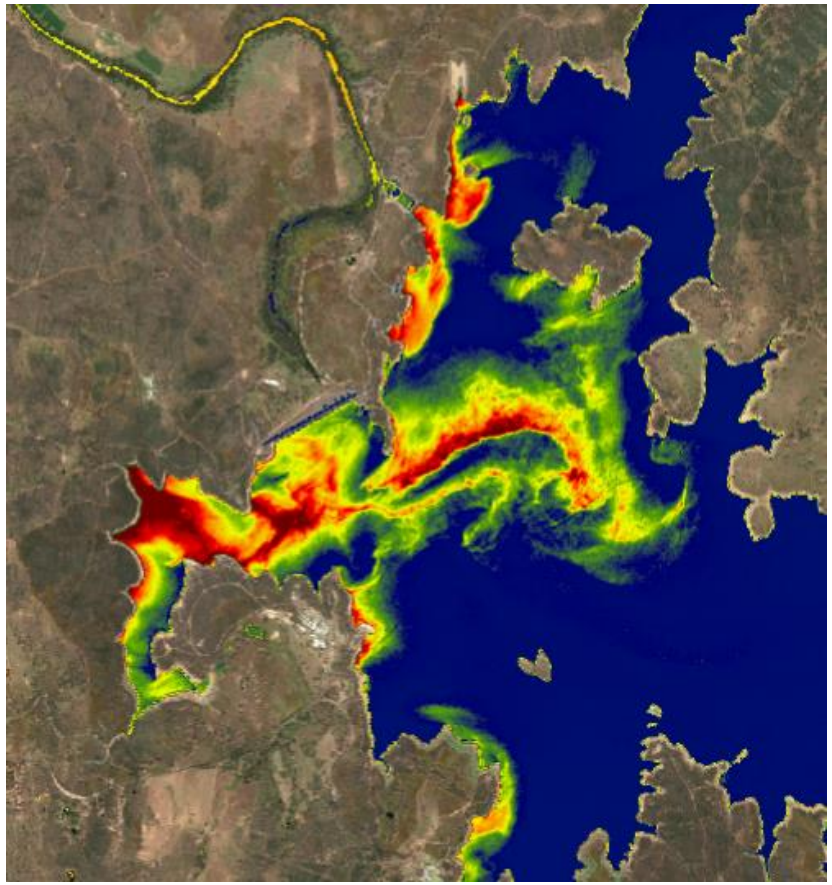
Developing a Sentinel Script and Framework to Manage Algae Risk in NSW

Burrendong Dam December 2022 – Sentinel-2 true colour composite (RGB)



Burrendong Dam December 2022 Sentinel-2 with WaterNSW-Custom Algae Script

SentinelHub [CC BY-NC 4.0] NSW-Custom Algae Script - TF, WaterNSW

WaterNSW coordinates a state-wide strategy for managing risk to recreational water users from harmful algal blooms (Cyanobacteria) in NSW.

A key component of undertaking this is:

- **Managing a state-wide algae sampling and reporting program consisting of 154 routine sites in the rivers and the storages.**

Constraints of the existing sampling process on these large scales are:

- Algae data is costly to collect and analyse.
- **Time lag from sample collection and sample analysis** - up to several days in remote areas.
  - → **Algae can be very mobile and dynamic in concentration changes**.
- Algae blooms can arise very quickly in areas not captured by routine sampling programs.
- Sampling data gives little information on the full extent of the algae bloom, unless algae sampling network is of a high density.

These constraints prompted WaterNSW to explore the use of satellite imagery to enhance algae risk management in NSW.

