

Explanatory guide and monitoring program

**Code of practice for the management of algal growth in water supply channels
of the Mareeba Dimbulah Water Supply Scheme and release of associated
treated water to receiving waters.**

**Prepared in accordance with Section 551 of the
*Environmental Protection Act 1994***

October 2020

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- Barron Catchment Care
- Cairns and Far North Environment Centre
- Department of Natural Resources, Mines and Energy and Department of Agriculture and Fisheries
- FNQ Growers
- Northern Gulf Resource Management Group
- Northern Irrigator Association
- North Queensland Land Council
- Mareeba Chamber of Commerce
- Mareeba Shire Council
- Mitchell River Watershed Management Group
- Tablelands Regional Council
- Terrain NRM
- Traditional Owner representative bodies
- World Wildlife Fund

Acknowledgement of the Traditional Owners of the Barron, Walsh and Mitchell river catchments

The Department of Environment and Science would like to acknowledge and pay respect to the past, present and future generations of Traditional Owners in the region and their Nations.

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1 Introduction

The Information Sheet, “Developing Codes of Practice” (ESR/2015/1695, Version 2.02, Department of Environment and Science) states, “*An explanatory guide must at least be submitted with the draft Code of Practice (Code) to inform the Minister’s decision on approval of the Code. The explanatory guide must:*

- *identify the source of content where appropriate*
- *justify the proposed measures, especially where they depart from usual practice*
- *demonstrate that the draft Code appropriately deals with the matters in section 5 that the Minister must consider when deciding whether to approve the Code.”*

This explanatory guide has been prepared to meet these requirements, as well as providing details on the monitoring program required under Performance Outcome 1.7 under the Code.

1.1 The activity

The activity is the management of algal growth in water supply channels of the Mareeba Dimbulah Water Supply Scheme (MDWSS) and release of associated treated water to receiving waters. Historically, Sunwater has treated algal growth with copper sulfate aquatic algicide.

As the licenced operator of the MDWSS, and other schemes, Sunwater is obligated to maintain efficient delivery of water to their customers, primarily, irrigators, industry and townships. Algal growth within distribution channels has a major negative impact on Sunwater’s ability to deliver water, particularly during peak irrigation season, which often coincides with conditions favourable to algal growth.

The primarily filamentous algae typically grow within the channel on beds and banks; structures within the channel (such as offtakes, gates or valves); aquatic plants growing within the channels; or fallen branches. If left untreated, algae can quickly grow to such an extent that channel structures and water flow become inefficient and water supply cannot be maintained at appropriate reliability. Blue-green algae are not a concern in these flowing channels. The algal species detected within the MDWSS are generally common and have historically not been associated with human toxicity or ecosystem health issues.

Sunwater manages algal growth in all of its water supply schemes but the potential for environmental harm, and the need for a Code, is only relevant to the MDWSS because the other schemes are ‘closed’. A closed system is one in which the treated water does not discharge to receiving waters and, if necessary, the water can be held until it is safe to use. However, the MDWSS is, in part, an ‘open’ system, meaning treated water can enter receiving waters either because:

- they are part of the water distribution system (i.e. supplemented streams); or
- as a result of engineering design features that allow overflow from the irrigation channels at specified points.

Supplementation is approved under the *Water Act 2000* and supplemented streams are named in the Resource Operations Licence for the MDWSS. Overflows occur when the amount of water released to a channel, or added via rainfall, exceeds the amount extracted from the channel by water users.

Algal management is not an environmentally relevant activity but if treated water which is a result of such management is released to receiving waters it could contravene section 440ZG of the *Environmental Protection Act 1994* (EP Act) which states that a person must

not unlawfully deposit a prescribed water contaminant in waters. Prescribed water contaminants are listed in schedule 10 of the *Environmental Protection Regulation 2019* and copper sulfate is considered a biocide.

As such, control measures to be included within the Code should:

- prevent or minimise the release of treated water
- ensure the concentration of contaminants is at a level that would not cause harm to the environmental values of receiving waters.

Sunwater is approved to use Copper Sulfate Aquatic Algaecide under the Australian Pesticides and Veterinary Medicines Authority (APVMA) Label Number 67673/105182 in:

- all Sunwater's 'closed' water distribution systems in Queensland
- the MDWSS, under specific conditions related to the dose rate and duration (being no greater than 0.2mg/L of copper sulfate and for no longer than 24 hours).

The conditions for the MDWSS are more stringent than for other schemes because of the risk of release to receiving waters, which only applies to that scheme. In other schemes, a concentration of copper may be applied at up to 2.0mg/L (equates to 8mg/L copper sulfate pentahydrate) and with no limit on the duration.

The label for the MDWSS also notes that treated water is suited for use on agricultural crops and that no withholding period is necessary when used in accordance with the label.

In approving the label, the APVMA undertook a risk assessment (APVMA, 2019), including a review of results of local trials conducted by Sunwater under an APVMA research permit for copper sulfate use. The trials were reported mainly in late 2015.

About copper sulfate and related contaminants

Copper sulfate is an algaecide used to treat toxic, odorous or otherwise problematic algal blooms in water reservoirs and other water supply storages or to reduce or remove algal blockages in pipes, drains or channels. The fact sheet 'Copper sulfate' in the Drinking Water Treatment Chemicals section of the current Australian Drinking Water Guidelines (ADWG: NHMRC, 2011) contains information on the use of copper sulfate for drinking water treatment.

The use of copper sulfate in some situations (i.e. treating drinking water storage outbreaks of cyanobacteria) could be hazardous, if the cyanobacterial toxins are also not treated or removed. Copper sulfate is a common component of swimming pool chemicals; is used to clean animal drinking troughs; remove roots from blocked sewer pipes; and is sometimes used as part of food supplements for horses and greyhounds. It is readily available for sale at retail outlets without restrictions. However, copper sulfate can be toxic to aquatic plants, invertebrates and fish.

