

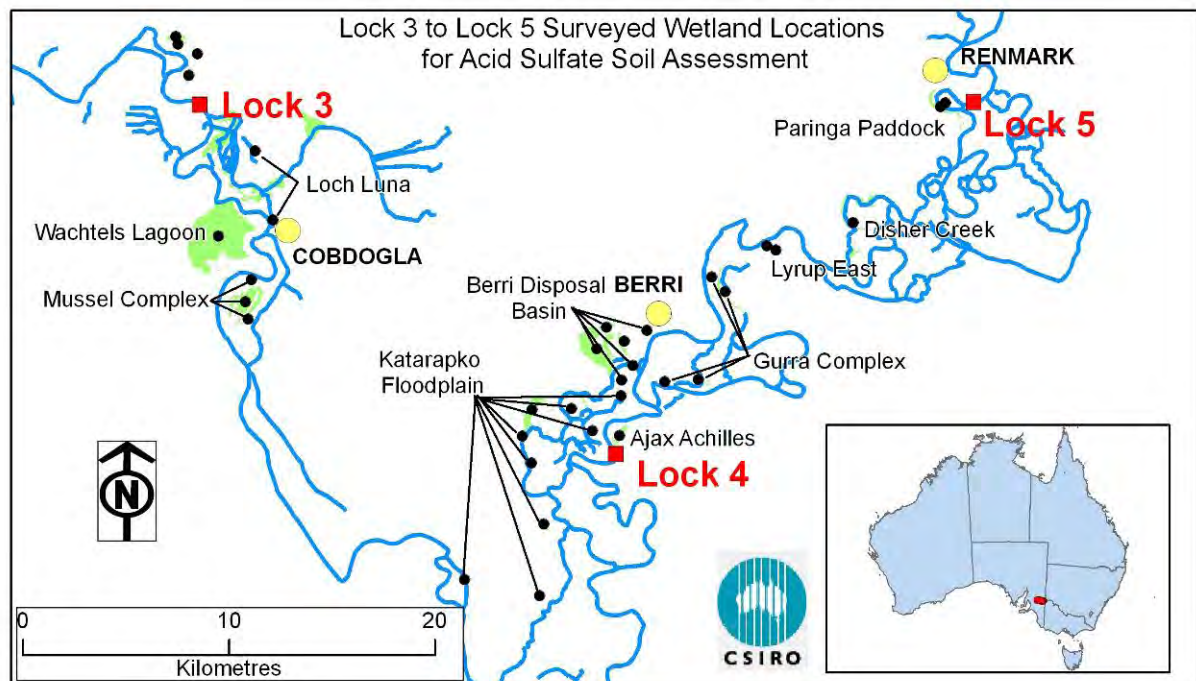
## APPENDIX B3

### DESCRIPTIONS FOR ASSESSED WETLANDS BETWEEN LOCK 3 AND LOCK 4

#### Table of Contents

1. Loch Luna (Wetland ID. 12492).....	373
2. Loch Luna (Wetland ID. 12531).....	384
3. Wachtels Lagoon (Wetland ID. 12075).....	402
4. Mussel Complex (Wetland ID. 12153).....	427
5. Mussel Complex (Wetland ID. 12155).....	437
6. Mussel Complex (Wetland ID. 12156).....	446
7. Katarapko Floodplain (Wetland ID. 12471) .....	464
8. Katarapko Floodplain (Wetland ID. 12474) .....	471
9. Katarapko Floodplain (Wetland ID. 12485) .....	482
10. Katarapko Floodplain (Wetland ID. 12486) .....	494
11. Katarapko Floodplain (Wetland ID. 12488) .....	504
12. Katarapko Floodplain (Wetland ID. 12514) .....	518
13. Katarapko Floodplain (Wetland ID. 12526) .....	525
14. Katarapko Floodplain (Wetland ID. 15002) .....	544
15. Katarapko Floodplain (Wetland ID. 15004) .....	556

#### MAP SHOWING LOCATION OF WETLANDS BETWEEN LOCK 3 AND LOCK 5



# 1. LOCH LUNA (WETLAND ID. 12492)

## 1.1. Location and setting description

Loch Luna (Wetland ID. 12492) is situated on the north-eastern side of the River Murray, up river from Lock 3 and approximately 500 metres west of the town of Cobdogla. The wetland is rectangular in shape. It is about 650 metres in length and about 50 metres at its widest, with a total surface area of 6 hectares. The wetland is bounded by a raised floodplain that separates it from the river and other wetlands. The other associated wetland in the Loch Luna Wetland Complex that was surveyed is wetland ID. 12531.

The wetland is permanently connected to the river at the southern end by an inlet and at the northern end it may temporarily connect with the adjacent wetland ID.12531. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Four sites were sampled as shown in Figure 1-1.

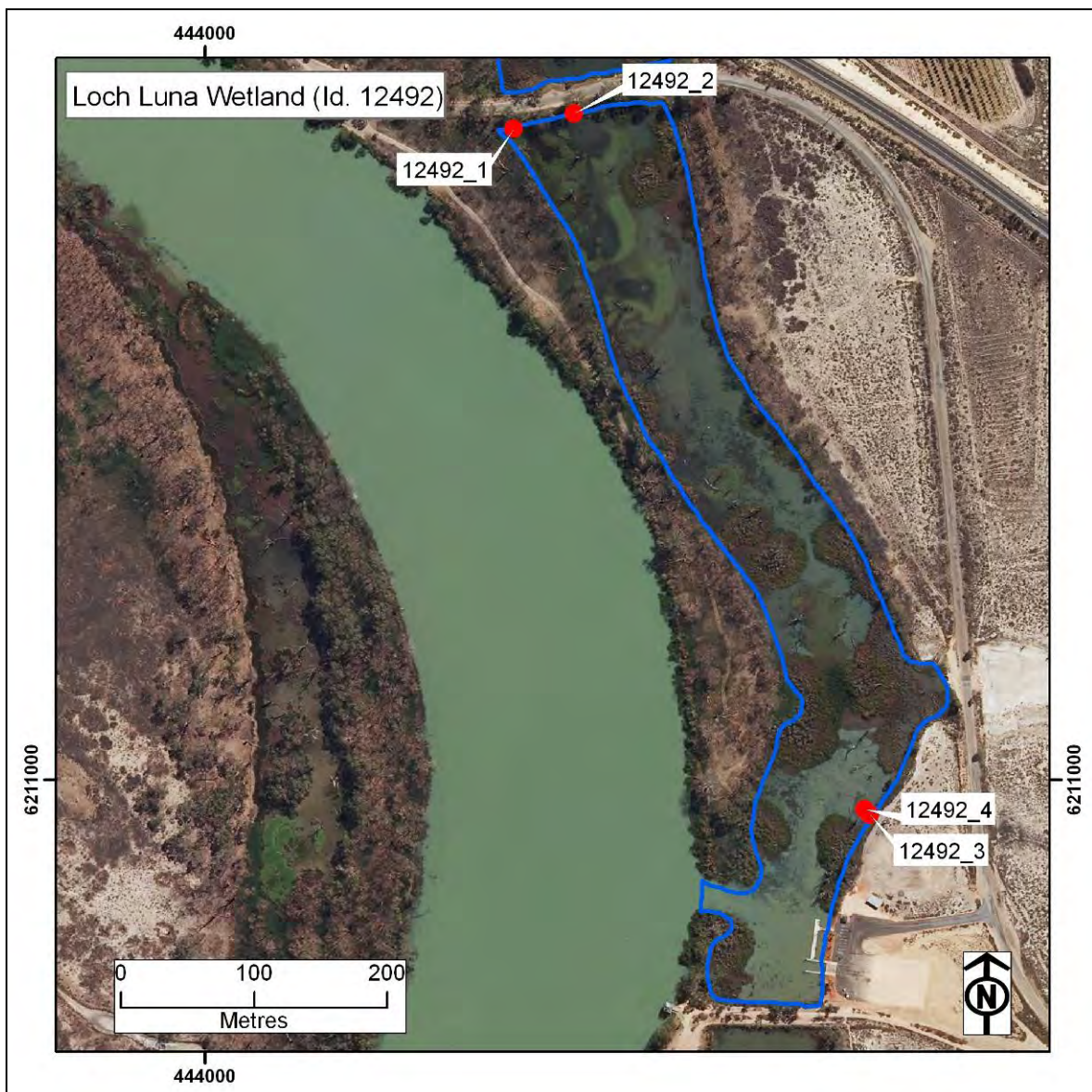


Figure 1-1. Loch Luna (Wetland ID. 12492) and sample site locations.

## 1.2. Soil profile description and distribution

Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 1-1. Sites were distributed in two areas as pairs, located at the northern end (Sites 1 and 2), and southern end (Sites 3 and 4) of the wetland. The site and soil profile descriptions are presented in Table 1-2 and Table 1-3, and a conceptual cross-section shown in Figure 1-2.

### Northern transect

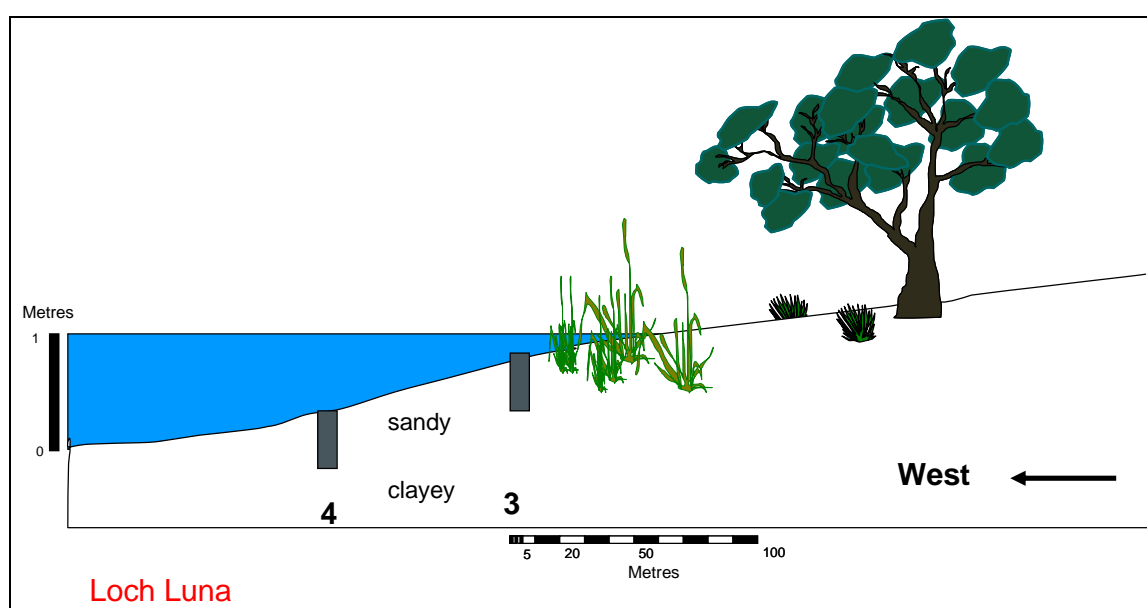
Site 1 (Figure 1-3) occurred near the shore in water (26 cm deep), and the soil consisted of a dark olive grey, very weak, gel, over a greenish grey, very weak, clay. Site 2 (Figure 1-4) occurred adjacent to a line of reeds (58 cm deep), and the soil consisted of a very dark grey, very weak, gel, over a dark grey, very weak, clay.

### Southern transect

Site 3 (Figure 1-5) occurred near the shore in water (26 cm deep), and the soil consisted of a dark olive grey, very weak, sand, over a dark grey, very weak, clay. Site 4 (Figure 1-6) occurred in open water (38 cm deep), and the soil consisted of a dark olive grey, very weak, sand, over a dark grey, very weak, clay. Site 5 was adjacent to Site 4 and is where a surface water sample was collected.

**Table 1-1. Soil identification, subtype and general location description for Loch Luna (Wetland ID. 12492).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12492_1	444232	6211488	Subaqueous Soil (loamy)	mid elevation, 5 m offshore
12492_2	444277	6211499	Subaqueous Soil (loamy)	edge of reed bed
12492_3	444499	6210974	Subaqueous Soil (clayey)	mid elevation, ca. 5 m from edge of water
12492_4	444495	6210978	Subaqueous Soil (clayey)	low elevation, ca. 25 m offshore



**Figure 1-2. Conceptual cross-section diagram, showing locations for Sites 3 and 4.**



**Figure 1-3. Photograph of Site 1, showing the site location near the shoreline and in water.**



**Figure 1-4. Photograph of Site 2, showing the site location adjacent to a line of reeds in water.**



**Figure 1-5. Photograph of Site 3, showing the site location adjacent to reeds in water.**



**Figure 1-6. Photograph of Site 4, showing the site location out from the reeds in open water.**

## 1.3. Laboratory data assessment

### 1.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 1-4 and pH profiles are presented in Figure 1-7. The  $pH_W$  data ranged from 5.75 to 8.95 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 1.44 to 8.75 and identified that upper layers for all profiles were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 4.09 to 7.55 and identified that no samples on incubation that declined below the critical values of  $pH < 4$ .

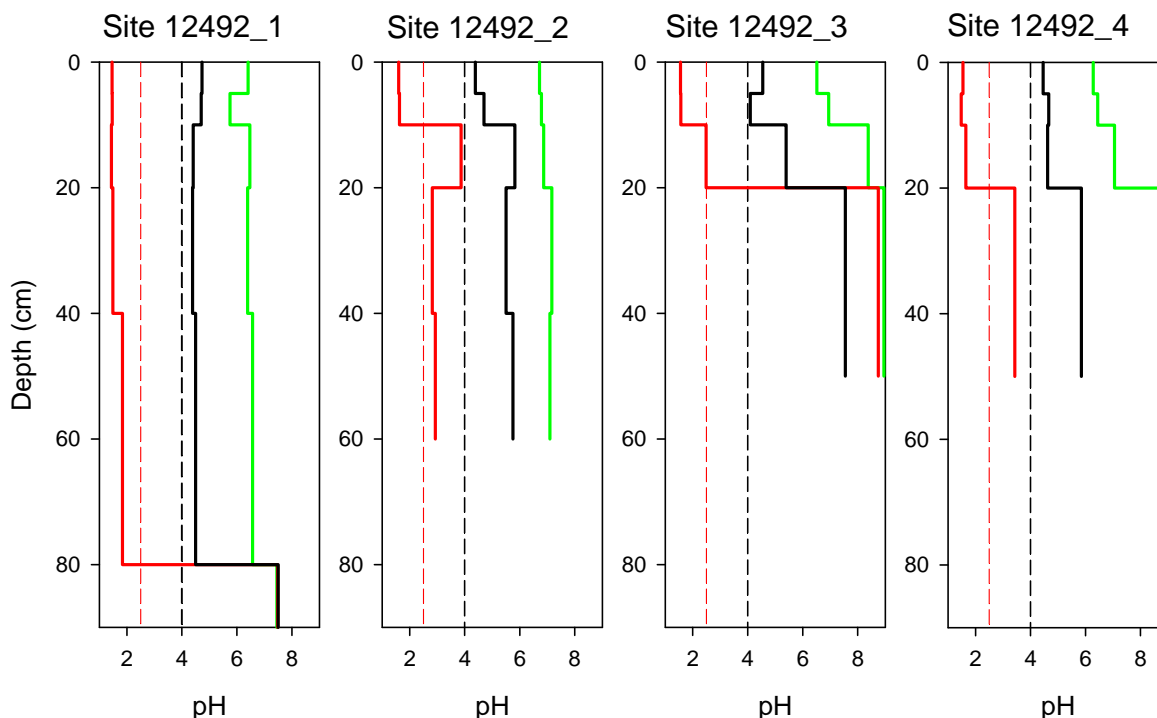


Figure 1-7. Depth profiles of soil pH for Loch Luna (Wetland ID. 12492), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 1.3.2. Acid base accounting

The acid base accounting data is provided in Table 1-4 and summarised in Figure 1-8.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.02 to 0.78 % $S_{CR}$  and sulfidic materials were detected in all samples.

#### Titrateable actual acidity

Titrateable actual acidity values ranged from 0.00 to 14.92 mole  $H^+$ /tonne and were detected in all samples except for the lower subsoil clay layers.

#### Retained acidity

Retained acidity was not measured in any of the layers as all samples had a  $pH_{KCl}$  of greater than 4.5.

### Acid neutralising capacity

Acid neutralising capacity values ranged from 0 to 2.45 %CaCO<sub>3</sub> and tended to be measured in the lower soil layers.

### Net acidity

Net acidity values ranged from -244 to 502 mole H<sup>+</sup>/tonne. High net acidity values were recorded in nearly all layers of the profiles and negative values were only recorded for the lower subsoil clay textured layers of Profiles 1 and 2.

### 1.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 1-4 identified that all profiles has a surface layers above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 1.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

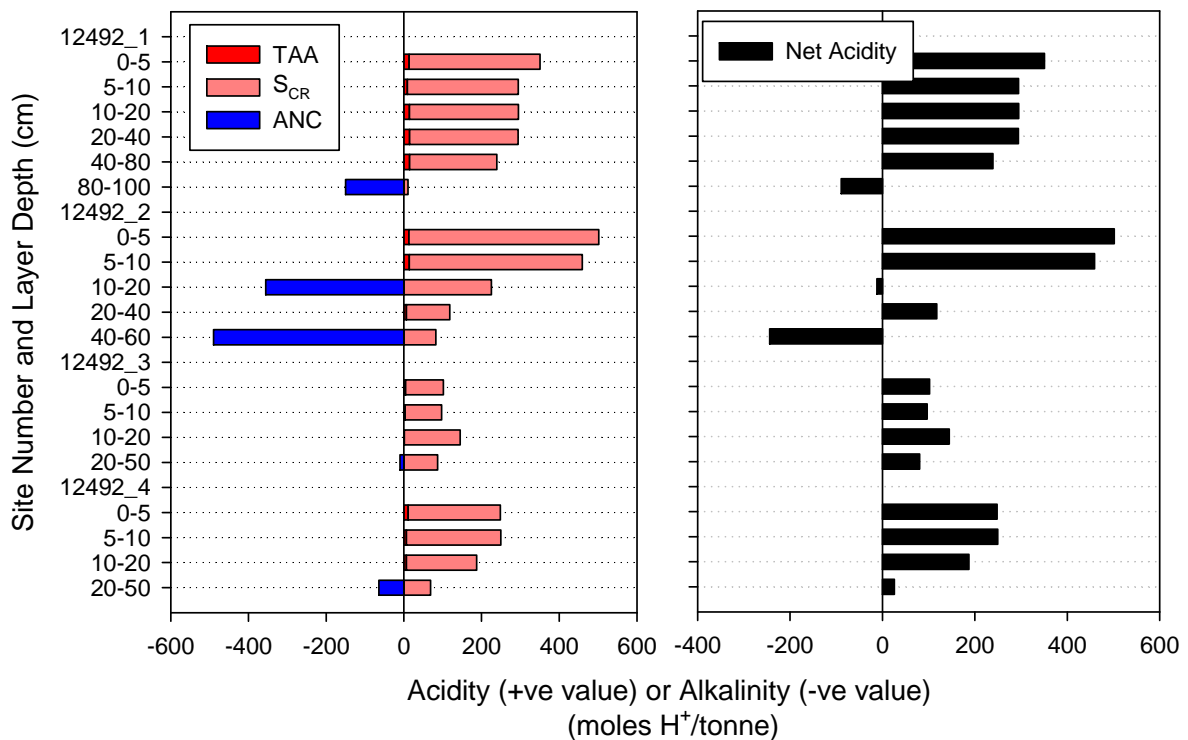


Figure 1-8. Acid base accounting depth profiles for Loch Luna (Wetland ID. 12492). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

### 1.3.5. Hydrochemistry

Two surface water samples were collected from this narrow wetland. Field parameters are shown in Table 1-5. The surface waters had circumneutral pH and low salinity. Dissolved oxygen was relatively low, turbidity was high, and alkalinity was moderate.

The surface waters were of mixed cation-HCO<sub>3</sub> to Na-Cl type (Table 1-6, Figure 1-9). Sulfate concentration in the surface water samples were low and varied from 6.2 to 6.5 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters (0.168 to 0.197) was slightly higher than seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values. Of the metals, Al and Zn concentrations were elevated above ANZECC Guideline values.

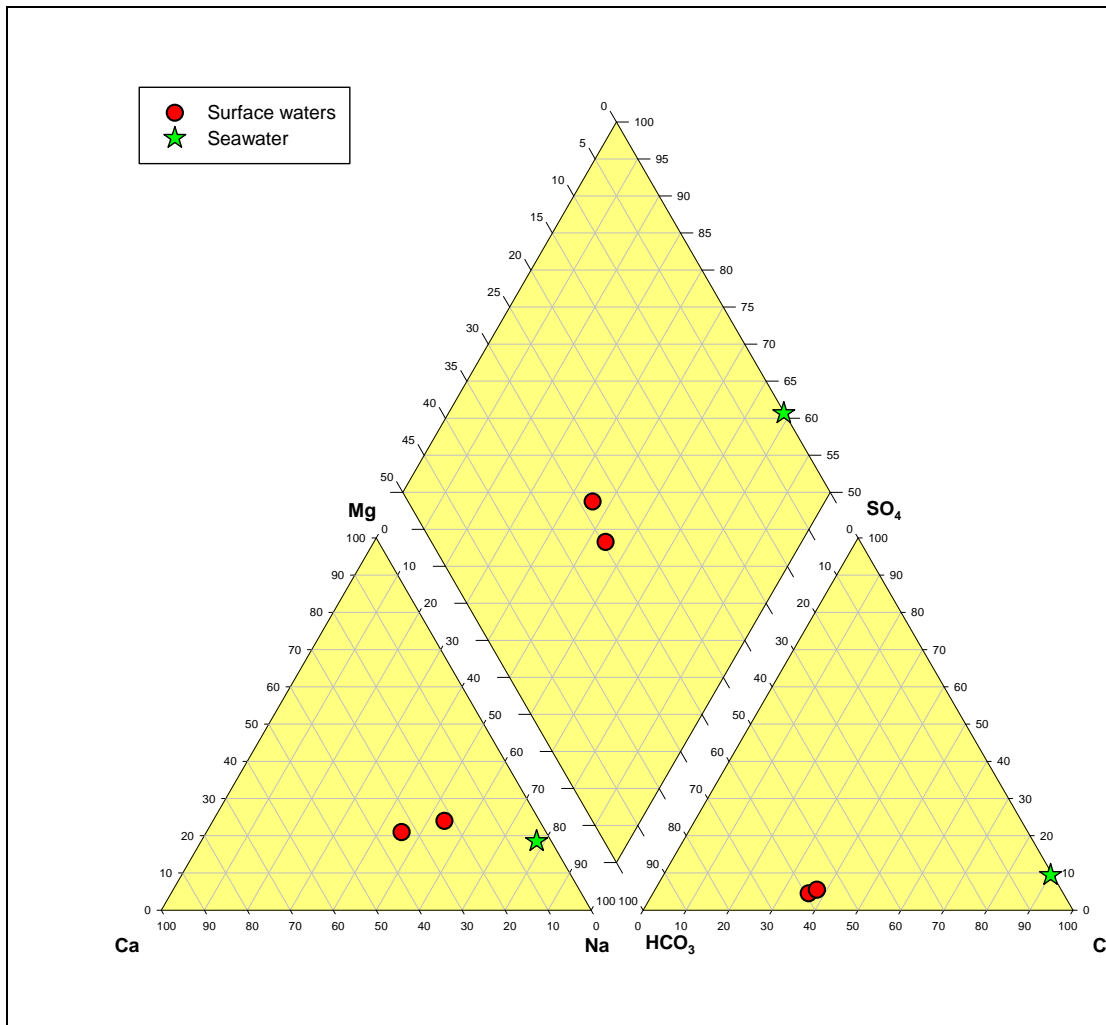


Figure 1-9. Piper diagram of hydrochemical data for Loch Luna (Wetland ID. 12492).

## 1.4. Discussion

Acid sulfate soil materials at Loch Luna (Wetland ID. 12492) were identified as hyposulfidic that occurred throughout all profiles. The acid sulfate soil subtype class identified was Subaqueous Soil (loamy or clayey) that occurred throughout the wetland.

The soils throughout the wetland were dominantly gel like or loamy textured in the surface layers. The subsoils were generally sandy or clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that all surface layers were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Loch Luna (Wetland ID. 12492) are:

- Acidification hazard: The data identified high net acidity values throughout the profile layers for nearly all samples especially in the upper soil layers and negative values for a few lower subsoil samples, and pH<sub>OX</sub> data identified surface samples with values that indicated a potential acidification hazard due to oxidation. There is a medium to high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of soils, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The medium to high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

### Summary of key findings Loch Luna (Wetland ID. 12492):

<b>Soil materials:</b>	The soil layers were hyposulfidic throughout the wetland. Soils were gel or loamy textured at the surface and loamy or clayey textured in the subsoil. All profiles had high net acidity values for most samples and pH <sub>OX</sub> data indicated a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (loamy or clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium to high level of concern</li> <li>• De-oxygenation hazard – medium level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>



**Table 1-2. Site description data for Loch Luna (Wetland ID. 12492).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	21/04/2010	444232	6211488	26	water, soft	water	mid elevation, 5 m offshore
2	21/04/2010	444277	6211499	58	water, soft	Phragmites	edge of reed bed
3	21/04/2010	444499	6210974	26	water, sandy	water	mid elevation, ca. 5 m from edge of water
4	21/04/2010	444495	6210978	38	water, sandy	water	low elevation, ca. 25 m offshore

**Table 1-3. Soil profile description data for Loch Luna (Wetland ID. 12492).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	dark olive grey (5Y3/2)	gel	wet		single grain	very weak	organic odour
1_2	5 - 10	small pit	dark olive grey (5Y3/2)	gel	wet		single grain	very weak	organic odour
1_3	10 - 20	small pit	dark olive grey (5Y3/2)	gel	wet		single grain	very weak	organic odour
1_4	20 - 40	push tube	dark olive grey (5Y3/2)	gel	wet		single grain	very weak	organic odour
1_5	40 - 80	push tube	olive grey (5Y4/2)	gel	wet		single grain	very weak	organic odour
1_6	80 - 100	push tube	greenish grey (5G5/1)	heavy clay	wet		massive	very weak	
2_1	0 - 5	small pit	very dark grey (5Y3/1)	gel	wet		massive	very weak	
2_2	5 - 10	small pit	dark olive grey (5Y3/2)	gel	wet		massive	very weak	
2_3	10 - 20	small pit	dark olive grey (5Y3/2)	gel	wet		massive	very weak	
2_4	20 - 40	small pit	dark grey (5Y4/1)	light clay	wet		massive	very weak	gel-like
2_5	40 - 60	push tube	dark grey (5Y4/1)	light clay	wet		massive	very weak	
3_W1	0 - 38	surface water							water sampled
3_1	0 - 5	small pit	dark olive grey (5Y3/2)	sand	wet		single grain	very weak	organic odour
3_2	5 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	organic odour
3_3	10 - 20	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	organic odour
3_4	20 - 50	push tube	dark gray (N4/0)	heavy clay	wet		massive	very weak	
4_1	0 - 5	small pit	dark olive grey (5Y3/2)	sand	wet		single grain	very weak	organic odour
4_2	5 - 10	small pit	dark olive grey (5Y3/2)	sand	wet		single grain	very weak	organic odour
4_3	10 - 20	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	organic odour
4_4	20 - 50	push tube	dark gray (N4/0)	heavy clay	wet		massive	very weak	
5_W1	0 - 58	surface water							water sampled

**Table 1-4. Laboratory data for acid sulfate soil assessment of Loch Luna (Wetland ID. 12492).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	93	6.41	1.46	6.12	4.73	170	6.04	13.43	0.54	..	0.00	351	hyposulfidic (S <sub>CR</sub> ≥0.10%)
1.2	5-10	Medium	159	5.75	1.47	6.15	4.70	160	5.78	8.95	0.46	..	..	295	hyposulfidic (S <sub>CR</sub> ≥0.10%)
1.3	10-20	Medium	121	6.47	1.44	6.18	4.41	20	5.75	14.42	0.45	..	..	295	hyposulfidic (S <sub>CR</sub> ≥0.10%)
1.4	20-40	Medium	131	6.39	1.49	6.21	4.39	300	5.61	14.92	0.45	..	..	294	hyposulfidic (S <sub>CR</sub> ≥0.10%)
1.5	40-80	Medium	128	6.57	1.84	6.35	4.50	320	5.71	14.92	0.36	..	..	239	hyposulfidic (S <sub>CR</sub> ≥0.10%)
1.6	80-100	Fine	154	7.45	7.48	7.50	7.50	22	7.51	0.00	0.02	..	0.75	-89	hyposulfidic (S <sub>CR</sub> <0.10%)
2.1	0-5	Medium	108	6.72	1.60	6.22	4.39	190	5.87	12.93	0.78	..	..	502	hyposulfidic (S <sub>CR</sub> ≥0.10%)
2.2	5-10	Medium	106	6.79	1.63	6.28	4.70	190	5.90	13.93	0.71	..	..	459	hyposulfidic (S <sub>CR</sub> ≥0.10%)
2.3	10-20	Medium	188	6.87	3.87	6.31	5.82	190	6.95	0.00	0.36	..	1.78	-12	hyposulfidic (S <sub>CR</sub> ≥0.10%)
2.4	20-40	Fine	162	7.17	2.82	6.74	5.50	110	6.07	6.34	0.18	..	0.00	118	hyposulfidic (S <sub>CR</sub> ≥0.10%)
2.5	40-60	Fine	160	7.10	2.93	6.63	5.75	77	6.85	0.00	0.13	..	2.45	-244	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.W2	0-38	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
3.1	0-5	Fine	141	6.51	1.56	6.74	4.55	18	6.28	4.39	0.16	..	0.00	102	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.2	5-10	Fine	100	6.94	1.57	6.75	4.09	71	5.93	3.42	0.15	..	..	97	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.3	10-20	Fine	98	8.38	2.49	7.23	5.40	130	6.44	1.46	0.23	..	0.00	145	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.4	20-50	Fine	225	8.95	8.75	8.66	7.55	130	6.82	0.00	0.14	..	0.05	81	hyposulfidic (S <sub>CR</sub> ≥0.10%)
4.1	0-5	Medium	127	6.28	1.54	6.33	4.46	78	5.77	11.22	0.38	..	..	248	hyposulfidic (S <sub>CR</sub> ≥0.10%)
4.2	5-10	Medium	110	6.44	1.48	6.32	4.66	160	5.66	6.34	0.39	..	..	250	hyposulfidic (S <sub>CR</sub> ≥0.10%)
4.3	10-20	Fine	105	7.05	1.65	6.39	4.62	220	5.89	6.34	0.29	..	..	187	hyposulfidic (S <sub>CR</sub> ≥0.10%)
4.4	20-50	Fine	119	8.91	3.43	7.99	5.85	240	6.60	0.00	0.11	..	0.32	26	hyposulfidic (S <sub>CR</sub> ≥0.10%)
5.W1	0-58	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water

**Table 1-5. Summary of hydrochemical field measurements for Loch Luna (Wetland ID. 12492).**

	pH	SEC µS cm <sup>-1</sup>	DO mg l <sup>-1</sup>	Eh mV	Turbidity NTU	Alkalinity as HCO <sub>3</sub>
Surface waters (n=2)	6.84-7.95	257-394	2.8-4.2	-92 - 5	15-85	85-104

**Table 1-6. Summary of hydrochemical field measurements for Loch Luna (Wetland ID. 12492).**

Parameter	units	ANZECC Guidelines	Site 3 (SW)	Site 5 (SW)
Na	mg l <sup>-1</sup>		10.5	27.2
K	mg l <sup>-1</sup>		2.2	5.1
Ca	mg l <sup>-1</sup>		7.63	10.8
Mg	mg l <sup>-1</sup>		2.88	7.1
Si	mg l <sup>-1</sup>		3.07	1.47
Br	mg l <sup>-1</sup>		0.1	0.1
Cl	mg l <sup>-1</sup>		33	37
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.028	<0.022
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.03</b>	0.008
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.010</b>	<b>0.010</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		6.5	6.2
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>190</b>	42
As <sup>B</sup>	µg l <sup>-1</sup>	13	0.9	1.2
Cd	µg l <sup>-1</sup>	0.2	0.04	<0.01
Co	µg l <sup>-1</sup>	2.8	0.12	0.06
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.3	<0.1
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	1.4	0.6
Fe	µg l <sup>-1</sup>	300	226	<100
Mn	µg l <sup>-1</sup>	1700	40.81	19.99
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.0	0.7
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.26	0.1
Se	µg l <sup>-1</sup>	11	<0.06	<0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>114</b>	<b>52</b>
DOC	mg l <sup>-1</sup>		7.8	10.4

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 2. LOCH LUNA (WETLAND ID. 12531)

### 2.1. Location and setting description

Loch Luna (Wetland ID. 12531) is situated on the north and eastern side of the River Murray, about 1 kilometre up river from Lock 3 and approximately 6 kilometres directly northwest of the town of Cobdogla, and it occurs on the inside bend of the river. The wetland is an irregular in shape with multiple branches and channels forming a 'U'. It is about 9 kilometres in length and about 700 metres at its widest, with a total surface area of 106 hectares. The wetland is bounded to the west by a raised floodplain that separates it from the river and to the north by hill slopes that separate it from farmland. The other associated wetland in the Loch Luna Wetland Complex that was surveyed is wetland ID. 12492.

The wetland is permanently connected to the river at the north-western end by a wide inlet and at the southern end by creeks and temporarily via Wetland ID. 12492 and at the north-eastern end by an inlet to Lake Bonney. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Twelve sites were sampled as shown in Figure 2-1.

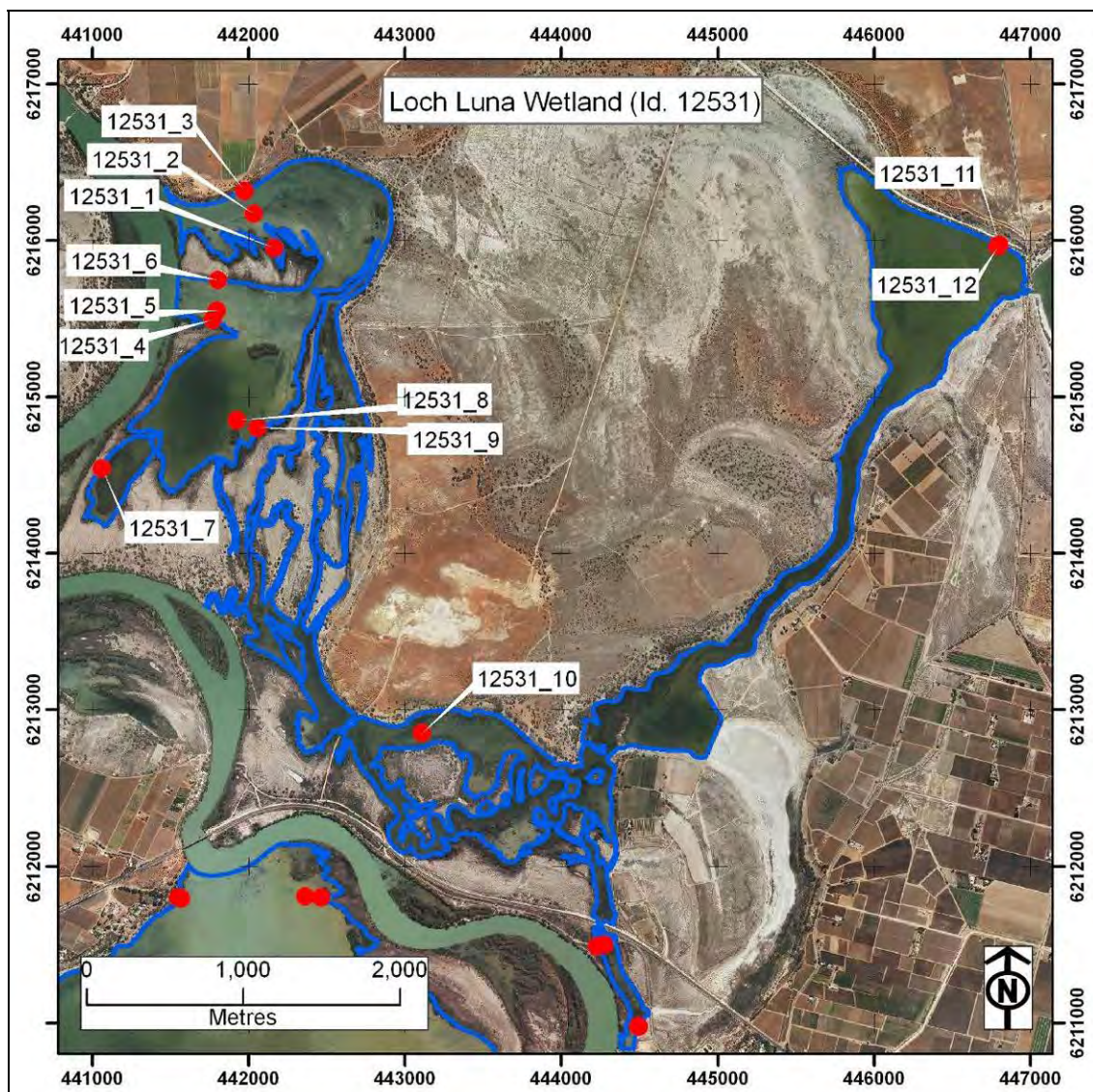


Figure 2-1. Loch Luna (Wetland ID. 12531) and sample site locations.

## 2.2. Soil profile description and distribution

Twelve sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 2-1. Sites were distributed along five transects which were placed around the wetland from the margin into the open water. Transects were located at the northwestern (Sites 1, 2 and 3), western (Sites 4, 5 and 6), central (Sites 7, 8 and 9), southern (Site 10), and eastern (Sites 11 and 12) sides of the wetland. The site and soil profile descriptions are presented in Table 2-2 and Table 2-3, and a conceptual cross-section diagram in Figure 2-2.

### Northwestern transect

Site 1 (Figure 2-3) occurred near the shore in water (40 cm deep), and the soil consisted of dark grey, very weak, gel, over a dark grey, very weak, clay. Site 2 (Figure 2-4) occurred in open water (42 cm deep), and the soil consisted of a very dark grey, very weak, gel, over a grey, very weak, clay. Site 3 (Figure 2-5) occurred amongst reeds in water (35 cm deep), and the soil consisted of a dark grey, very weak, sandy peat, over a dark grey, very weak, sandy clay.

### Western transect

Site 4 (Figure 2-6) occurred adjacent to reeds in water (40 cm deep), and the soil consisted of an olive grey, very weak, gel, over a grey, very weak, clay. Site 5 (Figure 2-7) occurred in open water (55 cm deep), and the soil consisted of an olive grey, very weak, gel, over a grey, very weak, clay. Site 6 (Figure 2-8) occurred adjacent to reeds in water (42 cm deep), and the soil consisted of a dark grey, very weak, gel, over a greenish grey, very weak, clay.

### Central transect

Site 7 (Figure 2-9) occurred adjacent to reeds in water (50 cm deep), and the soil consisted of a dark olive grey, very weak, gel, over a greenish grey, very weak, clay. Site 8 (Figure 2-10) occurred in open water (68 cm deep), and the soil consisted of dark greenish grey, very weak, gel, over grey, very weak, clay. Site 9 (Figure 2-11) occurred out from the reeds in open water (35 cm deep), and the soil consisted of an olive grey, very weak, gel, over a grey, very weak clay.

### Southern site

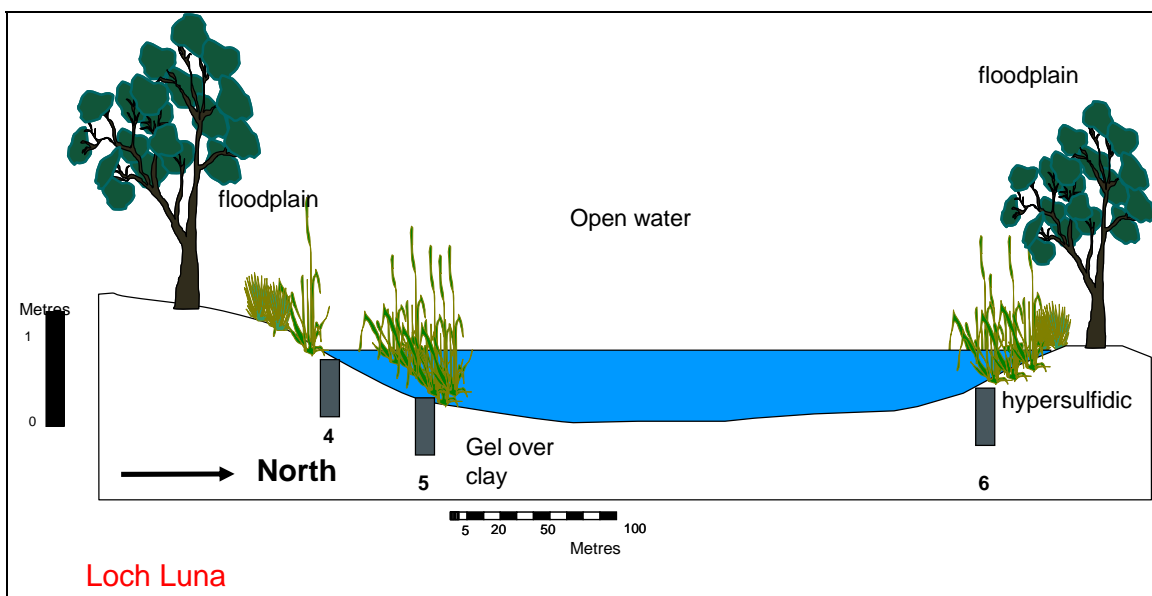
Site 10 (Figure 2-12) occurred in open water (43 cm deep), and the soil consisted of a dark grey, very weak, clay, over a grey, very weak, clay.

### Eastern transect

Site 11 (Figure 2-13) occurred adjacent to reeds in open water (48 cm deep), and the soil consisted of an olive grey, very weak, sand, over a dark grey, very weak, clay. Site 12 (Figure 2-14) occurred in open water (82 cm deep), and the soil consisted of an olive grey, very weak, sand, over a dark grey, very weak, clay.

**Table 2-1. Soil identification, subtype and general location description for Loch Luna (Wetland ID. 12531).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12531_1	442166	6215953	Subaqueous Soil (loamy)	mid elevation, about 25 m offshore
12531_2	442034	6216171	Subaqueous Soil (clayey)	low elevation, about 150 m offshore
12531_3	441976	6216315	Hypersulfidic Subaqueous Soil (loamy)	low elevation, about 4 m offshore in reeds
12531_4	441770	6215492	Subaqueous Soil (clayey)	mid elevation, about 10 m offshore from reeds
12531_5	441799	6215553	Subaqueous Soil (clayey)	low elevation, about 80 m offshore
12531_6	441805	6215746	Hypersulfidic Subaqueous Soil (clayey)	high elevation, about 5 m offshore
12531_7	441062	6214542	Subaqueous Soil (clayey)	high elevation, about 3 m offshore
12531_8	441928	6214851	Subaqueous Soil (clayey)	low elevation, about 130 m offshore
12531_9	442059	6214803	Subaqueous Soil (clayey)	mid elevation, about 10 m offshore from reeds
12531_10	443109	6212853	Subaqueous Soil (clayey)	low elevation, about 75 m offshore
12531_11	446802	6215973	Subaqueous Soil (clayey)	mid elevation, 7 m from shore
12531_12	446794	6215963	Hypersulfidic Subaqueous Soil (loamy)	mid elevation, about 20 m offshore



**Figure 2-2. Conceptual cross-section diagram, showing locations for Sites 4, 5 and 6.**



**Figure 2-3. Photograph of Site 1, showing the site location near the shoreline in water.**



**Figure 2-4. Photograph of Site 2, showing the site location in open water.**



**Figure 2-5. Photograph of Site 3, showing the site location amongst reeds in water.**



**Figure 2-6. Photograph of Site 4, showing the site location out from the reeds in open water.**





**Figure 2-7. Photograph of Site 5, showing the site location in open water**



**Figure 2-8. Photograph of Site 6, showing the site location next to reeds in water.**



**Figure 2-9. Photograph of Site 7, showing the site location in next to reeds in water.**



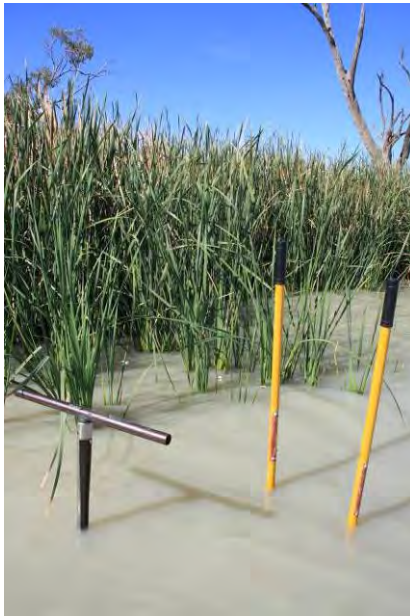
**Figure 2-10. Photograph of Site 8, showing the site location in open water.**



**Figure 2-11. Photograph of Site 9, showing the site location in open water.**



**Figure 2-12. Photograph of Site 10, showing the site location in open water.**



**Figure 2-13. Photograph of Site 11, showing the site location next to reeds in water.**

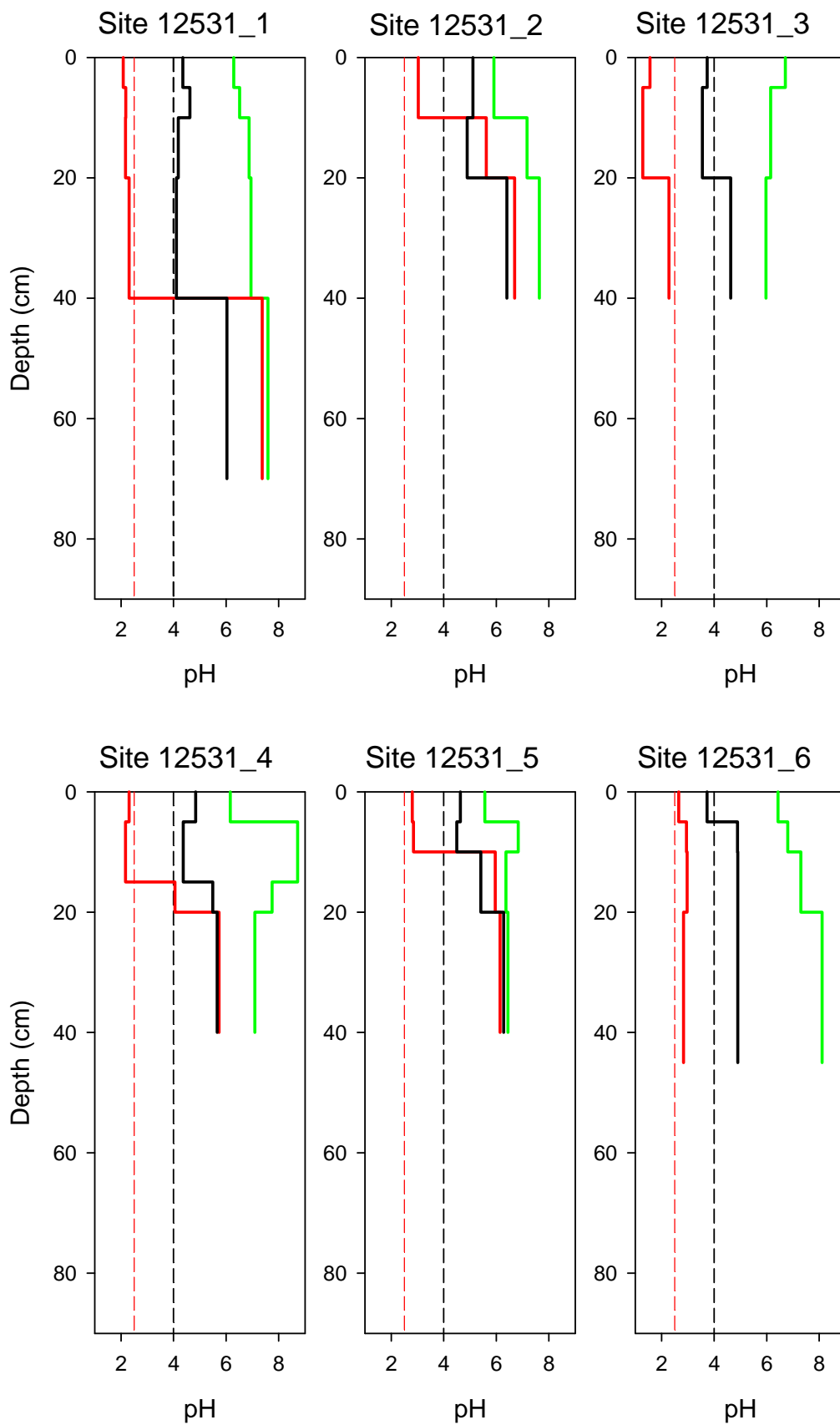


**Figure 2-14. Photograph of Site 12, showing the site location in open water.**

## **2.3. Laboratory data assessment**

### **2.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )**

The pH data are provided in Table 2-4 and pH profiles are presented in Figure 2-15. The  $pH_W$  data ranged from 5.56 to 9.14 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 1.29 to 8.36 and identified that surface layers in Profiles 1, 3, 4, 7 and 12 were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 3.55 to 8.15 and identified that Profiles 3, 6 and 12 had samples on incubation that declined below the critical values of  $pH < 4$ , indicating that these soils potentially would form sulfuric material on oxidation.



