <name organisations involved e.g. the Environmental Health Department of <name Local Authority>, SEPA, Scottish Water and NHS Greater Glasgow & Clyde.> At this stage there is no adverse effect on water supplies.

Media Briefing Note:
• Blue-green algae exist in fresh waters in Great Britain and throughout the world; they are noticed when their concentrations increase to form "blooms" and when they form scums – looking like blue-green paint – or when they collect on the shore line.
• Some blue-green algae may give rise to adverse medical effects – but not always. Effects on people coming into contact with toxic scums include skin rashes, eye irritations, vomiting and diarrhoea, fever and pains in muscles and joints. Toxic algae have caused deaths of livestock and dogs. The treatment of water supplies removes blue-green algae and additional treatment may be applied to destroy or remove toxins should they arise. The actions currently taken are precautionary.
• The behaviour of algae is erratic.
• The level of its toxicity can fluctuate; it can appear one day, be dispersed by the wind and mixing and re-accumulate at any time.

Ends
Press Contact: Corporate Communications, tel: <<number>>
Appendix 9:
NHS Greater Glasgow and Clyde: Blue-Green Algae – Event Reporting Form

LOCAL AUTHORITY AREA: ______________________________________________________

NAME OF WATER: ______________ MAP REFERENCE: _________________________

LOCATION DETAILS: ___________________________________________________________

OWNER: _____________________________ REF: ________________________________

USAGE
HOW IS THE WATERBODY USED?
______________________________________________________________________________

RISK CATEGORY:
______________________________________________________________________________

RECOGNITION
HOW WAS THE BLOOM DETECTED AND REPORTED?  Date
______________________________________________________________________________
______________________________________________________________________________

HEALTH EFFECTS
HAVE ANY ANIMAL OR HUMAN HEALTH EFFECTS BEEN REPORTED?
YES                                              NO
______________________________________________________________________________
IF YES PLEASE SPECIFY

ACTIONS
WHAT ACTIONS HAVE BEEN TAKEN TO DATE?
FOR WATER? __________________________________________________________________
______________________________________________________________________________

FOR PUBLIC/ANIMAL PROTECTION? ______________________________________________
______________________________________________________________________________

WHAT FURTHER ACTIONS ARE PLANNED?
1. ____________________________________________________________________________
______________________________________________________________________________

2. ____________________________________________________________________________
______________________________________________________________________________

3. ____________________________________________________________________________
______________________________________________________________________________

4. ____________________________________________________________________________
______________________________________________________________________________

RESULTS OF WATER ANALYSIS
______________________________________________________________________________

SIGNED ____________________________ DATE _______________________
ORGANISATION _________________________________________________
PRINT NAME _____________________________________________________
Appendix 10: MEDICAL/TREATMENT INFORMATION

Algae (Blue-Green)

Type of product
Cyanobacteria (blue-green algae) that inhabit fresh or brackish water and produce blue-green to dark-brown scums or blooms. They may also grow in sediment.

Genera commonly found: Anabaena, Aphanizomenon, Cylindrospermosis, Lyngba, Microcystis, Nostoc, Oscillatoria

Toxins produced
Several including: Hepatoxins e.g. microcystins, nodularin, cylindrospermopsin Neurotoxins e.g. anatoxin-a, anatoxin-a(s), saxitoxin, neosaxitoxin.
Lipopolysaccharide endotoxins - components of cell outer layers

Toxicity
Deaths have been reported in animals which have drunk contaminated water. Humans have developed a variety of illnesses after freshwater recreational activities but none has died.

Microcystins can cause atypical pneumonia.

A diagnosis of cyanobacteria-related illness usually depends on the time relationships between water sports and onset of symptoms. Occasionally, organisms can be identified in stool samples. Effects seem more serious in animals than they do in humans.

Deaths have occurred after water contaminated with microcystins was used for haemodialysis in Brazil. 116 of 131 patients became ill, 100 of which developed acute liver failure, 76 of these patients died (Carmichael et al, 2001).

Features
Ingestion/inhalation - May occur 3-5 hours after ingestion, and last 2-3 days. GI effects are common; abdominal pain, nausea, vomiting and diarrhoea. Respiratory features include cough and pneumonia. Less commonly headache, earache, swollen lips, pyrexia, rhinitis. Hepatitis and liver failure have also been reported.

Neurological features (paralysis, respiratory failure) have been reported in animals.

Eye contact - may cause irritation and conjunctivitis

Skin contact - rash is common, dermatitis

Management
1. Remove contaminated clothing and wash skin thoroughly with soap and water.
2. Gastric decontamination is unlikely to be of benefit.
3. Correct fluid and electrolyte balance as necessary.
4. Monitor liver function in symptomatic patients.
5. Other measures as indicated by the patient's clinical condition.
6. For eye contact please see eye irritants.
7. Allergic reactions should be treated conventionally.
8. For skin contact please see skin decontamination - irritants. Use antihistamines and/or topical corticosteroids if necessary.

Appendix 11: Blue-green algae – frequently asked questions

As the weather warms the season for the occurrence of blue-green algae gets underway.

**What are blue-green algae?**

Blue-green algae are tiny organisms that develop naturally in lochs, ponds, reservoirs, rivers and in the sea. When conditions are suitable they multiply and may grow to form visible “blooms” on water. In Scotland the algae and blooms are most common from April to the end of October.

The reason for asking the public to remain vigilant about blue-green algae is because of the potential ill effects which humans and animals may suffer if they come into contact with algae and the toxins they produce, some of which are harmful to humans and animals.

Canoeists, wind surfers and swimmers who have swum through algal scum or swallowed it have suffered from skin rashes, eye irritation, vomiting, diarrhoea or pains in muscles and joints. Although there have been no reports of long-term illness or death in human beings following exposure in recreational waters, illnesses have, in some cases, been severe. The toxins can, however, kill animals if they drink contaminated water or swallow quantities of scum and dogs have died after going into the water at the shores of affected lochs.

Human risk of exposure to toxins results from skin contact with algae during immersion in affected waters (even paddling can cause problems) and from drinking affected waters.

Public drinking water supplies are monitored regularly to prevent any harmful effects on health from blue-green algae. However, it is important to make sure that the public are informed of any other potential dangers and this is done by posting appropriate warning notices around affected areas where water sports are popular.

Blue-green algae discolour the water, which then appears green, blue-green, greenish brown or dark brown. Sometimes a scum may form on the surface. This scum can appear in different places at different times but it is most commonly found at the water’s edge or shoreline.

**What should I do about blue-green algae?**

- Avoid all contact with affected waters and ensure that children and pets are kept away.
- Farmers should ensure that their animals do not have access to contaminated water. This may require fencing around suspect waters.
- Owners and users of private water supplies discovering their supply is affected with blue-green algae should inform the local Environmental Health Service.
- Anyone finding an area of water with blue-green algae without a “warning sign” should inform the local Environmental Health Service.
- Recreational users, including anglers, should thoroughly rinse with clean water all parts of the body, clothing and equipment that have inadvertently come into contact with algae or scum.
- Anyone feeling any adverse health effects should seek medical advice promptly.
- It is currently thought that eating fish from affected waters is acceptable provided the fish show no behavioural abnormalities and there are no dead fish in the affected water. The fish should be thoroughly gutted and washed before eating and the offal should not be fed to pets.
- The consumption of freshwater shellfish gathered from affected waters should be avoided.