Copper sulfate is subject to registration and labelling requirements of the APVMA and as noted earlier, Sunwater is currently approved to use Sunwater Copper Sulfate Aquatic Algaecide (APVMA label Number 67673) in all of its water distribution schemes, including the MDWSS. Other water management authorities around Australia hold similar labels (including Goulburn Valley Region Water Authority, Melbourne Water and South Australia Water).

The Sunwater algaecide is a 100 per cent copper sulfate product ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, the pentahydrate form; technical specification as per the APVMA standard). It is a blue crystal, or blue crystalline granule or powder, but is white when dehydrated. The chemical has a nauseous metallic taste. The pentahydrate form contains 25.5 per cent copper. When dissolved in water, copper sulfate breaks down to its constituent copper cation (Cu^{++}) and sulfate anion (SO_4^{--}).

The ADWG (NHMRC, 2011) fact sheet for sulfate notes, “Sulfate is one of the least toxic anions. Ingestion of high doses can result in catharsis (loosening of the bowels) with dehydration as a possible side effect. No harmful effects have been reported in studies with animals.”

Sulfate is not included in the tables of toxicants in the Australian and New Zealand guidelines for fresh and marine water quality (ANZG) (Australian Government, Water Quality Australia 2018) nor in the list of ions of concern to irrigated agriculture. The highest concentration of copper sulfate aquatic algicide permitted by APVMA to be used by Sunwater in the MDWSS is 0.2mg/L for up to 24 hours. This equates to a concentration of sulfate below both ADWG and ANZG trigger values and, as a result, sulfate is not considered a key risk factor. It was also not addressed further by the APVMA assessment.

The ANZG (Australian Government, Water Quality Australia 2018) technical brief for copper states in the ‘Summary of factors affecting copper toxicity’:

- copper is an essential trace element required by many aquatic organisms
- copper toxicity decreases with increasing hardness and alkalinity and a hardness algorithm is available
- levels of dissolved organic matter (measured as DOM or DOC) found in most freshwaters are generally sufficient to remove copper toxicity but often not in very soft waters
- copper is adsorbed strongly by suspended material (measured as TSS)
- copper complexing is increased at higher pH, but the relationship to toxicity is complex
- copper toxicity in algae, invertebrates and fish generally increases as salinity decreases
- copper can bioaccumulate in aquatic organisms but, as it is an essential element, it is commonly regulated by the organisms.

Note: many of the interacting factors noted above (hardness, DOC, TSS, pH) will vary from site to site in the MDWSS but will generally be higher in remnant pools from small streams. These interacting factors have been incorporated within the monitoring program required under the Code, as described in **Appendix 1**.

2 Environmental sensitivity

APVMA (2019) concluded, “*The risk assessment had regard to the toxicity of the constituents and its residues, including metabolites and degradation products, in relation to ecosystems and relevant organisms. Based on the outcome of the risk assessment, the APVMA can be satisfied under s14 of the Agricultural and Veterinary Chemicals Code Act 1994 that the proposed use of the product meets the safety criteria with respect to:*

- *s5A (1) (c), provided that the recommendations made in the section below are adopted in the updated label*
- *the proposed label meets the labelling criteria under s5D (1), with respect to environmental considerations, provided that the recommendations made in the section below are adopted in the updated label.”*

The recommendations are the conditions included on the product label, specifically:

- Under DIRECTIONS FOR USE, dose rate for the MDWSS should be:
 - 0.02 – 0.05mg/L Copper (Cu) [0.08 to 0.2mg/L copper sulfate pentahydrate] for up to 24 hours.
 - DO NOT dose at rates greater than 0.05mg/L Copper (Cu) [0.2mg/L copper sulfate pentahydrate]

- DO NOT apply for more than 24 hours continuous dosing.

APVMA (2019) reviewed risks to all potential end points and concluded:

- copper concentrations in sediments have not increased over time, so the risk to sediment-dwelling organisms is acceptable
- when applied to irrigation water, copper sulfate does not accumulate in the surrounding soils
- risk to birds, mammals and honey bees (relevant in the event of spray irrigation) and soil organisms (earthworms, soil microorganisms, non-target soil dwelling arthropods and terrestrial plants exposed through the soil) was already assessed in the recent environmental assessment report and won't be considered here (as it was considered acceptable)
- copper levels in the final receiving waterways (i.e. rivers) do not increase above the current background levels when copper sulfate is used in accordance with the proposed use, and therefore risks for chronic exposure are acceptable
- the risk from bioaccumulation was addressed in aquatic organisms based on literature data on invertebrates and vertebrates (EFSA, 2013). These data provided sufficient evidence that there is no bioaccumulation in aquatic organisms.

As a result, Performance Outcome 1.7 of the Code includes an alternative approach to measure success of the control measures, specifically that concentrations of dissolved copper measured under the monitoring program within the Code are (a) consistent with the specifications of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity 2019); (b) are no higher than ambient (natural background) concentrations; or (c) where results exceed/depart from the ambient water quality of the receiving waters, 12 and 24-month Monitoring Reports will provide an analysis of the extent to which the releases have the potential to cause material or serious environmental harm or an environmental nuisance.

2.1 Threatened and priority species

Appendix 5 of APVMA (2019) addressed the likelihood of threatened and priority species in the MDWSS being impacted and while most were regarded as not relevant, Lake Eacham Rainbowfish and several species of frog were, and with respect to Black-footed Tree Rat, Eastern Osprey and Eastern Curlew the link is that they eat fish or aquatic invertebrates.

Despite drawing this link to the food chain, the APVMA assessment concluded, "*The risk from bioaccumulation was addressed in aquatic organisms based on literature data on invertebrates and vertebrates (EFSA 2013). This data provided sufficient evidence that there is no bioaccumulation in aquatic organisms*".

APVMA (2019) also concludes, "*Please note that based on a non-exhaustive review of these areas, endangered species inhabit the aquatic areas within the irrigation system. This is our concern for the proposed use, but adverse effects are expected to be non-significant due to the short-term effect of treated water on individual aquatic organism rather than on population.*" While the APVMA assessment regarded the species as possibly present within the MDWSS, the conclusion was that any adverse effects would be non-significant in any case.