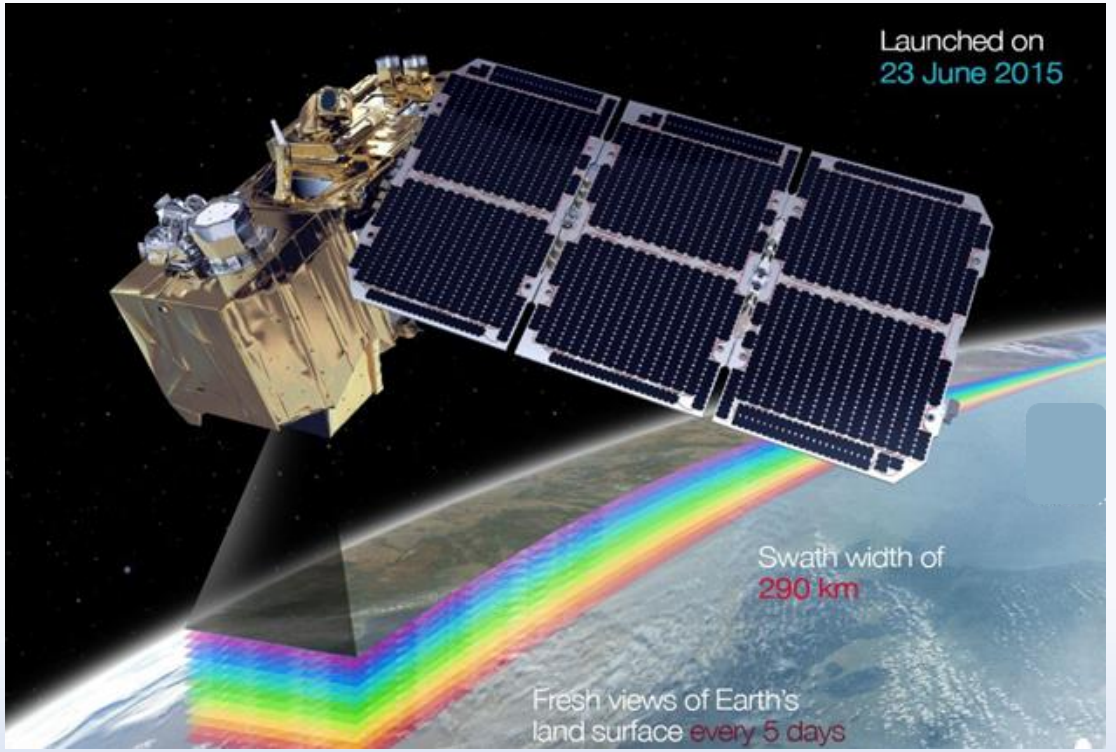
The aim:

- To develop a custom algae mapping script for use with the Sentinel-2 satellite platform using the web-based Sentinel-Hub EO-Browser to map algae risk. (https://www.sentinel-hub.com/)
  - The map needed to be easily identifiable by others with the Green, Amber and Red Alerts colour values that are used in NSW.
  - Be aligned as closely with existing NSW algae guidelines.
  - A universal fit for all inland NSW waters (one script fits all).

- To develop an algae risk framework that would:
  - Be compatible with the existing NSW algae management processes and guidelines.
  - Help with consistency in the way we monitor algae blooms using satellite imagery.

Sentinel-2 is a good platform for monitoring algae using the Normalised Difference Chlorophyll Index (NDCI) algorithm for estimating chlorophyll-a density to give an estimation of algae concentrations.

- 5-day return interval
- Resolution down to 20m using the NDCI
- Readily available imagery though various sources such as Sentinel EO Browser, National Map, etc



Https://www.airbus.com/en/asset-preview/91626

	Band	Resolution	Central Wavelength	Description
	B1	60 m	443 nm	Ultra blue *(peak absorbance chl-a)*
(Natural colour) RGB composite	B2	10 m	490 nm	Blue
	B3	10 m	560 nm	Green *(peak Reflectance of chl-a)*
NDCI	B4	10 m	665 nm	Red *(peak absorbance chl-a)* ★
NDCI	B5	20 m	705 nm	Visible and Near Infrared *(peak Reflectance of chl-a)* ★
	B6	20 m	740 nm	Visible and Near Infrared (VNIR)
	B7	20 m	783 nm	Visible and Near Infrared (VNIR)
	B8	10 m	842 nm	Visible and Near Infrared (VNIR)
	B8a	20 m	865 nm	Visible and Near Infrared (VNIR)
	B9	60 m	940 nm	Short Wave Infrared (SWIR)
	B10	60 m	1375 nm	Short Wave Infrared (SWIR)
	B11	20 m	1610 nm	Short Wave Infrared (SWIR)
	B12	20 m	2190 nm	Short Wave Infrared (SWIR)

WaterNSW-Custom Algae Script

= Chlorophyll-a ➡ approximate "total algae" (cyanobacteria + algae) concentration ➡ risk level

- Maps waterbodies as close as possible providing a general concentration guide ranges that can be further refined.
- Provides five risk levels that are desirable for recreational risk management of algae blooms in NSW.
- Attempts to be optimised for cyanobacteria estimates in NSW.

