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*

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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.

October 2020

sunwater

Foreword

I am pleased to share Sunwater's Code of Practice for the management of algal growth in water supply channels and the release of associated treated water.

This Code of Practice sets the standard for minimising impacts on the environment from our activities. It demonstrates Sunwater's commitment to the long-term sustainability of the communities and ecosystems where we operate. It also ensures the planning, management and reporting of algal growth and associated treatment is based on sound principles and applied consistently.

The Code relates to Sunwater's Mareeba-Dimbulah Water Supply Scheme, located on the Atherton Tablelands, which supports more than 1000 irrigation, industrial and urban customers. The 176-kilometre gravity-fed irrigation channels take water from Tinaroo Falls Dam through Mareeba, Walkamin, East Barron, Mutchilba and Dimbulah, with another 189 km of subsidiary channels and pipelines.

Sunwater continually strives to deliver improvement in our environmental performance.

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1. Introduction

This environmental code of practice (Code) provides guidance to help Sunwater comply with the *Environmental Protection Act 1994* (EP Act) and meet its general environmental duty. The Code outlines the environmental best management practices for algal management in the Mareeba Dimbulah Water Supply Scheme (MDWSS).

Under section 551 of the EP Act, all persons in Queensland must fulfil their general environmental duty. This is defined as follows: 'A person must not carry out an activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm' (refer **Appendix 1** for more details).

This document outlines algal growth management in water supply channels of the MDWSS and release of associated treated water to receiving waters (Queensland waters), the potential impacts on the environment, and how those potential impacts can be minimised or mitigated to comply with the EP Act.

Although the Code is a voluntarily adopted standard for the management of algal growth and treated water release in the MDWSS, complying with the Code provides Sunwater with a defence against a charge of unlawfully causing environmental harm and several other charges relevant to the Code. If Sunwater does not comply with the Code, it may still rely upon the defence of complying with the general environmental duty but will have to show how it has met its general environmental duty another way.

The Code complements the conditions of use approval issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA) to Sunwater for copper sulfate aquatic algaecide use in the MDWSS (Approval number 67673/105182). Reference is made to the APVMA approval where applicable.

2. Objective of the Code

To comply with the EP Act, there is a single overarching performance outcome in the Code, addressing potential consequential/indirect effects, as follows:

- there is no release to receiving waters[1] 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 water[2].

The Code contains several sub-outcomes and control measures to achieve the performance outcome. Refer to section 10 for more detail.

The Code aims to:

- describe environmental issues and challenges confronting Sunwater with respect to algal growth management and treated water release in water distribution channels of the MDWSS
- assist Sunwater to better consider the environment with which they interact
- guide planning with respect to algal growth management and treated water release to ensure operations meet requirements of decision-making authorities
- provide advice to decision-making authorities to enable them to make consistent decisions in respect to algal growth management and treated water release

[1] Receiving waters (Queensland waters) of the MDWSS are identified in section 7.1.1 (including Tables 1 and 2) of this document, and in the accompanying *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..

- suggest practical measures to minimise environmental and social impacts
- allow Sunwater to establish a benchmark environmental performance
- demonstrate to the community the environmental compatibility of algal growth management and treated water release operations.

3. Scope of the Code

The Code addresses environmental aspects of algae management in water supply channels of the MDWSS and their potential effects in receiving waters. The Code considers alternative mechanisms for algae management in the MDWSS (section 7.4), and focusses on the preferred algae management alternative, namely copper sulfate treatment in MDWSS channels. The spatial extent of the Code covers potential effects of copper-treated water entering receiving waters, while both direct and potential indirect effects are considered. It does not cover environmental issues to do with planning or construction and does not cover aspects covered by other legislation such as occupational health and safety or storage of bulk chemicals.

The Code does not extensively restate requirements of the EP Act, nor does it override or replace federal, state or local government legislation, regulation, plans or policies, including the approval issued by the APVMA (Approval number 67673/105182) for copper sulfate use in the MDWSS.

4. Commencement date

The Code commenced on 9 October 2020 and is in effect for seven years. To continue to have effect the Code must be reviewed and approved by the Minister by 9 October 2027. Sunwater staff are encouraged to provide feedback and to report new initiatives to Sunwater management, so that the Code can subsequently be considered by the Minister for amendment, as required.

Inception actions required prior to copper sulfate treatment under the Code include finalisation of monitoring locations (latitudes, longitudes) to the satisfaction of the Department of Environment and Science, as outlined in Performance Outcome 1.7 and the accompanying *Explanatory guide and monitoring program.*

5. Authorisation and amendment of the Code

Under section 551(1) of the EP Act, the Minister may, by gazette notice, make codes of practice stating ways of achieving compliance with the general environmental duty for an activity that causes, or is likely to cause, environmental harm. Once the Code has been gazetted it may also be amended by gazette notice.

6. About management of algal growth and treated water releases in the MDWSS

6.1. The scheme

The MDWSS is based in the Atherton Tablelands in North Queensland. It was largely constructed in the 1950s and services an irrigation area of about 17,000 hectares. It has over 1,000 bulk water customers.

The MDWSS straddles three catchments, with most channels being located within the Barron River catchment (which ultimately drains to the Great Barrier Reef), a significant proportion in the Walsh River catchment and a small proportion in the upper Mitchell River catchment. The Walsh River is also a tributary of the Mitchell River. The MDWSS is considered an ‘open’ scheme, as its irrigation channels have the potential to connect to

receiving waters (i.e. Queensland waters) through overflow and supplementation points. These locations are identified in the Code and the accompanying *Explanatory guide and description of monitoring program.*

The region in question is highly developed for irrigated and dryland agriculture, so the local streams receive runoff from this developed landscape. Some streams also flow through urban areas and receive urban runoff and in some cases, treated sewage effluent (e.g. Two Mile Creek). However, many streams flow through areas of intact dry or wet sclerophyll vegetation and often have substantial riparian zones, which are usually grazed by cattle. Substrates are variable, but sand, gravel and cobble are common.

The principal water storage is Tinaroo Falls Dam. The MDWSS regulates sections of the Barron catchment through Tinaroo Falls Dam, Granite Creek Weir and Dulbil Weir; and the Walsh catchment through Collins Weir, Leafgold Weir, Bruce Weir and Solanum Weir (on Eureka Creek).

Water from Tinaroo Falls Dam is distributed by gravity through 176 kilometres of main channel to the various sections of the MDWSS (**Appendix 2**), namely Walkamin to the south of Mareeba, East Barron and the Mareeba area, Paddy's Green and Arriga to the west of the town, and along the south bank of the Walsh River through Mutchilba to beyond Dimbulah.

Within these sections, a further 189 kilometres of subsidiary channels or pipes plus 14 supplemented streams distribute water to farms, dwellings and townships. The distribution system includes open channels which may be concrete, PVC or earth lined and pipelines of various diameters and constructing materials. Five balancing storages at Nardello's Lagoon, East Barron, Arriga, Biboohra and Jabiru Lagoon ensure that effective supply is maintained throughout the system.

The MDWSS supplies raw water to several townships including Tinaroo, Walkamin, Mareeba, Kuranda, Mutchilba and Dimbulah. Sunwater does not directly provide drinking water. The provided raw water is treated by the responsible authority prior to distribution to its customers.

Irrigation uses of water include sugarcane, mangoes, bananas, pawpaw, citrus, avocados, other horticulture and coffee. One sugar mill operates in the district.

6.2. Algal management in the MDWSS

As the licenced operator of the MDWSS, Sunwater is obligated to maintain efficient water delivery to their customers, primarily irrigators but also industry and towns. Algal growth within distribution channels has a major negative impact on Sunwater's ability to deliver water, particularly during peak irrigation season from August to January (start of wet season), which often coincides with conditions favourable to algal growth from May to January.

