Lower Lakes and Tributaries

Water Quality Report

Ambient and Event-based Monitoring

Report 21, November 2010

Government of South Australia
Department of Environment and Natural Resources

EPA South Australia

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Observations at a Glance

- ***Water quality continues to improved across the Lower Lakes following substantial inflows of floodwater from the Murray-Darling Basin***
- ***pH and alkalinity remain satisfactory at all sites in the main lake areas and tributaries***
- ***Salinity levels have decreased due to dilution and mixing from refill but still remain significantly above historic levels in Lake Albert and fringing areas***
- ***Localised acidity in and around event-based sample areas have decreased and the water body remains stable***

Background

The Environment Protection Authority (EPA), Department of Environment and Natural Resources (DENR), and the Department for Water (DFW) are co-ordinating a monitoring program to assess potential water quality impacts associated with changing water levels and acidity mobilisation in the Lower Lakes. Previous reports are contained on the EPA website[1].

Water Quality Parameters

A wide range of water quality parameters are monitored within the Lower Lakes with key parameters reported herein being pH, alkalinity, salinity, sulfate:chloride ratio, turbidity, nutrients (total nitrogen and total phosphorus), chlorophyll *a* and metals (aluminium and iron). A brief description of these parameters and typical historical (pre-drought) levels are provided below:

***pH** is an indicator of acidity or alkalinity. Neutral water has a pH of 7, acidic solutions have lower values and alkaline solutions have higher values. The pH in the Lower Lakes region is typically between 8.3 and 8.5.*

***Alkalinity** is a measure of the buffering capacity of water, or the capacity of the water to neutralise acids and resist pH change. Alkalinity within water bodies is consumed as acid is released from acid sulfate soils. Adding limestone contributes alkalinity to waters, helping to neutralise any acid released from the sediments. Historically, alkalinity levels within this region have been between 80 and 250 mg/L as* $CaCO_3$.

***Sulfate:chloride** is used to give an indication of any sulfate inputs to the water body from acid sulfate soils. Chloride concentration is largely determined by evaporation and dilution. An increase in the ratio of sulfate:chloride indicates possible external sulfate inputs from acid sulfate soils. This ratio is usually about 0.06 (SO_4:Cl) in the Lower Lakes.*

***Salinity** is a measure of the amount of dissolved salts in the water. Saline water conducts electricity more readily than freshwater, so electrical conductivity (EC) is routinely used to measure salinity. As salinity increases, it may become toxic to native freshwater organisms. Prior to the 2007–2009 drought conditions, salinity was on average less than 700 µS/cm (EC) in Lake Alexandrina (at Milang) and less than 1600 EC in Lake Albert (at Meningie).*

[1] See http://www.epa.sa.gov.au/environmental_info/water_quality/lower_lakes_water_quality_monitoring

***Turbidity** is a measure of the cloudiness or haziness in water caused by suspended solids (e.g. sediment, algae). Turbidity is expressed in Nephelometric Turbidity Units (NTU) and is measured using a relationship of light reflected from a given sample. Turbidity is very variable in the shallow Lower Lakes and influenced primarily by wind events. Prior to the 2007–2009 drought conditions, turbidity was on average about 60 NTU in Lake Alexandrina (at Milang).*

***Nutrients - total nitrogen (TN) and total phosphorus (TP)** are the total amount of nitrogen and phosphorus present in the water body. Nitrogen can be present in different forms (e.g. organic nitrogen in plant material, ammonia, nitrate and nitrite). Phosphorus can also be present in different forms (e.g. organic phosphorus, phosphate). High concentrations of phosphorus and nitrogen can result in excessive growth of aquatic plants such as phytoplankton, cyanobacteria, macrophytes and filamentous algae. Prior to the 2007–2009 drought conditions, TN was on average about 1.2 mg/L in Lake Alexandrina (at Milang) and 1.6 mg/L in Lake Albert (at Meningie) with TP on average about 0.15 mg/L in Lake Alexandrina (at Milang) and in Lake Albert (at Meningie).*

***Chlorophyll a** is the main photosynthetic pigment in green algae. The concentration of chlorophyll a gives an indication of the volume of aquatic plants present in the water column. Levels in excess of 15 μg/L are considered very high ("hyper-eutrophic") and nuisance algae and plant growth can occur. Prior to the 2007–2009 drought conditions, chlorophyll a was on average about 24 μg/L in Lake Alexandrina (at Milang) and 35 μg/L in Lake Albert (at Meningie).*

***Metals** such as iron and aluminium are measured primarily to determine interactions between sediments and the lake water body. During water level declines (i.e. due to evaporation and low inflows during droughts) metal concentrations are expected to increase. Similarly during large wind events total metal levels may also increase as they form part of the suspended solids composition. During floodwater inflows the concentration of metals may be diluted. Additional to this, if exposed acid sulfate sediments acidify and the pH is reduced, metals that were previously bound up within sediment are released. If these exposed sediments are rewet, any subsequent increase in metal concentrations in the water body may indicate acid sulfate soil impacts.*

Ambient Water Quality Monitoring

Ambient water quality sampling is undertaken fortnightly at 16 sites in Lake Alexandrina (including Wellington, the Goolwa Channel, Currency Creek and Finniss River tributary regions), and Lake Albert (Figure 1).

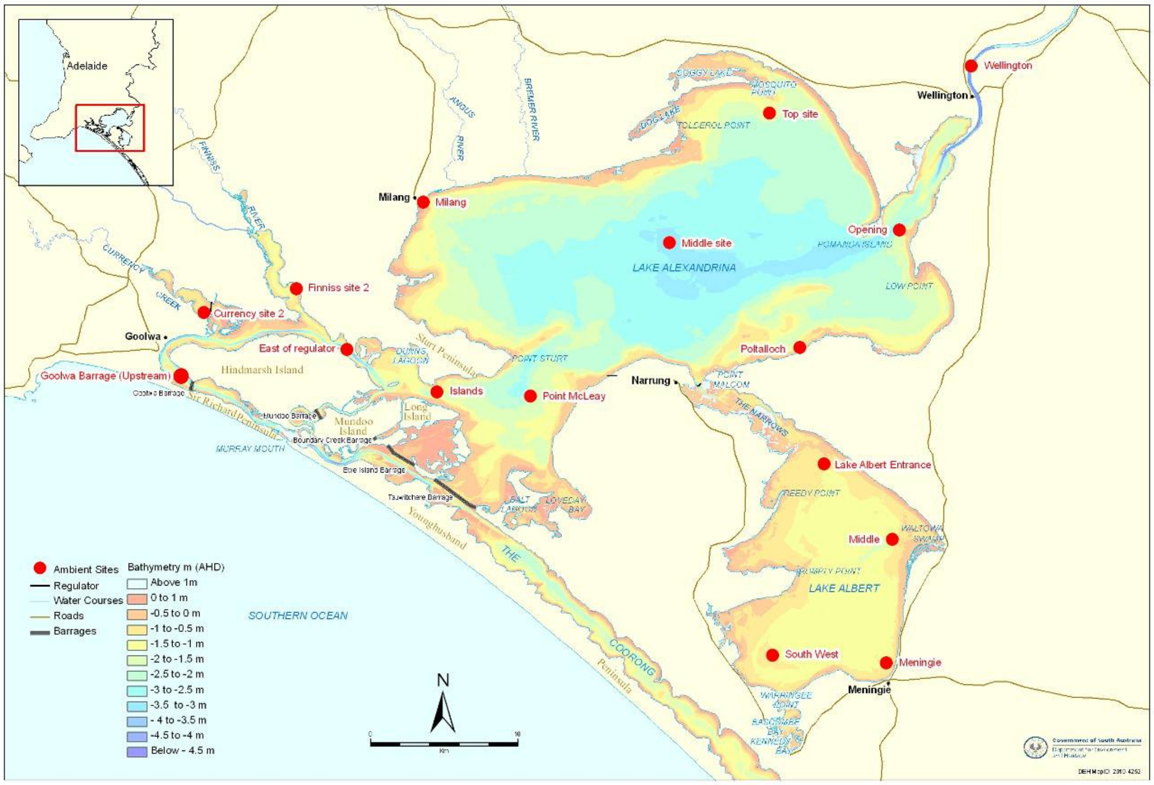

Figure 1 –Lower Lakes and tributaries ambient monitoring sites

Lake Alexandrina

Ambient water quality monitoring results are discussed below for selected sites and parameters in Lake Alexandrina. The four sites selected for reporting have been chosen as they are representative of the water body, incorporating water entering from the river (Opening) and a transect across Lake Alexandrina from the northern corner (Top) through the centre (Middle) to the southern edge of the lake (Point McLeay) before it enters the Goolwa Channel.

pH

- pH levels remain relatively stable and within ANZECC guideline levels (pH 6.5-9.0) at all sites in Lake Alexandrina (Figure 2).

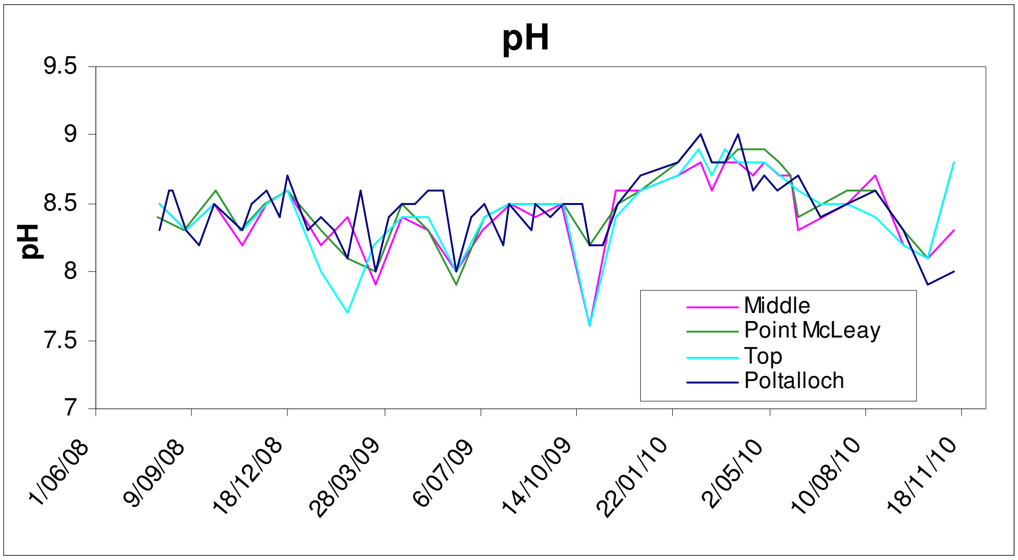

Figure 2 – pH at the Lake Alexandrina ambient monitoring sites

Alkalinity

- Alkalinity remains satisfactory for all sites in the main areas of Lake Alexandrina (Figure 3). Additional inflows to South Australia and subsequently Lake Alexandrina have led to an observable decline in alkalinity since May 2010 which is consistent with dilution and flushing of lake water with lower alkalinity river water. The exception to this is Poltalloch where alkalinity has stabilised during November, this is likely a result of mixing processes within Lake Alexandrina creating a more uniform body of water.

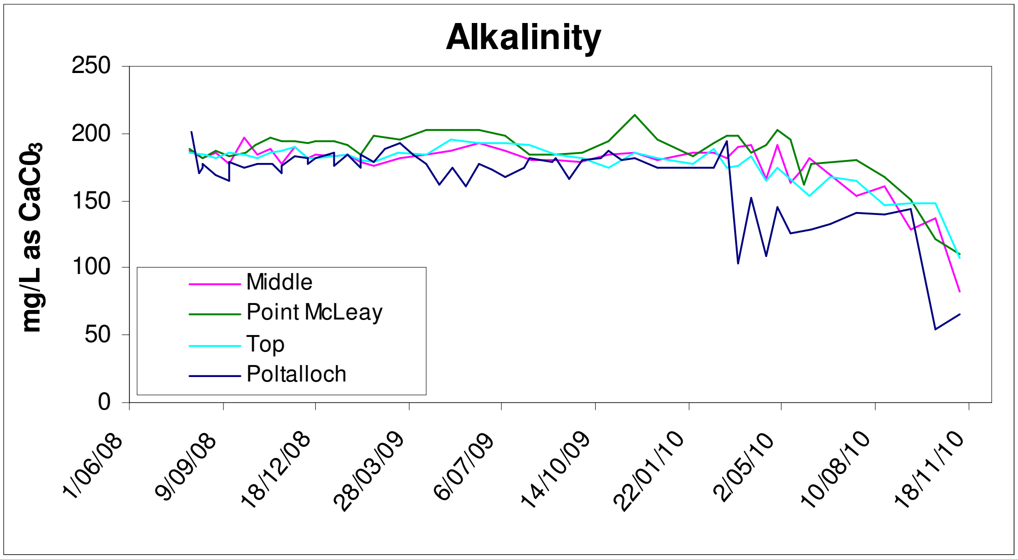

Figure 3 – Alkalinity at the Lake Alexandrina ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio continues to show some variability, but is not showing a clear trend that would suggest widespread acid sulfate soil influences (Figure 4). Over November the sulfate:chloride ratio has become more uniform across sites which indicates greater mixing in Lake Alexandrina. With continued inflows it is expected that this trend will continue.