Caveats:

- The "starting concentration guide range" can potentially vary by a significant margin due to environmental factors such as; *aquatic plants, geology of the waterbody, species of algae, turbidity, time of day of the image capture, aerosols in the atmosphere, etc.*
- The mapping is not the official **"Algae Alert Level",** but rather provides information on the "**potential risk from harmful algae**" providing more information to water users.
- The script was developed for regional NSW.

Estimated risk levels based on the for WaterNSW-Custom Algae Script – using Sentinel-2

Recreational guideline values and alert colours used in NSW

Map Colour	Risk Level - based on Chlorophyll-a	Starting concentration guide range		Recreational alert values approx. equivalence	Recreational guideline alert values
Blue	Very low	<0.05 mm^3/L		No Alert	<0.04 mm^3/L
Green	Low	0.05 to 0.5 mm^3/L		Green	0.04 to 0.4 mm^3/L
Yellow	Medium	0.5 to 5.0 mm^3/L		Amber	0.4 to 4.0 mm^3/L
Red	High	5.0 to 20.0 mm^3/L		Red	> 4.0 mm^3/L
Dark red	Extreme	> 20 mm^3/L		Red	> 4.0 mm^3/L

Managing Algae Risk Framework:

Is used to incorporate satellite imagery into existing algae sampling and reporting programs to combine the best attributes of each monitoring method.

- If there is a red (high risk) on the map, it may or may not trigger a red alert. Other factors still need to be considered, how extensive, where it is located and what other supporting information e.g., the **primary** and/or **secondary indicators**.
  - The indicators are divided into "primary" and "secondary". One, or more of the primary indicators can initiate an alert. The secondary indicators are used as supporting information for the primary indicators.

1. **Algae sampling results = primary indicator** → guideline results = alert
2. **On ground observations = primary indicator**
3. **Satellite imagery = primary indicator**

→ preferably use both before declaring an alert → sampling as per alert requirements

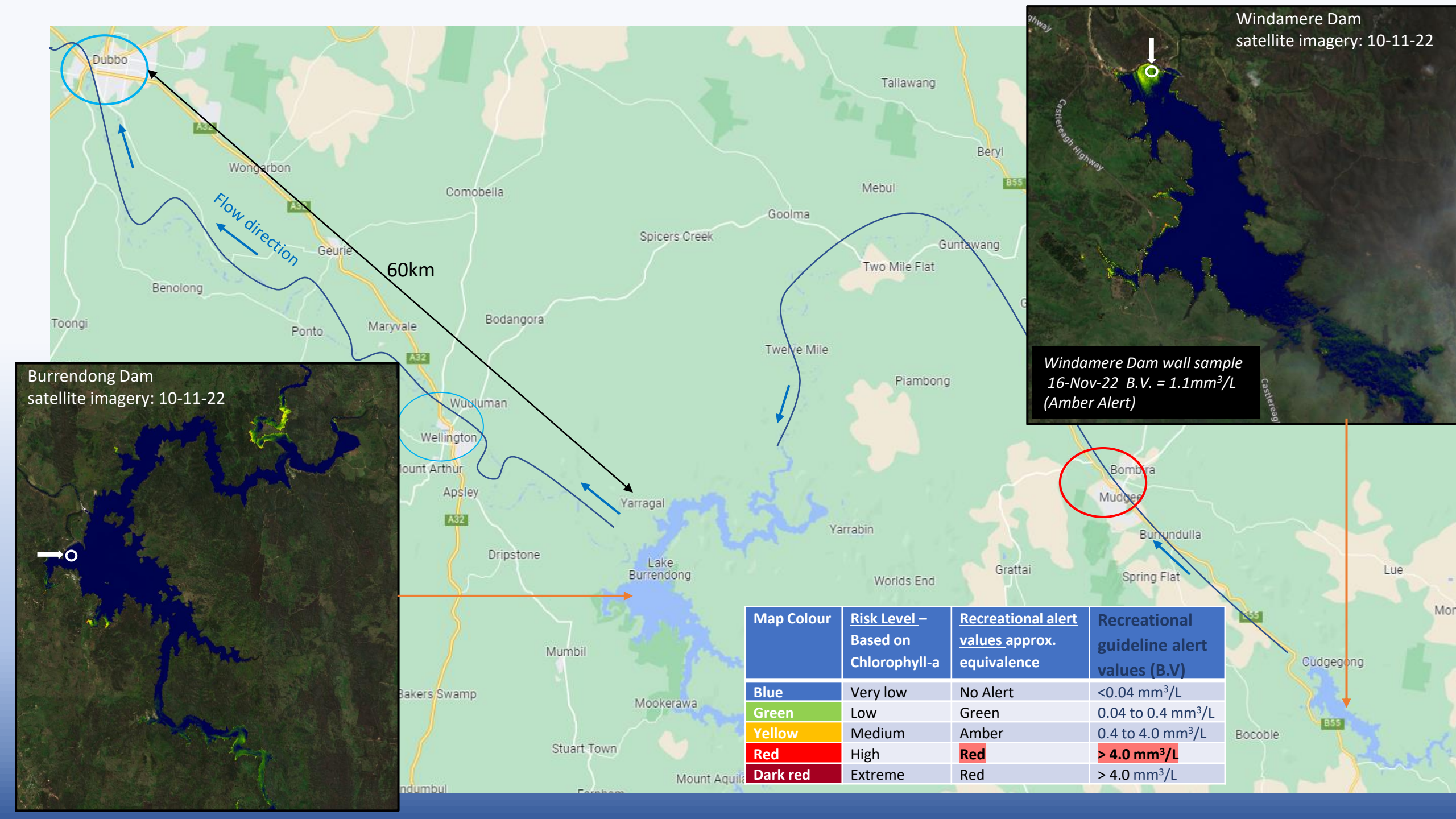
Secondary indicators use to support decision making on algae alerts