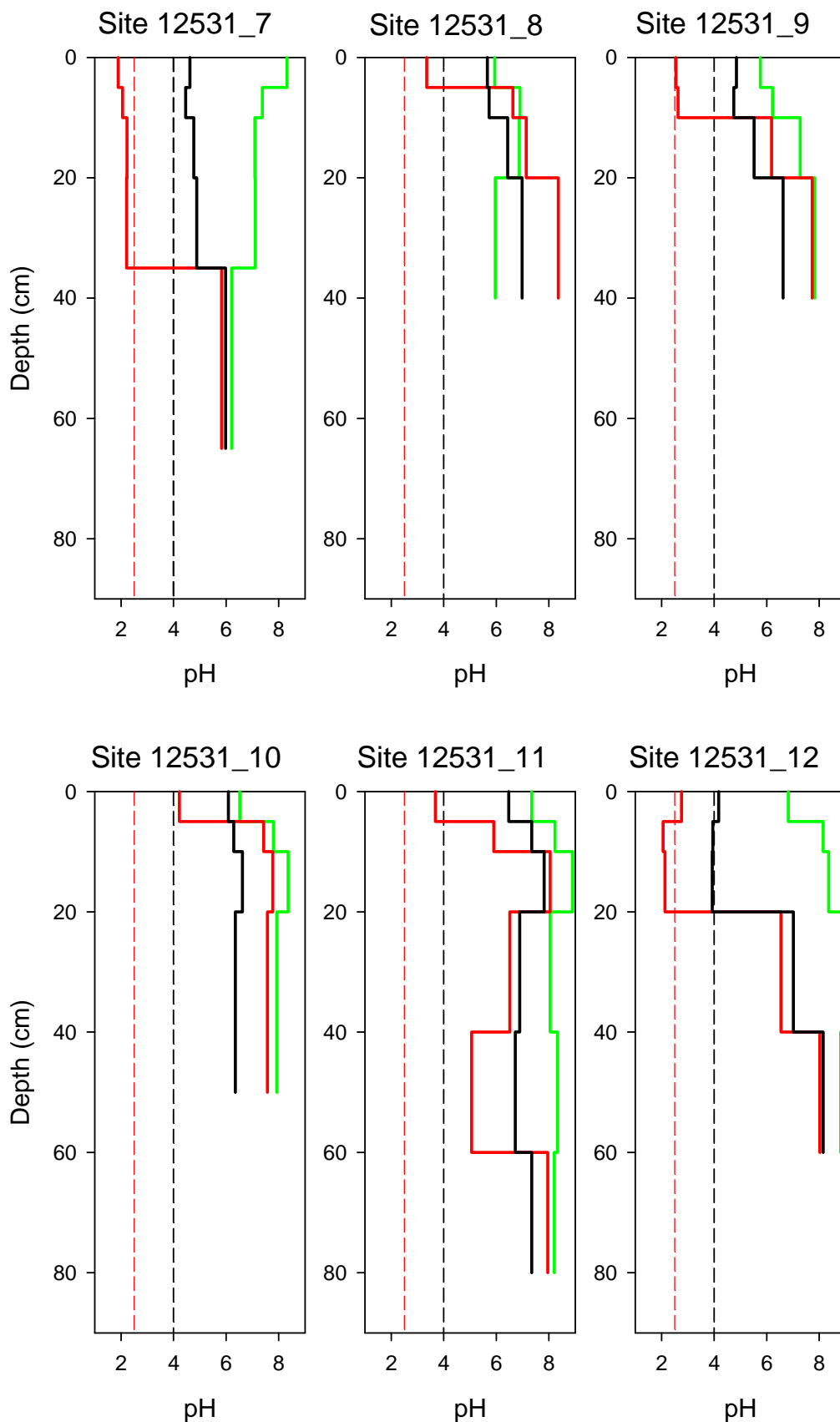


Figure 2-15. Depth profiles of soil pH for Loch Luna (Wetland ID. 12531), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 2.3.2. Acid base accounting

The acid base accounting data is provided in Table 2-4 and summarised in Figure 2-16.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.01 to 0.54 %S<sub>CR</sub> and sulfidic materials were detected in all samples.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 26.86 mole H<sup>+</sup>/tonne and were detected in all profiles except for those on the eastern side (Profiles 11 and 12).

#### Retained acidity

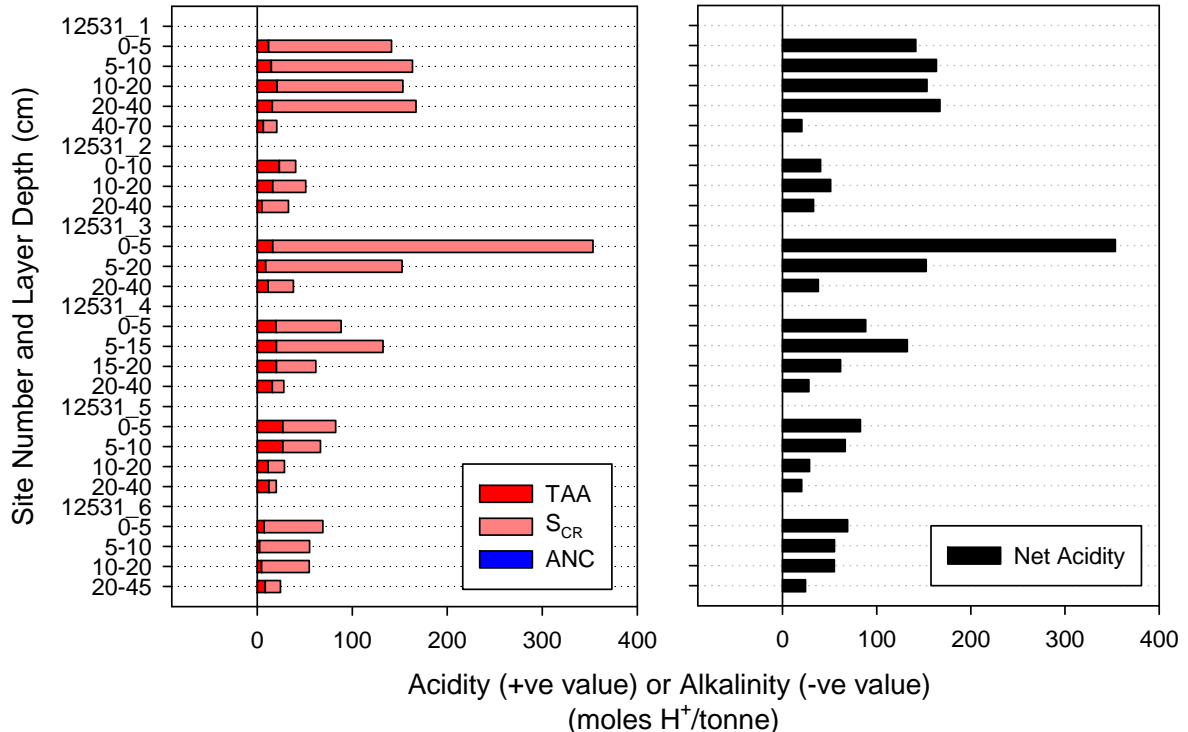
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

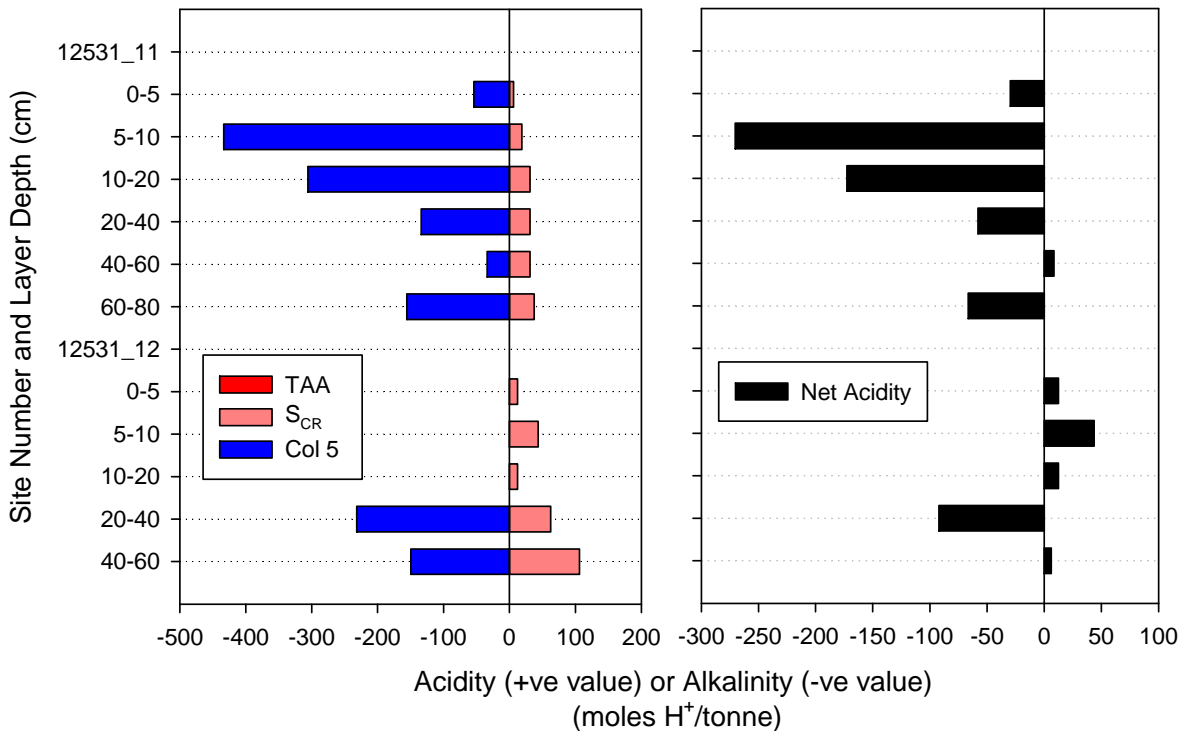
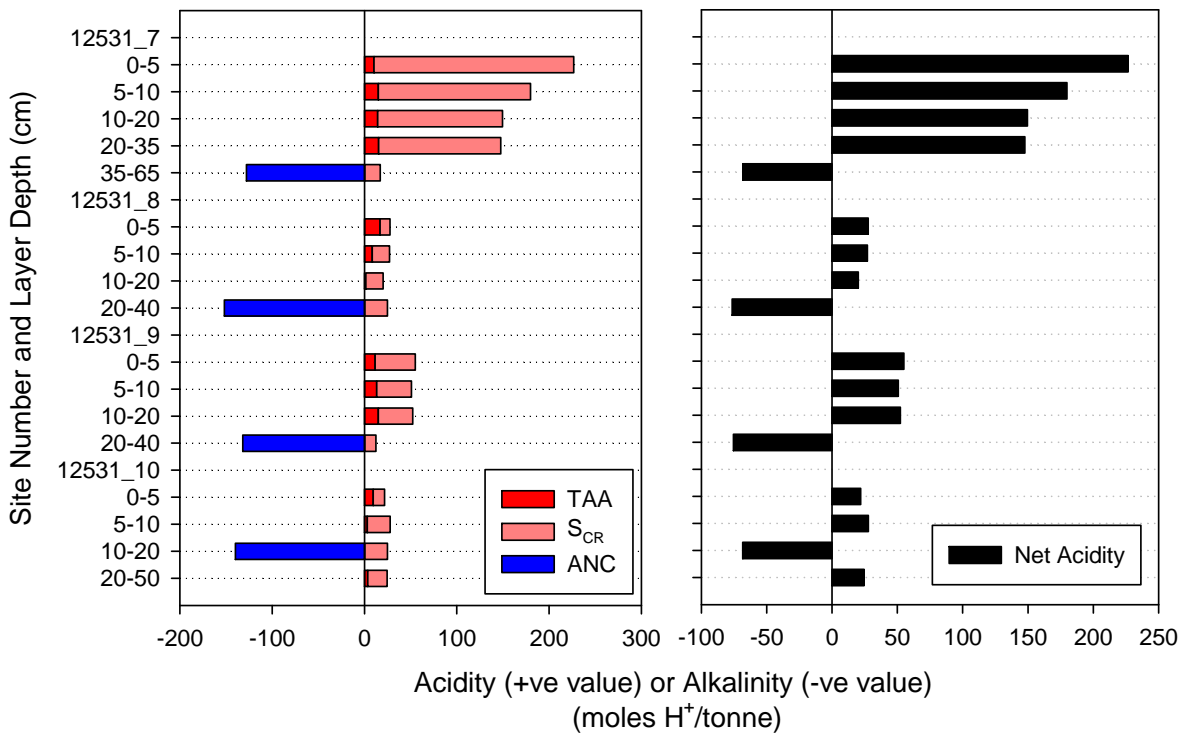
#### Acid neutralising capacity

Acid neutralising capacity values ranged from 0 to 2.17 %CaCO<sub>3</sub> and were measured in the lower subsoil layers of Profiles 7, 8, 10, 12 for all layers of Profile 11.

#### Net acidity

Net acidity values ranged from -270 to 353 mole H<sup>+</sup>/tonne. High or moderate net acidity values were recorded in all profiles and negative values were recorded in the lower layers of Profiles Profiles 7, 8, 10, 12 for nearly all layers of Profile 11. There did not appear to be any obvious spatial pattern.





**Figure 2-16. Acid base accounting depth profiles for Loch Luna (Wetland ID. 12531). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 2.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 2-4 identified Profiles 3 and 10 to have surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 2.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

### 2.3.5. Hydrochemistry

Five surface water samples were collected from this extensive wetland complex. Field parameters are shown in Table 2-5. The surface water samples had circumneutral to alkaline pH and low salinity, which varied little across the different wetlands. Dissolved oxygen was high, and turbidity and alkalinity varied significantly.

The surface water samples were of Na-HCO<sub>3</sub> to Na-Cl type (Table 2-5, Figure 2-17). Sulfate concentrations in the surface waters varied from 12 to 34 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratios in the surface water samples (0.191 to 0.309) were slightly higher than seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values in some samples. Of the metals, Al and Zn concentrations were locally elevated above ANZECC Guideline values, although this may be partly due the high turbidity in some samples with colloidal material present.

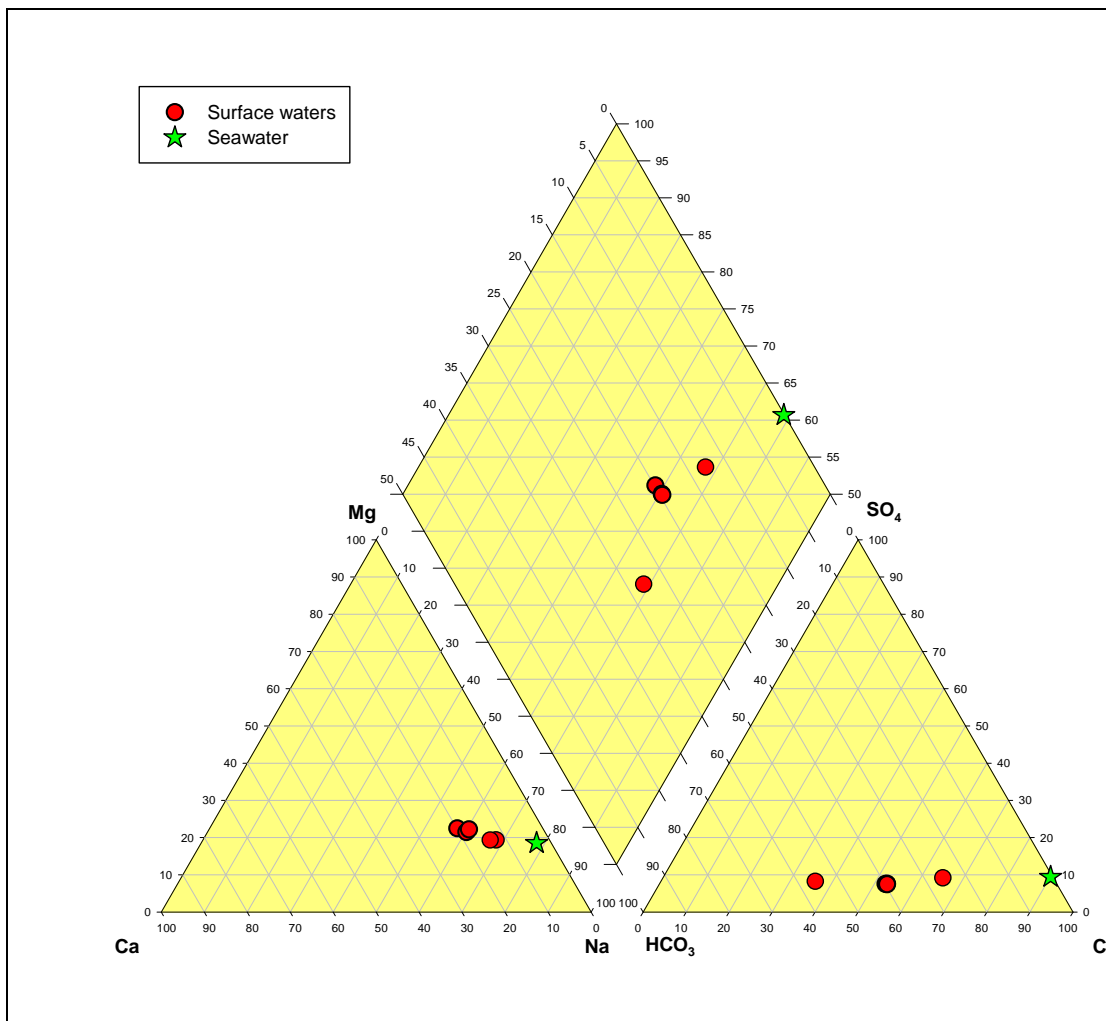


Figure 2-17. Piper diagram of hydrochemical data for Loch Luna (Wetland ID. 12531).

## 2.4. Discussion

Acid sulfate soil materials at Loch Luna (Wetland ID. 12531) were identified as hypersulfidic in the surface layers of Profiles 3, 6 and 12, the remaining samples were hyposulfidic that occurred throughout all profiles. The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (loamy or clayey) that tended to occur on the margins adjacent to reeds, Subaqueous Soil (loamy or clayey) that occurred throughout the wetland.

The soils throughout the main wetland area were dominantly gel like or loamy textured in the surface layers and in isolated areas they were sandy textured. The subsoils were generally sandy or clayey.

Monosulfidic material was not observed but water soluble sulfate data identified two profiles with surface layers that were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Loch Luna (Wetland ID. 12531) are:

- Acidification hazard: The data identified high or moderate net acidity values in nearly all profiles often in all layers of the profile at sites sampled closer to the inlet while negative values were more common for sites sampled further from the inlet. pH data identified surface samples with values that indicated a potential acidification hazard due to oxidation. There is a high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of 2 of the 12 profiles, although monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a high level of concern.

### Summary of key findings Loch Luna (Wetland ID. 12531):

<b>Soil materials:</b>	The soil layers were generally hyposulfidic throughout the wetland but there were also areas near reeds that had hypersulfidic soil layers. Soils were Gel, loamy or sandy textured at the surface and sandy or clayey textured in the subsoil. Generally profiles had high or moderate net acidity, and pH data indicated a potential for acidification.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (loamy or clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Hypersulfidic Subaqueous Soil (loamy or clayey) – occurring near reeds fringing the shoreline and where there were loamy textured soils. Minor (&lt;25%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – high level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – high level of concern</li> </ul>



**Table 2-2. Site description data for Loch Luna (Wetland ID. 12531).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	21/04/2010	442166	6215953	40	water, soft	water	mid elevation, ca. 25 m offshore
2	21/04/2010	442034	6216171	not reached	water, soft	water	low elevation, ca. 150 m offshore
3	21/04/2010	441976	6216315	35	water, soft	phragmites	low elevation, ca. 4 m offshore in reeds
4	21/04/2010	441770	6215492	40	water, soft	water	mid elevation, ca. 10 m offshore from reeds
5	21/04/2010	441799	6215553	80	water, soft	water	low elevation, ca. 80 m offshore
6	21/04/2010	441805	6215746	42	water, soft	water	high elevation, ca. 5 m offshore
7	21/04/2010	441062	6214542	50	water, soft	water	high elevation, ca. 3 m offshore
8	21/04/2010	441928	6214851	68	water, soft	water	low elevation, ca. 130 m offshore
9	21/04/2010	442059	6214803	35	water, soft	water	mid elevation, ca. 10 m offshore from reeds
10	21/04/2010	443109	6212853	43	water, soft	water	low elevation, ca. 75 m offshore
11	21/04/2010	446802	6215973	48	water, sandy	phragmites	mid elevation, 7 m from shore
12	21/04/2010	446794	6215963	82	water, sandy	water	mid elevation, ca. 20 m offshore

**Table 2-3. Soil profile description data for Loch Luna (Wetland ID. 12531).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
1_2	5 - 10	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
1_3	10 - 20	small pit	grey (5Y5/1)	gel	wet		massive	very weak	
1_4	20 - 40	small pit	grey (5Y5/1)	gel	wet		massive	very weak	
1_5	40 - 70	push tube	dark gray (N4/0)	heavy clay	wet		massive	very weak	
2_W1	42 - 0	surface water							water sampled
2_1	0 - 10	small pit	very dark grey (5Y3/1)	gel	wet		massive	very weak	abundant black specs of organic matter
2_2	10 - 20	small pit	gray (N5/0)	medium clay	wet		massive	very weak	
2_3	20 - 40	small pit	gray (N5/0)	heavy clay	wet		massive	very weak	
3_1	0 - 5	small pit	dark grey (10YR4/1)	sandy peat	wet		single grain	very weak	
3_2	5 - 20	small pit	dark olive grey (5Y3/2)	clayey peat	wet		single grain	very weak	
3_3	20 - 40	small pit	dark grey (10YR4/1)	sandy clay loam	wet		massive	very weak	
4_1	0 - 5	small pit	olive grey (5Y4/2)	gel	wet		massive	very weak	
4_2	5 - 15	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
4_3	15 - 20	small pit	gray (N5/0)	clay	wet		massive	very weak	
4_4	20 - 40	small pit	gray (N5/0)	clay	wet		massive	very weak	
5_W1	44 - 0	surface water							water sampled
5_1	0 - 5	small pit	olive grey (5Y4/2)	gel	wet		massive	very weak	
5_2	5 - 10	small pit	grey (5Y5/1)	gel	wet		massive	very weak	
5_3	10 - 20	small pit	grey (5Y5/1)	gel	wet		massive	very weak	
5_4	20 - 40	small pit	gray (N5/0)	heavy clay	wet		massive	very weak	
6_1	0 - 5	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
6_2	5 - 10	small pit	olive grey (5Y5/2)	light clay	wet		massive	very weak	
6_3	10 - 20	small pit	greenish grey (5G5/1)	medium clay	wet		massive	very weak	
6_4	20 - 45	small pit	greenish grey (5G5/1)	heavy clay	wet		massive	very weak	

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
7_1	0 - 5	small pit	dark olive grey (5Y3/2)	gel	wet		massive	very weak	
7_2	5 - 10	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
7_3	10 - 20	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
7_4	20 - 35	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
7_5	35 - 65	push tube	greenish grey (5G5/1)	heavy clay	wet		massive	very weak	
8_1	0 - 5	small pit	dark greenish grey (5GY4/1)	gel	wet		massive	very weak	
8_2	5 - 10	small pit	dark gray (N4/0)	medium clay	wet		massive	very weak	
8_3	10 - 20	small pit	gray (N5/0)	heavy clay	wet		massive	very weak	
8_4	20 - 40	small pit	gray (N5/0)	heavy clay	wet		massive	very weak	
9_W1	40 - 0	surface water							water sampled
9_1	0 - 5	small pit	olive grey (5Y4/2)	gel	wet		massive	very weak	
9_2	5 - 10	small pit	dark gray (N4/0)	gel	wet		massive	very weak	
9_3	10 - 20	small pit	gray (N5/0)	heavy clay	wet		massive	very weak	
9_4	20 - 40	push tube	gray (N5/0)	heavy clay	wet		massive	very weak	
10_1	0 - 5	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
10_2	5 - 10	small pit	gray (N5/0)	light clay	wet		massive	very weak	
10_3	10 - 20	small pit	greenish grey (5G5/1)	heavy clay	wet		massive	very weak	
10_4	20 - 50	push tube	gray (N5/0)	heavy clay	wet		massive	very weak	
11_W1	48 - 0	surface water							water sampled
11_1	0 - 5	small pit	olive grey (5Y4/2)	sand	wet		single grain	very weak	
11_2	5 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	
11_3	10 - 20	small pit	dark gray (N4/0)	sand	wet		single grain	very weak	
11_4	20 - 40	push tube	dark gray (N4/0)	heavy clay	wet		massive	very weak	
11_5	40 - 60	push tube	very dark gray (N3/0)	heavy clay	wet		massive	very weak	
11_6	60 - 80	push tube	dark gray (N4/0)	heavy clay	wet		massive	very weak	
12_1	0 - 5	small pit	olive grey (5Y4/2)	sand	wet		single grain	very weak	
12_2	5 - 10	small pit	grey (5Y5/1)	sand	wet		single grain	very weak	slight sulfurous odour
12_3	10 - 20	small pit	grey (5Y5/1)	sand	wet		single grain	very weak	slight sulfurous odour
12_4	20 - 40	small pit	olive grey (5Y5/2)	sand	wet		single grain	very weak	slight sulfurous odour
12_5	40 - 60	push tube	dark gray (N4/0)	medium clay	wet		massive	very weak	

**Table 2-4. Laboratory data for acid sulfate soil assessment of Loch Luna (Wetland ID. 12531).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg $\text{SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity (mole $\text{H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Retained Acidity (mole $\text{H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity (mole $\text{H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
1.1	0-5	Fine	134	6.29	2.08	6.44	4.35	56	6.14	11.94	0.21	..	0.00	141	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
1.2	5-10	Fine	135	6.51	2.18	6.74	4.62	66	5.80	14.92	0.24	..	..	163	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
1.3	10-20	Fine	138	6.87	2.17	6.50	4.18	63	5.75	20.89	0.21	..	..	153	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
1.4	20-40	Fine	147	6.95	2.31	6.46	4.11	50	5.73	15.92	0.24	..	..	167	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
1.5	40-70	Fine	81	7.59	7.37	6.68	6.03	26	6.23	6.47	0.02	..	0.00	21	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
2.W1	42-0														surface water
2.1	0-10	Fine	45	5.91	3.03	6.61	5.11	20	5.35	23.38	0.03	..	..	40	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
2.2	10-20	Fine	46	7.17	5.62	6.58	4.89	10	5.55	16.41	0.06	..	..	51	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
2.3	20-40	Medium	54	7.64	6.70	7.18	6.40	7	6.25	4.97	0.04	..	0.00	33	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
3.1	0-5	Medium	88	6.71	1.56	6.73	3.74	190	5.66	16.41	0.54	..	..	353	hypersulfidic
3.2	5-20	Medium	99	6.15	1.29	6.34	3.55	43	6.15	8.95	0.23	..	0.00	152	hypersulfidic
3.3	20-40	Medium	138	5.97	2.28	6.04	4.63	29	5.36	11.44	0.04	..	..	38	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
4.1	0-5	Fine	72	6.16	2.31	6.30	4.84	36	5.50	19.90	0.11	..	..	88	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
4.2	5-15	Fine	57	8.72	2.17	6.16	4.37	61	5.28	20.39	0.18	..	..	132	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
4.3	15-20	Fine	78	7.75	4.05	6.71	5.49	31	5.38	20.39	0.07	..	..	62	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
4.4	20-40	Fine	83	7.09	5.73	6.29	5.66	21	5.52	15.92	0.02	..	..	28	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
5.W1	44-0														surface water
5.1	0-5	Fine	60	5.56	2.80	6.44	4.63	31	5.25	26.86	0.09	..	..	83	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
5.2	5-10	Fine	69	6.83	2.85	6.39	4.49	38	5.31	26.86	0.06	..	..	67	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
5.3	10-20	Fine	115	6.37	5.96	6.48	5.41	37	5.93	11.44	0.03	..	..	29	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
5.4	20-40	Fine	80	6.44	6.14	6.83	6.28	5	5.71	12.43	0.01	..	..	20	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
6.1	0-5	Fine	106	6.43	2.65	6.28	3.73	18	5.78	7.46	0.10	..	..	69	hypersulfidic
6.2	5-10	Fine	74	6.80	2.95	6.60	4.89	24	6.26	2.49	0.08	..	0.00	55	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
6.3	10-20	Fine	68	7.30	2.97	6.72	4.90	4	6.21	4.48	0.08	..	0.00	55	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
6.4	20-45	Fine	39	8.11	2.84	6.72	4.90	13	5.49	8.46	0.03	..	..	24	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
7.1	0-5	Fine	188	8.32	1.89	6.66	4.62	42	6.04	10.45	0.35	..	0.00	227	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.2	5-10	Fine	146	7.38	2.06	6.50	4.46	19	5.86	14.92	0.26	..	..	180	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.3	10-20	Fine	195	7.09	2.23	6.42	4.77	22	5.75	14.42	0.22	..	..	150	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.4	20-35	Fine	156	7.11	2.21	6.39	4.88	19	5.75	15.42	0.21	..	..	148	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.5	35-65	Fine	121	6.21	5.83	6.61	5.98	22	6.88	0.00	0.03	..	0.64	-68	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S/cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity ( $\text{mole H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Retained Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
8.1	0-5	Fine	61	5.94	3.35	6.70	5.66	17	5.34	16.91	0.02	..	..	28	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
8.2	5-10	Fine	91	6.90	6.63	6.72	5.72	39	6.04	8.46	0.03	..	0.00	27	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
8.3	10-20	Fine	85	6.87	7.14	7.35	6.43	29	6.46	1.49	0.03	..	0.00	20	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
8.4	20-40	Fine	137	5.96	8.36	8.20	6.98	26	6.76	0.00	0.04	..	0.76	-76	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.W1	35-0														surface water
9.1	0-5	Fine	85	5.76	2.55	6.44	4.85	29	5.87	11.44	0.07	..	..	55	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.2	5-10	Fine	72	6.22	2.63	6.04	4.75	57	5.46	13.43	0.06	..	..	51	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.3	10-20	Fine	63	7.27	6.19	6.69	5.52	48	5.74	14.92	0.06	..	..	52	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.4	20-40	Fine	86	7.83	7.73	7.36	6.62	21	6.62	0.00	0.02	..	0.66	-75	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.W1	43-0														surface water
10.1	0-5	Medium	69	6.52	4.22	6.76	6.09	270	6.01	9.45	0.02	..	0.00	22	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.2	5-10	Fine	84	7.80	7.43	7.16	6.29	23	6.38	2.98	0.04	..	0.00	28	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.3	10-20	Fine	92	8.36	7.77	7.96	6.62	20	6.57	0.00	0.04	..	0.70	-68	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.4	20-50	Fine	107	7.93	7.57	7.39	6.35	27	6.39	3.48	0.03	..	0.00	25	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.W1	48-0														surface water
11.1	0-5	Coarse	100	7.35	3.68	7.33	6.47	16	8.12	0.00	0.01	..	0.27	-30	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.2	5-10	Coarse	136	8.23	5.90	7.41	7.35	22	9.08	0.00	0.03	..	2.17	-270	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.3	10-20	Medium	155	8.90	8.05	7.47	7.82	51	8.09	0.00	0.05	..	1.53	-173	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.4	20-40	Fine	242	8.05	6.51	7.36	6.89	32	7.88	0.00	0.05	..	0.67	-58	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.5	40-60	Medium	179	8.33	5.06	7.47	6.72	69	7.67	0.00	0.05	..	0.17	9	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.6	60-80	Fine	262	8.21	7.96	7.81	7.35	61	6.96	0.00	0.06	..	0.78	-66	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
12.1	0-5	Medium	62	6.82	2.76	6.58	4.17	21	6.80	0.00	0.02	..	0.00	12	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
12.2	5-10	Coarse	76	8.15	2.06	7.29	3.95	71	6.75	0.00	0.07	..	0.00	44	hypersulfidic
12.3	10-20	Coarse	52	8.36	2.13	7.11	3.93	19	6.70	0.00	0.02	..	0.00	12	hypersulfidic
12.4	20-40	Coarse	111	9.14	6.54	8.05	7.02	67	8.72	0.00	0.10	..	1.16	-92	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
12.5	40-60	Fine	236	8.82	8.02	8.38	8.15	74	8.14	0.00	0.17	..	0.75	6	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )

**Table 2-5. Summary of hydrochemical field measurements for Loch Luna (Wetland ID. 12531).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=5)	7.68-8.37	296-567	10.3-13.7	29-137	5-240	74-293

**Table 2-6. Summary of hydrochemical field measurements for Loch Luna (Wetland ID. 12531).**

Parameter	units	ANZECC Guidelines	Site 2 (SW)	Site 5 (SW)	Site 9 (SW)	Site 10 (SW)	Site 11 (SW)
Na	mg l <sup>-1</sup>		31.2	37	54.6	36.9	65.5
K	mg l <sup>-1</sup>		4.5	3.9	5.1	4.1	3.91
Ca	mg l <sup>-1</sup>		10.2	10.4	10.4	9.8	10.8
Mg	mg l <sup>-1</sup>		6.98	7.41	8.82	7.63	10.2
Si	mg l <sup>-1</sup>		4.01	4.1	3.52	3.05	3.05
Br	mg l <sup>-1</sup>		0.2	0.1	0.2	0.12	0.28
Cl	mg l <sup>-1</sup>		62	62	110	63	110
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.098	<0.022	<0.022	<0.022	0.1178
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	0.01	<b>0.017</b>	<b>0.011</b>	0.0137	0.0243
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.021</b>	0.004	<b>0.010</b>	0.0115	0.00736
SO <sub>4</sub>	mg l <sup>-1</sup>		12	12	21	12	34
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01	<0.01	<0.01	0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>200</b>	<b>180</b>	<b>160</b>	72	210
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.2	1.2	0.9	1.2	0.9
Cd	µg l <sup>-1</sup>	0.2	0.08	0.07	0.02	<0.01	0.08
Co	µg l <sup>-1</sup>	2.8	0.15	0.17	0.08	0.11	0.11
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.3	0.2	0.2	<0.1	0.3
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>2.2</b>	<b>2</b>	1.2	1	2.6
Fe	µg l <sup>-1</sup>	300	230	215	<1000	<100	162
Mn	µg l <sup>-1</sup>	1700	5.18	2.88	1.67	2.92	3.84
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.4	1.4	0.7	0.9	1
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.3	0.28	0.12	0.16	0.28
Se	µg l <sup>-1</sup>	11	0.06	0.06	<0.06	<0.06	<0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>110</b>	<b>53</b>	29	5.5	101
DOC	mg l <sup>-1</sup>		7.3	8.9	7.9	7.6	8.8

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

### 3. WACHTELS LAGOON (WETLAND ID. 12075)

#### 3.1. Location and setting description

Wachtels Lagoon (Wetland ID. 12075) is situated on the western side of the River Murray, up river from Lock 3 and approximately 1.5 kilometres directly southwest of the town of Cobdogla. The wetland is an irregular circle in shape. It is about 3.5 kilometres in length and about 3 kilometres at its widest, with a total surface area of 685 hectares. The wetland is bounded to the east by a raised floodplain that separates it from the river and to the west by hill slopes that separate it from farmland.

The wetland is permanently connected to the river at the northern end by a wide inlet and at the southern end by two creeks. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Twenty sites were sampled as shown in Figure 3-1.

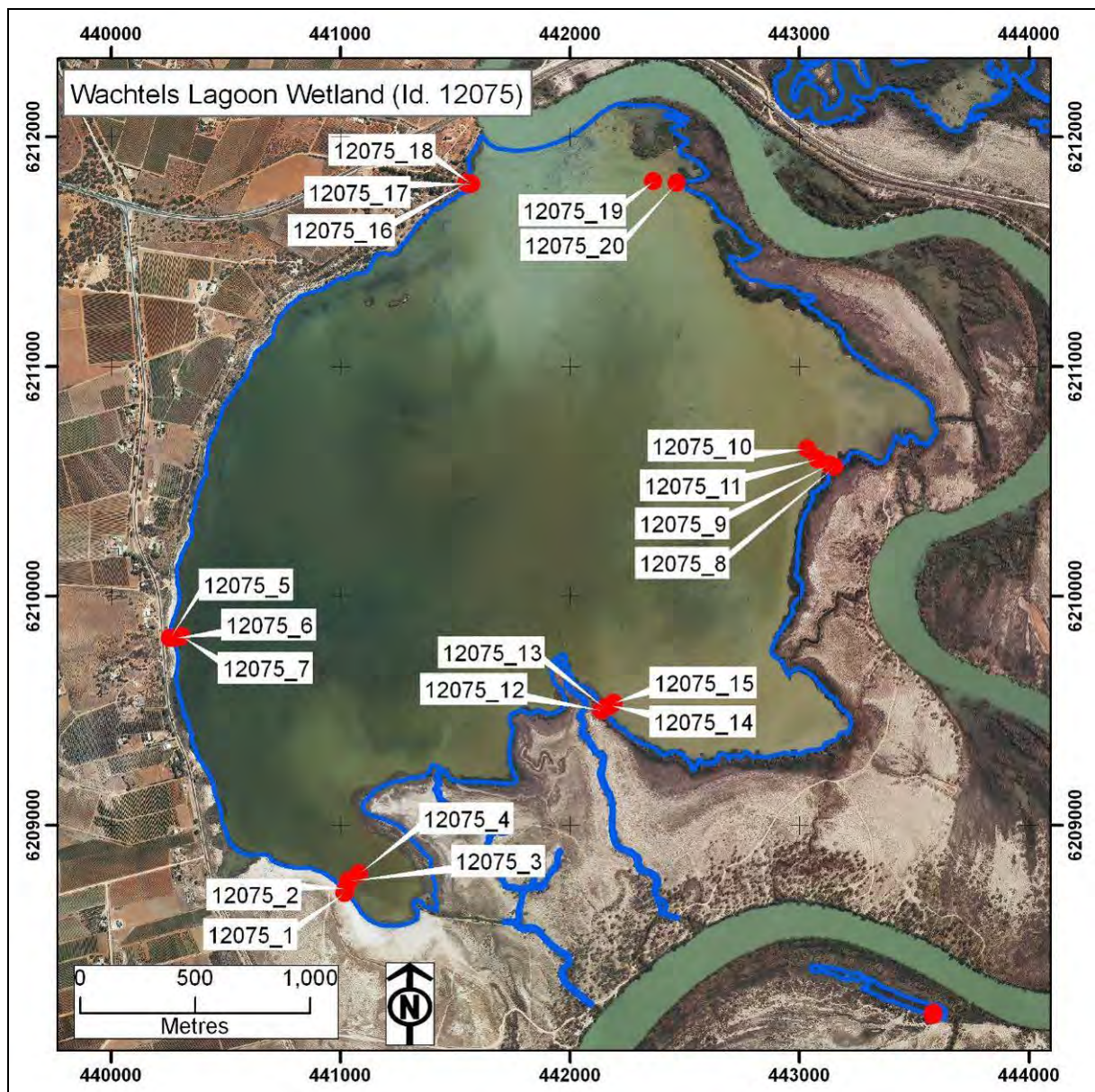


Figure 3-1. Wachtels Lagoon (Wetland ID. 12075) and sample site locations.

## 3.2. Soil profile description and distribution

Twenty sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 3-1. Sites were distributed along six transects placed around the wetland with sites on the transect from the margin into the open water, transects were located at the southern (Sites 1, 2, 3 and 4), western (Sites 5, 6 and 7), eastern (Sites 8, 9, 10 and 11), south eastern (Sites 12, 13, 14 and 15), north western (Sites 16, 17 and 18) and north eastern (Sites 19 and 20) of the wetland. The site and soil profile descriptions are presented in Table 3-2 and Table 3-3, and a conceptual cross-section diagram in Figure 3-2.

### Southern transect

Site 1 (Figure 3-3) occurred on the shore adjacent to water, the water table was about 60 cm depth, and the soil consisted of a brown, loose, sand with a sulfurous odour, over a grey, loose, clay. Site 2 (Figure 3-4) occurred amongst reeds in water (13 cm deep), and the soil consisted of a bluish black, very weak, clay, over a greenish grey, very weak, clay. Site 3 (Figure 3-5) occurred in open water (30 cm deep), and the soil consisted of a grey, very weak, sandy clay loam, over a bluish grey, firm, clay. Site 4 (Figure 3-6) occurred in open water (44 cm deep), and the soil consisted of a greenish grey, very weak, sand.

### Western transect

Site 5 (Figure 3-7) occurred on the shore above the water, the water table was about 10 cm depth, and the soil consisted of a grey, loose, clayey sand with a sulfurous odour, over a pale brown, very weak, sand. Site 6 (Figure 3-8) occurred in open water (20 cm deep), and the soil consisted of dark grey, very weak, clayey sand with sulfurous odour, over a grey, very weak, sandy clay. Site 7 (Figure 3-9) occurred in open water (70 cm deep), and the soil consisted of a dark olive grey, very weak, sandy gel with sulfurous odour, over a very dark grey, very weak, clay.

### Eastern transect

Site 8 (Figure 3-10) occurred adjacent to the shore in water (20 cm deep), and the soil consisted of an olive grey, very weak, clay, over a greenish grey, very weak, clay. Site 9 (Figure 3-11) occurred out from the reeds in open water (water depth not recorded), and the soil consisted of an olive grey, very weak, clay, over an olive, very weak, clay. Site 10 (Figure 3-12) occurred in open water (water depth not recorded), and the soil consisted of a dark grey, very weak, gel, over an olive, very weak, clay. Site 11 (Figure 3-13) occurred in open water (water depth not recorded), and the soil consisted of an olive grey, very weak, clay, over an olive, very weak, clay.

### South eastern transect

Site 12 (Figure 3-14) occurred adjacent to the shore next to reeds in water (not recorded cm deep), and the soil consisted of a dark olive grey, very weak, gel with strong odour, over a dark greenish grey, very weak, clay. Site 13 (Figure 3-15) occurred out from the reeds in open water (20 cm deep), and the soil consisted of a dark olive grey, very weak, gel, over a greenish grey, very weak, clay. Site 14 (Figure 3-16) occurred in open water (water depth not recorded), and the soil consisted of a grey, very weak, gel, over a dark grey, very weak, clay. Site 15 (Figure 3-17) occurred in open water (water depth not recorded), and the soil consisted of a dark grey, very weak, gel, over a dark grey, very weak, clay.

### North western transect

Site 16 (Figure 3-18) occurred adjacent to the bank amongst reeds in water (15 cm deep), and the soil consisted of a very dark greyish brown, very weak, sand, over an olive grey, very weak, sand. Site 17 (Figure 3-19) occurred amongst reeds in water (70 cm deep), and the soil consisted of a olive grey, very weak, sand, over an olive grey, very weak, sand. Site 18 (Figure 3-20) occurred amongst reeds in water (110 cm deep), and the soil consisted of a very dark grey, very weak, sand with sulfurous odour.



North eastern transect

Site 19 (Figure 3-21) occurred in open water (100 cm deep), and the soil consisted of a greenish grey, very weak, clay, over a greenish grey, very weak, clay. Site 20 (Figure 3-22) occurred in open water (33 cm deep), and the soil consisted of a greenish grey, very weak, sand, over a greenish grey, very weak, clay.