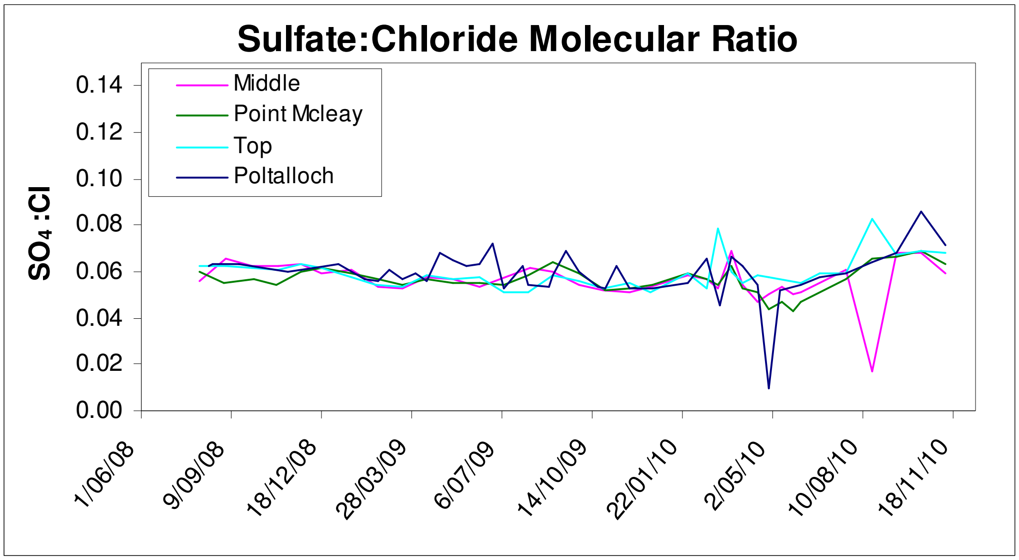

Figure 4 – Sulfate:chloride ratio at the Lake Alexandrina ambient monitoring sites

Salinity (EC)

- Salinity (as measured by electrical conductivity) has continued to decline across representative sites within Lake Alexandrina (Figure 5). Increased Murray-Darling Basin inflows have contributed to this decline in salinity. However salinity levels are still high (up to 2,000 EC) in comparison to historical levels (average of 700 EC prior to the drought). As flood waters continue to flow into South Australia and water is released from the barrages there should be ongoing decreases in salinity within Lake Alexandrina.

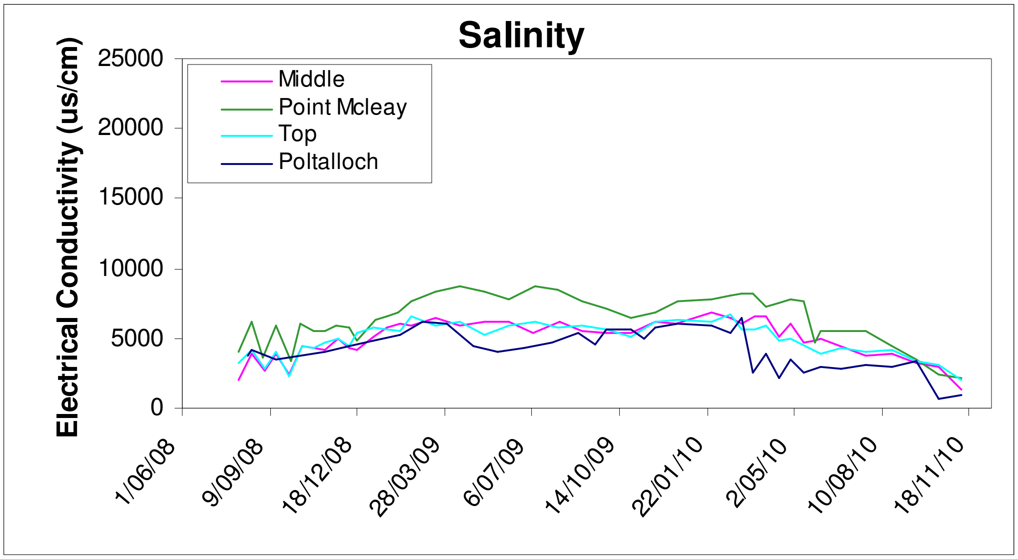

Figure 5 – Salinity at the Lake Alexandrina ambient monitoring sites

Turbidity

- Turbidity continues to be variable at selected sites within Lake Alexandrina (Figure 6). Large volumes of quick moving flood waters often contain high levels of suspended particles, this coupled with a large relatively shallow lake with fine alluvial silt often display high turbidity as a result of wind events causing re suspension of fine material.

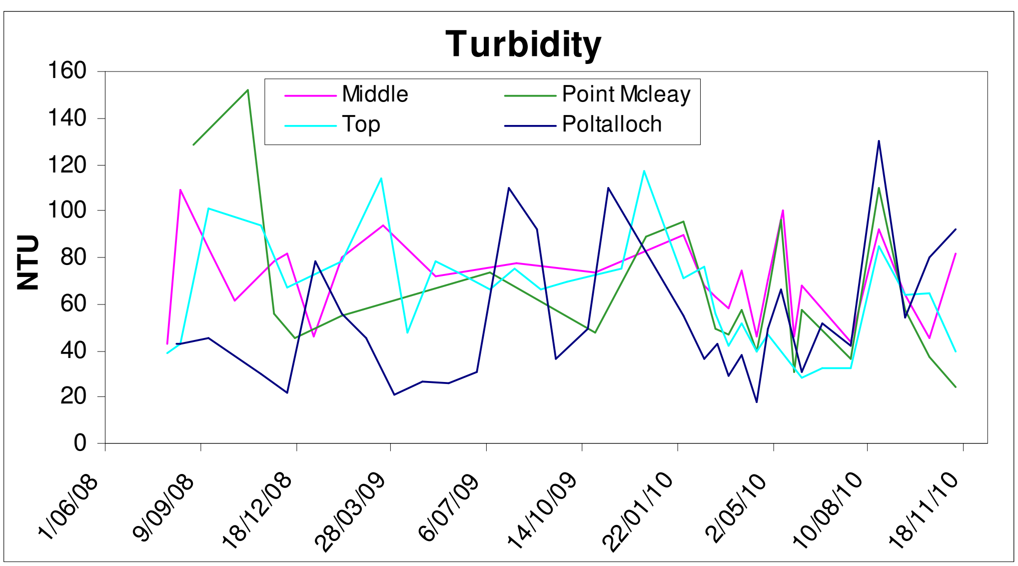

Figure 6 – Turbidity at the Lake Alexandrina ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and phosphorus levels have remained stable (see Figures 7 and 8) which is likely due to dilution from the River Murray floodwater inflows. However nutrient levels remain high compared to historical levels in and are well in excess of the ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

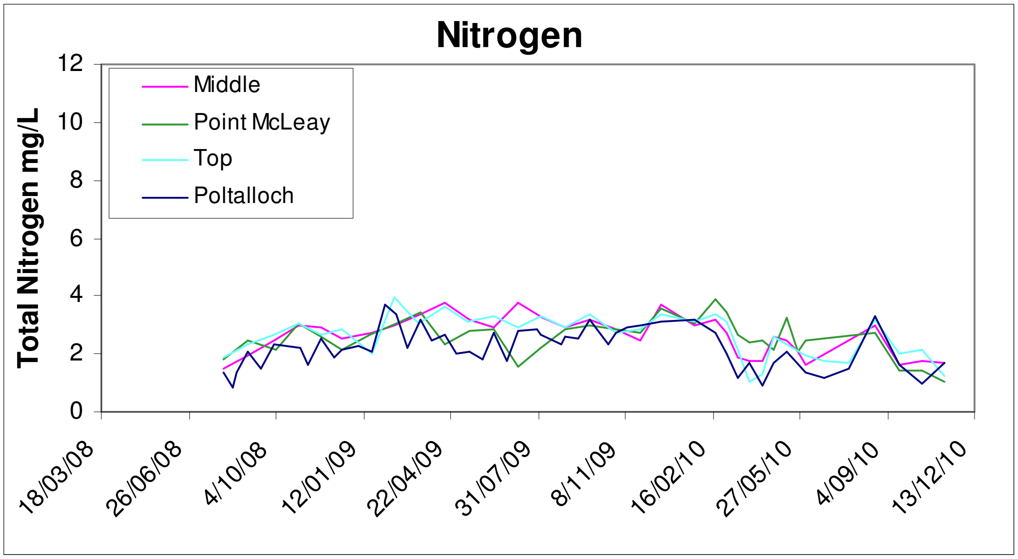

Figure 7 – Total nitrogen at the Lake Alexandrina monitoring ambient sites

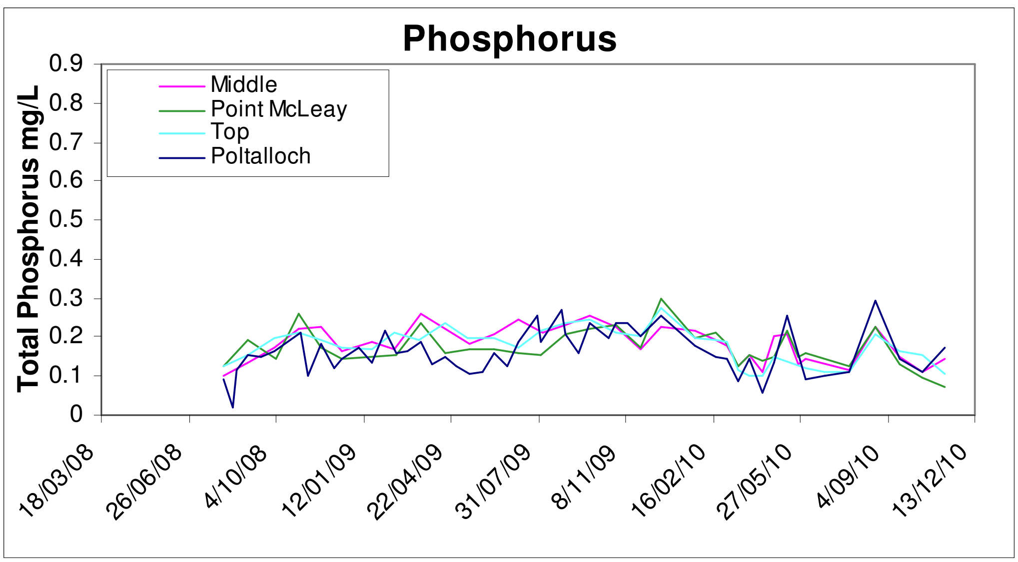

Figure 8 – Total phosphorus at the Lake Alexandrina monitoring ambient sites

Chlorophyll a (algae)

- Chlorophyll *a* stabilised over November which is likely due to dilution from the increased cross boarder inflows (Figure 9). These levels are still in excess of ANZECC guidelines (<15 µg/L) indicating a highly nutrient enriched (hyper-eutrophic) system. Although chlorophyll *a* levels in Lake Alexandrina are very high, no potentially toxic blue-green algal blooms are present. This will continue to be monitored over the coming summer months.