a. Weather conditions - *(sunny<->cloudy, hot <-> cold, wind direction & speed)*
b. River flows/storage levels - *(high flow <-> low flow)*
c. Water chemistry if known - *(pH, dissolved oxygen,…)*
d. Water physical attributes - (smell, turbidity, suspended sediments,…etc)

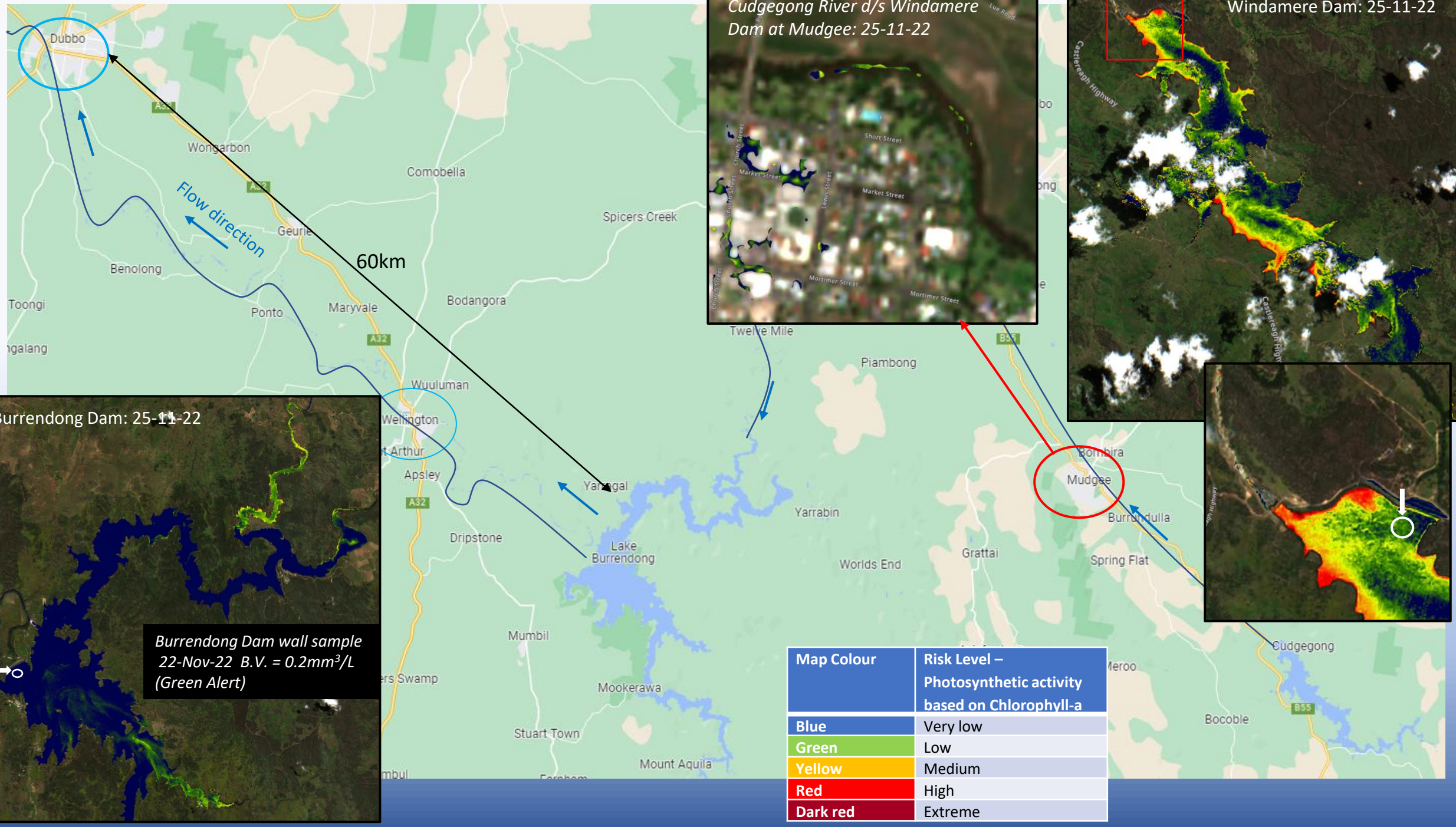
Algae event in Burrendong and Windamere Dams November-December 2022

