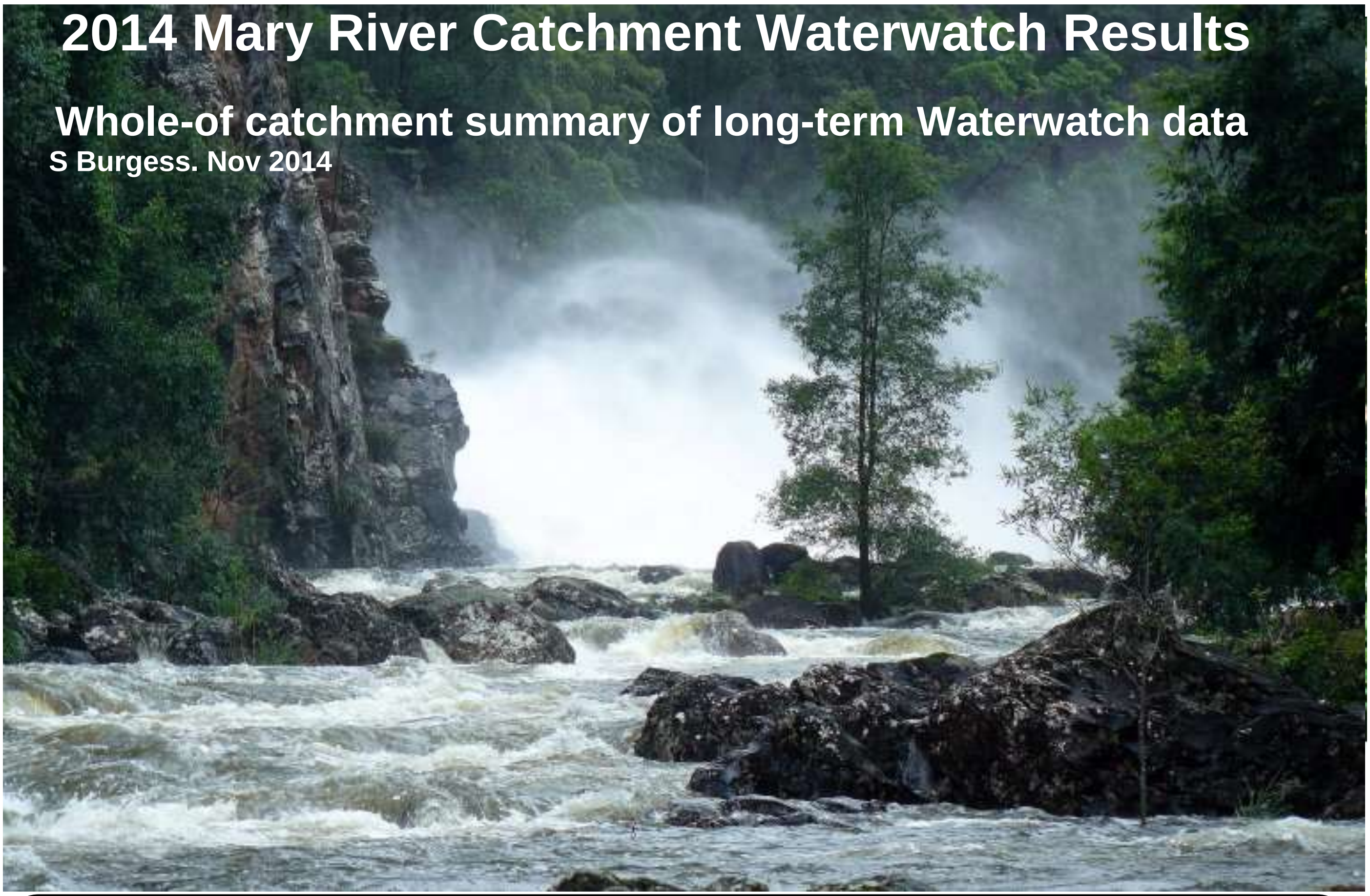
2014 Mary River Catchment Waterwatch Results

Whole-of catchment summary of long-term Waterwatch data

S Burgess. Nov 2014



This report combines data from all MRCCC community Waterwatch networks. It uses physical and chemical water quality data from those sites which were :

- **active between 1st July 2013 and 30th June 2014 and**
- **had sufficient long term data to compare against previous years**

Acknowledgements

The MRCCC would firstly like to thank the army of Waterwatch volunteers, past and present, who are the most important component of the Waterwatch program.

The Waterwatch program is a long-term endeavour, which has been funded at various times under a variety of programs. In particular, the MRCCC would like to acknowledge the long-term support of Gympie Regional Council and the Sunshine Coast Regional council over many years, without which the critical long-term continuity of the program would be extraordinarily difficult. The current Program is also funded by the Queensland Government's Everyone's Environment grants program. Hancocks Qld Plantations (HQP) are also an important supporter of the program.

Field staff from the Department of National Parks, Recreation, Sport and Racing, and HQP assist greatly in the regular collection of data, and allow the program to sample waterways that would be very difficult to access with community volunteers.

I would like to particularly acknowledge the long term administrative, logistical and technical management of Jenny Whyte, Deb Seal, office volunteers and students, and MRCCC project officers past and present.

Image above: Obi Obi Creek in flood. Courtesy of Todd Fauser.

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Whole-of-catchment comparison of Waterwatch results

MRCCC Waterwatch volunteers observe and record many aspects of the health of local waterways right throughout the Mary River catchment. Amongst these observations are a set of standard physical and chemical measurements which can be compared to accepted standards and guidelines. Waterwatch volunteers are trained in the use of water testing equipment and undergo refresher training once a year in accordance with the MRCCC Waterwatch Quality Assurance program.

Waterwatch sites are usually visited monthly and the volunteers use a TPS WP-81 to measure the temperature, pH and electrical conductivity, a TPS WP-82 to measure dissolved oxygen and a turbidity tube to measure turbidity. Volunteers are trained to follow the techniques as outlined in the Mary River Catchment Coordinating Committee's (MRCCC) Quality Assurance Manual. A network coordinator verifies all data before being entered into the Waterwatch database. Each equipment kit is maintained and calibrated monthly by MRCCC staff with periodic shadow testing against other equipment.

The MRCCC Waterwatch report cards for each site summarize how well the long-term set of water quality measurements at that site fit within the appropriate set of water quality guideline values for that part of the catchment. The guidelines and procedures for determining them are described in the *Mary River Environmental Values and Water Quality Objectives, July 2010* produced by the Queensland State Government. These guidelines are legally scheduled under the *Qld Environmental Protection (Water) Policy, 2009* . A map which shows which scheduled guidelines apply in each location is part of this policy. These documents can be found online at this URL: **Mary River Basin/Great Sandy Region**.

The physical/chemical parameters which are compared against guidelines are **Electrical Conductivity, pH, Oxygen Saturation, Turbidity and Temperature**. (There are no scheduled guidelines for temperature, but the MRCCC has developed local guidelines in accordance with the procedures in the legislation to identify extreme summer and winter water temperatures). A brief description of these water quality parameters is given in Appendix 1.

The appropriate guidelines are chosen for each MRCCC Waterwatch site based on

- Whether the site is *freshwater* or a *marine/estuarine* site. This affects **all** water quality parameters
- The altitude of the site (sites more than 150m above sea level are *Upland* sites, others are *Lowland*). This affects the **turbidity** and **pH** guidelines compared to most lowland sites.
- Whether the site is in the *Northern* or *Southern* part of the catchment. This affects the **Temperature** guidelines used. Water bodies north of Gympie, and watercourses that enter the river downstream of Deep Creek are regarded as *Northern,* the others as *Southern.*
- Whether the watercourse drains the ranges on the north-western edge of the catchment, (north of the Dagun escarpment). The underlying geology and climate of these *North Western* sites generally affects the **Electrical Conductivity** guidelines used. Watercourses draining to the Mary from the Gunalda Range (eg Gutchy Creek) are also grouped in with these *North Western* catchments. The Mary River itself is not included in this grouping.
- Whether the watercourse forms part of the acid *Tannin Stained* wetlands of the eastern sandplain in the Coondoo Creek catchment. This has a very large effect on the **pH** guidelines.
- Whether the watercourse is on the red soils of the basalt plateau of the Blackall ranges. This slightly affects the **pH** guidelines.

All these factors combine to give an overall set of guideline values appropriate for each site, with a number of sites sharing a the same combination of guideline values. This allows comparisons between sites that are expected to have broadly similar physical and chemical characteristics, and identify anomalous sites that may have an interesting story to tell. These comparisons are presented for each of the sites groupings later in this report. A full list of the active sites that were analysed to generate the 2013-2014 Waterwatch report cards is presented in Table 1.

Table 1. MRCCC Waterwatch site details, and overall 2014 report card grades

Site	Location		Network	Guidelines
AMA050	Amamoor Ck, South Branch	B	Gympie-Imbil	Upland freshwater (south)
AMA100	Amamoor Ck, Bluebell	B	Gympie-Imbil	Upland freshwater (south)
AMA800	Amamoor Ck, Busby St	B	Gympie-Imbil	Lowland freshwater (south)
ARA500	Aracaria Ck, first crossing	C	Gympie-Imbil	Lowland freshwater (south)
BAL500	Balgowlah Ck	A	Upper Mary	Upland freshwater (south)
BOO750	Booloumba Ck, US/ campground	A	Upper Mary	Lowland freshwater (south)
BOO800	Booloumba Ck, DS/ campground	A	Upper Mary	Lowland freshwater (south)
BOO830	Booloumba Ck, DS/causeways	A	Upper Mary	Lowland freshwater (south)
BOP500	Boompa Ck - Boompa	B	Munna	Lowland freshwater (north west creeks)
CAL700	Calgoa Ck - Cooke Rd	C	Munna	Lowland freshwater (north west creeks)
CAS500	Caseys Gully, bridge	C	Gympie-Imbil	Lowland freshwater (south)
CED600	Cedar Ck, Murray Rd	B	Kenilworth	Lowland freshwater (south)
CHG950	Chinaman Gully - Cooke Rd	B	Munna	Lowland freshwater (north west creeks)
CHI800	Chinaman Ck, Ferriers rock pool	A	Upper Mary	Lowland freshwater (south)
COE500	Coolabine Ck, Hunsley Rd	B	Kenilworth	Lowland freshwater (south)
COG450	Coonoongibber Ck, Callemonda Rd	C	Kenilworth	Lowland freshwater (south)
DEE500	Deep Ck - Richardson Rd	C	Gympie-Imbil	Lowland freshwater (north)
DEE920	Deep Ck- Bruce Hwy	C	Gympie-Imbil	Lowland freshwater (north)
DEE950	Deep Ck - mouth	C	Gympie-Imbil	Lowland freshwater (north)
DER400	Derrier Ck, Cutters Camp	C	Gympie-Imbil	Lowland freshwater (south)
DRY900	Dry Ck - Broweena Rd	C	Munna	Lowland freshwater (north west creeks)
EEL750	Eel Ck - Innooroolabar	B	Munna	Lowland freshwater (north west creeks)
ELC850	Eel Ck - Long Rd	B	Gympie-Imbil	Lowland freshwater (north west creeks)
FAT990	Fat Hen Ck - Bular Rd	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
GAP800	Gap Ck - Sinai Rd	C	Widgee-Wide Bay	Lowland freshwater (north west creeks)
GER750	Gerhatys Ck, Colliers	A	Upper Mary	Upland freshwater (south)
GLA450	Glastonbury Ck - Geiger Rd	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
GUT750	Gutchy Ck, Gundiah Hall	B	Gundiah-Tiaro	Lowland freshwater (north west creeks)
HIN400	Hines Ck	A	North-East	Lowland freshwater (north)
KAD499	Kandanga Ck, Perseverence	B	Gympie-Imbil	Lowland freshwater (south)
KIL800	Kilcoy Ck, Brokenbridge Rd	A	Upper Mary	Upland freshwater (south)
LOB990	Lobster Ck, mouth	A	Upper Mary	Lowland freshwater (south)
LYC700	Little Yabba Ck, campground swimhole	A	Upper Mary	Lowland freshwater (south)
LYC800	Little Yabba Ck, DS/campground	A	Upper Mary	Lowland freshwater (south)
LYC990	Little Yabba Ck, mouth	A	Upper Mary	Lowland freshwater (south)
MAR009	Mary R, McCrae Lane	A	Upper Mary	Upland freshwater (south)
MAR020	Mary R, Crystal Waters Causeway	A	Upper Mary	Upland freshwater (south)
MAR120	Mary R, Cambroon	A	Upper Mary	Lowland freshwater (south)
MAR148	Mary R, Walli Ck	A	Kenilworth	Lowland freshwater (south)
MAR240	Mary R, Pickering Bridge	A	Kenilworth	Lowland freshwater (south)
MAR290	Mary R, Old Moy Pkt Rd	A	Kenilworth	Lowland freshwater (south)