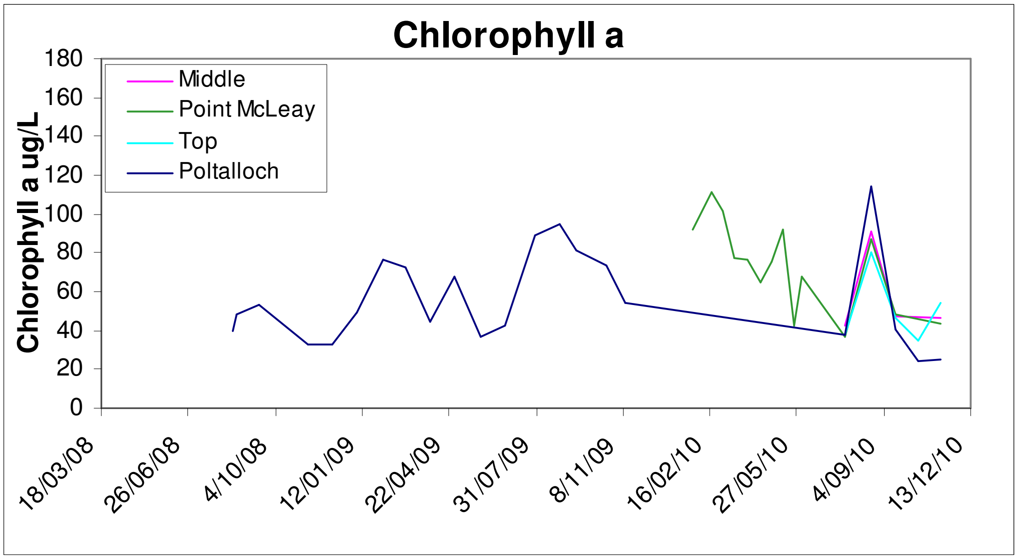

Figure 9 – Chlorophyll *a* at the Lake Alexandrina ambient monitoring sites

Metals

- Total aluminium and iron concentrations within Lake Alexandrina have decreased at most sites over November (Figures 10 and 11). This appears to be related to dilution though flood water inflows. The exception to this is the site at Poltalloch which has continued to increase over the past month, this is possible due to localised wind driven resuspension of sediments high in metals or inputs from reinundated local sediments. This area will be closely monitored over coming months to determine possible inputs.

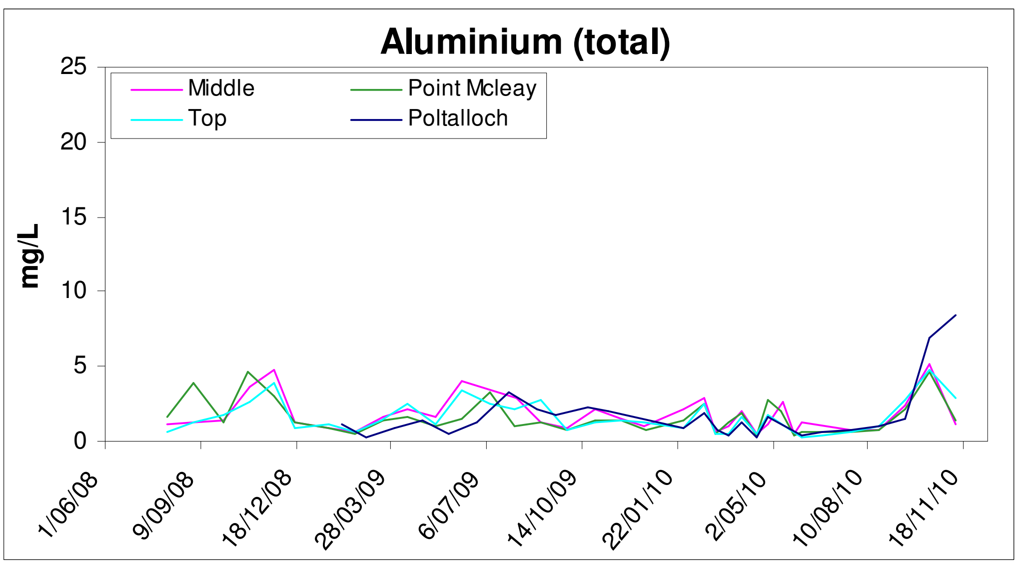

Figure 10 – Total aluminium at the Lake Alexandrina ambient monitoring sites

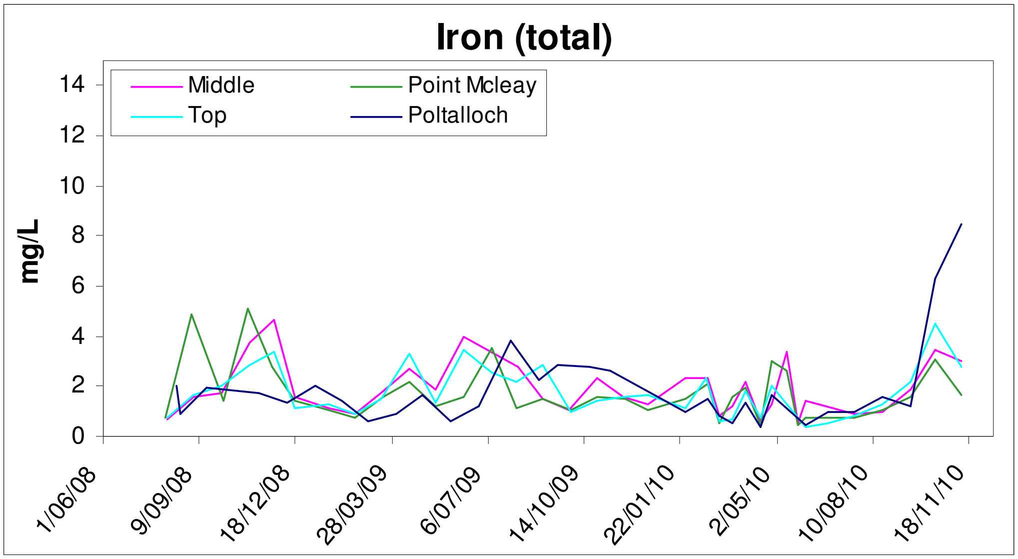

Figure 11 – Total iron at the Lake Alexandrina ambient monitoring sites

Lake Albert Water Quality

Ambient water quality monitoring results are discussed below for selected sites and parameters in Lake Albert. While the Lake Albert Opening site is not part of the ambient program (but rather part of monitoring for the pumping program) it is included at present to assist in interpretation of water quality data in the Northern lake region. In mid September (starting 19/9/10), the Narrung bund was partially breached, therefore monitoring data after then will reflect changes due to inflows from Lake Alexandrina.

pH

- pH levels are stable and within ANZECC guideline levels (pH 6.5-9.0) at all sites in the main Lake Albert water body (Figure 12).

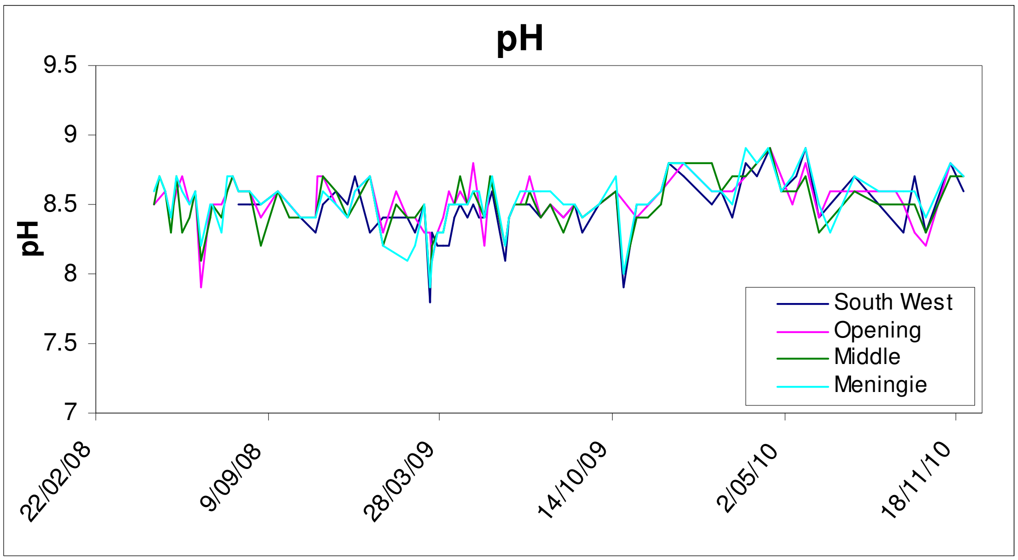

Figure 12 – pH at the Lake Albert ambient monitoring sites

Alkalinity

- Lake Albert alkalinity remains high at all sites (Figure 13). Since water levels have stabilised following breaching of the regulator separating Lake Albert from Lake Alexandrina the alkalinity has become more uniform across the Lake Albert. The alkalinity fluctuations are similar to those for salinity (see Figure 15), suggesting that trends are influenced by water inputs and mixing patterns. It is likely that the alkalinity will continue to decline slowly across Lake Albert with further inflows and mixing occurring with lower alkalinity Lake Alexandrina water.

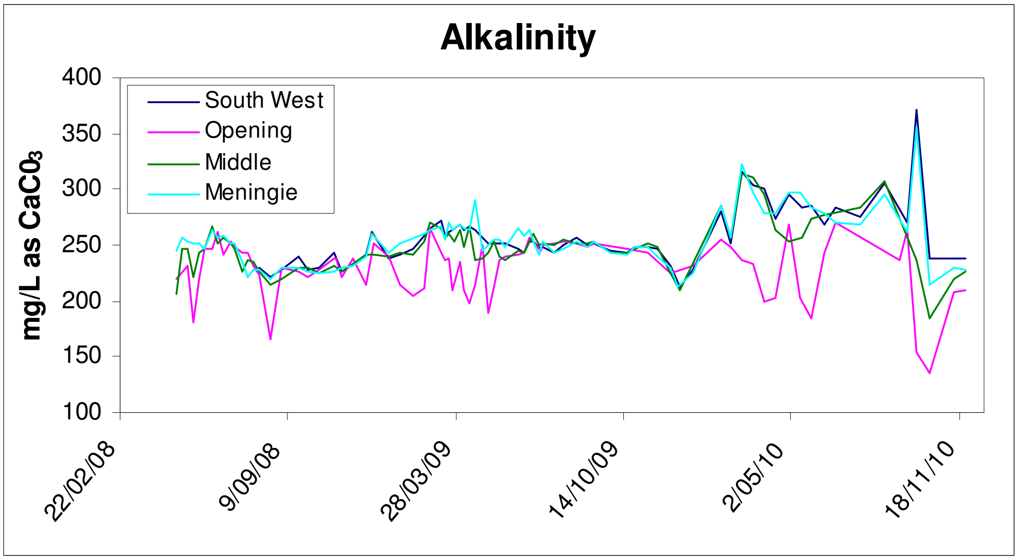

Figure 13 – Alkalinity at the Lake Albert ambient monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio continues to be variable at all sites (Figure 14). Water inflows following removal of the Narrung bund have caused the ratio to be similar to Lake Alexandrina (see Figure 4).

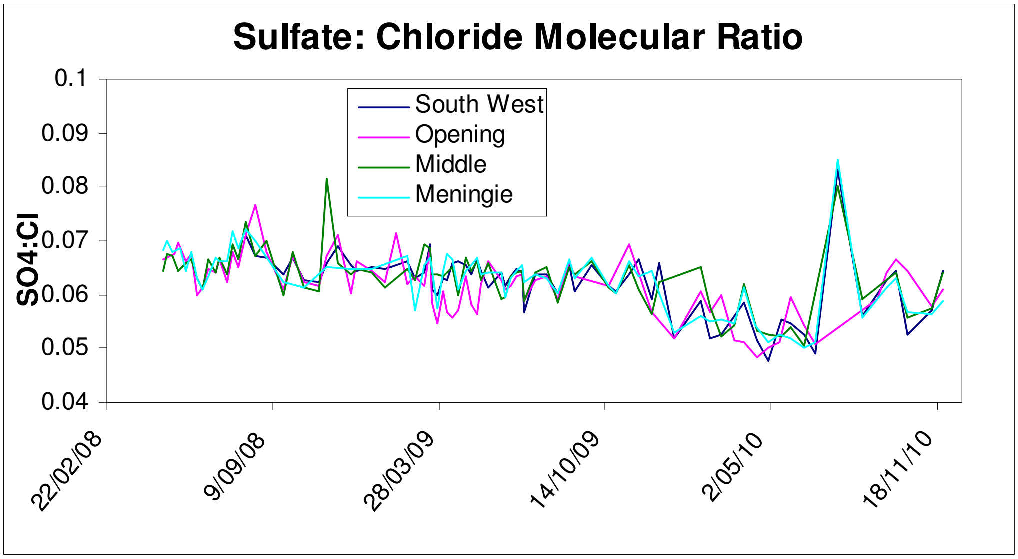

Figure 14 – Sulfate:chloride ratio at the Lake Albert ambient monitoring sites

Salinity (EC)

- Salinity has stabilised at all sites but still remains high (between 6500 and 8000 µS/cm) (Figure 15). Further inflow and mixing of water from Lake Alexandrina are expected to reduce salinities further across Lake Albert. However it is unlikely salinities will return to pre drought levels (<1600 µS/cm at Meningie) for some time due to the inability to export accumulated salt from the system.

