Annex 4

Manual

The Development of a Setting-specific Strategy against the Occurrence of Cyanotoxins in Drinking Water, from Catchment to Consumer

Twinning Light Project EE06-IB-TWP-ESC-01 "Reducing the health risks from algal toxins in drinking and bathing waters“

Workshop

The Development of a Setting-specific Strategy against the Occurrence of Cyanotoxins in Drinking Water, from Catchment to Consumer

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Twinning Light Project EE06-IB-TWP-ESC-01 "Reducing the health risks from algal toxins in drinking and bathing waters“

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Decision Support Tool for

the development of a setting-specific strategy against the occurrence of cyanotoxins in drinking-water, from catchment to consumer

Purpose: to analyse, assess and manage the risk of cyanotoxin occurrence

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Note: This document only presents parts of the decision support tool. In the online version (http://www.pepcy.de/public/dst.htm) you will find more information on cyanobacteria and cyanotoxins, various background information and comprehensive guidance for assessing and managing the risk of cyanotoxins.

Steps to take with the help of this tool:

1. Define direct and indirect targets

2. Preparatory steps

2.1 Compile a team with the necessary expertise

2.2 Describe the water supply / recreational system

2.3 Describe water use and users

3. Assess risk and system performance

3.1 for cyanobacterial proliferation in raw water / at recreational sites

3.2 for cyanotoxin intake and breakthrough in treatment

3.3 Evaluate your assessment for 3.1 / for 3.2 in relation to other health hazards from exposure to water and document it

4. Define control measures

4.1 in catchment management

4.2 in water-body management

4.3 in drinking-water offtake

4.4 in drinking-water treatment

4.5 **Document** your choice of control measures together with the reasons for your choice; develop management plans for each and a plan for early warning / contingency supply

5. Validate your assessment and your control measures
support from Literature and Cyano Websites

6. Verify that your water does not contain cyanotoxins at concentrations above your target

7. Cyanotoxin building-block for your *Water Safety Plan*

1. Define direct and indirect targets

Your overall target is to avoid cyanotoxin occurrence in drinking-water and in water used for recreation or at least to keep them under tolerable limits. These limits may be defined on the basis of the provisional WHO Guideline value for Microcystin-LR in drinking-water and the WHO Guidelines for Recreational Water use:

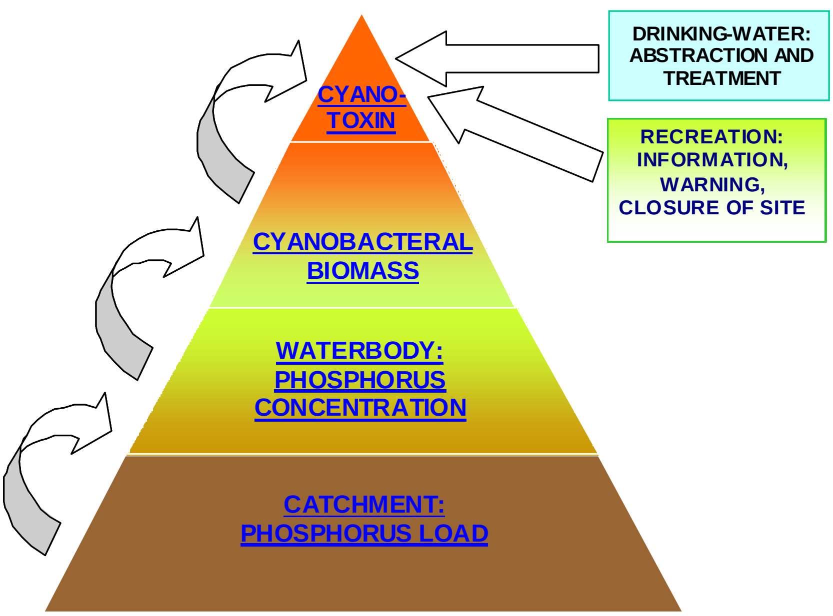
Drinking-water: WHO gives a value only for one microcystin, but this may be used as proxy for the other microcystin variants as well. This is likely to be a conservative approach, as Microcystin-LR is among the most toxic variants. For cylindrospermopsin, less toxicological information is available and few countries have guideline values or standards. They range from 15 µg/L (Brasil) to 1 µg/L (proposed by Humpage & Falconer 2003). As these Guideline values are intended for lifetime daily consumption, under certain conditions health authorities may consider slightly higher levels (3-5-fold) as acceptable for short time spans.

Recreational water use: Microcystin concentrations considered acceptable vary between countries from 20 – 100 µg/L between countries, and this strongly depends on assumptions for frequency and duration of bathing as well as the amounts of water ingested, i.e. behaviour of site users and type of water sports activity.

Management targets: Cyanotoxin concentrations will be below the target level if:

1. cyanobacterial biomass can be kept sufficiently low. Trigger values alerting to potential toxin occurrence can be set in terms of biovolume (usually < 1 mm³/L), in terms of Chlorophyll-a (usually < 5-10 µg/L) or in terms of cell numbers (less useful because cell size and thus toxin per cell can vary widely; see below for cell numbers in the WHO ALF). This biomass target can be achieved if
2. phosphorus concentrations in the waterbody are sufficiently low (Total phosphorus usually < 30-50 µg/L), and this target in turn can be achieved by managing the waterbody's catchment so as to avoid phosphorus loading.
3. Phosphorus loading targets need to be defined specifically for the site, because the resulting concentrations depend on waterbody characteristics. They can be set for the amount of fertiliser and manure that may be spread in the catchment, for buffer strips around the shorelines to avoid phosphorus input from erosion, or for limits on the concentration of phosphorus that may be contained in treated sewage that discharged into the waterbody or its tributaries.

These management target orient towards avoidance of cyanotoxin production. Where management is not effective in meeting these, drinking-water supply needs:



4. Treatment targets that define toxin removal measures and how effective they need to be.

Clearly, these quite different levels of tackling the problem require different types of expertise (from hydro-logy and limnology to drinking-water treat-ment), and decision-makers need support of experts.

2. Preparatory steps

2.1 Compile a team with the necessary expertise

Generally for developing a Water Safety Plan a team of experts is necessary that includes the competence needed to analyse the hazards, assess the risks they pose as well as the performance of the supply system in controlling them, to define new control measures or suggest improvements of existing ones, and to assess how effectively the control measures in place are being monitored and managed.

This team therefore should be multi-disciplinary. It should include knowledge of the specific supply system from catchment to consumer in order to ascertain that hazards and potentially occurring hazardous events can be comprehensively analysed. This ranges from technical operators to senior managers.

The full support of the leading management is essential for acceptance of the *Water Safety Plan*, both for the work input necessary to develop it and for its subsequent day-to-day use in practice. A team leader should be designated who drives the process.

External experts on specific issues can be included as needed.

Specifically for cyanotoxins the team would include expertise in:

- phytoplankton ecology to understand the likelihood of bloom occurrence and causes of eutrophication,
- nutrient dynamics to set adequate targets for nutrient concentrations and nutrient loading
- drinking-water treatment to set performance targets that ensure cyanotoxin removal
- potentially also toxicology for assessing health risks if elevated cyanotoxin concentrations cannot be excluded with certainty.

This is important, as many of the questions to address in assessing your system and its specific risk of cyanotoxin occurrence and break-through require quite specific expertise. This decision support tool can outline the expertise you will wish to get on board, but it cannot replace the experts.

➔ Document the members of your Water Safety Plan team, potentially differentiating between those who supported different parts of your risk and system assessment, e.g. in the worksheet provided on the starting page of this decision support tool.

➔ **continue to step 2.2 - describe the water supply / recreational system**

2.2 Describe the water supply / recreational system

A thorough understanding of the system – from the catchment to the point of exposure – is the basis for analysing hazards and assessing risks. A flow diagram may be very helpful for visualisation. Specifically for cyanotoxins this includes the following:

➔ -**Note**: **Often, not all of this information will be available. Following the motto: "It's important to get started", note these gaps in your worksheet, but do a first iteration of going through the rest of this decision support tool anyway to find out which information gaps are crucial for the decisions you need to make.**

- a description of the catchment, i.e. its delineation, map of tributaries, discharge of tributaries (if available) geographic and hydrological characterisation such as area, slope, soil types, drainage systems
- land use, e.g. areas covered by forest, settlements, agriculture
- estimates of nutrient loads from agriculture: while sophisticated modelling may provide excellent load calculations, visual inspection may be a highly effective first step; furthermore it is necessary also for modelling in order to validate assumptions used in a model
- estimates of nutrient loads from sewage: this is possible from data on the size of the population connected to a given system and the type of treatment; in EU countries data on effluent amounts and concentrations should be available from treatment plant operators
- For reservoirs: morphometry, retention time, thermal mixing regime, site(s) and depth(s) of drinking-water offtake
- For rivers: flow and discharge; site of drinking-water offtake
- For the water-body: water quality data, particularly nutrient concentrations, Secchi disk transparency, phytoplankton population data; potentially also data on populations at higher trophic levels as these may impact on phytoplankton population structure and biomass.
- If available, data on cyanobacterial and cyanotoxin occurrence and any indication of human or animal illness from these
- If used as drinking-water resource: drinking-water treatment: which steps does the treatment train include (e.g. pre-oxidation, flocculation, sedimentation, filtration, ozonation, GAC filtration, slow sand or riverbank filtration, disinfection, …), amount of water produced
- If used as drinking-water resource: distribution system: map of mains, reservoirs in the system including their condition and retention time (this may be relevant for cyanotoxin degradation in the mains)

It is of critical importance to validate such a description of the system by periodic inspection.

➔ Document your description of your system, e.g. in the worksheet provided on the starting page of this decision support tool.

➔ **continue to step 2.3 – describe water use and users**

2.3 Describe water use and users

(here specifically discussed with respect to cyantoxins)
Which share of the water is used for drinking-water, for irrigation, or for other uses? Is exposure to aerosols likely? Are there specific sensitive consumer groups such as children's swimming classes, hospitals or dialysis units, who should receive targeted warnings in times of risk of elevated cyanotoxin occurrence?

- Hospitals and dialysis units,
- Private supplies using surface water or shallow wells strongly influenced by surface water;
- Settings with formation of aerosol from surface water, e.g. irrigation, decorative fountains, in some settings water used for cooling (e.g. mining drills);
- Recreational use (including illegal use of sites such as drinking-water reservoirs)

➔ Document your list of water use and users, e.g. in the worksheet provided on the starting page of this decision support tool.

On to ➔ 3. Assessing risk and the system's performance in controlling them

3. Assess risk and system performance

3.1 Assessing the risk of cyanobacterial proliferation and the system's performance in controlling this risk

Were any of the following indications of cyanotoxin occurrence observed?
Example for filling in this table

For this assessment, supporting expertise is recommended in the areas of public health, toxicology, and limnology, particularly phytoplankton.

Please mark the fields you consider most appropriate for the water-body you are assessing. Then enter the reasons for your assessment and enter an estimate of the uncertainty of your assessment.

	N	O	F	?	Assessment of the situation	Uncertainty of this assessment?
Humans / animals: Illness indicating the presence of cyanotoxins? Link to background information						
Cyanotoxins observed at > 1 µg/L, particularly microcystins? Link to cyanotoxin overview						
Cyanobacteria – visual inspection: Visible blooms or discolouration; conspicuous olive-green or wine-red blooms? Don't confuse with Lemna minor ("duckweed") Secchi disc readings or turbidity that indicate cyanobacterial proliferation?						
Cyanobacteria in quantities > 1 mm³/L Biovolume detected by microscopy, or > 1 µg/l Chlorophyll-a, largely caused by cyanobacteria Link to an introduction to determining Microcystis spp., Planktothrix agardhii and P. rubescens, Aphanizomenon flos-aquae						

N = not observed, O = observed occasionally, F = observed frequently, ?= no information

Are cyanobacteria to be expected from water-body characteristics?

Example for filling in this table

For this assessment, supporting expertise is strongly recommended in limnology particularly with a focus on phytoplankton ecology.

Note: the categories suggested here provide very rough first estimates, and entries performed without such expertise are subject to major uncertainty.

		N	P	Y	?	Your assessment of the situation	Uncertainty of this assessment
Overall condition of the water-body	Is it eutrophic; deep with stable thermal stratification or shallow and usually mixed; not acidic; water retention time > 1 month ?						
Current situation	• Is the water temperature high,? • If the water-body stratifies in summer, is it stably stratified now? • Are TP-concentrations > 10-30 µg/L ? • Is Secchi Disc transparency < 1 m ?						

N = no, does not apply, P = applies partially, Y = yes, applies, ? = no information

Are current and future nutrient loads under sufficient control in order to meet the target level for this water-body?

Example for filling in this table

For this assessment, supporting expertise is needed in the areas of limnology or geoecology, particularly with a focus on estimating or modelling nutrient budgets in water-bodies. Without such expertise, entries are subject to major uncertainty.

	W	P	N	?	Your assessment of the situation	Uncertainty of this assessment
Assessment through site inspection					Example Dam Y	
Assessment through modelling loads					Example Reservoir Z	

W = well under control, P = partially under control, N = not sufficiently controlled, ? = no information

3.2 Assessing the risk of cyanotoxin intake and breakthrough in drinking-water abstraction and treatment

So far, you have dealt with assessing the risk of cyanobacterial proliferation in the water-body. As a result, you have either identified a risk of occurrence that you wish to address with appropriate control measures, or you found that you could not exclude such a risk. Therefore, to protect public health from cyanotoxins in drinking-water, it is important to assess the efficacy of further barriers potentially in place through your offtake strategy or drinking-water treatment system.

If bank filtration / soil passage is in place, please assess its characteristics:
example for filling in this table

For this assessment, including hydrogeological expertise in the team is recommended. For further information click here.

	Y	P	N	?	Your assessment of the situation	Uncertainty of your assessment
Substrate oxidised ?						
Travel time > 4 weeks						
Substrate fine-grained						
Temperatures > 10 ℃						
Accumulation of lysing cyanobacterial cells on the sediment likely to be low						
…..						

Y = yes, P = partially, N = no, ?= insufficient information

If the raw water source is a reservoir, where is the offtake located ? example for filling in this table

For this assessment, including expertise in reservoir management is recommended.

	Y	P	N	?	Your assessment of the situation	Uncertainty of this assessment
Is offtake depth and/or site variable ?						
Are water layers used for offtake continuously monitored for indication of cyanobacterial cells (e.g. by on-line turbidity- or fluorescence recording)?						
Is variability of offtake sufficient to avoid layers with cyanobacteria?						
…..						

Y = yes, P = partially, N = no, ?= insufficient information

Which treatment steps are implemented at the treatment plant ? example for filling in this table

For this assessment, including expertise in drinking-water treatment is recommended.

	Y	P	N	?	Your assessment of the situation	Uncertainty of this assessment
No pre-oxidation, or under control for lysis and liberation of dissolved toxin						
Flocculation						
Filtration						
Post-oxidation						
Dosing powdered activated carbon (PAC)						
Granular carbon filtration (GAC)						
.....						

Y = yes, P = partially, N = no, ?= insufficient information

On to ➔ Evaluation of your assessment of the risk of cyanotoxin intake and breakthrough

3.3 Evaluation of your assessment of the risk of cyanobacterial proliferation and your system's performance in controlling it

You have assessed the risk of cyanobacterial proliferation in your water-body. To evaluate this assessment, please check which colours you marked most frequently in the questionnaire.

Note: The outcome of this assessment supports you in positioning the human health risk from cyanotoxins in relation to other health risks from exposure to the same water in a matrix for relative ranking of health risks. This is a basis for setting priorities in controlling these risks.

- **Option A**
  You almost only marked **green** fields: Your risk of cyanobacterial proliferation is low, and all you need to do is to make sure you can maintain this good situation.

  Therefore, the next important step is: to identify the control measures in your catchment which currently are decisive for this level of safety and should have priority for maintenance and operational monitoring. For these, you should develop a management plan which would particularly define the operational monitoring for parameters that indicate the potential for problems and thus provide an early warning for changes towards conditions conducive for cyanobacterial proliferation.

➔ **Continue with documentation.**

- **Option B**

  You have frequently marked **orange** or **red** fields: Your risk of cyanobacterial proliferation is moderate to high.

  1.1. Immediate assessment of your raw water offtake strategy and/or drinking-water treatment system is important in order to assess the risk of intake of cells and breakthrough of cyanotoxins, i.e. how effective the barriers are that you have in place at these stages of your supply system.

  ➔ **Continue with Part II of the Questionnaire: Assessment of the risk of cyanotoxin intake and breakthrough in treatment**

  2.2. If the water-body is used for recreation, particularly involving water contact sports, you have no further barriers (like drinking-water treatment), and your only line of defence is to keep people out of the water during blooms through adequate public information. You can link here to a template flyer for informing site users and a flyer for medical professionals. Temporary closure at sites may also be adequate, e.g. in the context of an early warning and emergency response plan.

  3.3. For long-term safety, it is advised to assess whether and how cyanobacterial proliferation could be controlled more effectively.

  See ➔ Control measures in the catchment and ➔ Control measures in the water-body for suggestions of options to look at; check if any of them might be implemented in your setting and should be included in your Water Safety Plan.

- **Option C**

  You have frequently marked **grey** fields: the uncertainty of your assessment is high due to lack of information. The risk of cyanotoxin occurrence therefore cannot be safely excluded.

  1.1. Immediate assessment of your raw water offtake strategy and/or drinking-water treatment system is important in order to assess the risk of intake of cells and breakthrough of cyanotoxins in case cyanobacterial proliferation does occur, i.e. how effective the barriers are that you have in place at these downstream stages of your supply system.