**Table 3-1. Soil identification, subtype and general location description for Wachtels Lagoon (Wetland ID. 12075).**

<b>Wetland and Site ID</b>	<b>Easting zone 54H</b>	<b>Northing zone 54H</b>	<b>Acid sulfate soil subtype class</b>	<b>General location description</b>
12075_1	441018	6208705	Other Soil (sandy)	high elevation
12075_2	441022	6208724	Subaqueous Soil (clayey)	5 m offshore in reeds
12075_3	441036	6208758	Subaqueous Soil (clayey)	low elevation, about 40 m offshore
12075_4	441082	6208791	Subaqueous Soil (sandy)	low elevation, about 90 m offshore
12075_5	440258	6209818	Other Soil (sandy)	high elevation, 5 m above water level
12075_6	440282	6209817	Subaqueous Soil (sandy)	low elevation, about 5 m offshore
12075_7	440308	6209824	Subaqueous Soil (clayey)	low elevation, about 30 m offshore
12075_8	443151	6210563	Subaqueous Soil (clayey)	low elevation in reeds
12075_9	443130	6210573	Subaqueous Soil (clayey)	low elevation
12075_10	443033	6210640	Subaqueous Soil (loamy)	low elevation
12075_11	443078	6210597	Subaqueous Soil (clayey)	low elevation
12075_12	442140	6209502	Subaqueous Soil (clayey)	mid elevation, 3 m from reeds
12075_13	442152	6209511	Subaqueous Soil (clayey)	low elevation
12075_14	442174	6209522	Subaqueous Soil (clayey)	low elevation
12075_15	442191	6209535	Subaqueous Soil (clayey)	low elevation
12075_16	441550	6211800	Subaqueous Soil (sandy)	mid elevation, edge of water
12075_17	441564	6211795	Subaqueous Soil (sandy)	low elevation, in reed beds
12075_18	441570	6211794	Subaqueous Soil (sandy)	low elevation, edge of reeds
12075_19	442364	6211807	Subaqueous Soil (clayey)	low elevation, about 150 m offshore
12075_20	442466	6211800	Subaqueous Soil (clayey)	mid elevation, about 10 m offshore

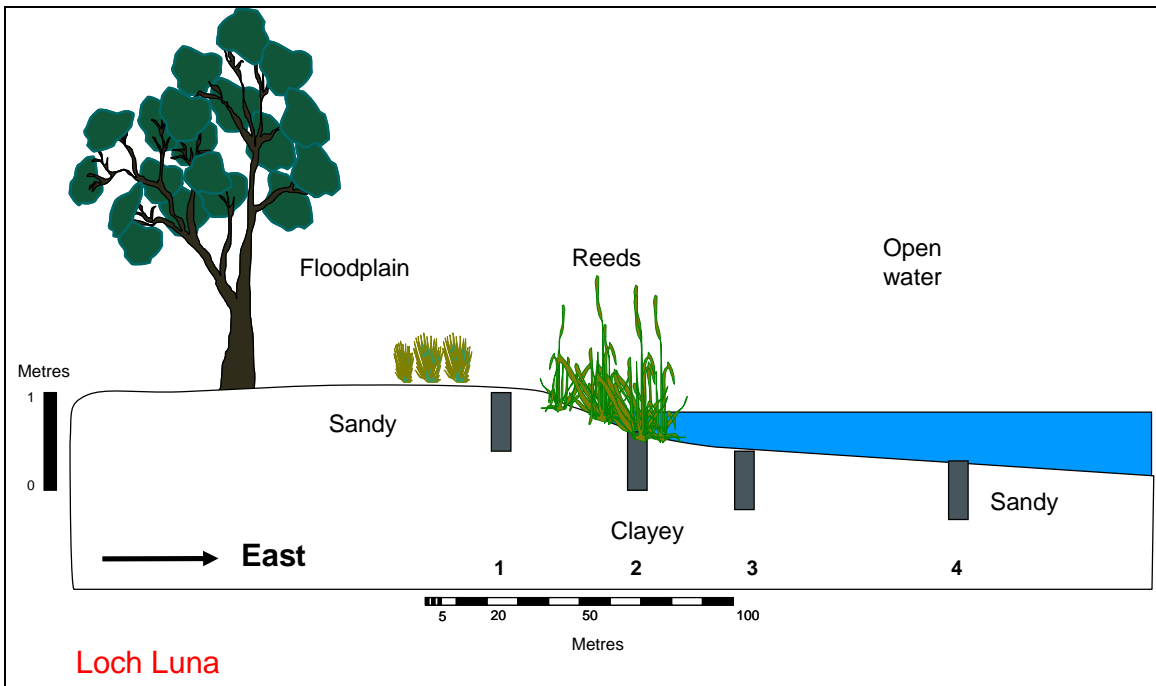


Figure 3-2. Conceptual cross-section diagram, showing locations for Sites 1 to 4.



Figure 3-3. Photographs of Site 1, showing the site location on the wetland margin above the water, and the soil profile.



Figure 3-4. Photograph of Site 2, showing the site location amongst thick reeds in water.



Figure 3-5. Photograph of Site 3, showing the site location in open water.



**Figure 3-6. Photograph of Site 4, showing the site location in open water.**



**Figure 3-7. Photograph of Site 5, showing the site location on the wetland margin.**



**Figure 3-8. Photograph of Site 6, showing the site location in open water out from the shore.**



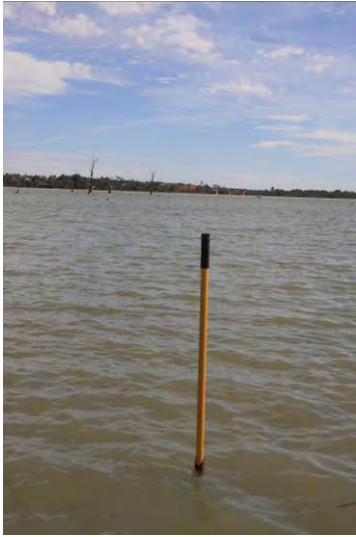
**Figure 3-9. Photograph of Site 7, showing the site location in open water.**



**Figure 3-10. Photograph of Site 8, showing the site location amongst reeds in water.**



**Figure 3-11. Photograph of Site 9, showing the site location in open water.**



**Figure 3-12. Photograph of Site 10, showing the site location in open water.**



**Figure 3-13. Photograph of Site 11, showing the site location in open water.**



**Figure 3-14. Photograph of Site 12, showing the site location near the shore amongst reeds in water.**



**Figure 3-15. Photograph of Site 13, showing the site location in open water.**



**Figure 3-16. Photograph of Site 14, showing the site location in open water.**



**Figure 3-17. Photograph of Site 15, showing the site location in open water.**



**Figure 3-18. Photograph of Site 16, showing the site location near the shore, amongst reeds in water.**



**Figure 3-19. Photograph of Site 17, showing the site location amongst reeds in water.**



**Figure 3-20. Photograph of Site 18, showing the site location amongst reeds in water.**



**Figure 3-21. Photograph of Site 19, showing the site location in open water.**



**Figure 3-22. Photograph of Site 20, showing the site location in open water.**

### **3.3. Laboratory data assessment**

#### **3.3.1. Soil pH testing (pH<sub>W</sub>, pH<sub>OX</sub>, pH<sub>INC</sub>)**

The pH data are provided in Table 3-4 and pH profiles are presented in Figure 3-24. The pH<sub>W</sub> data ranged from 5.98 to 9.14 and sulfuric materials with a pH<sub>W</sub> <4 were not identified. The pH<sub>OX</sub> data ranged from 1.56 to 8.81 and identified that surface layers in Profiles 3, 6, 7, 8, 12, 17 and 18 were below the critical value of pH<sub>OX</sub> <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material formation. The pH<sub>INC</sub> data ranged from 4.44 to 8.54 and identified that no samples on incubation declined below the critical values of pH <4.

#### **3.3.2. Acid base accounting**

The acid base accounting data is provided in Table 3-4 and summarised in Figure 3-24.

##### **Chromium reducible sulfur**

Chromium reducible sulfur values ranged from 0.0 to 0.42 %S<sub>CR</sub> and sulfidic materials were detected in all profiles.

##### **Titratable actual acidity**

Titratable actual acidity values ranged from 0.00 to 15.46 mole H<sup>+</sup>/tonne and were detected in profiles that were on the eastern side of the wetland and for samples elsewhere it was not detected.

##### **Retained acidity**

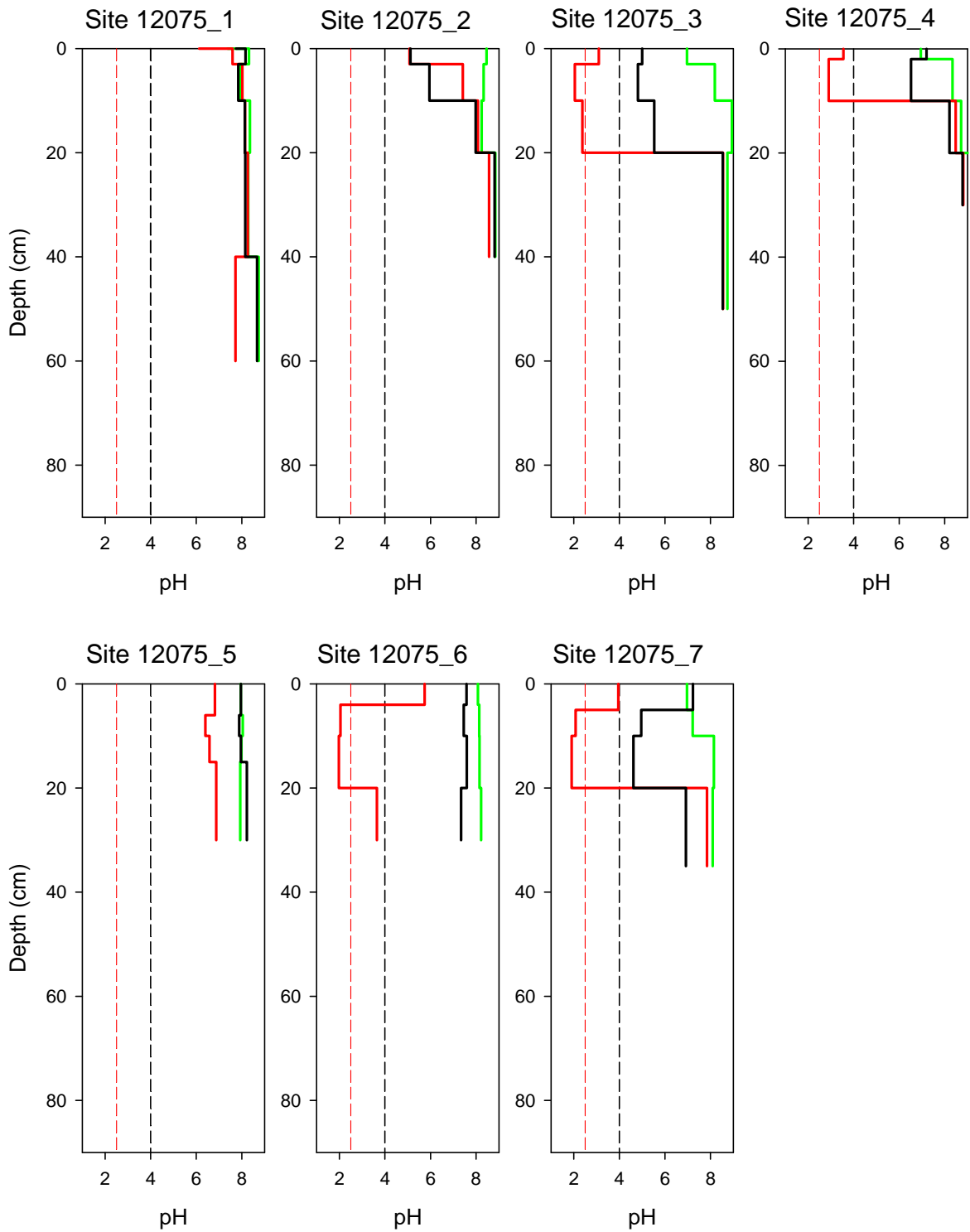
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

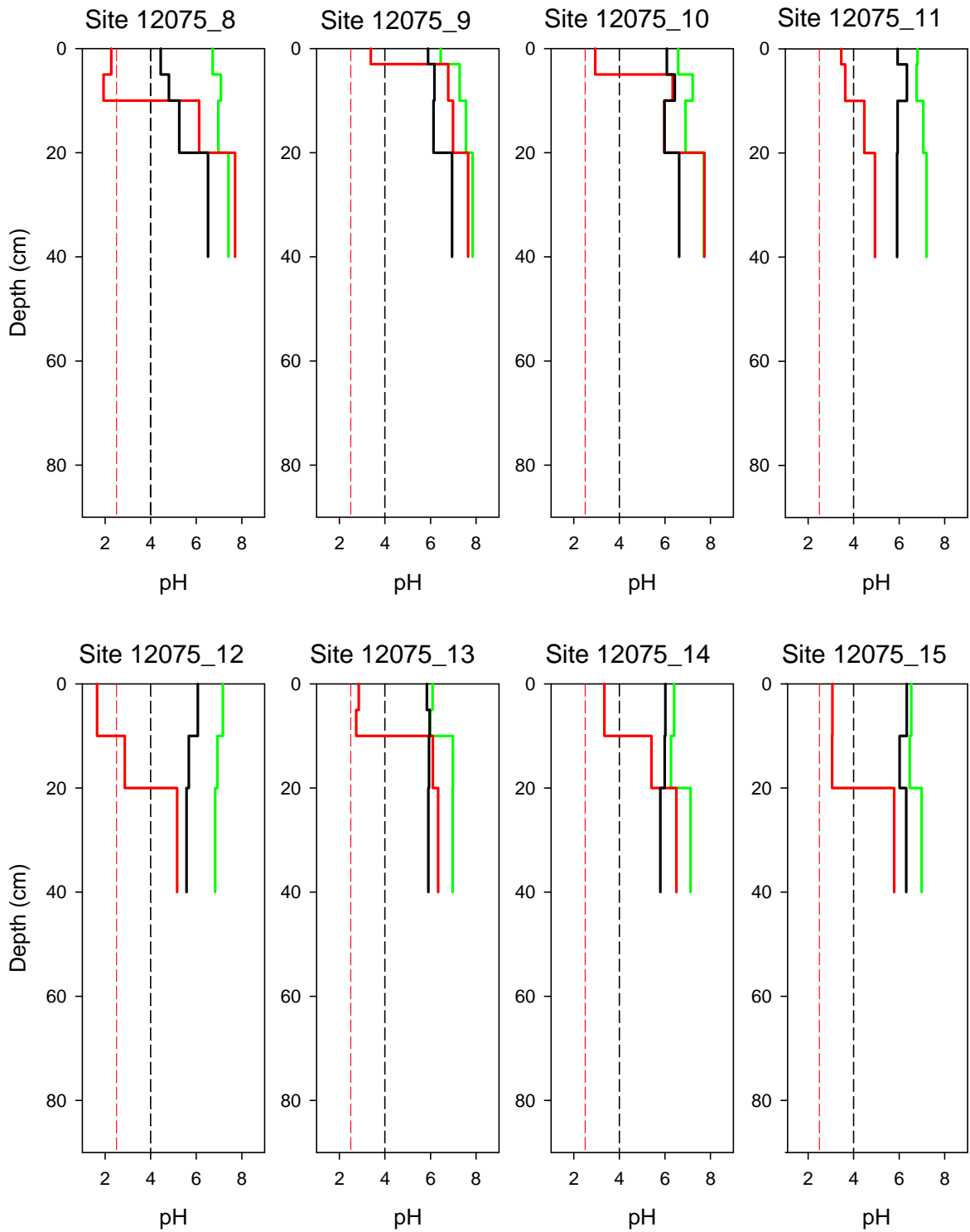
##### **Acid neutralising capacity**

Acid neutralising capacity values ranged from 0.00 to 22.52 %CaCO<sub>3</sub> and were measured in layers of Profiles 1 to 7, and not measured in Profiles 8 to 15.

##### **Net acidity**

Net acidity values ranged from -2931 to 143 mole H<sup>+</sup>/tonne. Low or moderate values were recorded in at least one layer for Profiles 2, 3, 4, 6, 7, 12, 16, 17, 19, 20 and in all layers of Profiles 8, 9, 10, 11, 13, 14, and 15. There did not appear to be any obvious spatial pattern.







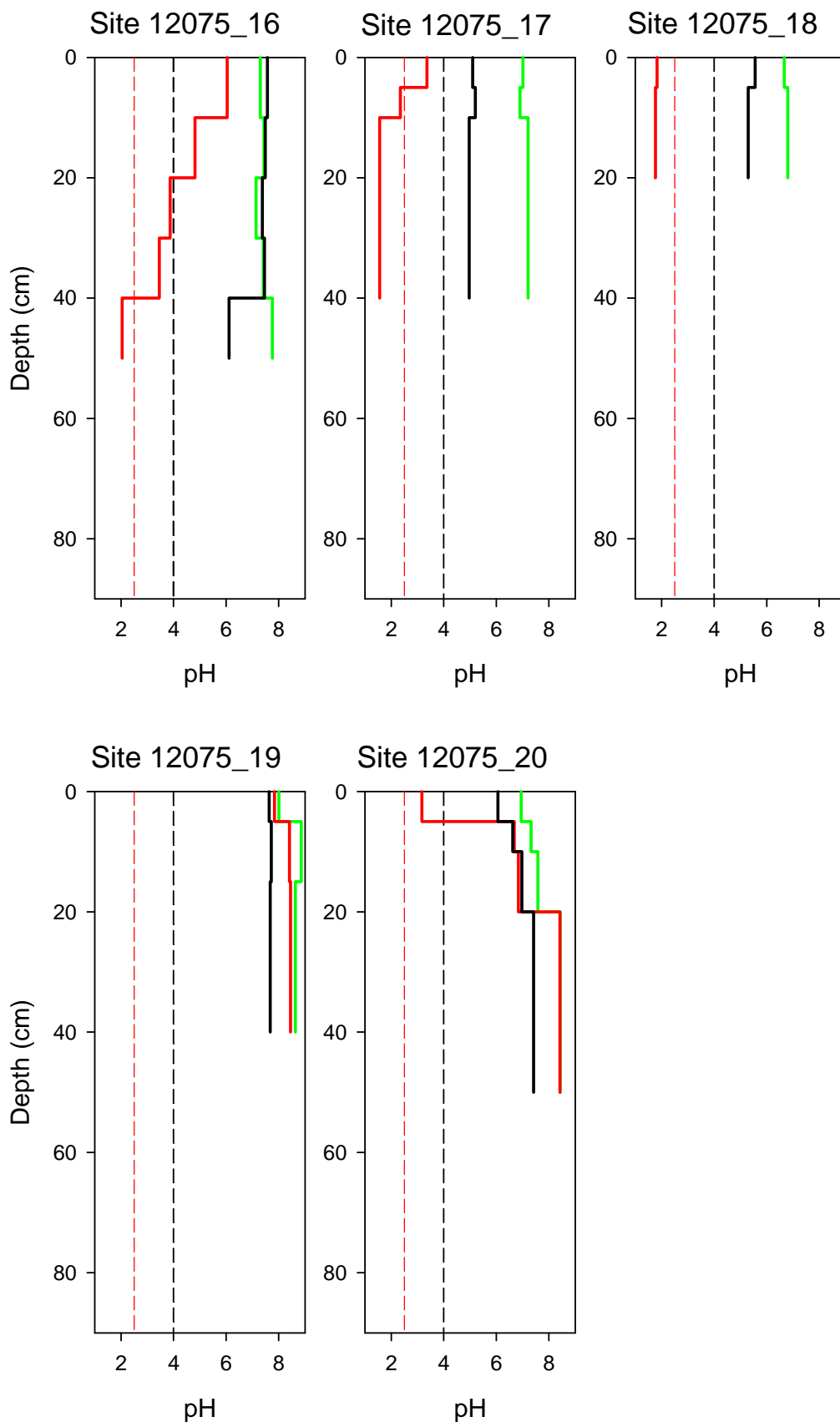
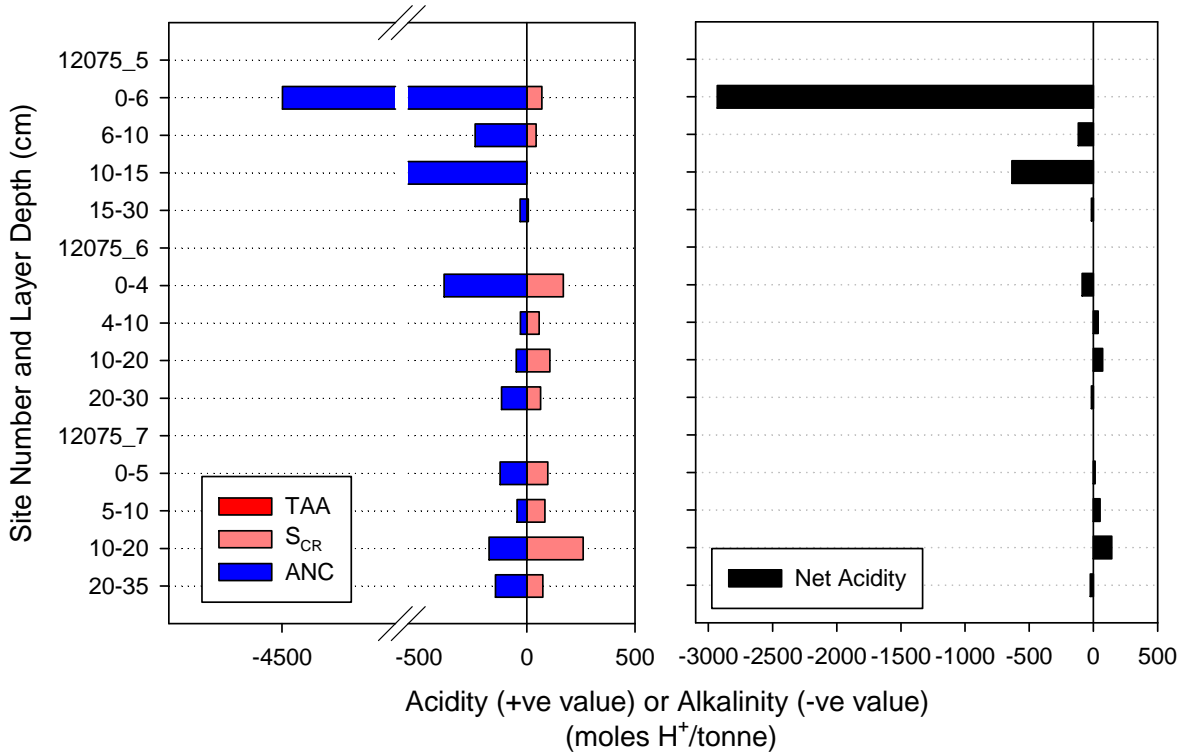
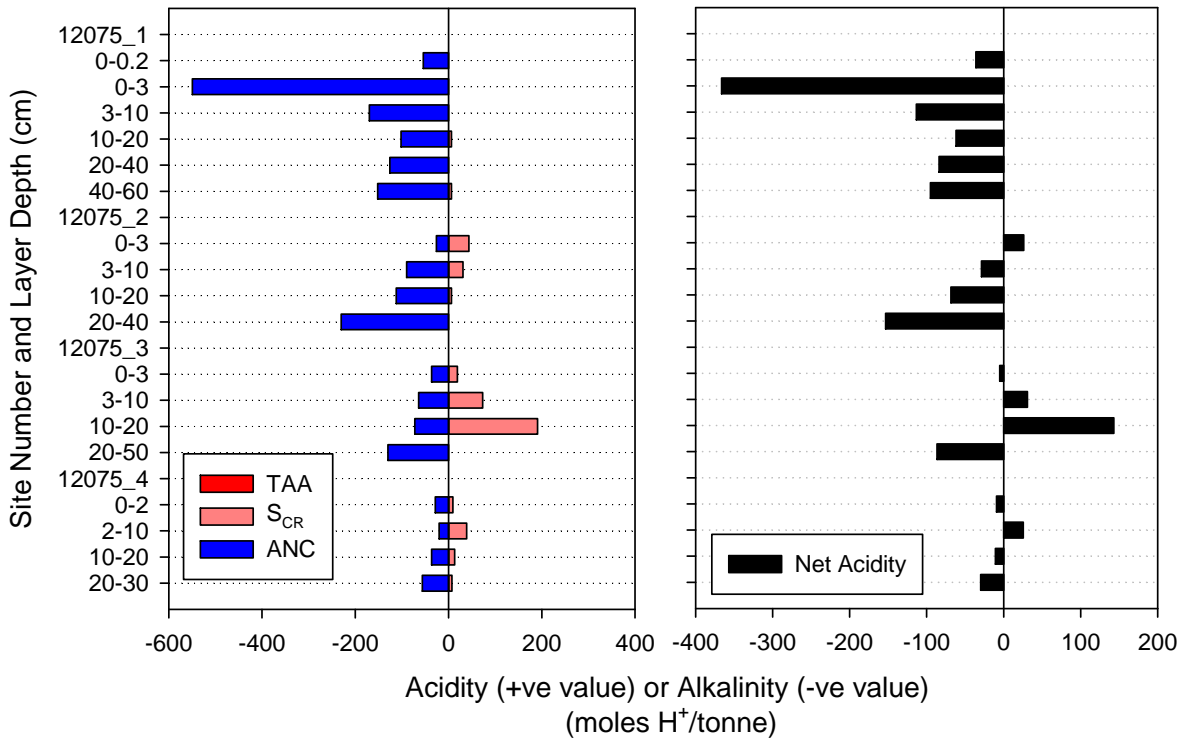
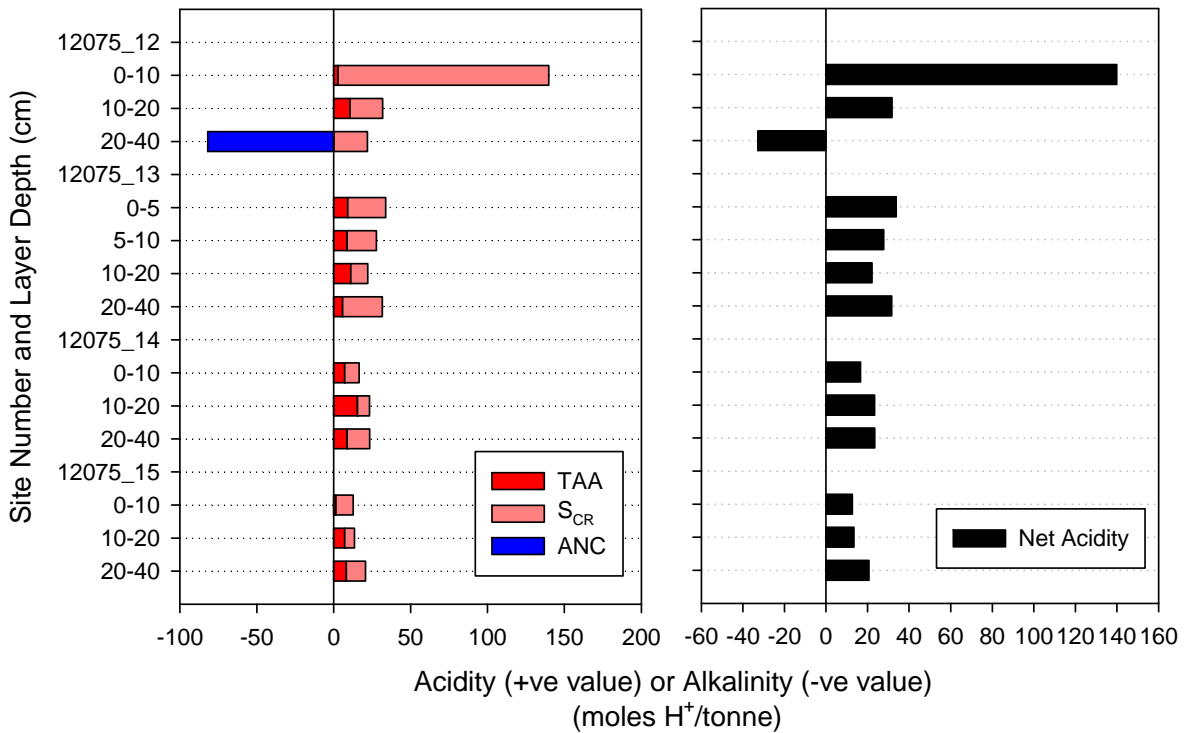
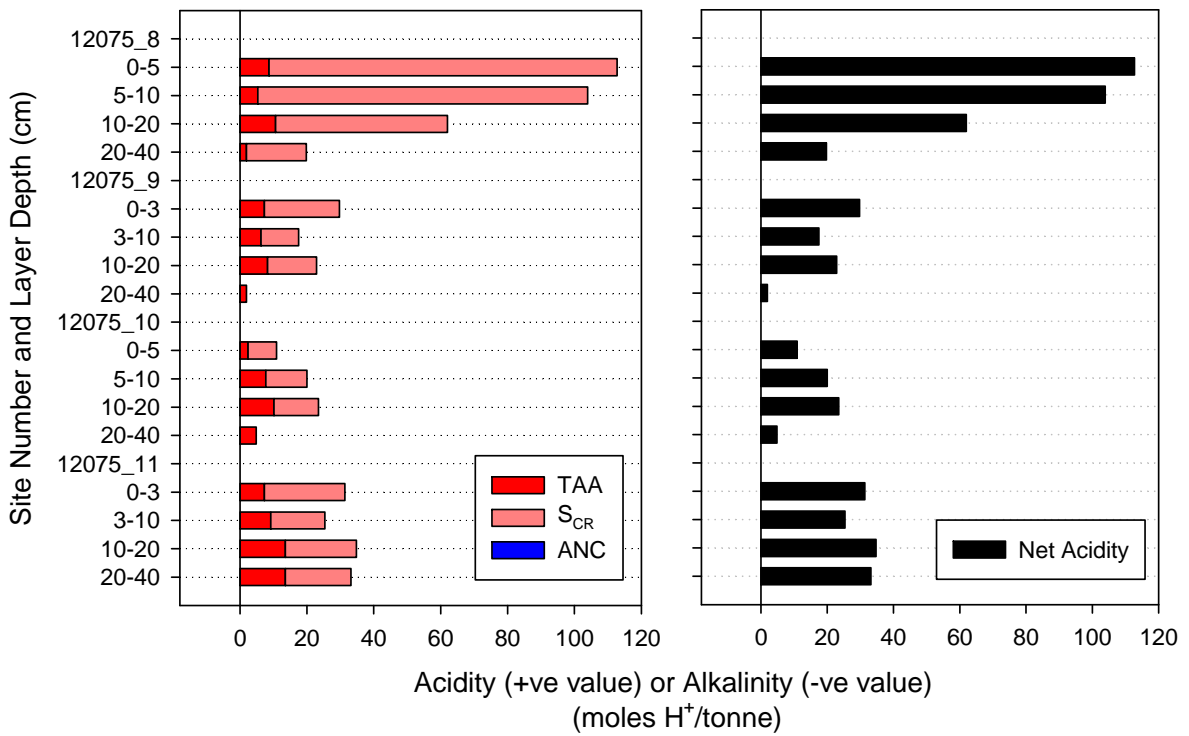
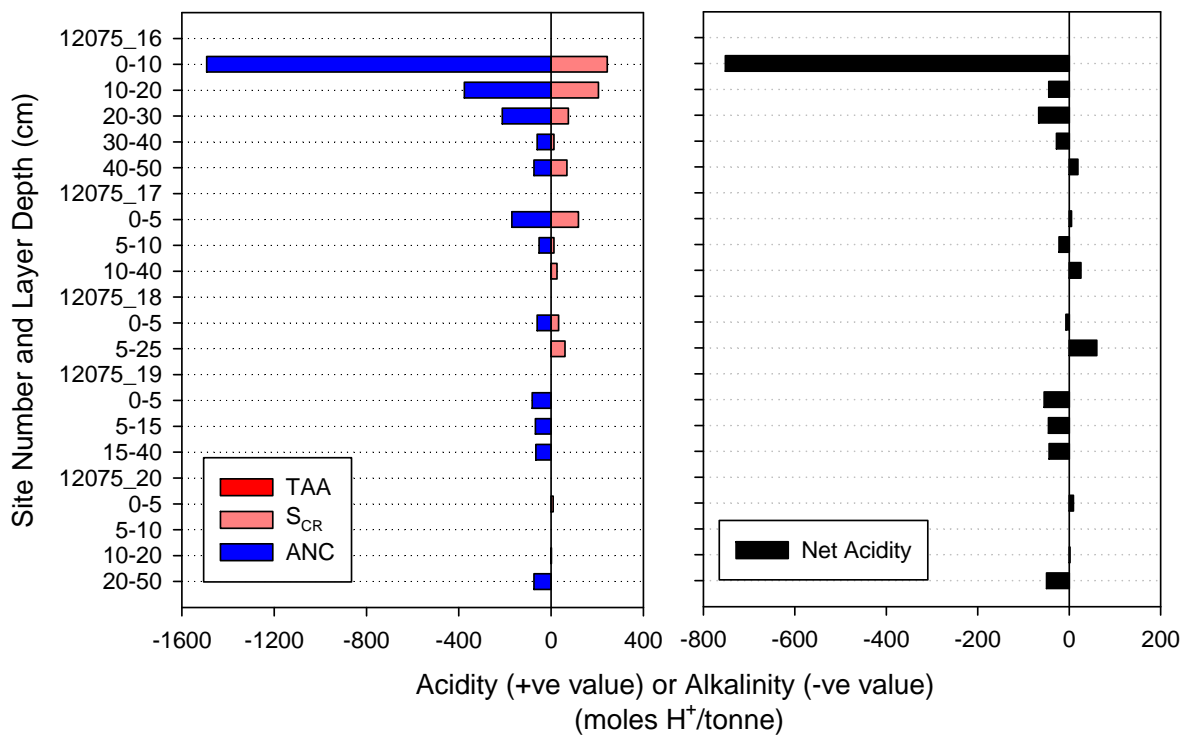


Figure 3-23. Depth profiles of soil pH for Wachtels Lagoon (Wetland ID. 12075), showing soil pH (pH<sub>W</sub> as green line), peroxide treated pH (pH<sub>OX</sub> as red line) and incubation pH (pH<sub>INC</sub> after 8 weeks as black line). Critical pH<sub>W</sub> and pH<sub>INC</sub> value of 4 (black dashed line) and critical pH<sub>OX</sub> value of 2.5 (red dashed line).







**Figure 3-24. Acid base accounting depth profiles for Wachtels Lagoon (Wetland ID. 12075). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 3.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 3-4 identified the profiles above the water (Profiles 1 and 5) to have surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>. All other profile surface layers were below the trigger value.

### 3.3.4. Acid volatile sulfur

Monosulfidic materials were observed in the upper layers of Profiles 2, 5 and 6 and sampled for analysis. The values shown in Table 3-4 were all above S<sub>AV</sub> ≥0.01% S, the criteria value for identifying monosulfidic material.

### 3.3.5. Hydrochemistry

Five surface waters and 1 pit water were collected from several transects in this large wetland. Field parameters are shown in Table 3-5. The surface waters had slightly alkaline to alkaline pH and SEC were variable. The waters were saturated to oversaturated with dissolved oxygen and turbidity was variable. Alkalinity was present in all samples, reaching moderately high concentrations.

The SEC in the single pit waters was much higher than in the surface water (Table 3-5). The pH was circumneutral, and DO and Eh were low (but have likely been modified by contact with the atmosphere). Alkalinity was much higher than in the surface waters.

The surface waters were of Na-Cl to Na-HCO<sub>3</sub> type, and the pit water of Na-Cl type (Table 3-6, Figure 3-25). Sulfate concentrations in the surface waters varied from 3400 to 4000 mg l<sup>-1</sup>, and were lower in the pit waters varying from 9.7 to 62 mg l<sup>-1</sup>, and the pit water was much higher at 2800 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratios in the surface waters (0.15-0.19) and pit water (0.17) were similar to seawater (0.142). Nitrate concentrations were variable but low. The concentrations of NH<sub>4</sub> and PO<sub>4</sub> were higher in the pit waters, with PO<sub>4</sub> in particular being significantly higher than ANZECC Guideline values (Table 3-6). Slightly elevated Al may be due to colloidal material as the waters were relatively turbid. Most metals were present at low concentrations although slightly elevated Zn was noted in some samples.

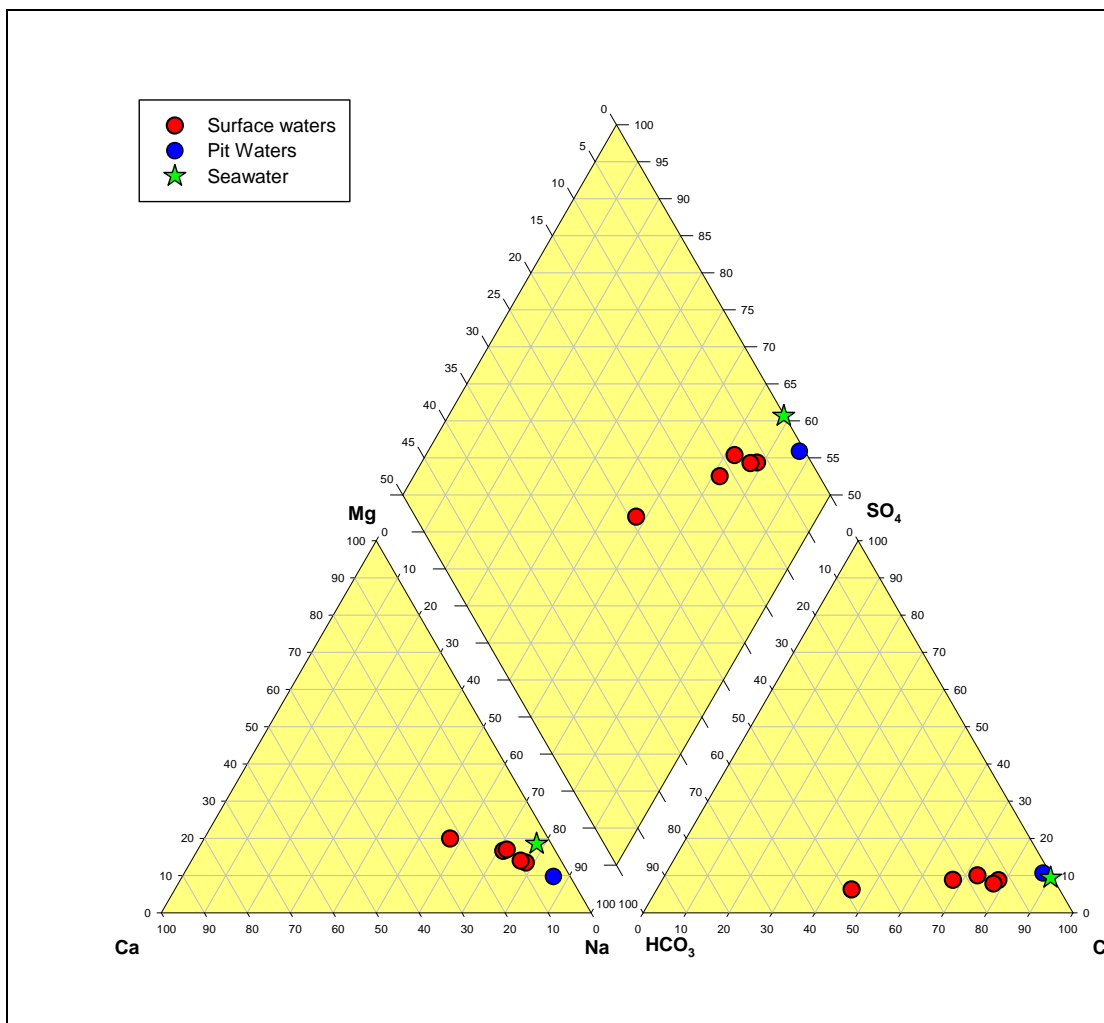


Figure 3-25. Piper diagram of hydrochemical data for Wachtels Lagoon (Wetland ID. 12075).

### 3.4. Discussion

Acid sulfate soil materials at Wachtels Lagoon (Wetland ID. 12075) were identified as hyposulfidic and they occurred throughout all profiles, some samples were characterised as other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Soil (sandy, loamy or clayey) that occurred throughout the wetland, and Other Soil (sandy) that occurred on the shoreline of the wetland margin.

The soils throughout the main wetland area were dominantly loamy textured in the surface layers and in isolated areas they were sandy textured. The subsoils were generally clayey and in some areas loamy.

Monosulfidic material was not observed but water soluble sulfate data identified that surface layers for Profiles 1 and 5 on the margins above the water were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Wachtels Lagoon (Wetland ID. 12075) are:

- Acidification hazard: The data identified positive net acidity values in nearly all profiles often in the subsoil layers and negative values for the surface samples and pH<sub>OX</sub> data identified surface samples with values that indicated a potential acidification hazard due to oxidation. There is a medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of profiles above water on the margins, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

#### Summary of key findings Wachtels Lagoon (Wetland ID. 12075):

<b>Soil materials:</b>	The soil layers were generally hyposulfidic throughout the wetland. Soils were loamy or sandy textured at the surface and loamy or clayey textured in the subsoil. All profiles had at least one layer that had a low or moderate net acidity value and this tended to be in the subsoil layers, and pH <sub>OX</sub> data for a few samples indicated a potential for acidification.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (sandy, loamy or clayey) – occurring where there was surface water throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Other Soil (sandy) – occurring on the shoreline of the wetland margins above the water. Isolated (&lt;10%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>

**Table 3-2. Site description data for Wachtels Lagoon (Wetland ID. 12075).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	18/04/2010	441018	6208705	-60	sandy	barren	high elevation
2	18/04/2010	441022	6208724	13	water, soft	Typha	5 m offshore in reeds
3	18/04/2010	441036	6208758	30	water, soft	water	low elevation, ca. 40 m offshore
4	18/04/2010	441082	6208791	44	water, soft	water	low elevation, ca. 90 m offshore
5	18/04/2010	440258	6209818	-10	sandy	samphire	high elevation, 5 m above water level
6	18/04/2010	440282	6209817	20	water, soft	water	low elevation, ca. 5 m offshore
7	18/04/2010	440308	6209824	70	water, soft	water	low elevation, ca. 30 m offshore
8	18/04/2010	443151	6210563	20	water, soft	phragmites, minor Typha	low elevation in reeds
9	18/04/2010	443130	6210573	not reached	water, soft	water	low elevation
10	18/04/2010	443033	6210640	not reached	water, soft	water	low elevation
11	18/04/2010	443078	6210597	not reached	water, soft	water	low elevation
12	18/04/2010	442140	6209502	not reached	water, soft	water	mid elevation, 3 m from reeds
13	18/04/2010	442152	6209511	20	water, soft	water	low elevation
14	18/04/2010	442174	6209522	not reached	water, soft	water	low elevation
15	18/04/2010	442191	6209535	not reached	water, soft	water	low elevation
16	18/04/2010	441550	6211800	15	water, soft	phragmites and Typha	mid elevation, edge of water
17	18/04/2010	441564	6211795	70	water, soft	phragmites and Typha	low elevation, in reed beds
18	18/04/2010	441570	6211794	110	water, soft	phragmites and Typha	low elevation, edge of reeds
19	18/04/2010	442364	6211807	100	water, firm	water	low elevation, ca. 150 m offshore
20	18/04/2010	442466	6211800	33	water, firm	water	mid elevation, ca. 10 m offshore

**Table 3-3. Soil profile description data for Wachtels Lagoon (Wetland ID. 12075).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
1_W1	30 - 0	surface water							water sampled
1_0	0 - 0.2	surface salt scrap	very pale brown (10YR7/4)	salt	dry		single grain	loose	white efflorescence
1_1	0 - 3	small pit	brown (10YR5/3)	sand	dry		single grain	loose	
1_2	3 - 10	small pit	grey (5Y5/1)	sand	dry	40% dark brownish black	single grain	loose	
1_3	10 - 20	small pit	dark grey (5Y4/1)	sandy loam	dry	10% dark brownish black	massive	loose	
1_4	20 - 40	small pit	grey (5Y5/1)	medium clay	moist		massive	loose	
1_5	40 - 60	small pit	greenish grey (5GY6/1)	heavy clay	moist		massive	very firm	
2_1	0 - 3	small pit	black (N2.5/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour
2_2	3 - 10	small pit	bluish black (5PB2.5/1)	light clay	wet	5% greyish brown	massive	very weak	sulfurous odour
2_3	10 - 20	small pit	grey (5Y6/1)	medium clay	wet	5% brown	massive	very weak	very sticky
2_4	20 - 40	small pit	greenish grey (5G5/1)	medium clay	wet	10% black	massive	very weak	
3_1	0 - 3	small pit	very dark gray (N3/0)	sandy loam	wet		massive	very weak	organic odour
3_2	3 - 10	small pit	grey (5Y5/1)	sandy clay loam	wet		single grain	very weak	minor plant roots
3_3	10 - 20	small pit	dark grey (5Y4/1)	light clay	wet		massive	very weak	
3_4	20 - 50	small pit	bluish grey (5B5/1)	light clay	moist		massive	very firm	
4_1	0 - 2	small pit	dark grey (5Y4/1)	sandy gel	wet		single grain	very weak	
4_2	2 - 10	small pit	dark greenish grey (5GY4/1)	clayey sand	wet	3% brown	single grain	very weak	few roots
4_3	10 - 20	small pit	greenish grey (5G5/1)	clayey sand	wet		single grain	very weak	few roots and charcoal
4_4	20 - 30	small pit	greenish grey (5BG5/1)	clayey sand	wet	2% brown	single grain	very weak	
5_1	0 - 6	small pit	black (N2.5/0)	sand	wet		single grain	very weak	sulfurous odour, very thin salt crust
5_2	6 - 10	small pit	grey (5Y5/1)	clayey sand	moist		single grain	very firm	
5_3	10 - 15	small pit	pale brown (10YR6/3)	clayey sand	moist		single grain	very firm	slight sulfurous odour
5_4	15 - 30	small pit	pale brown (10YR6/3)	sand	wet		single grain	very weak	
5_W1	-	pit water							water sampled



Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
6_W1	30 - 0	surface water							water sampled
6_1	0 - 4	small pit	black (N2.5/0)	gel	wet		single grain	very weak	sulfurous odour
6_2	4 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	sulfurous odour
6_3	10 - 20	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	sulfurous odour, few shells
6_4	20 - 30	small pit	gray (N5/0)	sandy clay loam	wet		single grain	very weak	few roots, charcoal
7_1	0 - 5	small pit	dark olive grey (5Y3/2)	sandy gel	wet		single grain	very weak	minor roots
7_2	5 - 10	small pit	dark greenish gray (5GY3/1)	sand	wet		single grain	very weak	weak sulfurous odour
7_3	10 - 20	small pit	very dark grey (5Y3/1)	light clay	wet		granular	very weak	
7_4	20 - 35	small pit	dark greenish grey (5BG4/1)	heavy clay	wet		massive	very weak	
8_W1	30 - 0	surface water							water sampled
8_1	0 - 5	small pit	olive grey (5Y4/2)	light clay	wet		massive	very weak	gel-like consistency
8_2	5 - 10	small pit	olive grey (5Y4/2)	light clay	wet		massive	very weak	organic odour, gel-like
8_3	10 - 20	small pit	dark bluish grey (5B4/1)	medium clay	wet		massive	very weak	few roots
8_4	20 - 40	small pit	greenish gray (10BG5/1)	medium clay	moist		massive	very weak	
9_W1	-	surface water							water sampled
9_1	0 - 3	small pit	olive (5Y4/3)	gel	wet		massive	very weak	
9_2	3 - 10	small pit	bluish grey (5B5/1)	light clay	wet		massive	very weak	
9_3	10 - 20	small pit	dark greenish gray (10BG4/1)	light clay	wet		massive	very weak	
9_4	20 - 40	small pit	olive (5Y4/3)	light clay	wet		massive	very weak	some sand
10_1	0 - 5	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	
10_2	5 - 10	small pit	olive grey (5Y4/2)	light clay	wet		massive	very weak	
10_3	10 - 20	small pit	dark bluish grey (5B4/1)	light clay	wet		massive	very weak	
10_4	20 - 40	small pit	dark greenish gray (10BG4/1)	light clay	wet		massive	very weak	bit pellety
11_1	0 - 3	small pit	dark greenish gray (10BG3/1)	gel	wet	2% brown	massive	very weak	moderate sulfurous odour
11_2	3 - 10	small pit	dark bluish grey (5B4/1)	clay	wet		massive	very weak	gel-like, sulfurous odour
11_3	10 - 20	small pit	dark greenish gray (10G4/1)	light clay	wet		massive	very weak	
11_4	20 - 40	small pit	dark gray (N4/0)	medium clay	wet		massive	very weak	