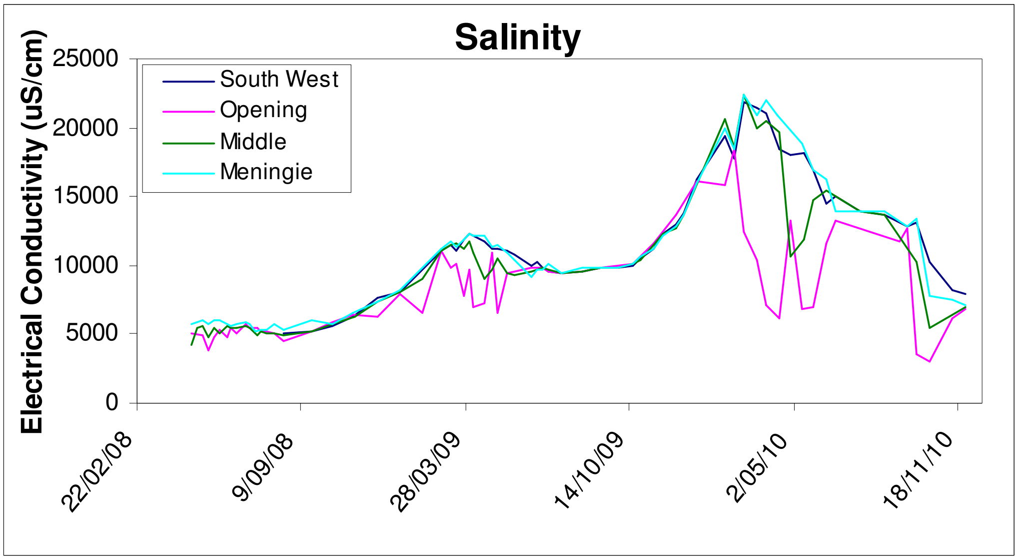

Figure 15 – Salinity at the Lake Albert ambient monitoring sites

Turbidity

- Turbidity in Lake Albert has continued to decrease during November which is likely due to the increased water levels within Lake Albert (Figure 16). Increased water levels mean that less resuspension of sediments occurs during wind events due to water depth and the reduced influence wind driven wave action will have upon them.

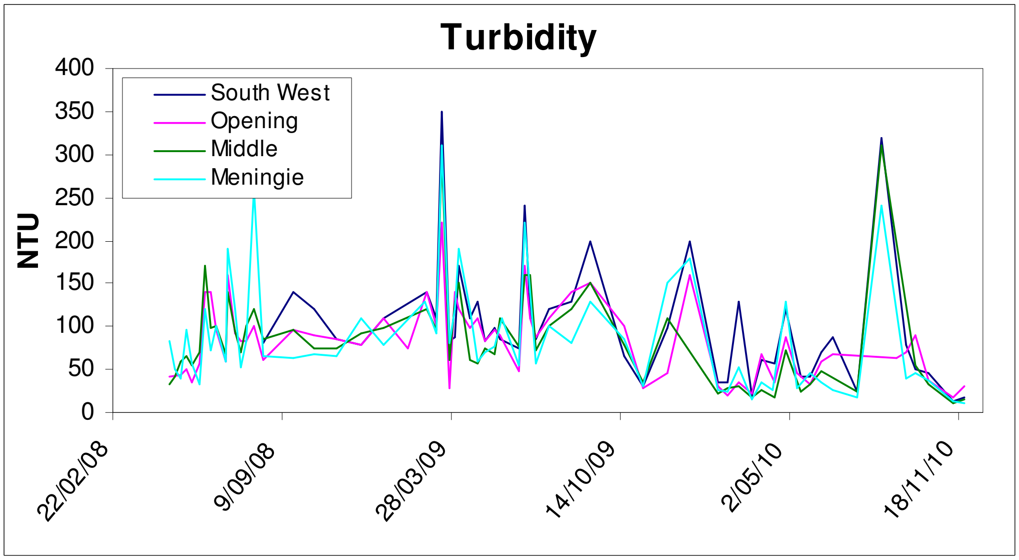

Figure 16 – Turbidity at the Lake Albert ambient monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen and total phosphorus levels have continued to reduce over November which is likely due to some dilution as the lake has refilled (Figures 17 and 18). Nutrient levels are now comparable to historic data however continue to be in excess of the ANZECC guidelines for freshwater ecosystems (<1mg/L TN, <0.025 mg/L TP).

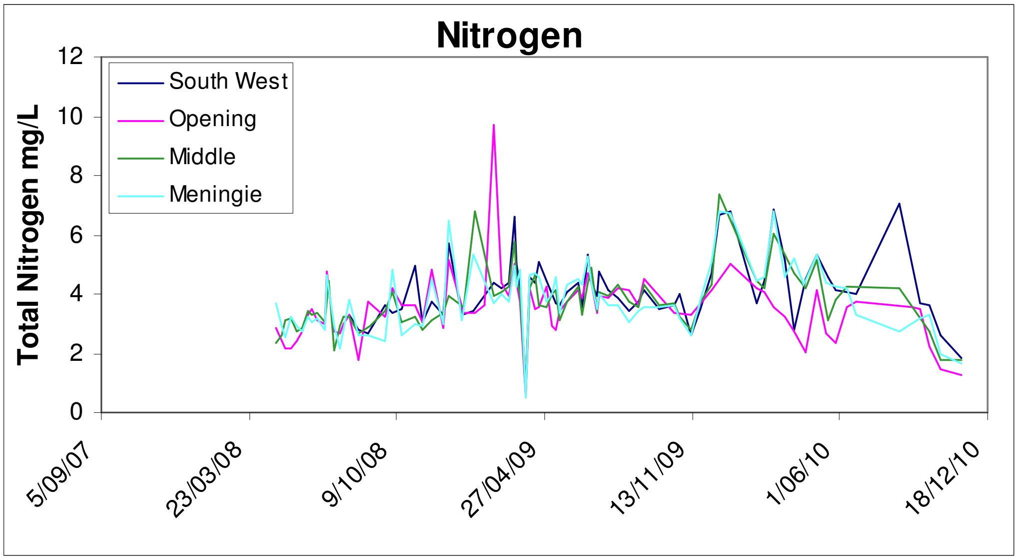

Figure 17 – Total Nitrogen at the Lake Albert ambient monitoring sites

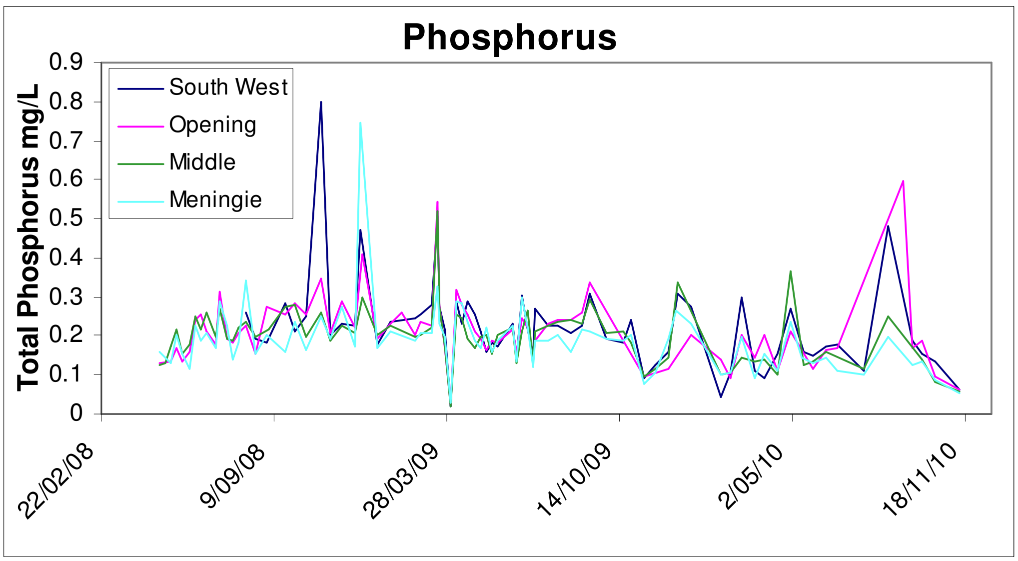

Figure 18 – Total phosphorus at the Lake Albert ambient monitoring sites

Chlorophyll a (algae)

- Chlorophyll *a* has decreased over recent months and is currently equal to or below historic data for Lake Albert (Figure 19). This is likely due to lowered nutrient inputs through floodwater dilution. However these levels continue to be in excess of the ANZECC guidelines (>15 µg/L) and indicate a nutrient enriched system. No toxic blue-green algal species have been identified at present.

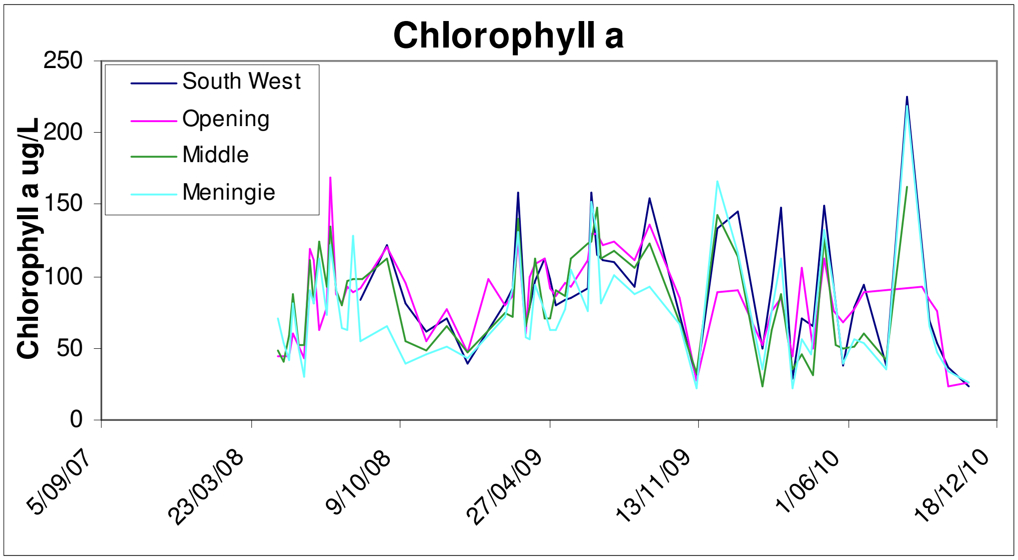

Figure 19 – Chlorophyll *a* at the Lake Albert ambient monitoring sites

Metals

- Total aluminium and iron concentrations within Lake Albert (Figures 20 and 21) have remained stable since water levels have been maintained. Shallow groundwater interaction from these soils may have been responsible for the elevated metal levels during the previous low water level periods.