➔ **Continue with Part II of the Questionaire: Assessment of the risk of cyanotoxin intake and breakthrough in treatment**

  2.2. If the water-body is used for recreation, particularly involving water contact sports, you have no further barriers (like drinking-water treatment), and your only line of defence is to keep people out of the water during blooms through adequate public information. You can link here to a template flyer for informing site users and a flyer for medical professionals. Temporary closure at sites may also be adequate, e.g. in the context of an early warning and emergency response plan.

  3.3. It is advised to assess whether decisions on implementing new control measures or upgrading ones can already be made on the basis of the information available, or whether this risks misguided investment, and the first priority should be to collect the missing information.

4.4. For long-term safety, it is advised to assess whether and how cyanobacterial proliferation could be controlled. See ➔ Control measures in the catchment and ➔ Control measures in the water-body for suggestions of options to look at and see if any of them might be implemented in your setting and should be included in your your Water Safety Plan.

On to ➔ Questionnaire: Assessment of the risk of cyanotoxin intake and breakthrough

Back to ➔ Assessing risks and the system's performance in controlling them

3.2 Evaluation of your assessment of the risk of cyanotoxin intake and breakthrough and your system's performance in controlling it

In assessing the risk of cyanobacterial proliferation your result was that this occurs or cannot be safely excluded. Subsequently you have assessed the performance of your further barriers – offtake strategy and treatment. Again, to evaluate this assessment, please check which colours you marked most frequently in the questionnaire.

Note: The outcome of this assessment supports you in positioning the human health risk from cyanotoxins in relation to other health risks from exposure to the same water in a matrix for relative ranking of health risks. This is a basis for setting priorities in controlling these risks.

- **Option A:**

  You have always marked **green** fields: Your risk of cyanobacterial intake and/or cyanotoxin breakthrough is low, and you aim to maintain this good situation.

  Therefore, the next important step is to identify the **control measures** in your system which currently are decisive for this level of safety and should have priority for **maintenance and operational monitoring**. For these, you should develop a management plan as key element of your Water Safety Plan which would particularly define the operational monitoring system to indicate the potential of break-through and thus provide an early warning.

➔ Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.

- **Option B:**

  You have frequently marked **orange** or **red** fields. Your risk of cyanobacteria being drawn into the offtake and/or cyanotoxin breakthrough is high:

  1. Immediate action to establish early warning for cyanobacterial bloom situations is adequate. This should trigger the provision of water from an alternative supply while blooms last. Continue with early warning and contingency planning.

  2. Rapid improvement of your offtake strategy (if possible) and/or your treatment chain is important for protecting public health from cyanotoxins in drinking-water.

Your Water Safety Plan will include a management plan for **operational monitoring** of those **control measures** already in place in your system. It will have a strong focus on **upgrading the control measures** that your assessment identified as necessary but currently insufficient, and/or for **implementing new ones** (i.e. investments).

➔ **Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.**

- **Option C:**

You have frequently marked **grey** fields. Your assessment is uncertain due to lack of information, and a risk of cyanobacterial intake and cyanotoxin break-through cannot be safely excluded.

1. Until the information gaps are closed and longer-term solutions are established, consider establishing early warning for cyanobacterial bloom situations which would trigger the provision of water from an alternative supply while blooms last. Continue with early warning and contingency planning.

2. Assess whether decisions on implementing new control measures or upgrading ones can already be made on the basis of the information available, or whether this risks misguided investment, and the first priority should be to collect the missing information.

3. Improvement of your offtake strategy (if possible) and/or your treatment chain may nonetheless be immediately adequate for protecting public health from cyanotoxins in drinking-water.

Your Water Safety Plan will include a management plan for **operational monitoring** of those **control measures** already in place in your system. It will have a strong focus on **closing information gaps** as basis for making investiment decisions.

➔ **Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.**

On to ➔ documentation of your system and risk assessment

Back to ➔ Assessing risks and the system's performance in controlling them, part II

4. Define control measures

4.1. Control Measures in the Catchment and their Operational Monitoring

These include planning, physical structures to prevent loading through discharges and erosion, and operational controls such as restrictions of human activities in vulnerable parts of the catchment.
The **monitoring and surveillance** of such control measures is crucial to ensure that they are in place and effective. This does not primarily imply cyanotoxin monitoring, but rather checking whether controls are operating as intended, i.e. **operational monitoring** as well as **surveillance** over plans, design and maintenance of structures.
When developing your Water Safety Plan (WSP) your WSP-team will assess the control measures already in place. If they are found to be insufficient, it will suggest upgrading or select new ones. The list of examples suggested below is not comprehensive, but merely intended for demonstrating the nature of control measures and their monitoring, and to trigger your own development of control measures adequate for your setting. This requires expertise in catchment management, particularly in estimating nutrient loading and the options for its reduction through management measures (see the bottom of the page assessing the risk of cyantoxin proliferation for setting targets that such measures should meet).
For each control measure, your Water Safety Plan should document the reasons for its choice and the targets it should achieve as well as how you validate that it is adequate for achieving the targets you set. Furthermore, a management plan should be developed which defines how performance of the control measure is operationally monitored and which corrective action should be taken if monitoring indicates poor performance, or if incidents occur.

Stakeholder involvement: Catchment management usually involves a number of different stakeholders. Success in implementation therefore is more likely if they collaboratively develop and define the control measures to be implemented in the given system.

<u>Note</u>: this is not a comprehensive catalogue of examples, but merely intends to trigger your own setting-specific concept of control measures !

Process Step	Examples of control measures for catchment management	Operational monitoring, surveillance and verification
Planning	Develop a land use plan that minimises nutrient loading through erosion, seepage and tributaries depending on vulnerability of areas in the catchment, e.g. through requiring forest cover for designated areas and/or buffer strips with shrub vegetation along shorelines	Monitor land use within vulnerable areas/buffer strips and ensure restricitions are implemented (site inspection); validate periodically whether they are still adequate to meet the nutrient loading target
	Develop water allocation plans that optimise the balance between stakeholder interests and water-body protection, ensuring sufficiently high minimal flows to avoid conditions conducive for cyanobacterial growth – targeting 1-2 % water renewal per day (see Padisak et al.)	Review plans and applications for permits in relation to vulnerability of the catchment area and water-body; validate management plans periodically
	Require permits for agricultural activities and for water discharge with management plans for the operations intended (e.g. nutrient removal in wastewater treatment; maximum stock density for pasture, fertilisation plans for fields etc.)	
	Require permits for discharges of sewage and from industries that stipulate maximum nutrient loads	
	Designate drinking-water protection zones in vulnerable reservoir catchment areas in which human activity is restricted	Monitor compliance
	… ?	… ?
Design, construction and maintenance	Construct fences around reservoirs and vulnerable tributary areas to keep out farm animals	Inspect integrity of fences
	Design wastewater treatment to meet loading targets for phosphours	Inspect wastewater and runoff systems; review plans and applications for upgrading and construction of new facilities
	Design surface runoff collection to avoid pulse nutrient loading during precipitation events	
	Design and construct sewers for wastewater and surface water to minimise overflow into reservoir tributaries	Inspect integrity of sewer structures
	… ?	… ?
Operation	Restrictions on agricultural activity in vulnerable catchments, e.g. fertiliser and manure application, stock density	Inspect farm records of fertiliser and manure application; count heads of stock
	Require and implement farm nutrient management plans with specific limitations on amounts and timing of the application of fertiliser and manure	Audit nutrient management plans; inspect farm records for timing and amounts of application; monitor residual soil nutrient content

	Implement soil tillage methods to minimise erosion	Visual site inspection after or during tillage
	Implement winter crop cover to reduce erosion	Visual site inspection
	Ascertain that wastewater treatment performance meets targets defined in permit	Inspect monitoring data of facility operator; conduct independent monitoring of nutrients in plant effluent
	… ?	… ?

➔ **Back to Evaluation of your assessment**
➔ **On to Documentation and Management plans**

4.2. Control Measures in the Water-Body and their Operational Monitoring

With few exceptions, cyanobacterial proliferation is most effectively controlled by measures in the catchment. “Internal” measures, i.e. those managing the water-body itself, in most cases have low success chances unless nutrient loads from the catchment are reduced sufficiently so that – in the longer term – their concentration in the water-body is too low to sustain a major cyanobacterial biomass. However, responses of a water-body may take a number of years until a new equilibrium is reached and cyanobacterial blooms actually do disappear, e.g. until phosphorus stored in the sediments has been sufficiently flushed out of the system by low-P inflow, and/or until reed-belts and other vegetation has sufficiently recovered to bind a fair share of the phosphorus load. In such situations, internal measures may speed up recovery towards a new equilibrium.

Also, in some settings, external loads cannot be sufficiently reduced to control cyanobacteria. While biological measures such as manipulating fish stock and nutrient loading from the sediments have NOT proven effective in such settings, controlling physical factors such as light availability or vertical mixing (to improve conditions for the growth of other phytoplankton that outcompetes cyanobacteria) has worked because these act independently of nutrient availability.

When developing your Water Safety Plan (WSP) your WSP-team will have assessed the conditions in the water-body, and might select control measures among those suggested below. Note that controlling cyanobacteria by measures in the water-body is particularly tricky and requires a high level of expertise in limnology, particularly in plankton ecology, and even if this is available, the uncertainty of predictions is higher than for control measures in the management of the catchment, drinking-water offtake or treatment system. Wherever possible, preference should therefore be given to controlling nutrient loading from the catchment, and if the load target derived for the given water-body is met, allowing sufficient time for the water-body to gain its new equilibrium may be more adequate than implementing (often expensive) internal measures.

If measures in water-body management are under consideration, the middle of the page on assessing the risk of cyantoxin proliferation gives some targets that measures should meet. For each control measure, your Water Safety Plan should document the reasons for its choice and the targets it should achieve as well as how you validate that it is adequate for achieving the targets you set. Furthermore, a management plan should be developed which defines how performance of the control measure is operationally monitored and which corrective action should be taken if monitoring indicates poor performance, or if incidents occur.

The **monitoring and surveillance** of such control measures is crucial to ensure that they are in place and effective. This does not primarily imply cyanotoxin monitoring, but rather checking whether controls are operating as intended, i.e. **operational monitoring** as well as **surveillance** over plans, design and maintenance of structures.

Stakeholder **involvement**: Water-body management usually involves a number of different stakeholders, among which conflicts of interest are particularly common with anglers. Success in implementation therefore is more likely If they collaboratively develop and define the control measures to be implemented in the given system.

Note: this is not a comprehensive catalogue of examples, but merely intends to trigger your own setting-specific concept of control measures !

Process Step	Examples of control measures for water-body management	Operational monitoring, surveillance and verification
Planning and design	Develop water allocation plans that optimise the balance between stakeholder interests and water-body protection, ensuring sufficiently high minimal flows to avoid conditions conducive for cyanobacterial growth – targeting at minimum 1-2 % water renewal per day (see Padisak et al.)	Monitor water offtake and water flow; ensure restrictions are implemented (site inspection)
	Plan and design measures to control light availability, targeting conditions less favourable for cyanobacteria, conducive to the growth of their less noxious competitors	Review plans and applications for permits in relation to characteristics of the water-body; Validate that measures are properly designed and meet their target
	Plan and design measures to control mixing intensity in order to suppress buoyancy-regulating cyanobacteria (see Visser et al. 1997 and 1999 for a successful case study)	
	Plan and design measures to control internal loading with phosphorus stored in the sediments, targeting a reduction of water-body concentrations below 10-25 µg/L of total P, e.g. through sediment capping or sediment oxidation	
	Plan and implement biological measures such as fostering macrophyte and reed-belt growth or stocking fish	
	… ?	… ?
Operation	Artificial mixing, designed for any of the 3 purposes above, i.e. for controlling light availability, for suppressing buoyant species, or for oxidising sediments	Any efficient monitoring system to check whether aerators are in operation as planned, e.g. visual inspection, records of pump operation
	Biological measures such as planting reeds or stocking fish ("food chain manipulation")	periodic visual inspection or mapping of reed growth and/or determination of fish population sizes
	… ?	… ?

➔ **Back to Evaluation of your assessment**
➔ **On to Documentation and Management plans**

4.3 Control Measures in Drinking-water Off take and their Operational Monitoring

Defining these begins with basic decisions on offtake systems to use (i.e. whether to abstract surface water directly or to use infiltration through river banks or through artificial groundwater recharge systems). It includes adequate planning and design of the physical structures for offtake (e.g. bank filtration wells or abstraction towers in reservoirs) and operational controls such as meeting restrictions for pumping rates to avoid break-through of cells or toxins.

The monitoring and surveillance of such control measures is crucial to ensure that they are in place and effective. This does not primarily imply cyanotoxin monitoring, but rather checking whether controls are operating as intended, i.e. operational monitoring as well as surveillance over plans, design and maintenance of structures.

When developing your Water Safety Plan (WSP) your WSP-team will assess the control measures already in place. If they are found to be insufficient, it will suggest upgrading or select new ones. The list of examples suggested below is not comprehensive, but merely intended for demonstrating the nature of control measures and their monitoring, and to trigger your own development of control measures adequate for your setting. This requires expertise in hydrology and – if infiltration is used – in hydrogeology.

For each control measure chosen, your Water Safety Plan should document the reasons for its choice and the targets it should achieve as well as how you validate that it is adequate for achieving the targets you set. Furthermore a management plan should be developed which defines how their performance is monitored and which corrective action should be taken if monitoring indicates poor performance or if incidents occur.

Note: this is not a comprehensive catalogue of examples, but merely intends to trigger your own setting-specific concept of control measures !

Process Step	**Examples of control measures for catchment management**	**Operational monitoring, surveillance and verification**
Planning	For infiltration, require permits for drilling wells and for siting artificial recharge schemes that are based on a system assessment which demonstrates that cyanotoxin break-through is unlikely	Review plans and applications for permits in relation to cyanotoxin occurrence and hydro(geo)logical conditions, potentially also in relation to subsequent water treatment
	For infiltration, optimise choice of locations for production wells to ensure sufficiently large minimal travel times for cyanotoxin removal	Review plans and applications for permits in relation to hydrogeological information
	For surface water offtake, plan site on the basis of observations of scum accumulation, e.g. sufficiently far outside of susceptible bays or vertically sufficiently deep to stay underneath surface scums or above deep-layer (metalimnetic) accumulations	Review records of scum accumulation in relation to offtake site

	… ?	… ?
Design, construction and maintenance	Ensure that wells are constructed according to best practice, avoiding filter bypass through the development of preferential flow paths	Ensure that wells are constructed by trained experts, carry out maximum capacity pumping test, TV-inspection and borehole geophysical examination
	For infiltration, ascertain that minimum residence times are achieved	Validate with tracer investigations
	Modify well locations / filter depth, if material proves coarser than expected	Analyse grain size of aquifer material prior to well lining to validate assumptions
	For direct surface water use, construct offtake with options for varying depth in response to an adequate indicator of cyanobacterial accumulation (e.g. turbidity or fluorescence)	Monitor integrity of structure and functioning of system that shifts offtake depths, validate adequacy of scheme inducing these shifts
	… ?	… ?
Operation	For artificial recharge, avoid anoxic / anaerobic conditions by regular removal of clogging layer	Monitor DOC in surface water and oxygen content in bank filtrate; validate that removal scheme is adequate to prevent anoxic conditions
	After clogging layer removal in artificial recharge basins: meet required residence times by reducing pumping rates	Monitor pumping rates regularly and occasionally validate that they are adequate to prevent break-through; for surveillance inspect records of clogging layer removal for documentation of ground water tables and pumping rates
	For variable surface water offtake, switch depth in response to a selected indicator of cyanoabacterial accumulation	Monitor the indicator chosen for cyanoabacterial accumulation at the offtake site; for surveillance check records of monitoring and of response in offtake site selection
	… ?	… ?

➔ **Back to Evaluation of your assessment**

➔ **On to Documentation and Management plans**

4.4 Control Measures in Drinking-water Treatment and their Operational Monitoring

Defining these includes basic investment decisions on treatment systems to use (e.g. whether to use pre-oxidation to enhance flocculation and precipitation of algae and cyanobacteria, to install ozonation and granular activated carbon filtration), adequate planning and design of the elements in the treatment chain, and operational controls to ensure that treatment is functioning as it should at all times – e.g. even when challenged by a massive cyanobacterial bloom.

The monitoring and surveillance of such control measures is crucial to ensure that they are in place and effective. This does not primarily imply cyanotoxin monitoring, but rather checking whether controls are operating as intended, i.e. operational monitoring as well as surveillance over plans, design and maintenance of structures.

When developing your Water Safety Plan (WSP) your WSP-team will WSP-team will assess the control measures already in place. If they are found to be insufficient, it will suggest upgrading or select new ones. The list of examples suggested below is not comprehensive, but merely intended for demonstrating the nature of control measures and their monitoring, and to trigger your own development of control measures adequate for your setting. This requires expertise in drinking-water treatment, particularly including an understanding of the treatment challenges for removal of algae and cyanobacteria.

For each control measure chosen, your Water Safety Plan should document the reasons for its choice and the targets it should achieve as well as how you validate that it is adequate for achieving the targets you set. Furthermore a management plan should be developed which defines how their performance is monitored and which corrective action should be taken if monitoring indicates poor performance or if incidents occur.

Note: this is not a comprehensive catalogue of examples, but merely intends to trigger your own setting-specific concept of control measures !