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
12_1	0 - 10	small pit	dark olive grey (5Y3/2)	gel	wet		massive	very weak	strong organic odour
12_2	10 - 20	small pit	dark greenish grey (5GY4/1)	gel	wet		massive	very weak	
12_3	20 - 40	small pit	dark greenish grey (5G4/1)	light clay	wet		massive	very weak	
13_1	0 - 5	small pit	dark olive grey (5Y3/2)	gel	wet		massive	very weak	organic odour
13_2	5 - 10	small pit	olive grey (5Y4/2)	gel	wet		massive	very weak	organic odour
13_3	10 - 20	small pit	greenish grey (5G5/1)	heavy clay	moist		massive	very weak	organic odour
13_4	20 - 40	small pit	greenish grey (5G5/1)	heavy clay	moist		massive	very weak	
14_W1	30 - 0	surface water							water sampled
14_1	0 - 10	small pit	grey (5Y5/1)	gel	wet		massive	very weak	organic odour
14_2	10 - 20	small pit	gray (N5/0)	medium clay	wet		massive	very weak	few roots
14_3	20 - 40	small pit	dark gray (N4/0)	medium clay	wet		massive	very weak	
15_1	0 - 10	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	organic odour
15_2	10 - 20	small pit	dark grey (5Y4/1)	gel	wet		massive	very weak	organic odour
15_3	20 - 40	small pit	dark gray (N4/0)	heavy clay	wet		massive	very weak	
16_1	0 - 10	small pit	very dark greyish brown (10YR3/2)	sand	wet		single grain	very weak	organic odour
16_2	10 - 20	small pit	very dark brown (10YR2/2)	sand	wet		single grain	very weak	organic odour
16_3	20 - 30	small pit	very dark grey (5Y3/1)	sand	wet		single grain	very weak	organic odour
16_4	30 - 40	small pit	olive grey (5Y5/2)	sand	wet		single grain	very weak	
16_5	40 - 50	push tube	dark grey (5Y4/1)	sand	wet	2% brown	single grain	very weak	
16_5DUP	40 - 50	push tube	olive grey (5Y4/2)	sand	wet		single grain	very weak	
17_1	0 - 5	small pit	dark greyish brown (2.5Y4/3)	plant material	wet	2% brown	single grain	very weak	reedy vegetation with sandy and clay
17_2	5 - 10	small pit	olive grey (5Y4/2)	sand	wet	2% brown	single grain	very weak	
17_3	10 - 40	small pit	olive grey (5Y4/2)	sand	wet		single grain	very weak	
18_W1	110 - 0	surface water							water sampled
18_1	0 - 5	small pit	very dark grey (5Y3/1)	sand	wet		single grain	very weak	slight sulfurous odour
18_2	5 - 25	small pit	dark olive grey (5Y3/2)	sand	wet		single grain	very weak	slight sulfurous odour
19_1	0 - 5	small pit	greenish grey (5GY5/1)	heavy clay	wet		massive	very weak	
19_2	5 - 15	small pit	greenish grey (5GY5/1)	heavy clay	wet		massive	very weak	
19_3	15 - 40	small pit	greenish grey (5GY5/1)	heavy clay	wet		massive	very weak	

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
20_1	0 - 5	small pit	greenish grey (5GY5/1)	sand	wet		massive	very weak	
20_2	5 - 10	small pit	greenish grey (5G5/1)	sand	wet		massive	very weak	
20_2DUP	5 - 10	small pit	greenish grey (5G5/1)	light clay	wet		massive	very weak	
20_3	10 - 20	small pit	greenish grey (5G5/1)	medium clay	wet		massive	very weak	
20_4	20 - 50	push tube	greenish grey (5GY6/1)	medium clay	wet		massive	very weak	

**Table 3-4. Laboratory data for acid sulfate soil assessment of Wachtels Lagoon (Wetland ID. 12075).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Volatile Sulfur (%Sav)	Acid Sulfate Soil Material Classification
1.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
1.0	0-0.2	Coarse	88	7.38	6.13	7.81	7.74	20,000	8.96	0.00	<0.01	0.27	-36	..	other soil material
1.1	0-3	Coarse	23,500	8.31	7.59	8.19	8.16	1,600	9.54	0.00	<0.01	2.75	-366	..	other soil material
1.2	3-10	Medium	16,550	7.91	8.02	7.84	7.84	590	8.43	0.00	<0.01	0.85	-113	..	other soil material
1.3	10-20	Fine	7,750	8.35	8.14	8.16	8.13	190	7.89	0.00	0.01	0.51	-62	..	hyposulfidic (S <sub>CR</sub> <0.10%)
1.4	20-40	Fine	5,320	8.28	8.26	8.34	8.15	140	7.29	0.00	<0.01	0.63	-84	..	other soil material
1.5	40-60	Fine	2,540	8.74	7.72	8.51	8.67	80	7.54	0.00	0.01	0.76	-95	..	hyposulfidic (S <sub>CR</sub> <0.10%)
2.1	0-3	Medium	642	8.46	5.08	7.49	5.12	41	7.48	0.00	0.07	0.13	26	0.03	hyposulfidic (S <sub>CR</sub> <0.10%) monosulfidic
2.2	3-10	Fine	864	8.33	7.42	7.12	5.95	89	7.06	0.00	0.05	0.45	-29	..	hyposulfidic (S <sub>CR</sub> <0.10%)
2.3	10-20	Fine	978	8.24	8.08	8.22	7.98	64	7.08	0.00	0.01	0.56	-68	..	hyposulfidic (S <sub>CR</sub> <0.10%)
2.4	20-40	Fine	1,636	8.84	8.57	8.46	8.81	160	7.79	0.00	<0.01	1.15	-153	..	other soil material
3.1	0-3	Fine	237	6.97	3.10	7.29	5.00	22	6.87	0.00	0.03	0.18	-5	..	hyposulfidic (S <sub>CR</sub> <0.10%)
3.2	3-10	Fine	765	8.19	2.05	7.56	4.82	110	6.85	0.00	0.12	0.32	31	..	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.3	10-20	Fine	1,041	8.94	2.38	8.03	5.53	240	6.92	0.00	0.31	0.36	143	..	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.4	20-50	Fine	1,699	8.74	8.55	8.14	8.54	97	7.81	0.00	<0.01	0.65	-87	..	other soil material
4.1	0-2	Fine	211	6.95	3.55	7.50	7.20	23	6.89	0.00	0.02	0.14	-9	..	hyposulfidic (S <sub>CR</sub> <0.10%)
4.2	2-10	Fine	646	8.34	2.91	6.87	6.52	60	6.67	0.00	0.06	0.10	26	..	hyposulfidic (S <sub>CR</sub> <0.10%)
4.3	10-20	Fine	1,095	8.72	8.48	7.49	8.21	110	7.19	0.00	0.02	0.18	-11	..	hyposulfidic (S <sub>CR</sub> <0.10%)
4.4	20-30	Fine	1,873	9.09	8.81	8.36	8.78	150	7.99	0.00	0.01	0.28	-30	..	hyposulfidic (S <sub>CR</sub> <0.10%)
5.1	0-6	Medium	26,300	7.95	6.82	7.34	7.96	3,200	8.99	0.00	0.11	22.52	-2931	0.09	hyposulfidic (S <sub>CR</sub> ≥0.10%) monosulfidic
5.2	6-10	Coarse	5,880	8.04	6.40	8.17	7.88	180	9.38	0.00	0.07	1.20	-118	..	hyposulfidic (S <sub>CR</sub> <0.10%)
5.3	10-15	Coarse	5,380	7.98	6.58	7.83	7.96	200	9.51	0.00	<0.01	4.77	-635	..	other soil material
5.4	15-30	Coarse	3,650	7.93	6.88	7.32	8.22	240	9.21	0.00	0.01	0.16	-15	..	hyposulfidic (S <sub>CR</sub> <0.10%)
5.W1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	pit water
6.W2	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
6.1	0-4	Medium	1,250	8.08	5.74	6.91	7.58	43	8.40	0.00	0.27	1.92	-87	0.06	hyposulfidic (S <sub>CR</sub> ≥0.10%) monosulfidic
6.2	4-10	Fine	2,116	8.14	2.05	7.05	7.46	100	7.52	0.00	0.09	0.15	36	..	hyposulfidic (S <sub>CR</sub> <0.10%)
6.3	10-20	Fine	4,000	8.15	1.98	7.08	7.59	330	7.38	0.00	0.17	0.25	73	..	hyposulfidic (S <sub>CR</sub> ≥0.10%)
6.4	20-30	Fine	4,140	8.22	3.65	7.46	7.34	280	7.30	0.00	0.10	0.59	-15	..	hyposulfidic (S <sub>CR</sub> ≥0.10%)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity (mole $\text{H}^+$ /tonne)	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity (mole $\text{H}^+$ /tonne)	Acid Volatile Sulfur ( $\%\text{Sav}$ )	Acid Sulfate Soil Material Classification
7.1	0-5	Fine	382	6.97	3.95	7.32	7.23	31	7.43	0.00	0.15	0.62	13	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.2	5-10	Fine	445	7.22	2.08	6.65	4.96	59	7.06	0.00	0.13	0.23	52	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.3	10-20	Fine	3,270	8.15	1.91	6.95	4.62	460	7.05	0.00	0.42	0.88	143	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
7.4	20-35	Fine	3,480	8.10	7.85	7.74	6.92	240	7.14	0.00	0.12	0.73	-24	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
8.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
8.1	0-5	Fine	150	6.72	2.27	6.51	4.44	33	6.11	8.70	0.17	0.00	113	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
8.2	5-10	Fine	155	7.08	1.93	6.43	4.80	35	6.33	5.32	0.16	0.00	104	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
8.3	10-20	Fine	296	6.97	6.13	6.38	5.25	30	6.08	10.63	0.08	0.00	62	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
8.4	20-40	Fine	178	7.41	7.70	7.04	6.52	16	6.47	1.93	0.03	0.00	20	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.W1															surface water
9.1	0-3	Fine	109	6.45	3.38	6.81	5.89	23	6.15	7.25	0.04	0.00	30	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.2	3-10	Fine	65	7.28	6.78	6.68	6.17	22	6.26	6.28	0.02	0.00	18	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.3	10-20	Fine	84	7.56	6.99	6.48	6.13	16	6.14	8.21	0.02	0.00	23	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.4	20-40	Fine	75	7.85	7.65	7.40	6.95	14	6.40	1.93	<0.01	0.00	2	..	other soil material
10.1	0-5	Fine	141	6.58	2.94	6.92	6.08	15	6.19	2.42	0.01	0.00	11	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.2	5-10	Fine	83	7.22	6.34	6.83	6.43	25	6.11	7.73	0.02	0.00	20	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.3	10-20	Fine	57	6.90	5.98	6.86	5.98	22	6.07	10.15	0.02	0.00	23	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.4	20-40	Fine	100	7.71	7.74	6.83	6.62	11	6.31	4.83	<0.01	0.00	5	..	other soil material
11.1	0-3	Fine	147	6.80	3.46	6.94	5.93	26	5.80	7.25	0.04	..	31	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.2	3-10	Fine	154	6.76	3.63	6.73	6.34	21	5.79	9.18	0.03	..	25	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.3	10-20	Fine	84	7.06	4.47	6.46	5.93	26	5.77	13.53	0.03	..	35	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.4	20-40	Fine	97	7.20	4.94	6.61	5.91	15	5.68	13.53	0.03	..	33	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
12.1	0-10	Fine	368	7.17	1.65	6.63	6.07	53	6.45	2.90	0.22	0.00	140	..	hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
12.2	10-20	Fine	185	6.93	2.86	6.32	5.67	29	5.72	10.63	0.03	..	32	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
12.3	20-40	Fine	124	6.83	5.16	6.45	5.57	28	6.55	0.00	0.04	0.41	-33	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
13.1	0-5	Fine	140	6.09	2.85	6.57	5.84	13	6.01	9.18	0.04	0.00	34	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
13.2	5-10	Fine	164	5.98	2.74	6.48	5.96	13	5.89	8.70	0.03	..	28	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
13.3	10-20	Fine	101	6.98	6.10	6.63	5.93	23	5.92	11.11	0.02	..	22	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
13.4	20-40	Fine	115	6.97	6.33	6.72	5.90	29	6.35	5.80	0.04	0.00	32	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
14.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
14.1	0-10	Fine	211	6.40	3.34	6.82	6.02	13	6.19	7.25	0.02	0.00	17	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
14.2	10-20	Fine	101	6.26	5.41	6.37	5.99	31	5.73	15.46	0.01	..	23	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
14.3	20-40	Fine	141	7.13	6.50	6.12	5.80	17	6.05	8.70	0.02	0.00	23	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
15.1	0-10	Fine	223	6.53	3.07	6.92	6.33	14	6.24	1.45	0.02	0.00	13	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
15.2	10-20	Fine	214	6.46	3.06	6.76	6.02	13	5.94	7.25	0.01	..	13	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
15.3	20-40	Fine	154	6.98	5.78	6.82	6.31	24	6.06	8.21	0.02	0.00	21	..	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S/cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity (mole $\text{H}^+$ /tonne)	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity (mole $\text{H}^+$ /tonne)	Acid Volatile Sulfur ( $\%\text{Sav}$ )	Acid Sulfate Soil Material Classification
16.1	0-10	Medium	236	7.30	6.04	7.09	7.57	49	7.76	0.00	0.39	7.47	-752		hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
16.2	10-20	Medium	225	7.44	4.82	7.24	7.49	28	7.56	0.00	0.33	1.88	-45		hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
16.3	20-30	Fine	320	7.14	3.87	6.74	7.38	34	7.60	0.00	0.12	1.06	-66		hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
16.4	30-40	Coarse	162	7.41	3.46	7.48	7.46	12	7.38	0.00	0.02	0.30	-27		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
16.5	40-50	Medium	197	7.76	2.04	7.48	6.11	45	7.85	0.00	0.11	0.37	19		hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
16.5DUP	40-50	Coarse	3,830	7.88	1.65	7.39	6.10	43	7.31	0.00	0.09	0.29	18		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
17.1	0-5	Medium	4,120	7.01	3.36	6.81	5.10	39	7.17	0.00	0.19	0.85	5		hyposulfidic ( $\text{S}_{\text{CR}} \geq 0.10\%$ )
17.2	5-10	Medium	5,520	6.90	2.35	6.42	5.20	15	6.81	0.00	0.02	0.26	-22		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
17.3	10-40	Medium	7,220	7.21	1.56	6.66	4.97	40	6.44	0.97	0.04	0.00	26		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
18.W1	110-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
18.1	0-5	Medium	9,150	6.67	1.83	6.47	5.56	22	6.53	0.00	0.05	0.30	-7		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
18.2	5-25	Fine	9,130	6.80	1.77	6.59	5.30	64	6.70	0.00	0.10	..	61		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
19.1	0-5	Fine	80	8.01	7.84	7.19	7.64	46	6.66	0.00	<0.01	0.41	-55		other soil material
19.2	5-15	Fine	71	8.86	8.41	8.03	7.72	9	6.74	0.00	<0.01	0.34	-45		other soil material
19.3	15-40	Fine	80	8.63	8.45	8.11	7.68	9	6.72	0.00	<0.01	0.33	-44		other soil material
20.1	0-5	Medium	53	6.95	3.17	6.57	6.06	18	6.50	0.00	0.01	0.00	9		hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
20.2	5-10	Fine	64	7.32	6.68	6.70	6.62	13	6.24	0.00	<0.01	0.00	0		other soil material
20.3	10-20	Fine	73	7.58	6.84	7.29	6.97	9	6.44	1.49	<0.01	0.00	1		other soil material
20.4	20-50	Fine	77	8.43	8.42	7.23	7.42	3	6.68	0.00	<0.01	0.37	-49		other soil material

**Table 3-5. Summary of hydrochemical field measurements for Wachtels Lagoon (Wetland ID. 12075).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=5)	8.07-9.44	356-1760	9.4-16.8	-102- -18	35-210	89-116
Pit waters (n = 1)	7.08	49441	4.5	-41		513

**Table 3-6. Summary of hydrochemical field measurements for Wachtels Lagoon (Wetland ID. 12075).**

Parameter	units	ANZECC Guidelines	Site 1 (SW)	Site 5 (PW)	Site 6 (SW)	Site 8 (SW)	Site 14 (SW)	Site 18 (SW)
Na	mg l <sup>-1</sup>		276	11100	205	99.6	124	32.9
K	mg l <sup>-1</sup>		4.8	107.0	5.7	5.6	2.7	5.7
Ca	mg l <sup>-1</sup>		26.3	440	22.3	15.3	17	12.6
Mg	mg l <sup>-1</sup>		25.4	664	20.1	12.7	15.7	6.67
Si	mg l <sup>-1</sup>		1.26	6.18	2.63	0.854	0.594	4.04
Br	mg l <sup>-1</sup>		1.0	52.0	0.8	0.5	0.6	0.1
Cl	mg l <sup>-1</sup>		410	17000	330	170	220	52
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.046	0.062	0.041	<0.022	<0.022	0.126
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	0.01	<b>0.061</b>	0.005	0.006	<b>0.013</b>	<b>0.037</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.040</b>	<b>0.155</b>	<b>0.053</b>	<b>0.028</b>	<b>0.035</b>	<b>0.077</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		62	2800	45	30	41	9.7
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.04	0.01	<0.01	<0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>72</b>	<60	<b>140</b>	<b>130</b>	<b>60</b>	<b>140</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.3	<1.2	1.6	0.9	1.2	1.5
Cd	µg l <sup>-1</sup>	0.2	<0.01	<0.12	<0.01	<0.01	<0.01	0.04
Co	µg l <sup>-1</sup>	2.8	0.15	0.14	0.16	0.15	0.26	0.15
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	<0.1	<1.2	0.15	0.1	<0.1	0.2
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	0.81	<5	0.88	1	1.2	2
Fe	µg l <sup>-1</sup>	300	<100	<2500	<100	<100	<100	145
Mn	µg l <sup>-1</sup>	1700	4.8	50	5.9	4.25	3.7	12.19
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	0.7	<4	0.8	1.3	0.9	1.6
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.017	<0.03	0.039	0.12	0.06	0.18
Se	µg l <sup>-1</sup>	11	<0.1	0.15	<0.1	0.06	0.06	0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>18</b>	<9	7.3	<b>17</b>	3	<b>82</b>
DOC	mg l <sup>-1</sup>		9.0	7.4	7.6	8.1	9.0	7.8

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

- <sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.
- <sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).
- <sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.
- <sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).
- <sup>H</sup> Hardness affected (refer to Guidelines).
- <sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 4. MUSSEL COMPLEX (WETLAND ID. 12153)

### 4.1. Location and setting description

Mussel Complex (Wetland ID. 12153) is situated on the eastern side of the River Murray, about 8 kilometres southwest of the town of Barmera. The wetland is rectangular but irregular in shape and is one of many wetlands in the complex. It is about 500 metres in length and about 170 metres at its widest, with a total surface area of 6 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Mussel Complex that were surveyed are wetland IDs. 12156 and 12155.

The wetland is not connected to the river. At the time when the soil survey was conducted in April 2010 the wetland had no surface water. The wetland is managed by the SA Field and Game Association Barmera-Moorook Region with assistance from SA MDB NRM Board (South Australian Murray Darling Basin Natural Resource Management Board) and BLAP (Barmera Land Action Planning Group). Lignum was growing in and along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Five sites were sampled as shown in Figure 4-1.

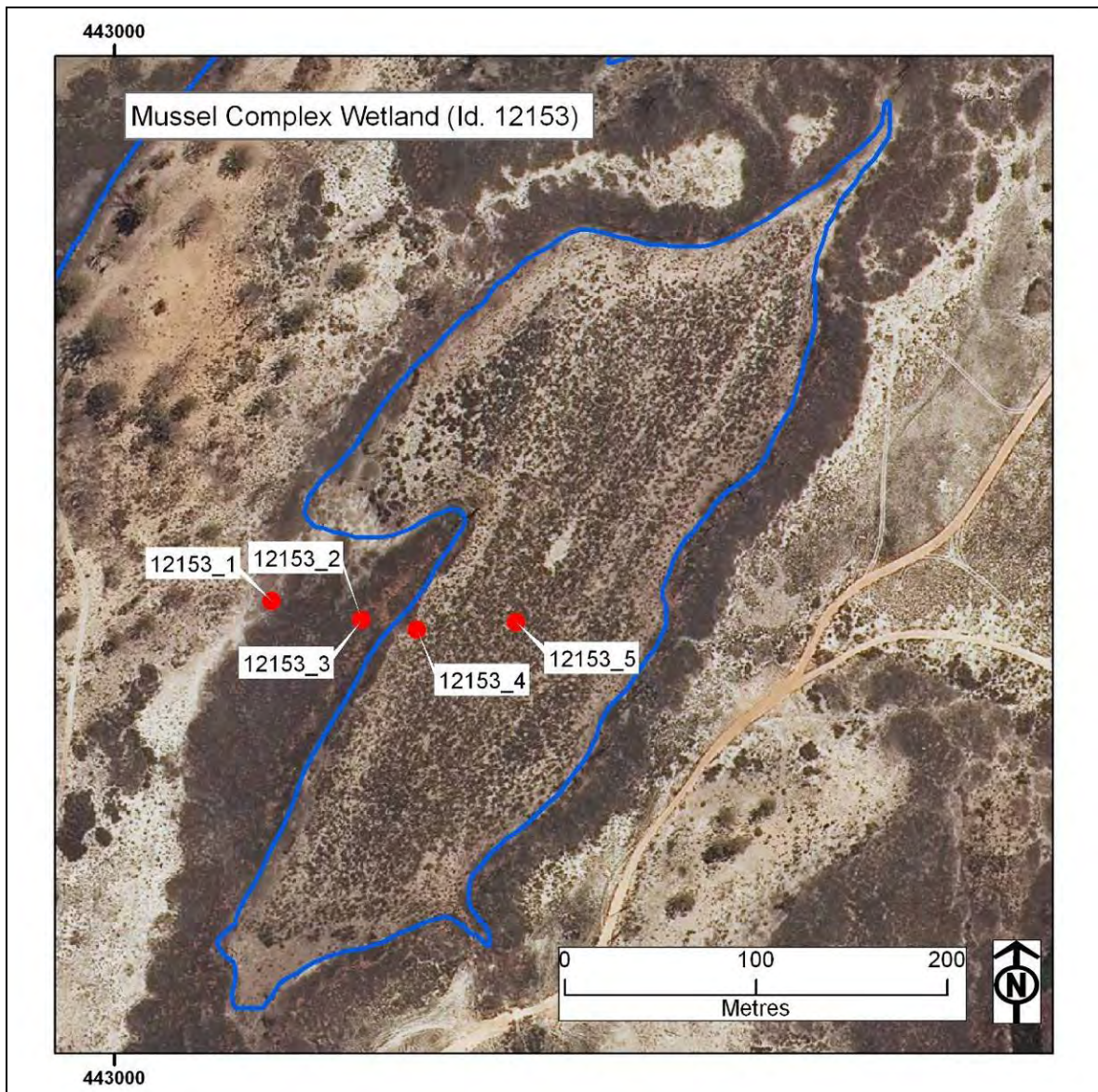


Figure 4-1. Mussel Complex (Wetland ID. 12153) and sample site locations.



## 4.2. Soil profile description and distribution

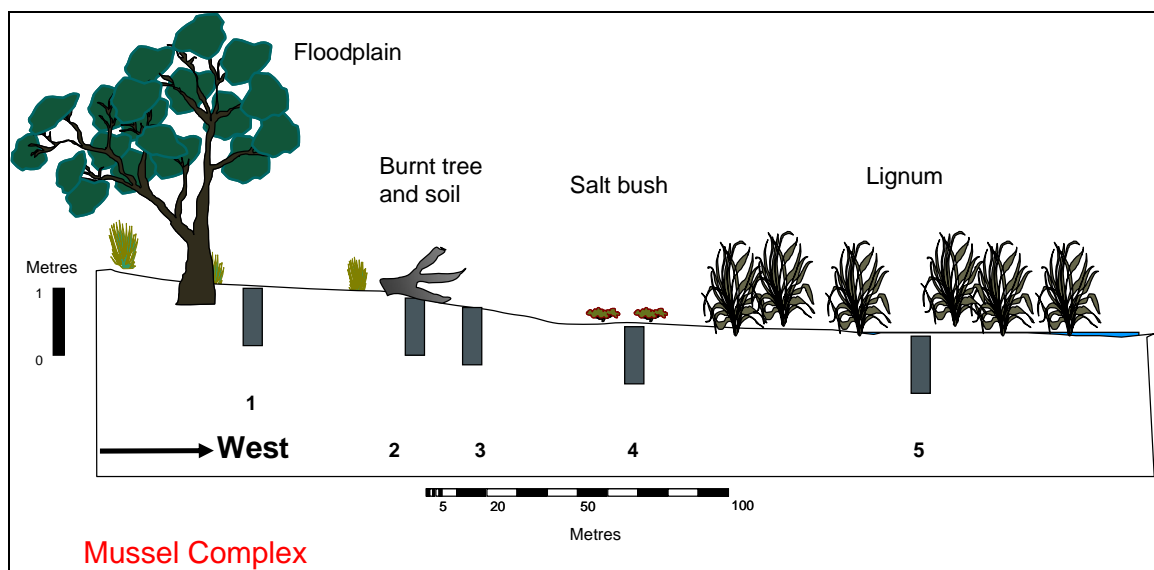
Five sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 4-1. Sites were distributed along one transect placed along the wetland from the margin to the centre (Sites 1, 2, 3, 4 and 5) of the wetland. The site and soil profile descriptions are presented in Table 4-2 and Table 4-3, and a conceptual cross-section diagram in Figure 4-2.

### Centre transect

Site 1 (Figure 4-3) occurred at high elevation above the wetland, and the soil consisted of a light brownish grey, weak, sandy loam, over a greyish brown, firm, sandy clay loam. Site 2 (Figure 4-4) occurred above the wetland, and the soil consisted of a yellowish brown and red, weak, ceramic from the burnt soil, over a dark grey, firm, clay. Site 3 (Figure 4-5) occurred above the lignum, and the soil consisted of a very dark grey, loose, clay, over a dark greyish brown, firm, clay. Site 4 (Figure 4-6) occurred at the edge of the lignum, and the soil consisted of a brown, loose, sand to sandy clay loam, over a dark grey, firm, blocky, clay. Site 5 (Figure 4-7) occurred in the lignum at the centre of the wetland, and the soil consisted of a dark grey, loose, sandy clay loam, over dark grey, very firm, blocky, clay.

**Table 4-1. Soil identification, subtype and general location description for Mussel Complex (Wetland ID. 12153).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12153_1	443082	6206342	Other Soil (loamy)	mid to high elevation, adjacent to sand dune
12153_2	443129	6206332	Other Soil (clayey)	mid elevation, burnt area, adjacent to burnt tree
12153_3	443129	6206332	Other Soil (clayey)	mid elevation, peat area, not burnt
12153_4	443158	6206327	Other Soil (clayey)	low elevation, below step down from raised floodplain/peat area/wetland
12153_5	443210	6206331	Other Soil (clayey)	low elevation, in lignum area



**Figure 4-2. Conceptual cross-section diagram, showing locations for Sites 1 to 5.**



**Figure 4-3. Photographs of Site 1, showing the site location at a high area that has limited vegetation growth, and the soil profile with a sealed surface.**



**Figure 4-4. Photographs of Site 2, showing the site location adjacent to a burnt log, and the soil profile showing the red burnt soil.**



**Figure 4-5. Photographs of Site 3, showing the site location above the lignum that is growing in the middle of the wetland, and the soil profile.**



Figure 4-6. Photographs of Site 4, showing the site location on the edge of the lignum, and the soil profile.

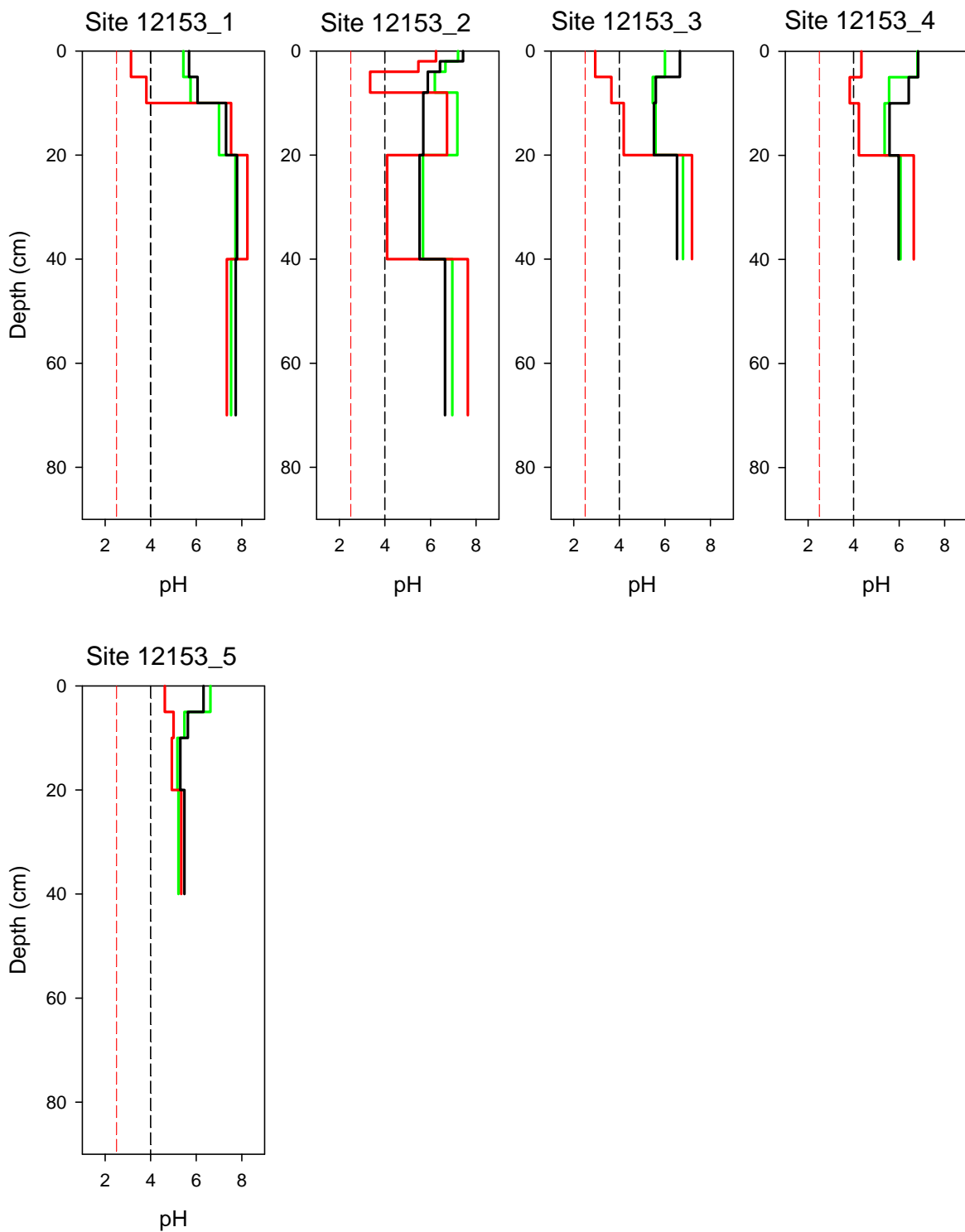


Figure 4-7. Photographs of Site 5, showing the site location amongst the lignum at the centre of the wetland, and the soil profile.

### 4.3. Laboratory data assessment

#### 4.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 4-4 and pH profiles are presented in Figure 4-8. The  $pH_W$  data ranged from 5.17 to 7.72 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 2.94 to 8.24 and identified that no samples were below the critical value of  $pH_{OX} < 2.5$ . The  $pH_{INC}$  data ranged from 5.30 to 7.79 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .



**Figure 4-8. Depth profiles of soil pH for Mussel Complex (Wetland ID. 12153), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).**

### 4.3.2. Acid base accounting

The acid base accounting data is provided in Table 4-4 and summarised in Figure 4-9.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.01 %S<sub>CR</sub> and sulfidic materials were at or below the detection limit for most samples.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 15.40 mole H<sup>+</sup>/tonne and were detected in nearly all samples.

#### Retained acidity

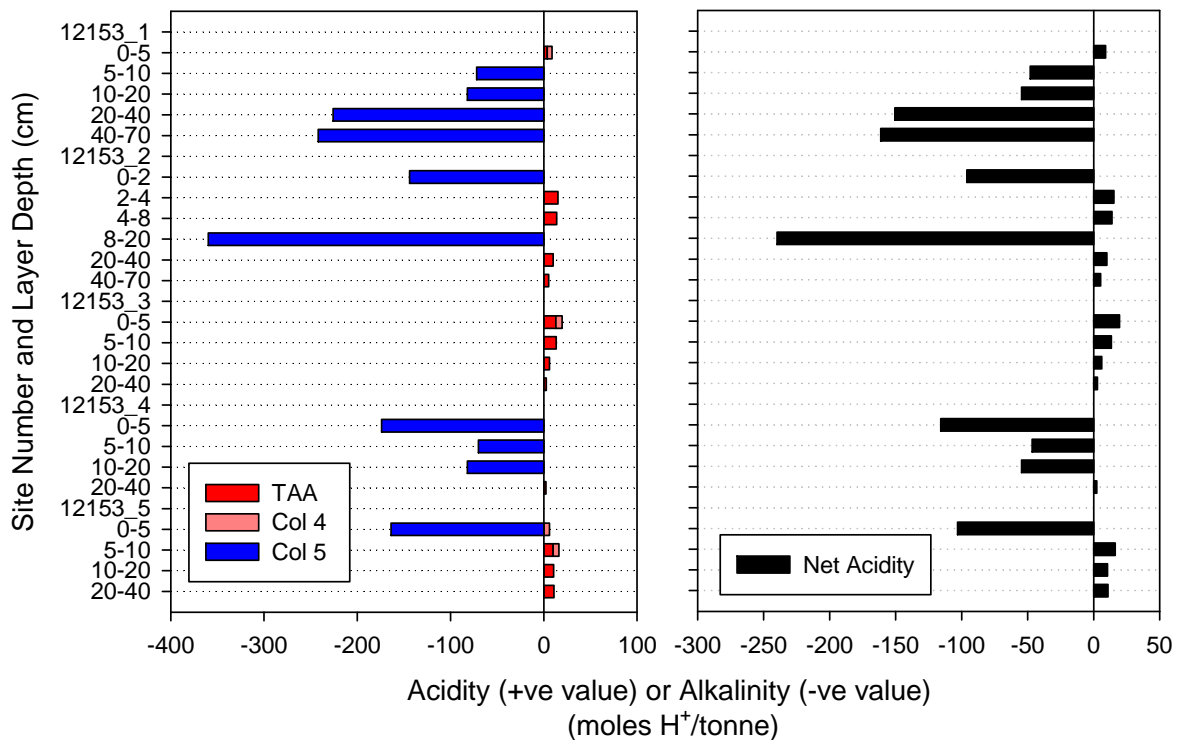
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values ranged from 0 to 1.80 %CaCO<sub>3</sub> and were measured in at least one layer for each profile.

#### Net acidity

Net acidity values ranged from -236 to 20 mole H<sup>+</sup>/tonne. Low net acidity values were recorded for at least one layer in each profile and negative values tended to occur in the surface layers.



**Figure 4-9. Acid base accounting depth profiles for Mussel Complex (Wetland ID. 12153).** Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

### 4.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 4-4 identified all profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 4.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and no samples were collected for analysis.

### 4.3.5. Hydrochemistry

Water was not observed on the surface or in the soil pits, no water samples were collected for this wetland.

## 4.4. Discussion

Acid sulfate soil materials at Mussel Complex (Wetland ID. 12153) were identified as hyposulfidic and occurred in at least some layers for all profiles, other samples were characterised as other acidic or other soil material. The acid sulfate soil subtype classes identified were Other Soil (clayey or loamy) that occurred throughout the wetland.

The soils throughout the wetland were dominantly clayey or loamy textured in the surface layers. The subsoils were clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers for all profiles were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Mussel Complex (Wetland ID. 12153) are:

- Acidification hazard: The data identified low or negative net acidity values in the profiles and pH data did not indicate a potential acidification hazard due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of soils, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Mussel Complex (Wetland ID. 12153):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic in at least some layers for all profiles. Soils were loamy or clayey textured at the surface and clayey textured in the subsoil. Most profile layers had a low or negative net acidity value and pH data did not indicate potential acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"><li>• Other Soil (clayey or loamy) – occurring throughout the wetland and margins above the wetland. Dominant (&gt;50%) in extent.</li></ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"><li>• Acidification hazard – low to medium level of concern</li><li>• De-oxygenation hazard – medium level of concern</li><li>• Metal mobilisation hazard – low level of concern</li></ul>

**Table 4-2. Site description data for Mussel Complex (Wetland ID. 12153).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	12/04/2010	443082	6206342	not reached	sandy, sealed	bare	mid to high elevation, adjacent to sand dune
2	12/04/2010	443129	6206332	not reached	loose	bare	mid elevation, burnt area, adjacent to burnt tree
3	12/04/2010	443129	6206332	not reached	loose	bare	mid elevation, peat area, not burnt
4	12/04/2010	443158	6206327	not reached	crusted, soft, few white salts	salt bush	low elevation, below step down from raised floodplain/peat area/wetland
5	12/04/2010	443210	6206331	not reached	crusted, soft	lignum	low elevation, in lignum area

**Table 4-3. Soil profile description data for Mussel Complex (Wetland ID. 12153).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	light brownish grey (10YR6/2)	sand	dry		subangular blocky	weak	many plant roots
1_2	5 - 10	small pit	grey (10YR6/1)	sandy loam	dry		subangular blocky	weak	many plant roots, faint jarosite?
1_3	10 - 20	small pit	greyish brown (10YR5/2)	sandy loam	moist		massive	firm	faint jarosite?
1_4	20 - 40	small pit	greyish brown (10YR5/2)	sandy clay loam	moist		massive	firm	
1_5	40 - 70	push tube	greyish brown (10YR5/2)	sandy clay loam	moist		massive	very firm	

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
2_0	0 - 0	small pit	dark greyish brown (10YR4/2)	ceramic	dry		massive	very firm	burnt soil flowing, salt flux, separate chip tray for XRD
2_1	0 - 2	small pit	light red (10R6/8)	ceramic	dry		angular blocky	weak	burnt soil, red colour, ceramic, separate chip tray for XRD
2_2	2 - 4	small pit	yellowish brown (10YR5/4)	ceramic	dry		angular blocky	weak	burnt soil, yellow colour, ceramic, separate chip tray for XRD
2_3	4 - 8	small pit	very pale brown (10YR7/3)	ceramic	dry		angular blocky	weak	burnt soil, black colour, ceramic, separate chip tray for XRD
2_4	8 - 20	small pit	pale brown (10YR6/3)	sandy clay loam	dry	20% light red infused into the matrix along faces of peds	massive	firm	
2_5	20 - 40	small pit	grey (10YR5/1)	clay	moist		massive	firm	
2_6	40 - 70	small pit	dark grey (10YR4/1)	clay	moist	20% reddish brown infused into the matrix along faces of peds	massive	firm	
3_1	0 - 5	small pit	very dark grey (10YR3/1)	clay	dry		granular	loose	common plant roots
3_2	5 - 10	small pit	grey (10YR5/1)	clay	moist		subangular blocky	firm	many plant roots
3_3	10 - 20	small pit	dark greyish brown (10YR4/2)	clay	moist		columnar	firm	many plant roots, white salts on column faces
3_4	20 - 40	small pit	dark greyish brown (10YR4/2)	clay	moist		massive	firm	
4_1	0 - 5	small pit	brown (10YR4/3)	sand	dry		single grain	loose	
4_2	5 - 10	small pit	brown (10YR4/3)	sandy clay loam	moist		angular blocky	firm	
4_3	10 - 20	small pit	dark greyish brown (10YR4/2)	clay	moist		massive	firm	
4_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist		massive	firm	too clayey to auger
5_1	0 - 5	small pit	dark grey (10YR4/1)	sandy clay loam	dry		granular	loose	
5_2	5 - 10	small pit	dark greyish brown (10YR4/2)	clay	dry		angular blocky	firm	
5_3	10 - 20	small pit	dark greyish brown (10YR4/2)	clay	moist		angular blocky	very firm	
5_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist	10% reddish brown infused into the matrix adjacent to pores	angular blocky	very firm	



**Table 4-4. Laboratory data for acid sulfate soil assessment of Mussel Complex (Wetland ID. 12153).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	10,760	5.43	3.14	5.34	5.68	1,300	6.40	3.80	<0.01	..	0.00	9	other acidic
1.2	5-10	Medium	5,230	5.75	3.81	5.93	6.06	140	6.79	0.00	<0.01	..	0.36	-48	other soil material
1.3	10-20	Medium	4,150	7.00	7.53	6.93	7.31	82	7.41	0.00	<0.01	..	0.41	-55	other soil material
1.4	20-40	Fine	4,100	7.72	8.24	7.12	7.79	120	8.15	0.00	<0.01	..	1.13	-151	other soil material
1.5	40-70	Fine	4,520	7.53	7.34	7.36	7.73	120	7.81	0.00	<0.01	..	1.21	-161	other soil material
2.0	0-0	..	..	..	..	7.05	7.73	..	..	..	..	..	..	..	salt crust
2.1	0-2	Fine	558	7.21	6.24	7.32	7.43	140	6.58	0.00	<0.01	..	0.72	-96	other soil material
2.2	2-4	Fine	2,750	6.66	5.47	6.69	6.42	260	5.76	15.40	<0.01	..	..	15	other soil material
2.3	4-8	Fine	1,702	6.19	3.35	6.02	5.88	220	5.56	13.90	<0.01	..	..	14	other soil material
2.4	8-20	Fine	3,690	7.18	6.73	6.15	5.68	750	7.06	0.00	<0.01	..	1.80	-240	other soil material
2.5	20-40	Fine	2,920	5.67	4.10	5.80	5.52	250	5.73	10.06	<0.01	..	..	10	other soil material
2.6	40-70	Fine	3,380	6.96	7.64	6.53	6.64	210	6.16	5.27	<0.01	..	..	5	other soil material
3.1	0-5	Medium	3,430	6.00	2.94	6.23	6.66	310	5.92	12.94	0.01	..	..	20	hyposulfidic (S <sub>CR</sub> <0.10%)
3.2	5-10	Fine	4,640	5.47	3.65	5.30	5.60	230	5.58	13.42	<0.01	..	..	13	other acidic
3.3	10-20	Fine	4,400	5.59	4.19	5.42	5.52	260	6.22	6.23	<0.01	..	0.00	6	other soil material
3.4	20-40	Fine	2,049	6.79	7.19	6.55	6.53	94	6.38	2.87	<0.01	..	0.00	3	other soil material
4.1	0-5	Medium	18,710	6.80	4.34	6.43	6.83	2,400	7.59	0.00	<0.01	..	0.87	-116	other soil material
4.2	5-10	Medium	11,360	5.56	3.83	5.82	6.42	1,100	6.87	0.00	<0.01	..	0.35	-47	other soil material
4.3	10-20	Fine	10,570	5.36	4.23	5.04	5.58	310	6.60	0.00	<0.01	..	0.41	-55	other acidic
4.4	20-40	Fine	7,960	6.06	6.64	5.60	5.98	140	6.40	2.40	<0.01	..	0.00	2	other soil material
5.1	0-5	Fine	17,150	6.62	4.62	6.28	6.32	2,000	6.61	0.00	0.01	..	0.82	-103	hyposulfidic (S <sub>CR</sub> <0.10%)
5.2	5-10	Fine	9,180	5.48	5.00	5.34	5.63	570	5.88	10.06	0.01	..	..	16	hyposulfidic (S <sub>CR</sub> <0.10%)
5.3	10-20	Fine	7,890	5.17	4.93	5.07	5.30	260	5.90	10.54	<0.01	..	..	11	other acidic
5.4	20-40	Fine	7,600	5.22	5.34	5.09	5.48	190	5.71	11.02	<0.01	..	..	11	other acidic

## 5. MUSSEL COMPLEX (WETLAND ID. 12155)

### 5.1. Location and setting description

Mussel Complex (Wetland ID. 12155) is situated on the eastern side of the River Murray, about 8 kilometres southwest of the town of Barmera. The wetland is linear in shape and is one of many wetlands in the complex. It is about 600 metres in length and about 50 metres at its widest, with a total surface area of 2 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Mussel Complex that were surveyed are wetland IDs. 12156 and 12153.

The wetland is adjacent to the river and likely connected at times at the eastern end of the wetland. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is managed by the SA Field and Game Association Barmera-Moorook Region with assistance from SA MDB NRM Board (South Australia Murray Darling Basin Natural Resource Management Board) and BLAP (Barmera Land Action Planning Group). Lignum was growing in and along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 5-1.