Stream-dwelling rainforest frogs of the Wet Tropics biogeographic region of North Queensland recovery plan 2000-2004 (North Queensland Threatened Frogs Recovery Team, 2001) concluded that, "*Nyctimystes dayi (now Litoria dayi) is now absent from all localities above 300m. Similarly, the Mountain mist frog (Litoria nyakalensis) has not been recorded on the Atherton Tablelands since 1973, despite intensive searches in preferred habitat. It is a rainforest specialist found in upland rainforest and wet sclerophyll forest along fast-flowing streams where there is white water from riffles and cascades. Several of the*

species are rainforest specialists or prefer specific habitats that are not present in the potentially affected ephemeral streams. For example, the Waterfall Frog (Litoria nannotis) is restricted to rocky stream habitats in rainforest or wet sclerophyll forest where there is fast flowing water, waterfalls and cascades."

The SPRAT profile (Species Profile and Threats Database, Australian Government Department of the Environment and Energy) notes the Lake Eacham Rainbowfish (*Melanotaenia eachamensis*; Endangered under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*) occurs in the upper reaches of the Barron catchment, including in Lake Tinaroo, Lake Euramo (an isolated crater lake directly east of Lake Tinaroo) Bromfield Swamp, North Johnstone and South Johnstone River catchments at altitudes above 500m above sea level, and also in Koombooloomba Dam on the Tully River. It is not likely to occur in ephemeral watercourses, which most of the overflow points lead to. However, it may be found in some of the supplemented streams.

The Eastern Osprey (*Pandion haliaetus*) is not listed as threatened in Queensland or nationally but is listed as marine and migratory under the EPBC Act. The SPRAT profile notes, "*They require extensive areas of open fresh, brackish or saline water for foraging. They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes.*" An environmental report, generated from a Queensland Government database on biodiversity and conservation values, confirms that the Eastern Osprey has been recorded in, or within approximately four kilometres of, the MDWSS (Department of Environment and Science, 2020).

The feeding habitat of the Eastern Curlew (*Numenius madagascariensis*) is described as, "*The eastern curlew mainly forages during the non-breeding season on soft sheltered intertidal sandflats or mudflats, open and without vegetation or covered with seagrass, often near mangroves, on saltflats and in saltmarsh, rockpools and among rubble on coral reefs, and on ocean beaches near the tideline. The birds are rarely seen on near-coastal lakes or in grassy areas*" (Marchant & Higgins, 1993). An environmental report, generated from a Queensland Government database on biodiversity and conservation values, confirms that the Eastern Curlew has been recorded in, or within approximately four kilometres of, the MDWSS (Department of Environment and Science, 2020). However, based on the description of their foraging areas, it is not anticipated that they would feed in the ephemeral creeks of the MDWSS.

With respect to Black-footed Tree Rat (*Mesembriomys gouldii*), the listing advice within the SPRAT profile says, "*The diet comprises mostly fruits (including of the tough Pandanus spiralis) and seeds, but also includes some invertebrates, flowers and grass (Morton, 1992; Rankmore, 2006; Rankmore & Friend, 2008)*". The SPRAT listing advice also states, "*A recent attempt (pre-2015) to undertake an ecological study of the black-footed tree rat (north Queensland) in the Mareeba area had to be abandoned when no individuals were recorded in intensive sampling, including at sites at which the taxon was previously reported, nor from requests for information from the community (C. Dickman, pers. comm.)*." However, the Queensland Government database on biodiversity and conservation values notes that the Black-Footed Tree Rat has previously been recorded in, or within approximately four kilometres of, the MDWSS (Department of Environment and Science, 2020).

In conclusion, the environmental values at risk from copper contamination are predominately the aquatic ecosystem values of the receiving waterways in the respective catchments, including aquaculture where it is relevant. The APVMA (2019) concluded that threatened and priority species, while potentially present in the MDWSS, are considered to be at a low risk, either directly or indirectly.

3 Justification for the proposed measures

The Code contains an overarching performance outcome containing monitoring and reporting commitments. Several sub-outcomes and control measures are specified in the Code to achieve the performance outcome. The discussion below lists the outcome, sub-outcomes, and the key control measures.

The justification to support the outcomes and control measures is drawn from the trials undertaken by Sunwater to support the APVMA permit assessment process and Sunwater's practical experience with scheme management over many years. The aims of the trials were:

- to investigate the optimum copper dosage treatment schedule (concentration vs. period of exposure – referred to as 'efficacy' trials)
- to improve management practices associated with the application of copper sulfate to minimise exposure of copper to the environment (via supplementation or overflows to creeks/gullies) while maintaining effective control of algae within irrigation channels.

3.1 Performance outcome 1

There is no release to receiving waters¹ of copper-treated water which directly or indirectly causes, or is likely to cause, material or serious environmental harm or creates an environmental nuisance from release of treated water²

Performance Outcome 1.1: In-channel treatment of algae is only undertaken when and where necessary and using a preventive maintenance approach

The eight efficacy trials across various channel locations within the MDWSS included a range of copper doses and durations. Algal monitoring was undertaken before and after dosing at an upstream control site and at several sites at increasing distances downstream of the dosing point. Monitoring for up to several weeks was based on per cent cover of algae and visual assessments of health (mainly colour change) using both transects and implanted substrates.

A key result of the efficacy trials showed satisfactory control could be achieved with relatively low doses of copper sulfate, if applied early in the growing season when compared to attempts to control more established algae later in the season. It also showed that algae was rarely eliminated in the treated area but its coverage and health could be sufficiently retarded such that follow-up treatments were fewer or not required until the next growing season.