MAR300	Mary R, Walker Rd	A	Kenilworth	Lowland freshwater (south)
MAR435	Mary R, Gildora	B	Gympie-Imbil	Lowland freshwater (south)
MAR565	Mary R, Reibels Crossing	B	Widgee-Wide Bay	Lowland freshwater (north)
MAR743	Mary R, Petrie Park boat ramp	B	Gundiah-Tiaro	Lowland freshwater (north)
MUN550	Munna Ck - Kolbor Rd	B	Munna	Lowland freshwater (north west creeks)
MUN700	Munna Ck - Ivanhoe	B	Munna	Lowland freshwater (north west creeks)
MUN750	Munna Ck - Marodian	B	Munna	Lowland freshwater (north west creeks)
OAK800	Oakey Ck, Laws waterhole	C	Kenilworth	Lowland freshwater (south)
OBI500	Obi Obi Ck, Skene Ck	A	Upper Mary	Lowland freshwater (south)
OBI940	Obi Obi Ck, Houston Bridge	A	Kenilworth	Lowland freshwater (south)
RAT900	Ramsey Ck tributary lagoon	B	Munna	Lowland freshwater (north west creeks)
ROS400	Ross Ck, US/Hines Ck	C	North-East	Lowland freshwater (north)
ROS450	Ross Ck, DS/Hines Ck	B	North-East	Lowland freshwater (north)
SAN750	Sandy Ck - Garthowen	B	Munna	Lowland freshwater (north west creeks)
SDY200	Sandy Ck - HQP WP 260	B	North-East	Tannin stained lowland freshwater
SDY550	Sandy Ck - HQP WP 256	A	North-East	Tannin stained lowland freshwater
SIX850	Six Mile Ck - Woondum Bridge	B	Gympie-Imbil	Lowland freshwater (south)
SKE010	Top Skene Ck lagoon , Russell Family Pk	B	Upper Mary	Upland freshwater (Blackall Ranges)
SKE011	Middle Skene Ck Lagoon , Russell Family Pk	B	Upper Mary	Upland freshwater (Blackall Ranges)
SKE900	Skene Ck/Obi Ck confluence	A	Upper Mary	Upland freshwater (Blackall Ranges)
SNY020	Sandy Ck, Downsfield	F	North-East	Lowland freshwater (north)
SRB750	Scrubby Ck -(Palms)	B	Gympie-Imbil	Lowland freshwater (north west creeks)
TEE750	Teebar Ck - Woolooga Rd	C	Munna	Lowland freshwater (north west creeks)
TIN050	Tinana Ck, Tagigan Rd	B	North-East	Lowland freshwater (north)
TIN580	Tinana Ck, FPQ water point 240	B	North-East	Lowland freshwater (north)
ULI200	Ulirrah Ck, FPQ Water Point 212	F	North-East	Lowland freshwater (north)
WAL195	Walli Ck, end of Walli Ck Rd	A	Kenilworth	Lowland freshwater (south)
WIB290	Wide Bay Ck - Kilkivan Weir	C	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WIB400	Wide Bay Ck - Whittaker Rd	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WIB900	Wide Bay Ck - Sexton rail bridge	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WIB950	Wide Bay Ck - Wilson Bridge	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WID095	Widgee Ck - Upper Widgee Rd	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WON195	Wonga Ck - Warhurst Rd U/S	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
WON200	Wonga Ck - Warhurst Rd D/S	B	Widgee-Wide Bay	Lowland freshwater (north west creeks)
YAB600	Yabba Creek - Stirlings crossing	A	Gympie-Imbil	Lowland freshwater (south)
YAB680	Yabba Ck, Imbil Town Bridge	A	Kenilworth	Lowland freshwater (south)
YDS500	Yards Ck - HQP WP 272	B	North-East	Tannin stained lowland freshwater

Google Map of 2014 WaterWatch Results

An interactive map showing the location of the sites in Table 1 is published in Google Maps. By clicking on each site's marker on the map it is possible to view information about each site, and view and download individual report cards for each site. You can also search for a particular Waterwatch site by typing in its site code into the map's search box. The site markers are colour-coded according to the site's overall Waterwatch grade in 2014. This is the most effective way of starting to understand the geographic context of WaterWatch sites across the wider Mary River Catchment.

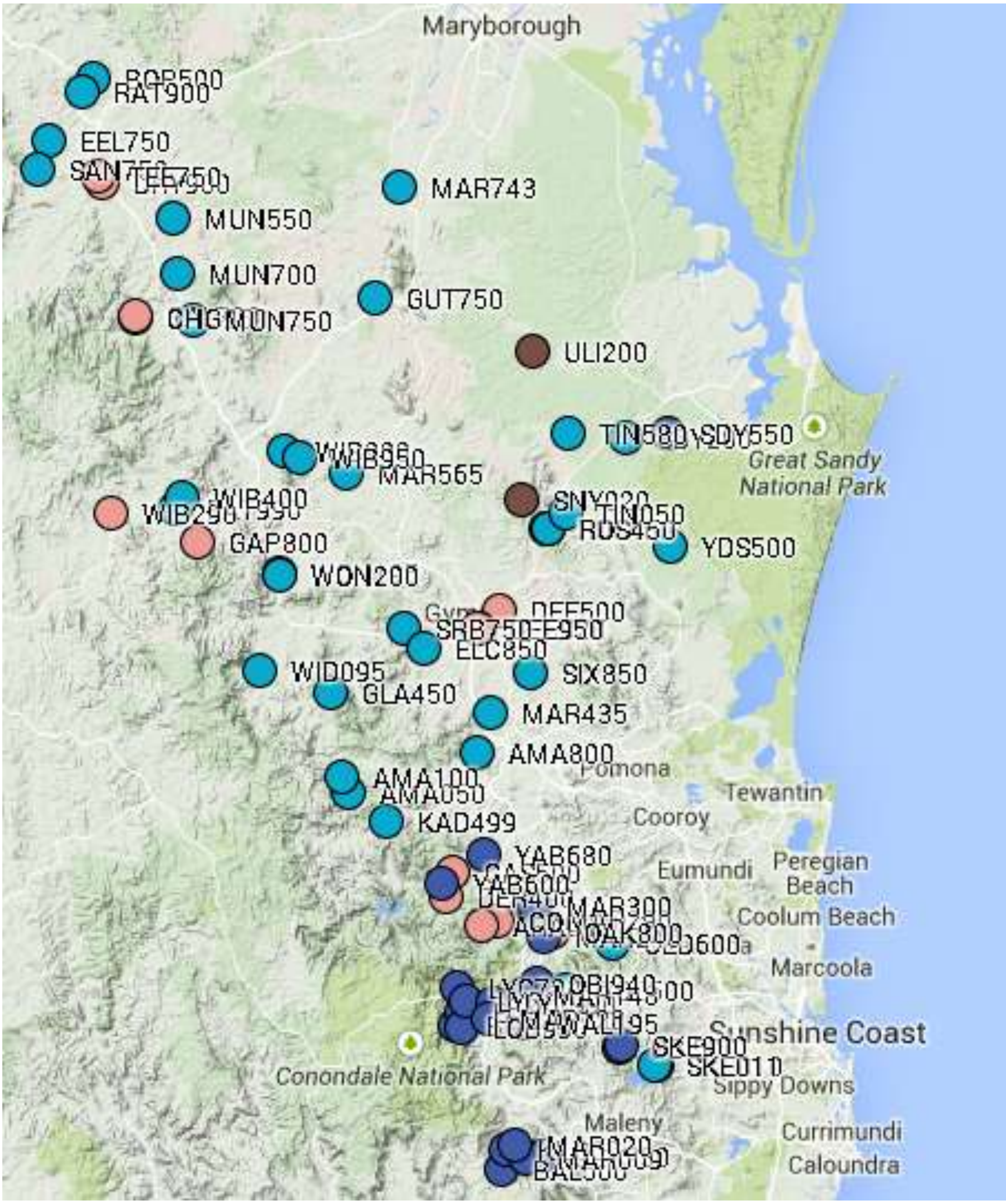
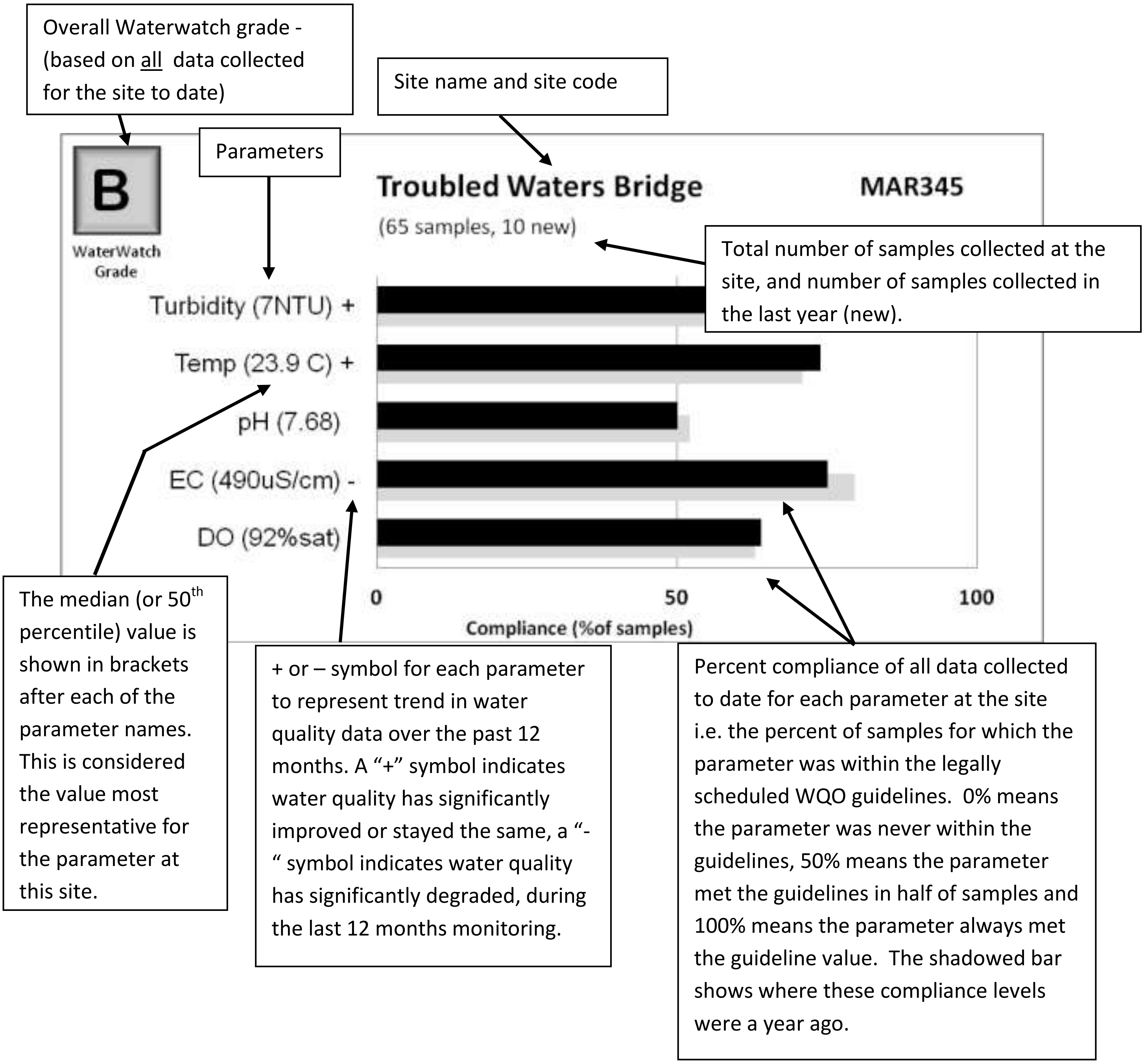