The primarily filamentous algae typically grow within the channel on the bed and banks, on structures within the channel such as offtakes, gates or valves, and upon aquatic plants growing within the channels or fallen branches. If left untreated, this type of 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.

The algal species detected within the MDWSS are generally common and have historically not been associated with human toxicity or ecosystem health issues. It is primarily these filamentous types of common algae species which cause problems for water supply within the irrigation channels, and which are the focus of the Code.

In contrast, blue-green algae (cyanobacteria) include genera[3] that can produce toxins causing adverse impacts such as poisoning in livestock and wildlife, human health impacts

[3] These include *Nodularia, Microcystis, Raphidiopsis* and *Dolichospermum.*

through ingestion, inhalation or skin contact, and impacts in fish including toxin accumulation in flesh. Historically, when high concentrations of cyanobacteria have been detected in Tinaroo Falls Dam, they may be transmitted to the irrigation channel network. However, existing monitoring programs have shown the toxin-producing genera referred to above are not typically present within the MDWSS and current blue-green algae concentrations remain generally low and have not resulted in significant human or environmental risks.

In a situation where high concentrations of blue green algae were present, algal treatment using copper-based products could increase algal toxin release, potentially causing environmental harm to receiving water environmental values including ecological health, suitability for drinking water, stock water and public health. Accordingly, the Code includes a requirement for Sunwater to assess potential risk associated with blue green algal impacts prior to channel treatment, and where risk is high, to review alternative treatments where possible. If a harmful algal bloom does occur, Sunwater will report outbreaks in accordance with the Queensland Government's Harmful Algal Bloom Response Plan and operational procedures. Provision exists in the Code to amend the monitoring program to more closely address this issue, e.g. because of environmental incidents.

Ongoing algae and other aquatic vegetation management within the constructed system is required because either existing treatment practices (e.g. dosing with copper sulfate) do not entirely kill the algae present or recolonisation can occur from upstream or other sources. The Code considers alternative mechanisms for algae management in the MDWSS (section 7.4).

6.3. Links to Great Barrier Reef water quality management

High levels of nutrients can exacerbate the level of algal growth in waterways. To limit nutrients, the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP) seeks to improve the water quality flowing from all catchments adjacent to the Reef, including the Barron River. Water quality targets are in place and define the required reductions in sediment and nutrient loads to the end of catchment needed by 2025. The Reef 2050 WQIP pesticide target aims to ensure that concentrations of pesticides at the end of each catchment are low enough that 99 per cent of aquatic species are protected.

Under the Reef 2050 WQIP work is being done to:

- expand and sustain the adoption of best management practices through agricultural best management practice programs that are industry led and improve the productivity, profitability and sustainability of farm enterprises
- establish and increase adoption of minimum standards across industries
- restore land condition and remediate degraded landscapes.

Improving the water quality flowing from the land to the Reef is critical for the Reef's health and, therefore, its ability to withstand and recover from extreme events.

7. Matters the Minister must have regard to when approving a Code of Practice under section 551 of the *Environmental Protection Act 1994*

7.1. The nature of the harm or potential harm

Section 440ZG of the EP Act states that a person must not unlawfully deposit a prescribed water contaminant in waters (where 'waters' means Queensland waters). Prescribed water contaminants are listed in Schedule 10 of the Environmental Protection Regulation 2019, and copper sulfate (the chemical algaecide currently used in treatment of algae in the MDWSS) is considered a biocide.

Environmental harm may be caused by an activity—

(a) whether the harm is a direct or indirect result of the activity; or

(b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.

The risk of potential environmental harm from current algal management measures relates to the release of copper-treated channel water to receiving waters (i.e. Queensland waters). As environmental harm also encompasses indirect and combined effects in receiving waters, the potential indirect effect of dead algae severely depressing dissolved oxygen levels and (in a situation involving blue-green algal blooms) increasing algal toxins in receiving waters are also relevant. As such the activity could, if not properly managed, potentially cause harm to environmental values for water under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity), subordinate legislation to the EP Act.

The potential for environmental harm in receiving waters is not relevant to other Sunwater water distribution systems in Queensland because they are 'closed' (a closed system is one in which the treated water does not release to a natural watercourse and, if necessary, the water can be held until it is safe to use). However, the MDWSS is in part an 'open' system, meaning the chemical can potentially enter receiving waters through the following pathways:

1. as part of the water distribution system via 'supplemented streams' (supplementation is approved under the *Water Act 2000* and supplemented streams are named in the Resource Operations Licence for MDWSS)
2. because of engineering design features which allow overflow from irrigation channels at specified points. 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.

Monitoring trials conducted by Sunwater have shown that historic treatment approaches using copper sulfate could at times exceed applicable water quality objectives in local streams. Following the monitoring trials, the Australian Pesticides and Veterinary Medicines Authority (APVMA) label instructions for dosing with copper sulfate were amended and this Code has been developed to reduce the risk of environmental harm.

Secondary impacts on water quality relating to the death and decay of treated algae are of low risk. A preventive maintenance approach for managing algae early in the growth cycle has been adopted. This will avoid the increased biochemical oxygen demand (BOD) and subsequent reduction in dissolved oxygen (DO) typical when large masses of algae die and decay. Precautionary actions are included in the Code to address these potential secondary impacts.

7.1.1 Receiving waters potentially affected by release of treated water

Receiving waters potentially affected include those which:

- are supplemented for irrigation supply purposes (supplemented watercourses)
- may be reached by a channel overflow.

Supplemented watercourses

When streams within the MDWSS are supplemented for water supply purposes, that supplementation is almost continuous but can be regulated or stopped through the operation of valves. Of the supplemented watercourses listed in **Table 1**, all but Granite Creek, Atherton Creek, Shanty Creek, Eureka Creek and Walsh River can be mechanically closed by Sunwater during treatment to prevent release of treated water to the watercourse. This commitment is built into the Code.

Channel overflows

Emergency and end-of-system channel overflows may, or may not, have mechanical means of control. The likelihood of overflow water reaching the watercourses named is discussed in section 7.2.

All open irrigation channels have an emergency overflow for the release of excess water where it exceeds the full supply level. These are very rarely used during normal operations to minimise water losses from the scheme. Generally, emergency overflows are only utilised during extreme weather events. Watercourses with the potential to directly receive channel water are listed in **Table 1**.

Releases from end-of-system overflows occur frequently during channel use. However, algae treatments are relatively infrequent and are not necessary in all sections of the MDWSS. As such, end-of-system overflow water is usually comprised of untreated channel water (sourced from Tinaroo Falls Dam) but may occasionally contain residual elements related to algal treatment. Watercourses with the potential to directly receive channel water via end-of-system overflows are listed in **Table 1**.