The trial results also showed that despite repeated treatments in a single growing season, the algae in-channel returned via colonisation, likely from upstream sources such as Tinaroo Falls Dam, balancing storages or via carriage on fauna (e.g. birds). It is assumed recolonisation would occur in natural streams if they were to be impacted by a release of treated water.

The control measures within the Code formalise monitoring of channels for early stages of algal growth and the scheduling of treatments to achieve maximum affect. The APVMA label (issued following the trials) now includes the following in the directions for use, "*Apply at first signs of algae growth. Retreatment may be necessary 3-5 weeks after treatment depending on environmental conditions affecting algae growth*".

Performance Outcome 1.2: The dose concentration and duration are the minimum which achieves a satisfactory result

¹ Receiving waters (Queensland waters) of the MDWSS are identified in section 7.1.1 (including Tables 1 and 2) of the Code, and in this *Explanatory guide and description of monitoring program*.

² This includes consideration of direct and potential indirect chemical and biological effects of copper treatment, including, for example, decomposition of algal matter and associated effects on oxygen.

As noted above, the efficacy trials showed satisfactory control of algae could be achieved with relatively low doses of copper sulfate. The APVMA label now includes a maximum dose rate of copper sulfate of 0.2mg/L (equating to 0.05mg/L of copper) for a maximum duration of 24 hours, which is quite stringent compared to other label limits. In Sunwater's closed schemes, copper may be applied at up to 2.0mg/L (40 times that allowed in the MDWSS) and with no limit on the duration.

The dose duration relates to the time it takes for water to travel from the dose location to the end of the treatment section (and related potential point of discharge from the channel). If a point discharge cannot be controlled, the period over which water discharges will be equal to the dose duration. As such, the shorter the dose duration, the shorter the period potential environmental harm can occur. The APVMA label for the MDWSS now includes a maximum dose duration of 24 hours and while for some dose locations this duration is necessary, the duration for the majority of dose locations is between four and seven hours.

As the operator of the water supply scheme, Sunwater is able to calculate the channel flow rates and hence the dose duration with precision, however that precision could be improved by further automation (see Performance Outcome 1.5 within the Code). A control measure is included in the Code which calculates a volume of copper sulfate to be made up in the mixing tank. This calculation ensures that no copper sulfate can be accidentally added to the channel beyond that calculated for the dose and duration.

Sunwater is aware that there are other sources of copper, besides natural sources, that can enter channels within the MDWSS. These sources include crop protection products, fertilisers, and unauthorised non-Sunwater related copper sulfate treatments.

Copper is used as a protective fungicide treatment in many crops including citrus, avocados, and mangoes, and is also present in fertilisers for crops such as sugar cane. All these crops are grown within, and receive irrigation water from, the MDWSS. Copper oxychloride and cupric hydroxide based fungicides are the most common copper-based fungicides. The labels for these products include many uses as a foliar fungicide in many fruit crops, vegetables and ornamentals. When applied as a foliar fungicide spray there will be occasions where copper sprays may drift to nearby irrigation channels and waterways. In the trials conducted by Sunwater, one example of spray drift into an irrigation channel was detected while it was being monitored by Sunwater.

Sunwater has no authority to regulate on-farm activities throughout the MDWSS. Instead, Sunwater will inform relevant landholders of the potential for copper (through spray drift and other farming activities) to enter channels and encourage good spray drift management practices throughout the scheme. The monitoring program required under the Code has been designed to be able to detect if copper, in addition to that dosed by Sunwater, has been added to the treated channel.

Sunwater is aware of the historic occurrence of unauthorised dosing undertaken by third parties in Sunwater channels wherein a perforated bag of copper sulfate was suspended in the channel. It is unknown to what extent this process has occurred or if it continues to occur. Copper sulfate is readily available through retail purchase, including in significant quantities. Sunwater will remain vigilant in detecting and deterring unauthorised access to its infrastructure to ensure there is no illegal addition of copper sulfate to the channel system. Where Sunwater becomes aware of unauthorised copper dosing by third parties, it will advise the relevant regulatory authorities (included in Performance Outcome 1.7 of the Code).

Performance Outcome 1.3: The dose concentration can be accurately calculated and delivered

Development of specialised equipment to achieve this outcome has occurred over several years and that equipment now represents best management practice in the delivery of accurate volumes of copper sulfate at a known concentration in the MDWSS. Control measures in the Code stipulate use of the equipment. Record keeping to validate the outcomes is included within Performance Outcome 1.7, but is otherwise already required under Sunwater's International Organisation for Standardisation (ISO) accredited Environmental Management System.

Performance Outcome 1.4: Procedures are in place to ensure adjustment of mechanical infrastructure is undertaken to minimise the risk or volume of releases

The aim of this outcome is to make the section of the scheme being treated as much like a closed water supply scheme as possible during the period of treatment. That is, within any one section of scheme there are items of mechanical infrastructure (valves or gates) which can be used to close the outflows from the channel and prevent treated water from discharging to receiving waters. The control measure in the Code stipulates that where these exist, they will be closed. As this action may mean water is not available to customers downstream from the isolation point during the treatment period, advance notification will be necessary. Some stream supplementation points, which were previously uncontrolled, have had shut-off valves fitted in recent years and further works are planned to be undertaken by Sunwater in future years.

Similarly, in some locations the level of water carried in the channel prior to it overflowing can be raised by adding drop boards to the overflow location or because the gate on the overflow has that capability. The higher the water level in channel, the lower the volume of potentially discharged treated water.

The remaining control measure in this section of the Code relates to the balance of water supplied to the channel and extracted from it, to ensure that no excess water is released to the channel and thereby lead to an overflow. The ability of Sunwater to achieve this outcome will be enhanced by improved scheme automation (addressed in Performance Outcome 1.5 under the Code).

Performance Outcome 1.5: Procedures are in place to implement other actions during treatments that reduce the risk of overflows

The control measures in this section relate to management arrangements or to long-term infrastructure improvements to be implemented by Sunwater, rather than the management of existing physical infrastructure, which is addressed under the previous performance outcome.