Process Step	Examples of control measures for catchment management	Operational monitoring, surveillance and verification
Planning	Plan treatment steps in relation to cyanobacterial bloom occurrence, e.g. to optimise removal of cells and dissolved toxins – see bottom of system assessment for treatment steps relevant to cyanotoxin removal	Review plans and applications for permits in relation to available information on cyanotoxin occurrence in the source water
	Plan situation-specific periodic dosing of powdered activated carbon (PAC) in relation to requirements of your specific setting	Review choice of carbon, amounts stored for use during bloom situations, conditions that trigger application
	… ?	… ?
Design, construction and maintenance	Design, construct and maintain filters so that backwashing effectively removes cells and cellular debris	Review plans, inspect structures and documented records of maintenance works
	Design, construct and maintain dosing for oxidants so that dose and contact time can be maintained as targeted	
	… ?	… ?

Operation	If pre-oxidation is performed, ascertain sufficient dosing of oxidant to ensure oxidation of released toxin, or ensure subsequent treatment steps will remove it (see below)	Monitor oxidant dosing in relation to pre-determined minimal amount (see validation) required for toxin oxidation, or monitor the subsequent treatment steps that should remove dissolved toxin (see below)
	Operate filters to ensure they retain cyanobacterial cells	Monitor on-line parameter that would indicate break-through, e.g. turbidity or pigment fluorescence
	Operate filters to avoid cell lysis and release of dissolved cyanotoxins by adapting backwashing frequency to the amount of cellular material accumulated on the filter	Monitor filter resistance in relation to pre-determined threshold that would indicate elevated risk of break-through (see validation)
	If post-oxidation is performed to remove dissolved toxin, operate it as specified to meet this target	Monitor dosing of oxidant in relation to pre-determined dose and contact time needed to ascertain sufficient oxidation (see validation)
	If granular activated carbon filtration (GAC) or PAC dosing is performed to remove dissolved toxin, operate it as specified to meet this target	Monitor filtration or dosing of PAC in relation to pre-determined dose and contact time needed to ascertain sufficient binding of dissolved toxin (see validation)
	… ?	… ?

➔ **Back to Evaluation of your assessment**
➔ **On to Documentation and Management plans**

4.5 Early warning, contingency plans and emergency response

Cyanobacterial blooms are a hazard that typically has an event nature: In many water-bodies, low levels of toxic cyanobacteria prevail many weeks or months on end, while hazardously high concentrations may be fairly short-lived events caused by accumulations of cells as surface blooms and/or by cell lysis leading to high levels of dissolved toxin that may break through drinking-water treatment trains.

Where cyanobacteria are known to occur or even to occasionally reach high levels or develop blooms or where this possibility needs to be taken into account, immediate response to such events is important to avoid human exposure. Planning for such events is an important part of the overall strategy for managing health hazards associated with toxic cyanobacterial blooms.

Immediate response requires preparedness and plans for action. These need to include:

- **When and What:** Triggers (alert levels) that put the plan into action – usually with 2-3 alert levels, depending on the intensity and/or toxicity of blooms – and specific pre-defined responses to each alert level that prevent human exposure
- **Who:** Clear lines of responsibility and action: (who needs to do what and by when ?)
- **After the incident:** Follow-up investigation

When and What?:

Planning what to do at which level of cyanobacteria and/or cyanotoxins requires defining triggers (alert levels) for specific immediate responses. For cyanobacteria and/or cyanotoxins the definition of 2-3 alert levels, depending on the intensity and/or toxicity of blooms, has proven useful. An approach proposed by WHO for recreational exposure is given in Chapter 5 of Toxic Cyanobacteria in Water (Chorus & Bartram 1999) and for and for drinking-water in Chapter 6 (ibid):

Guidance levels and responses for avoiding recreational exposure

Table 5.2 gives 3 guidance levels and responses, ranging from posting on-site risk advisory signs to possible prohibition of water-contact activities. Table 5.3. give examples of current regulation in different European countries.

Note that this is generic guidance only, and your guidelines or regulations should be adapted according to local conditions.

Table 5.2 from Chorus and Bartram (1999); link directly to: http://www.who.int/water_sanitation_health/resourcesquality/toxcyanchap5.pdf and see there for more details

Table 5.2 Guidelines for safe practice in managing bathing waters which may produce or contain cyanobacterial cells and/or toxins

Guidance level or situation	How guidance level derived	Health risks	Recommended action
Cyanobacterial scum formation in bathing areas	Inference from oral animal lethal poisonings Actual human illness case histories	Potential for acute poisoning Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness	Immediate action to prevent contact with scums; possible prohibition of swimming and other water-contact activities Public health follow-up investigation Inform relevant authorities
100,000 cells cyanobacteria per ml *or* 50 µg chlorophyll *a* per litre with dominance of cyanobacteria	From provisional drinking water guideline for microcystin-LR, and data concerning other cyanotoxins	Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness	Watch for scums Restrict bathing and further investigate hazard Post on-site risk advisory signs Inform relevant health authorities
20,000 cells cyanobacteria per ml *or* 10 µg chlorophyll *a* per litre with dominance of cyanobacteria	From human bathing epidemiological study	Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness, probably at low frequency	Post on-site risk advisory signs Inform relevant authorities

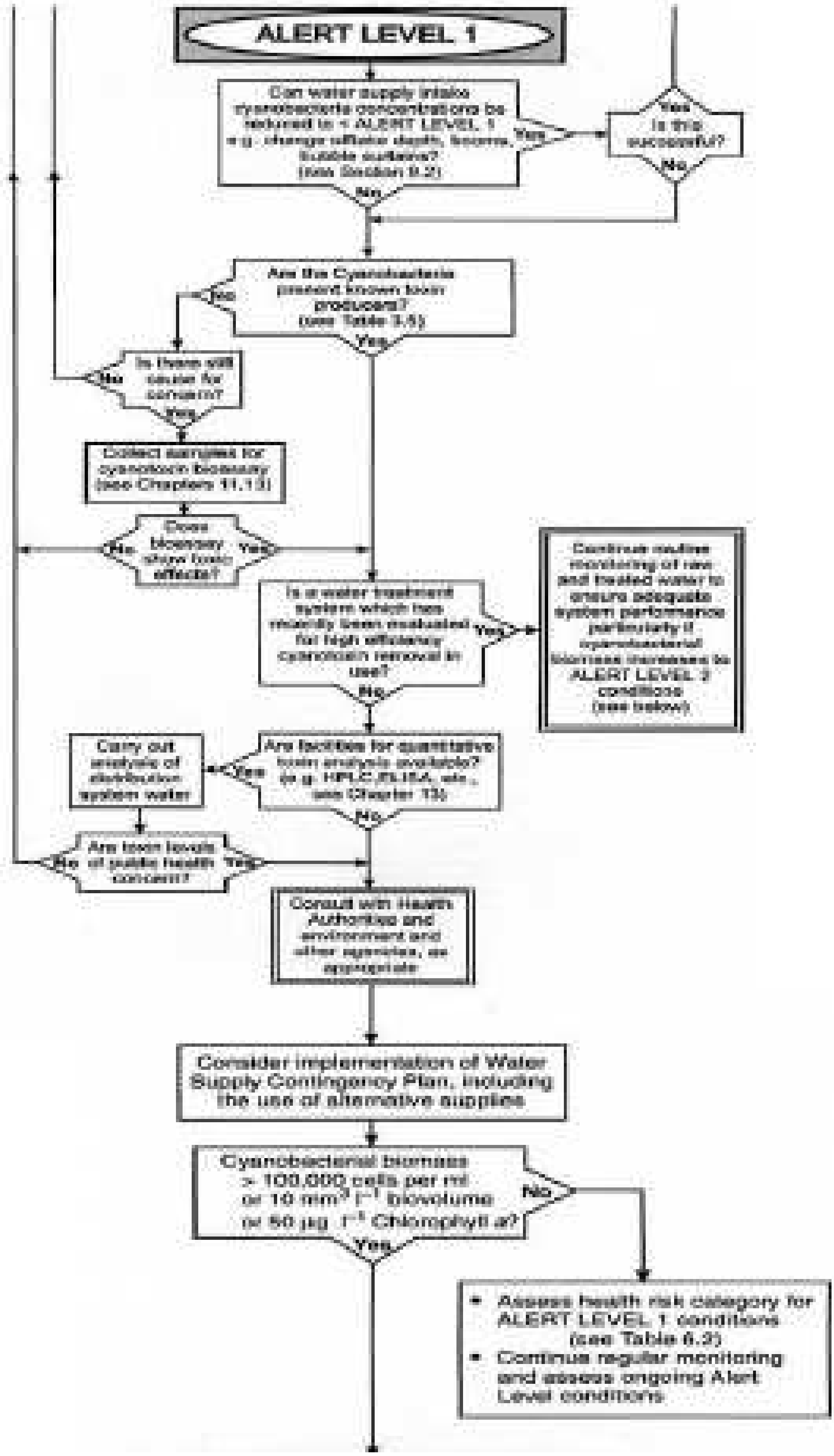
Table 5.3: Current regulation in European countries to avoid recreational exposure

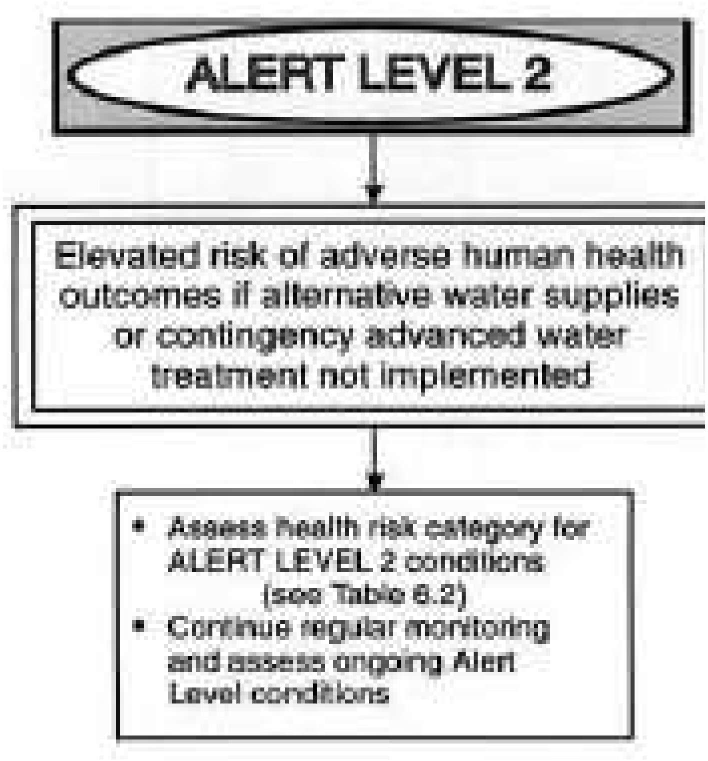
Country	**Concentration of microcystin or cyanobacterial biomass**	**Action to be taken**
Netherlands	10 µg/l MC-LR 20 µg/l MC-LR	Trigger warning Closure of sites
France	Three levels of cell density	Management response up to prohibition of water sports
Germany	Thresholds for cyanobacterial biomass 100 µg/l MC	Information of the public to closure of bathing sites
Denmark	Analysis of massive bloom	Warning signs and information of user groups
Hungary	Limit of the Chlorophyll-a concentration	

For drinking-water supplies Fig. 6.3 gives a decision tree with a vigilance level and 2 alert levels triggering responses ranging from weekly monitoring and regular inspection of offtakes to implementation of a contingency plan.

Decision tree incorporating a model Alert Levels Framework for monitoring and management of cyanobacteria in drinking-water supplies.

Note that this framework should be adapted according to local conditions. From: http://www.who.int/water_sanitation_health/resourcesquality/toxcyanchap6.pdf and see there for clearer image and text. Figure 6.3 from Chorus and Bartram (1999)


ALERT LEVEL 1
Yes
Is this successful?
No
Are the Cyanobacteria present known toxin producers?
Yes
No
Is there still cause for concern?
Yes
Collect samples for cyanotoxin bioassay
Does bioassay show toxic effects?
Yes
No
Is a water treatment system which has recently been evaluated for high efficiency cyanotoxin removal in use?
Yes
No
Continue routine monitoring of raw and treated water to ensure adequate system performance particularly if cyanobacterial biomass increases to ALERT LEVEL 2 conditions (see below)
Are facilities for quantitative toxin analysis available?
Yes
No
Carry out analysis of distribution system water
Are toxin levels of public health concern?
Yes
No
Consult with Health Authorities and environment and other agencies, as appropriate
Consider implementation of Water Supply Contingency Plan, including the use of alternative supplies
Cyanobacterial biomass
> 100,000 cells per ml
or 10 mm³ l⁻¹ biovolume
or 50 µg l⁻¹ Chlorophyll a?
No
Yes
• Assess health risk category for ALERT LEVEL 1 conditions (see Table 6.2)
• Continue regular monitoring and assess ongoing Alert Level conditions



These suggestions have been used in national policy and/or recommendations, usually somewhat adapted to the specifics of the region (see Chorus (ed., 2005: Current regulatory approaches to cyanotoxin risk assessment, risk management and regulations in different countries for examples).

➔ Use these templates and examples to develop your own alert levels to toxic cyanobacteria and your response plan ! (e.g. in your worksheet in this decision support tool)

Document your alert levels and response plans, and make sure to revise them regularly, e.g. in the context of periodic validation of your Water Safety Plan and particularly after an incident.

On to: ➔ **Early warning, contingency plans and emergency response: WHO?**
Back to: ➔ **Evaluating your assessment for cyanobacterial proliferation (3.1) or for cyanotoxin breakthrough (3.2)**

<u>Who</u>:

Clear lines of responsibility and action need to be defined and readily at hand for quick response when alert levels are exceeded, indicating the need for immediate action. Think about – and prepare a list of

- Who needs to make the decision for implementing the response (e.g. for temporary closure of a recreational site or supplying drinking-water from an alternative source, or even in bottles or tank trucks)
- Who else needs to be consulted if the criteria to trigger the response are not sufficiently clear ?
- Who needs to be informed?
- Which sensitive water users need to be contacted (e.g. dialysis units, including home units, hospitals, etc.)
- ?

Document your list of contacts, including telephone numbers, and make sure to revise regularly, e.g. in the context of periodic validation of your Water Safety Plan.

On to: ➔ **Early warning, contingency plans and emergency response: After the incident**

Back to: ➔ **Evaluating your assessment for cyanobacterial proliferation (3.1) or for cyanotoxin breakthrough (3.2)**

After the incident:

Evaluation of the incident: was it merely the top end of the usual range of cyanobacterial/cyanotoxin occurrence, or was it special?

Evaluation of the response, i.e. how well plans could be put into action? Examples of questions to ask and issues to investigate.

For drinking-water supply:

- Was switch to an alternative water supply done on time, was this supply of sufficient quality and quantity?
- If bottled water was provided, how well did it reach consumers?
- How well was the measure communicated to the population supplied? How well was it accepted?

For recreational sites: Information of potential users and/or temporary site closure will be a rather frequent measure in many settings, so it is of particular relevance not only to check adherence once, but also whether the effect of this measure "wears down" with time, or site user compliance keeps up till the end of the season.

For particularly sensitive sub-populations (e.g. dialysis patients): Was communication to them sufficiently effective?

Health investigation: If exposure probably occurred, possibly substantially or even with suspected symptoms, a health investigation of the potentially affected population should be instigated without delay. Information to the local medical professionals should be re-inforced.

Conclusions for risk and system assessment as well as control measures: Does the experience of the incident lead to changes in your assessment of the risks of cyanobacterial proliferation and/or cyanotoxin break-through? Are further control measures needed, or do existing ones need to be upgraded or managed more effectively?

Overall conclusions for contingency planning and emergency response: Did lines of communication work adequately? Does the experience show any need to change the plans, e.g. for alert levels, their monitoring or the responses to them, or the lists for communication?

On to: ➔ **Validation**

Back to: ➔ **Evaluating your assessment for cyanobacterial proliferation (3.1) or for cyanotoxin breakthrough (3.2)**

5. Validation

Almost always when measures are implemented to control cyanobacterial occurrence or cyanotoxin break-through there remains some degree of uncertainty whether or not they are adequately chosen and designed to achieve the target they are intended for. Validation is a periodic investigative activity to identify the effectiveness of a control measure. It is typically intensive when a system is initially constructed or rehabilitated and is not intended for day-to-day management.

Validation begins with considering data and information that already exist, e.g. from scientific literature, guidelines, regulations and their explanatory text, historical data, experience. Research on site, specific to the individual setting, is adequate for validation particularly where uncertainty is large as to whether or not a measure will "work" sufficiently well in this situation.

Examples for the validation of measures from catchment to drinking-water treatment are given below. They include limited and targeted specific experimental or monitoring programmes. These should be periodically repeated as adequate for each, but particularly after changes in the system were undertaken. Running intensified monitoring programmes during extreme blooms is particularly valuable for validation of the performance of control measures. Vice versa, follow-up investigations after an event such as a cyanobacterial bloom or occurrence of toxin in finished drinking-water will usually include validation of the whole system / Water Safety Plan.

Additional expertise may be necessary for some validation programmes. It may be useful to invite experts on board a *Water Safety Plan* team for such specific programmes.

An outcome of validation may be a change in a control measure or its monitoring system, or confirmation that it is (still) adequate to ensure safety from cyanotoxin occurrence.

Your validation activities should also be documented in your Water Safety Plan, i.e. in the worksheet for your entries provided by this decision support tool. With such documentation, you can demonstrate having observed your duties of due diligence towards the public surveillance agency responsible for your setting, and also towards journalists and the general public in case questions or incidents arise.