Table 1: Receiving waters to which irrigation channel water may be released

Catchment	Watercourse	Type of Release		
		Supplementation	Overflow (Emergency)	Overflow (End of system)
Barron River	Tinaroo Creek	✓		
	Granite Creek	✓	✓	
	Nicotine Creek			✓
	Atherton Creek	✓	✓	✓
	Cobra Creek	✓		✓
	Emerald Creek	✓	✓	
	Levison Creek	✓	✓	
	Shanty Creek	✓		✓
	Brindle Creek	✓		✓
	Davies Creek	✓		
	Chlosey River	✓		
	Unnamed Creek (M18 outfall)			✓
	Maude Creek		✓	
	Basalt Gully	✓		
	Emerald Creek		✓	
	Narcotic Creek		✓	
	Gorge Creek		✓	
	Barron River	✓	✓	

Catchment	Watercourse	Type of Release		
		Supplementation	Overflow (Emergency)	Overflow (End of system)
Walsh River	Eureka Creek	✓		✓
	Murphy's Creek	✓		
	Walsh River	✓	✓	✓
	Cattle Creek		✓	✓
	Chinaman Creek		✓	
	Colledge Creek		✓	
	Price Creek		✓	
	Horse Creek		✓	
	Dingo Creek		✓	✓
Mitchell River	Two Mile Creek	✓	✓	✓
	Marianne Creek		✓	
	Boyle Creek		✓	
	Wetlands Gully			✓
	Douglas Creek			✓

Environmental values and water quality objectives

Environmental values prescribed in section 9 of the EP Act are relevant to this Code of Practice and are to be considered and protected. These are ecological health and public safety and amenity. Additional applicable environmental values (EVs) and water quality objectives (WQOs) for the waters of the MDWSS (including Barron, Walsh and Mitchell catchments) are stated in the EPP Water and Wetland Biodiversity 2019. WQOs for the Aquatic Ecosystem EV are based on local monitoring data (where available) or refer to the Australian and New Zealand guidelines for fresh and marine water quality (ANZG, 2018, as amended). For Human Use EVs (e.g. irrigation, stock watering, drinking water, recreation), WQOs typically refer to ANZG or other relevant national guidelines, including for example Australian Drinking Water Guidelines (ADWG: NHMRC, 2011, as amended), and Guidelines for Managing Risks in Recreational Water (NHMRC, 2008, as amended).

The EPP Water and Wetland Biodiversity 2019 currently identifies the nearest High Ecological Value waters adjacent to the boundaries of the MDWSS along Brindle Creek. Site-specific actions have been identified within the Code and must be undertaken during copper sulfate treatments to eliminate the potential risk for treated channel water to enter the environment at this location. Otherwise, all waters within the MDWSS are regarded as Moderately Disturbed.

Wetlands of High Ecological Significance exist downstream of the MDWSS, adjacent to Four Mile and Two Mile creeks (tributaries of the Mitchell River), and adjacent Cattle Creek on the Walsh River. These sites are located approximately 10km, 14km and 5km respectively downstream of existing release points from the irrigation system. Strict water delivery management practices are in place to avoid releases of treated water during copper sulfate treatments. These practices include isolating release structures, suspending supplementation of creeks and reducing water delivery volumes to avoid channel overflow. As such, these wetlands are unlikely to be affected by release of treated water.

Nardello's Lagoon and Biboohra Storage are artificial balancing storages of the MDWSS that are listed as wetlands of High Ecological Significance. These structures serve an important function in balancing the flow of water through the irrigation system, whilst also providing refuge for a variety of birdlife throughout the region. As such, copper sulfate is not utilised to manage algae growth within these storages.

Under the Code, Sunwater must ensure all active aquaculture operators are notified prior to commencement of copper sulfate aquatic algaecide treatment, in order to temporarily halt any extraction of water. This is to ensure that if the WQOs for aquaculture were to be exceeded following treatment of irrigation channels, any potential harm to aquaculture operations would be prevented.

The only water quality parameters of direct relevance to the current treatment process and in accordance with definitions of prescribed water contaminants is copper sulfate ($CuSO_4$) and its constituents when dissolved (copper and sulfate). Toxicity relates to the dissolved rather than total or particulate form. Other water quality parameters which can affect the toxicity of copper are secondarily relevant.

7.1.2 Copper Sulfate Aquatic Algaecide

Copper sulfate is highly soluble in water and breaks down into its individual components (copper and sulfate). The free copper ion (Cu^{2+}) is the active constituent and is the most toxic form of the metal. The discussion below focusses on the potential risk of copper sulfate in waterways.

The ADWG fact sheet on 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." The highest concentration of copper sulfate aquatic algaecide permitted by APVMA (Approval number 67673/105182) 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 for the purposes of the code of practice.

The ANZG guideline technical brief for copper states the following, with comments specifically applying to the MDWSS shown in italics.

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. (*Note the local water is generally regarded as soft*). Table 3.4.4 of ANZG notes that for soft water, (hardness between 0 and 60mg/L of $CaCO_3$), the trigger value applies; that is, the trigger value is the most stringent.
- Levels of dissolved organic matter found in most freshwaters are generally sufficient to remove copper toxicity but often not in very soft waters. (*Note this will vary from site to site but will generally be higher in remnant pools of small streams*).
- Copper is adsorbed strongly by suspended material. (*Note this will vary from site to site but is likely to be greater in natural streams than in irrigation channels*).
- Copper complexing is increased at higher pH, but the relationship to toxicity is complex. (*Note this will vary from site to site but will generally be higher in remnant pools of small streams*).
- Copper toxicity in algae, invertebrates and fish generally increases as salinity decreases. (*Note this will vary from site to site but, in general, in natural areas salinity is generally lower unless groundwater fed*).
- Copper can bioaccumulate in aquatic organisms but, as it is an essential element, it is commonly regulated by the organisms.

An area which includes significant fine sediment (silt or clay), organic matter or plant life is regarded as a copper sink as the dissolved copper will be taken up by, or adsorbed onto, that material and it will no longer be regarded as toxic.

Based on the highest concentration of copper sulfate permitted by the APVMA (Approval number 67673/105182) to be used in the MDWSS by Sunwater (0.2mg/L for up to 24 hours), this equates to a maximum concentration of 0.05mg/L of specifically the copper component. At this level, copper does not present a risk to human uses (including raw drinking water, livestock, irrigated agriculture), except for aquaculture (discussed below). In addition, this level is also well below the sediment water quality objective under the ANZG. This has been confirmed by the APVMA via the permit approval process for Sunwater's use of copper sulfate aquatic algaecide in the MDWSS.

At a concentration of 0.05mg/L, copper could potentially pose a risk to aquatic ecosystems. As such, the Aquatic Ecosystem EV is relevant to all potential release locations. The monitoring program under the Code will compare and report water quality against relevant WQOs and ambient (natural background level) water quality. Note that hardness, pH, salinity and dissolved organic carbon levels will influence the level of risk of copper in aquatic ecosystems. As the waters of the MDWSS are classified as Moderately Disturbed, the management intent listed under section 15 of the EPP Water and Wetland Biodiversity 2019 for these waters will apply to protect the established EVs.

Aquaculture operations may be present in the MDWSS. Under the Code, Sunwater must notify any active aquaculture venture within the MDWSS of a dosing event and seek agreement not to take water during that time.

7.2. The sensitivity of the receiving environment

The receiving waters are classified as Moderately Disturbed under the EPP Water and Wetland Biodiversity 2019. Based on the following risk assessment conducted by Sunwater and the subsequent control measures included in the Code, the risk posed by the activity is considered low. In addition, a monitoring program has been incorporated into the Code to measure the successful implementation of the control measures by Sunwater.

Sunwater identified and risk-assessed all sites with the potential to release treated water to natural watercourses. Sunwater ranked the risk of treated water reaching a natural watercourse during an algal treatment in terms of:

- the distance from the dosing point to the release point (which varies from a few kilometres to over 20 kilometres)
- whether a release can be managed and to what extent (such as closing the outlet, adding drop boards to the overflow location, or through agreement with irrigators regarding the take of water)
- the presence of a copper sink between the dose point and the release point (in-line balancing storages act as copper sinks because the copper binds to organic matter or sediment in the storage, thus reducing the concentration of copper which progresses past the storage). Note: while balancing storages are constructed infrastructure, they are not actively treated with copper sulfate due to their incidental environmental value in the form of plant life and associated fauna
- the nature of the irrigation channel (earth lined channels similarly adsorb copper faster than plastic or cement-lined channels)
- distance from the release point to a defined watercourse (releases generally enter a formed or unformed drain or overland flow path which flows for a distance before reaching a natural watercourse)

- the nature of the intervening drain or overland flow path (again relating to the likelihood that copper will be adsorbed onto sediment or organic matter before it reaches the watercourse).