The measures include coming to agreement with water users regarding extraction of water from the channel during treatments. To manage impacts on aquaculture within the MDWSS, Sunwater will notify any active operators so that they can avoid extracting water during treatments. This is to ensure that if the water quality objective for aquaculture were to be exceeded following treatment of irrigation channels with copper sulfate aquatic algaecide, any potential harm to aquaculture operations would be prevented. This approach worked successfully when the Queensland Government Walkamin Research Facility was undertaking research on aquaculture through extraction of water from the MDWSS.

The benefit in arranging for irrigators to extract water during treatment is that it lowers the volume of water in the channel to avoid triggering an overflow. If an overflow is still triggered, it would be a lower volume than it otherwise may have been.

Any imposition on irrigators to participate in flow management during treatments is considered minor given the short duration of the imposition (hours to potentially one day)

and the improvement in water delivery achieved by the treatment. This is likely why cooperation from irrigators has historically been forthcoming. Sunwater has various powers as the owner and operator of the scheme which could ultimately be used to implement such measures but as the scheme services over 1000 customers, Sunwater prefers to reach the desired level of cooperation (with respect to irrigation demand management during treatments) through mutual agreement. The Code's environmental monitoring program (Appendix 1) will assist in determining whether further revision to these or other procedures is necessary to meet the objective of the Code.

Control measures relating to long-term infrastructure improvements relate to scheme automation and to changes to the physical channel structures. With respect to the former, modernisation of water supply schemes is gradually being undertaken throughout Queensland and technological improvements are being implemented to provide more accurate, real time data that can be applied to flow management. This will result in reduced risk of overflows within the MDWSS.

Conversion of the current, open, earth lined channels to PVC lined channels or to pipes, will reduce, and in some cases eliminate, the need for treatment of algae, or allow alternative management measures to be implemented. However, this is a very expensive undertaking and can only be achieved when funding is available.

In an unforeseen event, the addition of copper sulfate to the channel can be quickly stopped at the application site. A control measure in the Code has been built in to address this.

Performance Outcome 1.6: Staff and contractors are appropriately trained

Relevant training ensures staff and contractors are competent to undertake the control measures and are familiar with all aspects of the operation.

Performance Outcome 1.7: Accurate records of each treatment are maintained, including results of environmental monitoring and notification to administering authority of any exceedances/departures (greater than 20%) or incidents

Accurate records are an essential component that allows auditing, reporting and continuous improvement. Sunwater operates under an ISO accredited EMS so is fully aware of such obligations. Procedures will be updated to comply with the Code.

The control measures in the Code specify recording of all data critical to confirmation that other control measures have been implemented as intended.

A monitoring program must be undertaken under the Code. The monitoring program will be reviewed by Sunwater and the Department of Environment and Science 12 months and 24 months after commencement of the monitoring program and revised when required. (If, during the first year of monitoring, Sunwater or the Department of Environment and Science identify an urgent need to amend the monitoring program, this will be negotiated between the parties.)

Further details regarding the monitoring program are provided in **Appendix 1**. The aim of the monitoring program is to ensure that the control measures implemented as part of the Code achieve the intended outcome that there is no release to receiving waters of copper-treated waters at a level that causes, or is likely to cause, material or serious environmental harm or create a nuisance from release of treated water.

4 Record of consultation

As part of the Code development, Sunwater undertook a consultation process. Stakeholders were identified from the range of existing local and regional forums. The consultation list was then expanded to ensure representatives of groups which might be considered stakeholders or interested parties were identified. Invited participants included organisations or persons representing:

- customers of the MDWSS
- local government
- Traditional Owners
- State Government Departments (with assistance from Department of Environment and Science)
- Regional Natural Resource Management (NRM) bodies
- conservation groups
- local agricultural organisations
- local business groups.

Invitees were sent a range of material including:

- a fact sheet with an invitation for feedback on the draft Code
- the draft Code
- Sunwater's Operation Manual.

A workshop was held in Mareeba on 19 January 2020. Minutes were kept, and participants were invited to provide any further comments by email to the Sunwater project manager.

Workshop attendees and other stakeholders consulted during the development of the code included:

- Barron Catchment Care
- Cairns and Far North Environment Centre
- Department of Natural Resources, Mines and Energy and Department of Agriculture and Fisheries
- FNQ Growers
- Northern Gulf Resource Management Group
- Northern Irrigator Association
- North Queensland Land Council
- Mareeba Chamber of Commerce
- Mareeba Shire Council
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Issues raised by participants either at the meeting or in later correspondence are noted below, and a response to the issues follows.

Issue 1: Consideration of on-going field monitoring (water samples) to ensure copper concentrations continue to meet water quality objectives for the receiving waterways. One respondent suggested that monitoring of aquatic fauna should be included.

Response: The draft Code was amended to include the requirement for a monitoring program that aims to confirm the utility of the control measures to achieve their performance outcomes. The monitoring program would be reviewed after 12 months by the Department of Environment and Science and Sunwater, with any updates implemented as required. The targeted outcome of the Code is to (1) prevent releases or (2) ensure any releases of dissolved copper are consistent with the specifications of the EPP Water and Wetland Biodiversity 2019 and/or are no higher than ambient (background) concentrations of dissolved copper. Where this target is achieved, monitoring of aquatic fauna in receiving waters is unnecessary. If the outcome is not achieved, then such monitoring would be considered where results of the monitoring program indicate a potential risk to the aquatic ecosystem values of receiving waters.

Issue 2: Enzyme-based treatment methods should be considered for the management of filamentous algae.

Response: This comment was particularly related to Sunwater's balancing storages and aimed to eliminate these as a source of colonists for algae. Enzyme treatment of balancing storages was not considered the preferred treatment location or method because:

- enzyme technology is typically used to treat relatively small ponds
- the storages often have significant environmental values, with Nardello's Lagoon considered an "e-bird" birdwatching hotspot. The resident algae are a core component of these ecosystems, even though they exist in an artificially constructed environment. Sunwater's preference is to treat downstream of, rather than within, these lagoons
- Sunwater suggests that Tinaroo Dam is the primary source of algal colonists and given the size and environmental values of this storage it would not be suited for enzyme treatment
- other sources of algal colonists (e.g. carried on birds) cannot be eliminated so direct treatment of channels would be required in any case.