Measure or Method	Potential approach to its validation
Indicators for cyanobacterial occurrence – example	
Turbidity or pigment fluorescence as indicators of cyanobacterial density	Validate whether signals reflect cyanobacterial occurrence sufficiently well in your specific setting by performing cell counts and/or biovolume determination. This may be different for different parts of the supply chain, e.g. for raw water and for filter outlets, and separate validation may be adequate.
Choice and efficacy of control measures in the catchment – example	
Catchment management measures	Validate whether the measures implemented actually meet the targets set for phosphorus loading by running specific research programmes to determine the load, e.g. by sampling tributaries under normal conditions and during heavy precipitation or snowmelt events and modelling the P budget
Choice and efficacy of control measures in the waterbody – examples	
Artificial mixing and/or biological measures to reduce cyanobacterial growth in a water-body	In situations where visual inspection indicates cyanobacteria might be increasing in spite of mixing, take a sample and determine their cell density and/or biovolume, e.g. through cell counting
Measures to control phosphorus release from water-body sediments	Monitor phosphorus concentrations over time to detect patterns that indicate the sediments to be the source and/or model the phosphorus budget to differentiate between internal and external loading
Choice and efficacy of control measures for offtake – examples	
Minimum residence times in the underground	Validate assumptions made in planning and design through tracer test under the extremes of conditions expected
Choice of offtake depths to minimise intake of cyanobacteria	Measure depth profiles of cyanobacterial occurrence, e.g. by cell counts or *in situ* fluorescence probe, in a range of different situations of cyanobacterial occurrence and compare your plan for the selection of offtake depths to the findings
Scheme for clogging layer removal and pumping afterwards	Check redox conditions and cyanotoxin concentrations in water pumped from the artificial recharge system under selected extreme situations

Choice and efficacy of control measures in drinking-water treatment – examples	
Pre-oxidation	evaluate amount of oxidant needed at minimum to ensure cyanotoxin released by cell lysis will be oxidised, even if the system is challenged by high levels of organic carbon, as is the case during a cyanobacterial bloom. For example, conduct jar tests with bloom material and the oxidising agent used in your treatment scheme, analysing dissolved cyanotoxin, or run a temporary sampling programme for the analysis of dissolved cyanotoxin when a heavy bloom occurs in your reservoir and challenges your system. Such data may result in a scheme for dosing oxidant in relation to some indicator of cyanobacterial cell density that proves most useful to you, e.g. pigment fluorescence, cell counts or chlorophyll-a concentration analysis in the raw water, or even visual inspection of the reservoir, and this indicator can then be used for operational monitoring in your system.
Filtration in drinking-water treatment	Evaluate situations of pronounced cell accumulation on filters for indication of cell lysis and break-through
Dosing of oxidant to remove or of powdered activated carbon (PAC) to bind dissolved cyanotoxins	evaluate amount needed at minimum to ensure cyanotoxin degradation / binding even in situations in which the system is challenged by high levels of competing organic carbon, as is the case during a cyanobacterial bloom. For example, conduct jar tests with bloom material and the oxidising agent or PAC used in your treatment scheme, analysing dissolved cyanotoxin, or run a temporary sampling programme for the analysis of dissolved cyanotoxin when a heavy bloom occurs in your reservoir and challenges your system. Such data may result in a scheme for dosing in relation to some indicator of cyanobacterial cell density that proves most useful to you, e.g. pigment fluorescence, cell counts or chlorophyll-a concentration analysis in the raw water, or even visual inspection of the reservoir, and this indicator can then be used for operational monitoring in your system.

➔ **Back to start**
➔ **On to verification**

6. Verification

Verification is complementary to operational monitoring of the individual control measures. In verification, actual cyanotoxin and/or cyanobacterial monitoring has its key role. Monitoring cyanotoxin concentrations in finished drinking-water or cyanobacterial biomass at recreational sites provides the overall reassurance that the whole system is working safely and people are not being exposed to cyanotoxins.

Conceptually, verification is also complementary to validation. Validation may also analyse cyanotoxins or cyanobacteria, but for a different purpose and thus following completely different sampling schemes:

- For validation, cyanotoxin analyses are performed in the context of short-term and very specific research-type programmes e.g. under extreme bloom conditions in order to ascertain that a system challenged with a high load of cells or toxins can still cope effectively. Sampling schemes will target quantifying cyanotoxin removal rates.

- For verification, cyanotoxin analyses are performed at regular time intervals, primarily from the water to which people get exposed.

Verification can be undertaken both by the operator of a facility (waterworks or recreational site) and by an independent surveillance agency. In practice, it is often done by both.

Developing a verification scheme for your setting requires consideration of adequacy of time intervals and sampling sites in relation to the heath risk from cyanotoxins that you assessed for your setting. It is important to understand that safety from exposure is not effectively generated by tight verification programmes, but rather by well designed and validated control measures together with their effective operational monitoring. This is particularly relevant to cyanotoxins, as their occurrence and concentrations may vary extremely rapidly when wind action shifts bloom locations in waterbodies.

- For recreational sites, consider frequency, intensity and duration of blooms in relation to patterns of their use, both with respect to time (e.g. largely on week-ends or continuously as on camp sites) and number of users
- For drinking-water supplies, consider time patterns of cyanobacterial occurrence in the source water and adapt sampling patterns accordingly. Triggers such as minimum turbidity levels in source water may be used for intensifying sampling and analyses for verification.
- For both, consider whether analysing specific cyanotoxins or / and cyanobacterial biomass provides the more useful information about potential health risks. This will depend on dominant species and toxins expected from them.

Your verification activities should also be documented in your *Water Safety Plan*, i.e. in the worksheet for your entries provided by this decision support tool. With such documentation, you can demonstrate having observed your duties of due diligence towards the surveillance authority responsible for your setting, and also towards journalists and the general public in case questions or incidents arise.

On to ➔ Cyanotoxin building block for your *Water Safety Plan*

7. Cyanotoxin building-block for your *Water Safety Plan*

With the steps of this decision support tool you have followed the conceptual logic for developing a *Water Safety Plan* (WSP) specifically for your setting, though only for one group of several potentially occurring hazards. Your tables and entries in your worksheet document the results of your risk assessment, your reasons for it, your judgement of the uncertainty of this assessment, your identification and validation of specific control measures and your scheme for verification that the system is working safely. This serves transparency of your decision criteria.

For completing your WSP, further hazards (e.g. Cryptosporidia and further faecal contaminants, industrial chemicals, pesticides, etc.) would be analysed and the risk they pose be assessed comprehensively in analogous manner, and control measures identified. Often they will address several hazards simultaneously. It is strongly recommended to perform such a more comprehensive assessment, as the outcome will set the health risk from toxic cyanobacteria into perspective against other health risks from hazards that may occur in your system, and this is valuable for making decisions on management priorities (see cyanotoxins in relation to risks from other hazards).

Your assessment of risks and control measures should be periodically reviewed and updated. Simplified, the **process** of developing a *Water Safety Plan* consists of the following elements:

Your actual **Water Safety Plan Document** should include outcome of steps 2 – 6 of this decision support tool as outlined by your entries in the worksheet provided on the starting page. A particularly important aspect is to make your assessment transparent, by including the criteria you used and your estimates of the uncertainty of your assessments. Documentation in the context of a WSP should further include monitoring records that demonstrate process control, and results of water quality verification.

Thus, the completed worksheet, together with accompanying documents to which it refers, actually **constitutes** the cyanotoxin building block of your Water Safety Plan Document.

Comprehensive documentation is extremely valuable for securing information and experience, including for training staff. It is further a good basis for communication with authorities responsible for independent surveillance (e.g. health authorities), which can use this as basis for assessment of the safety of your system. Thus good documentation serves as protection against accusations of inadequate management. This can be strengthened by an external audit of your *Water Safety Plan.* Last but not least, your documentation is a useful basis for public communication about the control measures implemented in your water supply and the stringency of their monitoring.

Nõustamissüsteem

joogivees tsüanotoksiinide vältimise strateegia väljatöötamiseks valglast tarbijani

Eesmärk: analüüsida, hinnata ja ohjata tsüanotoksiinide esinemisega seotud riske

Autorid: Ingrid Chorus ja Verena Niesel, UBA

Käesolevat nõustamissüsteemi, aga ka seda toetavaid WHO suuniseid toksiliste sinivetikate jaoks, arendatakse edasi. Seetõttu on väga teretulnud tagasiside autoritele!

Tänusõnad: Käesolev nõustamissüsteem on välja töötatud Euroopa Liidu projekti "PEPCY" (Toxic and bioactive PEPtides in CYanobacteria, toetus nr. QLRT-2001-02634) raames. Aluseks on saksakeelne süsteem, mis loodi Saksamaa Hariduse ja Teaduse Föderaalministeeriumi rahastatud projektis (toetus nr. 02WT9852/7).

Miks on joogivees olevad tsüanotoksiinid riskiallikaks?

- **Vaata siit**

Kelle jaoks on see nõustamissüsteem mõeldud?

- **Vaata siit**

Käesolev meetod põhineb *veeohutuskavade* kontseptsioonil, mis on esitatud WHO joogiveeohutuse suunistes.

- **Vaata siit**
- **Tööleht Teie kannete jaoks (arvutisse või värviprinterile)**

Selle vahendi abil tehakse järgmised sammud:

1. **Määratletakse vahetud ja kaudsed eesmärgid**
2. **Ettevalmistavad sammud**
   - **2.1 Koostatakse vajalike oskustega meeskond**
   - **2.2 Kirjeldatakse veevarustussüsteemi ja supluskohti**
   - **2.3 Kirjeldatakse veekasutust ja -kasutajaid**
3. **Hinnatakse riske ja süsteemi toimimist**
   - **3.1 toorvees ja suplusvees sinivetikate paljunemise seisukohast**
   - **3.2 tsüanotoksiinide sissevõtu ja veetöötluses säilumise seisukohast**
   - **3.3 Hinnatakse punkte 3.1 ja 3.2 seoses veega kokkupuutel tekkivate teiste terviseriskidega ja dokumenteeritakse hinnang**
4. **Määratletakse meetmed**
   - **4.1 valgla majandamisel**
   - **4.2 veekogu majandamisel**
   - **4.3 joogivee ammutamisel**
   - **4.4 joogivee töötlemisel**
   - **4.5 Dokumenteeritakse valitud meetmed koos valikupõhjustega; iga etapi jaoks töötatakse välja majanduskavad ja varase hoiatamise kava ning veevarustuse situatsiooniplaanid**
5. **Valideeritakse saadud hinnang ja väljatöötatud meetmed kirjandusallikate ja WWW sinivetikalehekülgede abil**
6. **Tehakse kindlaks, et vesi ei sisalda tsüanotoksiine seatud sihttasemest rohkem**
7. ***Tsüanotoksiinide moodul veeohutuskava jaoks***

1. Define direct and indirect targets - Määratletakse vahetud ja kaudsed eesmärgid

Your overall target is to avoid cyanotoxin occurrence in drinking-water and in water used for recreation or at least to keep them under tolerable limits. These limits may be defined on the basis of the provisional WHO Guideline value for Microcystin-LR in drinking-water and the WHO Guidelines for Recreational Water use:

Drinking-water: WHO gives a value only for one microcystin, but this may be used as proxy for the other microcystin variants as well. This is likely to be a conservative approach, as Microcystin-LR is among the most toxic variants. For cylindrospermopsin, less toxicological information is available and few countries have guideline values or standards. They range from 15 µg/L (Brasil) to 1 µg/L (proposed by Humpage & Falconer 2003). As these Guideline values are intended for lifetime daily consumption, under certain conditions health authorities may consider slightly higher levels (3-5-fold) as acceptable for short time spans.

Recreational water use: Microcystin concentrations considered acceptable vary between countries from 20 – 100 µg/L between countries, and this strongly depends on assumptions for frequency and duration of bathing as well as the amounts of water ingested, i.e. behaviour of site users and type of water sports activity.

Management targets: Cyanotoxin concentrations will be below the target level if:

1. cyanobacterial biomass can be kept sufficiently low. Trigger values alerting to potential toxin occurrence can be set in terms of biovolume (usually < 1 mm^3/L), in terms of Chlorophyll-a (usually < 5-10 µg/L) or in terms of cell numbers (less useful because cell size and thus toxin per cell can vary widely; see below for cell numbers in the WHO ALF). This biomass target can be achieved if
2. phosphorus concentrations in the waterbody are sufficiently low (Total phosphorus usually < 30-50 µg/L), and this target in turn can be achieved by managing the waterbody's catchment so as to avoid phosphorus loading.
3. Phosphorus loading targets need to be defined specifically for the site, because the resulting concentrations depend on waterbody characteristics. They can be set for the amount of fertiliser and manure that may be spread in the catchment, for buffer strips around the shorelines to avoid phosphorus input from erosion, or for limits on the concentration of phosphorus that may be contained in treated sewage that discharged into the waterbody or its tributaries.
4. Treatment targets that define toxin removal measures and how effective they need to be.

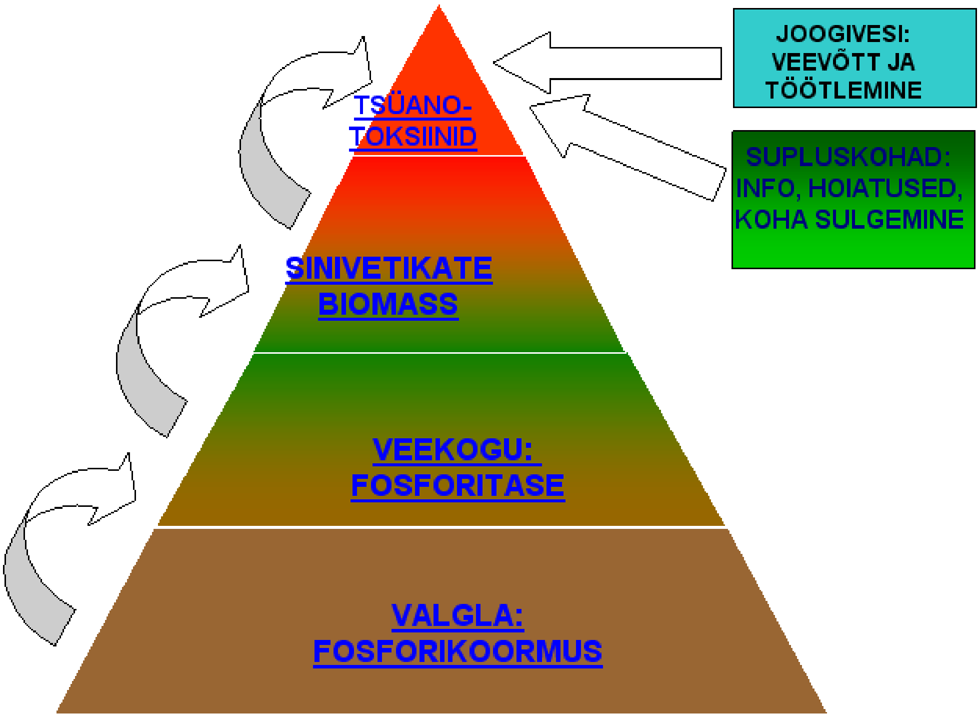
Clearly, these quite different levels of tackling the problem require different types of expertise (from hydrology and limnology to drinking-water treatment), and decision-makers need support of experts.

Otseste ja kaudsete eesmärkide määratlemine:

Vees leiduvate tsüanotoksiinide kontsentratsiooni sihtväärtusi võib saavutada, järgides veekogus leiduvate tsüanobakteritebiomassi sihttaset.

Viimast on võimalik saavutada,järgides veekogus fosfori üldkontsentratsooni sihttaset.

Seda on omakorda võimalik (sageli) saavutada, järgides valglast veekogusse sattuva fosforikoguse sihttaset.



2. Preparatory steps - Ettevalmistavad sammud

2.1 Compile a team with the necessary expertise -Koostatakse vajalike oskustega meeskond

<u>Üldjuhul vajatakse veeohutuskavade väljatöötamiseks</u> ekspertide meeskonda, kes suudab analüüsida ohte, hinnata neist tekkivaid riske, aga ka veevarustussüsteemi toimimist nende välistamiseks, välja töötada uusi kontrollimeetmeid või teha ettepanekuid olemasolevate täiustamiseks, ning hinnata, kui efektiivselt olemasolevaid meetmeid jälgitakse ja juhitakse.

Seetõttu peaks see meeskond olema multidistsiplinaarne. Tema liikmetel peaksid olema teadmised veevarustussüsteemi kohta valglast kuni tarbijani, et oleks tagatud kõigi ohtude ja juhtuda võivate sündmuste ülevaatlik analüüs. Liikmetena on hõlmatud nii tehniline personal kui ka juhtkond.

Tippjuhtkonna täielik toetus on nii veeohutuskava väljatöötamisel ja hilisemal igapäevasel praktilises rakendamisel äärmiselt oluline. Selle töö suunamiseks tuleb meeskonnale määrata juht.

Vajadusel võib spetsiifiliste probleemide korral kasutada välisekspertide abi.

<u>Tsüanotoksiinidele spetsialiseerunud meeskonnas peaksid olema esindatud järgmised erialad:</u>

- fütoplanktoni ökoloogia, et aru saada õitsengute tekkimise seaduspärasustest ja eutrofeerumise põhjustest,
- toitainete dünaamika, et leida toitainete kontsentratsiooni ja juurdekandeadekvaatsed sihttasemed
- joogiveetöötlus, et leida tsüanotoksiinide eemaldamist tagavad parameetrid
- tõenäoliselt ka toksikoloogia, et hinnata terviseriske juhul, kui tsüanotoksiinide kõrgendatud sisaldust ei saa täielikult välistada.

See on oluline, kuna mitmed süsteemi hindamisega, tsüanotoksiinide spetsiifiliste esinemisriskidega ja joogivette sattumisega seotud asjaolud nõuavad küllaltki spetsiifilisi teadmisi. Käesolev nõustamissüsteem võib küll esile tuua kaasatavate ekspertide vajalikud oskused, kuid ei asenda eksperte endid.