From the risk assessment above, 37 release points return a low risk rating (largely resulting from the ability of Sunwater staff to control the release via a mechanical valve or gate), seven are high risk and six are medium risk. High and medium risk release points are shown in **Table 2**.

*Table 2: High and Medium risk sites with the potential to release treated water to receiving waters (Refer to map at **Appendix 2**)*

Catchment	Site no.	Release point and coordinates (to be confirmed with DES prior to commencement)	Distance from nearest dose point	Risk Level
Barron River	16	EBMC overflow/supp to Shanty Creek	6,232 m	High
	18	ACMC overflow to Nicotine Creek	6,856 m	High
	20	Granite Creek supplementation	8,042 m	High
	19	Granite Creek overflow	8,042 m	High
	5	M 9 overflow to Atherton Creek	9,824 m	Medium
	6	M18 overflow to un-named creek	11,022 m	Medium
Mitchell River	35	B3/B3A overflows to Two Mile Creek	9,786 m	Medium
	30	Marianne Creek overflow	2,601 m	Medium
	31	Boyle Creek overflow	8,465 m	Medium
Walsh River	25	Cattle Creek overflow	6,697 m	High
	49	Solanum Weir overflow (flows to Eureka Creek)	11,005 m	High
	50	Leafgold Weir overflow	19,408 m	High
	41	Arriga A2 overflow to Dingo Creek	5,821 m	Medium

*Note: Works are currently being conducted by Sunwater to improve the ability to mechanically close this site.

It should be noted that the above risk ratings represent the raw risk that treated water may potentially reach receiving waters, rather than the risk of environmental harm that could occur once the treated water enters them. The overall risk (including risk of environmental harm) will change dependent on the average number of treatment doses per year applied to the relevant section of channel. This number is highly variable depending upon the frequency of environmental conditions conducive to filamentous algal growth. For example, during the 2018/19 financial year, the number of times dosing was required ranged

from zero to nine depending on the channel section. Coordinates of monitoring locations (and any monitoring contingencies required to address flow variations in channels and receiving waters) will be confirmed to satisfaction of the Department of Environment and Science prior to commencement of COP activities. Refer to the accompanying *Explanatory guide and description of monitoring program* for more details.

The key factors of relevance to the sensitivity of the receiving environment are:

- the volume of treated water reaching the watercourse relative to the volume of water in the watercourse
- the concentration of copper in both water sources.

The majority of locations where release of water from irrigation channels may enter receiving waters are in headwaters of order 1-3 upland streams. These locations are naturally ephemeral, often ceasing to flow and substantially drying out during the dry season. As such, recolonisation of aquatic flora and fauna would only occur once flows have recommenced. The presence of irrigation water almost permanently in the supplemented streams, and in those streams where releases are common, maintains flow at times when the streams would naturally be dry and consequently supports the existence of aquatic species at times when they naturally would often not be present. Most streams are either too small, or ephemeral, at, or upstream from, the receiving point and would not support recreational uses. The Walsh River and Barron River are exceptions to this.

As most locations at which any released waters enter a watercourse intermittently, it would be expected that the in-situ water quality would be highly variable and reflect the time since last flow. It is probable that at commencement of flow, the natural watercourse would contain substantial organic matter and any water present would likely be relatively high in salinity and pH. However, once flow commences, the physico-chemical characteristics (such as electrical conductivity (EC), pH, DO, and temperature) of the natural watercourse would quickly become more reflective of the incoming water. The resident sediment and organic matter would initially have the potential to adsorb copper, but this capacity would reduce as the flow flushes the organic material.

7.3. The current state of technical knowledge for the activity

Based on over 65 years of operation, Sunwater has gained a thorough understanding of the engineering components of the MDWSS system, the locations at which algae commonly occurs, the risk points related to release of treated water and the available management options related to mechanical infrastructure and irrigation demand management.

Sunwater has an in-depth understanding of the toxicity related risk regarding copper as it is a common element and relatively well researched. Sunwater also undertook extensive trials on the use of copper sulfate in the MDWSS as part of the APVMA permit approval process. Sunwater has gained an in-depth knowledge of the application of copper sulfate because it has a long history of use internationally and within Australia. Sunwater also has significant long-term local experience tailoring the treatment of algae with copper sulfate within the MDWSS.

Sunwater operates under an International Organisation for Standardisation (ISO) accredited Environmental Management System (EMS) and has developed a series of internal procedures and reporting documents to manage the use of copper sulfate within the MDWSS. Record keeping as part of the process has shown that since its inception, the accuracy of application of copper sulfate has improved and as a result, the total amount of copper sulfate applied has reduced. Continuous improvement forms part of the EMS and this process may identify improvements to management practices over time. Opportunities to improve practices identified through the continual improvement process will require Sunwater to consult with the Department of Environment and Science and may result in Ministerial consideration of an amendment to the Code to incorporate improvements.

Sunwater's internal procedures and documents will be updated to reflect the Code but will remain independent from each other. Documented Sunwater procedures will be audited regularly to ensure compliance with the Code and ensure any actions undertaken are not in conflict with the Code.

7.4. Likelihood of successful application of different measures that might be taken

Sunwater's historic management approach has been to use copper sulfate to reduce algal abundance. Consideration has been given to alternative measures for treating filamentous algae in distribution channels with respect to potential risks to worker safety, the environment, the effectiveness of control options, system design constraints and the cost of implementation (see also section 7.5 for further discussion of financial implications). The findings of the assessment are summarised in the table in **Appendix 3**.

Based on the assessment, copper sulfate aquatic algaecide is currently considered to be the best available option for managing filamentous algae in irrigation supply channels of the MDWSS.

Control measures are listed in section 8.2 of the Code to seek to ensure that the release of copper sulfate to receiving waters in the MDWSS is not at a level which causes or is likely to cause environmental harm or nuisance. The control measures seek to achieve this through the following:

- the algal management approach is now one of preventive maintenance
- treatment is only undertaken when and where required and is based on specific observations of algal growth and weather forecasts
- the dose concentration and duration are the minimum which achieves a satisfactory result
- the dose concentration can be accurately calculated and delivered
- procedures are in place to ensure the supplementation outlets and overflow structures 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.
- staff and contractors are appropriately trained
- accurate records of each treatment are maintained and allow confirmation that control measures have been implemented
- a monitoring program is incorporated to measure the success of implementation of the control measures, including the quality of treated water discharges to receiving waters, and water quality in the receiving waters.

The control measures are practical, directly targeted at avoiding or minimising releases to natural watercourses and if releases do occur, they will be comprised of irrigation channel water treated for the minimum time and at the lowest concentration required to achieve algae control.

To establish the dosing and duration of copper sulfate treatment, extensive trials were undertaken to support an application to the APVMA for approval to continue use of Sunwater Copper Sulfate Aquatic Algaecide (APVMA label Number 67673). The application applied to:

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

The approval to continue use of copper sulfate aquatic algaecide was granted to Sunwater in late 2019 by the APVMA (Approval number 67673/105182). Throughout the course of the research to support the APVMA variation of the product label, Sunwater refined the operation of a trailer-mounted precision dosing system (designed by Sunwater specifically for this task). The system allows automated dosing concentrations to be achieved for a period of up to 24 hours.

The control measures will largely be implemented through existing Sunwater procedures, but further improvement to the MDWSS is anticipated through enhanced cooperation with irrigators and planned improvements to scheme management automation. Most control measures represent improvement to existing systems and processes so do not require substantial re-training or major construction works beyond normal system maintenance. There are a few costly exceptions and they are discussed in section 7.5.