Issue 3: Monitoring of potentially increasing resistance to copper sulfate should be included.

Response: Increased resistance would be evidenced by an increased need to treat the channels, both in terms of frequency and concentration of chemical treatment. Historical algal monitoring conducted by Sunwater has detected algal outbreaks, with records maintained of the frequency of treatment and the concentration used. There is no evidence of a trend to increase the need for algal treatment and the APVMA trials showed that effective control could be achieved with lower concentrations than have been historically used.

Issue 4: Failure to refer to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

Response: The EPP Water and Wetland Biodiversity came into effect 1 September 2019. The first draft of the Code and other documents were produced prior to this date when the Environmental Protection (Water) Policy 2009 had effect. All references have now been updated to reflect the updated legislation.

Issue 5: The Net Benefit Policy (under Reef 2050) is relevant and the Operation Manual and Code should include measures that provide a positive change to the ecological condition of the Great Barrier Reef.

Response: The intent of the Code documents (comprising the Code and this Explanatory guide and description of monitoring program) is to

- ensure no release to receiving waters of copper sulfate or copper at a level that causes, or is likely to cause, material or serious environmental harm or create a nuisance from release of copper-treated water, and
- monitor and report on the effectiveness of copper sulfate treatment procedures to reduce or eliminate copper contamination in receiving waters.

In the Barron Basin parts of the scheme (which flow to the Great Barrier Reef), Sunwater considers that preventing an increase to copper concentrations in receiving waters could only be interpreted as a positive change for the Great Barrier Reef. The Net Benefit Policy is not relevant to the Walsh and Mitchell parts of the MDWSS as they are not Great Barrier Reef catchments.

5 Summary

This document has been prepared to satisfy the requirements for an explanatory guide described within the information sheet, “Developing Codes of Practice” (ESR/2015/1695, Version 2.02, Department of Environment and Science).

As a result of the investigations and operator experience discussed in the sections above, the control measures included within the Code minimise or mitigate the risk of environmental harm as a result of the following:

- the algal management approach is now one of preventive maintenance and early intervention
- treatment is only undertaken when required and is based on specific observations of algal growth and weather forecasts
- the dose concentration and duration have been reduced to the minimum which achieves a satisfactory result
- the dose concentration can be accurately calculated and delivered
- procedures are in place to ensure the outlets which can be closed are in fact closed prior to treatment
- procedures are in place to implement other actions, where feasible, during treatments which reduce the risk of overflows, including:
 - arranging for the terminal irrigator to take excess water into storage
 - arranging with irrigators within the treatment section to match extraction to the volume of treated water.
- accurate records of each treatment are maintained, and a monitoring program has been included to measure the results of implementation of the control measures.

The control measures are practical, directly targeted at avoiding or minimising releases to receiving waters and, if releases do occur, they will be for the minimum time and at the lowest concentration required to achieve algal control.

The draft Code appropriately deals with the matters in section 5 that the Minister must consider when deciding whether to approve the Code.

6 References

APVMA (2019) *Label Number 67673*.

APVMA (2019) *Environmental Technical Report. Application 105182 for registration of variation of label to allow use of copper sulfate to control algae in open systems including the Mareeba-Dimbulah Water Supply Scheme*.

Australian Government Department of the Environment and Energy; *Species Profile and Threats Database*. (Accessed November 2019).

Australian Government, Water Quality Australia (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (formerly referred to as ANZECC guidelines).

Department of Environment and Resource Management (2009) *Queensland Water Quality Guidelines*, Version 3. ISBN 978-0-9806986-0-2.

Department of Environment and Science (2018) *Monitoring and Sampling Manual*.

National Health and Medical Research Council (2011) *Australian Drinking Water Guidelines (update 2018)*.

North Queensland Threatened Frogs Recovery Team (2001) *Stream-dwelling rainforest frogs of the Wet Tropics biogeographic region of North Queensland recovery plan 2000-2004*.

Queensland Government (2014) *Developing Codes of Practice* (ESR/2015/1695 • Version 2.02).

State of Queensland (2019) *Environment Protection (Water and Wetland Biodiversity) Policy 2019*.

7 Appendix 1: Description of monitoring program to be conducted during dosing with copper sulfate under the Code

7.1 Purpose of the monitoring

The aim of the water quality monitoring is to show that the control measures implemented as part of the Code achieve the intended outcome that, where there are releases from the MDWSS of treated water to receiving waters, the releases do not cause, or are likely to cause, material or serious environmental harm or create a nuisance.

The Code recognises that the outcome can be achieved by ensuring:

1. there is no release through the control measures; or
2. any released water is consistent with the specifications of the EPP Water and Wetland Biodiversity 2019, or no higher than the ambient (natural background) concentrations of the receiving waters; or
3. any released water is shown not to cause or is unlikely to cause material or serious environmental harm or create a nuisance.

Performance Outcome 1.7 under the Code includes record keeping, auditing related to the control measures themselves and to the occurrence of releases (triggering of overflows or flows in supplemented watercourses) and notification requirements to the administering authority. The following describes the monitoring program also required under this performance outcome.

7.2 Release Point Monitoring Locations

Sunwater undertakes copper sulfate aquatic algaecide treatments at specified dosing locations within irrigation channels of the MDWSS.

Release points (i.e. supplementation and/or overflow points) exist downstream of dosing locations, from which copper sulfate treated water could potentially be released to receiving waters. The likelihood of treated channel water reaching each release point has been assessed against a range of factors described in section 7.2 of the Code.

For the water quality monitoring program, release point monitoring locations have been selected based on them having:

- a high or medium risk that treated channel water will reach this location
- more than one dosing location located upstream of the release point.