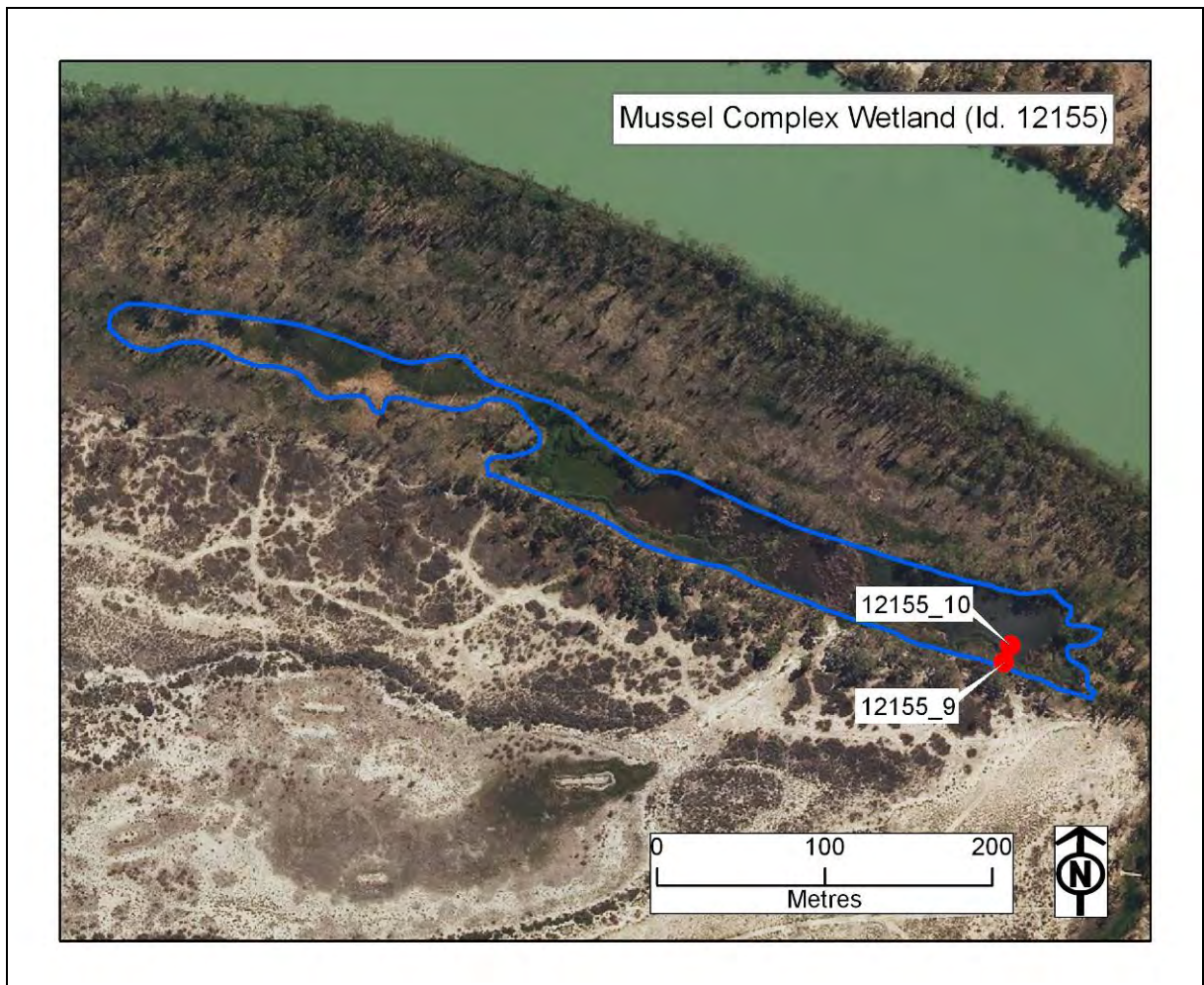


Figure 5-1. Mussel Complex (Wetland ID. 12155) and sample site locations.

## 5.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 5-1. Sites were distributed along one transects at the eastern end (Sites 9 and 10) of the wetland. The site and soil profile descriptions are presented in Table 5-2 and Table 5-3.

Eastern transect

Site 9 (Figure 5-2) occurred adjacent to the bank in water (10 cm deep), and the soil consisted of a black, weak, plant material with a sulfurous odour, over very dark greyish brown, weak to firm with depth, sandy clay loam. Site 10 (Figure 5-3) occurred in open water (30 cm deep), and the soil consisted of a very dark greyish brown, very weak, sandy peat with a sulfurous odour, over a very dark grey, firm, clay.

**Table 5-1. Soil identification, subtype and general location description for Mussel Complex (Wetland ID. 12155).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12155_9	443581	6208175	Subaqueous Soil (loamy)	mid elevation, edge of bank into water
12155_10	443585	6208185	Hypersulfidic Subaqueous Soil (clayey)	low elevation, near middle of creek



**Figure 5-2. Photograph of Site 9, showing the site location adjacent to the bank amongst thick reeds.**



**Figure 5-3. Photograph of Site 10, showing the site location in open water.**

## 5.3. Laboratory data assessment

### 5.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 5-4 and pH profiles are presented in Figure 5-4. The  $pH_W$  data ranged from 4.43 to 5.81 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 1.66 to 3.37 and identified that surface samples in both profiles were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 3.96 to 6.23 and identified one sample from Profile 10 on incubation declined below the critical values of  $pH < 4$ , indicating that these soils potentially would form sulfuric material on oxidation.

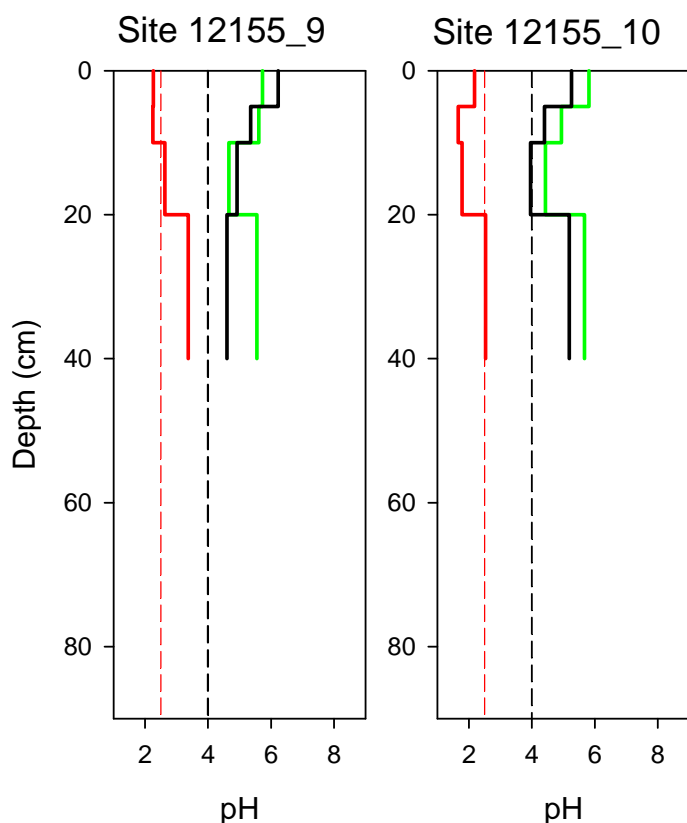


Figure 5-4. Depth profiles of soil pH for Mussel Complex (Wetland ID. 12155), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 5.3.2. Acid base accounting

The acid base accounting data is provided in Table 5-4 and summarised in Figure 5-5.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.15 % $S_{CR}$  and sulfidic materials were detected for most samples.

#### Titrateable actual acidity

Titrateable actual acidity values ranged from 18.21 to 92.76 mole  $H^+$ /tonne and were detected in all samples.

#### Retained acidity

Retained acidity was measured in two layers of Profile 10 with values of 7 and 6 mole H<sup>+</sup>/tonne.

### Acid neutralising capacity

Acid neutralising capacity was not measured in any of the samples as all samples had a pH<sub>KCl</sub> of < 6.5.

### Net acidity

Net acidity values ranged from 18 to 192 mole H<sup>+</sup>/tonne. Moderate to high values were recorded for all layers.

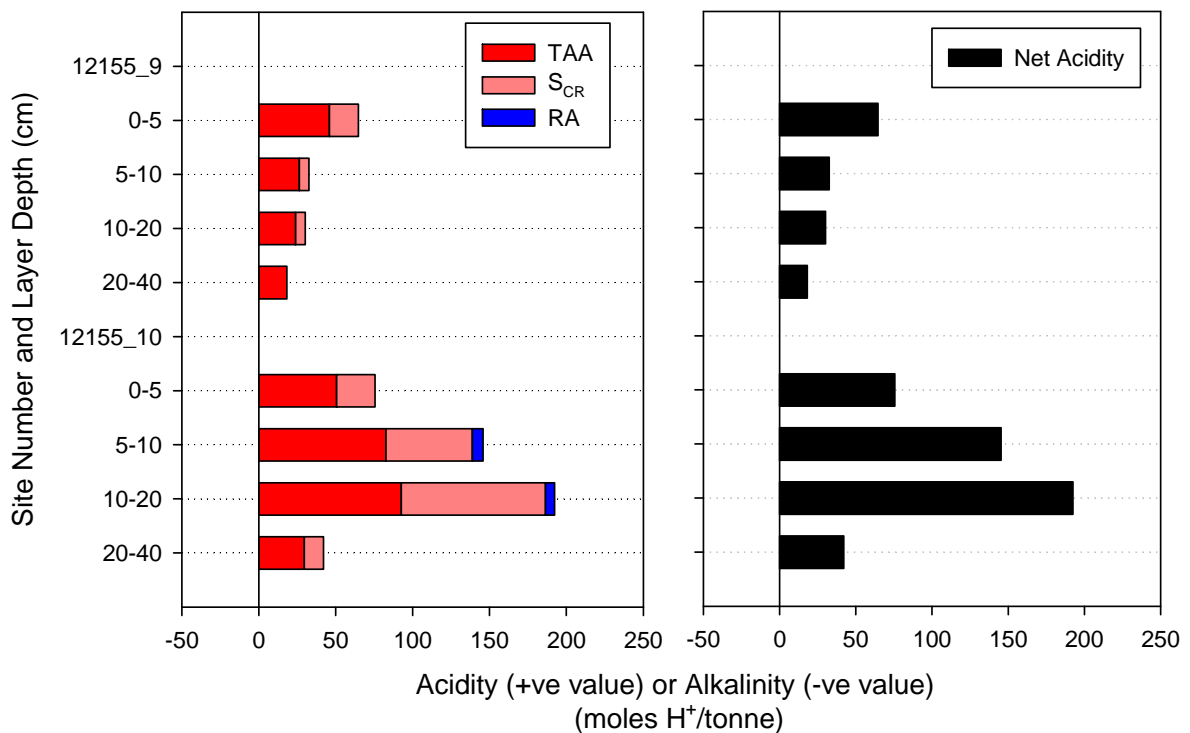


Figure 5-5. Acid base accounting depth profiles for Mussel Complex (Wetland ID. 12155). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and retained acidity (RA - blue bar), and right side shows net acidity.

### 5.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 5-4 identified that surface layers were not above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 5.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and no samples were collected for analysis.

### 5.3.5. Hydrochemistry

A single surface water was collected from this small wetland. Field parameters are shown in Table 5-5. The surface water had a slightly acidic pH and was very fresh. The water was saturated with dissolved oxygen, and turbidity and alkalinity were high.

The surface water was strongly of Na-HCO<sub>3</sub> type (Table 5-6, Figure 5-6). Sulfate concentration in the surface water was 6.7 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface water (0.209) was slightly higher than seawater (0.142). Nitrate was below detection limit, and NH<sub>4</sub> and PO<sub>4</sub> were slightly above ANZECC Guideline values. Iron and Mn were present but moderately low. The concentrations of most metals were low consistent with the neutral pH, but Zn was moderately high.

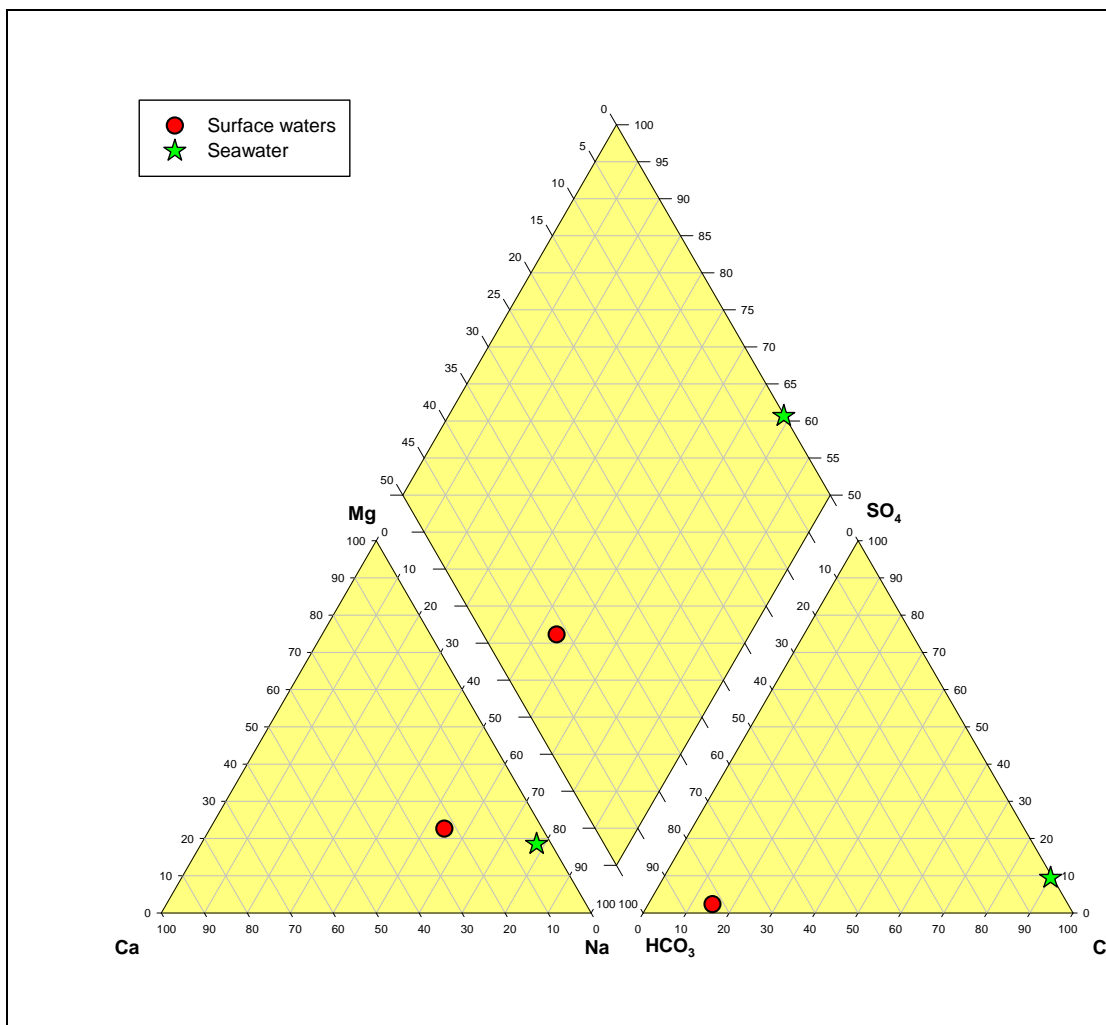


Figure 5-6. Piper diagram of hydrochemical data for Mussel Complex (Wetland ID. 12155).

## 5.4. Discussion

Acid sulfate soil materials at Mussel Complex (Wetland ID. 12155) were identified as hypersulfidic in a layer of Profile 9, and hyposulfidic for most of the other sampled layers. The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (clayey) that occurred throughout the main wetland area and Subaqueous Soil (loamy) occurred on the wetland margins adjacent to the bank.

The soils throughout the wetland were dominantly clayey or loamy textured in the surface layers. The subsoils were clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers for all profiles were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Mussel Complex (Wetland ID. 12155) are:

- Acidification hazard: The data identified moderate and high net acidity values in all samples and pH data identified samples with values that indicated a potential acidification hazard due to oxidation. There is a high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a high level of concern.

### Summary of key findings Mussel Complex (Wetland ID. 12155):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic with one layer characterised as hypersulfidic. Soils were loamy or clayey textured at the surface and clayey textured in the subsoil. All samples for both profiles had a moderate or high net acidity and pH data indicated a potential acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Hypersulfidic Subaqueous Soil (clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Subaqueous Soil (loamy) – occurring on the wetland margins adjacent to the bank. Minor (&lt;25%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – high level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – high level of concern</li> </ul>

**Table 5-2. Site description data for Mussel Complex (Wetland ID. 12155).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
9	12/04/2010	443581	6208175	10	water, plant material	Typha	mid elevation, edge of bank into water
10	12/04/2010	443585	6208185	30	water, soft	water	low elevation, near middle of creek

**Table 5-3. Soil profile description data for Mussel Complex (Wetland ID. 12155).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
9_1	0 - 5	small pit	black (2.5Y2/0)	plant material	wet		massive	weak	weak sulfur odour
9_2	5 - 10	small pit	very dark greyish brown (2.5Y3/2)	sand	wet		massive	weak	
9_3	10 - 20	small pit	very dark greyish brown (2.5Y3/2)	sandy loam	wet		massive	firm	
9_4	20 - 40	small pit	very dark greyish brown (2.5Y3/2)	sandy clay loam	moist	10% yellowish red infused into the matrix adjacent to pores	massive	very firm	
10_W1	30 - 0	surface water							water sampled
10_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	sandy peat	wet		massive	very weak	weak sulfur odour
10_2	5 - 10	small pit	very dark grey (10YR3/1)	sand	wet		massive	weak	
10_3	10 - 20	small pit	very dark grey (10YR3/1)	sand	wet		massive	firm	
10_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist		massive	very firm	too clayey to auger



**Table 5-4. Laboratory data for acid sulfate soil assessment of Mussel Complex (Wetland ID. 12155).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity ( $\text{mole H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%S_{\text{CR}}$ )	Retained Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
9.1	0-5	Medium	87	5.73	2.26	5.97	6.23	32	4.73	46.00	0.03	..	..	65	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
9.2	5-10	Medium	50	5.61	2.25	5.85	5.35	21	4.77	26.35	0.01	..	..	33	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
9.3	10-20	Fine	80	4.66	2.63	5.44	4.92	37	4.60	23.96	0.01	..	..	30	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
9.4	20-40	Fine	253	5.55	3.37	4.77	4.60	68	4.81	18.21	<0.01	..	..	18	other acidic
10.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
10.1	0-5	Fine	44	5.81	2.18	6.20	5.26	43	4.59	50.68	0.04	..	..	76	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
10.2	5-10	Fine	38	4.94	1.66	5.53	4.40	53	4.17	82.72	0.09	7	..	145	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
10.3	10-20	Fine	139	4.43	1.78	4.81	3.96	150	3.96	92.76	0.15	6	..	192	hypersulfidic
10.4	20-40	Fine	171	5.67	2.53	5.36	5.19	70	4.71	29.64	0.02	..	..	42	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )

**Table 5-5. Summary of hydrochemical field measurements for Mussel Complex (Wetland ID. 12155).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=1)	6.50	248	10.5	180	170	302

**Table 5-6. Summary of hydrochemical field measurements for Mussel Complex (Wetland ID. 12155).**

Parameter	units	ANZECC Guidelines	Site 10 (SW)
Na	mg l <sup>-1</sup>		25.1
K	mg l <sup>-1</sup>		4.3
Ca	mg l <sup>-1</sup>		10.1
Mg	mg l <sup>-1</sup>		6.06
Si	mg l <sup>-1</sup>		4.56
Br	mg l <sup>-1</sup>		0.1
Cl	mg l <sup>-1</sup>		32
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	<0.022
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.04</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.033</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		6.7
Ag	µg l <sup>-1</sup>	0.05	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>72</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	0.9
Cd	µg l <sup>-1</sup>	0.2	0.02
Co	µg l <sup>-1</sup>	2.8	0.42
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.2
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>2.2</b>
Fe	µg l <sup>-1</sup>	300	125
Mn	µg l <sup>-1</sup>	1700	28.99
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.9
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.1
Se	µg l <sup>-1</sup>	11	0.12
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>117</b>
DOC	mg l <sup>-1</sup>		8.1

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

- <sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.
- <sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).
- <sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.
- <sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).
- <sup>H</sup> Hardness affected (refer to Guidelines).
- <sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 6. MUSSEL COMPLEX (WETLAND ID. 12156)

### 6.1. Location and setting description

Mussel Complex (Wetland ID. 12156) is situated on the eastern side of the River Murray, about 8 kilometres southwest of the town of Barmera. The wetland is somewhat irregular in shape and is one of many wetlands in the complex. It is about 1.7 kilometres in length and about 1 kilometre at its widest, with a total surface area of 131 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Mussel Complex that were surveyed are wetland IDs. 12153 and 12155.

The wetland is connected to the river by an inlet at the northern end and this is controlled by structures. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland has been managed by the SA Field and Game Association Barmera-Moorook Region with assistance from SA MDB NRM Board (South Australia Murray Darling Basin Natural Resource Management Board) and BLAP (Barmera Land Action Planning Group). The wetland went through many partial dries since the installation of structures. When the wetland was closed in October 2006 it went through its first complete dry. It received water in March 2009, disconnected in September 2009 and reconnected in March 2010. Typha and Phragmites were growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Twelve sites were sampled as shown in Figure 6-1.

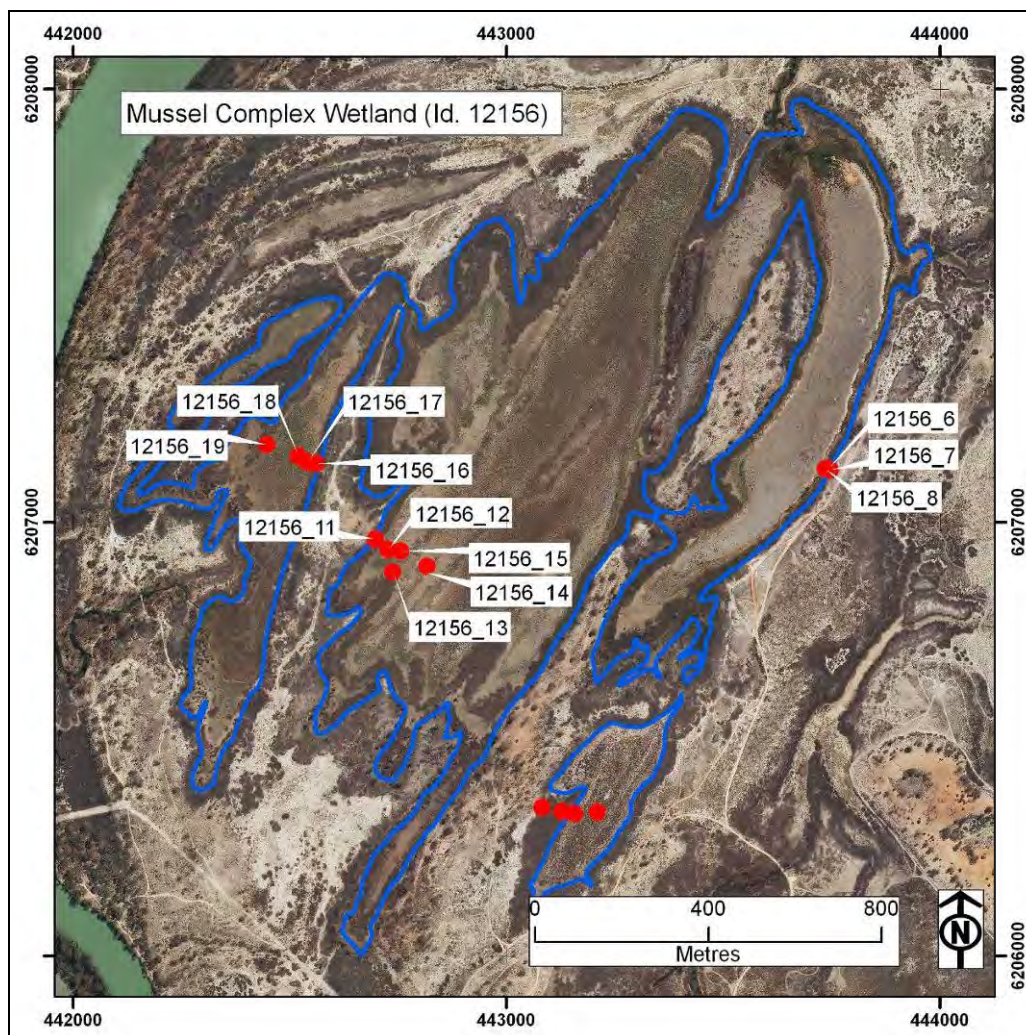


Figure 6-1. Mussel Complex (Wetland ID. 12156) and sample site locations.

## 6.2. Soil profile description and distribution

Twelve sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 6-1. Sites were distributed along three transects placed around the wetland, with transects at the eastern side (Sites 6, 7 and 8), centre (Sites 11, 12, 13, 14 and 15), western side (Sites 16, 17, 18 and 19) of the wetland. The site and soil profile descriptions are presented in Table 6-2 and Table 6-3, and a conceptual cross-section diagram in Figure 6-2.

### Eastern transect

Site 6 (Figure 6-3) occurred at the edge of the water (15 cm deep), and the soil consisted of a very dark greyish brown, weak, sand with sulfurous odour, over a dark greyish brown, very firm, sandy clay loam. Site 7 (Figure 6-4) occurred above the shoreline in reeds, the water table was at about 15 cm depth, and the soil consisted of a black and light brownish grey, weak, plant material and sand, over a greyish brown, very firm, clay loam. Site 8 (Figure 6-5) occurred in water (90 cm deep), and the soil consisted of a very dark greyish brown, very weak, sand with sulfurous odour, over a dark greyish brown, very firm, clay.

### Centre transect

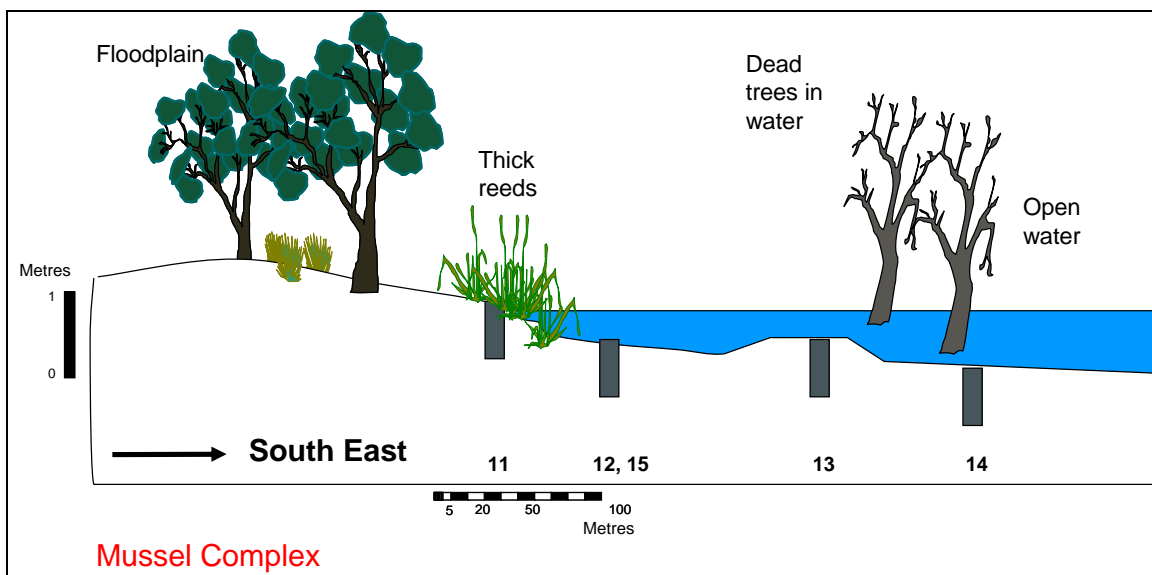
Site 11 (Figure 6-6) occurred at the waters edge in shallow surface water (10 cm deep), and the soil consisted of a black, weak, sandy peat with sulfurous odour, over a very dark grey, very weak, sandy clay loam. Site 12 (Figure 6-7) occurred in water (50 cm deep), and the soil consisted of a dark greyish brown, weak, sandy clay loam, over a very dark grey, very firm, clay. Site 13 (Figure 6-8) occurred on a raised area in water (20 cm deep), and the soil consisted of a very dark greyish brown, firm, clay loam, over a very dark grey, very firm, clay. Site 14 (Figure 6-9) occurred in open water (60 cm deep), and the soil consisted of a dark grey, firm, clay loam, over a very dark grey, very firm, clay. Site 15 (Figure 6-10) occurred in open water (50 cm deep), and the soil was similar to Site 12, the only water sample was collected here and soil samples were not collected.

### Western transect

Site 16 (Figure 6-11) occurred on the wetland margin above the water, the water table was at about 10 cm, and the soil consisted of very dark greyish brown, firm, loamy sand, with many plant roots, over a dark grey, very firm, clay loam. Site 17 (Figure 6-12) occurred in water (35 cm deep), and the soil consisted of a very dark grey, very weak, peaty sandy clay loam, over a dark grey, very firm clay. Site 18 (Figure 6-13) occurred in open water (40 cm deep), and the soil consisted of a very dark greyish brown, very weak, clay loam, over a dark grey, very firm, clay. Site 19 (Figure 6-14) occurred near the opposite shoreline in water (25 cm deep), and the soil consisted of a very dark grey, weak, clay loam, over a dark grey, very firm, clay.

**Table 6-1. Soil identification, subtype and general location description for Mussel Complex (Wetland ID. 12156).**

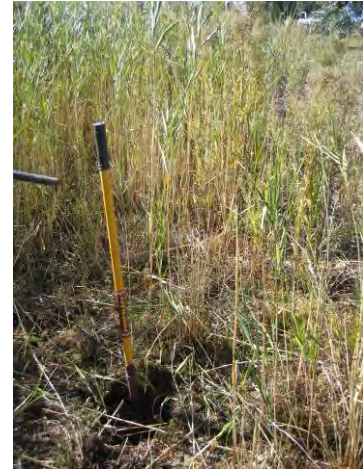
Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12156_6	443210	6206331	Subaqueous Soil (loamy)	low to mid elevation, waters edge
12156_7	443742	6207124	Other Soil (loamy)	high elevation, dry side of wetland, 2 m from waters edge
12156_8	443748	6207121	Subaqueous Soil (clayey)	low elevation, in water
12156_11	443737	6207124	Subaqueous Soil (loamy)	high elevation, in reeds on wetland margin
12156_12	442698	6206961	Subaqueous Soil (clayey)	mid elevation, 30m from reeds in water
12156_13	442727	6206938	Subaqueous Soil (clayey)	raised area in wetland (almost like an island) in water
12156_14	442738	6206885	Subaqueous Soil (clayey)	low elevation, middle of wetland in water
12156_15	442817	6206898	Subaqueous Soil (clayey)	low elevation, water sample only no soil sampled
12156_16	442757	6206934	Other Soil (loamy)	high elevation, in reeds on wetland margin
12156_17	442563	6207135	Subaqueous Soil (clayey)	mid to low elevation, side of wetland in water
12156_18	442541	6207139	Subaqueous Soil (clayey)	low, near wetland centre in water
12156_19	442520	6207153	Subaqueous Soil (clayey)	mid elevation, in water 10m from edge



**Figure 6-2. Conceptual cross-section diagram.**



**Figure 6-3. Photograph of Site 6, showing the site location amongst thick reeds at the waters edge.**



**Figure 6-4. Photograph of Site 7, showing the site location on the wetland margin.**



**Figure 6-5. Photographs of Site 8, showing the site location in open water where there are a few isolated trees and away from the thick reed vegetation.**



**Figure 6-6. Photograph of Site 11, showing the site location amongst thick reeds on the wetland margin.**



**Figure 6-7. Photograph of Site 12, showing the site location in open water.**



**Figure 6-8. Photograph of Site 13, showing the site location on a raised spit area in open water.**



**Figure 6-9. Photograph of Site 14, showing the site location in open water.**



**Figure 6-10. Photograph of Site 15, showing the site location and view along the wetland.**



**Figure 6-11. Photograph of Site 16, showing the site location placed on the wetland margin amongst reeds.**



**Figure 6-12. Photograph of Site 17, showing the site location placed in open water near the reeds.**



Figure 6-13. Photograph of Site 18, showing the site location placed in open water.

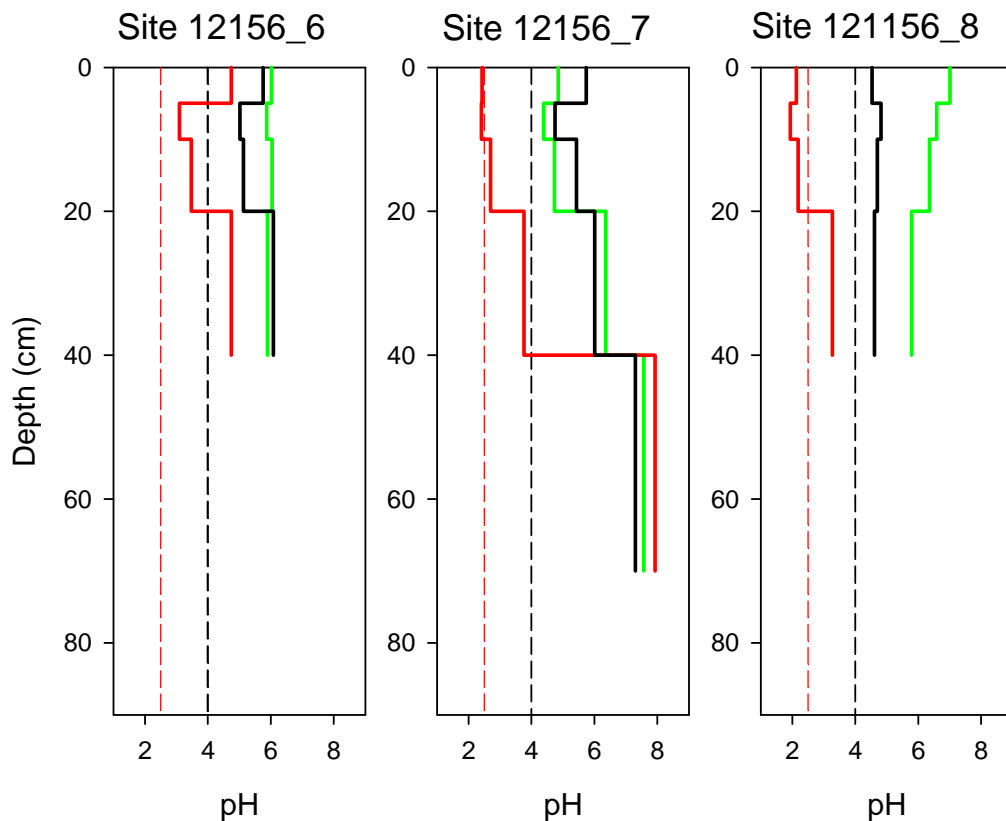


Figure 6-14. Photograph of Site 19, showing the site location near the wetland bank across the wetland from Site 16.

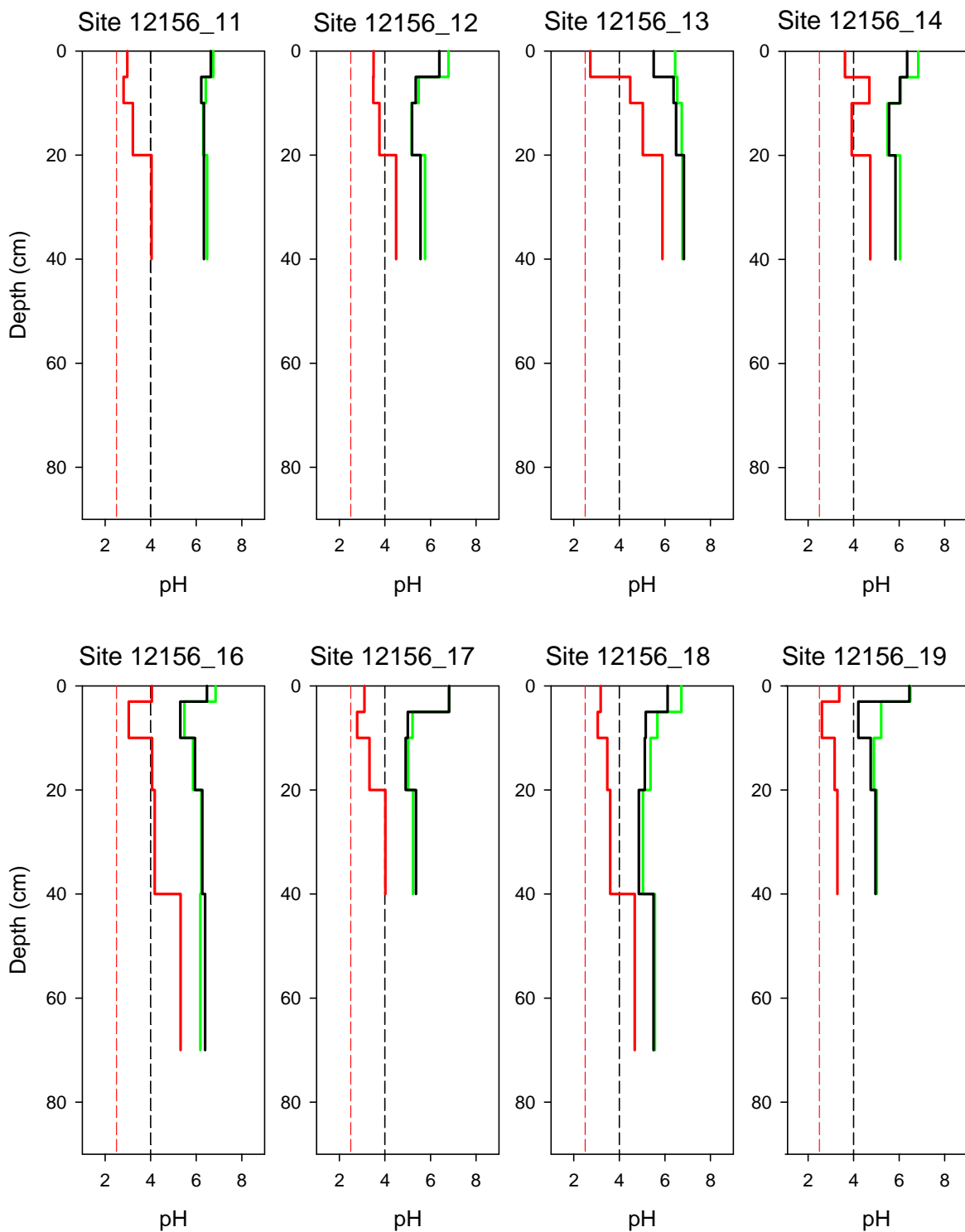
### 6.3. Laboratory data assessment

#### 6.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 6-4 and pH profiles are presented in Figure 6-15. The  $pH_W$  data ranged from 4.39 to 7.57 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 1.94 to 7.93 and identified that surface samples in Profiles 7 and 8 were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 4.21 to 7.30 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .







**Figure 6-15. Depth profiles of soil pH for Mussel Complex (Wetland ID. 12156), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).**

### 6.3.2. Acid base accounting

The acid base accounting data is provided in Table 6-4 and summarised in Figure 6-16.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.11 %S<sub>CR</sub> and sulfidic materials were at or below detection limit for most samples.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 42.17 mole H<sup>+</sup>/tonne and were detected in nearly all samples.

#### Retained acidity

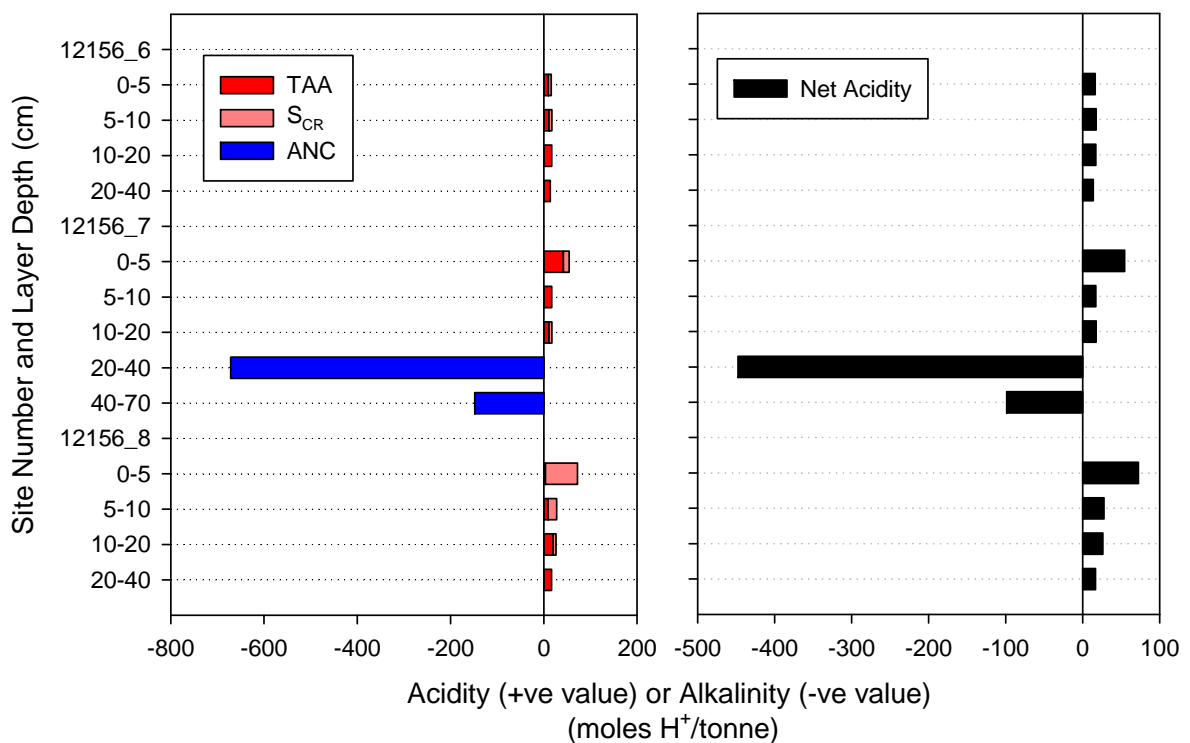
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values ranged from 0 to 3.36 %CaCO<sub>3</sub> and were measured in a few samples of Profiles 7 and 16.

#### Net acidity

Net acidity values ranged from -448 to 72 mole H<sup>+</sup>/tonne. All profile layers were low or moderate values except for negative values that occurred in an upper layer of Profile 16 and the lower layers of Profile 7.



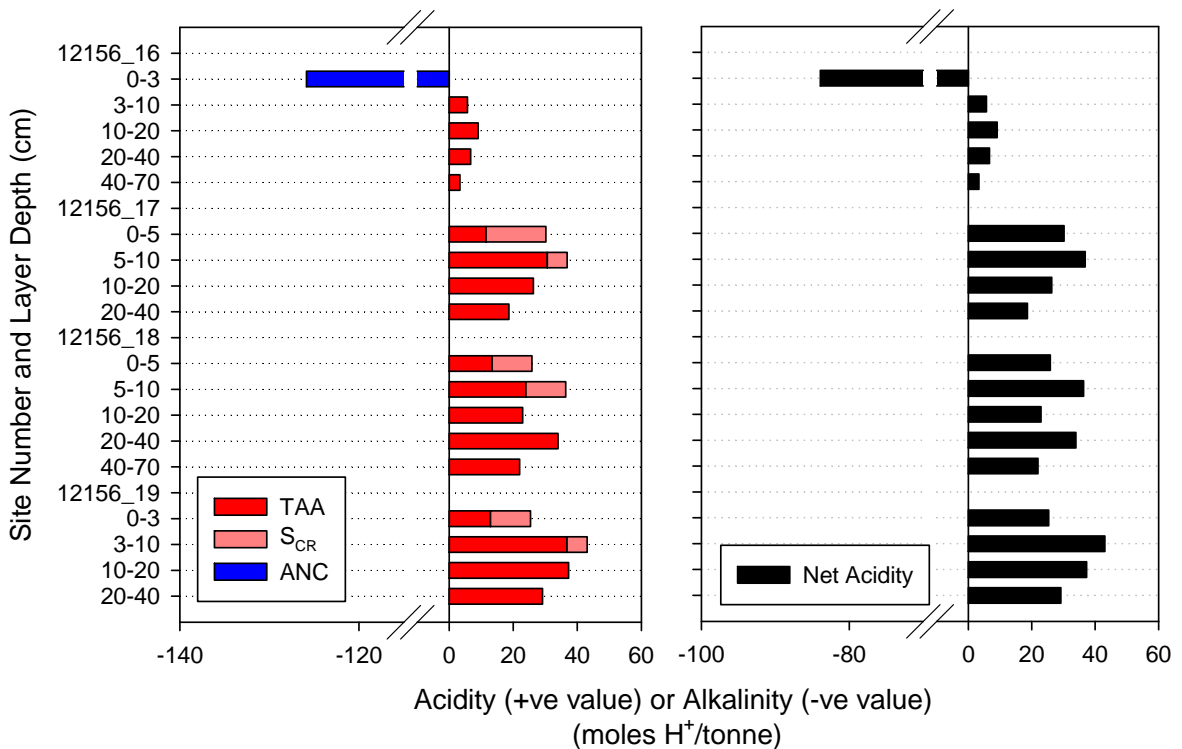
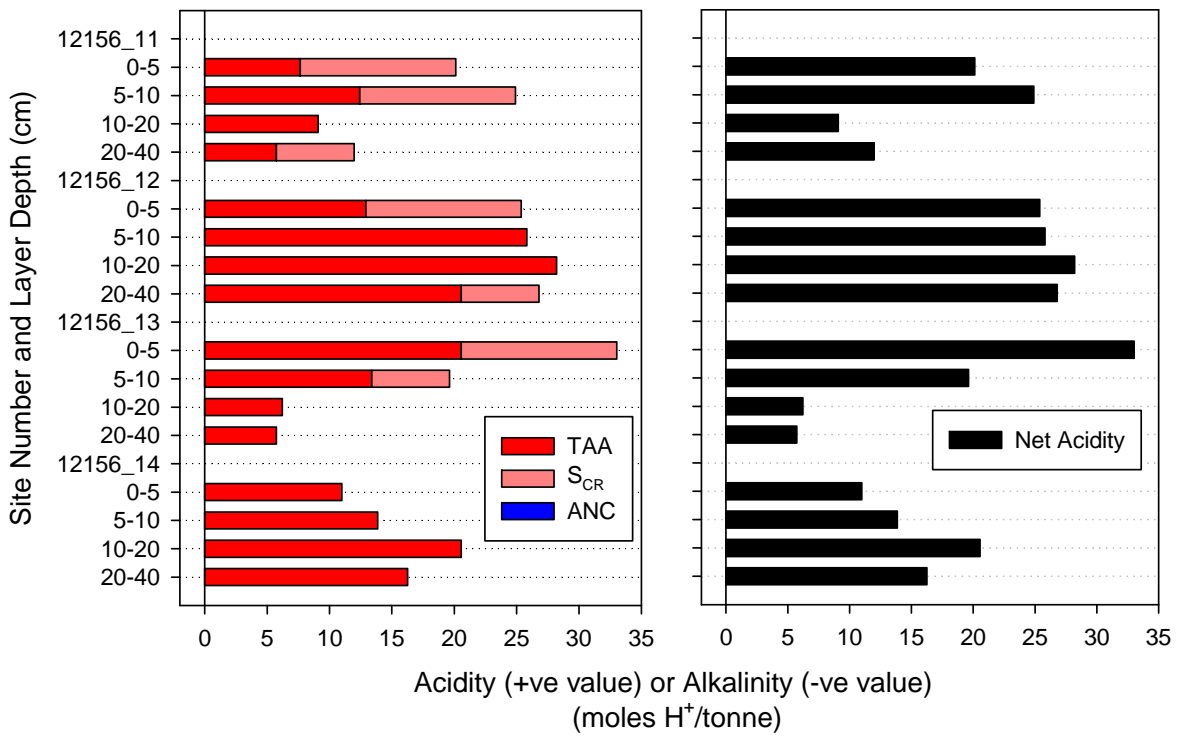


Figure 6-16. Acid base accounting depth profiles for Mussel Complex (Wetland ID. 12156). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

### 6.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 6-4 identified that 7 out of 12 profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 6.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and no samples were collected for analysis.