→ Dokumenteerige oma veeohutuskava ekspertmeeskonna koosseis, püüdes ühtlasi kirja panna, millistes riskide ja süsteemi hindamise osas nad on hõlmatud, nagu näiteks selle nõustamissüsteemi avalehel <u>töölehel</u> on tehtud.

→ Järgmiseks: Aste 2.2 - veevarustussüsteemi/ supluskoha kirjeldamine

2.2 Describe the water supply / recreational system - Kirjeldatakse veevarustussüsteemi ja supluskohti

Põhjalik süsteemist arusaamine – valglast kuni ekspositsioonikohani – on ohtude analüüsi ja riskide hindamie põhialuseks. Piltlikuks ettekujutamiseks võib väga palju kasu olla voodiagrammist. Tsüanotoksiinide erijuhul sisaldab see järgmist:

→ **<u>Märkus</u>: Sageli pole kogu allpool olev teave kättesaadav. Järgides motot: "Oluline on alustada", märkige sellised lüngad töölehele, kuid esimeses lähenduses läbige ikkagi kogu ülejäänud nõustamissüsteem, et teada saada, millised teabelüngad on tehtavate otsuste seisukohast olulise tähtsusega.**

- valgla kirjeldus, näiteks selle skeem, jõgede kaart, jõgede toodud heited (kui sellised andmed on olemas), geograafiline ja hüdroloogiline iseloomustus, nagu pindala, langus, mullatüübid, maaparandussüsteemid.
- maakasutus, näiteks metsaalad, asulad, põllumaa.
- põllumajandusest pärineva toitainete juurdekande hinnang: ehkki keeruka modelleerimise abil võib juurdekannet suurepäraselt arvutada, võib visuaalne vaatlus olla esialgu väga efektiivne; veelgi enam, see on oluline ka modelleerimisel, et hinnata mudelis kasutatavate eelduste õigsust.
- kanalisatsioonist pärineva toitainete juurdevoolu hinnang: selle võib leida antud süsteemiga ühendatud elanike arvu ja heitvee töötlemisviisijärgi; Euroopa Liidu riikides peaks heitmete kogus ja kontsentratsioon olema kättesaadav puhastusseadmete käitajatelt.
- Veehoidlate jaoks: morfomeetrilised andmed, viibeaeg, termaalsegunemisrežiim, joogiveevõtukohad ja -sügavused
- Jõgede jaoks: vooluhulk ja heitmete kontsentratsioon; joogiveevõukoha asukoht
- Veekogu jaoks: veekvaliteedi andmed, eriti toitainete kontsentratsiooni, Secchi sügavuse ja fütoplanktoni populatsiooni osas; võimaluse korral ka toitumisahela kõrgemate lülide kohta, kuna need võivad mõjutada fütoplanktoni populatsiooni struktuuri ja biomassi.
- Kui võimalik, siis andmed sinivetikate ja nende toksiinide esinemise kohta ning mistahes viited nendest tingitud inimeste või loomade terviserikete kohta
- Kasutamise korral joogiveeallikana: veetöötluse andmed: millised on käitlusahela elemendid (näiteks eeloksüdeerimine, flokuleerimine, sadestamine, filtreerimine, osoneerimine, filtreerimine granuleeritud aktiivsöega, aeglane liiva- või kaldafiltreerimine, desinfektsioon, …), toodetava vee kogus
- Kasutamise korral joogiveeallikana: jaotussüsteem: torustiku kaart, süsteemis leiduvad reservuaarid, kaasa arvatud nende seisukord ja viibeaeg (see võib olla seotud tsüanotoksiinide lagunemisega torustikus)

On kriitilise tähtsusega, et selline süsteemikirjeldus oleks perioodiliselt kontrollitud.

→ Dokumenteerige oma süsteemi kirjeldus, näiteks käesoleva nõustamissüsteemi avalehel oleva <u>töölehe</u> abil.

→ **Järgmine: Aste 2.3 – veekasutamise ja -kasutajate kirjeldus**

2.3 Describe water use and users - Kirjeldatakse veekasutust ja -kasutajaid

(siinkohal on arutelu keskendunud tsüanotoksiinidele)
Milline osa veest kasutatakse joogiks, niisutamiseks või muuks otstarbeks? Kas võib esineda kokkupuutumist aerosoolidega? Kas esineb tundlikke kasutajaid, nagu laste ujumiskursused, haiglad või dialüüsiosakonnad, keda tuleks tsüanotoksiinide suurenenud sisalduse puhul eraldi hoiatada?

- Haiglad ja dialüüsiosakonnad ,
- Individuaalne veevarustus pinnaveeallikast või pinnaveest tugevasti mõjutatud madalatest kaevudest;
- Pinnaveest pärinevaid aerosoole moodustav keskkond, näiteks niisutamine, ilupurskkaevud, mõnel puhul jahutusvesi (näiteks kaevanduspuuride puhul);
- Kasutamine suplusveena (ka ebaseaduslik , näiteks joogiveehoidlate puhul)

→ Dokumenteerige vee kasutusviiside ja kasutajate nimistud, näiteks käesoleva nõustamissüsteemi alguses oleva töölehe abil.

Tagasi: → **ALGUS**

Järgmiseks: → **Riskide hindamine ning süsteemi riskikontrollitõhususe hindamine**

3. Asses risk and system performance - Hinnatakse riske ja süsteemi toimimist

3.1 Assessing the risk of cyanobacterial proliferation and the system's performance in controlling this risk - toorvees ja suplusvees sinivetikate paljunemise seisukohast

Palun märgistage väljad, mida Te peate hinnatava veekogu puhul kõige kohasemaks. Seejärel sisestage sellise hinnangu põhjendused ja antud hinnangu määramatus.

Kas esines mistahes allpool loetletud tsüanotoksiinide esinemisele osutavaid märke?
Tabeli täitmise näidis
Hinnangu andmisel on soovitatav konsulteerida tervisekaitse, toksikoloogia ja limnoloogia, eriti fütoplanktoni asjatundjatega.

	E	M	S	?	Olukorra hinnang	Hinnangu määramatuse kirjeldus
Inimesed / loomad: Kas esineb tsüanotoksiinide esinemisele viitavat haigestumist? Viit taustinfole						

Kas on täheldatatud tsüanotoksiinide, eriti mikrotsüstiinide kontsentratsioone > 1 µg/L? Viit ülevaatele tsüanotoksiinidest						
Sinivetikate esinemise visuaalne kontroll: Kas esineb nähtavat õitsemist või hägustumist, kahtlasi oliivrohelisi või veinpunaseid õitsenguid? Ärge ajage segi *Lemna minor (väike lemmel)* esinemisega. Kas Secchi ketta lugem või hägusus viitab sinivetikate paljunemisele?						
Kas esineb sinivetikate sisaldust > 1 mm³/L mikroskoopiliselt määratava bioruumalana või > 1 µg/l klorofüll-a, mille esinemist suures osas põhjustavad sinivetikad Viidad määramisele: Microcystis spp., Planktothrix agardhii and P. rubescens, Aphanizomenon flos-aquae						

E = pole täheldatud, M = mõnikord, S = sageli, ? = teave puudub
Kas veekogu omaduste põhjal võib oodata sinivetikate esinemist??
Tabeli täitmise näidis

Hinnangu andmiseks on soovitatav konsulteerida limnoloogidega, eriti fütoplanktoni ökoloogia osas.
Märkus: siintoodud liigitus põhineb väga jämedale esialgsele hinnangule, ilma vastavate teadmisteta tehtud sissekanded on väga suure määramatusega.

		E	O	J	?	Teie poolt antud hinnang olukorrale	Hinnangu määramatuse kirjeldus
Veekogu üldine seisund	Kas veekogu on eutroofne, sügav ja stabiilse termaalse kihistumisega või madal, tavaliselt segunenud veega, mittehappeline, vee vahetumise aeg rohkem kui 1 kuu?						

Praegune olukord	Kas vee temperatuur on kõrge? Kas veekogu suviti kihistunud, kas praegu esineb püsiv kihistumine? Kas üldfosfori kontsentratsioon on üle 10-30 µg/l ? Kas Secchi kettaga mõõdetud läbipaistvus on väiksem kui 1 m ?						

N = ei,   O = osaliselt,   J = jah,   ? = teave puudub

Are Kas praegune ja tulevane toitainete juurdekanne on piisava kontrolli all, et rahuldada antud veekogu jaoks seatud sihttaset?

Hinnangu andmiseks on vaja konsulteerida limnoloogia või geoökoloogia, eriti veekogude toitainebilansi modelleerimise asjatundjatega. Vastasel juhul on sissekanded väga suure määramatusega.

	J	O	E	?	Teie poolt antud hinnang olukorrale	Hinnangu määramatuse kirjeldus
Kohapealse inspekteerimisega saadud hinnang					Näide: Tamm Y	
Toitainekoormuse modelleerimisega saadud hinnang					Näide: Veehoidla Z	

J = hästikontrollitav, O = osaliselt kontrollitav, E = ebapiisavalt kontrollitav, ? = teave puudub

Järgmine ➔ Hinnangu andmine

3.2 Assessing the risk of cyanotoxin intake and breakthrough in drinking-water abstraction and treatment - tsüanotoksiinide sissevõtu ja veetöötluses säilumise

So far, you have dealt with assessing the risk of cyanobacterial proliferation in the water-body. As a result, you have either identified a risk of occurrence that you wish to address with appropriate control measures, or you found that you could not exclude such a risk. Therefore, to protect public health from cyanotoxins in drinking-water, it is important to assess the efficacy of further barriers potentially in place through your offtake strategy or drinking-water treatment system.

If bank filtration / soil passage is in place, please assess its characteristics: example for filling in this table

For this assessment, including hydrogeological expertise in the team is recommended. For further information click here.

	Y	P	N	?	Your assessment of the situation	Uncertainty of your assessment
Substrate oxidised ?						
Travel time > 4 weeks						
Substrate fine-grained						
Temperatures > 10 ℃						
Accumulation of lysing cyanobacterial cells on the sediment likely to be low						
…..						

Y = yes, P = partially, N = no, ? = insufficient information

If the raw water source is a reservoir, where is the offtake located ?
example for filling in this table

For this assessment, including expertise in reservoir management is recommended.

	Y	P	N	?	Your assessment of the situation	Uncertainty of this assessment
Is offtake depth and/or site variable ?						
Are water layers used for offtake continuously monitored for indication of cyanobacterial cells (e.g. by on-line turbidity- or fluorescence recording)?						
Is variability of offtake sufficient to avoid layers with cyanobacteria?						
…..						

Y = yes, P = partially, N = no, ? = insufficient information

Which treatment steps are implemented at the treatment plant ?
example for filling in this table

For this assessment, including expertise in drinking-water treatment is recommended.

	Y	P	N	?	Your assessment of the situation	Uncertainty of this assessment
No pre-oxidation, or under control for lysis and liberation of dissolved toxin						
Flocculation						
Filtration						
Post-oxidation						
Dosing powdered activated carbon (PAC)						
Granular carbon filtration (GAC)						
…..						

Y = yes, P = partially , N = no , ? = insufficient information

On to ➔ ***Evaluation of your assessment of the risk of cyanotoxin intake and breakthrough***

Seite: 11
Pre-oxidation risks damaging cells, i.e. inducing lysis and toxin release without providing sufficient oxidation potential for toxin degradation. This may constitute a risk, which is why "no" should be entered here if pre-oxidation is being practiced.

3.3. Evaluation of your assessment of the risk of cyanobacterial proliferation and your system's performance in controlling it

You have assessed the risk of cyanobacterial proliferation in your water-body. To evaluate this assessment, please check which colours you marked most frequently in the questionnaire.

Note: The outcome of this assessment supports you in positioning the human health risk from cyanotoxins in relation to other health risks from exposure to the same water in a matrix for relative ranking of health risks. This is a basis for setting priorities in controlling these risks.

- **Option A**

  You almost only marked **green** fields: Your risk of cyanobacterial proliferation is low, and all you need to do is to make sure you can maintain this good situation.

  Therefore, the next important step is: to identify the control measures in your catchment which currently are decisive for this level of safety and should have priority for maintenance and operational monitoring. For these, you should develop a management plan which would particularly define the operational monitoring for parameters that indicate the potential for problems and thus provide an early warning for changes towards conditions conducive for cyanobacterial proliferation.

  → **Continue with documentation.**

- **Option B**

  You have frequently marked **orange** or **red** fields: Your risk of cyanobacterial proliferation is moderate to high.

  1. Immediate assessment of your raw water offtake strategy and/or drinking-water treatment system is important in order to assess the risk of intake of cells and breakthrough of cyanotoxins, i.e. how effective the barriers are that you have in place at these stages of your supply system.

  → **Continue with Part II of the Questionnaire: Assessment of the risk of cyanotoxin intake and breakthrough in treatment**

  2. If the water-body is used for recreation, particularly involving water contact sports, you have no further barriers (like drinking-water treatment), and your only line of defence is to keep people out of the water during blooms through adequate public information. You can link here to a template flyer for informing site users and a flyer for medical professionals. Temporary closure at sites may also be adequate, e.g. in the context of an early warning and emergency response plan.

  3. For long-term safety, it is advised to assess whether and how cyanobacterial proliferation could be controlled more effectively.

     See → Control measures in the catchment and è Control measures in the water-body for suggestions of options to look at; check if any of them might be implemented in your setting and should be included in your Water Safety Plan.

- **Option C**

You have frequently marked **grey** fields: the uncertainty of your assessment is high due to lack of information. The risk of cyanotoxin occurrence therefore cannot be safely excluded.

1. Immediate assessment of your raw water offtake strategy and/or drinking-water treatment system is important in order to assess the risk of intake of cells and breakthrough of cyanotoxins in case cyanobacterial proliferation does occur, i.e. how effective the barriers are that you have in place at these downstream stages of your supply system.

→ Continue with Part II of the Questionaire: Assessment of the risk of cyanotoxin intake and breakthrough in treatment

2. If the water-body is used for recreation, particularly involving water contact sports, you have no further barriers (like drinking-water treatment), and your only line of defence is to keep people out of the water during blooms through adequate public information. You can link here to a template flyer for informing site users and a flyer for medical professionals. Temporary closure at sites may also be adequate, e.g. in the context of an early warning and emergency response plan.
3. It is advised to assess whether decisions on implementing new control measures or upgrading ones can already be made on the basis of the information available, or whether this risks misguided investment, and the first priority should be to collect the missing information.
4. For long-term safety, it is advised to assess whether and how cyanobacterial proliferation could be controlled.
   See è Control measures in the catchment and è Control measures in the water-body for suggestions of options to look at and see if any of them might be implemented in your setting and should be included in your your Water Safety Plan.

On to → Questionnaire: Assessment of the risk of cyanotoxin intake and breakthrough

Back to → Assessing risks and the system's performance in controlling them

3.2 Evaluation of your assessment of the risk of cyanotoxin intake and breakthrough and your system's performance in controlling it

In assessing the risk of cyanobacterial proliferation your result was that this occurs or cannot be safely excluded. Subsequently you have assessed the performance of your further barriers – offtake strategy and treatment. Again, to evaluate this assessment, please check which colours you marked most frequently in the questionnaire.

Note: The outcome of this assessment supports you in positioning the human health risk from cyanotoxins in relation to other health risks from exposure to the same water in a matrix for relative ranking of health risks. This is a basis for setting priorities in controlling these risks.

- **Option A:**

  You have always marked **green** fields: Your risk of cyanobacterial intake and/or cyanotoxin breakthrough is low, and you aim to maintain this good situation.

  Therefore, the next important step is to identify the **control measures** in your system which currently are decisive for this level of safety and should have priority for **maintenance and operational monitoring**. For these, you should develop a management plan as key element of your Water Safety Plan which would particularly define the operational monitoring system to indicate the potential of break-through and thus provide an early warning.

  ➔ Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.

- **Option B:**

  You have frequently marked **orange** or **red** fields. Your risk of cyanobacteria being drawn into the offtake and/or cyanotoxin breakthrough is high:

  1. Immediate action to establish early warning for cyanobacterial bloom situations is adequate. This should trigger the provision of water from an alternative supply while blooms last. Continue with early warning and contingency planning.
  2. Rapid improvement of your offtake strategy (if possible) and/or your treatment chain is important for protecting public health from cyanotoxins in drinking-water.

  Your Water Safety Plan will include a management plan for **operational monitoring** of those **control measures** already in place in your system. It will have a strong focus on **upgrading the control measures** that your assessment identified as necessary but currently insufficient, and/or for **implementing new ones** (i.e. investments).

  ➔ Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.

- **Option C:**

  You have frequently marked **grey** fields. Your assessment is uncertain due to lack of information, and a risk of cyanobacterial intake and cyanotoxin break-through cannot be safely excluded.

  1. Until the information gaps are closed and longer-term solutions are established, consider establishing early warning for cyanobacterial bloom situations which would trigger the provision of water from an alternative supply while blooms last. Continue with early warning and contingency planning.

2. Assess whether decisions on implementing new control measures or upgrading ones can already be made on the basis of the information available, or whether this risks misguided investment, and the first priority should be to collect the missing information.
3. Improvement of your offtake strategy (if possible) and/or your treatment chain may nonetheless be immediately adequate for protecting public health from cyanotoxins in drinking-water.

Your Water Safety Plan will include a management plan for **operational monitoring** of those **control measures** already in place in your system. It will have a strong focus on **closing information gaps** as basis for making investiment decisions.

➔ Continue with control measures for drinking-water offtake and/or control measures for drinking-water treatment.