Burrendong Dam

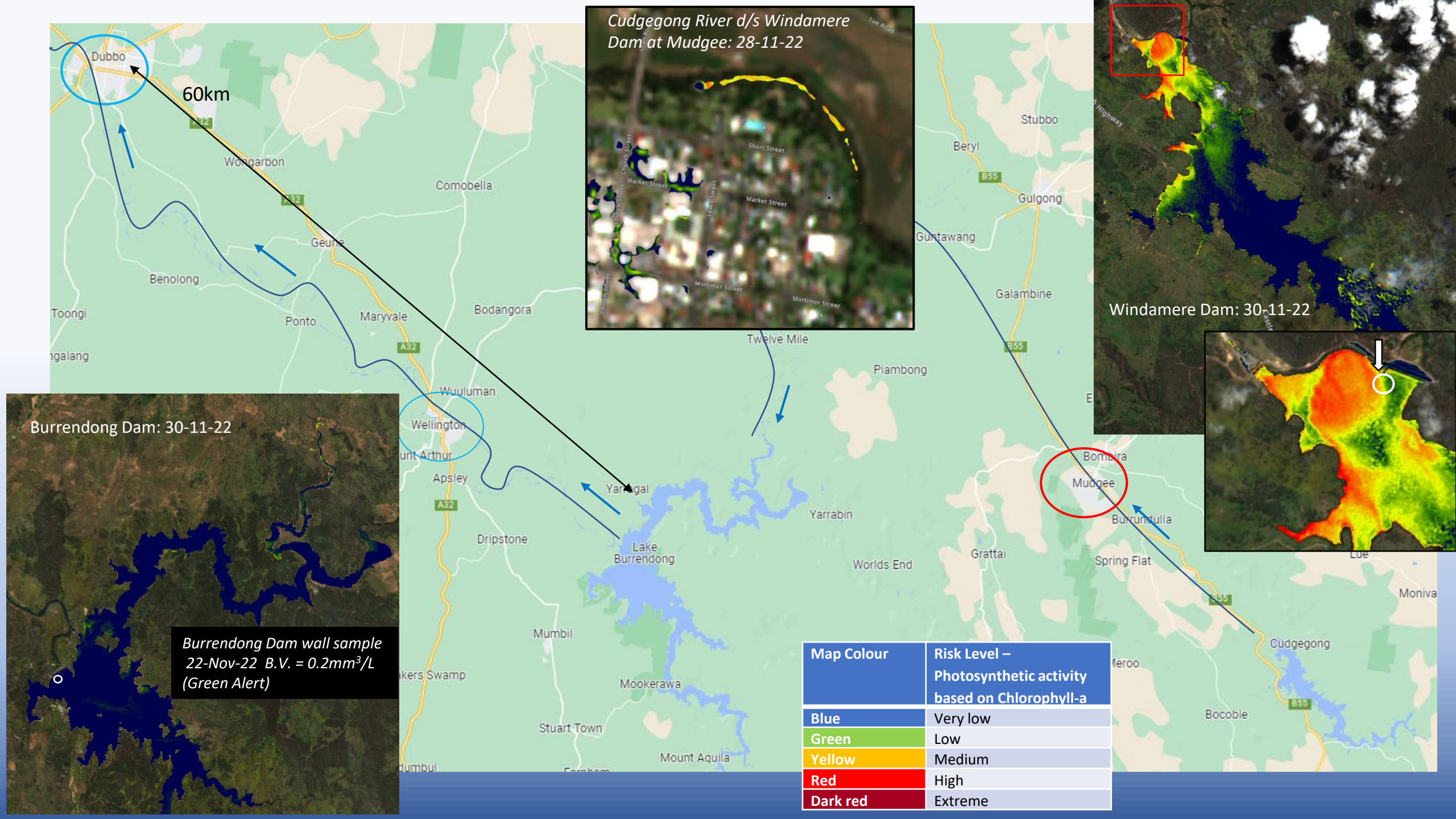
Windamere Dam



Map Colour	Risk Level – Based on Chlorophyll-a	Recreational alert values approx. equivalence	Recreational guideline alert values (B.V)
Blue	Very low	No Alert	<0.04 mm³/L
Green	Low	Green	0.04 to 0.4 mm³/L
Yellow	Medium	Amber	0.4 to 4.0 mm³/L
Red	High	Red	> 4.0 mm³/L
Dark red	Extreme	Red	> 4.0 mm³/L



Map Colour	Risk Level – Photosynthetic activity based on Chlorophyll-a
Blue	Very low
Green	Low
Yellow	Medium
Red	High
Dark red	Extreme