7.5. Financial implications of different measures as they relate to the type of activity

Consideration of the financial implications of alternative measures for algal management is presented in **Appendix 3**. As per section 7.4, based on the assessment, copper sulfate aquatic algaecide is currently considered to be the best available option for managing filamentous algae in irrigation supply channels of the MDWSS. The following section addresses the financial implications of the different control measures included in the Code for the use of copper sulfate aquatic algaecide.

Irrigation water is highly valued by the regional population, as is the production and employment it fosters. Any restrictions on supply due to inadequate algal management could have significant consequences for the region, hence the importance of the implementation of successful control measures under the Code.

The control measures largely reflect those in the existing Sunwater procedures so they represent little additional financial burden for Sunwater. In addition, implementation of the improved copper sulfate dosing techniques has to date resulted in cost savings for Sunwater. This is because efficient application leads to less copper sulfate being applied, as well as Sunwater spending reduced time on algal control. This is expected to continue with implementation of the Code.

The major physical infrastructure (valves, managed overflow points, etc.) is currently in place and the cost of any improvements related to fitting additional or better suited infrastructure will be met within Sunwater's scheme maintenance budget. Possible improvements in terms of piped distribution rather than open channels or stream supplementation, are major cost items (each one often tens of millions of dollars) so these are usually met through successful grant applications.

Any impost 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.

8. Using the code of practice

Best management practice for use of copper sulfate in irrigation channels of the MDWSS is currently represented by the directions for use on the APVMA label and by Sunwater's relevant procedures. These documented internal procedures respond to the risk assessment undertaken by the APVMA as part of the assessment to vary the product label for Sunwater Copper Sulfate Aquatic Algaecide, are part of Sunwater's ISO accredited EMS, and otherwise represent an Environmental Management Plan (EMP).

Sunwater's procedures will be updated to reflect the Code but remain independent of the Code and will be regularly audited and reported upon in accordance with the Sunwater EMS.

Sunwater will undertake the activity in accordance with the Code. Evidence of compliance with the Code will be through monitoring and record keeping as described in Performance Outcome 1.7.

It should be noted that a laboratory-based analysis of the quality of water at an overflow or supplementation point during a treatment event[4] and showing results consistent with either:

1. the specifications of the EPP Water and Wetland Biodiversity; or
2. the ambient (natural background) water quality of the receiving waters at the time of release

will be taken as evidence of the success of control measures, without further need to show compliance with each control measure in the Code. This is taken as an appropriate alternative course of action (refer to the alternative control measure listed under Performance Outcome 1.7).

If, through ongoing experience it was thought worthwhile to amend the Code, this will be discussed with the Department of Environment and Science and an amendment to the Code by the Minister sought.

The Code:

- gives practical guidance on how environmental best management practices can be achieved in the management of algal growth
- should be followed unless there is an alternative course of action that achieves the same or better environmental objective.

Where the Code refers to legislation by date, it should be read as referring to any updates of that legislation applicable at the time of conducting the activity.

8.1. Performance outcomes

Performance outcomes are the result that Sunwater needs to achieve to meet the 'general environmental duty' described under the EP Act. The outcomes may relate to any environmental value (values of air, water, land, or the acoustic environment and to the correct management of waste such that these values are protected) which may be affected by algal growth management in the MDWSS. As noted, this Code only relates to protection of the environmental values of water and wetlands.

There is a single overarching performance outcome in this Code:

[4] As per the monitoring program required under Performance Outcome 1.7 and described in the *Explanatory guide and description of monitoring program* accompanying the Code.

- there is no release to receiving waters[5] 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 water[6].

Sub-outcomes and suggested control measures to achieve the performance outcome are specified in Section 10. If Sunwater does not use the suggested control measures, then compliance with the Code cannot be relied on as a defence if unlawful environmental harm is caused. Sunwater may still rely upon the defence of complying with the general environmental duty under the EP Act but will have to demonstrate how the general environmental duty was met another way.

Note: Some performance sub-outcomes provide the option for an environmentally harmful activity to be prevented or minimised. Prevention is the more desirable outcome. If Sunwater selects to minimise the harmful activity it must be demonstrated that consideration has been made to the following:

- sensitivity of the receiving environment
- nature of the harm
- existing technical knowledge for the activity
- feasibility to relocate activity
- financial implications of using different control measures.

8.2. Control measures

There are several control measures provided which, if undertaken in combination, will help to achieve the performance sub-outcomes and the performance outcome. The control measures are described in Section 10 as they relate to each performance sub-outcome. If Sunwater chooses to use control measures other than those provided, it will not be able to rely on complying with the Code as a defence if it causes unlawful environmental harm. Sunwater may still rely upon the defence of complying with the general environmental duty but will have to show how it has met its general environmental duty another way.

The focus of the control measures is on best management practice related to:

- preventive maintenance (to minimise the need to manage algae)
- actions which make the ‘open’ MDWSS act more like a ‘closed’ system during treatment (to prevent releases to natural watercourses)
- record keeping and monitoring to ensure results are measurable, and continuous improvement is fostered.

9. Best practice

Best practice for use of copper sulfate in irrigation channels in the MDWSS is currently represented by the directions for use on the APVMA label and by the internal procedures developed by Sunwater for this activity, including Sunwater’s ISO accredited EMS. The Code has drawn on these sources and itself now represents best practice for the MDWSS.

The Code may be amended if necessary (refer to section 5) but otherwise remains in effect for seven years.

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

[6] 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.

An operator can implement updated control measures and still comply with their environmental duty if they can show that the updated actions represent an alternative course of action that achieves the same or better environmental objective.

10. Environmental management plan

The performance outcome, sub-outcomes and control measures listed in this section of the Code constitute an appropriate Environmental Management Plan (EMP). If an action is brought against Sunwater related to (1) environmental harm or (2) depositing of a prescribed water contaminant, section 493A (5) (a) and (b) of the EP Act determines that Sunwater will be deemed to have complied with its general environmental duty if it is able to demonstrate compliance with the Code (to the extent relevant).

If the EMP is not implemented, Sunwater will not be able to rely on complying with this Code as a defence if it causes unlawful environmental harm. Sunwater may still rely upon the defence of complying with the general environmental duty but will have to demonstrate how it met its general environmental duty another way.

This EMP ensures:

- all potential environmental risks from the activity are identified and control measures are in place to prevent or minimise the potential for environmental harm
- contingency measures are in place to avoid environmental harm in the event of unforeseen circumstances or natural disasters (e.g. flood)
- operators, staff and contractors are trained and aware of their requirements of the EP Act
- reviews of environmental performance are undertaken periodically
- records of treatments, monitoring, incidents, investigations and complaints are kept.
- the administering authority is notified within 72 hours of any exceedances/departures in excess of 20% of natural background water quality or relevant WQOs in receiving waters (whichever is greater) for key indicators addressed in the Code (copper, DO).

To reiterate, compliance with the Code must be able to be supported by documentary evidence. The EMP includes reference to Sunwater's internal record keeping procedures (including of monitoring, incidents and complaints) incorporated within its ISO accredited EMS, which, if completed fully, will satisfy the requirement for documentary evidence. The reporting and monitoring procedures are nominated in this EMP.

10.1. Performance outcome 1

There is no release to receiving waters 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 water[7].