The need to undertake copper sulfate aquatic algaecide treatments at a given dosing location changes from year to year depending upon the extent of algal growth. Some flexibility is necessary in the program to accommodate the varying needs for treatment.

Release Point Monitoring Locations with multiple upstream dosing locations will allow for more dosing events to be captured in the monitoring program and improve the opportunity for data collection. Selected Release Point Monitoring Locations are listed in **Table 1**.

Table 1: Release Point Monitoring Locations¹

Catchment	Site No.	Release Point ¹ (from channel)	Upstream Dosing Location (in channel)	Distance from Release point
Barron River	16	EBMC Overflow/supp to Shanty Creek	EBMC Storage Outlet	6,232m
	19, 20	Granite Creek overflow (19) and supplementation (20)	WBMC 9-Mile Gates/Parshall Flume	8,042m
			WBMC 7-Mile	10,837m
			WBMC 5-Mile	14,620m
			WBMC 320m Compensator Lift Gates	23,230m
			WBMC 0m TFD Radial Gates	23,550m
	5	M9 Overflow to Atherton creek	MMC 6403m Nardellos outlet	9,824m
Walsh River	50	Leafgold Weir overflow	SWMC 43780m	9,795m
			SWMC 34167m	19,408m
			SWMC SW13 Structure	21,794m
			SWMC 29578m	23,997m
			SWMC 25050m Mutchilba Storage	28,525m
			SWMC 20436m Borzi Bench Flume Outlet	33,139m
			SWMC 16916m Borzi Bench Flume Inlet	36,659m

Note:

1. Coordinates of monitoring locations (and any monitoring contingencies required to address flow variations in channels and receiving waters) to be confirmed to satisfaction of the Department of Environment and Science prior to commencement of COP activities.

Monitoring will be undertaken over two treatment seasons (years) at each of the above locations during each copper sulfate dosing event, up to a maximum of four events per Release Point Monitoring Location per year. The Code (in particular Performance outcome 1.7) specifies requirements to review and report results of monitoring before determining the need for and scope of further monitoring.

If a channel section affecting one of the above monitoring locations requires less than four dose events in a year, consideration will be given to a new monitoring location for inclusion in the monitoring program to achieve the targeted number of sampled dose events.

This program targets replication of:

- four (4) Release Point Monitoring Locations (Site 16, Site 19/20, Site 5, Site 50)
- four (4) dosing events sampled for each Release Point Monitoring Location per year (Sixteen (16) dose events in total, per year)
- two (2) years of monitoring (to be reviewed at conclusion on year 2 prior to determination of scope/need for further monitoring)

7.3 Parameters to be monitored

Dissolved (filtered) copper is of primary concern in the monitoring program as it potentially poses a risk to the aquatic ecosystem and human use values (namely, aquaculture) of receiving waters. The parameters included in the monitoring program have the potential to affect the toxicity of dissolved copper or are associated with secondary water quality impacts of algal treatment.

The list of parameters to be monitored is as follows:

- dissolved copper
- total copper
- pH
- hardness (CaCO_3)
- salinity (Electrical Conductivity)
- temperature
- dissolved oxygen
- dissolved organic carbon
- total organic carbon (initial 12 months)

Sunwater is also to ensure site details at the time of sample collection are recorded, including:

- site location
- time and date of sampling
- weather conditions at time of sampling
- flow rate at time of sampling
- estimate of volume of treated water discharged at receiving water sites
- start time and end time of when treated water was reaching receiving water sites
- a description of the condition of receiving waters sites, including whether a permanent waterhole or natural spring is present.

For more information, refer to the Monitoring and Sampling Manual 2018 (Department of Environment and Science), which provides common techniques, methods and standards for sample collection, handling, quality assurance and control, custodianship and data management. Either laboratory filtration or field filtration is acceptable.

7.4 Water quality sampling locations

Water quality sampling locations downstream of the channel release points are often remote, isolated, overgrown with vegetation and physically difficult to access. Sunwater is committed to the health and safety of its workers, and as such, workplace health and safety considerations are at the forefront of the water quality sampling program. Sunwater staff shall only collect water quality samples where they have assessed the risk and deemed it safe to do so (for example, during daylight hours).

Where releases occur, the critical factors determining the final concentration of copper in receiving waters as a result of releases during channel treatment by Sunwater include:

- initial concentration of copper in the channel prior to being treated
- dose concentration in the channel after it has fully mixed and maintenance of that appropriate concentration
- concentration of treated channel water at the release point. This concentration is affected by various factors including:

- the distance from the dosing location and the uptake
- transformation or dilution of copper within that distance as influenced by the channel structure (e.g. earth-lined or otherwise)
- the extent of algae or other vegetation or organic matter within the channel
- input of copper from other sources (e.g. farming operations)
- variations to flow rate caused by irrigator extraction activities
- input of water from other sources (e.g. rainfall).
- ambient concentration in the receiving watercourse prior to receiving treated water
- concentration in the receiving watercourse after receiving treated water and mixing.

The Release Point Monitoring Locations include best available control and impact sites in both the channel and receiving water. A description of the physical location of each sample site is provided in **Table 2** below:

Table 2 Physical location of each sample site¹

Sample site	Description
Channel - U/S	In irrigation channel, between 100m and 200m upstream of copper sulfate dosing location.
Channel - D/S	In irrigation channel approximately 1 kilometre, but within 500 metres to 1,500 metres, downstream from copper sulfate dosing location.
Channel - D/S2 (Release point)	In irrigation infrastructure, immediately prior to release of treated water at the release point.
Watercourse - U/S	In receiving watercourse, immediately upstream from the point of entry of the treated water in a location not influenced by the release.
Watercourse - D/S	In watercourse, not more than 650 metres downstream from the point of entry of the treated water with no other potential sources of copper in-between.

Note:

1. Coordinates of monitoring locations (and any monitoring contingencies required to address flow variations in channels and receiving waters) to be confirmed to satisfaction of the Department of Environment and Science prior to commencement of COP activities.