Map Colour	Risk Level – Photosynthetic activity based on Chlorophyll-a
Blue	Very low
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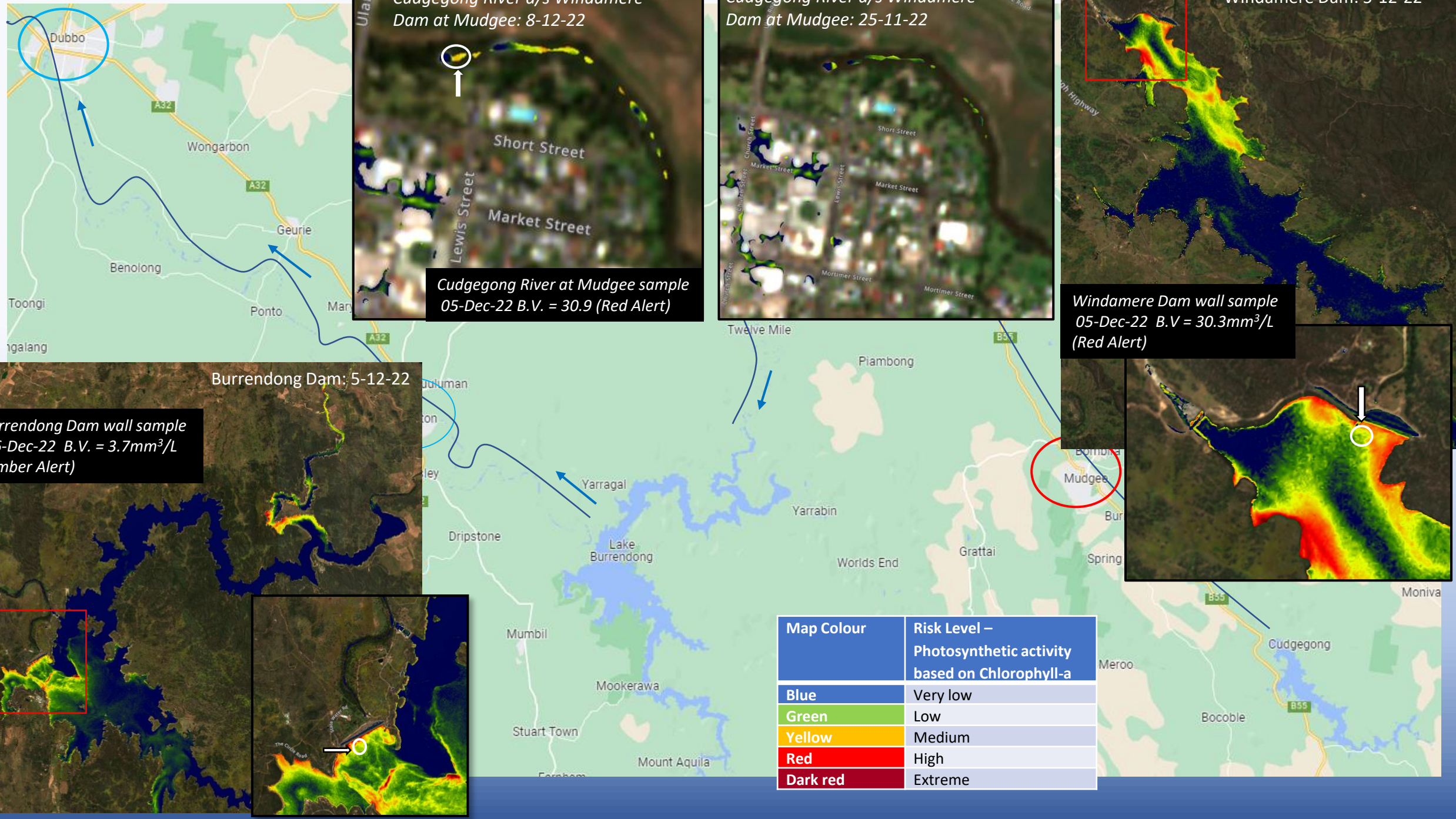