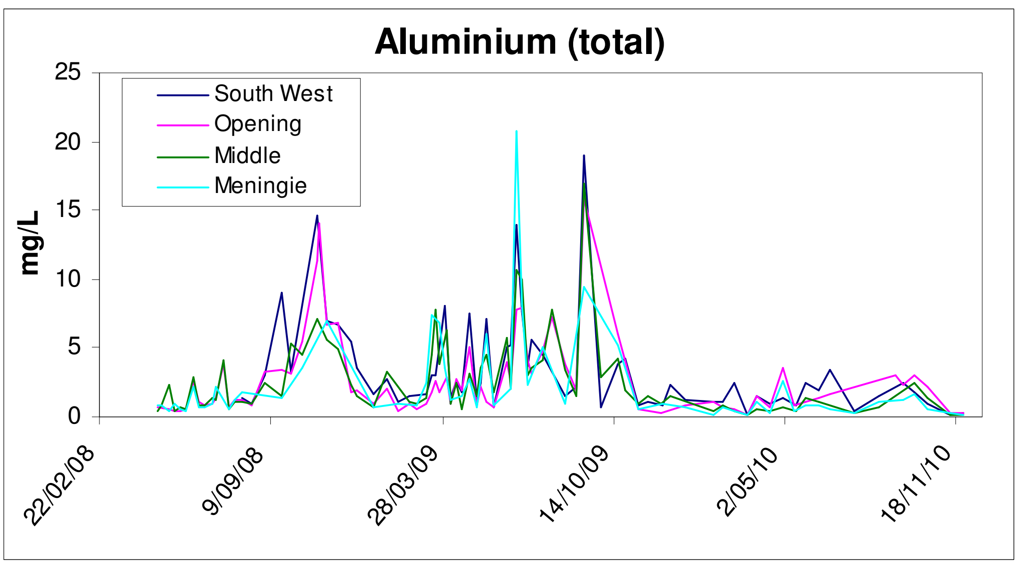

Figure 20 – Total aluminium at the Lake Albert ambient monitoring sites

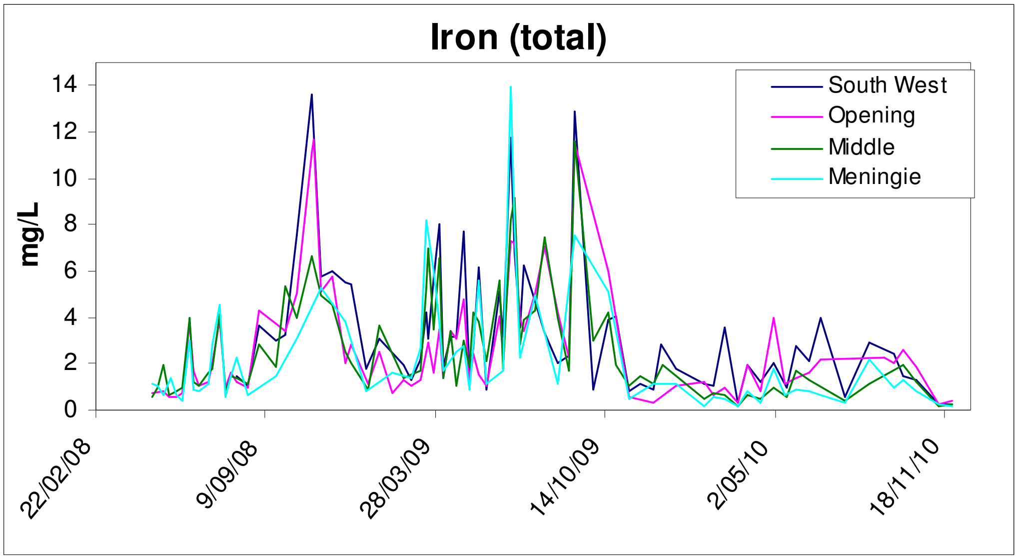

Figure 21 – Total iron at the Lake Albert ambient monitoring sites

Goolwa Channel and Tributaries Water Quality

Ambient and event-based water quality monitoring results are discussed for selected sites and parameters in the Goolwa Channel and tributaries region (see Figures 1 and 22 for site locations). Due to the nature of the monitoring program both the ambient and event-based sites have been included in this section to compare data collected over the month. In late September (starting 26/9/10), the Goolwa regulator near Clayton was partially breached and so monitoring data after then will reflect changes due to inflows from Lake Alexandrina.

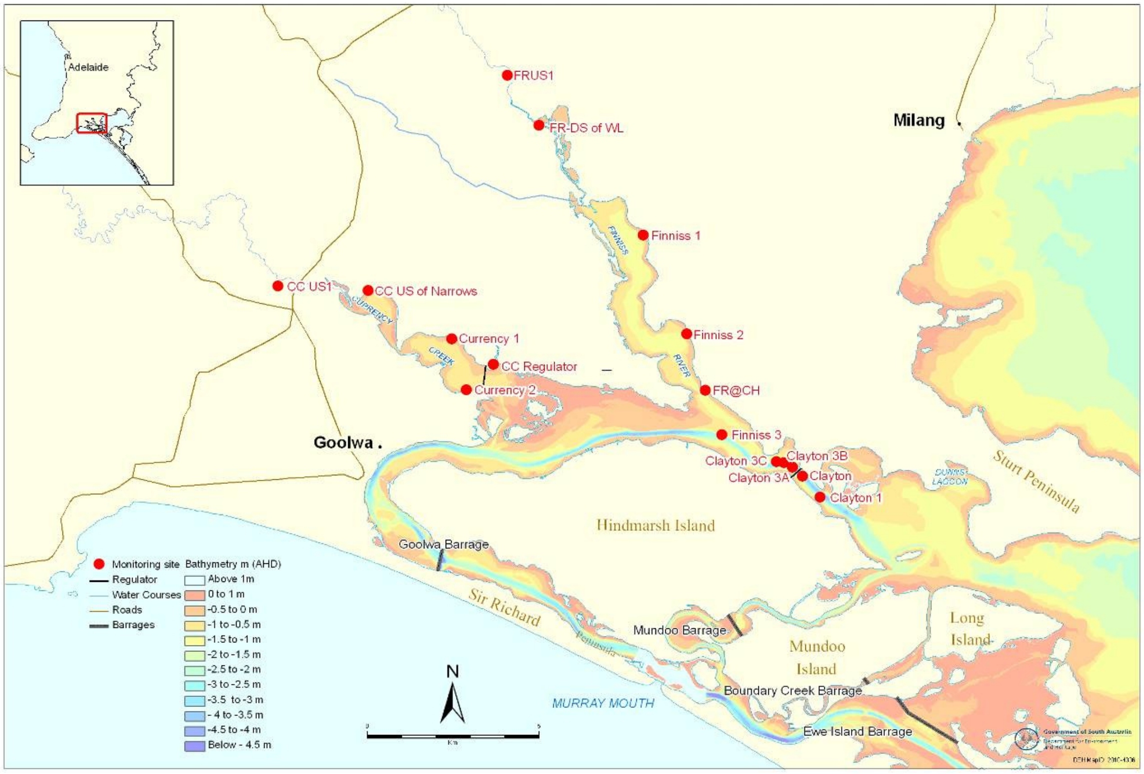

Figure 22 – Goolwa Channel and tributaries ambient and event-based monitoring sites

pH

- pH levels remain stable and within ANZECC guideline levels (pH 6.5-9.0) at all sites in the Goolwa Channel and tributaries region (Figure 23).

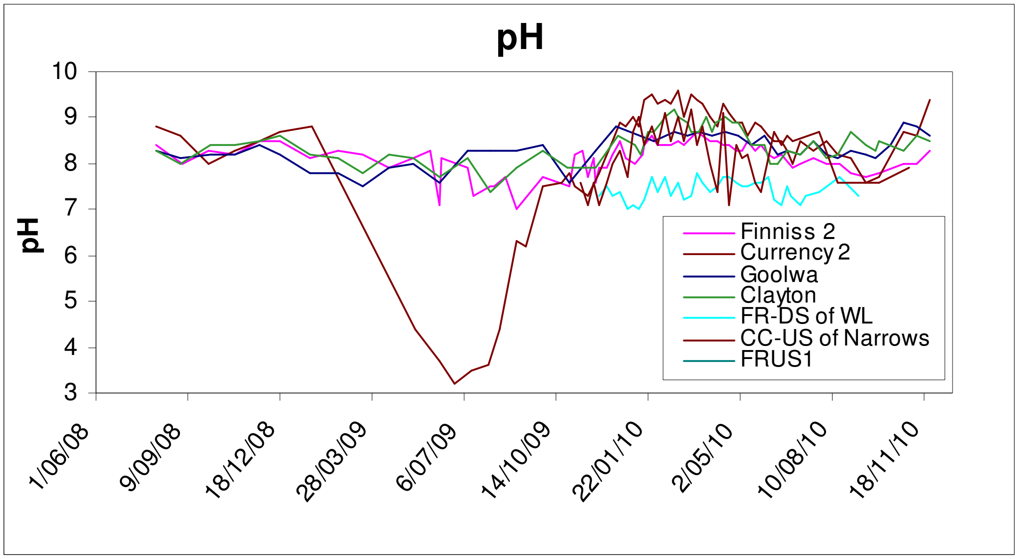

Figure 23 – pH at the Tributary monitoring sites

Alkalinity

- Alkalinity at all of the Goolwa Channel and tributaries sites remains stable and satisfactory (Figure 24). This is currently due the flood water flows from over the border making their way through the system diluting and flushing alkalinity within the Goolwa pool.

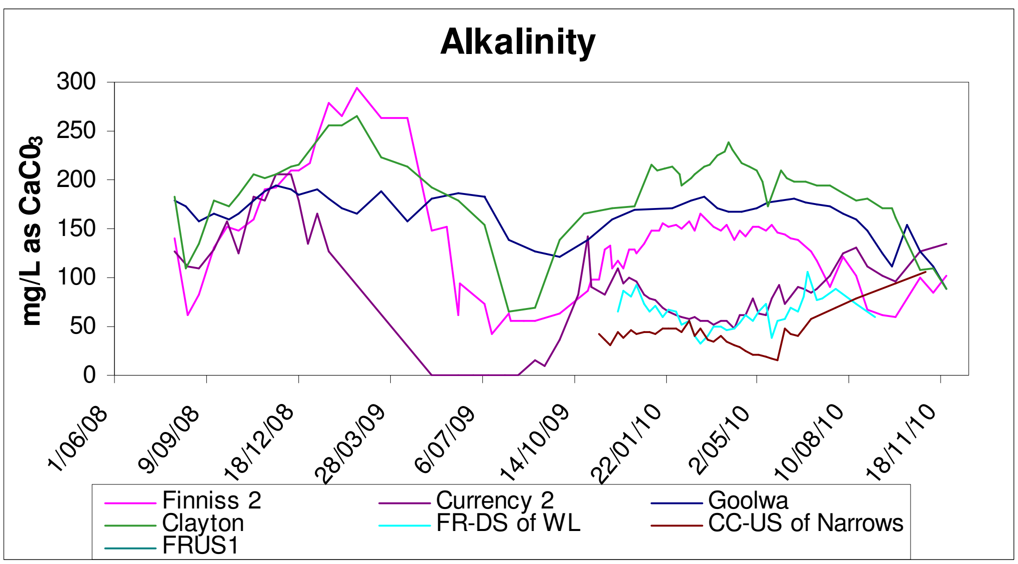

Figure 24 – Alkalinity at the Goolwa Channel and Tributaries monitoring sites

Sulfate:chloride ratio

- The sulfate:chloride ratio is consistent at most sites and does not show any clear trends that would suggest widespread acid sulfate soil inputs (Figure 25).

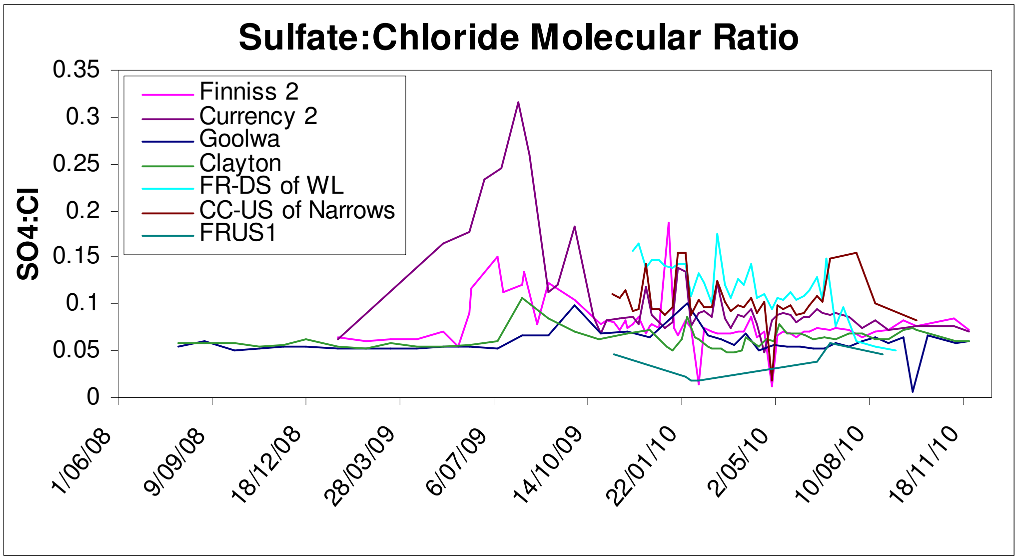

Figure 25 – Sulfate:chloride molecular ratio at the Goolwa Channel and Tributaries monitoring sites

Salinity (EC)

- Salinity is decreasing at all sites but still remains high compared to historical levels at some sites (Figure 26). The salinity is expected to continue to decrease over coming months as water is released through the Goolwa Barrage.