Water released to receiving waters may be contaminated with substances that have the potential to cause material or serious environmental harm.	**Potential risks and impacts** Copper-treated water released at supplementation or overflow points may contain copper, blue green algal cells, blue green algal toxins or oxygen demanding substances in concentrations which could affect the environmental values for the receiving waters as listed in Schedule 1 of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 as updated.
	Performance outcome 1.1 ***In-channel treatment of algae is only undertaken when and where necessary and using a preventive maintenance approach*** √ Suggested control measures □ Prior to treatment, check blue green algae (BGA) results (Tinaroo Falls Dam, Mutchilba WTP, raw water) prior to copper sulfate treatment. Where potential BGA risk is high (i.e. high cell count for toxic species and/or toxins present) review alternative mechanisms, including deferral of treatment where possible. □ Monitor during and following release to ensure that adverse impacts to aquatic life, offensive odours and unsightly conditions due to the release are not caused. □ Where there are no visible traces of algae, channels will be visually inspected on a weekly basis by a team of Sunwater Operator Maintainers as part of routine surveillance activities. □ Where visible traces of algae are evident, channels will be visually inspected every three days, with observations communicated to the Sunwater Operator Maintainer – Vegetation Maintenance (within 24 hours. □ Designated Sunwater 'Algae monitoring points' along irrigation channels are identified for each operational section of the MDWSS. □ Where conditions are suited to algal growth (e.g. hot, sunny weather) and if operationally feasible, staff are advised to take photos from designated Sunwater

[7] 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.

	'Algae monitoring points' to assist the Operator Maintainer – Vegetation Maintenance in identifying growth stage of algae. • Provision of raw water quality monitoring data (Tinaroo Falls Dam, Mutchilba WTP) to the Department collected as per existing routine monitoring programs. The 12 and 24-month report will be submitted to provide analysis of data regarding direct or indirect impacts upon the receiving environment, particularly in relation to dissolved oxygen. • The Operator Maintainer – Vegetation Maintenance will review weather forecasts from the Bureau of Meteorology and advise the priority scheduling of copper sulfate treatments. Treatment will not be conducted if significant rain or storm events are forecast during the proposed treatment period.

Performance outcome 1.2

The dose concentration and duration are the minimum that achieves a satisfactory result.

√ Suggested control measures

- Copper sulfate dose concentration and duration must not exceed those specified in the directions for use on the APVMA label (APVMA approval 67673/105182): namely '*DO NOT dose water at rates greater than 0.05 mg/L Copper (Cu) [0.2 mg/L copper sulfate pentahydrate]. DO NOT apply for more than 24 hours continuous dosing'*
- Identify and confirm the extent of the algal growth and the applicable dosing location for treatment.
- Determine the dose concentration for the copper sulfate treatment period (i.e. in-channel mixed concentration).
- Determine the dose duration (the minimum treatment time required to ensure an effective algae treatment at the nominated dose concentration for the targeted treatment area).
- Obtain the anticipated channel flow rate for the treatment period from the Sunwater Operator Maintainer – Water Distribution.
- Use the dose concentration, dose duration and anticipated channel flow rate to calculate the quantity of copper sulfate required to be dissolved in the mixing tank.
- Where practicable, defer treating when:
  - weather conditions are likely to significantly reduce dissolved oxygen saturation concentrations (e.g. prolonged hot weather combined with extensive algal growth), or
  - there is a potential for blue green algal toxin impacts on the environmental values or the receiving waters

Performance outcome 1.3

The dose concentration can be accurately calculated and delivered.

√ Suggested control measures

- A Certificate of Analysis for the product (Sunwater Copper Sulfate Aquatic Algaecide (APVMA label Number 67673) should be obtained from the supplier to confirm the quality of the product. A copy of the APVMA Approval (No. 67673/105182), this Code of Practice and the Safety Data Sheet for Copper Sulfate Pentahydrate must be on display and available to Sunwater employees (or contractors) at the Mareeba Depot equipment storage area and the mixing location/s.
- Only approved Sunwater copper sulfate dosing equipment can be used to treat channels. The currently approved copper sulfate dosing equipment consists of the following components:
  - (1) dosing tank
  - (2) circulating pump or electric agitator
  - (3) generator
  - (4) dosing pump.
- Copper sulfate dosing equipment will be operated as summarised in the following points.
  - At the Sunwater Mareeba Depot, pre-fill the mixing tank with at least 200 litres of clean water and turn on the circulation pump. Check equipment for leaks or any other issues.
  - Add the previously calculated quantity of copper sulfate.
  - Fill the tank to 800 litres and continue circulation until thoroughly mixed.
  - Upon arrival at the dosing site and after securing the trailer, commence circulation for at least 10 minutes to ensure copper sulfate has not settled out.
  - Set delivery rate of the dosing pump for the previously calculated dose duration.
  - Apply hose to irrigation channel and commence dosing, including any in-channel mixing actions.
  - Check delivery rate by capturing release in a graduated measuring cylinder. Adjust if necessary.

	▪ Upon completion of the dosing event, rinse equipment with clean water within the Sunwater Mareeba Depot wash-down area. ▪ Record actual dose duration time and the volume of copper sulfate solution delivered.
	Performance outcome 1.4 ***Procedures are in place to ensure adjustment of mechanical infrastructure is undertaken to minimise the risk or volume of releases.*** √ Suggested control measures □ Inspection and necessary maintenance of control structures at supplementation and overflow points is undertaken during the low risk algal growth period (Winter) in order to confirm seal and function. □ Prior to copper sulfate treatment, isolate supplementation sections at locations where this is possible (by closing the valve or gate). □ Manage water levels in treated channels so that only the volume of water required to service orders is passed through the treated section. □ Manage water levels in channels so that water is retained in channel sections (where option is available to do so). An example is ensuring the outlets which can be closed are in fact closed prior to algal treatment. □ Raise the trigger level of overflows in locations where this is possible (the ability to do so varies with the type of structure installed).
	Performance outcome 1.5 ***Procedures are in place to implement other actions during treatments that reduce the risk of overflows***. √ Suggested control measures □ Contact all interested parties in the region (Reference list held in Sunwater Mareeba office) to make them aware of algal treatment and to arrange management measures (e.g. notifying any active aquaculture venture within the MDWSS of a dosing event and seeking agreement not to take water during that time). □ Where feasible, and by mutual, documented agreement, dosing will be scheduled with customers to coordinate extraction of water during a treatment, thereby reducing the quantity of water which may overflow from supply channels. □ Where feasible, and by mutual, documented agreement, arrange for the terminal irrigator, or an

	irrigator downstream of the algal infestation, to take excess water prior to channel overflowing. - Sunwater will investigate opportunities to convert sections of open channel, which are high risk sections for algal growth, to alternative low risk infrastructure (e.g. pipeline). Conversion will be undertaken dependent upon funding availability. - Sunwater will continue to investigate opportunities to further improve scheme automation and confirm water orders to minimise the risk of overflow during dosing. Feasible and practical actions will be implemented dependent upon funding availability, noting some scheme improvements are currently underway where funding has been secured. - Should any unforeseen event occur during treatment, which may impact the achievement of performance outcomes, treatment will cease immediately.
	Performance outcome 1.6 ***Staff and contractors are appropriately trained.*** √ Suggested control measures - Sunwater employees (or contractors) who are involved in the storage, transport, and application of copper sulfate – including their supervisors – must have the following training and/or licencing prior to involvement in copper sulfate treatment activities: ▪ Commercial Operators Licence under the *Agricultural Chemicals Distribution Control Act 1966* ▪ Current Australian Drivers Licence ▪ Competency in trailer towing ▪ Knowledge of the contents of this Code ▪ Knowledge of the Copper Sulfate Product Label (Approval No. 67673/105182) ▪ Knowledge of the Safety Data Sheet for Copper Sulfate Pentahydrate ▪ Knowledge of Sunwater documents developed to ensure compliance with the Code, the Copper Sulfate Product Label (Approval No. 67673/105182) and the Safety Data Sheet for Copper Sulfate Pentahydrate ▪ Knowledge of irrigation channel operations, including control of water flow rates in irrigation channels. - Records of training are to be kept on file.