Yellow	Medium
Red	High
Dark red	Extreme



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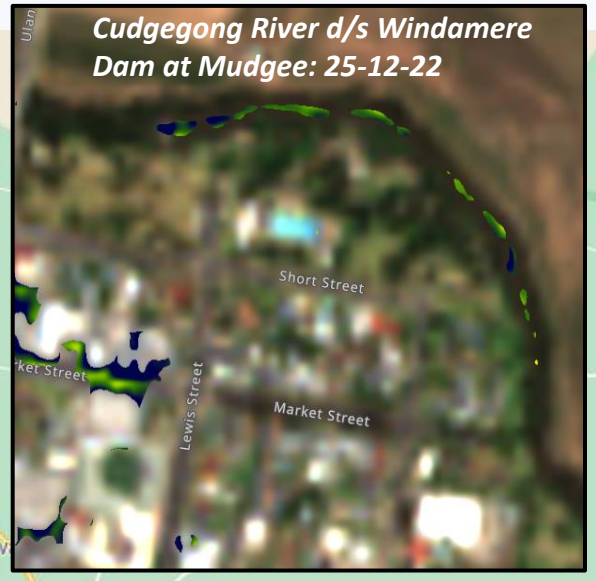
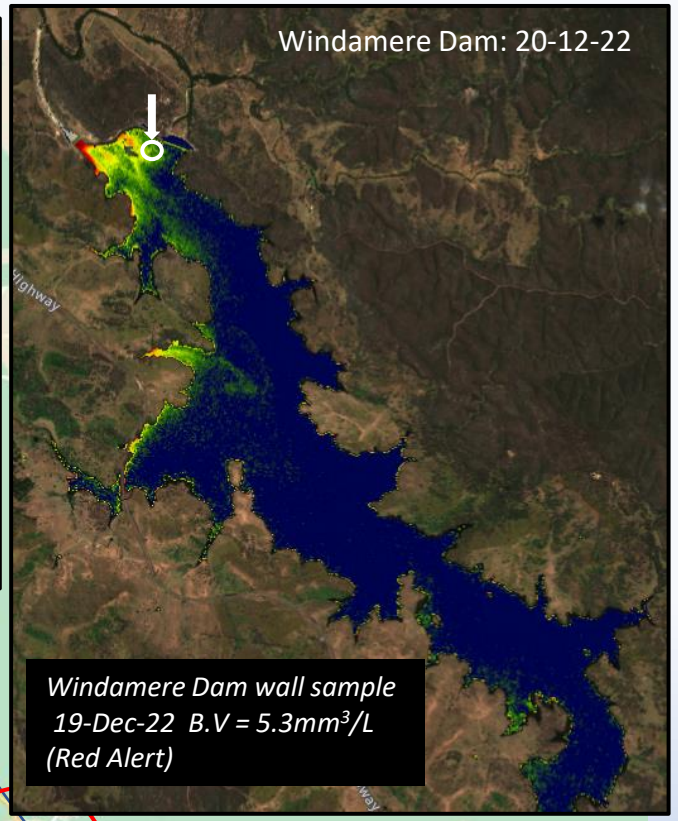