### 6.3.5. Hydrochemistry

Three surface water samples were collected from this wetland. Field parameters are shown in Table 6-5. The surface waters had circumneutral pH and were moderately fresh. The waters were saturated with dissolved oxygen, turbidity was moderately high and alkalinities were relatively high.

The surface waters were of Na-Cl type, but relatively enriched in HCO<sub>3</sub> compared with seawater composition (Table 6-6, Figure 6-17). Sulfate concentrations in the surface waters varied from 10-66 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters varied significantly from 0.09 to 0.392 compared with the seawater ratio (0.142). Nitrate was below detection limit, and NH<sub>4</sub> and PO<sub>4</sub> were generally above ANZECC Guideline values. Iron was high in one sample. The concentrations of most metals were low (although Zn was elevated in all samples), consistent with the neutral pH.

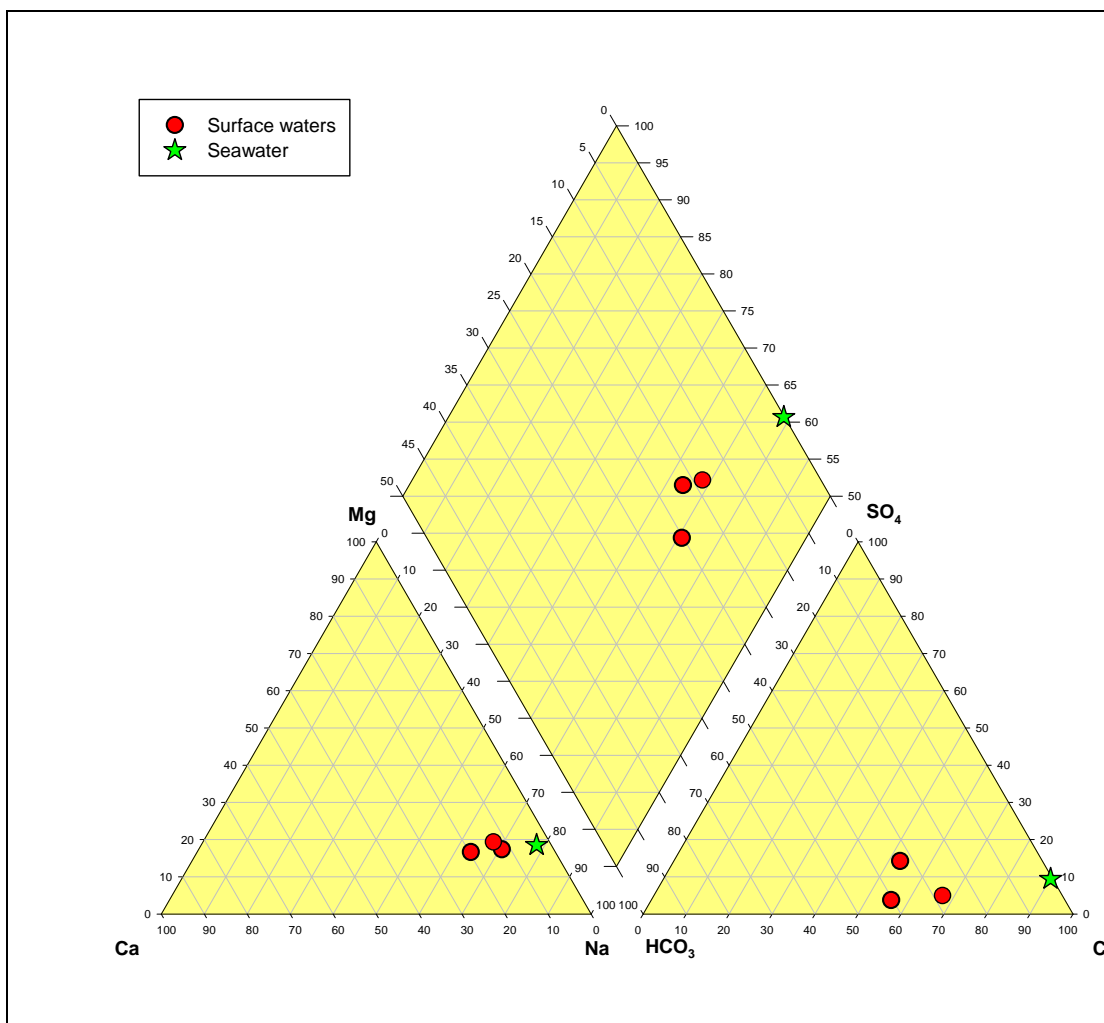


Figure 6-17. Piper diagram of hydrochemical data for Mussel Complex (Wetland ID. 12156).

## 6.4. Discussion

Acid sulfate soil materials at Mussel Complex (Wetland ID. 12156) were identified as hyposulfidic and occurred in at least some layers for most profiles, other samples were characterised as other acidic or other soil material. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey or loamy) that occurred throughout the main wetland area, and Other Soil (loamy) occurred on the wetland margins.

The soils throughout the main wetland area were dominantly loamy textured in the surface layers and in isolated areas on the wetland margins they were sandy textured. The subsoils were generally clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers for seven out of twelve profiles were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Mussel Complex (Wetland ID. 12156) are:

- Acidification hazard: The data identified low or moderate net acidity values in nearly all samples and  $pH_{OX}$  data identified a few samples with values that indicated a potential acidification hazard due to oxidation. There is a medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of soils, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

### Summary of key findings Mussel Complex (Wetland ID. 12156):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic in at least some layers for all profiles. Soils were sandy or loamy textured at the surface and clayey textured in the subsoil. Most profiles had samples with low or moderate net acidity and $pH_{OX}$ data in a few samples indicated potential acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (clayey or loamy) – occurring where there was surface water throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Other Soil (loamy) – occurring on the wetland margins above the water shoreline. Minor (&lt;25%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium level of concern</li> <li>• De-oxygenation hazard – medium level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>

**Table 6-2. Site description data for Mussel Complex (Wetland ID. 12156).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
6	12/04/2010	443742	6207124	15	water, plant material	Phragmites	low to mid elevation, waters edge
7	12/04/2010	443748	6207121	-60	plant material	Phragmites	high elevation, dry side of wetland, 2 m from waters edge
8	12/04/2010	443737	6207124	90	water, soft	water	low elevation
11	13/04/2010	442698	6206961	10	water, plant material	water, Phragmites	high elevation, in reeds on wetland margin
12	13/04/2010	442727	6206938	50	water, soft	water	mid elevation, 30m from reeds
13	13/04/2010	442738	6206885	20	water	water, reeds	raised area in wetland (almost like an island)
14	13/04/2010	442817	6206898	60	water, soft	water	low elevation, middle of wetland
15	13/04/2010	442757	6206934	50	water, soft	water	low elevation, adjacent to ML12, no soil sampled here
16	13/04/2010	442563	6207135	-10	firm	Phragmites	high elevation, in reeds on wetland margin
17	13/04/2010	442541	6207139	35	water, soft	water	mid to low elevation, side of wetland
18	13/04/2010	442520	6207153	40	water, soft	water	low, near wetland centre
19	13/04/2010	442448	6207179	25	water	water	mid elevation, 10m from edge

**Table 6-3. Soil profile description data for Mussel Complex (Wetland ID. 12156).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
6_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	sand	wet		single grain	weak	weak sulfur odour
6_2	5 - 10	small pit	greyish brown (2.5Y5/3)	sandy loam	wet		angular blocky	weak	weak sulfur odour
6_3	10 - 20	small pit	greyish brown (2.5Y5/3)	sandy loam	wet	5% reddish brown infused into the matrix adjacent to pores	angular blocky	firm	
6_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	sandy clay loam	moist	10% reddish brown infused into the matrix adjacent to pores	massive	very firm	
7_1	0 - 5	small pit	black (7.5YR2/0)	plant material	moist		massive	weak	mostly plant root material
7_2	5 - 10	small pit	light brownish grey (10YR6/2)	sand	moist		massive	weak	
7_3	10 - 20	small pit	greyish brown (2.5Y5/3)	sand	moist	10% yellowish red infused into the matrix adjacent to pores	massive	firm	
7_4	20 - 40	small pit	greyish brown (2.5Y5/3)	sandy loam	moist	20% yellowish red infused into the matrix adjacent to pores	massive	firm	
7_5	40 - 70	push tube	greyish brown (2.5Y5/3)	clay loam	wet	15% yellowish red infused into the matrix adjacent to pores	massive	very firm	10% carbonate fragments
8_W1	90 - 0	surface water							water sampled
8_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	sand	wet		massive	very weak	weak sulfur odour
8_2	5 - 10	small pit	dark greyish brown (2.5Y4/2)	sand	wet		massive	weak	weak sulfur odour
8_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay loam	wet		massive	firm	
8_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	clay	wet		massive	very firm	
11_1	0 - 5	small pit	black (2.5Y2/0)	sandy peat	wet		massive	weak	weak sulfurous odour
11_2	5 - 10	small pit	very dark greyish brown (2.5Y3/2)	sand	wet		massive	very weak	
11_3	10 - 20	small pit	very dark greyish brown (2.5Y3/2)	sand	wet		massive	very weak	
11_4	20 - 40	small pit	dark grey (10YR4/1)	sandy clay loam	wet		massive	very weak	too sandy and wet to auger below

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
12_1	0 - 5	small pit	dark greyish brown (10YR4/2)	sandy clay loam	wet		subangular blocky	weak	
12_1DUP	0 - 5	small pit	dark greyish brown (10YR4/2)	sandy clay loam	wet		subangular blocky	weak	
12_2	5 - 10	small pit	dark grey (10YR4/1)	peaty clay	wet	5% yellowish red In the matrix	subangular blocky	weak	
12_3	10 - 20	small pit	very dark grey (10YR3/1)	clay	wet	15% yellowish red In the matrix	massive	firm	
12_4	20 - 40	small pit	very dark grey (10YR3/1)	clay	moist		massive	very firm	
13_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	clay loam	wet		subangular blocky	firm	
13_2	5 - 10	small pit	very dark grey (10YR3/1)	clay loam	wet		subangular blocky	firm	
13_3	10 - 20	small pit	very dark grey (10YR3/1)	clay	wet	5% red infused into the matrix adjacent to pores	subangular blocky	firm	
13_4	20 - 40	small pit	very dark grey (10YR3/1)	clay	moist	5% red infused into the matrix adjacent to pores	massive	very firm	
14_1	0 - 5	small pit	dark grey (5Y4/1)	clay loam	wet		subangular blocky	firm	
14_2	5 - 10	small pit	very dark grey (10YR3/1)	clay loam	wet	5% yellowish red infused into the matrix adjacent to pores	subangular blocky	firm	very sticky
14_3	10 - 20	small pit	very dark grey (10YR3/1)	clay	wet	5% yellowish red infused into the matrix adjacent to pores	massive	firm	very sticky
14_4	20 - 40	small pit	very dark grey (10YR3/1)	clay	moist	15% reddish brown infused into the matrix adjacent to pores	massive	very firm	
15_W1	60 - 0	surface water							water sampled, only measurement at this site
16_1	0 - 3	small pit	very dark grey (10YR3/1)	sand	wet		massive	firm	many plant roots
16_2	3 - 10	small pit	very dark greyish brown (10YR3/2)	loamy sand	wet		massive	firm	few plant roots
16_3	10 - 20	small pit	dark grey (10YR4/1)	sandy clay loam	wet	5% yellowish brown infused into the matrix adjacent to pores	massive	firm	
16_4	20 - 40	push tube	dark grey (10YR4/1)	clay loam	moist	10% yellowish brown infused into the matrix adjacent to pores	massive	very firm	
16_5	40 - 70	push tube	dark grey (10YR4/1)	clay loam	moist	10% yellowish brown infused into the matrix adjacent to pores	massive	very firm	



Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
17_1	0 - 5	small pit	very dark grey (2.5Y3/0)	peaty sandy clay loam	wet		granular	very weak	
17_2	5 - 10	small pit	very dark grey (2.5Y3/0)	clay	wet	10% reddish brown infused into the matrix along faces of peds	angular blocky	very firm	
17_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet	5% yellowish brown infused into the matrix adjacent to pores	massive	firm	
17_4	20 - 40	push tube	dark grey (5Y4/1)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	massive	very firm	
18_W1	40 - 0	surface water							water sampled
18_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	clay loam	wet		granular	very weak	
18_2	5 - 10	small pit	dark grey (10YR4/1)	clay	wet		angular blocky	very firm	
18_3	10 - 20	small pit	dark grey (10YR4/1)	clay	wet	5% yellowish brown infused into the matrix adjacent to pores	subangular blocky	firm	
18_4	20 - 40	push tube	dark grey (10YR4/1)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	massive	very firm	
18_5	40 - 70	push tube	dark grey (10YR4/1)	clay	moist	3% yellowish brown infused into the matrix adjacent to pores	massive	very firm	
19_1	0 - 3	small pit	very dark grey (10YR3/1)	clay loam	wet		granular	weak	
19_2	3 - 10	small pit	very dark grey (10YR3/1)	clay	wet		angular blocky	weak	
19_3	10 - 20	small pit	very dark grey (10YR3/1)	clay	wet	10% strong brown infused into the matrix adjacent to pores	massive	firm	
19_4	20 - 40	push tube	very dark grey (10YR3/1)	clay	moist	5% strong brown infused into the matrix adjacent to pores	massive	very firm	

**Table 6-4. Laboratory data for acid sulfate soil assessment of Mussel Complex (Wetland ID. 12156).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
6.1	0-5	Medium	110	6.02	4.74	6.32	5.76	10	5.68	10.06	0.01	..	..	16	hyposulfidic (S <sub>CR</sub> <0.10%)
6.2	5-10	Fine	133	5.87	3.10	5.40	5.02	17	5.03	11.50	0.01	..	..	18	hyposulfidic (S <sub>CR</sub> <0.10%)
6.3	10-20	Fine	109	6.04	3.47	5.61	5.13	21	4.87	17.25	<0.01	..	..	17	other soil material
6.4	20-40	Fine	364	5.89	4.74	5.85	6.08	48	5.13	13.90	<0.01	..	..	14	other soil material
7.1	0-5	Medium	1,045	4.85	2.43	5.02	5.74	420	4.70	42.17	0.02	..	..	55	hyposulfidic (S <sub>CR</sub> <0.10%)
7.2	5-10	Medium	502	4.39	2.41	4.20	4.75	71	4.80	17.25	<0.01	..	..	17	other acidic
7.3	10-20	Fine	551	4.73	2.70	4.59	5.43	84	4.67	11.50	0.01	..	..	18	hyposulfidic (S <sub>CR</sub> <0.10%)
7.4	20-40	Fine	342	6.36	3.76	5.58	6.01	40	8.47	0.00	<0.01	..	3.36	-448	other soil material
7.5	40-70	Fine	318	7.57	7.93	6.59	7.30	26	7.80	0.00	<0.01	..	0.74	-99	other soil material
8.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
8.1	0-5	Coarse	153	7.01	2.13	6.44	4.53	28	6.10	3.83	0.11	..	0.00	72	hyposulfidic (S <sub>CR</sub> ≥0.10%)
8.2	5-10	Medium	89	6.59	1.94	6.05	4.82	17	5.34	9.10	0.03	..	..	28	hyposulfidic (S <sub>CR</sub> <0.10%)
8.3	10-20	Medium	91	6.36	2.19	5.73	4.70	9	4.85	20.12	0.01	..	..	26	hyposulfidic (S <sub>CR</sub> <0.10%)
8.4	20-40	Fine	109	5.79	3.27	5.40	4.61	19	4.72	16.77	<0.01	..	..	17	other acidic incubation
11.1	0-5	Coarse	177	6.75	2.97	6.88	6.64	11	5.93	7.65	0.02	..	..	20	hyposulfidic (S <sub>CR</sub> <0.10%)
11.2	5-10	Medium	117	6.42	2.81	6.13	6.22	8	5.30	12.43	0.02	..	..	25	hyposulfidic (S <sub>CR</sub> <0.10%)
11.3	10-20	Medium	131	6.31	3.22	6.04	6.34	6	5.36	9.08	<0.01	..	..	9	other soil material
11.4	20-40	Medium	158	6.48	4.04	6.08	6.34	15	5.69	5.74	0.01	..	..	12	hyposulfidic (S <sub>CR</sub> <0.10%)
12.1	0-5	Fine	199	6.79	3.50	6.80	6.39	51	5.77	12.91	0.02	..	..	25	hyposulfidic (S <sub>CR</sub> <0.10%)
12.2	5-10	Fine	446	5.48	3.49	5.40	5.35	130	4.76	25.82	<0.01	..	..	26	other acidic
12.3	10-20	Fine	672	5.17	3.76	5.08	5.19	150	4.68	28.21	<0.01	..	..	28	other acidic
12.4	20-40	Fine	615	5.76	4.49	5.23	5.56	110	4.88	20.56	0.01	..	..	27	hyposulfidic (S <sub>CR</sub> <0.10%)
13.1	0-5	Medium	195	6.45	2.73	6.46	5.51	30	5.20	20.56	0.02	..	..	33	hyposulfidic (S <sub>CR</sub> <0.10%)
13.2	5-10	Fine	248	6.54	4.48	6.27	6.38	32	5.54	13.39	0.01	..	..	20	hyposulfidic (S <sub>CR</sub> <0.10%)
13.3	10-20	Fine	347	6.74	5.03	6.33	6.49	42	5.92	6.22	<0.01	..	..	6	other soil material
13.4	20-40	Fine	536	6.77	5.89	6.51	6.83	89	6.03	5.74	<0.01	..	0.00	6	other soil material
14.1	0-5	Medium	160	6.84	3.62	6.49	6.35	28	5.87	11.00	<0.01	..	..	11	other soil material
14.2	5-10	Fine	416	6.07	4.69	5.83	6.03	77	5.33	13.87	<0.01	..	..	14	other soil material
14.3	10-20	Fine	633	5.49	3.92	5.34	5.56	110	5.01	20.56	<0.01	..	..	21	other acidic
14.4	20-40	Fine	417	6.04	4.73	5.60	5.84	81	5.19	16.26	<0.01	..	..	16	other soil material
15.W1	60-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity ( $\text{mole H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%S_{\text{CR}}$ )	Retained Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
16.1	0-3	Medium	4,360	6.85	4.05	5.92	6.47	440	7.13	0.00	<0.01	..	0.63	-84	other soil material
16.2	3-10	Medium	1,261	5.48	3.04	5.16	5.30	120	5.81	5.74	<0.01	..	..	6	other acidic
16.3	10-20	Fine	1,423	5.86	4.06	5.64	5.95	140	5.77	9.08	<0.01	..	..	9	other soil material
16.4	20-40	Fine	1,680	6.23	4.18	5.90	6.27	190	5.84	6.69	<0.01	..	..	7	other soil material
16.5	40-70	Fine	2,390	6.18	5.31	5.84	6.39	470	6.15	3.35	<0.01	..	..	3	other soil material
17.1	0-5	Medium	415	6.81	3.10	6.68	6.82	80	5.99	11.48	0.03	..	..	30	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
17.2	5-10	Fine	797	5.21	2.78	5.12	5.00	150	4.79	30.60	0.01	..	..	37	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
17.3	10-20	Fine	799	5.02	3.32	4.62	4.91	130	4.64	26.30	<0.01	..	..	26	other acidic
17.4	20-40	Fine	1,062	5.23	4.02	5.03	5.36	180	5.02	18.65	<0.01	..	..	19	other acidic
18.W1	40-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
18.1	0-5	Fine	239	6.72	3.18	6.78	6.12	55	5.85	13.39	0.02	..	..	26	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
18.2	5-10	Fine	522	5.67	3.05	5.40	5.16	150	4.72	23.91	0.02	..	..	36	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
18.3	10-20	Fine	1,154	5.37	3.47	4.92	5.12	230	4.85	22.95	<0.01	..	..	23	other acidic
18.4	20-40	Fine	1,119	5.04	3.60	4.64	4.86	160	4.75	33.95	<0.01	..	..	34	other acidic
18.5	40-70	Fine	1,426	5.56	4.68	5.25	5.50	150	5.12	21.99	<0.01	..	..	22	other acidic
19.1	0-3	Fine	678	6.49	3.37	6.29	6.45	330	6.23	12.91	0.02	..	0.00	25	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
19.2	3-10	Fine	1,260	5.21	2.61	5.04	4.21	180	5.01	36.82	0.01	..	..	43	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
19.3	10-20	Fine	1,565	4.89	3.17	4.67	4.75	270	4.92	37.29	<0.01	..	..	37	other acidic
19.4	20-40	Fine	1,124	5.02	3.29	4.75	4.96	200	5.10	29.17	<0.01	..	..	29	other acidic

**Table 6-5. Summary of hydrochemical field measurements for Mussel Complex (Wetland ID. 12156).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=3)	7.22-7.27	607-1057	11.0-13.2	-134 - 11	40-53	100-194

**Table 6-6. Summary of hydrochemical field measurements for Mussel Complex (Wetland ID. 12156).**

Parameter	units	ANZECC Guidelines	Site 8 (SW)	Site 15 (SW)	Site 18 (SW)
Na	mg l <sup>-1</sup>		91.4	87.8	131
K	mg l <sup>-1</sup>		7.4	4.6	11.2
Ca	mg l <sup>-1</sup>		22	13.5	37
Mg	mg l <sup>-1</sup>		14.5	11.8	19
Si	mg l <sup>-1</sup>		1.7	9.76	9.79
Br	mg l <sup>-1</sup>		0.5	0.4	0.7
Cl	mg l <sup>-1</sup>		130	110	180
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	<0.022	<0.022	<0.022
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	0.01	<b>0.034</b>	<b>0.153</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.026</b>	<b>1.113</b>	<b>0.981</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		51	10	66
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	20	34	<2
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.8	10.5	12.3
Cd	µg l <sup>-1</sup>	0.2	<0.01	0.01	0.04
Co	µg l <sup>-1</sup>	2.8	0.65	1.56	<b>6.15</b>
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	<0.1	0.2	0.2
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	0.8	<b>1.8</b>	3
Fe	µg l <sup>-1</sup>	300	<100	<100	<b>1320</b>
Mn	µg l <sup>-1</sup>	1700	260	16.32	900
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	3.5	5.0	10.0
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.1	0.1	0.3
Se	µg l <sup>-1</sup>	11	0.18	0.24	0.3
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>27.5</b>	<b>47</b>	<b>93</b>
DOC	mg l <sup>-1</sup>		19.8	26.0	44.0

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 7. KATARAPKO FLOODPLAIN (WETLAND ID. 12471)

### 7.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12471) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri located in the Eckert Creek and the Splash area. The wetland is a segment in shape. It is about 500 metres in length and about 100 metres at its widest, with a total surface area of 3 hectares. The wetland is bounded to the east by a raised floodplain that separates it from other wetlands and the river and to the west by a steep hill slope that separates it from farmland. The other associated wetlands in the Katarapko Floodplain Complex that were surveyed are wetland IDs. 12488, 12474, 12485, 12486, 12514 and 12526.

The wetland is not connected to the river but may have an occasional connection with an adjacent wetland ID. 12474. At the time when the soil survey was conducted on 16<sup>th</sup> April 2010 the wetland had no surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing throughout the wetland, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 7-1.

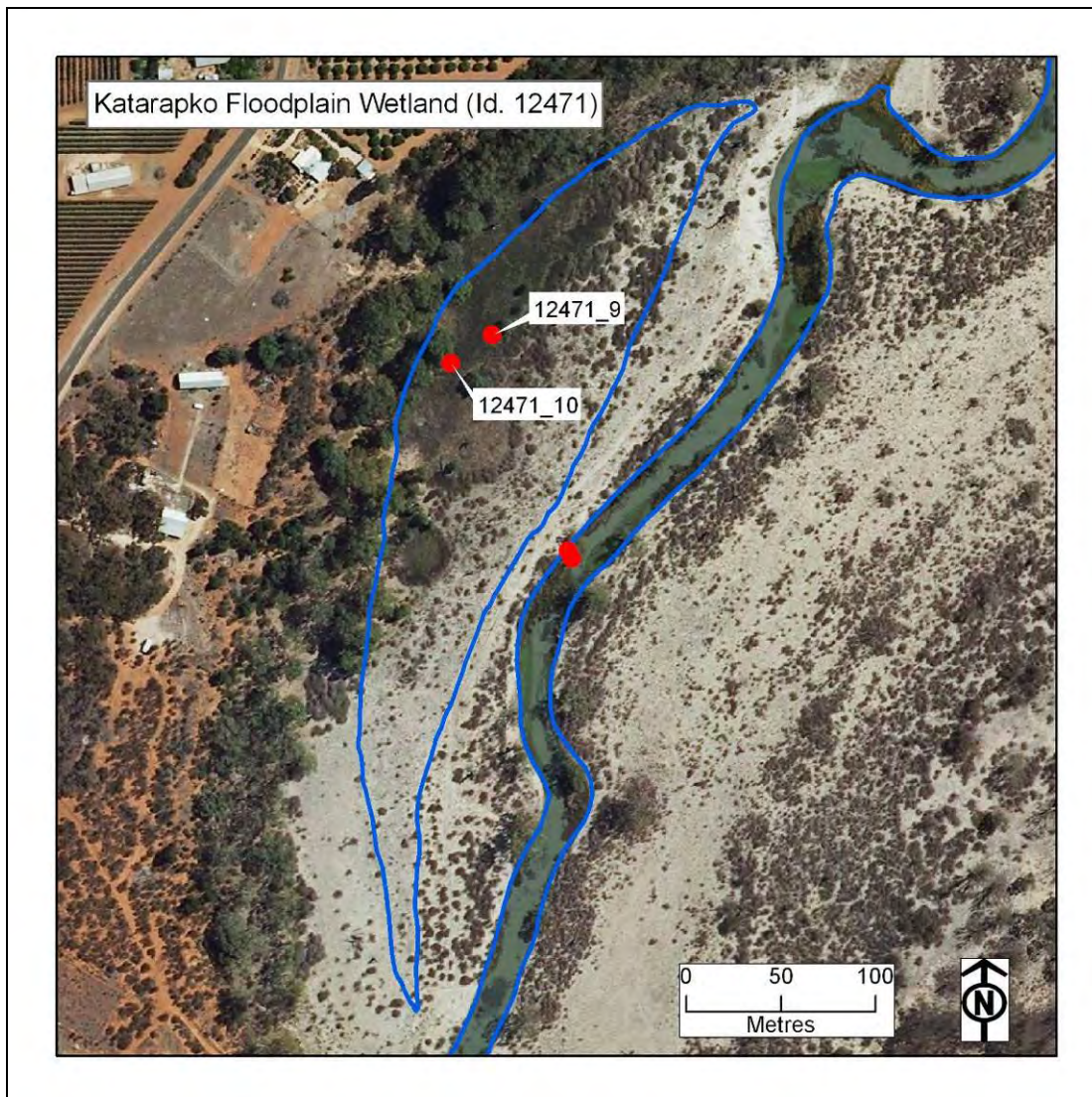


Figure 7-1. Katarapko Floodplain (Wetland ID. 12471) and sample site locations.

## 7.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 7-1. Sites were placed near the centre of the wetland where thick reeds were growing (Sites 9 and 10). The site and soil profile descriptions are presented in Table 7-2 and Table 7-3. A conceptual cross-section diagram is not presented as there was insufficient information from the two profiles and their location to generate a diagram.

Centre transect

Site 9 (Figure 7-2) occurred in the centre of the wetland amongst thick reeds, and the soil consisted of a yellowish brown, loose, fibrous plant material, over a dark greyish brown, very firm, clay. Site 10 (Figure 7-3) occurred in the centre of the wetland amongst thick reeds, and the soil consisted of a dark grey, loose, plant material, over a grey, very firm, clay.

**Table 7-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12471).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12471_9	456513	6200722	Other Soil (clayey)	low elevation, middle of wetland, amongst thick reeds
12471_10	456491	6200707	Other Soil (clayey)	low elevation, middle of wetland, amongst thick reeds



**Figure 7-2. Photographs of Site 9, showing the site location in the wetland amongst thick Phragmites growing.**



**Figure 7-3. Photograph of Site 10, showing the soil profile with a thick layer of plant material on the soil surface.**

### 7.3. Laboratory data assessment

#### 7.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 7-4 and pH profiles are presented in Figure 7-4. The  $pH_W$  data ranged from 5.01 to 7.54 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 2.71 to 5.80 and identified that samples were not below the critical value of  $pH_{OX} < 2.5$ . The  $pH_{INC}$  data ranged from 4.71 to 7.58 and identified that samples did not on incubation declined below the critical values of  $pH < 4$ , indicating that these soils potentially would form sulfuric material on oxidation.

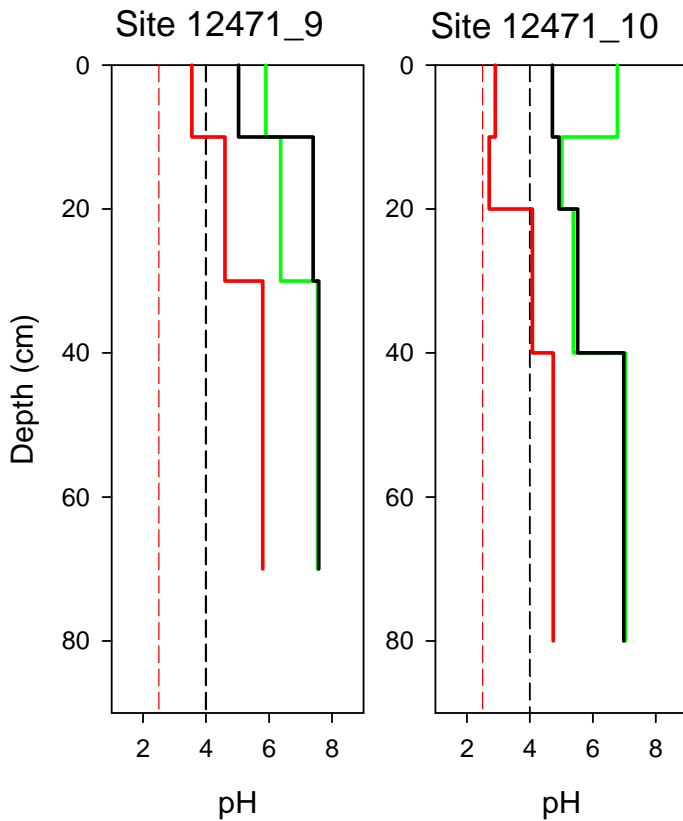


Figure 7-4. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12471), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 7.3.2. Acid base accounting

The acid base accounting data is provided in Table 7-4 and summarised in Figure 7-5.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.03 %S<sub>CR</sub> and sulfidic materials were detected in both profiles.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 58.84 mole H<sup>+</sup>/tonne and were detected in both profiles.

#### Retained acidity

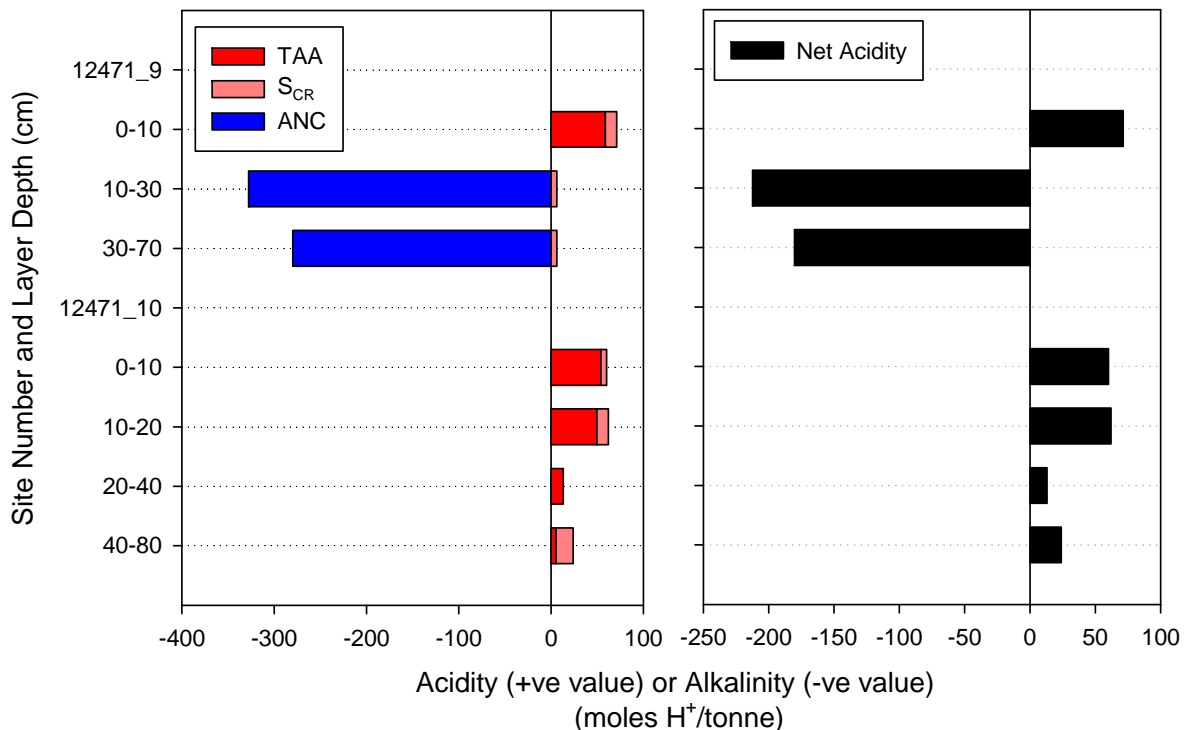
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values ranged from 0 to 1.64 %CaCO<sub>3</sub> and were measured in the lower layers Profile 9.

#### Net acidity

Net acidity values ranged from -212 to 71 mole H<sup>+</sup>/tonne. Samples were moderate values in the surface layers and declined in value with depth and for Profile 9 they subsoils were negative values.



**Figure 7-5. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12471). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**



### 7.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 7-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 7.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

### 7.3.5. Hydrochemistry

Water was not observed on the soil surface or in the pits and water samples were not collected for analysis.

## 7.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12471) were identified as hyposulfidic, a subsoil sample from Profile 10 was characterised as other soil materials. The acid sulfate soil subtype class identified was Other Soil (clayey).

The soils throughout the wetland were dominantly loamy and clayey textured in the surface layers. The subsoils were generally clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12471) are:

- Acidification hazard: The data identified moderate net acidity values in both profiles for the surface layers and pH data did not identify samples with values that indicated a potential acidification hazard due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12471):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic. Soils were loamy or clayey textured at the surface and clayey textured in the subsoil. Both profiles had a moderate net acidity values in the surface layers and pH data did not indicate potential acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"><li>• Other Soil (loamy or clayey) – occurring throughout the wetland. Isolated (&gt;50%) in extent.</li></ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"><li>• Acidification hazard – low to medium level of concern</li><li>• De-oxygenation hazard – low level of concern</li><li>• Metal mobilisation hazard – low level of concern</li></ul>

**Table 7-2. Site description data for Katarapko Floodplain (Wetland ID. 12471).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
9	16/04/2010	456513	6200722	not reached	plant material, very firm	Phragmites	low elevation, middle of wetland
10	16/04/2010	456491	6200707	not reached	plant material	Phragmites	low elevation, middle of wetland

**Table 7-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12471).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
9_1	0 - 10	small pit	yellowish brown (10YR5/4)	plant material	dry		massive	firm	fibrous plant material
9_2	10 - 30	small pit	dark yellowish brown (10YR4/4)	plant material	dry		massive	firm	fibrous plant material
9_3	30 - 70	small pit	dark greyish brown (2.5Y4/2)	clay	moist		massive	very firm	
10_1	0 - 10	small pit	dark grey (10YR4/1)	plant material	dry		massive	loose	fibrous plant material
10_2	10 - 20	small pit	dark greyish brown (10YR4/2)	plant material	dry		massive	loose	fibrous plant material
10_3	20 - 40	small pit	greyish brown (2.5Y5/2)	clay	dry		massive	very firm	
10_4	40 - 80	small pit	grey (10YR5/1)	clay	dry		massive	very firm	

**Table 7-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12471).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity (mole $\text{H}^+$ /tonne)	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Retained Acidity (mole $\text{H}^+$ /tonne)	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity (mole $\text{H}^+$ /tonne)	Acid Sulfate Soil Material Classification
9.1	0-10	Coarse	434	5.90	3.55	5.03	5.03	89	4.84	58.84	0.02	..	..	71	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.2	10-30	Fine	697	6.37	4.60	7.23	7.40	160	7.04	0.00	0.01	..	1.64	-212	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
9.3	30-70	Fine	1,010	7.54	5.80	7.62	7.58	99	7.43	0.00	0.01	..	1.40	-180	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.1	0-10	Fine	253	6.78	2.90	4.86	4.71	52	4.50	53.98	0.01	..	..	60	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.2	10-20	Fine	1,067	5.01	2.71	4.82	4.92	410	4.82	49.60	0.02	..	..	62	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
10.3	20-40	Fine	1,026	5.38	4.08	5.58	5.52	240	5.73	13.13	<0.01	..	..	13	other soil material
10.4	40-80	Fine	881	7.03	4.74	7.33	6.98	160	6.28	5.35	0.03	..	0.00	24	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )

## 8. KATARAPKO FLOODPLAIN (WETLAND ID. 12474)

### 8.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12474) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri, located in the Eckert Creek and the Splash area. The wetland is a creek that is sinuous in shape. It is about 6 kilometres in length and about 50 metres at its widest, with a total surface area of 18 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Katarapko Floodplain Complex that were surveyed are wetland IDs. 12471, 12488, 12485, 12486, 12514 and 12526.

The wetland is permanently connected to the river via the creek inlet of Wetland ID. 12526 at the eastern end. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins and in some areas grasses on the creek bank, with open woodland and shrubland on the surrounding higher floodplain. Four sites were sampled as shown in Figure 8-1.

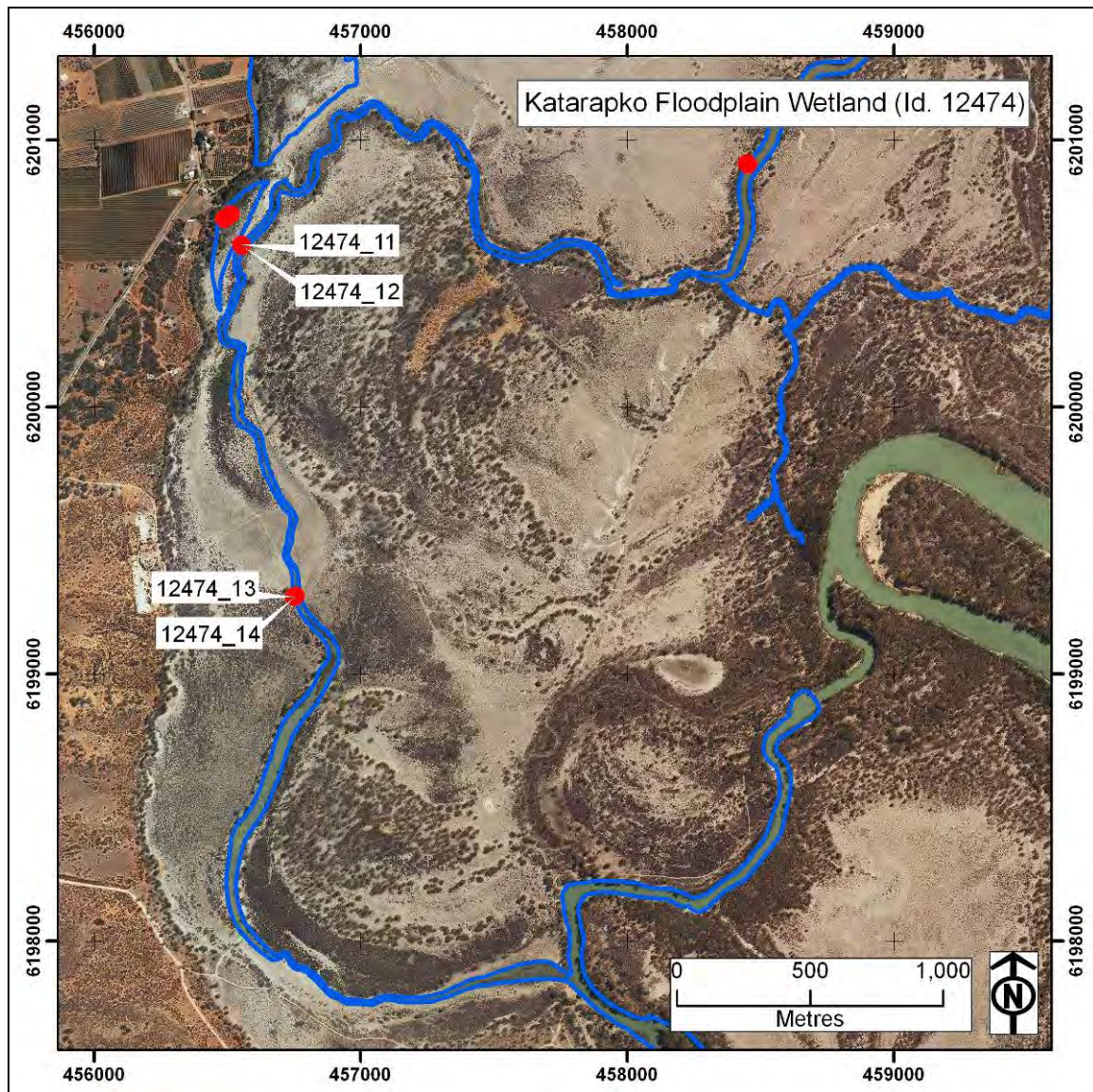


Figure 8-1. Katarapko Floodplain (Wetland ID. 12474) and sample site locations.

## 8.2. Soil profile description and distribution

Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 8-1. Sites were distributed as pairs (side and open water) at two locations, at the northern end (Sites 11 and 12), and middle (Sites 13 and 14) of the wetland. The site and soil profile descriptions are presented in Table 8-2 and Table 8-3, and a conceptual cross-section diagram in Figure 8-2.

### Northern transect

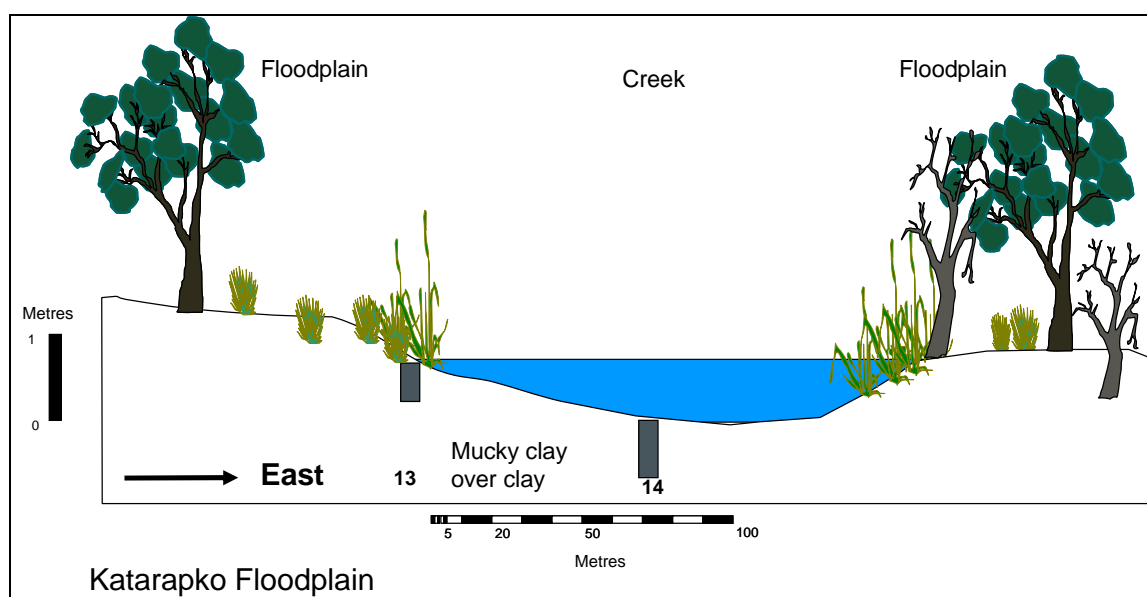
Site 11 (Figure 8-3) occurred adjacent to the bank amongst reeds in water (70 cm deep), and the soil consisted of a dark grey, firm clay. Site 12 (Figure 8-4) occurred in open water (110 cm deep), and the soil consisted of a dark grey, very firm clay.

### Middle transect

Site 13 (Figure 8-5) occurred adjacent to the bank where grasses were growing in water (10 cm deep), and the soil consisted of a dark grey, firm, clay with many plant roots, over a dark greyish brown, very firm clay. Site 14 (Figure 8-6) occurred in open water (30 cm deep), and the soil consisted of a very dark grey, very weak, mucky clay, over a grey, very firm, clay.

**Table 8-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12474).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12474_11	456553	6200608	Subaqueous Soil (clayey)	low elevation, 2m from bank step down
12474_12	456555	6200604	Subaqueous Soil (clayey)	low elevation, open water, middle of water
12474_13	456750	6199289	Subaqueous Soil (clayey)	edge of bank step down into creek
12474_14	456758	6199292	Subaqueous Soil (clayey)	low elevation, middle of creek



**Figure 8-2. Conceptual cross-section diagram, showing locations for Sites 13 and 14.**



**Figure 8-3. Photograph of Site 11, showing the site location adjacent to the bank amongst thick reeds and in water.**



**Figure 8-4. Photograph of Site 12, showing the site location in open water of the wetland.**



**Figure 8-5. Photograph of Site 13, showing the site location adjacent to the bank, and in the back ground the paired site in open water.**



**Figure 8-6. Photographs of Site 14, showing the site location in open water and a view along the wetland.**

## 8.3. Laboratory data assessment

### 8.3.1. Soil pH testing (pH<sub>W</sub>, pH<sub>OX</sub>, pH<sub>INC</sub>)

The pH data are provided in Table 8-4 and pH profiles are presented in Figure 8-7. The pH<sub>W</sub> data ranged from 6.00 to 7.80 and sulfuric materials with a pH<sub>W</sub> <4 were not identified. The pH<sub>OX</sub> data ranged from 2.37 to 7.69 and identified that the surface layer of Profiles 14 was below the critical value of pH<sub>OX</sub> <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming. The pH<sub>INC</sub> data ranged from 4.97 to 7.26 and identified that no samples on incubation declined below the critical values of pH <4.

### 8.3.2. Acid base accounting

The acid base accounting data is provided in Table 8-4 and summarised in Figure 8-8.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.07 %S<sub>CR</sub> and sulfidic materials were detected in all profiles.

#### Titrateable actual acidity

Titrateable actual acidity values ranged from 4.86 to 22.37 mole H<sup>+</sup>/tonne and were detected in all samples.

#### Retained acidity

Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values were not measured in any of the soil layers as the pH<sub>KCl</sub> values were all below 6.5.