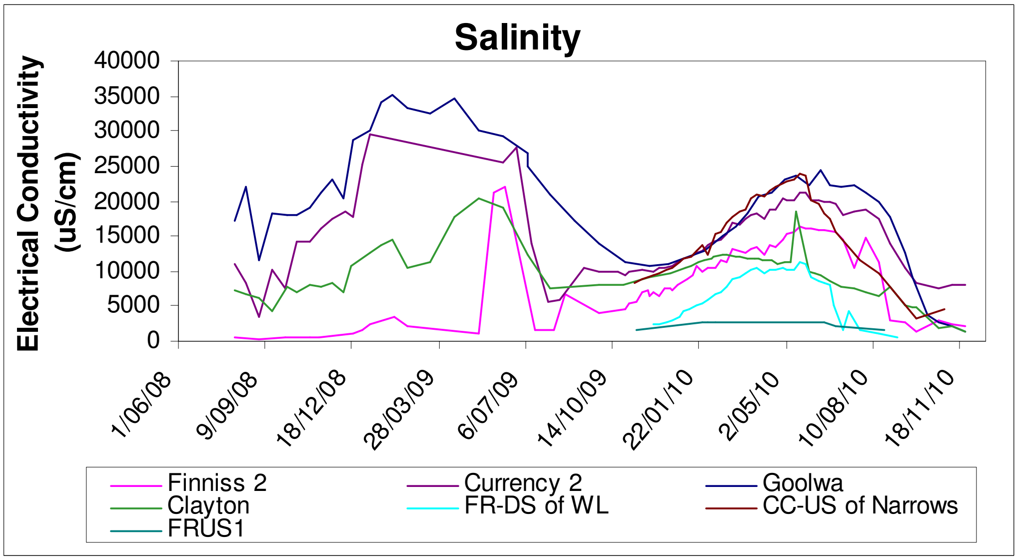

Figure 26 – Salinity at the Goolwa Channel and Tributaries monitoring sites

Turbidity

- Turbidity is variable in the Goolwa Channel and Tributaries sites (Figure 27), since the partial breach in the regulator has taken place turbidity has increased to match that as seen in Lake Alexandrina (see Figure 6). Turbidity within the Goolwa Channel is expected to increase as floodwaters flow through the regulator bringing increased turbidity.

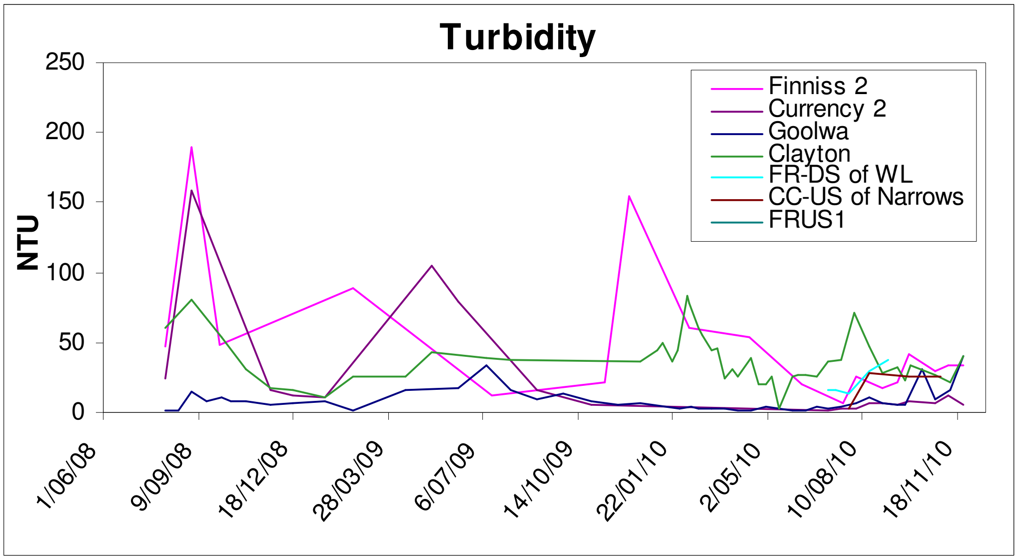

Figure 27 – Turbidity at the Goolwa Channel and Tributaries monitoring sites

Nutrients (total nitrogen and phosphorus)

- Total nitrogen is stable and at high levels in the Goolwa Channel and tributaries. In comparison. total phosphorous has been more variable The reason for this recent increase is unclear but could be related to runoff of phosphorus from the catchment during large rain events (Figures 28 and 29). This will be closely monitored over coming months.

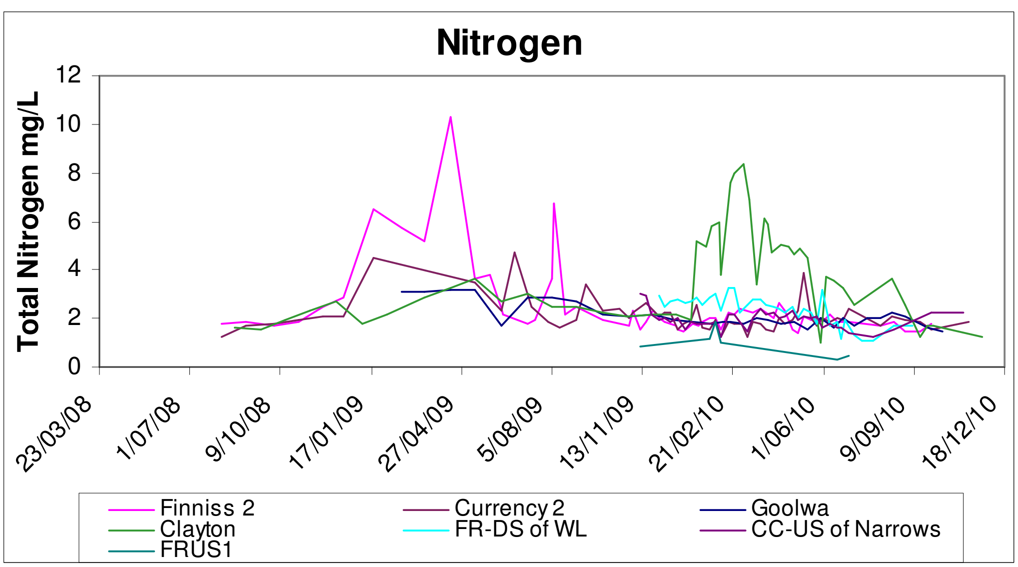

Figure 28 – Total Nitrogen at the Goolwa Channel and Tributaries monitoring sites

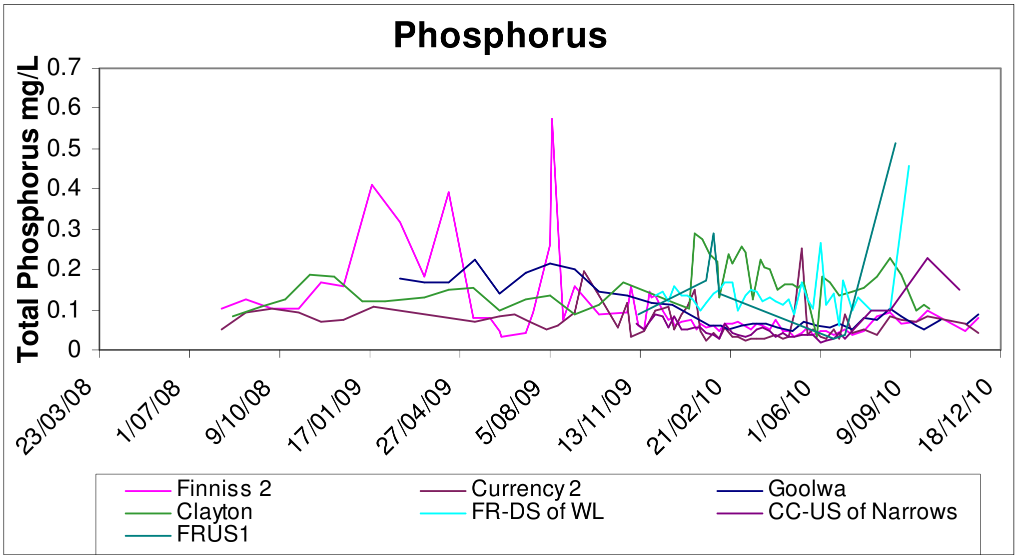

Figure 29 – Total phosphorus at the Goolwa Channel and Tributaries monitoring sites

Chlorophyll (algae)

- Chlorophyll *a* continues to be variable at the Goolwa Channel and tributaries sites (Figure 30). The increase observed at the Currency 2 site has reduced over November likely due to water movement and dilution up the creek.

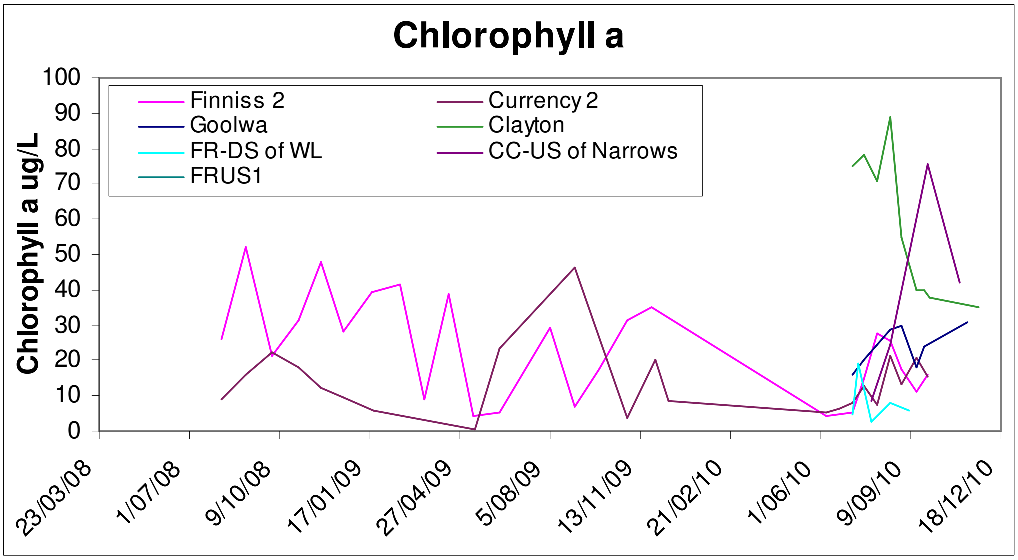

Figure 30 – Chlorophyll *a* at the Goolwa Channel and Tributaries monitoring sites

Metals

- Total aluminium and iron concentrations within the tributaries continue to remain relatively low since the limestone additions to neutralise acidity in the winter of 2009 (Figures 31 and 32).