Fig 1. A screenshot from the online maps available at https://www.google.com/maps/d/edit?mid=zGIQzjdBcxy0.ktIDaHQ9QgGE

Interpreting the Site Report Cards

The long-term data from each site is analysed and presented as a graphical report card. These graphs present the long-term median value of each parameter and the level of compliance with the relevant guidelines across all the individual samples from that site. The illustration and descriptions below show where this information can be found on the report cards and how to interpret the graphs.



Assigning overall grades for physical/chemical water quality.

The MRCCC Waterwatch Report Card assessment is based on all the data collected for each site to date. Using these data, we assign a report card grade from A to F for each of sites. The report card grade is derived from the physical and chemical parameters monitored by the Waterwatch volunteers and is not a grade that represents the holistic health of the site or stream. To obtain a comprehensive overall rating of stream health we would need to incorporate and summarize observations of aquatic animal and plant health and diversity, nutrient loads, riparian zone health, geomorphology etc. Volunteers record anecdotal observations of these aspects of stream health, but not in a way that would allow a valid comparison across all sites. Nonetheless the Report Card Grade provides us with an excellent general rating of the physical/chemical water quality of our sites.

The Report Card grade for each site is determined by comparing the Waterwatch measurements to the appropriate water quality guidelines for that site For each of the parameters pH, Oxygen Saturation, Electrical Conductivity and Turbidity, the number of samples at that site which comply with the guidelines is calculated. This is then converted to a "percent compliance" figure for each parameter at each site. For example if 100 pH samples were taken, and 85 of them were within the guideline values, the site would score 85 percent compliance for pH.

A weighted average of percent compliance of the 5 measured parameters is calculated. Oxygen saturation is only given a half weighting due to the variable nature of spot dissolved oxygen measurements. Turbidity is also given a half weighting, because the ambient measurements do not capture turbidity impacts of flood events.. This weighted average is then graded as A, B, C or F based on the following:

A – Greater than 80 percent compliance. The water quality at this site is within the guidelines more than 80% of the time, and is considered to have **very good water quality**, similar to a reference site in natural condition.

B – Between 66 and 80 percent compliance. The water quality at this site is within the guidelines more than two thirds of the time, and is considered to have **good water quality** most of the time.

C – Between 50 and 66 percent compliance. The water quality at this site was within the guidelines more than half of the time, and is considered to have **acceptable water quality** more often than not.

F – Less than 50 percent compliance. The water quality at this site was *outside* the accepted WQO guidelines more than half of the time, and is considered to have **poor water quality** most of the time

Box and Whisker Charts

Within each set of comparable Waterwatch sites, the distribution of Electrical Conductivity, pH and Oxygen Saturation values recorded at each site are presented as a set of modified box-and-whisker charts. These charts allow a rapid inter-site comparison for each of these water quality parameters, against the guideline values.

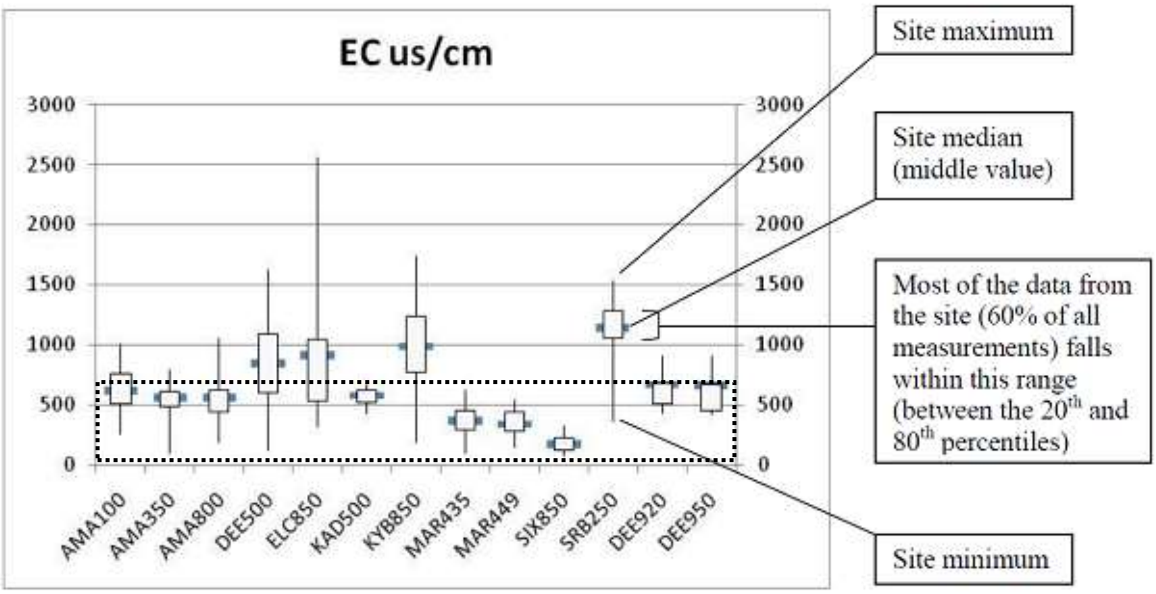
For each site on each graph:

- the vertical line (whiskers) shows the range between the maximum and minimum values ever recorded at the site
- the horizontal bar shows the median (50 percentile) value of all the data recorded at the site.
- the vertical box shows the range between the 20 and 80 percentile values. Most (60%) of the data recorded at the site falls within this range.

Values that lay within the dashed rectangle are within guideline levels

These comparisons are useful for identifying sites that are unusually variable, or have higher or lower overall values compared to other similar sites. However it is important to remember that the graph illustrates *all* the long-term data collected from each site, not just the last year's data and thus reflect the variation in conditions experienced at these sites over the entire time the data has been collected. Some sites have a long history of data, and these be expected to have been subject to more variation than sites with a data set covering fewer seasons.

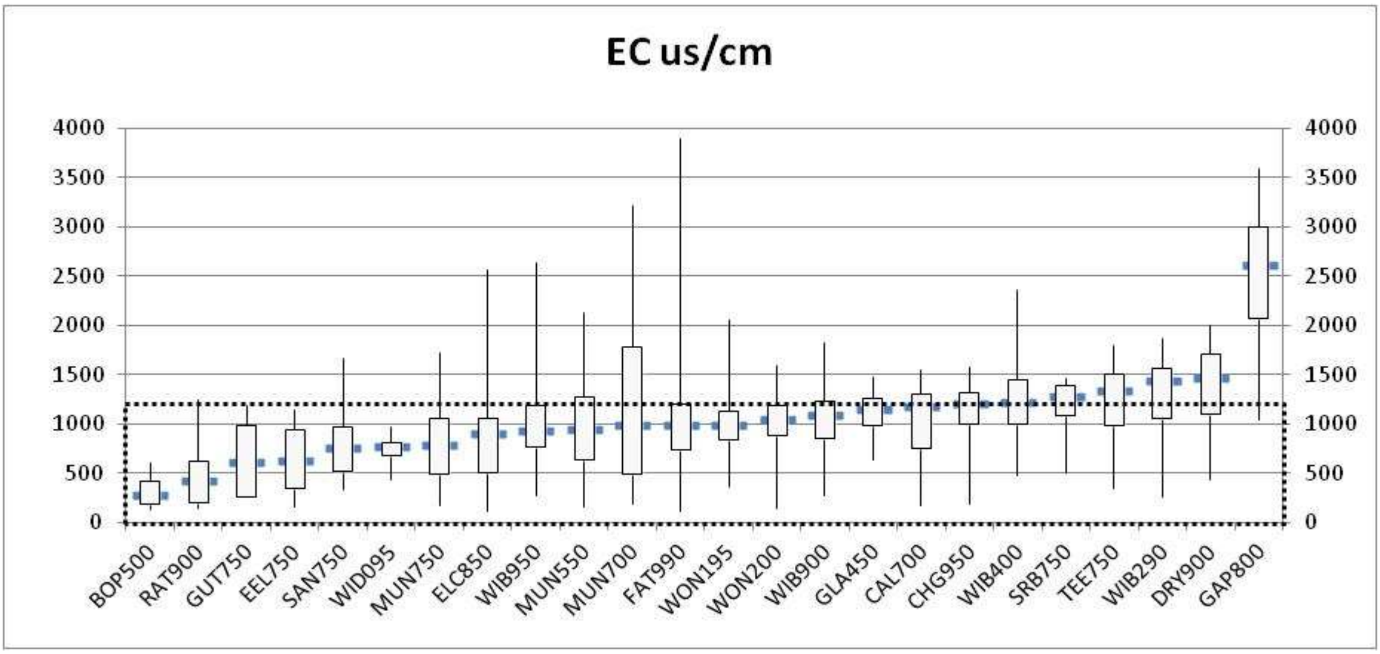
Comparisons of this nature are not done with the Turbidity measurements, because the volunteer sampling program does not reliably record highly turbid events (which would require volunteers to be sampling during flood events). It is also not very useful to compare the temperature measurements in this simple manner because of the overriding seasonal pattern throughout the year and during the day.