#### Net acidity

Net acidity values ranged from 12 to 64 mole H<sup>+</sup>/tonne. All profile layers had low or moderate net acidity values.

### 8.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 8-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 8.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

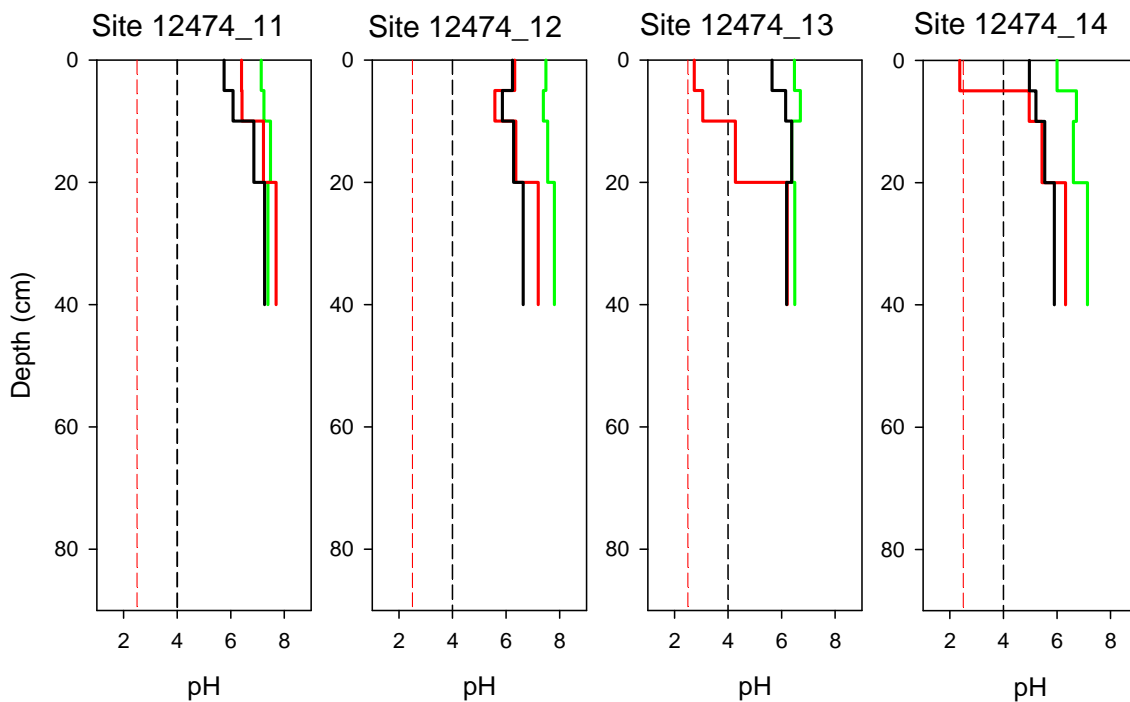


Figure 8-7. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12474), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

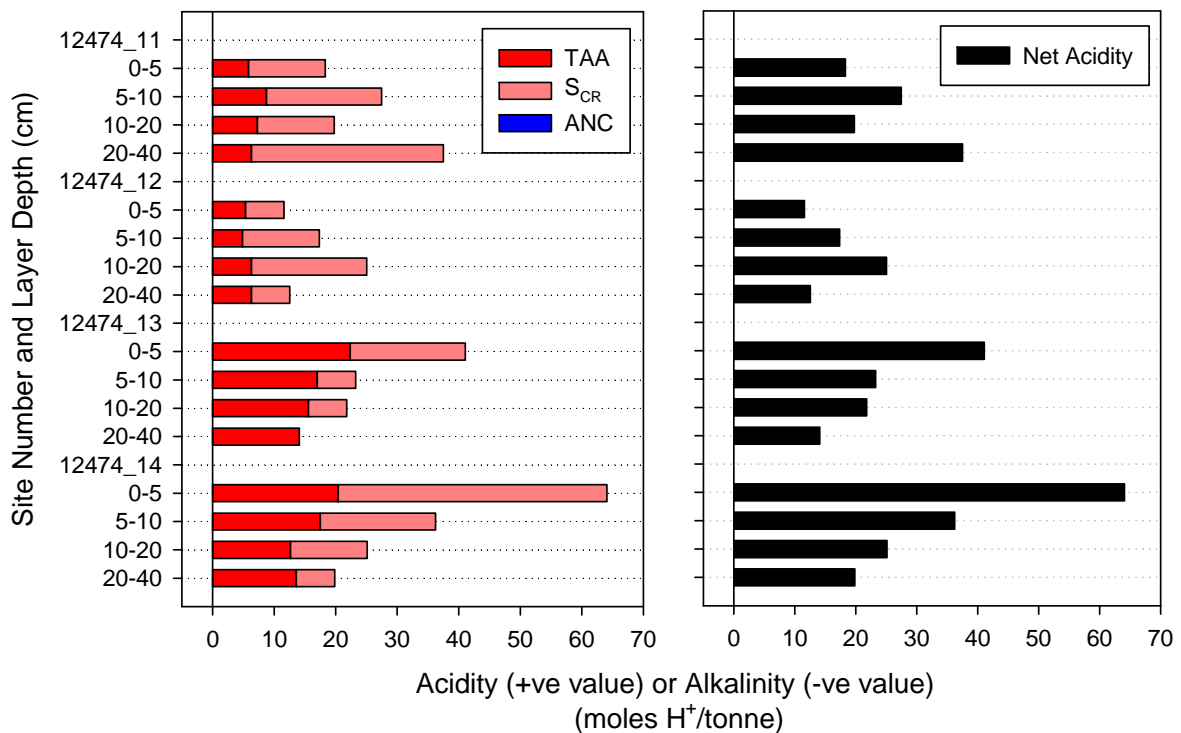


Figure 8-8. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12474). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as  $S_{CR}$  - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.



### 8.3.5. Hydrochemistry

Two surface water samples were collected from the wetland. Field parameters are shown in Table 8-5. The surface waters had circumneutral pH and low salinity. Dissolved oxygen and turbidity were high, and alkalinity moderate.

The surface water was of Na-HCO<sub>3</sub> type (Table 8-6, Figure 8-9). Sulfate concentration in the surface waters were low from 8.0 to 8.2 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters (0.186) was similar to seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values. Of the metals, Fe, Al and Zn (and Cu slightly) concentrations were elevated above ANZECC Guideline values.

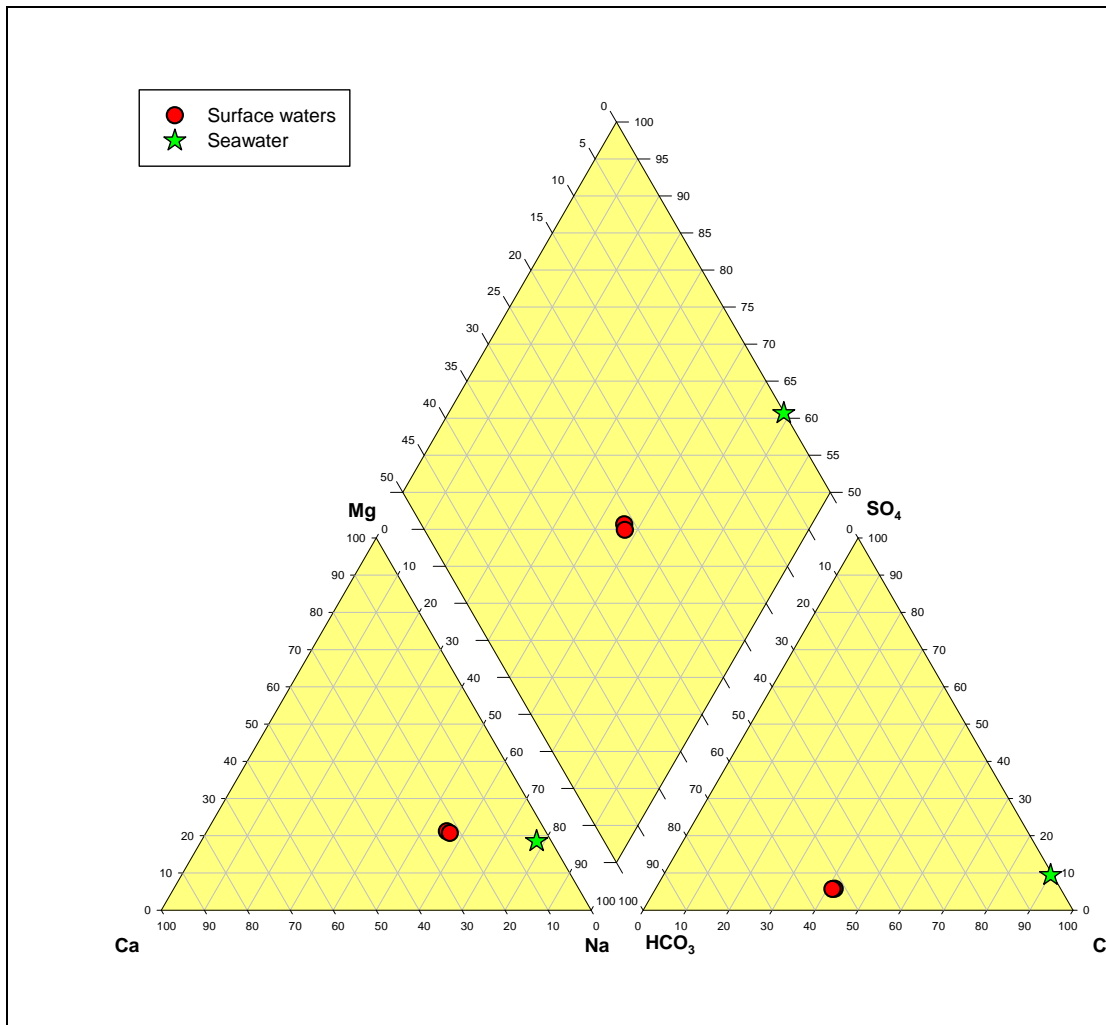


Figure 8-9. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 12474).

## 8.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12474) were identified as hyposulfidic for nearly all samples, a subsoil samples from Profile 13 was characterised as other soil materials. The acid sulfate soil subtype class identified was Subaqueous Soil (clayey) that occurred throughout the wetland.

The soils throughout the wetland were dominantly clayey textured in the surface and subsoil layers.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12474) are:

- Acidification hazard: The data identified moderate net acidity values in all profiles and pH<sub>OX</sub> data identified one surface sample with a value that indicated a potential acidification hazard due to oxidation. There is a medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12474):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic. Soils were clayey textured at the surface and clayey textured in the subsoil. All profiles below water had moderate net acidity values and pH <sub>OX</sub> values for a few samples indicated a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>

**Table 8-2. Site description data for Katarapko Floodplain (Wetland ID. 12474).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
11	16/04/2010	456553	6200608	70	water	water, Phragmites	low elevation, 2m from bank step down
12	16/04/2010	456555	6200604	110	water	water	low elevation, open water, middle of water
13	16/04/2010	456750	6199289	10	water, plant material	water, grasses	edge of bank step down into creek
14	16/04/2010	456758	6199292	30	water	water	low elevation, middle of creek

**Table 8-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12474).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
11_W	70 - 0	water							
11_1	0 - 5	small pit	dark grey (2.5Y4/0)	clay	wet		massive	firm	
11_2	5 - 10	small pit	dark grey (2.5Y4/0)	clay	wet		massive	firm	
11_3	10 - 20	small pit	dark grey (2.5Y4/0)	clay	moist		massive	firm	very sticky
11_4	20 - 40	small pit	dark grey (2.5Y4/0)	clay	moist		massive	very firm	very sticky, inclusions of nontronite
12_W1	110 - 0	surface water							water sampled
12_1	0 - 5	small pit	dark grey (2.5Y4/0)	clay	moist		angular blocky	very firm	
12_2	5 - 10	small pit	dark grey (2.5Y4/0)	clay	moist		angular blocky	very firm	
12_3	10 - 20	small pit	grey (5Y5/1)	clay	moist		massive	very firm	contains charcoal fragments
12_4	20 - 40	small pit	grey (5Y5/1)	clay	moist		massive	very firm	inclusions of nontronite
13_W	10 - 0	water							
13_1	0 - 5	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	firm	many plant roots
13_2	5 - 10	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	firm	plant roots
13_3	10 - 20	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	very firm	
13_4	20 - 40	small pit	very dark grey (5Y3/1)	clay	moist		massive	very firm	inclusions of nontronite, too clayey to auger below water sampled
14_W1	30 - 0	surface water							
14_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	
14_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		angular blocky	firm	
14_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	moist		angular blocky	firm	
14_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	clay	moist		massive	very firm	inclusions of nontronite collected for XRD

**Table 8-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12474).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
11.1	0-5	Fine	66	7.14	6.40	6.88	5.75	22	5.71	5.84	0.02	..	..	18	hyposulfidic (S <sub>CR</sub> <0.10%)
11.2	5-10	Fine	68	7.24	6.42	7.00	6.09	14	6.07	8.75	0.03	..	0.00	27	hyposulfidic (S <sub>CR</sub> <0.10%)
11.3	10-20	Fine	131	7.48	7.22	6.90	6.86	8	6.17	7.29	0.02	..	0.00	20	hyposulfidic (S <sub>CR</sub> <0.10%)
11.4	20-40	Fine	129	7.39	7.69	6.85	7.26	7	6.15	6.32	0.05	..	0.00	38	hyposulfidic (S <sub>CR</sub> <0.10%)
12.W1	110-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
12.1	0-5	Fine	56	7.49	6.32	7.19	6.24	32	6.22	5.35	0.01	..	0.00	12	hyposulfidic (S <sub>CR</sub> <0.10%)
12.2	5-10	Fine	57	7.39	5.58	7.11	5.86	22	5.92	4.86	0.02	..	..	17	hyposulfidic (S <sub>CR</sub> <0.10%)
12.3	10-20	Fine	58	7.55	6.36	7.22	6.28	41	6.16	6.32	0.03	..	0.00	25	hyposulfidic (S <sub>CR</sub> <0.10%)
12.4	20-40	Fine	95	7.80	7.20	6.87	6.64	22	6.14	6.32	0.01	..	0.00	13	hyposulfidic (S <sub>CR</sub> <0.10%)
13.1	0-5	Fine	70	6.48	2.74	6.50	5.64	24	5.12	22.37	0.03	..	..	41	hyposulfidic (S <sub>CR</sub> <0.10%)
13.2	5-10	Fine	78	6.70	3.05	6.46	6.15	12	5.07	17.02	0.01	..	..	23	hyposulfidic (S <sub>CR</sub> <0.10%)
13.3	10-20	Fine	122	6.38	4.27	6.37	6.38	9	5.33	15.56	0.01	..	..	22	hyposulfidic (S <sub>CR</sub> <0.10%)
13.4	20-40	Fine	225	6.49	6.21	6.43	6.19	19	5.42	14.10	<0.01	..	..	14	other soil material
14.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
14.1	0-5	Fine	61	6.00	2.37	6.61	4.97	43	5.07	20.42	0.07	..	..	64	hyposulfidic (S <sub>CR</sub> <0.10%)
14.2	5-10	Fine	52	6.73	4.96	6.75	5.21	18	5.24	17.51	0.03	..	..	36	hyposulfidic (S <sub>CR</sub> <0.10%)
14.3	10-20	Fine	65	6.61	5.44	6.87	5.54	17	5.36	12.64	0.02	..	..	25	hyposulfidic (S <sub>CR</sub> <0.10%)
14.4	20-40	Fine	81	7.14	6.32	6.80	5.90	78	5.72	13.62	0.01	..	..	20	hyposulfidic (S <sub>CR</sub> <0.10%)

**Table 8-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12474).**

	pH	SEC µS cm <sup>-1</sup>	DO mg l <sup>-1</sup>	Eh mV	Turbidity NTU	Alkalinity as HCO <sub>3</sub>
Surface waters (n=2)	7.24-7.31	283-337	10.2-11.8	-100- -98	170-180	95

**Table 8-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12474).**

Parameter	units	ANZECC Guidelines	Site 12 (SW)	Site 14 (SW)
Na	mg l <sup>-1</sup>		27.6	29.4
K	mg l <sup>-1</sup>		4.7	4.6
Ca	mg l <sup>-1</sup>		10.9	11.1
Mg	mg l <sup>-1</sup>		6.08	6.19
Si	mg l <sup>-1</sup>		3.82	4.03
Br	mg l <sup>-1</sup>		0.1	0.1
Cl	mg l <sup>-1</sup>		44	43
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.045	0.026
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.02</b>	<b>0.018</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.014</b>	<b>0.014</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		8.2	8
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>180</b>	<b>320</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	0.9	0.9
Cd	µg l <sup>-1</sup>	0.2	0.04	0.05
Co	µg l <sup>-1</sup>	2.8	0.13	0.19
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.2	0.4
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>2.2</b>	<b>2.4</b>
Fe	µg l <sup>-1</sup>	300	176	<b>347</b>
Mn	µg l <sup>-1</sup>	1700	12.24	10.5
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.4	1.4
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.24	0.44
Se	µg l <sup>-1</sup>	11	<0.06	0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>126</b>	<b>152</b>
DOC	mg l <sup>-1</sup>		7.1	7.2

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 9. KATARAPKO FLOODPLAIN (WETLAND ID. 12485)

### 9.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12485) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri, located in the Eckert Creek and the Splash area. The wetland is rectangular in shape. It is about 2 kilometres in length and about 400 metres at its widest, with a total surface area of 70 hectares. The wetland is bounded to the east by a raised floodplain that separates it from other wetlands and the river and to the west a steep hill slope that separates it from farmland. The other associated wetlands in the Katarapko Floodplain Complex that were surveyed are wetland IDs. 12471, 12474, 12488, 12486, 12514 and 12526.

The wetland is not connected to the river and appears to be an internal basin at the base of the hill slope with possible ground water seeps. At the time when the soil survey was conducted in April 2010 the wetland had no surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing in parts and there was a large area of lignum, with open woodland and shrubland on the surrounding higher floodplain. Eight sites were sampled as shown in Figure 9-1.

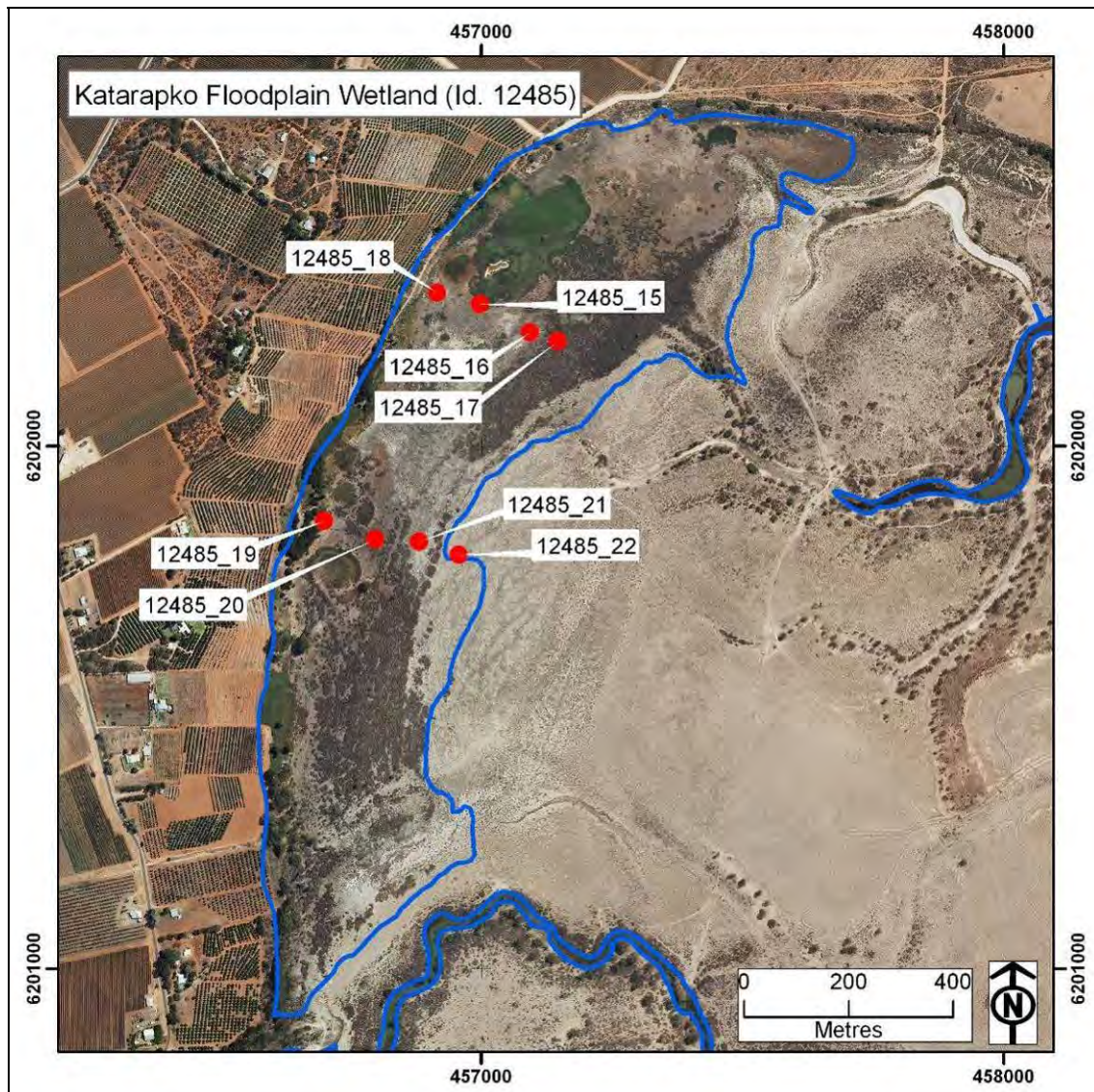


Figure 9-1. Katarapko Floodplain (Wetland ID. 12485) and sample site locations.

## 9.2. Soil profile description and distribution

Eight sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 9-1. Sites were distributed along two transects, at the northern end (Sites 15, 16, 17 and 18), and southern end (Sites 19, 20, 21 and 22) of the wetland. The site and soil profile descriptions are presented in Table 9-2 and Table 9-3, and a conceptual cross-section diagram in Figure 9-2.

### Northern transect

Site 15 (Figure 9-3) occurred amongst thick Phragmites, and the soil consisted of a very dark grey, firm, clay, over a grey, very firm, clay. Site 16 (Figure 9-4) occurred in an open salt bush area, and the soil consisted of a greyish brown, very firm to rigid with depth, clay. Site 17 (Figure 9-5) occurred in a thick lignum area, and the soil consisted of a greyish brown very firm to rigid with depth, clay. Site 18 (Figure 9-6) occurred on the hill slope margin where there was a saline ground water seep, and the soil consisted of a dark greyish brown, very firm to rigid with depth, sandy clay loam.

### Southern transect

Site 19 (Figure 9-7) occurred amongst reeds on the hill slope margin adjacent to a saline groundwater seep, and the soil consisted of a very dark grey, weak, sandy loam, over a brown, weak, loamy sand. Site 20 (Figure 9-8) occurred in thick lignum, and the soil consisted of a very dark greyish brown, weak, sandy clay loam, over a grey, very firm, clay loam. Site 21 (Figure 9-9) occurred in a salt bush area, and the soil consisted of a dark grey, very firm to rigid with depth, clay loam. Site 22 (Figure 9-10) occurred in a salt bush area with cracking surfaces, and the soil consisted of a light brownish grey, firm, clay loam, over a dark grey, very firm, clay.

**Table 9-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12485).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12485_15	456998	6202271	Other Soil (clayey)	mid elevation, in reeds
12485_16	457094	6202217	Other Soil (clayey)	low elevation, in open salt bush area adjacent to lignum
12485_17	457147	6202200	Other Soil (clayey)	low elevation in lignum
12485_18	456916	6202293	Other Soil (loamy)	mid to high elevation, in saline groundwater seep?
12485_19	456700	6201856	Other Soil (sandy)	high elevation, in groundwater seep
12485_20	456798	6201821	Other Soil (loamy)	low elevation, in lignum area
12485_21	456882	6201817	Other Soil (loamy)	low elevation, in salt bush area
12485_22	456958	6201792	Other Soil (clayey)	low elevation, in large salt bush area



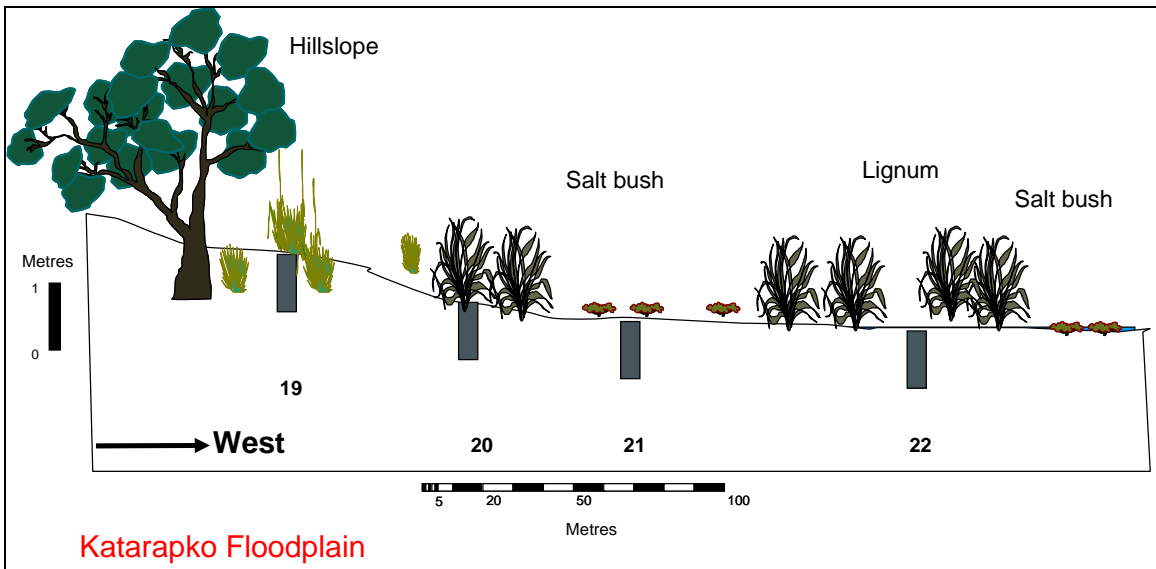


Figure 9-2. Conceptual cross-section diagram, showing locations for Sites 19 to 22.



Figure 9-3. Photograph of Site 15, showing the site location amongst thick reeds.



Figure 9-4. Photograph of Site 16, showing the site location in an open area with salt bush growing.



Figure 9-5. Photograph of Site 17, showing the site location placed in thick lignum.



Figure 9-6. Photograph of Site 18, showing the soil profile with a sealed surface containing salt efflorescences.



**Figure 9-7. Photograph of Site 19, showing the site location amongst reeds, and the soil profile with plant material on the surface.**



**Figure 9-8. Photograph of Site 20, showing the soil profile located in a salt bush area.**

**Figure 9-9. Photograph of Site 21, showing the site location in a salt bush area.**

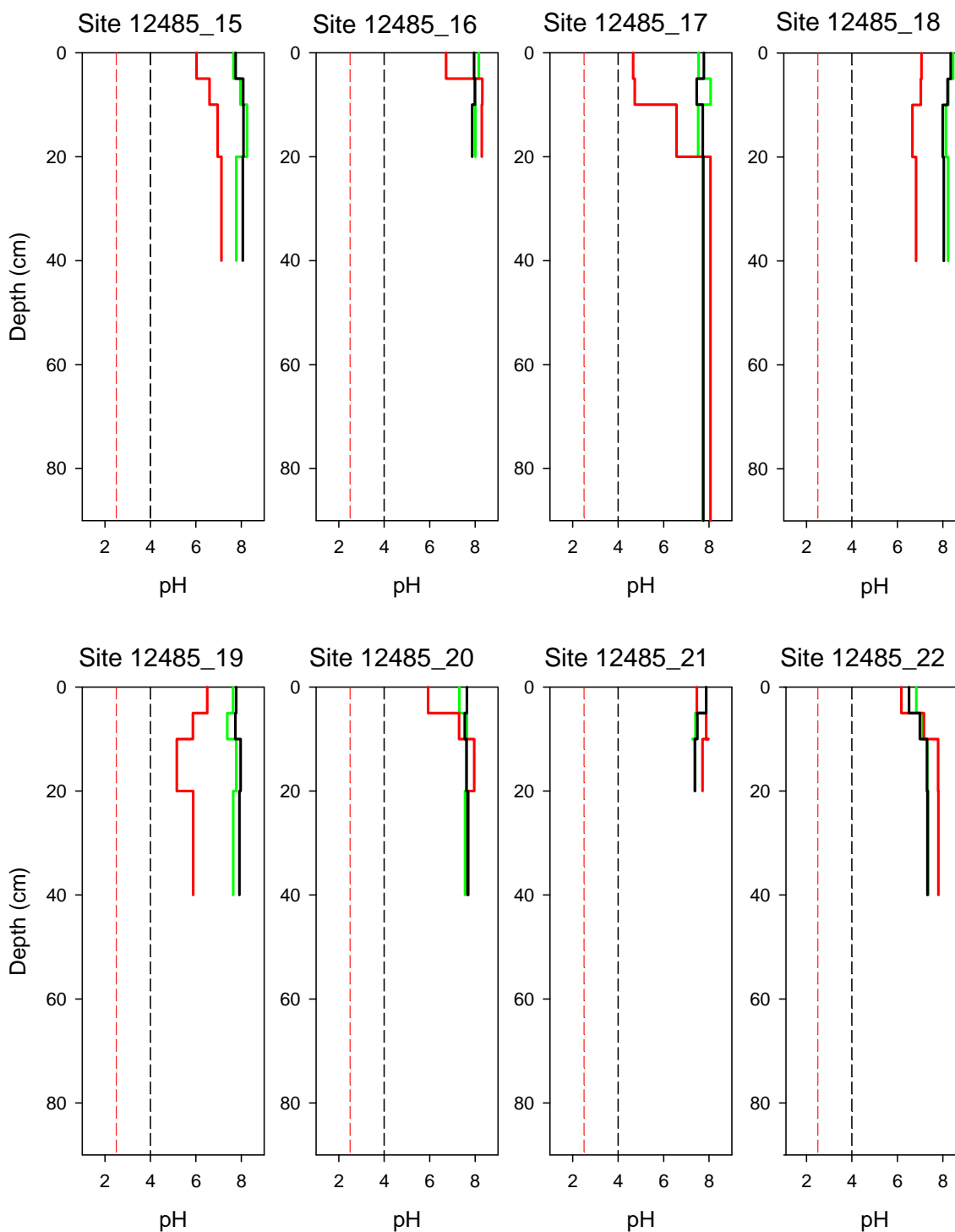


**Figure 9-10. Photographs of Site 22, showing the site location in open salt bush area with thick lignum that is part of the wetland in the back ground, and the soil profile.**

### 9.3. Laboratory data assessment

#### 9.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 9-4 and pH profiles are presented in Figure 9-11. The  $pH_W$  data ranged from 6.83 to 8.45 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 4.66 to 8.31 and identified that no samples were below the critical value of  $pH_{OX} < 2.5$ . The  $pH_{INC}$  data ranged from 6.51 to 8.34 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .



**Figure 9-11. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12485), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).**

### **9.3.2. Acid base accounting**

The acid base accounting data is provided in Table 9-4 and summarised in Figure 9-12.

#### **Chromium reducible sulfur**

Chromium reducible sulfur values ranged from 0.0 to 0.04 %S<sub>CR</sub> and sulfidic materials were at the detection limit for the surface samples and in the subsoil samples not detected.

#### **Titrateable actual acidity**

Titrateable actual acidity was not detected.

#### **Retained acidity**

Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### **Acid neutralising capacity**

Acid neutralising capacity values ranged from 0.43 to 34.16 %CaCO<sub>3</sub> and were measured in samples from all profile layers.

#### **Net acidity**

Net acidity values ranged from -4525 to -57 mole H<sup>+</sup>/tonne. All profile layers were negative values, and tended to have the largest negative value in the surface layers.

### **9.3.3. Water soluble sulfate**

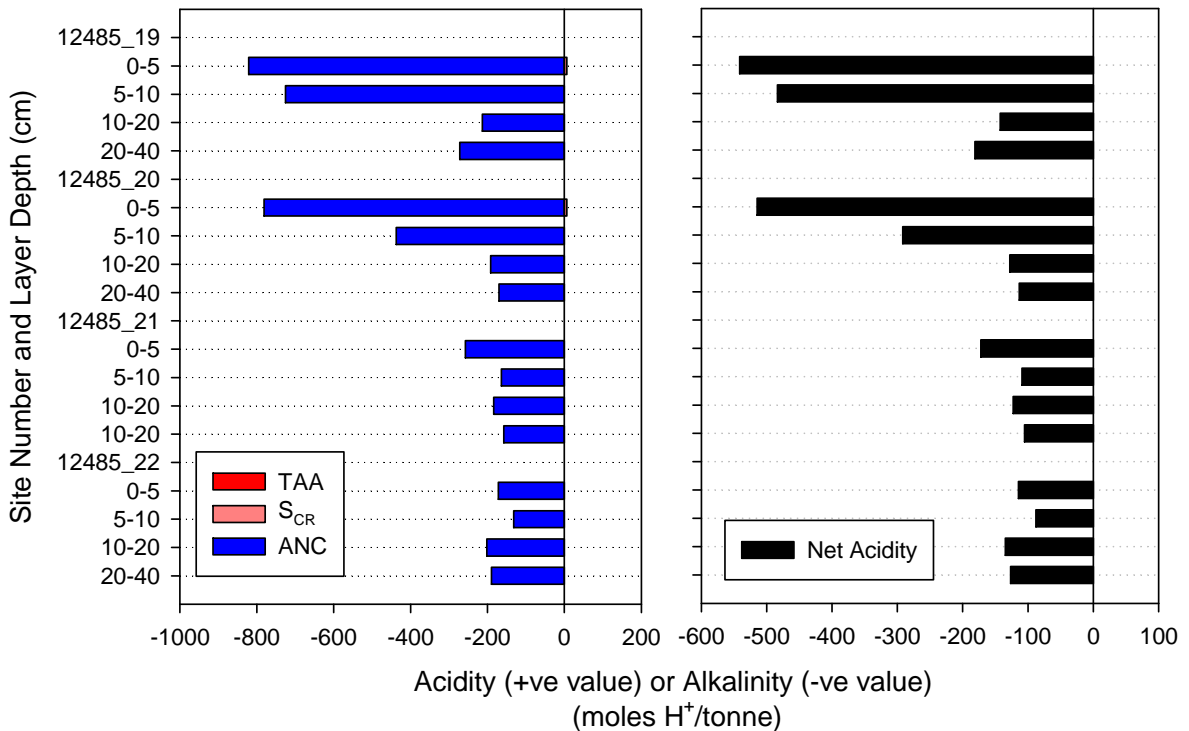
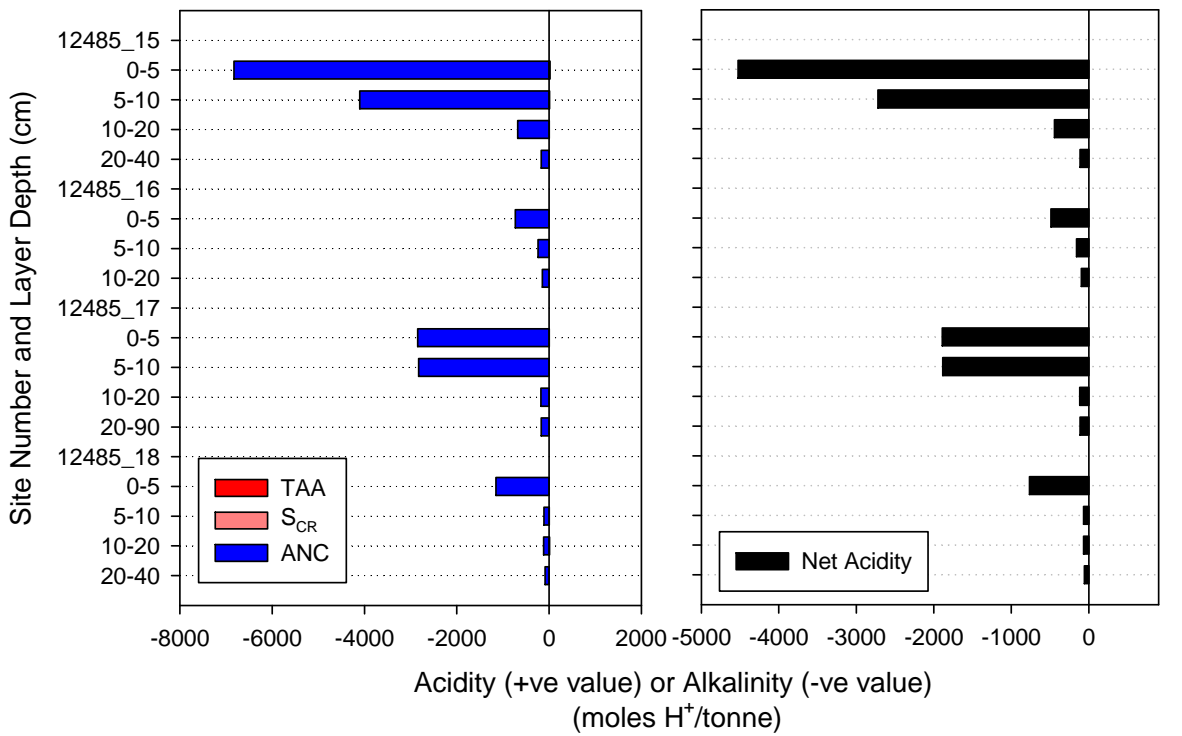
Water soluble sulfate data values shown in Table 9-4 identified surface layers in all profiles were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### **9.3.4. Acid volatile sulfur**

Monosulfidic materials were not observed and samples were not collected for analysis.

### **9.3.5. Hydrochemistry**

Water was not observed on the soil surface or in the soil pits and samples were not collected for analysis.



**Figure 9-12. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12485). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as  $S_{CR}$  - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

## 9.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12485) were identified as hyposulfidic in the surface layers, the subsoil layers were characterised as other soil materials. The acid sulfate soil subtype classes identified were Other Soil (clayey or loamy) that occurred on the wetland or Other Soil (sandy) that occurred on the margin adjacent to the hill slopes.

The soils throughout the main wetland area were dominantly clayey texture in the surface layers and in isolated areas adjacent to the hill slope they were sandy textured. The subsoils were clayey.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12485) are:

- Acidification hazard: The data identified negative net acidity values in all samples and pH data did not indicate a potential acidification hazard due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12485):

<b>Soil materials:</b>	The surface soil layers were hyposulfidic and the subsoil layers were characterised as other soil material. Soils were generally clayey textured in the surface and subsoil layers. All profiles had samples with negative net acidity values, and pH data did not identify samples that indicated a potential for acidification.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Other Soil (sandy or loamy or clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – low level of concern</li> <li>• De-oxygenation hazard – medium level of concern</li> <li>• Metal mobilisation hazard – low level of concern</li> </ul>

**Table 9-2. Site description data for Katarapko Floodplain (Wetland ID. 12485).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
15	16/04/2010	456998	6202271	not reached	plant material	Phragmites	mid elevation, in reeds
16	16/04/2010	457094	6202217	not reached	sealed, firm	salt bush	low elevation, in open salt bush area adjacent to lignum
17	16/04/2010	457147	6202200	not reached	plant material, firm	lignum, thick	low elevation in lignum
18	16/04/2010	456916	6202293	not reached	crusted, isolated white salt patches	salt bush	mid to high elevation, in saline groundwater seep?
19	17/04/2010	456700	6201856	not reached	plant material	Phragmites	high elevation, in groundwater seep
20	17/04/2010	456798	6201821	not reached	cracking, firm	lignum, open area	low elevation, in lignum area
21	17/04/2010	456882	6201817	not reached	sealed, firm, sodic	salt bush	low elevation, in salt bush area
22	17/04/2010	456958	6201792	not reached	cracking, sealed	salt bush	low elevation, in large salt bush area

**Table 9-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12485).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
15_1	0 - 5	small pit	very dark grey (10YR3/1)	plant material	dry		massive	loose	
15_2	5 - 10	small pit	very pale brown (10YR8/2)	clay	dry		subangular blocky	firm	
15_3	10 - 20	small pit	light brownish grey (10YR6/2)	clay	moist		subangular blocky	very firm	
15_4	20 - 40	small pit	grey (5Y5/1)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	massive	very firm	
16_1	0 - 5	small pit	greyish brown (10YR5/2)	sandy clay loam	dry		angular blocky	very firm	contains 10% carbonate inclusions contains 15% carbonate inclusions too rigid to dig below
16_2	5 - 10	small pit	greyish brown (10YR5/2)	clay	dry		angular blocky	very firm	
16_3	10 - 20	small pit	greyish brown (10YR5/2)	clay	moist		angular blocky	rigid	
17_1	0 - 5	small pit	very dark grey (10YR3/1)	clay	dry		subangular blocky	very firm	
17_2	5 - 10	small pit	greyish brown (10YR5/2)	clay	dry		subangular blocky	very firm	
17_3	10 - 20	small pit	greyish brown (10YR5/2)	clay	moist		subangular blocky	rigid	
17_4	20 - 90	small pit	greyish brown (10YR5/2)	clay	dry		subangular blocky	rigid	
18_0	0 - 0.2	surface salt scrap	white (10YR8/1)	salt			crystalline	weak	salts collected from isolated areas
18_1	0 - 5	small pit	greyish brown (10YR5/2)	sandy clay loam	dry		angular blocky	very firm	
18_2	5 - 10	small pit	dark greyish brown (10YR4/2)	sandy clay loam	dry		angular blocky	very firm	
18_3	10 - 20	small pit	dark greyish brown (10YR4/2)	sandy clay loam	dry	15% strong brown infused into the matrix adjacent to pores	angular blocky	rigid	
18_4	20 - 40	small pit	dark greyish brown (10YR4/2)	sandy clay loam	moist	5% strong brown infused into the matrix adjacent to pores	angular blocky	rigid	
19_1	0 - 5	small pit	very dark grey (10YR3/1)	sandy loam	dry		granular	weak	
19_2	5 - 10	small pit	dark greyish brown (10YR4/2)	loamy sand	moist	20% black In the matrix	granular	weak	
19_3	10 - 20	small pit	dark grey (10YR4/1)	loamy sand	moist	15% yellowish brown In the matrix	massive	weak	
19_4	20 - 40	small pit	brown (10YR5/3)	loamy sand	moist	20% yellowish brown In the matrix	massive	very weak	



Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
20_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	sandy clay loam	dry		granular	weak	
20_2	5 - 10	small pit	dark grey (10YR4/1)	clay loam	moist		angular blocky	firm	white carbonate inclusions
20_3	10 - 20	small pit	dark grey (10YR4/1)	clay loam	moist		angular blocky	firm	5% carbonate segregations
20_4	20 - 40	small pit	grey (10YR5/1)	clay loam	moist		angular blocky	very firm	5% carbonate segregations
21_1	0 - 5	small pit	greyish brown (10YR5/2)	clay loam	dry		angular blocky	firm	
21_2	5 - 10	small pit	dark grey (10YR4/1)	clay loam	moist		angular blocky	firm	10% carbonate segregations
21_3	10 - 20	small pit	dark grey (10YR4/1)	clay loam	moist		angular blocky	firm	15% carbonate segregations
21_3	10 - 20	small pit	dark grey (10YR4/1)	clay loam	moist		angular blocky	firm	15% carbonate segregations
22_1	0 - 5	small pit	light brownish grey (10YR6/2)	clay loam	dry		angular blocky	firm	
22_2	5 - 10	small pit	light brownish grey (10YR6/2)	clay loam	moist		angular blocky	firm	contains carbonate segregations
22_3	10 - 20	small pit	grey (10YR5/1)	clay	moist		angular blocky	firm	contains carbonate segregations
22_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist		angular blocky	very firm	contains carbonate segregations

**Table 9-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12485).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
15.1	0-5	Medium	542	7.65	6.03	7.99	7.75	78	7.81	0.00	0.04	..	34.16	-4525	hyposulfidic (S <sub>CR</sub> <0.10%)
15.2	5-10	Fine	739	7.96	6.60	8.09	8.08	130	8.38	0.00	0.02	..	20.52	-2721	hyposulfidic (S <sub>CR</sub> <0.10%)
15.3	10-20	Fine	1,628	8.25	6.96	8.04	8.09	190	8.46	0.00	0.01	..	3.38	-444	hyposulfidic (S <sub>CR</sub> <0.10%)
15.4	20-40	Fine	1,747	7.78	7.12	7.88	8.06	510	7.75	0.00	<0.01	..	0.85	-113	other soil material
16.1	0-5	Fine	5,530	8.16	6.72	8.16	7.95	360	8.43	0.00	<0.01	..	3.66	-488	other soil material
16.2	5-10	Fine	5,330	7.97	8.31	8.02	7.99	450	8.58	0.00	<0.01	..	1.19	-159	other soil material
16.3	10-20	Fine	4,710	8.01	8.29	7.83	7.87	410	7.71	0.00	<0.01	..	0.71	-95	other soil material
17.1	0-5	Medium	1,443	7.54	4.66	8.09	7.77	61	7.02	0.00	0.01	..	14.25	-1892	hyposulfidic (S <sub>CR</sub> <0.10%)
17.2	5-10	Fine	1,553	8.07	4.73	7.42	7.45	72	6.76	0.00	<0.01	..	14.15	-1885	other soil material
17.3	10-20	Fine	2,140	7.52	6.57	7.61	7.72	130	6.74	0.00	<0.01	..	0.88	-117	other soil material
17.4	20-90	Fine	2,262	7.72	8.06	7.78	7.75	190	6.72	0.00	<0.01	..	0.84	-112	other soil material
18.0	0-0.2	..	..	..	..	8.29	0.00	..	..	..	..	..	..	..	salt crust
18.1	0-5	Medium	6,580	8.45	7.06	8.41	8.34	610	9.26	0.00	<0.01	..	5.75	-766	other soil material
18.2	5-10	Medium	5,510	8.24	7.03	8.34	8.21	740	8.30	0.00	0.01	..	0.55	-67	hyposulfidic (S <sub>CR</sub> <0.10%)
18.3	10-20	Fine	5,100	8.13	6.66	8.15	7.99	560	7.21	0.00	0.02	..	0.59	-66	hyposulfidic (S <sub>CR</sub> <0.10%)
18.4	20-40	Fine	5,430	8.23	6.82	8.30	8.04	640	7.15	0.00	<0.01	..	0.43	-57	other soil material
19.1	0-5	Fine	2,681	7.63	6.50	7.37	7.77	480	7.54	0.00	0.01	..	4.11	-541	hyposulfidic (S <sub>CR</sub> <0.10%)
19.2	5-10	Fine	2,310	7.38	5.87	7.51	7.74	280	7.84	0.00	<0.01	..	3.63	-484	other soil material
19.3	10-20	Medium	1,803	7.78	5.16	7.84	7.97	69	7.72	0.00	<0.01	..	1.07	-143	other soil material
19.4	20-40	Medium	871	7.64	5.88	7.35	7.91	53	6.95	0.00	<0.01	..	1.36	-181	other soil material
20.1	0-5	Medium	795	7.30	5.93	7.32	7.64	71	7.68	0.00	0.01	..	3.91	-515	hyposulfidic (S <sub>CR</sub> <0.10%)
20.2	5-10	Fine	2,970	7.64	7.29	7.34	7.54	230	8.12	0.00	<0.01	..	2.19	-292	other soil material
20.3	10-20	Fine	2,760	7.62	7.96	7.29	7.62	150	7.35	0.00	<0.01	..	0.96	-128	other soil material
20.4	20-40	Fine	2,920	7.55	7.70	7.18	7.67	160	7.18	0.00	<0.01	..	0.85	-113	other soil material
21.1	0-5	Fine	5,100	7.87	7.46	7.53	7.87	130	8.00	0.00	<0.01	..	1.29	-172	other soil material
21.2	5-10	Fine	10,580	7.40	7.87	7.05	7.48	1,200	7.08	0.00	<0.01	..	0.82	-109	other soil material
21.3	10-20	Fine	8,430	7.29	7.96	6.92	7.43	1,200	6.77	0.00	<0.01	..	0.92	-123	other soil material
21.3	10-20	Fine	11,620	7.37	7.71	6.93	7.38	800	6.70	0.00	<0.01	..	0.79	-105	other soil material
22.1	0-5	Fine	11,410	6.83	6.17	6.45	6.51	1,800	6.65	0.00	<0.01	..	0.86	-115	other soil material
22.2	5-10	Fine	14,480	7.09	7.17	6.77	6.99	2,300	6.71	0.00	<0.01	..	0.66	-88	other soil material
22.3	10-20	Fine	12,260	7.31	7.79	6.85	7.30	1,200	6.79	0.00	<0.01	..	1.01	-135	other soil material
22.4	20-40	Fine	10,580	7.36	7.80	7.04	7.32	950	6.76	0.00	<0.01	..	0.95	-127	other soil material

## 10. KATARAPKO FLOODPLAIN (WETLAND ID. 12486)

### 10.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12486) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri, located in the Eckert Creek and the Splash area. The wetland is a creek that is sinuous in shape. It is about 2.5 kilometres in length and about 50 metres at its widest, with a total surface area of 5 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Katarapko Floodplain Complex that were surveyed are wetland IDs. 12471, 12488, 12485, 12474, 12514 and 12526.