On to ➔ documentation of your system and risk assessment

Back to ➔ Assessing risks and the system's performance in controlling them, part II

4. Define control measures - Määratletakse meetmed

4.1 Control Measures in the Catchment and their operational Monitoring - valgla majandamisel

Siia hulka kuuluvad planeerimine, füüsilised rajatised heitmetest ja erosioonist tingitud juurdekande vähendamiseks, ning meetmed nagu inimtegevuse piiramine valgla tundlikes osades.

Selliste meetmete **järelevalve ja seire** on oluline nende kohasuse ja efektiivsuse tagamise seisukohalt. See ei tähenda mitte tsüanotoksiinide seiret, vaid kontrollimist, et meetmed toimiksid nii nagu plaanitud, s.t. **tegevuse seiret** kui ka **järelevalvet** plaanide, projektide ja rajatiste hooldusnõuete täitmise osas.

Veeohutuskava väljatöötamisel hindab töörühm juba olemaolevaid meetmeid. Kui leitakse, et nendest ei piisa, pakutakse välja täiendused või uued lahendused. Allpool toodud näited pole kõikehõlmavad, vaid lihtsalt demonstreerivad võimalikke meetmeid ja nende seiret, mis võiskid olla aluseks Teie oludele sobivate abinõude väljatöötamiseks. See nõuab kogemusi valgla majandamise, eriti toiteainete juurdekande hindamise ja vähendamisviiside osas (saavuatatvate eesmärkide püstitamiseks vaadake lehekülje allosas tsüanotoksiinide paljunemise riski hindamist).

Iga meetme jaoks peaks veeohutuskavas olema dokumenteeritud sellise valiku põhjused ja saavutatavad eesmärgid, aga ka püstitatud sihtide piisavuse valideerimimeetodid. Lisaks sellele tuleks välja töötada majanduskava, milles on kirjeldatud, kuidas meetmete tõhusust jälgitakse, ja kuidas tuleks toimida ebaefektiivse talitluse või intsidentide korral.

Huvipoolte kaasamine: Valgla majandamisega on tavaliselt seotud mitu huvipoolt. Kava rakendamine on tõenäolisem, kui kontrollimeetmed antud süsteemi jaoks töötatakse välja ja määratletakse nende rühmade koostöös.

Märkus: tegemist pole kõikehõlmava näidete kataloogiga, vaid eesmärgiks on lihtsalt tõuke andmine Teie oludele kohaste spetsiifiliste meetmete väljatöötamiseks!

Tegevus	Valgla majandamismeetmete näiteid	Operatiivseire, järelevalve ja tõendamine
Planeerimine	Töötage välja maakasutuskava, mis minimeerib toitainete juurdekande erosiooni, nõrgumise ja lisajõgede kaudu, sõltuvalt valgala tundlikkusest, näit. nõudes teatud alade metsastamist ja/või piki kallast põõsastikuga kaetud puhverribade loomist.	Jälgige tundlike alade/puhverribade kasutamist ja tagage piirangute toimimine (inspekteerimine kohapeal); valideerige perioodiliselt kas rakendatud abinõudest piisab toitainete juurdekande osas seatud eesmärkide saavutamiseks.
	Töötage välja veevarustuskava, milles on optimaalselt tasakaalustatud huvirühmade ja veekaitse eesmärgid, tagades piisavalt suure minimaalse tarbimise sinivetikatele soodsate paljunemistingimuste vältimiseks. Eesmärgiks peaks olema 1..2% vee uuenemine päevas (vt. Padisak et al.)	Vaadake üle kavad ja loataotlused valgla ja veekogu tundlikkuse aspektist, valideerige majanduskavasid perioodiliselt.
	Nõudke põllumajandustegevuseks ja veekogusse heitvee juhtimiseks luba, mille juurde kuulub vastav majanduskava (näit. toitainete eemaldamine heitvee töötlemisel, maksimaalne loomade tihedus karjatamisel, põldude väetamiskavad jne.)	
	Nõudke luba fekaalvee ja suuri toitainekoguseid sisaldavate tööstusheitmete veekogusse juhtimiseks.	
	Looge tundlikele valglatele piiratud inimtegevusega veekaitsealad.	Jälgige nõuetest kinnpidamist
	… ?	… ?
Projekteerimine, ehitamine ja hooldus	Ehitage loomade eemalhoidmiseks tarad ümber veehoidlate ja tundlike lisajõgede.	Kontrollige tarade terviklikkust.

	Projekteerige heitveetöötlus fosforikoormuse osas seatud eesmärkidele vastavaks	Kontrollige heit- ja sadeveesüsteeme; vaadake üle plaanid ja taotlused olemasolevate seadmete täiendamiseks ja uute ehitamiseks.
	Projekteerige pinneveekogumissüsteem, et sademete esinemisel vältida äkilist toitainete juurdekannet	
	Projekteerige ja ehitage heit- ja pinnavee jaoks kollektorid, et minimeerida heitmete sattumist veehoidlat varustavatesse jõgedesse.	Kontrollige kollektorite terviklikkust.
	… ?	… ?
Käitamine	Põllumajandustegevuse, näiteks väetiste ja sõnniku laotamise ning karja tiheduse piiramine tundlikel valglatel.	Kontrollige väetiste kasutamise ja sõnnikulaotamise registrit, lugege üle loomad karjas.
	Nõudke farmi toitainete piiramise kava olemasolu ja rakendamist, nii et oleksid kehtestatud spetsiifilised piirangud väetise ja sõnniku hulga ja laotamisaja osas.	Auditeerige toitainete piiramise kava; kontrollige registrit ajastuse ja hulkade osas; jälgige toitainete jääkhulka pinnases.
	Kasutage võimalikult vähest mullaerosiooni tekitavaid maaviljelusmeetodeid.	Visuaalne jälgimine maaharimise ajal või pärast seda
	Kasvatage erosiooni vähendamiseks talivilju	Visuaalne põllu jälgmine
	Tagae, et heitveetöötlus toimiks loas kirjeldatud tõhususega.	Kontrollige heitveetöötleja seireandmeid, korraldage seadmest väljuva heitvee toitainetesisalduse sõltumatu uuring.
	… ?	… ?

→ Eelmine: Hinnagu andmine

→ Järgmine: Dokumentatsioon ja Majanduskavad

4.2 Control Measures in the Water-Body and their Operational Monitoring - veekogu majandamisel

Väheste eranditega on sinivetikate paljunemine kõige paremini kontrollitav valglas rakendatavate meetmetega. "Sisemised" meetmed, mis on veekogu enda majandamisele suunatud, on tavaliselt vähetulemuslikud, kuni toitainete juurdekanne valglast pole oluliselt vähenenud, nii et pikemas perspektiivis nende kontsentratsioon vees osutub suure sinivetikate biomassi ülelpidamiseks liiga väikeseks. Siiski võib veekogus uue tasakaalu saavutamine ja sinivetikaõitsengute kadumine võtta aastaid, s.o. ajani, mil setetes ladestunud fosfor on madala juurdekande tõttu süsteemist välja uhutud, ja/või kuni kõrkjavöönd ja muu taimestik on suurema osa fosfori sidumiseks piisavalt taastunud. Sellises olukorras võivad sisemised meetmed uue tasakaaluseisundini jõudmist kiirendada.

Ka ei õnnestu teatud oludes väliskoormust sinivetikate kontrollimiseks piisavalt vähendada. Bioloogilised meetmed, nagu kalade arvukuse ja setetest pärineva toitekoormuse mõjutamine, POLE sellistel puhkudel olnud efektiivsed, samas kui füüsikaliste tegurite, nagu valgustatuse või vertikaalse segunemise muutmine teiste konkureerivate fütoplanktoniliikide edendamiseks on olnud edukas, kuna see toimib toitainete kättesaadavusest sõltumatult.

Kui hakkate välja töötama veeohutuskava, siis sellega tegelev meeskond hindab veekogus valitsevaid tingimusi ja võib valida kontrollimeetmeid ka allpool pakutute hulgast. Pange tähele, et sinivetikate mõjutamine veekogus rakendatavate meetmetega on eriti keerukas ja nõuab suuri teadmisi limnoloogias, eriti planktoni ökoloogias. Isegi kui sellised teadmised on olemas, on prognooside määramatus suurem kui valgla, joogiveevõtukoha või veetöötlussüsteemi puhul rakendatavate meetmete korral. Kus iganes võimalik, tuleks eelistada valglast toitainete juurdekande mõjutamist. Pärast antud veekogu jaoks ettenähtud juurdekande saavutamist võib veekogule piisava aja andmine uue tasakaalu saavutamiseks osutuda sobivamaks kui (sageli kulukate) sisemiste meetmete rakendamine.

Kui kaalutakse veekogu majandamise meetmeid, siis võib tsüanotoksiinide esinemise riski hindamise leheküljе keskosast leida mõningad nõuded, mida meetmed peaksid rahuldama. Iga kontrollimeetme puhuks peaks veemajanduskavas olema dokumenteeritud sellise meetme valimise põhjendused ja saavutatav eesmärk, aga ka eesmärkide saavutamise meetodite asjakohasuse valideerimine. Lisaks tuleks välja töötada majanduskava, mis määratleb kontrollimeetmete operatiivseire meetodid, ja kuidas tuleks toimida ebaefektiivse talitluse või intsidentide korral.

Selliste meetmete asjakohasuse ja tõhususe tagamiseks on oluline nende **seire ja järelevalve**. See ei puuduta niivõrd sinivetikate seiret, vaid pigem meetmete kavakohase toimimise kontrolli, s.o. **operatiivseiret** ja ka kavade, projektide ja rajatiste hooldusnõuete täitmise **järelevalvet.**

Huvipoolte kaasamine: Veekogu majandamisega on tavaliselt seotud mitu huvipoolt, kelle hulgas esineb sageli huvide konflikte, eriti kalurite hulgas. Kava rakendamine on tõenäolisem, kui kontrollimeetmed antud süsteemi jaoks töötatakse välja ja määratletakse nende rühmade koostöös.

Märkus: tegemist pole kõikehõlmava näidete kataloogiga, vaid eesmärgiks on lihtsalt tõuke andmine Teie oludele kohaste spetsiifiliste meetmete väljatöötamiseks!

Tegevusfaas	Veekou majandamise kontrollmeetmete näited	Operatiivseire, järelevalve ja tõendamine
Planeerimine ja projekteerimine	Töötage välja veekasutuskavad, mis tasakaalustavad optimaalselt huvipoolte ja veekaitse vajadused, tagades piisavalt suure minimaalse veetarbimise, et välistada sinivetikate kasvuks soodsate tingimuste teket – eesmärgiks on minimaalselt 1..2% vee uuenemine päevas (vt. Padisak et al.).	Jälgige veevõttu ja kasutatavaid koguseid, tagage piirangute rakendamine (inspekteerimine kohapeal).

	Kavandage ja projekteerige meetmed valgustatuse mõjutamiseks, saavutamaks sinivetikate elutegevuseks vähemsoodsaid ja nende vähemmürgiste konkurentide jaoks soodsamaid tingimusi.	Vaadake üle loataotlused antud veekogu omaduste aspektist. Valideerige meetmete kavandamise õigsus ja eesmärgipärasus.
	Kavandage ja projekteerige meetmed vee segunemisintensiivsuse mõjutamiseks, et alla suruda ujuvust muutvaid sinivetikaid (vt. Visser et al. 1997 and 1999 edukate meetmete kirjeldusega)	
	Kavandage ja projekteerige meetmed setetes ladestunud fosforit tingitud toitekoormuse mõjutamiseks, seades eesmärgiks veekogudes esineva fosfori üldsisalduse vähendamise alla 10-25 µg/l, näit. setete katmisega või oksüdeerimisega.	
	Planeerige ja rakendage bioloogilised meetmed, nagu makrofüütide ja kõrkjavööndi arengu soodustamine või kalade kasvatamine.	
	… ?	… ?
Käitamine	Tehislik segamine, mis on kavandatud ülalpool toodud kolme eesmärgi saavutamiseks, s.o. valgustatuse mõjutamiseks, muutuva ujuvusega liikide allasurumiseks või setete oksüdeerimiseks.	Mistahes toimiv seiresüsteem, mis kontrollib aeraatorite plaanipärast tööd, näit. visuaalne inspekteerimine, pumpade tööregister.
	Bioloogilised meetmed, nagu kõrkjate istutamine või kalade kasvatamine (toiduahela mõjutamine ”)	Perioodiline visuaalne inspekteerimine või kõrkjakasvu kaardistamine ja/või kalapopulatsioonide suuruse määramine.
	… ?	… ?

→ Eelmine: Hinnagu andmine

→ Järgmine: Dokumentatsioon ja majanduskavad

Kõrkjate ja teiste makrofüütide kasvatamine on sageli olnud edutud, väga eutroofsetes veekogudes toimub väljasuremine, kuna vetikaõitsengud muudavad vee liiga häguseks ja/või setete läheduses liiga anoksiliseks. Sellised meetmed on kõige mõjusamad mesotroofsetes veekogudes, kus taimed suudavad siduda suure osa saadaolevast üldfosforist ja seega efetkiivselt panustada sinivetikatele kättesaadava osa vähendamisse.

Toiduahela mõjutamine planktonitoiduliste kalade sissetoomisega nõuab kalandusbioloogia-alast pädevust, hoolikat planeerimist ja seiret. Mingil juhul pole tegemist *a priori* odava meetmega, kuna seire nõuab intensiivset tööd. Ei saa määratleda üldisi eesmärke, pigem on vaja igal juhul eraldi testida, millisel määral on võimalik sinivetikapopulatsioone mõjutada. Sageli ei ole nad zooplanktoni kaudu mõjutamisele kuigi vastuvõtlikud. Ka toiduahela mõjutamine on kõige edukam olnud mesotroofsetes veekogudes..

4.3 Define control measures in drinking-water offtake -Kontrollimeetmed joogiveevõtukoha osas ja nende jälgimine

Meetmete määratlemine algab kasutatavast veevõtusüsteemist (kas pinnavett võetakse otse, kasutatakse filtreerimist läbi jõekallaste või tehislike põhjavee taastussüsteemide kaudu). See hõlmab ka veevõtukohtade füüsiliste rajatiste (näiteks kaldafiltreerimiskaevude või veehoidlate veevõtutornide) asjakohast planeerimist ja projekteerimist, ning käitlemisprotsessi kontrolli, näiteks pumbatava vee piirkoguse järgimist, et välistada sinivetikarakkude või -toksiinide joogivette sattumist.

Selliste kontrollmeetmete **seire ja järelevalve** on olulise tähtsusega nende asjakohasuse ja tühususe tagamisel. See ei tähenda eelkõige tsüanotoksiinide sisalduse seiret, vaid pigem rakendatud meetmete tõhususe kontrollimist, s.o. **operatiivseiret** ja **järelevalvet** plaanide, projektide ja rajatiste hooldusnõuete täitmise osas.

Veeohutuskava väljatöötamisel hindab seda tegev meeskond juba olemasolevaid meetmeid. Kui need leitakse olevat ebapiisavad, tehakse ettepanekud nende täistamiseks või uute meetmete väljatöötamiseks. Allpool toodud näidete loend pole kõikehõlmav, vaid on toodud lihtsalt meetmete ja nende jälgimistoimingute olemuse näitamiseks, et anda tõuge Teie konkreetsele olukorrale vastavate meetmete väljatöötamiseks. Selleks on vajalikud teadmised hüdroloogia, infiltratsiooni kasutamisel ka hüdrogeoloogia valdkonnas.

Iga valitud meetme puhul peaks veeohutuskavas olema dokumenteeritud sellise valiku põhjendused ja seatud eesmärgid, aga ka seatud eesmärkide asjakohasuse valideerimine. Lisaks sellele tuleks välja töötada majanduskava, mis määratleb, kuidas meetmete tõhusust jälgitakse, ja milliseid korrigeerivaid meetmeid rakendatakse ebapiisava talitluse või intsidentide puhul.

Märkus: tegemist pole kõikehõlmava näidete kataloogiga, vaid eesmärgiks on lihtsalt tõuke andmine Teie olukorrale kohaste spetsiifiliste meetmete väljatöötamiseks!

Tegevus	Veevõtukoha majandamismeetmete näiteid	Operatiivseire, järelevalve ja tõendamine
Planeerimine	Infiltratsiooni puhul nõudke süsteemi hindamisel põhinevaid lube kaevude puurimiseks ja tehislike põhjavee taastussüsteemide rajamisel, et vähendada tsüanotoksiinide joogivette sattumise tõenäosust.	Vaadake üle plaanid ja loataotlused tsüanotoksiinide esinemise ja hüdro(geo)loogiliste tingimuste aspektist, võimaluse korral arvesse võttes ka järgnevat veekäitlust.
	Infiltratsiooni korral optimeerige tootmikaevude asukoht, et tagada piisavalt pikk teekonna minimaalne kestus tsüanotoksiinide eemaldamiseks.	Vaadake üle plaanid ja loataotlused hüdrogeoloogilise informatsiooni aspektist.