North West Lowland Freshwaters

Guideline Values

Electrical Conductivity	0 - 1200 uS/cm
pH	6.5 – 8.0
Dissolved Oxygen	85 – 110 %saturation
Turbidity	0 – 50 ntu
Summer Temperature	22 – 30 ^{o}c
Winter Temperature	16 – 24 ^{o}c



- In many cases, streams in this area have a mineralized or salty baseflow which dominates the water quality in times of low flow, and is diluted by surface run-off during periods of high flow. This can cause a large seasonal variation in EC . Fat Hen Creek is a good example of this at FAT990. Overall it is within guidelines, but has experienced some very high EC levels during drought. MUN700 is the most variable site overall, because the site is just downstream of a very salty tributary, which results in high localized EC levels when this tributary is discharging into Munna Creek at time of low flows in Munna Creek.

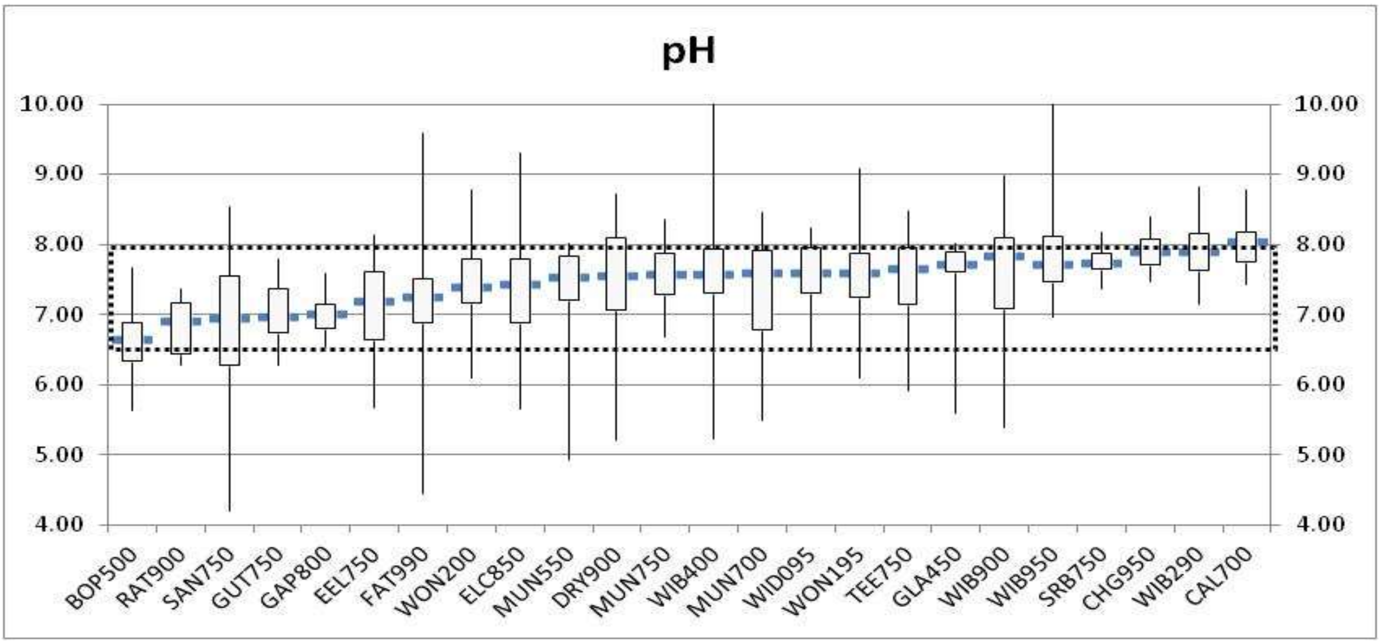
- Teebar and Dry Creeks TEE750, DRY990 have a long data history and are consistently salty in comparison to other creeks in this area.

- Upstream sections of Wide Bay Creek WIB290 also have consistently high EC levels. This part of Wide Bay Creek has been greatly altered and influenced by surface and groundwater extraction, and badly affected during long periods of drought.

- Gap Creek GAP800, has a much higher overall EC than any of the sites and is also the second-most variable of all the creeks in water quality group. The catchment of Gap Creek has been highly modified by plantation forestry , a feature which has been noted on some other sites elsewhere in the Mary catchment with very high EC levels. This may be a coincidence, or it may reflect an aspect of the underlying local geology which ccorrelates with favorable sites for establishing plantation hoop pine

- The lagoon systems associated with Boompa Creek and tributaries of Ramsey Creek (BOP500, RAT900) seem to be relatively fresh compared to the other waters tested of this type.

- Upper Widgee Creek (WID095) shows remarkably little variation in EC, through a long record of wet and dry years. (Data from two nearby sites sampled by the same volunteer were combined to give a long period of record)



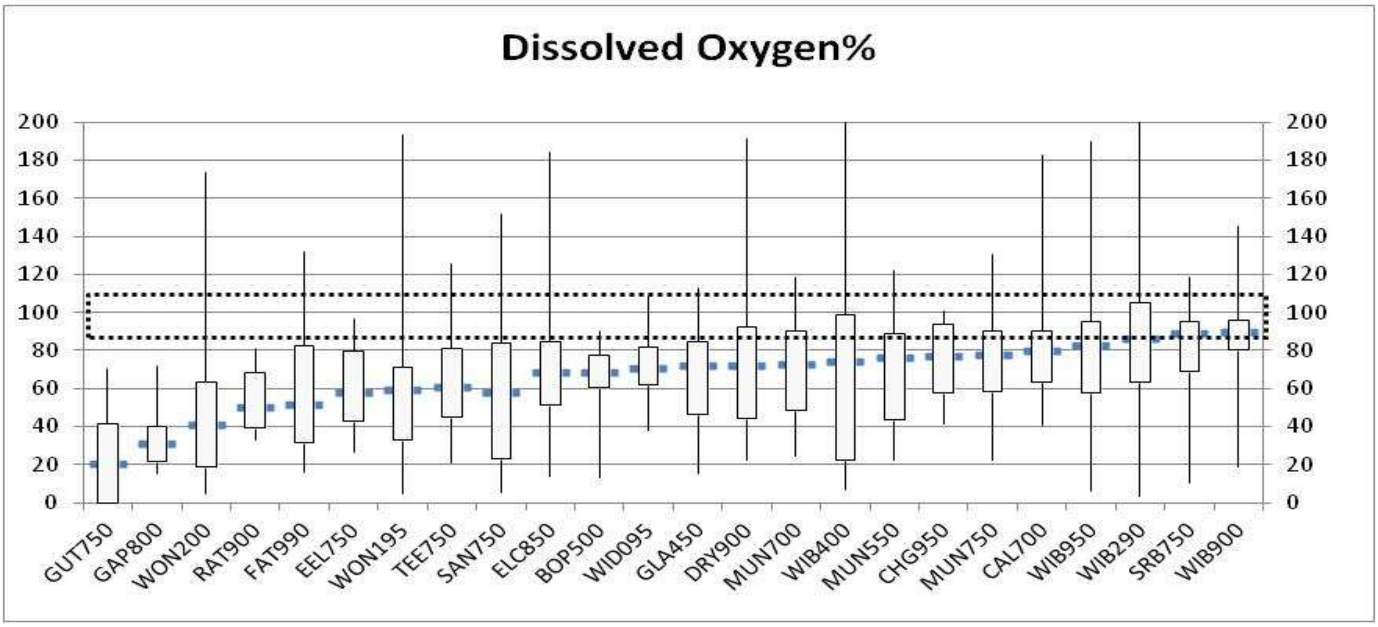
Most of the pH data from these sites lay within the guideline values

- In many cases pH values in water are strongly influenced by the geochemistry of the surrounding landscape and groundwater systems, and baseflow may have quite a different pH to surface runoff water. This interaction produces variation in pH at site on a seasonal basis, (similar to seasonal effects on Electrical Conductivity. It is interesting to note that some of the sites with the high levels and variability in EC show very little variation in pH. Gap Creek (GAP800) is a good example – it probably has very good pH buffering (stable pH levels) because of chemical complexity of dissolved minerals.

- Some waterbodies can display a huge variation in pH during a 24 hr cycle. Slow flowing, nutrient-rich waters exposed to full sun tend to develop a dense growth of aquatic plants and algae. The daily cycle of photosynthesis and respiration can cause huge fluctuations in dissolved oxygen and carbon dioxide levels, which can disrupt the chemical and pH balance in the water, as well as stimulating the production and uptake of a range of acidic phytochemicals which influence pH. Under these conditions, water bodies can be acidic in the morning, and quite alkaline in the late afternoon. A large variation in pH levels at a site, particularly occuring during times of drought may be indicative of periods of time where ther are conditions of open shallow warm water with a lot of plant and algae growth. Several of the sites in Wide Bay Creek (WIB) suggest these conditions, and at times have been profusely filled with dense aquatic plants.

- The generally alkaline quality of the water in Chinaman's Gully and nearby Calgoa Ck CHG950 and CAL700 seems to be associated with a small lens of limestone geology upstream of these sites.

- The freshwater lagoons of BOP500 and RAT900 are slightly acidic in character



- A dissolved oxygen saturation percentage greater than 100 is not an anomaly. It merely means that the oxygen concentration in the water is greater than the oxygen concentration in the ambient air. This can easily occur when waterplants are photosynthesising and pumping oxygen into the water at a faster rate than the oxygen is released from the water surface into the atmosphere.

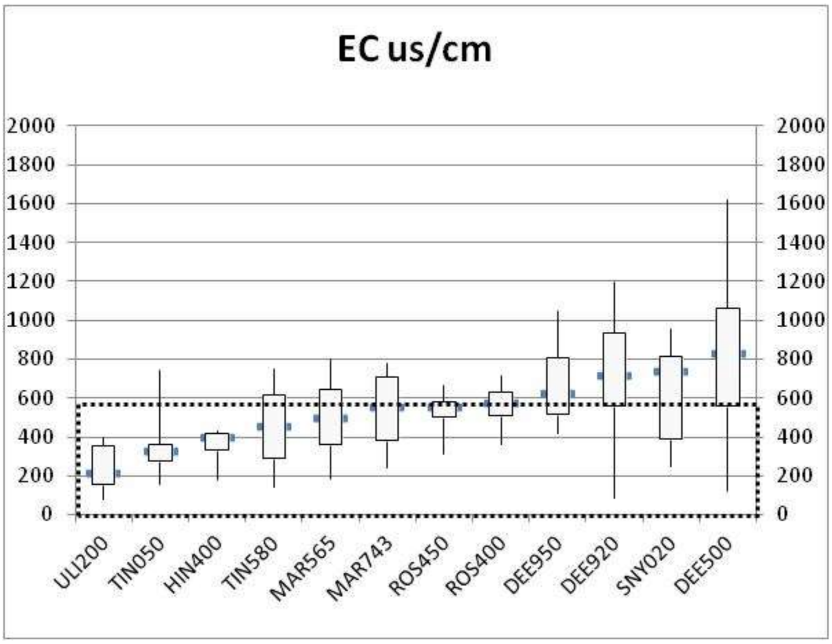
- Most of the dissolved oxygen data from these sites lay well below the guideline values. This may well be due to the official guideline values being derived from larger, more regularly flowing, more sunlit and well mixed sites in the Mary River itself. Smaller more ephemeral streams, with more shading and a different carbon inputs may be very 'healthy' at lower overall oxygen levels than those suggested by the guidelines. This has been observed right throughout the Mary Catchment. Some examples of very healthy sites in this group which rarely comply with the official oxygen guidelines are WID095, GLA450, EEL750

- Some waterbodies can display a huge variation in Dissolved Oxygen during a 24 hr cycle. Slow flowing, nutrient-rich waters exposed to full sun tend to develop a dense growth of aquatic plants and algae. The daily cycle of photosynthesis and respiration can cause huge fluctuations in dissolved oxygen levels.Under these conditions, water bodies can be almoist devoid of oxygen in the morning, and supersaturated in the late afternoon. A large variation in dissolved oxygen at a site, particularly occuring during times of drought may be indicative of periods of time where ther are conditions of open shallow warm water with a lot of plant and algae growth. Several of the sites in Wide Bay Creek (WIB) suggest these conditions, and at times have been profusely filled with dense aquatic plants. Note that this variation in oxygen levels at these sites is related to a high variation in pH levels at these same sites.