Figures 1 and 2 provide example maps of water quality sampling locations for Release Point No. 16 EBMC overflow/supplementation to Shanty Creek.

7.5 Frequency of sampling

Depending on the location of a copper sulfate dosing site within the MDWSS, the duration of a dosing event generally varies between 4 and 24 hours.

For the Release Point Monitoring Locations included within the monitoring program (**Table 1**), dosing events occur for a set duration of 6 hours (Site 5 and Site 16) and 24 hours (Sites 19, 20 and 50).

For each water quality sampling event during the monitoring program, the duration of the event will be at least twice that of the dosing event (e.g. for a 6-hour dosing event, sampling must be undertaken for at least a 12-hour period).

Sample times provide the before and after components of a BACI (Before-After-Control-Impact) monitoring approach, while sample sites provide the control and impact.

For each copper sulfate dosing event Release Point Monitoring Location included within the monitoring program, the associated sites described in **Tables 3 and 4** will be sampled for

the nominated water quality parameters. During a dosing event, samples should be collected in accordance with **Tables 3 and 4**.

Table 3 Water quality monitoring program for a 6-hour copper sulfate treatment.

6-HOUR COPPER SULFATE TREATMENT <ul style="list-style-type: none"> • Site 5: M9 Overflow to Atherton Creek • Site 16: EBMC Overflow/supplementation to Shanty Creek 			
Stage of dosing	Sampling frequency	Locations	Parameters
Pre-dosing	Immediately before dose commences.	<u>ALL SITES:</u> Channel - U/S	<u>ALL PARAMETERS:</u> Dissolved copper
During dosing	3 hours after dosing starts.	Channel - D/S	Total copper
Post-dosing	Immediately after dose concludes.	Channel - D/S2 (Release point)	Hardness (CaCO ₃)
	24 hours after dosing starts.	Watercourse - U/S Watercourse - D/S	pH Electrical conductivity Temperature Dissolved Oxygen mg/L and % saturation Dissolved Organic Carbon (DOC) Total Organic Carbon (TOC)* <i>*Pre-Dosing and Post-dosing (24 hours) only, for initial 12-month monitoring period.</i> Offensive odour Unsightly appearance

Table 4 Water quality monitoring program for a 24-hour copper sulfate treatment.

24-HOUR COPPER SULFATE TREATMENT			
<ul style="list-style-type: none"> Sites 19 and 20: Granite Creek overflow (19) and supplementation (20) Site 50: Leafgold Weir overflow 			
Stage of dosing	Sampling frequency	Locations	Parameters
Pre-dosing	Immediately before dose commences.	<u>ALL SITES:</u> Channel - U/S Channel - D/S Channel - D/S2 (Release point) Watercourse - U/S Watercourse - D/S	<u>ALL PARAMETERS:</u> Dissolved copper Total copper Hardness (CaCO ₃) pH Electrical conductivity Temperature Dissolved Oxygen mg/L and % saturation Dissolved Organic Carbon (DOC) Total Organic Carbon (TOC)* <i>*Pre-Dosing and Post-dosing (48 hours) only, for initial 12-month monitoring period.</i> Offensive odour Unsightly appearance
During dosing	6 hours after dosing starts.		
Post-dosing	Immediately after dose concludes. 48 hours after dosing starts.		

7.6 Data validation

All sampling, storage and analysis will be consistent with the following:

- be undertaken by appropriately trained staff and in accordance with the Queensland Monitoring and Sampling Manual 2018 and any specific requirements of the laboratory conducting the analysis (including meeting requirements for time between collection and analysis)
- field data (at least pH, dissolved oxygen, temperature and EC) must be collected using a meter calibrated as per the instrument manufacturer's instructions
- collected samples must be analysed at a National Association of Testing Authorities laboratory that has been accredited to conduct the relevant analyses.

7.7 Reporting of monitoring results and review of monitoring program

The Code specifies that the monitoring program will be reviewed by Sunwater and the Department of Environment and Science 12 months after commencement of the monitoring program, and revised if required. Sunwater will be required to supply a report to the Department of Environment and Science on the results of the first year's monitoring program to support the review. The results of the monitoring program must be reviewed in the context of the EPP Water and Wetland Biodiversity 2019 and the ambient (natural background) concentration of the receiving waters. The ambient (natural background) concentration of the receiving waters must be determined based on the results of the Watercourse - U/S sample site located within the watercourse, upstream from the point of entry of the treated water.

Reporting will include analysis to support discussion of:

- achievement of the APVMA dose and duration conditions
- the achieved concentrations at release points relative to dosage details (and flow/volume calculations used to determine dosage)
- water quality sampling results compared to the specifications of the EPP Water and Wetland Biodiversity 2019 and the ambient (background) concentration of the receiving waters
- factors which may have affected the results (such as records relating to control measures, weather or flow in receiving watercourses)
- if necessary, improvements in the control measures
- if necessary, amendments to the Code
- the need for and scope of ongoing monitoring.

In order to provide discussion in the report, other recording undertaken as part of Sunwater's documented procedures around this activity will be assessed, such as the calculation of flow rate in the channel prior to dosing and the extraction of water by irrigators within the treated section.

Raw monitoring data supporting the report must be available to the Department of Environment and Science, if requested. Reporting will include mapping of sufficient accuracy to identify receiving waters and the location of all monitoring sites. GIS shapefiles will be made available to the Department of Environment and Science.

Following the report based on the first year of the monitoring program, any recommendations to refine the monitoring program may be implemented in the second year, with agreement from the Department of Environment and Science.

The Code also specifies that in the case of an environmental incident potentially associated with the application of copper sulfate aquatic algaecide, Sunwater must notify the Department of Environment and Science within 24 hours of becoming aware of the issue. If

the incident potentially affects drinking water supply, then Sunwater must notify the responsible authority for drinking water and Queensland Health immediately.