	Pinnavee võtmise koht planeerige ujukõntsa kogunemist arvestades, näit. piisavalt kaugele kahtlastest abajatest ja piisavalt sügavamale ujukõntsast ja piisavalt ülespoole sügavates kihtides (metalimnionis) akumuleeruda võivatest vetikatest.	Vaadake üle veevõtukoha kohta käivad teated ujukõntsa kogunemise kohta.
	… ?	… ?
Projekteerimine, ehitamine ja hooldus	Tagage, et kaevud oleksid ehitatud parimate tavade järgi, vältige filtrist möödavoolamist eelistatud vooluradade kasutamisega	Tagage, et kaevud oleksid ehitatud oskustööliste poolt, viige läbi katsepumpamine maksimaalsel koormusel, TV-inspekteerimine ja puuraugu geofüüsikaline uuring.
	Tagage, et infiltratsiooni korral järgitakse minimaalset peetumisaega.	Valideerige märgistusainete abil
	Muutke kaevu asukohta / filtrimissügavust, kui materjal on oodatust jämedam.	Enne kaevu täitmist analüüsige filtrimaterjali osakeste suurust ja selle vastavust eeldustele
	Pinnavee vahetuks kasutamiseks ehitage veevõtt sügavuse muutmise võimalusega tsüanobakterite kogunemist kajastava asjakohase indikaatori (näit. hägususe või fluorestsentsi) põhjal.	Jälgige sügavust muutva süsteemi terviklikkust ja talitlust, valideerige sügavuse muutmise skeemi sobivus.
	… ?	… ?
Käitamine	Tehistoite korral vältige anoksilisi/ anaeroobseid tingimusi settinud kihi regulaarse eemaldamisega.	Jlgige DOC taset pinnavees ja hapnikusisaldust kaldafiltraadis; valideerige settekihi eemaldamise toimingute sobivus anoksiliste tingimuste vältimiseks
	Pärast settinud kihi tehistoitega hoidlates: After clogging layer removal in artificial recharge basins: järgige nõutud viibeaegu pumpamiskiiruse vähendamisega.	Jälgige pumpamiskiirust regulaarselt, aeg-ajalt valideerige, et see oleks sobiv vältimaks tsüanotoksiinide sattumist joogivette; järelevalveks uurige settekihi eemaldamise registrist kasutatud põhjaveekihtide ja pumpamiskiiruste andmeid.
	Muudetavalt sügavuselt veevõtu puhul valige sügavus vastusena sinivetikate akumuleerumisele osutavale parameetrile.	Jälgige veevõtukohas sinivetikate akumulatsiooni indikaatoriks valitud parameetreid; järelevalveks uurige seireregistrit ja tulemuste põhjal tehtud sügavuste muutusi.
	… ?	… ?

- Eelmine: Hinnangu andmine
- Järgmine: Dokumentatsioon and Majanduskavad

4.4 Control Measures in Drinking-water Treatment and their Operational Monitoring - joogivee töötlemisel

Nende meetmete määratlemine hõlmab kasutatavate töötlemismeetodite osas tehtavad investeerimisotsuseid (näit. kas vetikate ja sinivetikate flokuleerumise ja sadestamise parendamiseks kasutada eeloksüdeerimist, või paigaldada osoneerimissüsteem ja aktiivsöefilter), töötlusahela elementide asjakohast projekteerimist ja konstruktsiooni, ning tööprotsessi jälgimismeetmeid, et tagada töötlusahela tavakohane funktsioneerimine igal ajal – isegi juhul, kui esineb sinivetikate ulatuslikke õitsenguid.

Selliste meetmete asjakohasuse ja tõhususe tagamiseks on oluline nende **seire ja järelevalve**. See ei puuduta niivõrd sinivetikate seiret, vaid pigem meetmete kavakohase toimimise kontrolli, s.o. **operatiivseiret** ja ka kavade, projektide ja rajatiste hooldusnõuete täitmise **järelevalvet.**

Veeohutuskava väljatöötamisel hindab töörühm juba olemaolevaid meetmeid. Kui leitakse, et nendest ei piisa, pakutakse välja täiendused või uued lahendused. Allpool toodud näited pole kõikehõlmavad, vaid lihtsalt demonstreerivad võimalikke meetmeid ja nende seiret, mis võiskid olla aluseks Teie oludele sobivate abinõude väljatöötamiseks. See nõuab kogemusi joogivee töötlemise alal, ning eriti vetikate ja sinivetikate eemaldamise probleemidest arusaamist .

Iga meetme jaoks peaks veeohutuskavas olema dokumenteeritud sellise valiku põhjused ja saavutatavad eesmärgid, aga ka püstitatud sihtide piisavuse valideerimimeetodid. Lisaks sellele tuleks välja töötada majanduskava, milles on kirjeldatud, kuidas meetmete tõhusust jälgitakse, ja kuidas tuleks toimida ebaefektiivse talitluse või intsidentide korral.

Märkus: tegemist pole kõikehõlmava näidete kataloogiga, vaid eesmärgiks on lihtsalt tõuke andmine Teie oludele kohaste spetsiifiliste meetmete väljatöötamiseks!

Process Step	Veetöötluse kontrollimeetmete näited	Operatiivseire, järelevalve ja tõendamine
Planeerimine	Planeerige töötlemisetapid sõltuvalt sinivetikaõitsengute esinemisest, näit. vetikarakkude ja lahustunud toksiinide eemaldamiseks – vaadake allpool süsteemi hindamist tsüanotoksiinide eemaldamiseks oluliste töötlusetappide osas.	Vaadake üle tegevuskavad ja loataotlused, lähtudes veeallikas sinivetikate esinemise teabest.
	Planeerige olukorraspetsiifiline pulbrilise aktiivsöe doseerimiskava, mis on vastavuses kohapealsete oludega.	Vaadake üle kasutatava söe valik, õitsenguolukorraks ladustatavad kogused, kasutamist käivitavad tingimused.
	… ?	… ?
Projekteerimine, ehitamine ja hooldus	Projekteerige, ehitage ja hooldage filtreid nii, et vastupesu eemaldaks tõhusalt rakud ja nende jäänused.	Vaadake üle tegevuskavad, uurige rajatisi ja hooldustööde registreid.
	Projekteerige, ehitage ja hooldage oksüdantide doseerimissüsteem nii, et oleks võimalik doosi ja kontaktiaja reguleerimine vastavalt nõuetele.	
	… ?	… ?

Käitamine	Eeloksüdeerimise kasutamise korral tagage oksüdeerija piisav kogus vabanenud toksiini lagundamiseks, või tagage mürkide eemaldamiseks vajalikud tingimused järgmistel töötlusetappidel (vt. allpool).	Jälgige, et oksüdandi doseeritav kogus oleks suurem kui toksiini oksüdeerimiseks vajatav miinimumkogus (vt. valideerimine), või jälgige järgnevaid töötlusetappe, mis peaksid eemaldama lahustunud toksiinid (vt. allpool).
	Käitage filtreid nii, et tagate sinivetikarakkude eemaldamise.	Jälgige jooksvaid parameetreid, mis osutavad võimalikule läbimurdele, näit. hägusust või pigmendist tingitud fluorestsentsi.
	Käitage filtreid nii, et oleks välistatud rakkude lagunemine ja lahustuvate tsüanotoksiinide vabanemine, reguleerides tagasipesu sagedust vastavalt filtrile kogunenud materjali kogusele.	Jälgige, et filtril esinev rõhk oleks väiksem kui kindlaksmääratud lävi, mille ületamine võib kaasa tuua kõrgendatud läbimurderiski (vt. valideerimine)
	Kui toksiinide eemaldamiseks on ette nähtud järeloksüdeerimine, siis käitage teda vastavalt läbimurde välistamiseks püstitatud nõuetele.	Jälgige Monitor dosing of oxidant in relation to pre-determined dose and contact time needed to ascertain sufficient oxidation (see valideerimine)
	If granular activated carbon filtration (GAC) or PAC dosing is performed to remove dissolved toxin, operate it as specified to meet this target	Jälgige, et aktiivsöe kogus ja kontaktiaeg filtreerimisel oleks suurem kui lahustunud toksiini sidumiseks vajatav miinimumsuurus (vt. valideerimine).
	… ?	… ?

→ **Eelmine:** Hinnangu andmine

→ **Järgmine**: Dokumentatsioon and Majanduskavad

4.5 Document your choice of control measures - Majanduskavad võtmemeetmete rakendamiseks ja nende operatiivseire tulemuste dokumenteerimine

Cyanobacterial blooms are a hazard that typically has an event nature: In many water-bodies, low levels of toxic cyanobacteria prevail many weeks or months on end, while hazardously high concentrations may be fairly short-lived events caused by accumulations of cells as surface blooms and/or by cell lysis leading to high levels of dissolved toxin that may break through drinking-water treatment trains.

Where cyanobacteria are known to occur or even to occasionally reach high levels or develop blooms or where this possibility needs to be taken into account, immediate response to such events is important to avoid human exposure. Planning for such events is an important part of the overall strategy for managing health hazards associated with toxic cyanobacterial blooms.

Immediate response requires preparedness and plans for action. These need to include:

- **When and What:** Triggers (alert levels) that put the plan into action – usually with 2-3 alert levels, depending on the intensity and/or toxicity of blooms – and specific pre-defined responses to each alert level that prevent human exposure
- **Who:** Clear lines of responsibility and action:(who needs to do what and by when?)
- **After the incident:** Follow-up investigation

WHEN and WHAT?:

Tegevuste planeerimine sinivetikate ja/või tsüanotoksiinide teatud sisalduse esinemise puhuks nõuab spetsiifilist ja kohest reageerimist vallandavate tingimuste (häiretasemete) defineerimist. Sinivetikate ja/või tsüanotoksiinide puhul on kasulikuks osutunud 2..3 häiretaset sõltuvalt õitsengute intensiivsusest ja/või toksilisusest. WHO poolt pakutav lähenemisviis suplusvee jaoks on toodud raamatu "Toxic Cyanobacteria in Water" V peatükis (Chorus & Bartram 1999), joogivee jaoks VI peatükis (ibid):

- Suplemisest tingitud kokkupuute puhul on Tabelis 5.2 toodud kolm sihttaset ja reageerimisviis, mis ulatub teavitusmärkide paigaldamisest supelranda kuni veega kontaktisattumist võimaldavate tegevuste keelustamiseni.

- Joogiveeallikate puhul on Joonisel 6.3 toodud otsustusskeem, milles on valvsustase ja kaks häiretaset, mille puhul reageering ulatub iganädalasest seirest ja korrapärasest veevõtukohtade inspekteerimisest situatsiooniplaanide rakendamiseni.

Neid soovitusi on kasutatud riiklku poliitika ja/või soovituste väljatöötamiseks. Tavaliselt on neid regiooni eripärale vastavamiseks mõnevõrra kohandatud. (näiteid vt. Chorus (toimetaja., 2005: Olemasolevad eeskirjad tsüanotoksiinidest tingitud riskide hindamiseks, riskide ohjamiseks ja erinevate maade õigusaktid).

è Kasutage sealtoodud dokumendimalle ja näiteid toksiliste sinivetikatre esinemise häiretasemete ja reageerimiskava väljatöötamiseks! (näit. selles nõustamissüsteemis leiduval töölehel)

Dokumenteerige häiretasemed ja reageerimiskavad, ning ärge unustage neid korrapäraselt üle vaadata, näit. veeohutuskava perioodilise valideerimise käigus, ning eriti pärast erakorralist sündmust.

Järgmine: □ Varane hoiatamine, situatsiooniplaanid ja sündmusele reageerimine: KES?

Eelmine: □ Hinnangu andmine sinivetikate paljunemise (3.1) või ctsüanotoksiinide joogivette pääsemise (3.2) riskile.

Tagasi □ **ALGUSESSE**

WHO ?:

Viivitamatut tegutsemist nõudva häiretaseme ületamise puhuks on oluline välja töötada ja kiireks tegutsemiseks käepärast hoida selged vastutus- ja tegevusvaldkonnad. Mõelge sellele ja valmistage ette nimekirjad:

- Kes peab otsustama reageerimisviisi valiku (näit. supelranna ajutise sulgemise või joogiveevarustuse tagamise alternatiivsest allikast või isegi pudelivee või paakveokite kasutamise).
- Kellega tuleb veel konsulteerida, kui tegevuse alustamise kriteeriumid pole piisavalt selged?
- Keda on vaja teavitada?
- Milliste tundlike veekasutajatega tuleb ühendust võtta (näit. dialüüsiosakonnad, kaasa arvatud koduseadmete kasutajad, haiglad jne.)
- …?

Koostage kontaktisikute nimekiri koos telefoninumbritega ning kontrollige seda regulaarselt näiteks veeohutuskava perioodilise valideerimise käigus.

Järgmine: ➔ Varane hoiatamine, situatsiooniplaanid ja reageerimine hädaolukorras: Pärast sündmust

Eelmine: ➔ Hinnagu andmine sinivetikate paljunemisega (3.1) või ctsüanotoksiinide joogivette pääsemisega (3.2) seotud riskidele

➔ Tagasi algusesse

After the incident:

Hinnnang sündmusele: kas oli tegemist tavalise ulatusliku sinivetikate/ tsüanotoksiinide esinemisega, või oli selles midagi erilist?

Hinnang reageerimisele, s.o. kuidas õnnestus plaanide rakendamine?.Allpool on toodud vastamist vajavate küsimuste näited ja lähemat uurimist nõudvad asjaolud.

Joogiveeallika puhul:

- Kas lülitumine tagavaraallikale toimus õigeaegselt, kas selle veevaru kvaliteet ja hulk oli piisav?

- Kui tarvitamiseks jagati pudelivett, siis kui hästi jõudis see tarbijani?

· Kui hästi teavitati rakendatud meetmetest tarbijaid? Kui hästi see vastu võeti?

Supluskohtade puhul: Paljudel puhkudel on potentsiaalsete kasutajate teavitamine ja/või ajutine ranna sulgemine võrdlemisi sage abinõu. Seetõttu tuleks kasutajate käitumist jälgida mitte ainult üks kord, vaid ka mõõta, kas rakendatud abinõu "kulub" aja jooksul, või kestab kasutajate kuulekus suplushooaja lõpuni.

Eriti tundlike sihtrühmade puhul (näit. dialüüsipatsiendid): Kas nendega kommunikeerumine oli piisavalt efektiivne?

Terviseuuringud: Kui kokkupuude tõenäoliselt toimus, võimalik et koos kaasnevate sümptoomidega või isegi nende kahtlustusega, tuleks potentsiaalselt mõjutatud elanikkondsa uurida viivitamatult. Tuleks tugevdada lkohalikele tervishoiuteenuste osutajatele suunatud teavet.

Järeldused riskide ja süsteemi hindamise, aga ka kontrollimeetmete kohta: Kas sündmusest tulenev kogemus viib muutusteni sinivetikate paljunemisega ja/või tsüanotoksiinide läbimurdega seotud riskide hindamisel? Kas on vaja rakendada uusi kontrollimeetmeid, või piisab olemasolevate täiendamisest ja efektiivsemast juhtimisest?

Kokkuvõtlik järeldus situatsiooniplaneerimise ja sündmusele reageerimise osas: Kas kommunikatsiooniahelad toimisid adekvaatselt? Kas kogemustest tuleneb vajadus muuta plaane näiteks häiretasemete osas, näit. nende seire või nendele reageerimise osas. Kas on vaja muuta teavitamisnimekirju?

Järgmine: ➔ Valideerimine
Eelmine: ➔ Sinivetikate paljunemise (3.1) või tsüanotoksiinide joogivette pääsemise (3.2) riski hinnang
Tagasi ➔ **ALGUSESSE**

contingency plans and emergency response:

Sinivetikate õitsemine on tavaliselt sündmuselaadne oht. Paljudes veekogudes võib toksilisi sinivetikaid vähesel hulgal esineda nädalate või kuude kaupa. Ohtlikult suure kontsentratsiooni esinemine võib olla võrdlemisi lühiajaline sündmus, mille põhjustab rakkude kogunemine pinnaõitsenguna ja/või rakkude lagunemine, mis tekitab suurel hulgal lahustunud toksiini, mis võib läbida veetöötlusahela.

Kohtades, kus teadaolevalt esineb sinivetikaid või koguni nende arvukuse suur tõus või õitsemine, või juhul, kui selline asi võib kõne alla tulla, on inimeste tervisekahjude vältimiseks oluline reageerida sellistele sündmustele viivitamatult. Tegevuste planeerimine sellisteks puhkudeks on oluline osa toksilistest sinivetikaõitsengutest tingitud terviseriskide ohjamise strateegiast.

Kohene reageerimine nõuab ettevalmistust ja tegevuskavasid. Neis peab sisalduma:

- **Millal ja kuidas**: Triggers (häiretasemed) mis käivitavad kavandatud tegevuse – tavaliselt 2-3 häiretaset sõltuvalt õitsengute intensiivsusest ja/või toksilisusest. Iga häiretaseme puhul on eelnevalt määratletud spetsiifilised toimingud inimeste tervisekahjude vältimiseks.

- **Kes**: Selged vastutus- ja tegevusvaldkonnad: (kes teeb mida ja mis ajaks?)
- **Pärast juhtumit**: Järeluuring

Järgmine: ➔ Varane hoiatus, situatsiooniplaanid ja reageerimine hädaolukorras: MILLAL ja KUIDAS?

Eelmine: ➔ Hinnangu andmine sinivetikate paljunemisega (3.1) või tsüanotoksiinide joogivette sattumisega (3.2) seotud riskidele

➔ Tagasi algusesse

5. Validation - Valideerimine

Peaaegu alati, kui rakendatakse meetmeid sinivetikate esinemise või tsüanotoksiinide joogivette sattumise vähendamiseks, jääb õhku ka teatud kahtlus, kas meetmed on asjakohased ja saavutavad planeeritud eesmärgi. Valideerimine on perioodiline uurimistegevus kontrollimeetme tõhususe tuvastamiseks. Tavaliselt on see kõige intensiivsem süsteemi ülesehitamise ja taastamise ajal, olles väljaspool igapäevakasutust.

Valideerimine algab juba olemasoleva andmete ja informatsiooni hindamisega, näit. teaduskirjanduse, juhendmaterjalide, eeskirjade ja nende selgituste, ajalooliste andmete ja kogemuete põhjal. Valideerimiseks on kohased ka spetsiifilistes kohalikes oludes tehtavad uuringud, eriti kui pole kindel, et rakendatud meede antud situatsioonis piisavalt hästi töötab.