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

√ Suggested control measures

- Standardised reports of copper sulfate treatment related activities and any associated incidents or complaints will be kept and recorded in accordance with Sunwater's ISO14001 compliant EMS, i.e.:
  - The monitoring of algal growth and decision to proceed with treatment at a particular location.
  - The calculation of the appropriate treatment concentration and duration (as per performance outcome 1.2).
  - The pre-treatment actions undertaken to minimise the likelihood of channel overflow, including agreements with customers to take water during a treatment.
  - Notifications provided to water users and other relevant landholders as required.
  - Post-treatment confirmation of the dose concentration and duration, the triggering of any overflows or flow in supplemented streams and an estimate of the volume of treated water released.
  - Results of monitoring undertaken in accordance with the monitoring program described in the accompanying *Explanatory guide and description of monitoring program*.
  - Incidents or complaints arising from activities associated with copper sulfate treatments.
- Any copper treatment records must be provided to the administering authority upon request.
- Undertake regular internal audit of records and procedures associated with this activity, in accordance with Sunwater's ISO14001 compliant EMS.
- As part of auditing, and to facilitate continuous improvement, a monitoring program must be undertaken in accordance with the specifications outlined in the accompanying *Explanatory guide and description of monitoring program*. The aim of the monitoring is to ensure that the control measures implemented as part of the Code achieve the intended outcomes – that there is no release to receiving waters of copper sulfate or copper, blue green algae or oxygen demanding substances at a level that causes,

	or is likely to cause, material or serious environmental harm or an environmental nuisance. □ Prior to commencement of the monitoring program, Sunwater will submit the proposed coordinates of upstream and downstream monitoring locations to the Department of Environment and Science, including any monitoring contingencies required to address flow variations in channels and receiving waters. Once these are agreed by the department, Sunwater will submit amended tables outlining site details to the Department of Environment and Science for record. □ The monitoring program will be reviewed by Sunwater and the Department of Environment and Science 12 months after commencement of monitoring and revised if required. Sunwater will be required to supply a report to the Department of Environment and Science on the results of the 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 and the ambient (natural background) water quality of the receiving waters at the time of release, as monitored through the *Explanatory guide and description of monitoring program.* □ A review of all monitoring and treatment results after year 2 will inform the need for and scope of further monitoring. □ In the case of an environmental incident potentially associated with the application of copper sulfate aquatic algaecide, Sunwater will 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 the responsible authority for drinking water and Queensland Health must be notified by Sunwater immediately. If, during the first year of monitoring, Sunwater or the Department of Environment and Science identify an urgent need to amend the monitoring program (for example, as a result of an environmental incident), this will be negotiated between the parties. □ If, through the monitoring program or other observations, Sunwater becomes aware of unauthorised copper dosing by third parties, it will advise the relevant regulatory authorities. ▪ For key indicators addressed in the Code (i.e. copper and DO), the administering authority will be notified of any exceedances/departures from ambient (background) water quality or WQOs,

	whichever is greater, in excess of 20% at the receiving environment downstream monitoring locations within 72 hours of identification/receipt of monitoring results.
	Alternative control measure to achieve performance outcome: √ Suggested control measures □ There is no release from a channel that has been treated with copper sulfate aquatic algaecide or, if a release does occur, the next point applies. □ Analysis of the relevant water quality parameters (including copper concentration, dissolved oxygen) of an overflow or supplementation point during a treatment event will be taken as evidence of the success of control measures, without further need to show compliance with each control measure in this Code, if (as per monitoring and analytical procedures in the *Explanatory guide and description of monitoring program* accompanying this Code): ▪ the results are consistent with the specifications of the EPP Water and Wetland Biodiversity 2019; ▪ the results do not exceed/depart from the ambient (natural background) water quality of the receiving waters at the time of release. ▪ 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. Note: Ambient (natural background) water quality excludes locations or situations where there are impacts from copper treatment activities (by Sunwater). Refer to *Explanatory guide and description of monitoring program* for more details on ambient monitoring sites.

11. Appendix 1: General obligations under the Environmental Protection Act 1994

11.1. General environmental duty

The *Environmental Protection Act 1994* (EP Act) section 319 states that we all have a general environmental duty. This means that we are all responsible for the actions we take that affect the environment. We must not carry out any activity that causes or is likely to cause environmental harm unless we take all reasonable and practicable measures to prevent or minimise the harm. To decide what meets your general environmental duty, you need to think about these issues:

- the nature of the harm or potential harm
- the sensitivity of the receiving environment
- the current state of technical knowledge for the activity
- the likelihood of successful application of the different measures to prevent or minimise environmental harm that might be taken
- the financial implications of the different measures as they would relate to the type of activity.

It is not an offence not to comply with the general environmental duty however maintaining your general environmental duty is a defence against the following acts:

(a) an act that causes serious or material environmental harm or an environmental nuisance

(b) an act that contravenes a noise standard

(c) a deposit of a contaminant, or release of stormwater run-off, mentioned in section 440ZG.

11.2. Duty to notify

The duty to notify (sections 320-320G of the EP Act) requires a person or company to give notice where serious or material environmental harm is caused or threatened to occur. Notice must be given of the event, its nature and the circumstances in which the event happened. Notification can be verbal, written or by public notice depending on who is notifying and being notified.

For more information on the duty to notify requirements, refer to the guideline 'The duty to notify of environmental harm'[8].

[8] Available at www.qld.gov.au, using the publication number ESR/2016/2271 as a search term.

11.3. Relevant offences under the *Environmental Protection Act 1994*

1. Causing serious or material environmental harm (sections 437-439)

Material environmental harm is environmental harm that is not trivial or negligible in nature. It may be great in extent or context or it may cause actual or potential loss or damage to property. The difference between material and serious harm relates to the costs of damages or the costs required to either prevent or minimise the harm or to rehabilitate the environment. Serious environmental harm may have irreversible or widespread effects, or it may be caused in an area of high conservation significance. Serious or material environmental harm excludes environmental nuisance.

2. Causing environmental nuisance (section 440)

Environmental nuisance is unreasonable interference with an environmental value caused by aerosols, fumes, light, noise, odour, particles or smoke. It may also include an unhealthy, offensive or unsightly condition because of contamination.

3. Depositing a prescribed water contaminant in waters (section 440ZG)

Prescribed contaminants include a wide variety of contaminants listed in Schedule 10 of the Environmental Protection Regulation 2019. It is your responsibility to ensure that prescribed contaminants are not left in a place where they may or do enter a waterway, the ocean or a stormwater drain. This includes making sure that stormwater falling on or running across your site does not leave the site contaminated. Where stormwater contamination occurs, you must ensure that it is treated to remove contaminants. You should also consider where and how you store material used in your processes onsite to reduce the chance of water contamination.