Cudgegong River d/s Windamere Dam at Mudgee: 25-12-22

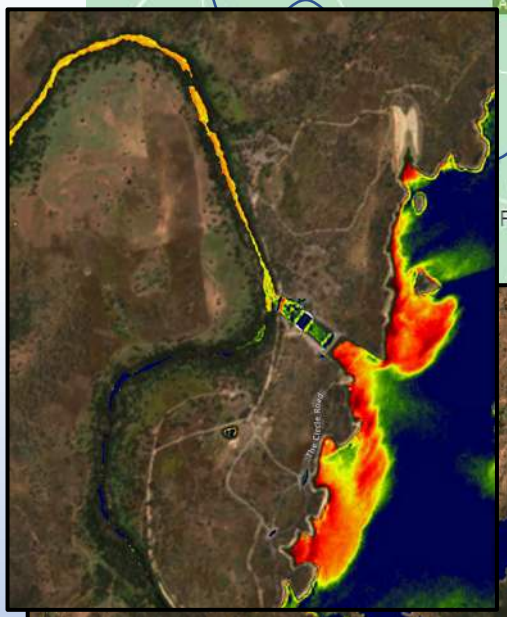
Cudgegong River d/s Windamere Dam at Mudgee: 8-12-22

Cudgegong River at Mudgee Biovolume = 30.9mm³/L (Red Alert) on 5th December



Windamere Dam: 20-12-22

Windamere Dam wall sample 19-Dec-22 B.V = 5.3mm³/L (Red Alert)



Burrendong Dam wall sample 03-Jan-23 B.V = 74.5mm³/L (Red Alert)

Burrendong Dam: 20-12-22

Map Colour	Risk Level – Photosynthetic activity based on Chlorophyll-a
Blue	Very low
Green	Low
Yellow	Medium
Red	High
Dark red	Extreme

Algae Report to stakeholders for the Central West Region = 100+ recipients

Algae Alerts for the Central West Region

22nd December 2022

This blue-green algal alert report is based on routine algae monitoring at sites in the Central West Reporting Area. These sites are monitored by WaterNSW and local councils. The report also includes information that comes from visual observations and satellite imagery.

Summary

These alert levels apply to **non-consumptive or recreational contact**. Drinking water safety thresholds are much more stringent.

Burrendong is on a Red Alert. This alert has been applied by visual observations and satellite imagery. The satellite imagery for Burrendong is on page 2 of this report.

The Macquarie River below Burrendong Dam to Dubbo is on Red Alert. This alert has been applied by visual observations and satellite imagery.

Windamere Dam is on Red Alert. Algae samples have confirmed the Red Alert put in place by the satellite imagery. The satellite imagery of Windamere is on page 3.

The Red Alert for Cudgegong River downstream of Windamere Dam to Mudgee has been lifted. Cudgegong River at Mudgee is on Green Alert.

Comments:

As most of the storages are at, or near 100% capacity, any algae blooms on the storages will be easily flushed out of the storages via the spillway downstream into the river system if inflows increase. Those that are directly below the storage would be at greatest risk.

The end

Thanks for listening ☺