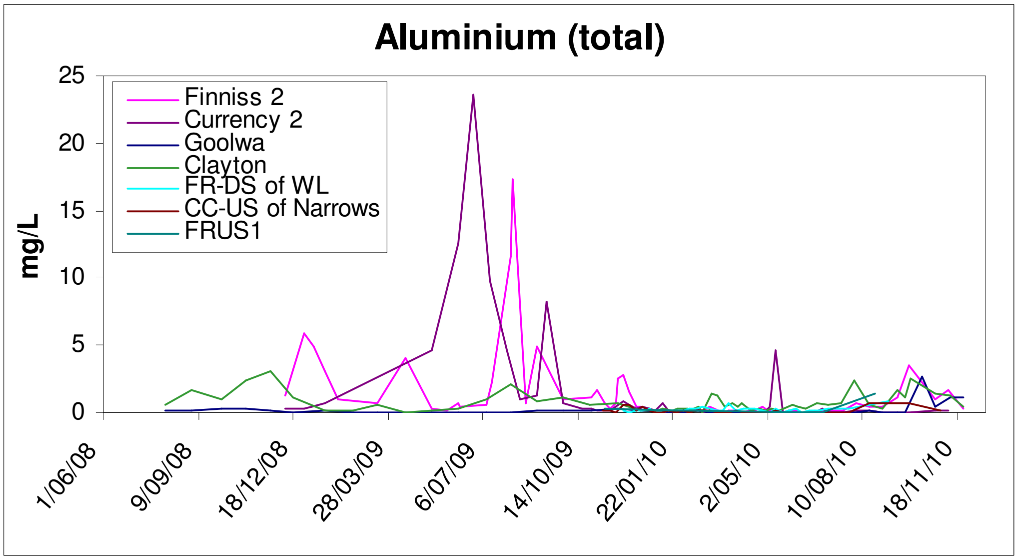

Figure 31 – Total aluminium at the Goolwa Channel and Tributaries monitoring sites

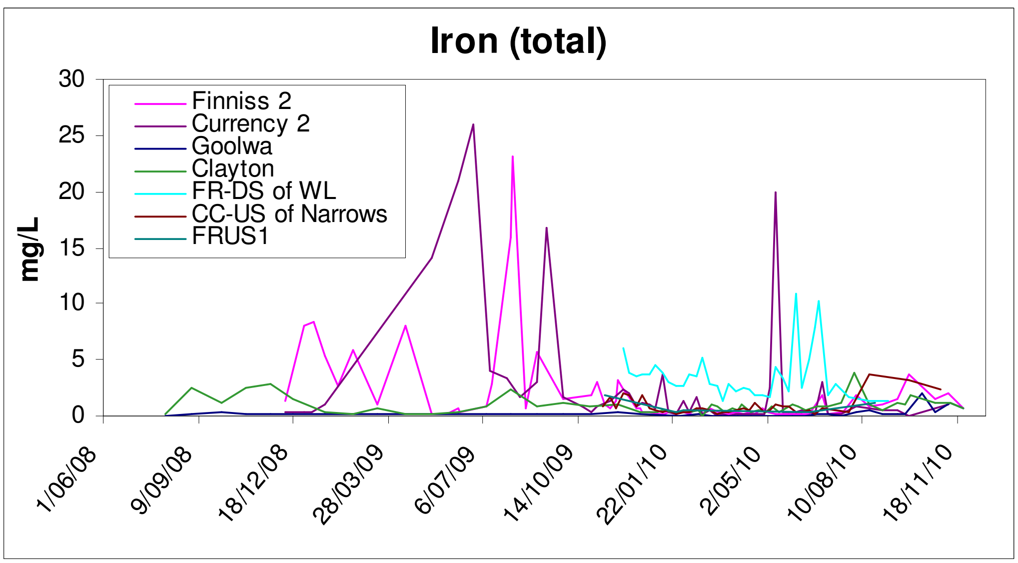

Figure 32 – Total iron at the Goolwa Channel and Tributaries monitoring sites

Event-based monitoring

Event-based water quality sampling is undertaken in selected regions that have experienced acidification or are at risk of acidification (Figure 33). The selection of sites is based upon acid sulfate soil risk assessment, in accordance with available data on the distribution of sulfidic and sulfuric materials and research and modelling into potential acidity fluxes. High risk locations were initially screened to identify the presence and extent of any acidity, and the frequency of further monitoring was determined from these results. The information is used to determine the need for management actions, such as limestone dosing, which has the capacity to reduce the acidity hazard and mitigate further metal release.

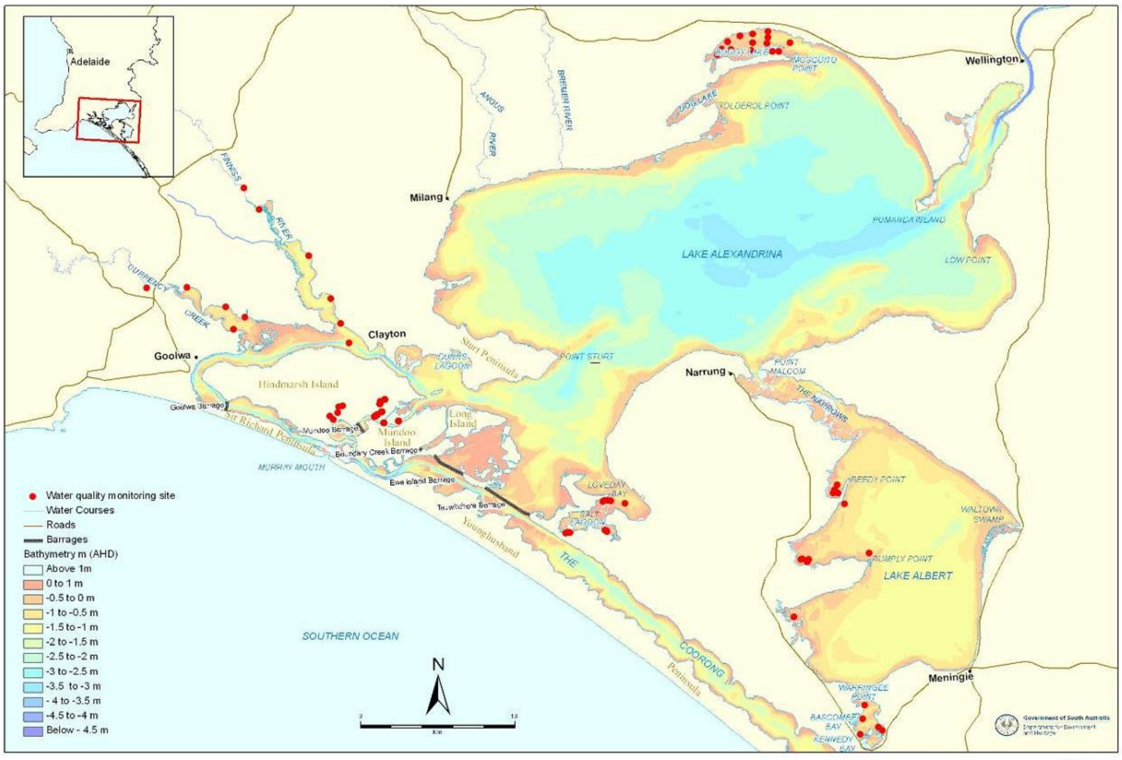

Figure 33 – Map of the event-based water quality monitoring sites

Boggy Lake

Figure 34 shows a map of sampling locations in Boggy Lake with water quality results from selected sites shown in Figure 35. During November, satisfactory alkalinity was recorded at all of the sites within Boggy Lake and the pH continued to be at levels within guideline values. Salinity has now stabilised however remains higher than Lake Alexandrina, this is expected to reduce over coming months as fresh water continues to flow. However due to the location of Boggy Lake water exchange is a slower process primarily driven by wind seiching events rather than water flow. Sampling and evaluation of this site will continue to assess the potential for ongoing acid fluxes from the reinundated sediment.