North East Lowland Freshwaters

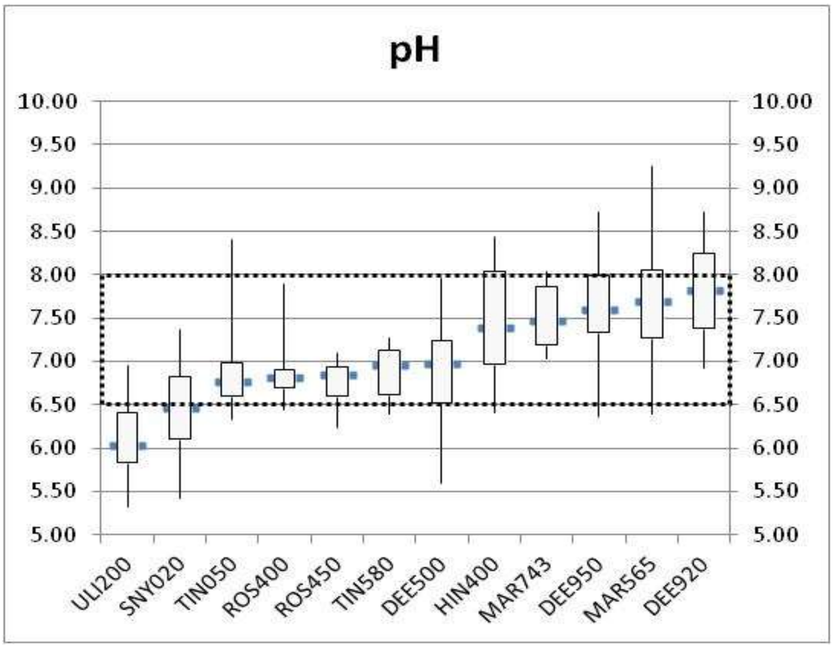
Guideline Values

Electrical Conductivity	0 - 580 uS/cm
pH	6.5 – 8.0
Dissolved Oxygen	85 – 110 %saturation
Turbidity	0 – 50 ntu
Summer Temperature	22 – 30 ^{o}c
Winter Temperature	16 – 24 ^{o}c



- The Deep Creek sites (DEE) have a very long data history of variable EC values nearly always above the guideline values. In context, these values are nowhere near as salty in absolute terms as several other creeks elsewhere in the Mary Catchment (Casey's Gully, Gap Creek)

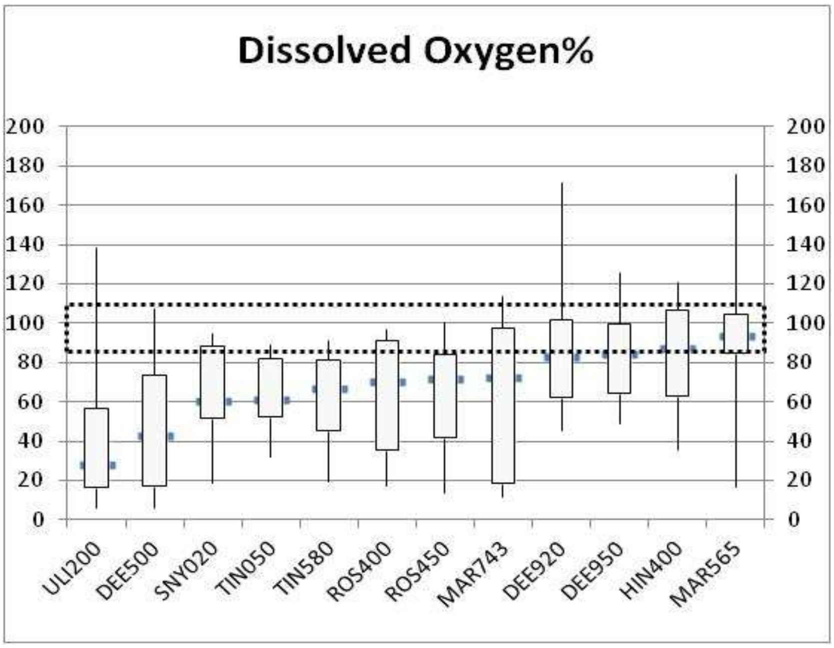
- The site on upper Sandy Creek(SNY020) is mostly above the guideline values, but it only has a short series of data, mostly recorded in drought conditions, and this data set may not be representative of the site over the long term. The same comment may well apply to the data from the Mary River Barrage (MAR743)



- Most of the pH data from these sites lay within the guideline values

- Ulirah Creek (ULI200) is significantly more acid and fresh than the other sites in this group, which is not surprising, given it's proximity to the very acidic freshwaters on the coastal sandplain. It is a relatively new site in a disturbed forestry area, which has mainly been sampled during drought. It doesn't yet seem to fit easily within any guidelines, hence it's overall F rating.

- SNY020 only has a relatively short data history, mostly during drought. This is the major reason behind its overall F rating. The data so far may not represent its true long term characteristics

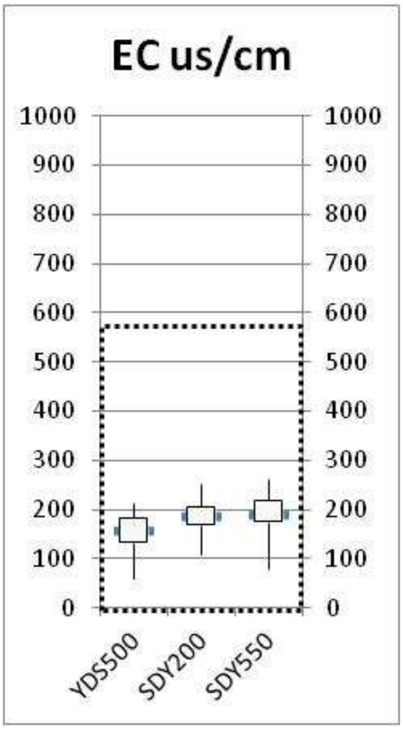


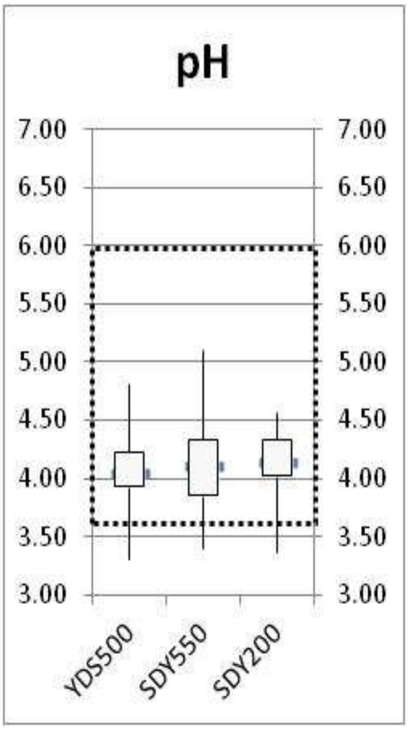
- Most of the dissolved oxygen data from these sites lay well below the guideline values.(as discussed in the first set of oxygen cross-site comparisons).
- Reibels Crossing (MAR565) is a typical open, flowing Mary River site which matches the guidelines well, because it is the kind of site from which the guidelines were derived.
- Again, Ulirah Creek (ULI200) doesn't seem to 'fit'.
- The generally low and highly variable levels in the Mary Barrage (MAR743) are consistent with being in a backwater area near the boatramp.
- The low levels at DEE500 are associated with being in a shaded position in a weir pool, and not necessarily an indicator of poor overall stream health.

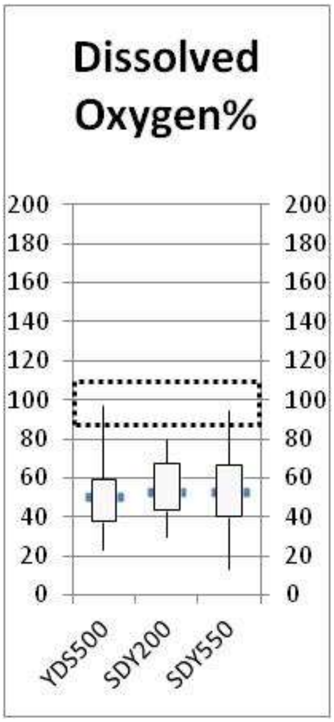
North East Tannin-Stained Lowland Freshwaters

Guideline Values

Electrical Conductivity	0 - 580 uS/cm
pH	3.6 – 6.0 (from footnotes notes in Mary WQO document for water bodies in the natural state)
Dissolved Oxygen	85 – 110 %saturation
Turbidity	0 – 50 ntu
Summer Temperature	22 – 30 ^{o}c
Winter Temperature	16 – 24 ^{o}c





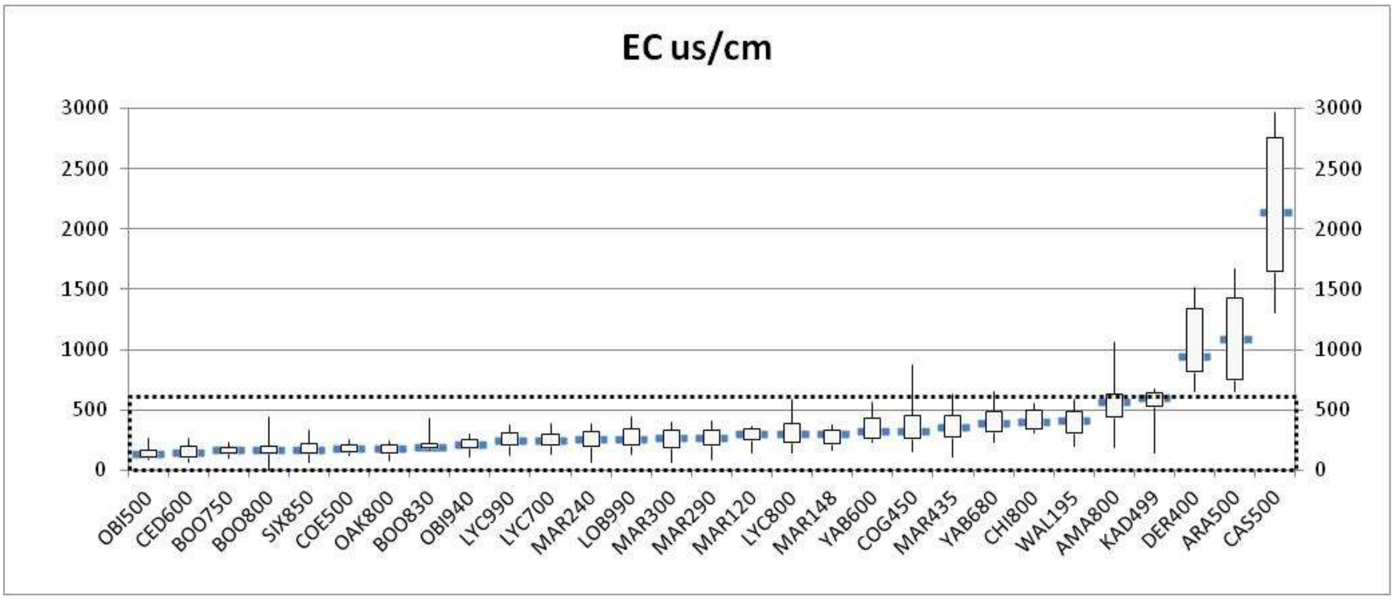


- These sites in the eastern sandplain part of the Coondoo Creek system are very fresh, and very acid.
- The overall stream health for all these three sites is very good, based on site inspections.
- Rather than apply the suggested pH guidelines for tannin-stained water, it seemed more appropriate to compare these sites against the pH values referenced in the footnotes of the water quality objectives for tannin stained water bodies in their natural state ranging from 3.6 to 6.
- These sites, in good condition, have relatively stable oxygen levels well below the suggested guideline values. Again, this raises questions about the appropriateness of applying oxygen guidelines derived from flowing river sites to these small, generally slow flowing, high carbon aquatic systems.