Allpool on toodud valglast kuni joogiveekäitluseni rakendatud meetmete näited. Need hõlmavad piiratud ja kindla suunitlusega spetsiifilisi katse- või seireprogramme. Neid tuleks vastavalt vajadusele perioodiliselt korrata, eriti just pärast süsteemi muutmist. Õitsengute ajal intensiivsete seireprogrammide läbiviimine on meetmete valideerimise seisukohalt eriti väärtuslik. Teisest küljest hõlmavad pärast õitsengut, puhastatud joogivees tokssinide leidmist või muud sarnast sündmust tehtavad järeluuringud tavaliselt ka terve süsteemi / veeohutuskava valideerimist.

Mõne valideerimisprogrammi puhul on vajalik kaasata täiendavaid spetsialiste, sellistel puhkudel võib tulla kasuks nende kaasamaine *veeohutuskava* meekonda.

Valideerimise tulemiks võib olla kontrollimeetme või seda seirava süsteemi muutmine, või siis kinnitus, et kaitse tsüanotoksiinide eest vastab (veel) nõuetele.

Valideerimisega seotud tegevus peaks olema dokumenteeritud ka veeohutuskavas, näiteks selle nõustamissüsteemi töölehel. Dokumentide põhjal saate järelevalveasutustele, vahejuhtumite korral ka ajakirjanikele ja üldsusele tõestada, et olete oma nõuetekohased kohustused täitnud.

Meede või meetod	Potentsiaalne valideerimismeetod
Sinivetikate esinemise indikaatorid – näide	
Hägusus või pigmendist tingitud fluorestsents sinivetikate	Valideerige rakkude loendamisega ja/või bioruumala leidmisega, et signaalid kajastavad sinivetikate esinemist kohalike olude jaoks piisavalt hästi. Asjakohased võivad olla erinavad valideerimisprotseduurid erinevate veevarustusahela lülide, näit. toorvees ja filtrite väljundi puhul.

kontsentratsiooni indikaatorina	
Valgla kontrollimeetmete valik ja tõhusus – näide	
Valgla majandamise meetmed	Valideerige rakendatud meetmete tõhusus spetsiifiliste toitekoormuse uurimisprogrammide läbiviimisega, näit. analüüsides lisajõgede vete analüüsimisega tavalistes, rikkalike sademete ja lumesulamise tingimustes või modelleerides fosforibilanssi.
Veekogu kontrollimeetmete valik ja tõhusus – näited	
Tehislik segamine ja/või bioloogilised meetmed veekogus sinivetikate kasvu vähendamiseks.	Kui visuaalsel inspekteerimisel tuvastatakse, et vaatamata segamisele tundub sinivetikate hulk suurenevat, võetakse proov ja määratakse selles rakkude kontsentratsioon ja/või bioruumala, näit. rakkude loendamisega.
Veekgu põhjasetetest vabaneva fosforihulga vähendamise meetmed	Põhjasetetest vabaneva fosforikoormuse leidmiseks jälgige fosforikontsentratsioonide muutumist ajast ja/või modelleerige fosforibilanss, et eristada sisemisi ja väliseid allikaid.
Veevõtukoha kontrollimeetmete valik ja tõhusus – näited	
Pinnases viibimise minimaalne aeg	Valideerige planeerimisel ja projekteerimisel tehtud eeldused, viies oodatavates ekstreemtingimustes läbi katsed märgistusainega.
Sinivetikate kaasasattumist miniveeriva veevõtusügavuse valik	Erinevate sinivetikate levikusituatsioonide jaoks määrake sinivetikate esinemise sõltuvus sügavusest, näit. rakkude loendamise või kohapeal tehtud flueorestsentsanalüüsiga. Võrrelge leide veevõtusügavuse valimise kavaga.
Kolmatsioonikihi eemaldamise ja sellele järgneva pumpamise eeskiri.	Kontrollige tehislikust põhjavee taastamise süsteemist pumbatava vee redokstingimusi ja tsüanotoksiinide kontsentratsiooni valitud ekstreemtingimuste korral.
Jooogivee töötlemise kontrollimeetmete valik ja tõhusus – näited	
Eeloksüdeerimine	Hinnake, milline on oksüdeerija miinimumkogus rakkude lagunemisel vabanenud toksiinide oksüdeerimiseks, isegi kui tegemist on õitsengute puhul tekkiva orgaanilise süsiniku kõrge kontsentratsiooniga. Näiteks viige õitsengust kogutud materjaliga ja vee töötlemisel kasutatava oksüdeerijaga läbi purgikatse ning määrake lahustunud sinivetikatoksiinide sisaldus. Veehoidlas esinevate ulatuslike õitsengute korral võib käivitada ka ajutise seireprogrammi lahustunud tsüanotoksiinide määramiseks. Selliste andmete tulemuseks võib olla protsess, kus oksüdeerijat doseeritakse sinivetikarakkude

	kontsentratsiooni kajastamiseks kõige kasulikumaks osutunud näitaja, näiteks pigmendist põhjustatud fluorestsentsi, toorvees leiduvate rakkude arvu või klorofüll-a sisalduse järgi. Kasutada võib isegi veehoidla visuaalset inspkteerimist. Selliseid indikaatoreid saab seejärel kasutada süsteemi töö seiramiseks.
Filtratsioon joogiveetöötluses	Tehke kindlaks, kas filtritele suure hulga rakkude kogunemisel ilmneb rakkude lagunemist ja tsüanotoksiinide pääsemist joogivette.
Oksüdeerija doseerimine lahustunud tsüanotoksiinide eemaldamiseks, pulbrilise aktiivsöe (PAC) doseerimine lahustunud tsüanotoksiinide sidumiseks	Hinnake, milline on miinimumkogus rakkude lagunemisel vabanenud toksiinide oksüdeerimiseks /sidumiseks, isegi kui tegemist on õitsengute puhul tekkiva orgaanilise süsiniku kõrge kontsentratsiooniga. Näiteks viige õitsengust kogutud materjaliga ja vee töötlemisel kasutatava oksüdeerijaga või aktiivsöega läbi purgikatse ning määrake lahustunud sinivetikatoksiinide sisaldus. Veehoidlas esinevate ulatuslike õitsengute korral võib käivitada ka ajutise seireprogrammi lahustunud tsüanotoksiinide määramiseks. Selliste andmete tulemuseks võib olla protsess, kus oksüdeerijat doseeritakse sinivetikarakkude kontsentratsiooni kajastamiseks kõige kasulikumaks osutunud näitaja, näiteks pigmendist põhjustatud fluorestsentsi, toorvees leiduvate rakkude arvu või klorofüll-a sisalduse järgi. Kasutada võib isegi veehoidla visuaalset inspkteerimist. Selliseid indikaatoreid saab seejärel kasutada süsteemi töö seiramiseks.

➔ Tagasi algusesse
➔ Järgmine: tõendamine

6. Verification - Verifitseerimine

Verifitseerimine täiendab üksikute kontrollimeetmete operatiivseiret. Verifitseerimise korral on võtmeroll tegelikul sinivetikate ja/või tsüanotoksiinide seirel. Tsüanotoksiinide sisalduse seire tarbijale minevas joogivees või sinivetikate biomassi seire suplusvees annab üldise kindluse, et kogu süsteem töötab nii nagu peab ning et inimesed pole tsüanotoksiinidest mõjutatud.

Kontseptuaalselt täiendab verifitseerimine ka valideerimist. Ka valideerimisel võib ette tulla tsüanotoksiinide või sinivetikate analüüse, kuid see toimub teisel eemärgil, mistõttu proovide võtmise käik on täiesti erinev:

- Verifitseerimisel tehakse tsüanotoksiinide analüüse lühiajaliste ja väga spetsiifiliste uurimisprogrammide käigus, näiteks et tõestada süsteemi toimimist ka massilise õitsemise korral esineva kõrge raku- või toksiinikontsentratsioonide korral. Proovivõtukava on suunatud toksiinide eemaldamise jälgimisele.
- Verifitseerimisel tehakse tsüanotoksiinide analüüse regulaarselt, peamiselt veest, millega inimesed kokku puutuvad.

Verifitseerimimisega võib tegeleda nii veevärgi või supelranna valdaja, kui ka sõltumatu seirega tegelev asutus. Praktikas esinevad sageli mõlemad juhud üheaegselt.

Verifitseerimiskava väljatöötamine kohalike olude jaoks vajab proovivõtmise sageduse ja kohtade sobivuse hindamist tsüanotoksiinidest tingitud terviseriskide seisukohalt. On oluline mõista, et intensiivsed verifitseerimisprogrammid ei kaitse inimesi kuigi efektiivselt, pigem saavutatakse see hästiplaneeritud ja -valideeritud kontrollimeetmetega, millega kaasneb efektiivne operatiivseire. Eriti kehtib see tsüanotoksiinide osas, kuna nende kontsentratsioonid võivad muutuda äärmiselt kiiresti, kui tuul õitsengu veekogus teise kohta kannab.

- Supelrandade puhul pidage silmas õitsengute sageduse, ulatuse ja kestuse seost nii ranna kasutamise ajaga (näit. kas on tegemist peamiselt nädalalõpukasutusega või pideva kasutusega laagrite puhul) kui ka inimeste arvukusega.
- Joogiveeallikate puhul pidage silmas sinivetikate esinemist toorvees ning vastavalt kohandage proovivõtukava. Tavalisest intensiivsema proovivõtu ja verifitseerimise käivitamiseks võib kasutada päästikuna kasutada näiteks toorvee hägusust.
- Mõlemal juhul hinnake, kas võimalike terviseriskide seisukohalt annab kõige rohkem spetsiifiliste tsüanotoksiinide või sinivetikate biomassi analüüs, või tuleks mõlemat teha koos. See sõltub domineerivatest liikidest ja neilt oodatavast toksiinidest.

Verifitseerimistegevus peaks olema dokumenteeritud ka *veeohutuskavas,* näit. selle nõustamissüsteemiga kaasasoleval töölehel. Dokumentide põhjal saate järelevalveasutustele, vahejuhtumite korral ka ajakirjanikele ja üldsusele tõestada, et olete oma nõuetekohased kohustused täitnud.

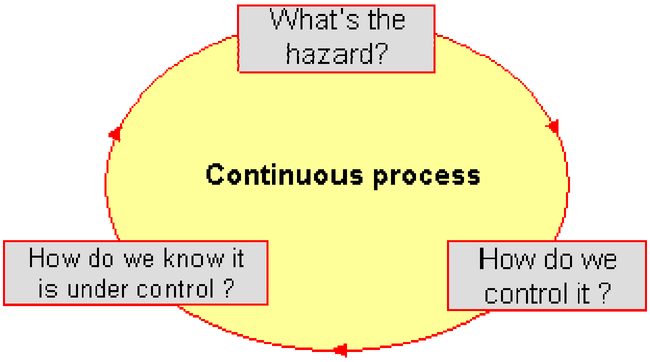
Järgmine ➔ ***Veeohutuskava* tsüanotoksiinide moodul**

7. Cyanotoxin building-block for your *Water Safety Plan* - Tsüanotoksiinide moodul veeohutuskava jaoks

With the steps of this decision support tool you have followed the conceptual logic for developing a *Water Safety Plan* (WSP) specifically for your setting, though only for one group of several potentially occurring hazards. Your tables and entries in your worksheet document the results of your risk assessment, your reasons for it, your judgement of the uncertainty of this assessment, your identification and validation of specific control measures and your scheme for verification that the system is working safely. This serves transparency of your decision criteria.

For completing your WSP, further hazards (e.g. Cryptosporidia and further faecal contaminants, industrial chemicals, pesticides, etc.) would be analysed and the risk they pose be assessed comprehensively in analogous manner, and control measures identified. Often they will address several hazards simultaneously. It is strongly recommended to perform such a more comprehensive assessment, as the outcome will set the health risk from toxic cyanobacteria into perspective against other health risks from hazards that may occur in your system, and this is valuable for making decisions on management priorities (see cyanotoxins in relation to risks from other hazards).

Continuous process



Your assessment of risks and control measures should be periodically reviewed and updated. Simplified, the **process** of developing a *Water Safety Plan* consists of the following elements:

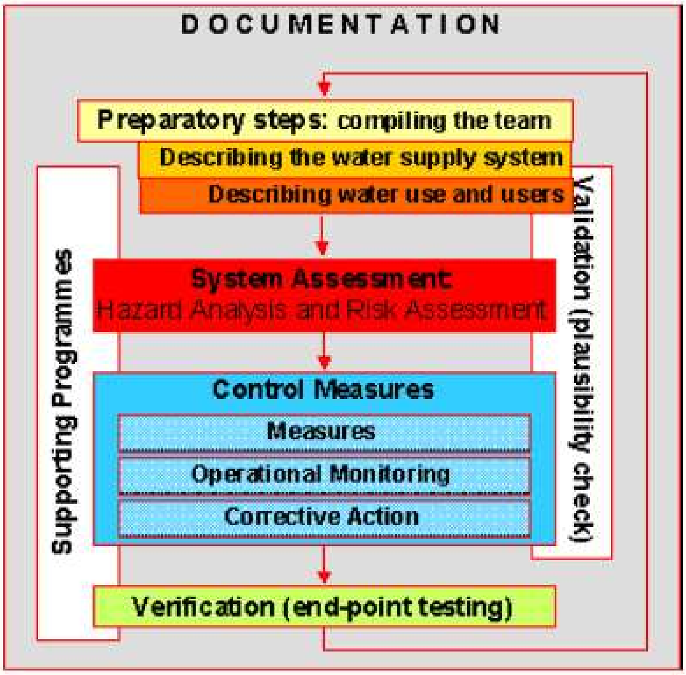
Your actual **Water Safety Plan Document** should include outcome of steps 2 – 6 of this decision support tool as outlined by your entries in the worksheet provided on the starting page. A particularly important aspect is to make your assessment transparent, by including the criteria you used and your estimates of the uncertainty of your assessments. Documentation in the context of a WSP should further include monitoring records that demonstrate process control, and results of water quality verification.

Thus, the completed worksheet, together with accompanying documents to which it refers, actually **constitutes** the cyanotoxin building block of your Water Safety Plan Document.

Comprehensive documentation is extremely valuable for securing information and experience, including for training staff. It is further a good basis for communication with authorities responsible for independent surveillance (e.g. health authorities), which can use this as basis for assessment of the safety of your system. Thus good documentation serves as protection against accusations of inadequate management. This can be strengthened by an external audit of your Water Safety Plan. Last but not least, your documentation is a useful basis for public communication about the control measures implemented in your water supply and the stringency of their monitoring.

Mis on *veeohutuskava*?

Maailma Terviseorganisatsiooni joogiveekvaliteedi juhendi 2004. aasta väljaanne järgib joogivee ohutuse tagamisel täiesti teistsugust skeemi. Rõhutatakse, et tarbijale minevas joogivee puhul ei piisa ohutuse tagamiseks keskendumisest standardite või sihtväärtuste järgimisele. Pigem tuleks ohutus saata valglast tarbijani viiva ahela range kontrolliga. Uue süstemaatilise lähenemise paradigma väljenduseks on veeohutuse raamakava, mille keskseks elemendiks on *veeohutuskava*. Need on spetsiaalselt välja töötatud iga üksiku veevärgi jaoks. Eesmärgiks on:



1. Võimalike ohutegurite identiftseerimine ja **analüüs,** nende poolt tekitatavate **terviseriskide hindamine,** aga ka neid riske vähendava **süsteemi tõhususe hindamine** valglas, veekogus, veevõtukohas, torustikus ja majapidamises asuvatel tõketel;

2. Olulise riskiga ohutegurite jaoks **kontrollimeetmete** määratlemine ja nende tõhususe jälgimine seda efektiivselt kajastava **seiresüsteemi** abil. See hõlmab ka seiretulemuste **kriitiliste piiride** ja nende ületamisele järgneva **korrigeeriva tegevuse** määratlemist;

3. nende sammude **dokumenteerimine** ja kindla ajavahemiku tagant kogu süsteemi **valideerimine,** s.o. tagamine, et riskihindamine on kestvalt adekvaatne, et süsteemi ehitus hõlmab kõigi asjassepuutuvate riskide kontrolli, ja et kogu süsteem toimib rahuldavalt.

Veeohutuskava kontseptsioon keskendab tähelepanu **riskihindamisele** ja **protsesside kontrollile.** Tegemist on kvaliteediohjamise operatiivsüsteemiga. Selline struktureeritud ja süstemaatiline lähenemine on tsüanotoksiinidega seotud riskide ohjamisel eriti kasulik.

WHO poolt pakutud veeohutuse raamkava põhineb nii rahvatervisele suunatud eesmärkide määratlemisele – mis tavaliselt on valitsuse ja ametiasutuste ülesanne – kui ka veekvaliteedi ja varustussüsteemide sõltumatule seirele. See hõlmab juba tuttava sihtväärtuste või standardite nõuete järgimise järelevalvet, selles on oma osa täita tsüanotoksiinide osas kehtestatud normidel. Lisaks saab neid kasutada süsteemi kvaliteedieesmärgi püstitamiseks. Uus WHO joogiveekvaliteedi juhend nimetab seda seireastet nüüd **"verifitseerimiseks"**, et välja tuua selle peaeesmärk: üldine kontroll, et süsteemi ülesehitus oleks ohutegurite tõkestamiseks adekvaatne, ja et protsessikontroll töötaks.

Valitud teaduskirjandust

Suur osa sinivetikaid käsitlevast kirjandusest on abiks kontrollimeetmete valikul ja valideerimisel esimese sammu tegemiseks.

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