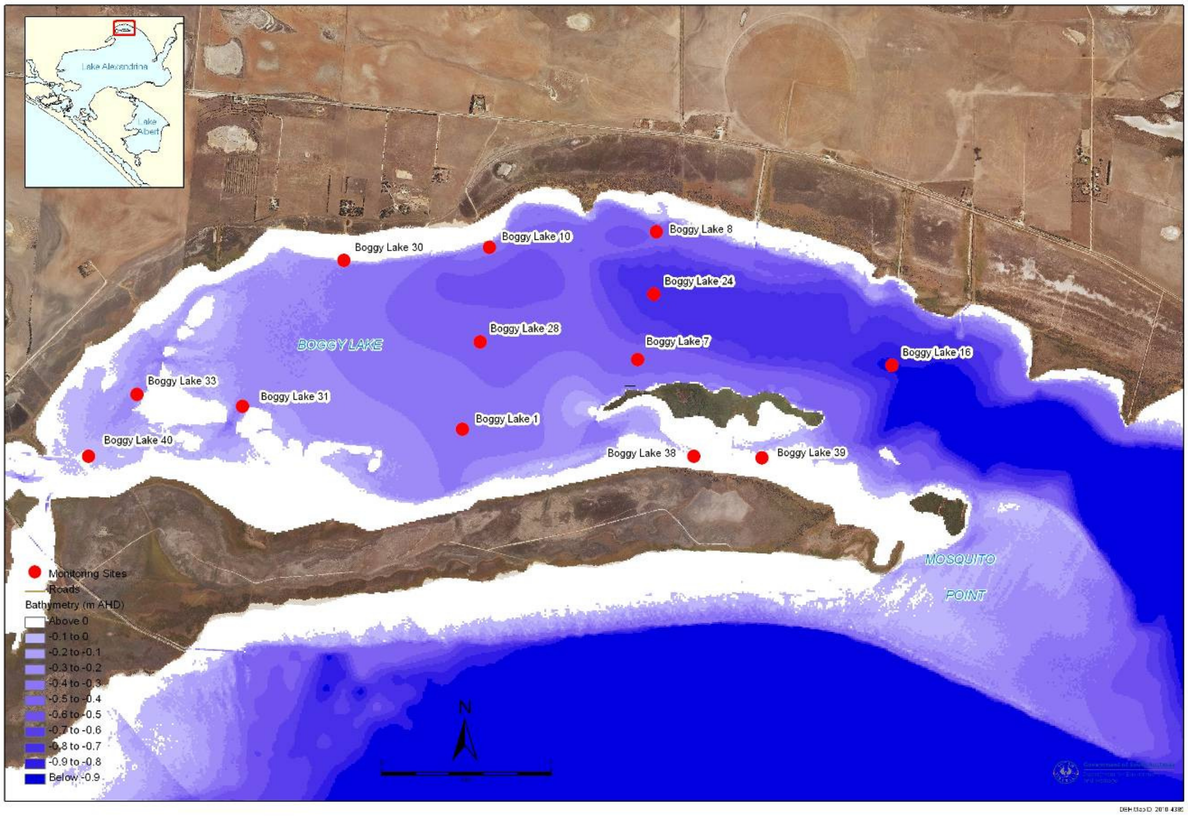

Figure 34 – Map of Boggy Lake monitoring sites

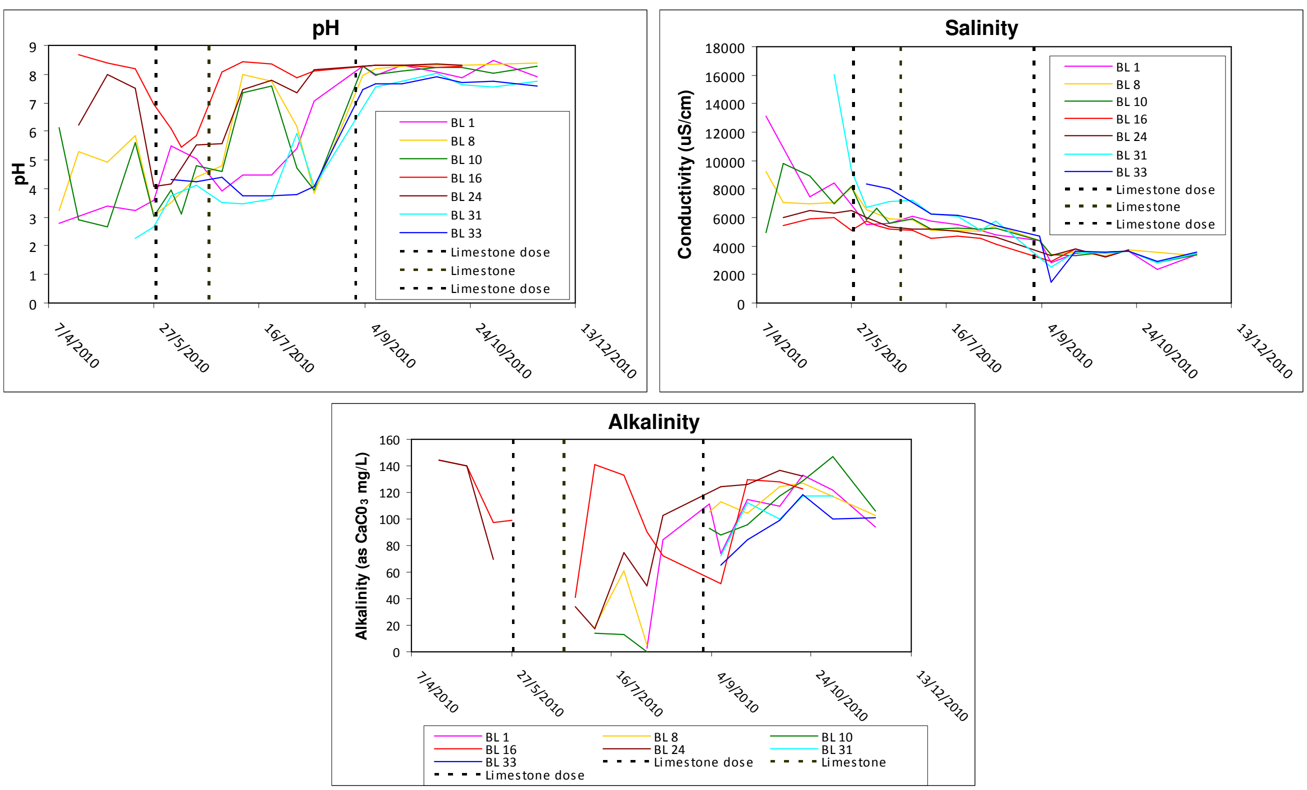

Figure 35 –Boggy Lake water quality results

Boggy Creek

The continued increase in water levels in Lake Alexandrina has resulted in a number of sites within Boggy Creek being reinundated. Sampling over November indicated all of Boggy Creek now has a neutral pH with minimal spatial variation in water quality between the different sampling sites This neutralisation is likely due to the input of alkalinity and dilution from River Murray flows. Salinity within Boggy Creek has continued to fall where it is now comparable to that seen within Lake Alexandrina. As flood waters continue to dilute the salinity of Lake Alexandria this should continue to reduce. Sampling and evaluation of this site will continue to assess the recovery of this site.

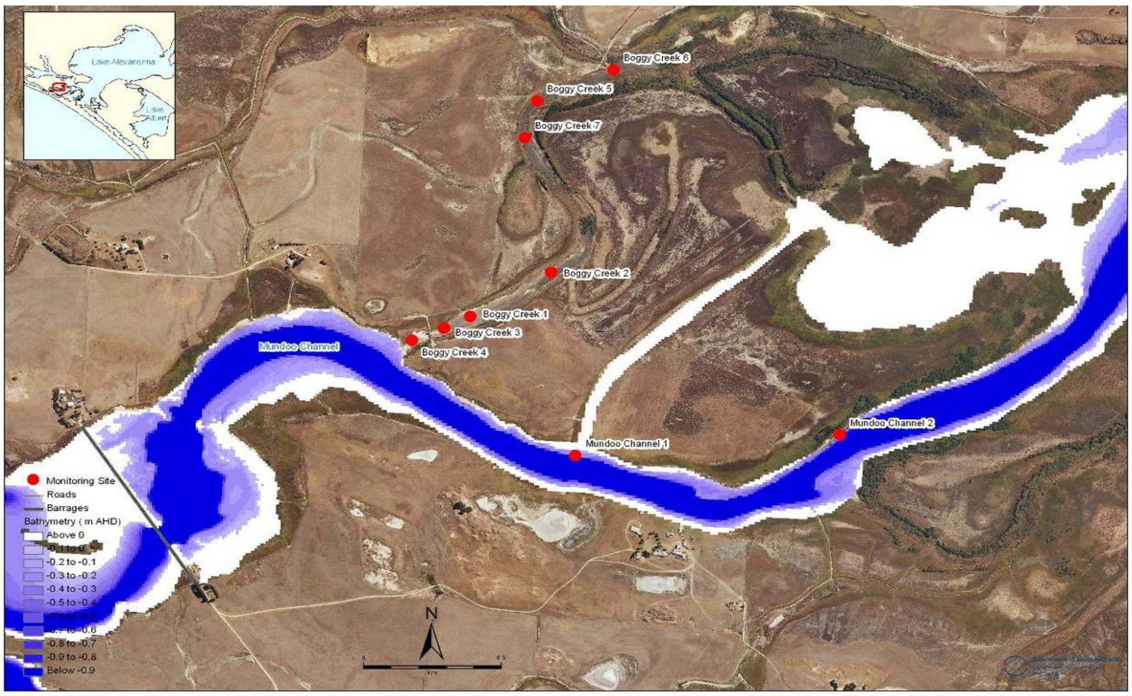

Figure 36– Map of Boggy Creek sample site

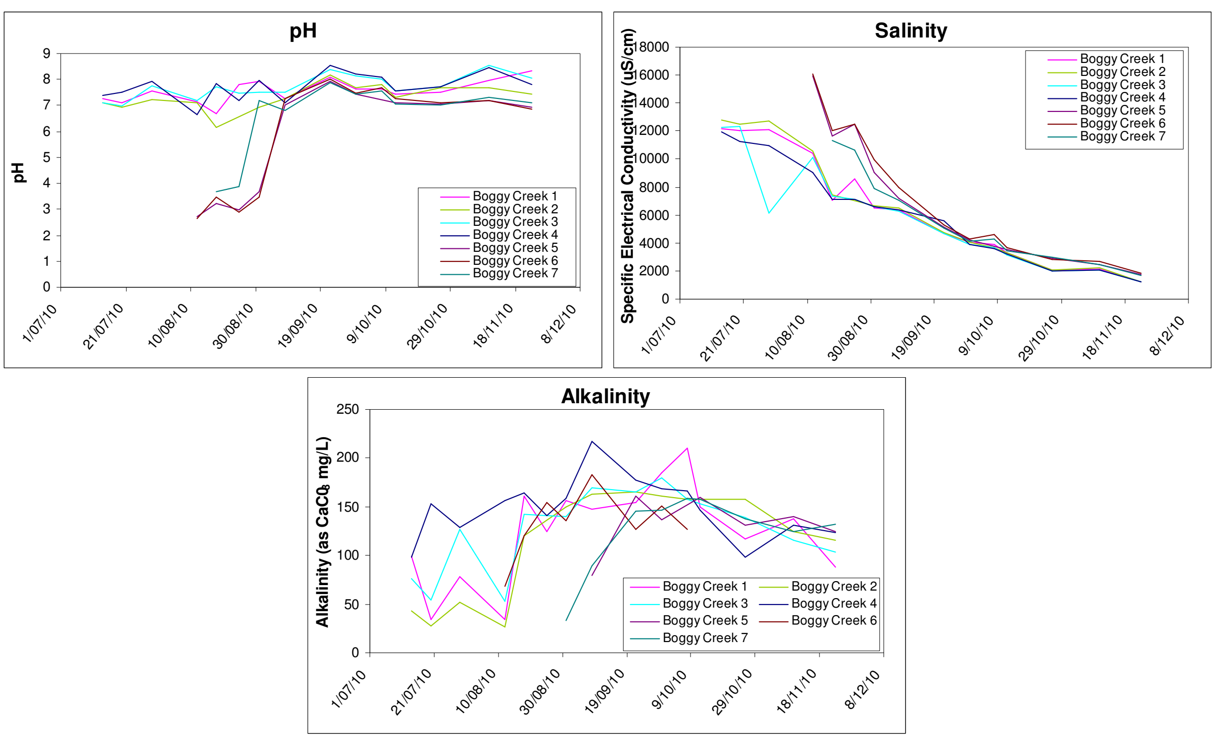

Figure 37 –Boggy Creek water quality results

Hunters Creek

When water levels within Lake Alexandrina previously fell below 0 m AHD, sediments containing acid sulfate materials in Hunters Creek (near Mundoo barrage, Figure 38) dried and oxidised. Recent rises in water levels rewet these sediments, which resulted in pools of acidic water (Figure 39). Sampling over November has shown that waters within the creek have now been neutralised with marked reductions in salinity (from approximately 4,000 to under1,000 EC). pH and alkalinity continue to remain at satisfactory levels and above trigger levels This is due to substantial inflow of fresh lake water which has neutralised the acidity in the water column and shallow sediments.

Figure 38– Map of Hunters Creek sample sites

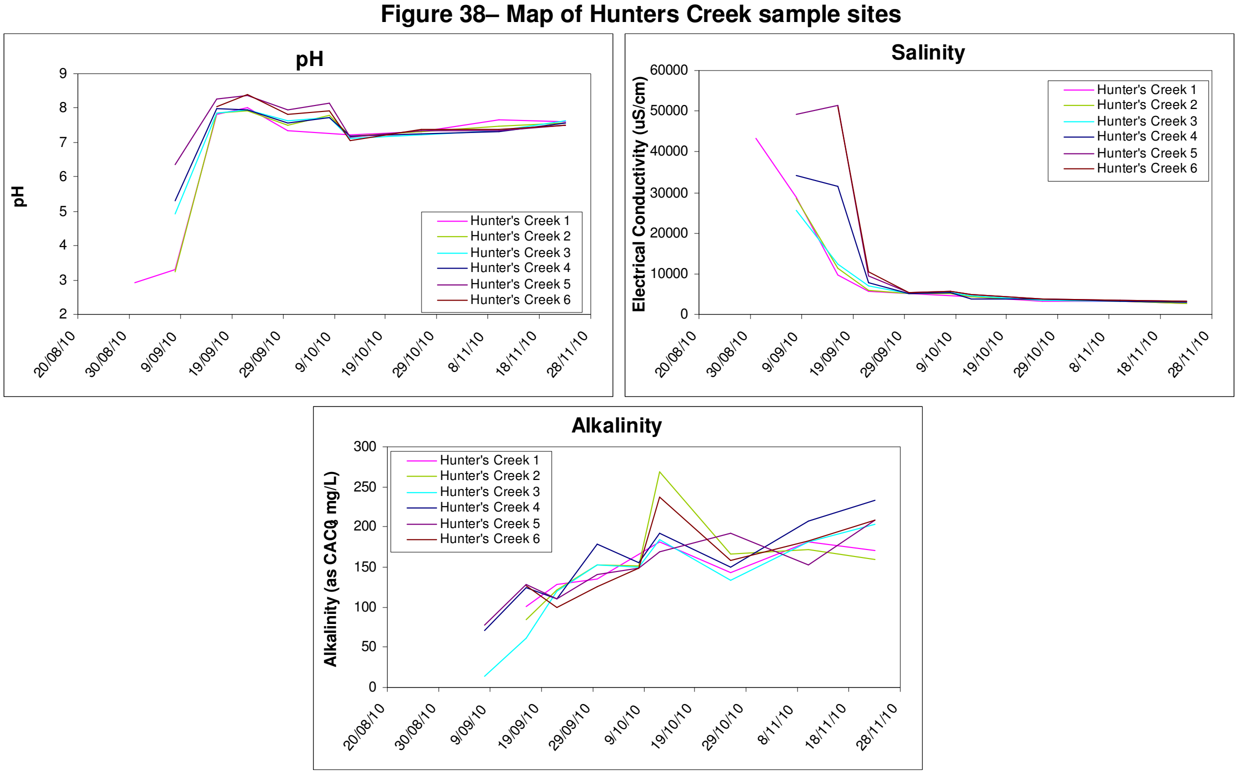

Figure 39 – Hunters Creek water quality results

Further Information

Further information on water quality and quantity, and acid sulfate soils, can be found on the following websites:

- Department of Environment and Natural Resources www.environment.sa.gov.au/cllmm/
- River Murray Data http://data.rivermurray.sa.gov.au/ (real-time data)
- Environment Protection Authority www.epa.sa.gov.au or for specific Lower Lakes data see www.epa.sa.gov.au/environmental_info/water_quality/monitoring_programs_and_assessments/lower_lakes
- Department for Water www.waterforgood.sa.gov.au/
- South Australian Murray–Darling Basin Natural Resource Management Board www.samdbnrm.sa.gov.au
- Murray–Darling Basin Authority www.mdba.gov.au
- Waterwatch www.waterwatch.org.au
- CSIRO acid sulfate soils www.clw.csiro.au/acidsulfatesoils/murray.html