Southern Lowland Freshwaters

Guideline Values

Electrical Conductivity	0 - 580 uS/cm
pH	6.5 – 8.0
Dissolved Oxygen	85 – 110 %saturation
Turbidity	0 – 50 ntu
Summer Temperature	18 – 28 ^{o}c
Winter Temperature	13 – 21 ^{o}c

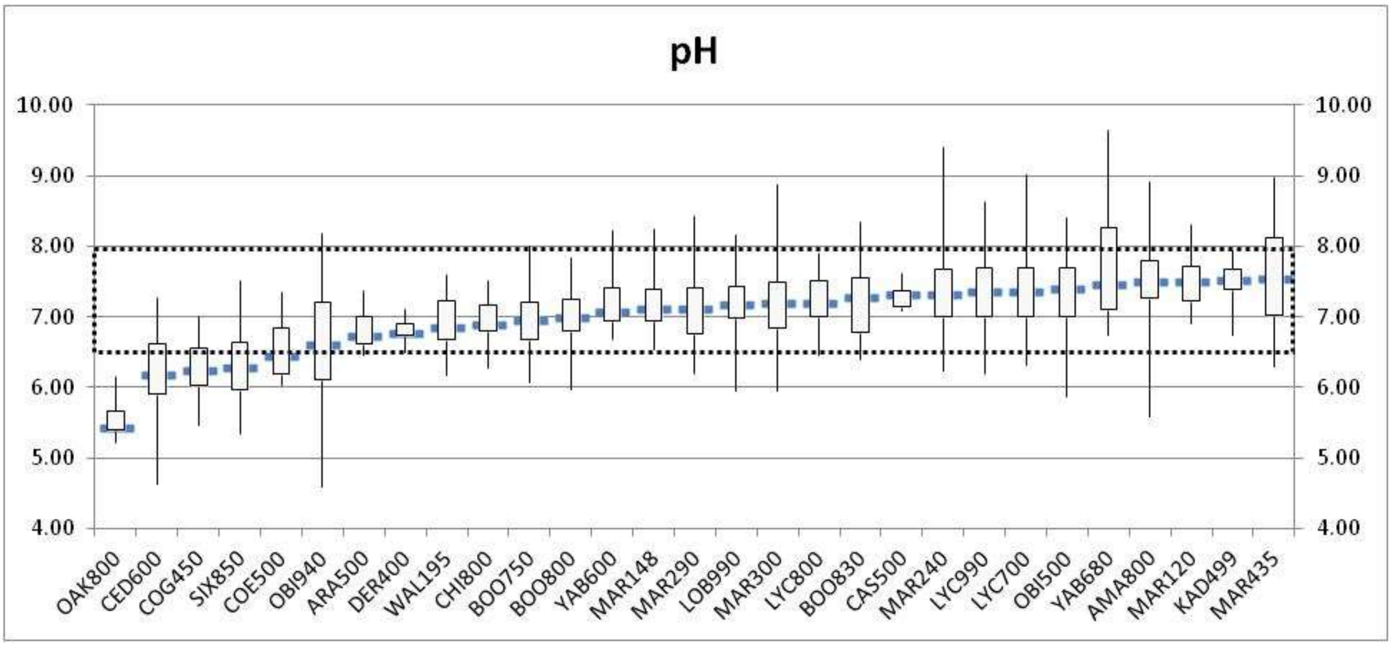


- Most of the data from this group of sites fall completely within the guideline values

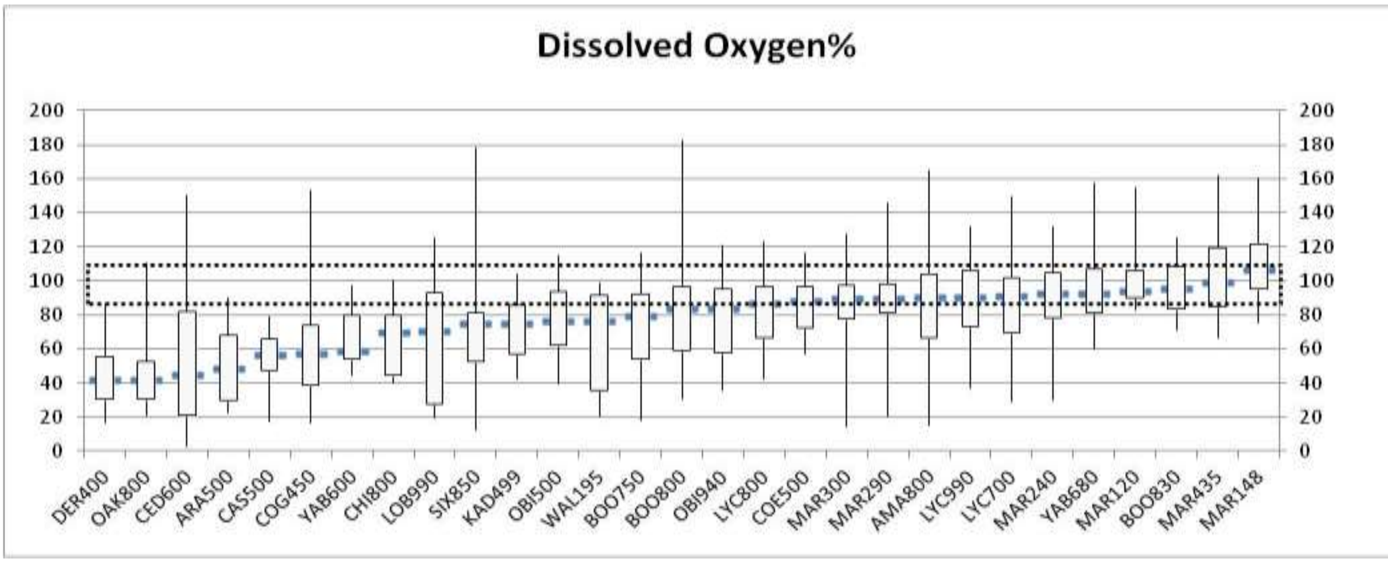
- The very notable exceptions are three new sites in minor creeks which drain the hoop pine plantations on the southern side of Yabba Creek.. Electrical conductivity readings from Derrier Creek (DER400), Aracauria Creek (ARA500), and Casey's Gully (CAS500) are all well above the guideline levels, and surprisingly so. The reason for this is yet unknown. These are relatively new sites, and most of the sampling has occurred in drought conditions, so these data may not represent the long-term water quality in these creeks, This observation is worth investigating to understand why these creeks seem to be so different (like Gap Creek further north)

- The general trend is for low EC in the south and east, and increasing EC as you move to towards the North West. The geology of the Amamoor Beds (the geological structure underlying the North West corner of this group of sites) is derived from metamorphosed ,very old marine sediments. This may be related to higher EC values in the water at these sites.

- Although also draining metamorphosed ranges to the west of the Mary, the Conondale Range sites in Lobster (LOB), Little Yabba (LYC) and Booloumba (BOO) creeks (upstream of the campgrounds) have very fresh water.



- Most of the data from this group of sites fall completely within the guideline values
- Oaky (OAK800), Cedar(CED600), CoonoonGibber(COG450) and Six Mile Creeks (SIX850) have a consistently acidic character, compared to the guideline values
- Sites with highly variable pH values, (which may indicate periods of high sun, nutrients and warmth which result in rampant plant and algae growth) include Lower Obi Obi Creek (OBI940), Mary River at Gilldora(MAR435), and Yabba Creek at Imbil (YAB860)

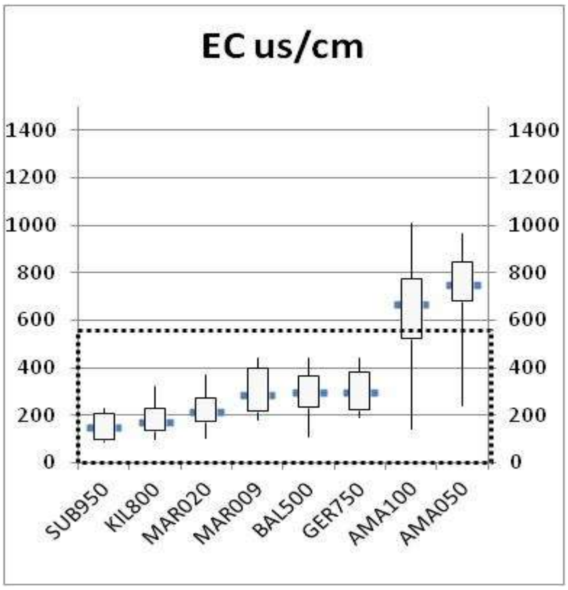


- Data from sites with open water and reliable flow regimes seem to align best with the guideline values (Mary River , lower Yabba Creek, lower Little Yabba, lower Booloumba Creek)
- Data from slow flowing, well shaded streams do not match the guidelines, even at sites where stream heath would be generally assessed as good eg Six Mile Creek at Woondum (SIX850)
- Unusually drought conditions have severely affected a number of these streams over the last two years, even though they are in what is normally regarded as a wet part of the catchment. This has contributed to relatively large fluctuations in dissolved oxygen levels, in streams that would generally be regarded as in good condition.