4. Placing a contaminant where environmental harm or nuisance may be caused (sections 443 and 443A).

11.4. Relevant offences under the *Waste Reduction and Recycling Act 2011*

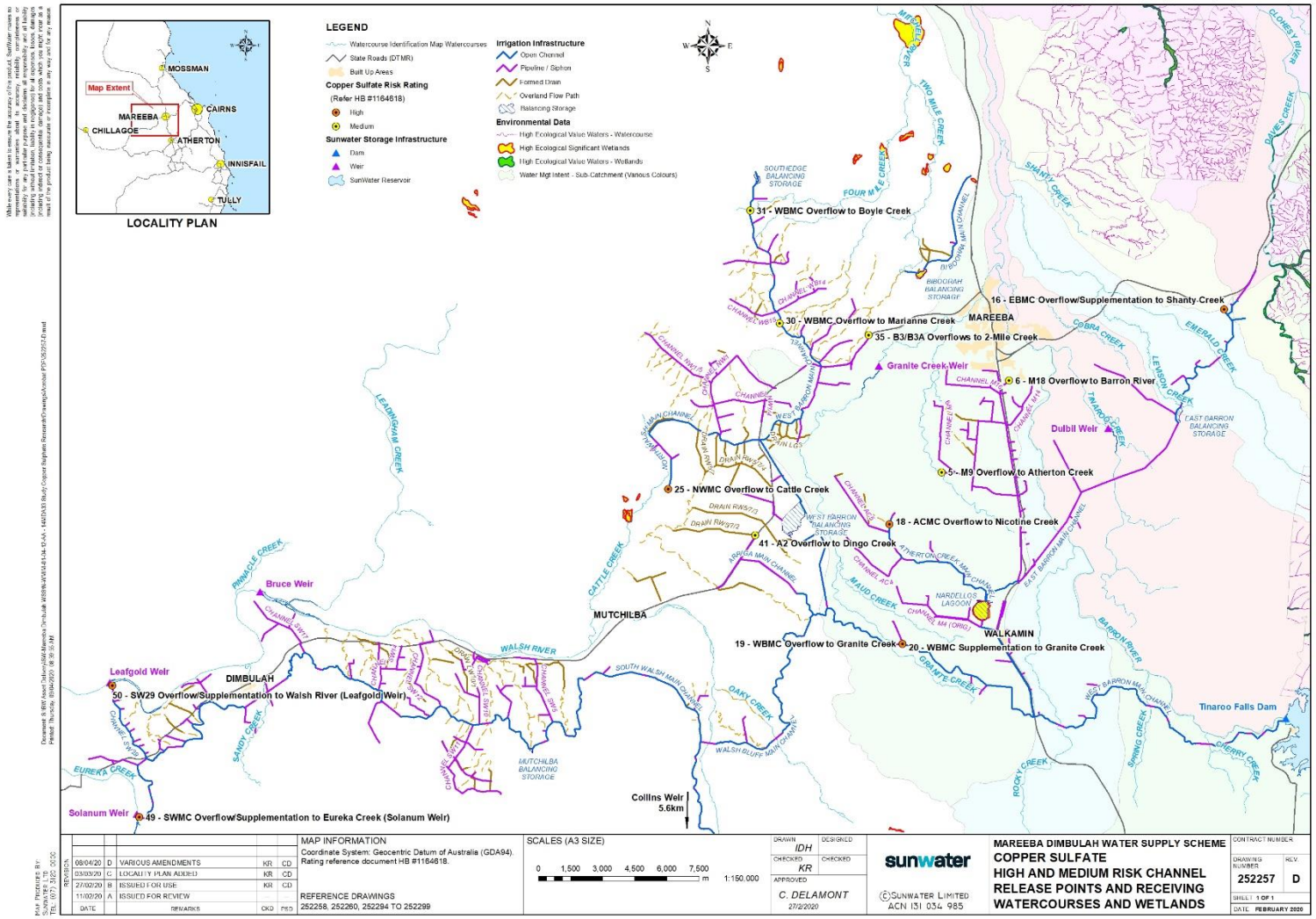
1. Littering (section 103)

Litter is any domestic or commercial waste and any material a person might reasonably believe is refuse, debris or rubbish. Litter can be almost any material that is disposed of incorrectly. Litter includes cigarette butts and drink bottles dropped on the ground, fast food wrappers thrown out of the car window, poorly secured material from a trailer or grass clippings swept into the gutter. Litter can also be an abandoned vehicle. However, litter does not include any gas, dust, smoke or material emitted or produced during, or because of, the normal operations of a building, manufacturing, mining or primary industry.

2. Illegal dumping of waste (section 104)

Illegal dumping is the dumping of large volumes of litter (200 litres or more) at a place.

12. Appendix 2: MDWSS – Copper sulfate high and medium risk channel release points and receiving watercourses and wetlands



13. Appendix 3: Summary - alternative measures for managing filamentous algae in the MDWSS

Physical/mechanical measures		
Manual removal (raking by hand)		
WHS	✗	Significant risks to employees.
Environment	✓	No significant risk.
Effective	✗	Rate of algal growth too fast in peak growing conditions.
System Design	✓	No significant issues.
Cost	✗	Large labour workforce required to maintain control of algal growth during peak growing season is cost prohibitive.
Draining/drying channel		
WHS	✓	No significant risk.
Environment	✓	No significant risk.
Effective	✓	Draining/drying channel (2-3 weeks) effectively controls algal growth.
System Design	✓	No significant issues.
Cost	✗	Diversification of crops throughout irrigation area in recent years requires constant supply of irrigation water. Costs to regional productivity resulting from extended shut-down of irrigation scheme means this measure is cost prohibitive.
Artificial shading of channel		
WHS	✗	Hinders visual observation of channel structure and potential dangers to workers (e.g. snakes). Risk to public safety (entrapment).
Environment	✗	Potential risk for trapping wildlife in channels.
Effective	✗	Can limit algal growth in its direct area of influence but some algae can still grow in quite low light conditions.
System Design	✗	Hinders visual observation of channel structure, which is necessary for maintaining channel integrity (e.g. detecting cracks, signs of damage).
Cost	✗	Very expensive given the long distances to be covered and the covers can potentially be damaged by wet season storms and cyclones.

Physical/mechanical measures		
Conversion of channels to pipeline		
WHS	✓	No significant risk.
Environment	✓	No significant risk.
Effective	✓	Piping flow eliminates sunlight - a major factor in filamentous algal growth.
System Design	✓	Sunwater has investigated opportunities for, and the feasibility of, replacing some open channels with pipes. Where Government funding has been successfully applied for, works are currently underway to improve the scheme infrastructure.
Cost	✗	Very expensive. Dependent on Government funding to implement.

Chemical measures		
Chelated copper (e.g. Coptrol Aquatic Algaecide, Cupricide Algaecide)		
WHS	✓	No significant risks.
Environment	✗	Treated waters cannot be released to natural waterways, according to product label specifications.
Effective	✗	Requires extended contact time (2-3 days).
System Design	✗	Open channel system with potential for release to waterway.
Cost	✗	Cost prohibitive - approximately $15,000 for a single treatment.
Water conditioner (e.g. Phoslock)		
WHS	✓	No significant risks.
Environment	✓	No significant risks.
Effective	✗	Limits phosphorus bio-availability to algae. During the management of the scheme, Sunwater has found that sunlight, rather than high nutrient levels, is a more significant contributing factor to algae growth in irrigation channels of the MDWSS.
System Design	✗	Applied to stationary water bodies. Action method requires extended contact time (4+ hours) and gradual settlement out of suspension.
Cost	✗	Irrigation channel water is constantly moving through system and replenished from upstream. Would require constant reapplication of product.

Chemical measures		
Acrolein (e.g. Magnacide H™)		
WHS	✗	Highly hazardous. Rigorous WHS controls required.
Environment	✗	Very toxic to aquatic organisms.
Effective	✗	Primary use is for control of aquatic macrophytes (plants), not algae.
System Design	✗	Treated water must be isolated and held in-channel for an extended period until it is safe to release to irrigators or environment. Current open channel design with potential for release to waterway does not support this.
Cost	✗	Cost of product, associated WHS controls and channel system modifications required to allow use of product are cost prohibitive.
Copper sulfate		
WHS	✓	No significant risks.
Environment	✗	Water quality objectives exist for copper. Toxicity to aquatic organisms depends on a number of factors including but not limited to pH, water hardness and, salinity and dissolved organic carbon concentrations.
Effective	✓	Widely used in Australia for control of algae. Proven effectiveness at low concentrations.
System Design	✗	Open channel system with potential for release to waterway. Requires overflow prevention through system management (including mechanical management of gates/valves, water scheduling with water users, etc.), and improved automation of water delivery to reduce and/or eliminate releases from channel.
Cost	✓	Product relatively inexpensive to purchase.
Enzyme-based treatment: This was raised as a treatment option during the consultation process on the Code, and is addressed in the explanatory guide to the Code		