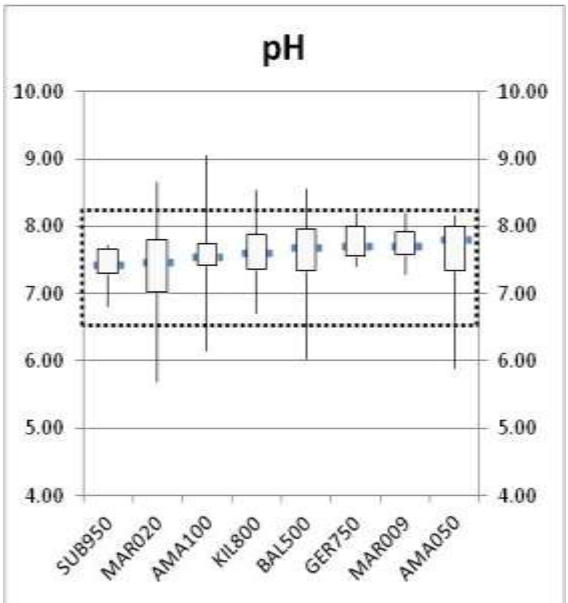
Southern Upland Freshwaters

Guideline Values

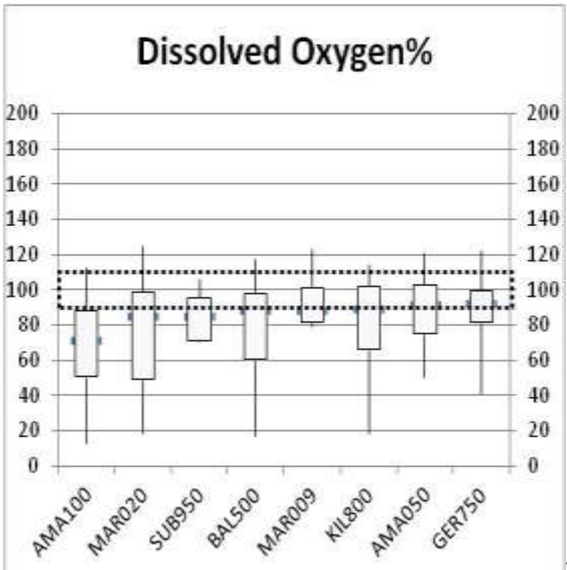
Electrical Conductivity	0 - 580 uS/cm
pH	6.5 – 8.2
Dissolved Oxygen	90 – 110 %saturation
Turbidity	0 – 25 ntu
Summer Temperature	18 – 28 °c
Winter Temperature	13 – 21 °c



- The data from upland sites from the South and East of the catchment lay well between the scheduled guidelines.
- Although definitely mapped as upland freshwater in the water quality guidelines, and well over 150m in elevation, the upper Amamoor Creek sites seem to belong more with the North West guideline values for EC of 0-1200 uS/cm.
- This adds support to an argument that streams draining the geology of the Amamoor Beds have similar EC characteristics to the North Western guidelines, irrespective of whether they are upland or lowland sites.



- The data from all these sites lay well within the guideline values for pH.
- None of these sites display the sort of variability in pH that would suggest problems with profuse aquatic plant and algae growth.

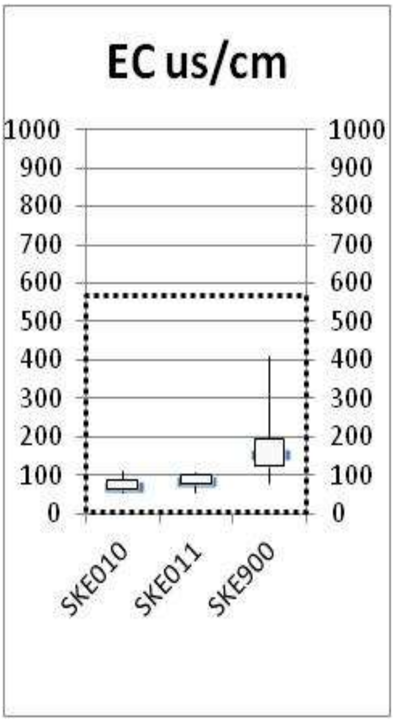


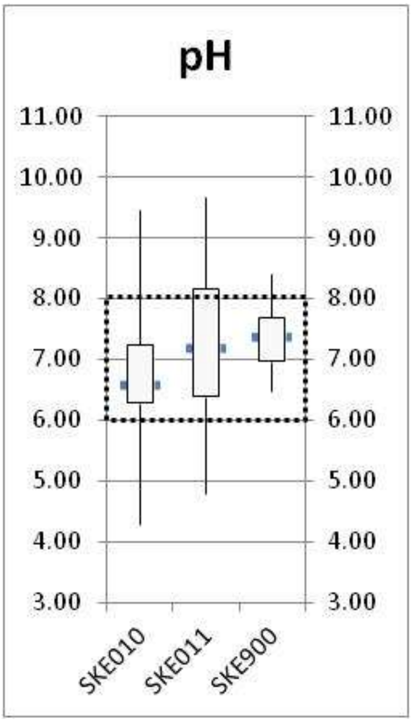
- More than half of the data from sites falls below the suggested Oxygen guidelines. This reinforces the impression from right throughout the catchment that these guidelines are not very applicable to well shaded, high carbon streams
- None of these sites display the sort of variation and super-saturation of oxygen levels that would suggest problems with profuse aquatic plant and algae growth.
- The site with the most variability in oxygen levels is the Crystal Waters causeway over the Mary Rive (MAR020), which is perhaps the most open and disturbed of these sites

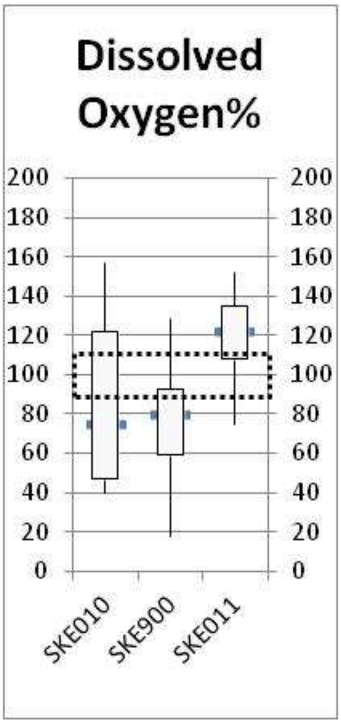
Southern Upland Freshwaters (acid Blackall Range)

Guideline Values

Electrical Conductivity	0 - 580 uS/cm
pH	6.0 – 8.0
Dissolved Oxygen	90 – 110 %saturation
Turbidity	0 – 25 ntu
Summer Temperature	18 – 28 ^{o}c
Winter Temperature	13 – 21 ^{o}c







- These sites consist of a pair of lagoons on Skene Ck above Kondalilla Falls, which are subject to some urban runoff (SKE010 and SKE011) , and a site at the bottom of Skene Creek before it joins Obi Obi Ck. (SKE090)
- All sites have very fresh water which is well under with the EC guidelines
- The bottom lagoon (SKE011) seems to be more alkaline and variable in pH than the top lagoon (SKE010)., which may be a symptom of problems with weed and algae growth stimulated by open conditions and high nutrient levels
- The lower lagoon (SKE011) was mostly supersaturated with oxygen when the samples were taken (this may be a symptom of nutrient input and overgrowth of weeds and algae).

Major points and suggestions for future Waterwatch activities

- The most important aspect of MRCCC Waterwatch is having an extensive network of people throughout the catchment who regularly visit familiar places over a period of years to observe and hopefully record changes to general stream health. This gives the MRCCC a way of noticing and responding to stream health issues as they occur, not necessarily through formal data collection and analysis, simply by people talking together and cooperating on important issues.

- Having a formalised structure for systematically recording and documenting observations and measurements in place over a long period of time has enabled the MRCCC to also develop an extensive and credible long-term data set across the Mary River Catchment. This unique and valuable data set would have been extraordinarily difficult and prohibitively expensive to collate in any other way.

- The set of physical/chemical water quality parameters analysed in this report are only one part of information currently collected from the Waterwatch program that could be used in a systematic way to inform better management of the Mary River Catchment. For example, Waterwatch volunteers conduct systematic monitoring of a number of key invasive aquatic weeds, and are encouraged to record sightings of fauna species of particular interest. As time continues, the data accumulated from these observations will become more useful for informing the way we take practical actions to manage these issues. Ensuring that species location data generated by Waterwatch is properly verified, processed and handed over to larger data collections such as WildNet and Atlas of Living Australia is an obvious important next step in putting MRCCC Waterwatch data to effective use.

- The analyses in this report suggest some overall priorities for future water quality investigations in the catchment:
  - The legally scheduled dissolved oxygen guidelines for the Mary Basin only seem to be appropriate for open sites with consistent flowing water. Sites in smaller, more ephemeral creeks in very good condition, (usually with good riparian shade, high organic carbon loads from leaf litter and woody debris) hardly ever comply with the scheduled guidelines. This observation is consistent across the entire catchment. The science behind this observation should be investigated further, because understanding the oxygen ecology of some of these creeks is very important for managing the recovery of some of our important local species such as Mary River Cod.
  - Several sites across the catchment stand out for having very high Electrical Conductivity, quite distinct from nearby watercourses. The most notable of these are on relatively small creeks which drain long-established hoop pine plantation logging areas. (Gap Creek, Casey's Gully, Aracauria Creek, Derrier Creek). There may be many reasons underlying these high values (relatively new data with the majority of data collected during drought conditions, local geochemical properties of the type of 'scrub' landscapes preferred for hoop pine plantations). However, the data is so startling that further investigation to understand 'why is it so' is certainly warranted.
  - The generally high Electrical Conductivity of waters draining the ranges in the North West of the catchment is well recognised, with extensive data analysis during the development of the Qld Water Quality Objectives suggesting a much higher guideline value for these waters. A practical question is, where is the boundary of these naturally saltier waters? They are a product of interactions between climate, landscape and geology. The analysis in this report suggests that it may be appropriate to extend these higher guideline values to all the streams which drain the Amamoor Beds (geological formation) in the west of the Mary, but

not to those which drain the Booloumba Beds further south. This extension would include all the watercourses which run into Amamoor, Kandanga and Yabba Creeks.

- We have little data on the waterways which flow into the Mary downstream of Munna Creek, and those which drain the country between Tinana Creek and the main trunk of the Mary. A number of new Waterwatch sites have been established in this area, but it will require another year or so of data to start to be able to understand water quality in this area.

- The Waterwatch sites in the Coondoo Creek catchment (YDS500, SDY250, SDY500) are very different in their chemical characteristics to all other current Waterwatch sites, being extraordinarily acidic, fresh and low oxygen. As such they do not fit within scheduled guideline values, even for tannin stained waters. Similar characteristics can be observed for other water bodies on the Cooloola Sandmass. Although for this report MRCCC has adopted a set of pH guidelines for these sites based on a footnote in the Water Quality Objectives document, (rather than the formally scheduled values), these sites are certainly worthy of further investigation. The Coondoo Creek catchment has experienced extensive landscape-scale clearing and establishment of exotic pine plantations, and it is worth pursuing pre-forestry historical data for that catchment and investigating other comparable but undisturbed streams on the Cooloola Sandmass to help understand these sites.

Appendix 1

An explanation of Waterwatch physical/chemical parameters:

Temperature

The temperature of a waterbody directly affects many physical, biological and chemical characteristics. Warm waters are more susceptible to eutrophication - a build-up of nutrients and possible algal blooms - because photosynthesis and bacterial decomposition both work faster at higher temperatures. Oxygen is less soluble in warmer water and this can affect aquatic life. By contrast, salts are more soluble in warmer water, so temperature can affect the water's salinity.

Temperature directly affects the metabolic rate of plants and animals. Aquatic species have evolved to live in water of specific temperatures. If the water becomes colder or warmer, the organisms do not function as effectively, and become more susceptible to toxic wastes, parasites and diseases. With extreme temperature change, many organisms will die. Changes in long-term temperature average may cause differences in the species that are present in the ecosystem.

What factors affect temperature?

Water temperature varies in response to:

- air temperature
- exposure to sunlight and amount of shade
- turbidity of the water, which is often a result of erosion in the catchment
- groundwater inflows to the waterbody
- discharge of warmed water from industry and power plants, or cold water from dams
- vegetation
- type, depth and flow of waterbody

Flowing upland streams have a more consistent temperature than do large rivers, due to the churning and relatively uniform mixing of the water. In slow-moving deep rivers, the non-turbulent water does not mix well, so the temperature can vary across the river and from the top to the bottom of the water column. The large volume of water in large streams also prevents rapid changes in temperature. On the other hand ephemeral streams with small pools of non flowing water can experience rapid fluctuations in temperature

Riparian (river-bank) vegetation provides shade and traps sediment particles that would otherwise enter the waterway and absorb heat from sunlight. The shade and clarity of the water help to keep the water cool and well oxygenated.

Dissolved Oxygen

Dissolved oxygen is a measure of the quantity of oxygen present in water (it has nothing to do with the oxygen atoms within the water molecules)

Oxygen is essential for almost all forms of life. Aquatic animals, plants and most bacteria need it for respiration (getting energy from food), as well as for some chemical reactions.

The concentration of dissolved oxygen is an important indicator of the health of the aquatic ecosystem. Persistently low dissolved oxygen will harm most aquatic life because there will not be enough for them to use.

In some circumstances, water can contain too much oxygen and is said to be supersaturated with oxygen. This can be dangerous for fish. Supersaturated conditions occur in highly turbulent waters in turbines and at spillways, because of aeration, and also on sunny days in waters experiencing algal blooms or with many aquatic plants, because of photosynthesis. In this supersaturated environment, the oxygen concentration in fishes' blood rises. When the fish swim out into water that has less dissolved oxygen, bubbles of oxygen quickly form in their blood, harming the circulation.

Waterwatch volunteers measure dissolved oxygen as percent saturation.

What factors affect dissolved oxygen?

The air is one source of dissolved oxygen, and aquatic plants, including algae, are another. The speed at which oxygen from the air enters and mixes through a waterbody depends on the amount of agitation at the water surface, the depth of the waterbody and the rate at which it mixes itself. As water temperature rises, oxygen diffuses out of the water into the atmosphere.

Shallow flowing waterways usually have high dissolved oxygen concentrations. In still waters, such as lakes, dissolved oxygen concentrations often vary from the surface to the bottom, with little dissolved oxygen in the deep, poorly mixed, layers.

Dissolved oxygen concentrations change with the seasons, as well as daily, as the temperature of the water changes. At very high altitudes, the low atmospheric pressure means dissolved oxygen concentrations are lower. For example, at 1850 metres above sea level, the amount of dissolved oxygen in the water, in absolute terms (mg/L), will be only 80% of the amount at sea level in otherwise identical conditions.

Deep muddy lowland rivers, which contain more organic matter than upland streams, are likely to have lower dissolved oxygen concentrations than upland streams because bacteria are using the oxygen to break down the organic matter. Likewise, dissolved oxygen is usually lower than normal after storms have washed organic materials into any waterbody.

Aquatic plants photosynthesise during daylight and increase dissolved oxygen concentrations around them. Conversely they respire at night using up oxygen and Releasing carbon dioxide.

In summary, dissolved oxygen concentrations are affected by:

- water temperature
- photosynthesis by aquatic plants
- respiration by aquatic plants and animals
- breakdown of organic materials in the water
- water movement and mixing
- flow (discharge)
- salinity
- altitude
- depth
- daily and seasonal cycles
- presence of nutrients
- chemicals in the water
- thermal contamination
- removal of vegetation

pH

pH is a measure of acidity (or alkalinity). Pure water has a pH of 7, acidic solutions have lower pH values and alkaline solutions have higher values.

Values of pH range from 0 (highly acidic) to 14 (highly alkaline). Where water has no net alkalinity or acidity it is said to be neutral and has a pH of 7. pH can be a little misleading unless you remember that one pH unit represents a ten-fold change. So if the pH of a water sample falls from pH 7 to pH 6, that is equivalent to a 10-fold increase in acidity. The figure below shows the pH of some common liquids.

Many compounds are more soluble in acidic waters than in neutral or alkaline waters. The pH of the wet area around roots affects nutrient uptake by the plants. pH also affects the solubility of heavy metals in water and the concentrations of total dissolved solids in rivers.

All aquatic animals and plants are adapted to specific pH ranges, generally between 6.5 and 8.0. If the pH of a waterway or waterbody is outside the normal range for an organism it can cause stress or even death to that organism.

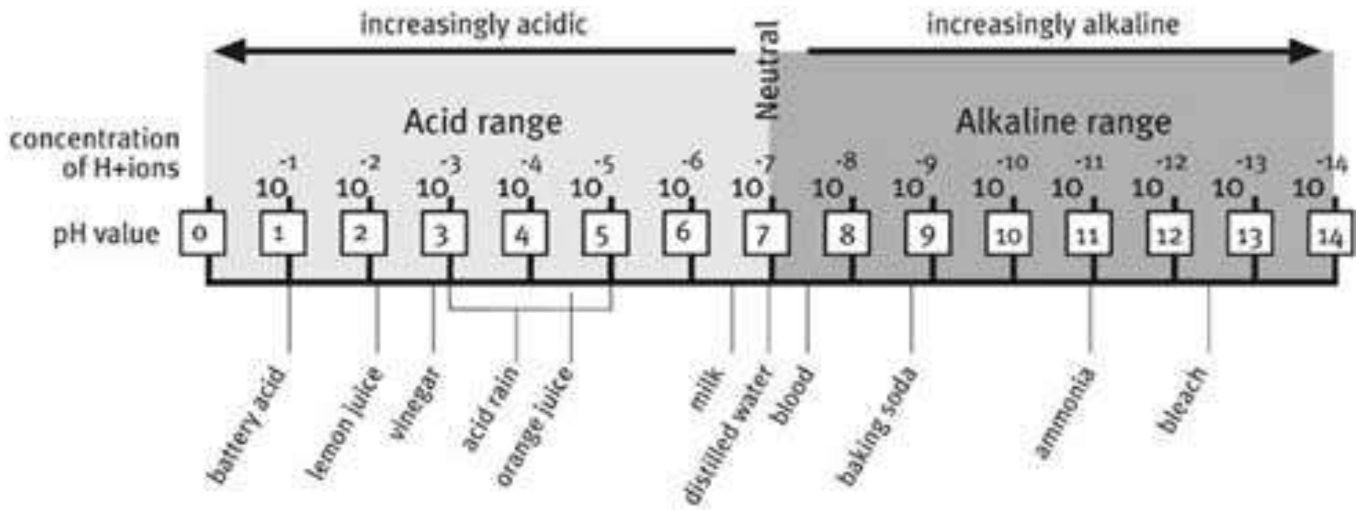


Figure 1. pH scale and pH of selected liquids

What factors affect pH?

A wide variety of factors may have an effect on the pH of water. These include:

- source of the water
- rainfall
- time of day
- water temperature
- amount of algal or plant growth in the water
- geology and soils, e.g. acid sulfate soils
- discharges of industrial wastes
- disturbance of acid sulfate soils due to agriculture, urban development or mining
- atmospheric deposition (acid rain, dry particle deposition)
- burning of fossil fuels by cars, factories and smelters
- photosynthesis and respiration
- salinity

The pH of a waterbody varies during the course of the day as the balance between photosynthesis and respiration changes with the light intensity and temperature. Aquatic plants use amino acids in the water as they photosynthesise so increasing pH during the day. Inflowing water may affect the pH of the waterbody as well as rainfall is naturally slightly acidic because of carbon dioxide dissolved in it and water running off limestone areas has relatively high pH. On the other hand, streams and lakes in coastal dune areas may have very low pH (sometimes less than 5) due to the presence of naturally-occurring humic acids.

Electrical Conductivity

Electrical conductivity is the property of a substance which enables it to serve as a channel or medium for electricity

Salty water conducts electricity more readily than purer water. Therefore, electrical conductivity is routinely used to measure salinity. The types of salts (ions) causing the salinity usually are chlorides, sulphates, carbonates, sodium, magnesium, calcium and potassium.

While an appropriate concentration of salts is vital for aquatic plants and animals, salinity that is beyond the normal range for any species of organism will cause stress or even death to that organism. Salinity also affects the availability of nutrients to plant roots.

Depending on the type of salts present, salinity can increase water clarity. At very high concentrations, salts make water denser, causing salinity gradations within an unmixed water column and slightly increasing the depth necessary to reach the water table in groundwater bores.

What factors affect electrical conductivity?

Electrical conductivity in waterways is affected by:

- geology and soils
- land use, such as agriculture (irrigation), urban development (removal of vegetation, sewage and effluent discharges), industrial development (industrial discharges)
- flow (electrical conductivity is generally lowest during high flows and increases as flows decrease, with extreme levels occurring during droughts)
- run-off
- groundwater inflows
- temperature
- evaporation and dilution.

Contamination discharges can change the water's electrical conductivity in various ways. For example, a failing sewage system raises the conductivity because of its chloride, phosphate, and nitrate content, but an oil spill would lower the conductivity. The discharge of heavy metals into a waterbody can raise the conductivity as metallic ions are introduced into the waterway.

Turbidity

Turbidity is the opacity or muddiness of water caused by particles of extraneous matter; not clear or transparent.

In general, the more material that is suspended in water, the greater is the water's turbidity and the lower its clarity. Suspended material can be particles of clay, silt, sand, algae, plankton, micro-organisms and other substances. Turbidity affects how far light can penetrate into the water. It is not related to water colour. Tannin-rich waters that flow through peaty areas are highly coloured but are usually clear, with very low turbidity. Measures of turbidity are not measures of the concentration, type or size of particles present, though turbidity is often used as an indicator of the total amount of material suspended in the water (called total suspended solids). Turbidity can indicate the presence of sediment that has run off from construction, agricultural practices, logging or industrial discharges.

Suspended particles absorb heat, so water temperature rises faster in turbid water than it does in clear water. Then, since warm water holds less dissolved oxygen than cold water, the concentration of dissolved oxygen decreases.

If penetration of light into the water is restricted, photosynthesis of green plants in the water is also restricted. This means less food and oxygen is available for aquatic animals. Plants that can either photosynthesise in low light or control their position in the water, such as blue-green algae, have an advantage in highly turbid waters.

Suspended silt particles eventually settle into the spaces between the gravel and rocks on the bed of a waterbody and decrease the amount and type of habitat available for creatures that live in those crevices. Suspended particles can clog fish gills, inducing disease, slower growth and, in extreme cases, death.

Fine particles suspended in water carry harmful bacteria and attached contaminants, such as excess nutrients and toxic materials. This is a concern for drinking water, which often requires disinfection with chlorine to kill harmful bacteria.

What factors affect turbidity?

Turbidity is affected by:

- rainfall and catchment runoff
- catchment soil erosion
- bed and bank erosion
- bed disturbance, e.g. by introduced fish species such as carp
- waste discharge
- stormwater
- excessive algal growth
- riparian vegetation
- floodplain and wetland retention and deposition
- flow
- waterway type
- soil types
- salinity.

Regular turbidity monitoring may detect changes to erosion patterns in the catchment over time. Event monitoring (before, during and immediately after rain) above and below suspected sources of sediment can indicate the extent of particular runoff problems.