The wetland is permanently connected to the river at the eastern end. At the time when the soil survey was conducted on 17<sup>th</sup> April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins and in some areas grasses on the creek bank, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 10-1.

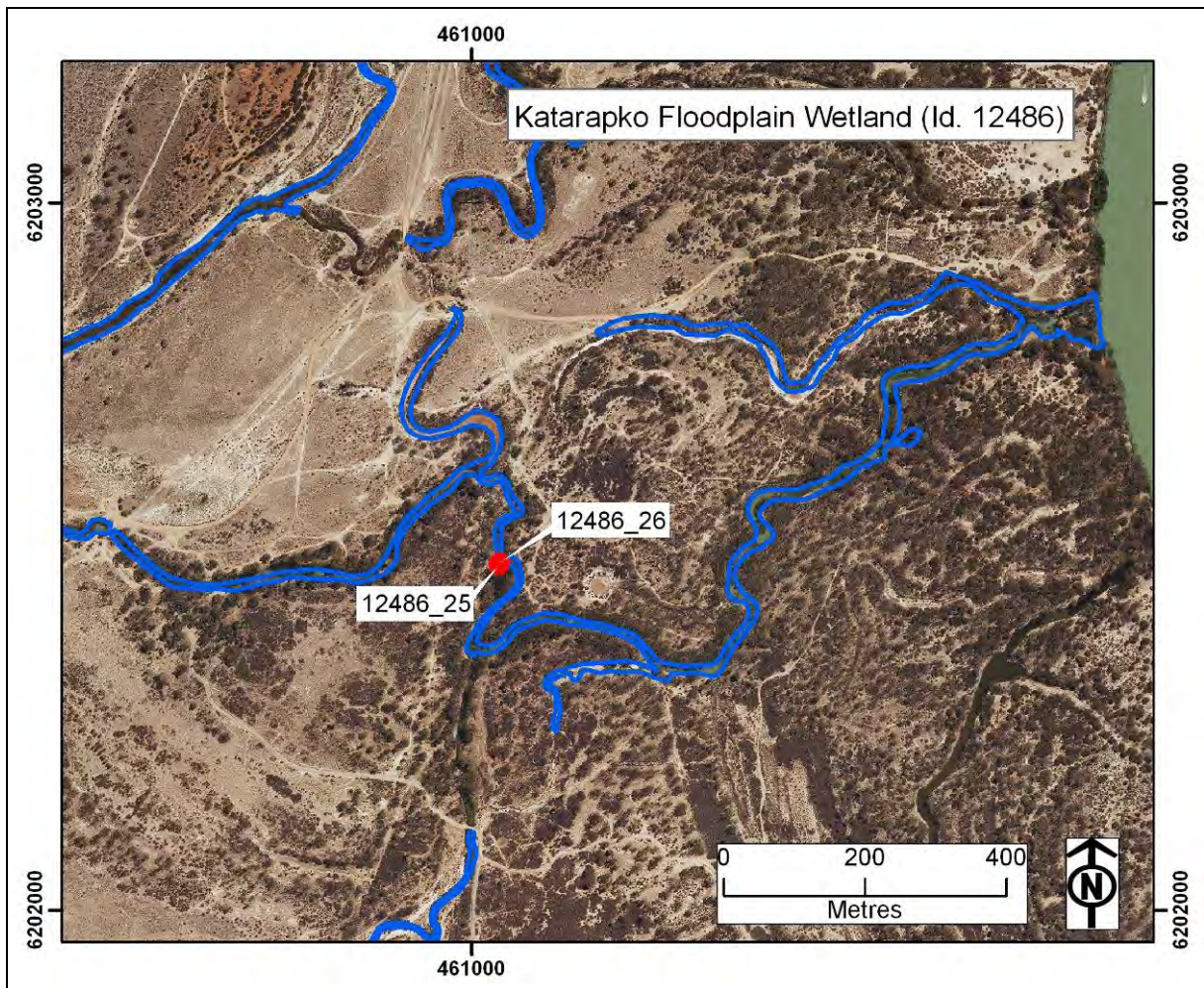


Figure 10-1. Katarapko Floodplain (Wetland ID. 12486) and sample site locations.

## 10.2. Soil profile description and distribution

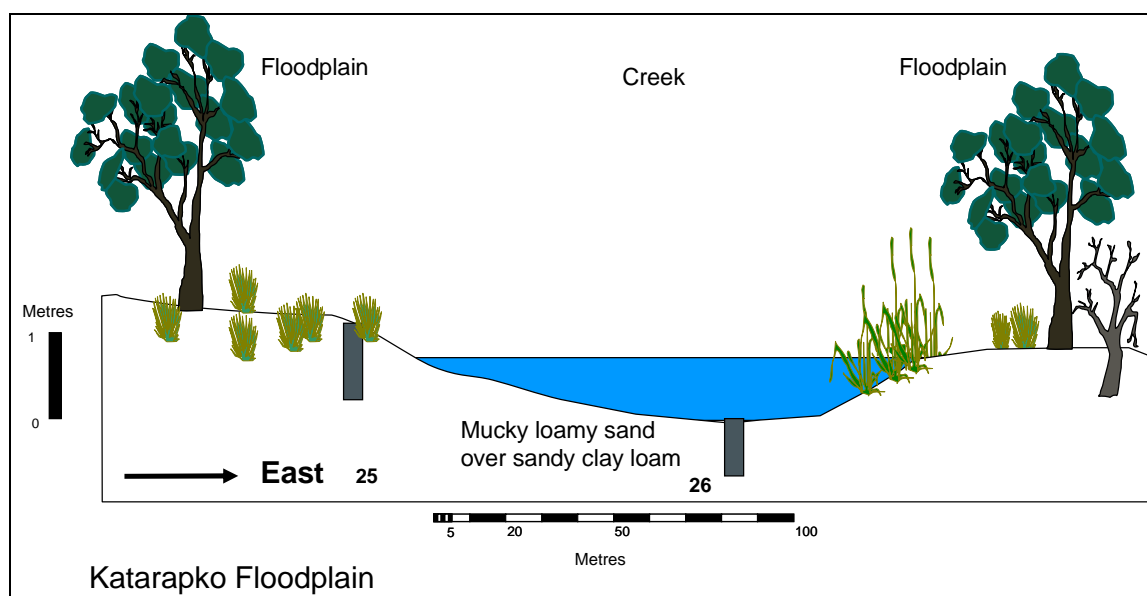
Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 10-1. Sites were distributed as a pair (side and open water) at the middle (Sites 25 and 26) of the wetland. The site and soil profile descriptions are presented in Table 10-2 and Table 10-3, and a conceptual cross-section shown in Figure 10-2.

Middle transect

Site 25 (Figure 10-3) occurred on the grassed bank adjacent to the water, and the soil consisted of a very dark greyish brown, very firm, clay loam, over a brown, very firm, clay. Site 26 (Figure 10-4) occurred in open water (90 cm deep), and the soil consisted of a dark grey, very weak, mucky loamy sand, over a dark grey, very firm sandy clay loam.

**Table 10-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12486).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12486_25	461039	6202487	Other Soil (clayey)	high elevation, 1 m from bank step down to water
12486_26	461041	6202491	Subaqueous Soil (sandy)	low elevation, middle of creek



**Figure 10-2. Conceptual cross-section diagram, showing locations for Sites 25 and 26.**



**Figure 10-3. Photographs of Site 25, showing the site location on the grassed bank adjacent to the water, and the soil profile.**



**Figure 10-4. Photograph of Site 26, showing the site location in open water.**

### **10.3. Laboratory data assessment**

#### **10.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )**

The pH data are provided in Table 10-4 and pH profiles are presented in Figure 10-5. The  $pH_W$  data ranged from 5.65 to 7.48 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 2.06 to 5.98 and identified that surface layers in Profile 26 that occurred in the water were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 4.26 to 7.69 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .

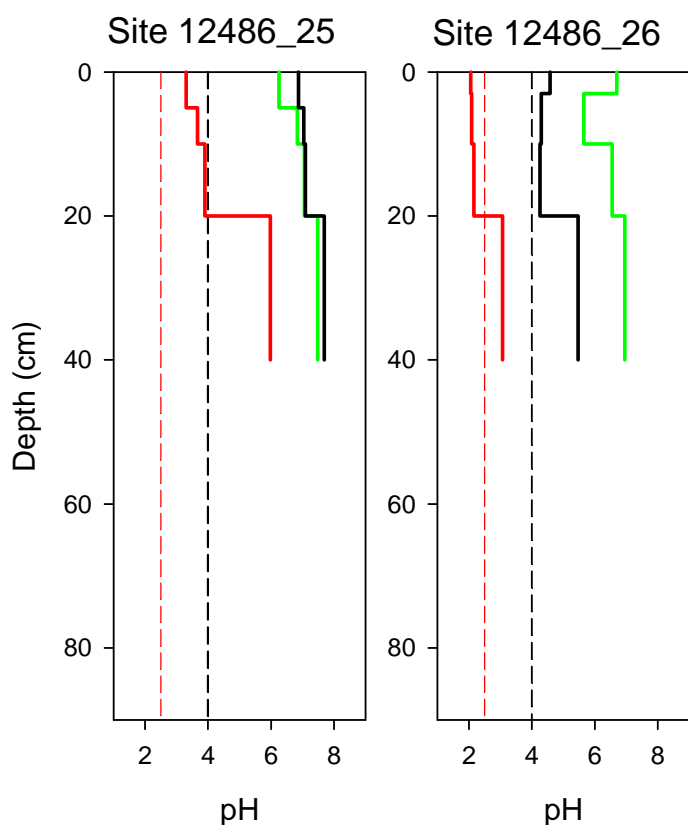


Figure 10-5. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12486), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 10.3.2. Acid base accounting

The acid base accounting data is provided in Table 10-4 and summarised in Figure 10-6.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.04 % $S_{CR}$  and sulfidic materials were detected in all profiles.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 9.81 mole  $H^+$ /tonne and were detected in all but one sample.

#### Retained acidity

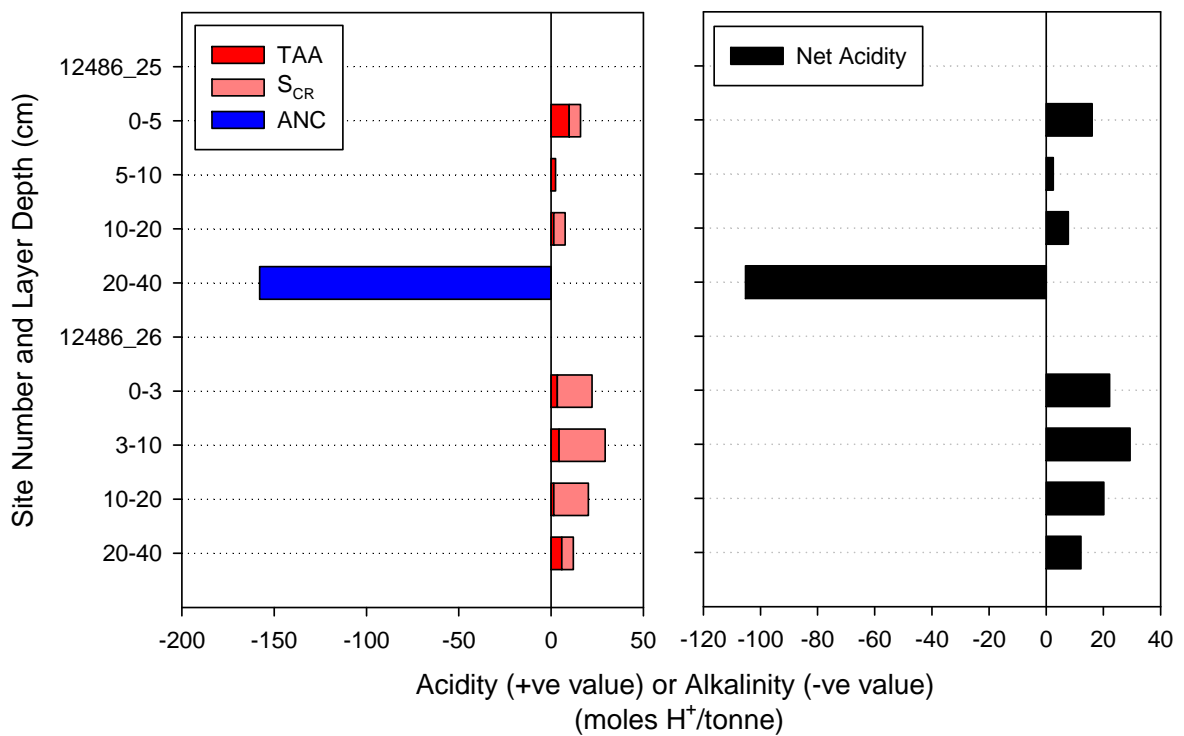
Retained acidity was not measured in any of the layers as all samples had a  $pH_{KCl}$  of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values were 0 except for the lower subsoil layer of Profile 25 that was 0.24 % $CaCO_3$ .

#### Net acidity

Net acidity values ranged from -105 to 29 mole  $H^+$ /tonne. Moderate or low net acidity values occurred in most samples with a negative value in the subsoil of Profile 25.



**Figure 10-6. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12486). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 10.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 10-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 10.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

### 10.3.5. Hydrochemistry

One surface water sample was collected from the wetland. Field parameters are shown in Table 10-5. The surface waters had circumneutral pH and low salinity. Dissolved oxygen and turbidity were high, and alkalinity moderate.

The surface water was of Na-HCO<sub>3</sub> type (Table 10-6, Figure 10-7). Sulfate concentration in the surface water was low at 5.4 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters (0.208) was slightly higher than seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values. Of the metals, Al and Zn (and Cu slightly) concentrations were elevated above ANZECC Guideline values.

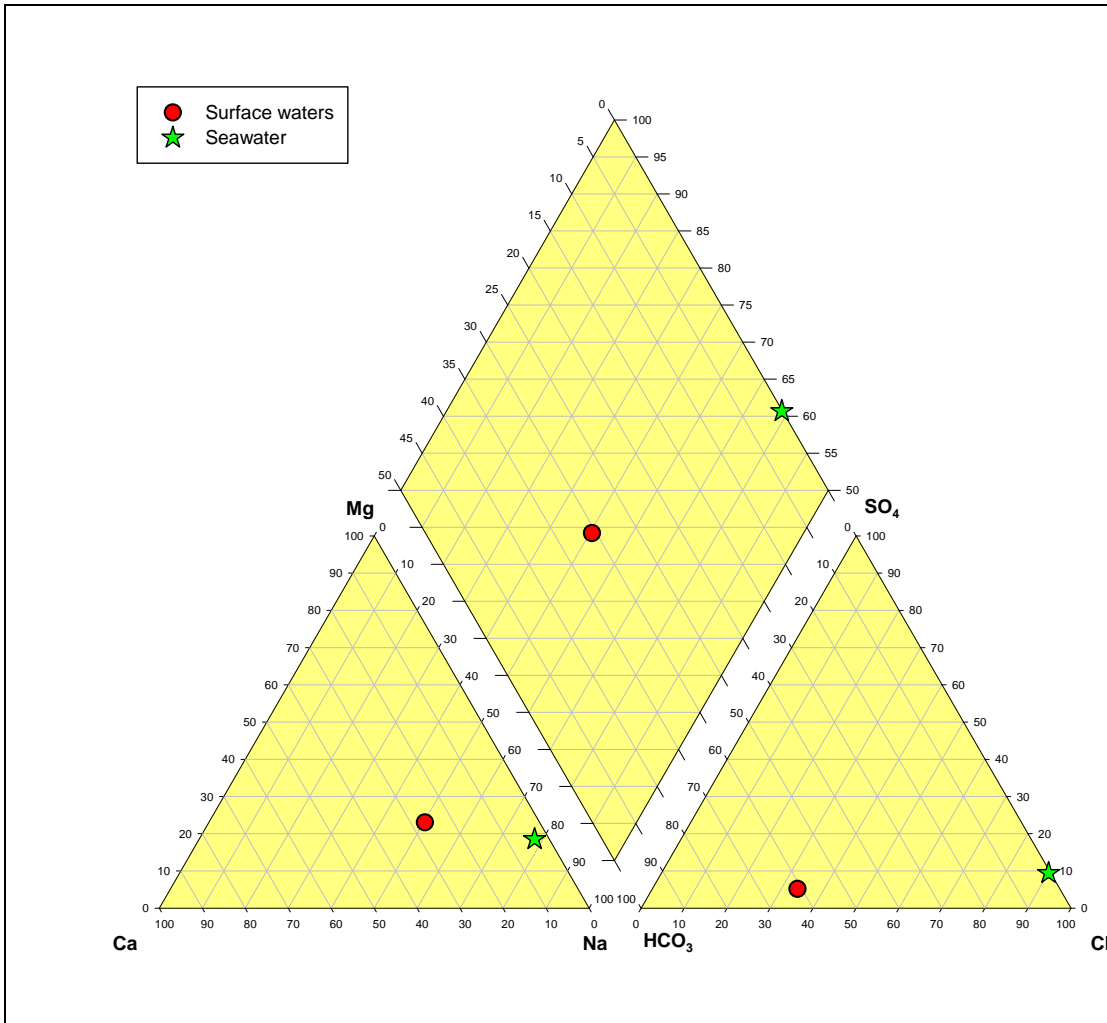


Figure 10-7. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 12486).



## 10.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12486) were identified as hyposulfidic for nearly all samples, subsoil samples from Profile 25 that occurred above the water were characterised as other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Soil (sandy) that occurred throughout the wetland and Other Soil (clayey).

The soils throughout the wetland were dominantly loamy textured in the water areas and clayey on the margins.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12486) are:

- Acidification hazard: The data identified moderate or low net acidity values in both profiles and pH<sub>OX</sub> data identified the surface sample from the profile in the water had a value that indicated a potential acidification hazard due to oxidation. There is a medium to high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The medium to high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12486):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic. Soils were loamy textured in the water areas and clayey on the margins. The profile below water had moderate net acidity values, and pH <sub>OX</sub> data for a few samples indicated a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (sandy) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Other Soil (clayey) – occurring on the creek bank margins of the wetland. Isolated (&lt;10%) in extent</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium to high level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>

**Table 10-2. Site description data for Katarapko Floodplain (Wetland ID. 12486).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
25	17/04/2010	461039	6202487	not reached	firm	grasses	high elevation, 1m from bank step down to water
26	17/04/2010	461041	6202491	90	water	water	low elevation, middle of creek

**Table 10-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12486).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
25_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	clay loam	moist		subangular blocky	very firm	contains sandy lenses
25_2	5 - 10	small pit	brown (10YR4/3)	clay	moist	15% yellowish brown In the matrix	subangular blocky	very firm	
25_3	10 - 20	small pit	brown (10YR4/3)	clay	moist	10% yellowish brown In the matrix	subangular blocky	very firm	
25_4	20 - 40	small pit	brown (10YR4/3)	clay	moist	5% yellowish brown In the matrix	subangular blocky	very firm	too clayey and hard to auger below water sampled
26_W1	90 - 0	surface water							
26_1	0 - 3	small pit	dark grey (5Y4/1)	mucky loamy sand	wet		gel	very weak	
26_2	3 - 10	small pit	dark grey (5Y4/1)	loamy sand	wet		single grain	weak	
26_3	10 - 20	small pit	dark grey (5Y4/1)	loamy sand	wet		single grain	weak	
26_4	20 - 40	small pit	olive grey (5Y5/2)	sandy clay loam	wet		massive	very firm	

**Table 10-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12486).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
25.1	0-5	Medium	2,306	6.25	3.31	6.11	6.87	100	6.16	9.81	0.01	..	..	16	hyposulfidic (S <sub>CR</sub> <0.10%)
25.2	5-10	Fine	1,858	6.84	3.67	6.49	7.04	37	6.39	2.45	<0.01	..	..	2	other soil material
25.3	10-20	Fine	1,343	7.06	3.90	6.80	7.09	35	6.46	1.47	0.01	..	..	8	hyposulfidic (S <sub>CR</sub> <0.10%)
25.4	20-40	Fine	1,712	7.48	5.98	7.42	7.69	9	6.75	0.00	<0.01	..	0.79	-105	other soil material
26.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
26.1	0-3	Coarse	46	6.70	2.06	6.83	4.58	7	6.03	3.43	0.03	..	..	22	hyposulfidic (S <sub>CR</sub> <0.10%)
26.2	3-10	Coarse	83	5.65	2.09	6.57	4.30	9	5.84	4.42	0.04	..	..	29	hyposulfidic (S <sub>CR</sub> <0.10%)
26.3	10-20	Coarse	26	6.55	2.16	6.47	4.26	61	6.42	1.47	0.03	..	..	20	hyposulfidic (S <sub>CR</sub> <0.10%)
26.4	20-40	Fine	65	6.95	3.07	6.84	5.47	23	5.87	5.89	0.01	..	..	12	hyposulfidic (S <sub>CR</sub> <0.10%)

**Table 10-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12486).**

	pH	SEC µS cm <sup>-1</sup>	DO mg l <sup>-1</sup>	Eh mV	Turbidity NTU	Alkalinity as HCO <sub>3</sub>
Surface waters (n=1)	7.35	228	9.3	-115	190	80

**Table 10-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12486).**

Parameter	units	ANZECC Guidelines	Site 26 (SW)
Na	mg l <sup>-1</sup>		22.7
K	mg l <sup>-1</sup>		4.4
Ca	mg l <sup>-1</sup>		11.7
Mg	mg l <sup>-1</sup>		6.12
Si	mg l <sup>-1</sup>		4.22
Br	mg l <sup>-1</sup>		0.1
Cl	mg l <sup>-1</sup>		26
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.406
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.02</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.047</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		5.4
Ag	µg l <sup>-1</sup>	0.05	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>240</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.7
Cd	µg l <sup>-1</sup>	0.2	0.07
Co	µg l <sup>-1</sup>	2.8	0.14
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.25
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>2.3</b>
Fe	µg l <sup>-1</sup>	300	187
Mn	µg l <sup>-1</sup>	1700	8
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.4
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.25
Se	µg l <sup>-1</sup>	11	<0.1
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>110</b>
DOC	mg l <sup>-1</sup>		7.0

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

- <sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.
- <sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).
- <sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.
- <sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).
- <sup>H</sup> Hardness affected (refer to Guidelines).
- <sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 11. KATARAPKO FLOODPLAIN (WETLAND ID. 12488)

### 11.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12488) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri, located in the Eckert Creek and the Splash area. The wetland is a crescent in shape formed from an oxbow lake and there are at least four linear creek lines connected and forming part of this wetland. It is about 3 kilometres in length and about 180 metres at its widest for the main part of the wetland excluding the connecting creeks, with a total surface area of 59 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Katarapko Floodplain Complex that were surveyed are wetland IDs. 12471, 12474, 12485, 12486, 12514 and 12526.

The wetland is probably connected to the river by the creek line at the southern end. At the time when the soil survey was conducted on 16<sup>th</sup> April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins and in some areas grasses on the creek bank, with open woodland and shrubland on the surrounding higher floodplain. Eight sites were sampled as shown in Figure 11-1.

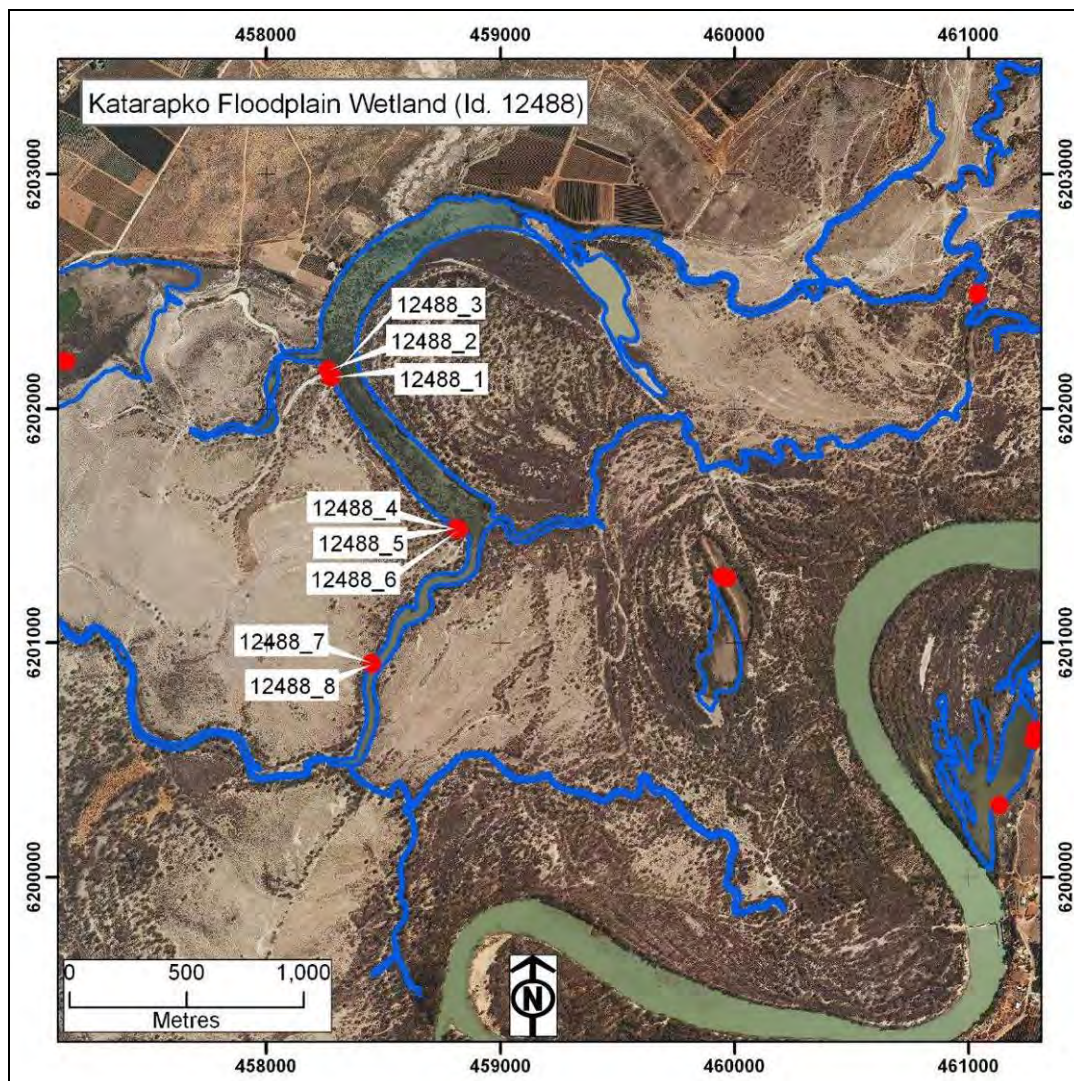


Figure 11-1. Katarapko Floodplain (Wetland ID. 12488) and sample site locations.

## 11.2. Soil profile description and distribution

Eight sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 11-1. Sites were distributed along three transects placed along the wetland, with transects at the northern end (Sites 1, 2, and 3), middle (Sites 4, 5 and 6), and on the creek line in the south (Sites 7 and 8) of the wetland. The site and soil profile descriptions are presented in Table 11-2 and Table 11-3, and a conceptual cross-section diagram in Figure 11-2.

### Northern transect

Site 1 (Figure 11-3) occurred on the bank adjacent to water, the water table was about 30 cm depth, and the soil consisted of a black, firm, sandy clay loam, over a greyish brown, firm, clay. Site 2 (Figure 11-4) occurred in water (30 cm deep), and the soil consisted of a dark grey, weak, sand, over a dark grey, very firm, clay. Site 3 (Figure 11-5) occurred in open water (90 cm deep), and the soil consisted of a dark grey, very weak, mucky clay with sulfurous odour, over a dark grey, very weak, clay.

### Middle transect

Site 4 (Figure 11-6) occurred adjacent to the bank in water (5 cm deep), and the soil consisted of a dark grey, loose, sand with sulfurous odour over a grey, firm sandy clay loam. Site 5 (Figure 11-7) occurred amongst reeds in water (40 cm deep), and the soil consisted of a dark greyish brown, very weak sandy peat, over an olive grey, very firm, sandy loam. Site 6 (Figure 11-8) occurred in open water (50 cm deep), and the soil consisted of an olive grey, very weak, mucky clay, over a very dark grey, very firm, clay loam.

### Southern transect

Site 7 (Figure 11-9) occurred near the bank in water (35 cm deep), and the soil consisted of a very dark grey, very weak, mucky clay, over a dark grey, very firm, clay. Site 8 (Figure 11-10) occurred in open water (80 cm deep), and the soil consisted of a dark grey, very weak, mucky sandy clay loam, over a very dark grey, very firm, sandy loam

**Table 11-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12488).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12488_1	458279	6202133	Other Soil (clayey)	on bank adjacent to open water
12488_2	458265	6202163	Subaqueous Soil (loamy)	in reeds
12488_3	458283	6202140	Subaqueous Soil (clayey)	low elevation, in open water
12488_4	458811	6201483	Subaqueous Soil (loamy)	edge of bank
12488_5	458814	6201489	Subaqueous Soil (loamy)	mid elevation in reeds
12488_6	458824	6201483	Subaqueous Soil (clayey)	open water, adjacent to reeds
12488_7	458452	6200913	Subaqueous Soil (clayey)	mid elevation, edge of open water adjacent to bank
12488_8	458454	6200909	Subaqueous Soil (loamy)	mid to low elevation, 5m from bank in water

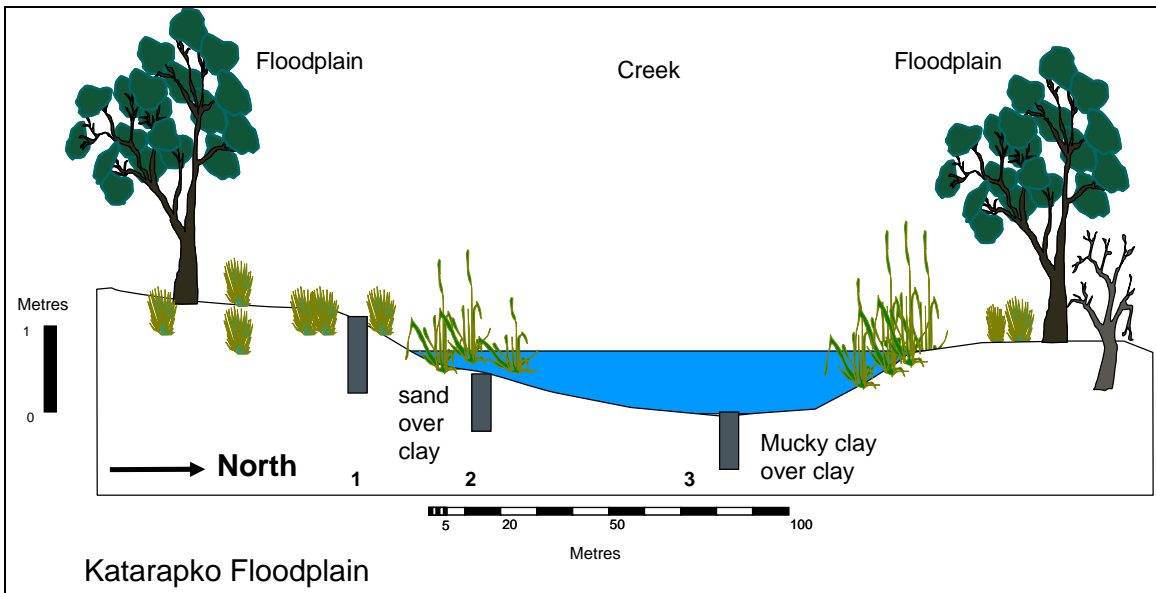


Figure 11-2. Conceptual cross-section diagram, showing locations for Sites 1, 2 and 3.



Figure 11-3. Photograph of Site 1, showing the site location on the creek bank wetland margin above the water, and the soil profile.



Figure 11-4. Photograph of Site 2, showing the site location adjacent to the bank amongst thick reeds in water.



Figure 11-5. Photograph of Site 3, showing the site location in open water.



**Figure 11-6. Photograph of Site 4, showing the site location on the bank in shallow water.**



**Figure 11-7. Photograph of Site 5, showing the site location amongst reeds in water.**



**Figure 11-8. Photograph of Site 6, showing the site location in open water.**



**Figure 11-9. Photograph of Site 7, showing the site location adjacent to the bank in water.**



**Figure 11-10. Photograph of Site 8, showing the site location in open water.**



### **11.3. Laboratory data assessment**

#### **11.3.1. Soil pH testing (pH<sub>W</sub>, pH<sub>OX</sub>, pH<sub>INC</sub>)**

The pH data are provided in Table 11-4 and pH profiles are presented in Figure 11-11. The pH<sub>W</sub> data ranged from 6.06 to 8.58 and sulfuric materials with a pH<sub>W</sub> <4 were not identified. The pH<sub>OX</sub> data ranged from 1.51 to 8.62 and identified that surface layers in Profiles 2, 3, 4, 5, 6, 7 and 8 were below the critical value of pH<sub>OX</sub> <2.5, the threshold value normally used to indicate a high likelihood of sulfuric material forming. The pH<sub>INC</sub> data ranged from 4.45 to 8.24 and identified that no samples on incubation declined below the critical values of pH <4.

#### **11.3.2. Acid base accounting**

The acid base accounting data is provided in Table 11-4 and summarised in Figure 11-12.

##### **Chromium reducible sulfur**

Chromium reducible sulfur values ranged from 0.0 to 0.19 %S<sub>CR</sub> and sulfidic materials were detected in all profiles.

##### **Titratable actual acidity**

Titratable actual acidity values ranged from 0.00 to 40.36 mole H<sup>+</sup>/tonne and were detected in all samples except one.

##### **Retained acidity**

Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

##### **Acid neutralising capacity**

Acid neutralising capacity values were 0 except for the lower subsoil of Profile 1 that was 0.91 %CaCO<sub>3</sub>.

##### **Net acidity**

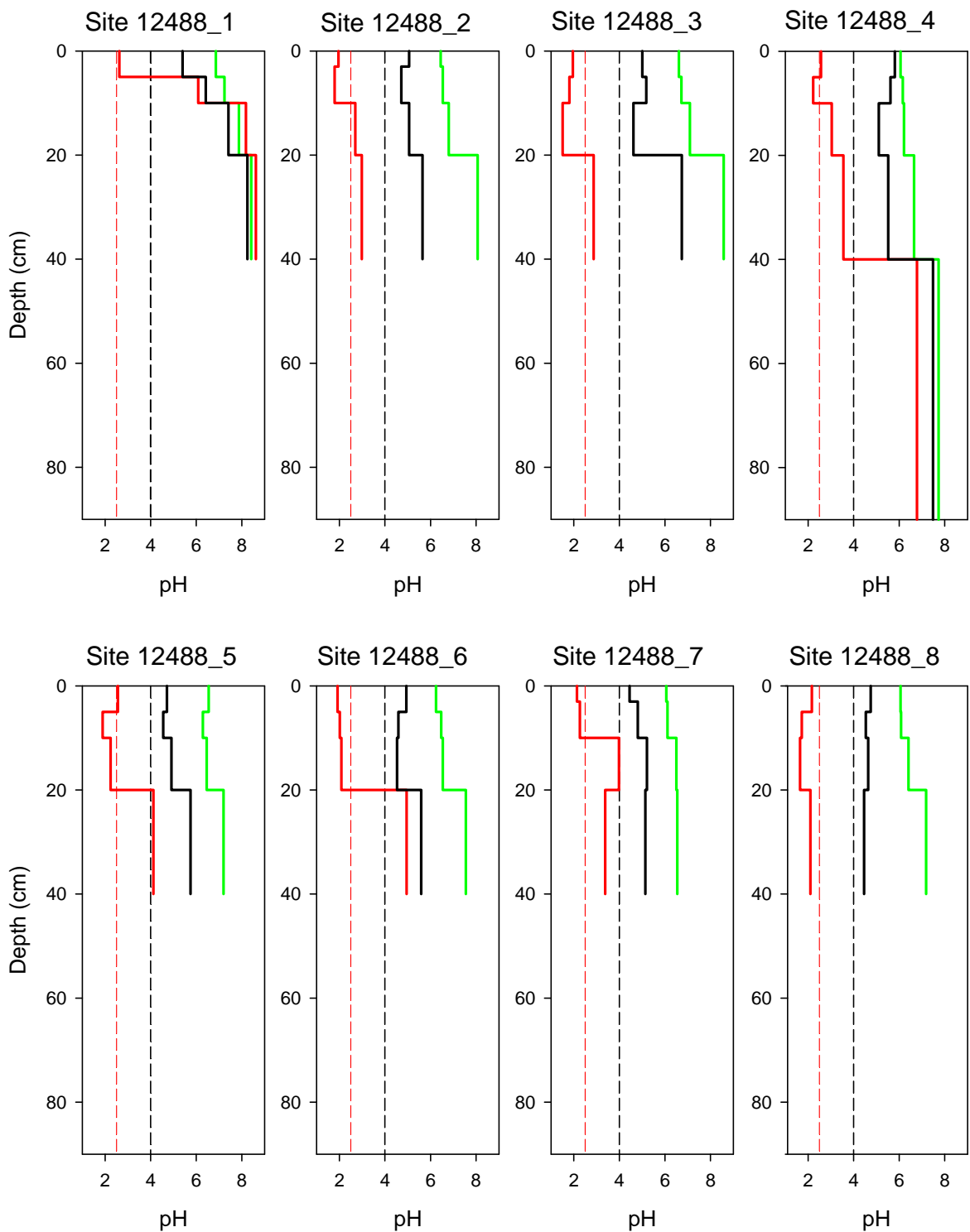
Net acidity values ranged from -121 to 141 mole H<sup>+</sup>/tonne. Samples had moderate or high net acidity values for all profile layers, except for the Profile 1 that had low or negative values for layers.

#### **11.3.3. Water soluble sulfate**

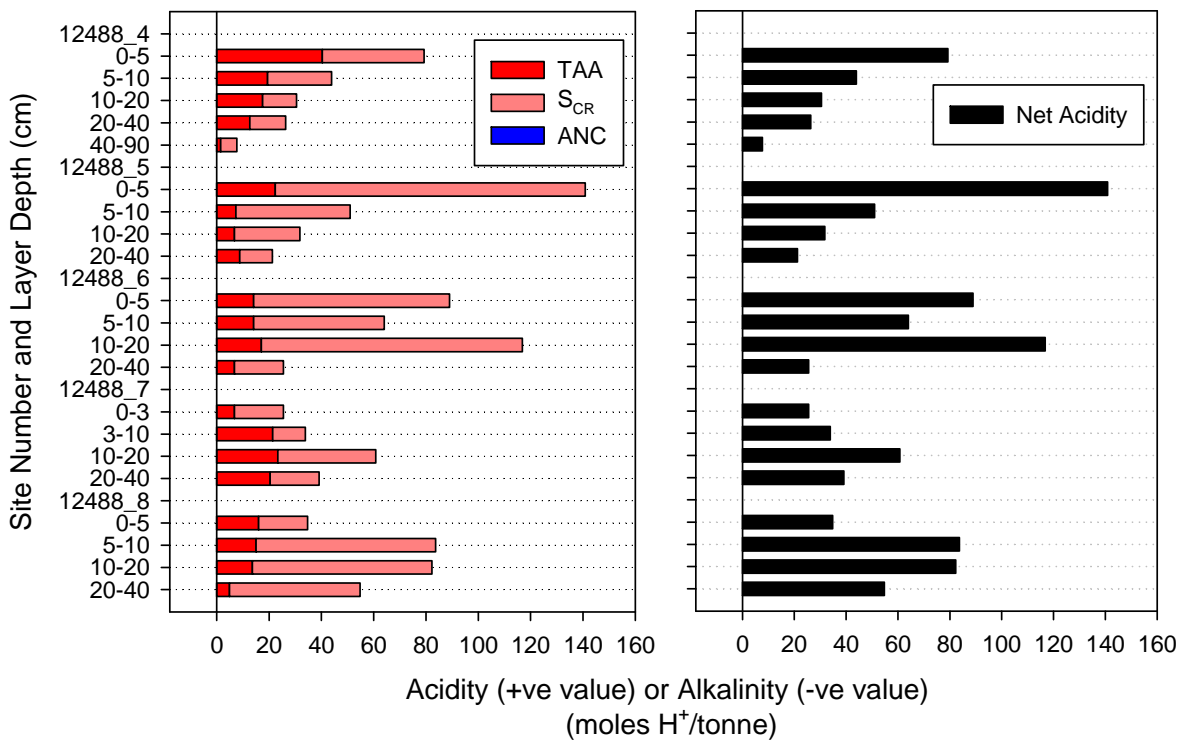
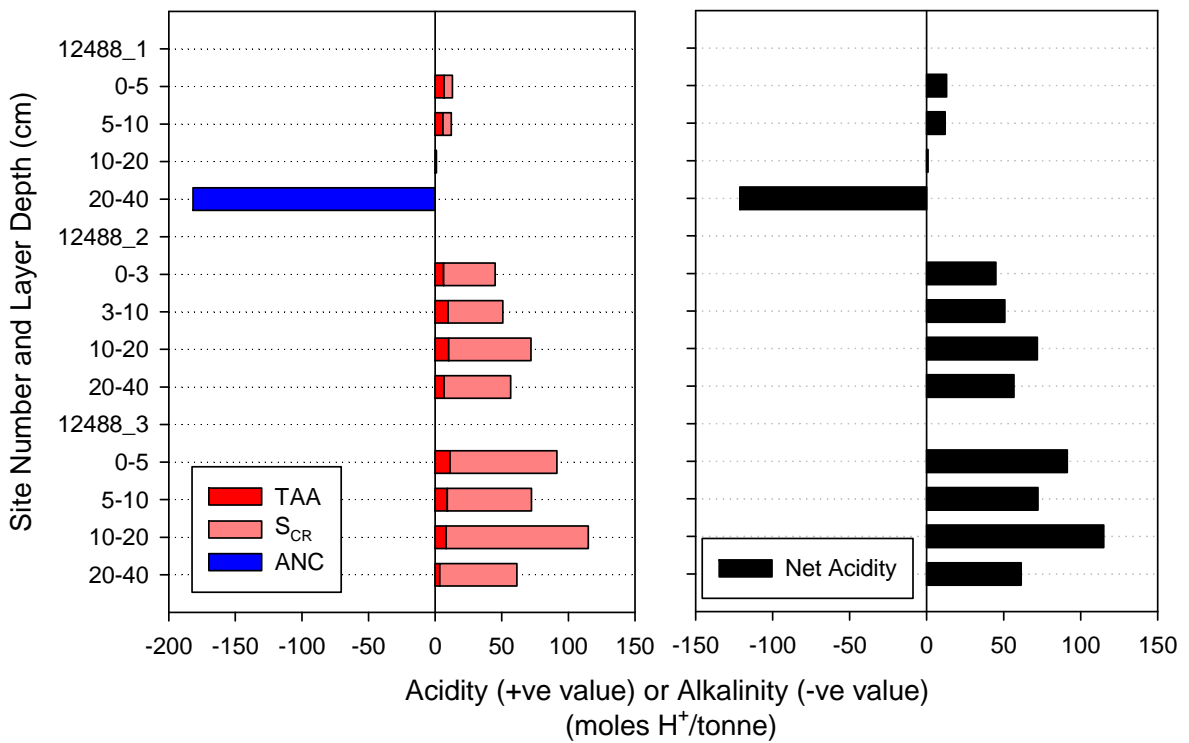
Water soluble sulfate data values shown in Table 11-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

#### **11.3.4. Acid volatile sulfur**

Monosulfidic materials were not observed and samples were not collected for analysis.



**Figure 11-11. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12488), showing soil pH (pH<sub>W</sub> as green line), peroxide treated pH (pH<sub>OX</sub> as red line) and incubation pH (pH<sub>INC</sub> after 8 weeks as black line). Critical pH<sub>W</sub> and pH<sub>INC</sub> value of 4 (black dashed line) and critical pH<sub>OX</sub> value of 2.5 (red dashed line).**



**Figure 11-12. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12488). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 11.3.5. Hydrochemistry

Three surface waters was collected from this narrow wetland. Field parameters are shown in Table 11-5. The surface waters had circumneutral pH and low salinity. Dissolved oxygen and turbidity were high, and alkalinity moderate.

The surface water was of Na-Cl to Na-HCO<sub>3</sub> type (Table 11-6, Figure 11-13). Sulfate concentration in the surface water varied from 8.6 to 12 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters (0.179 to 0.187) was slightly higher than seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values. Of the metals, Al and Zn (and Cu slightly) concentrations were elevated above ANZECC Guideline values.

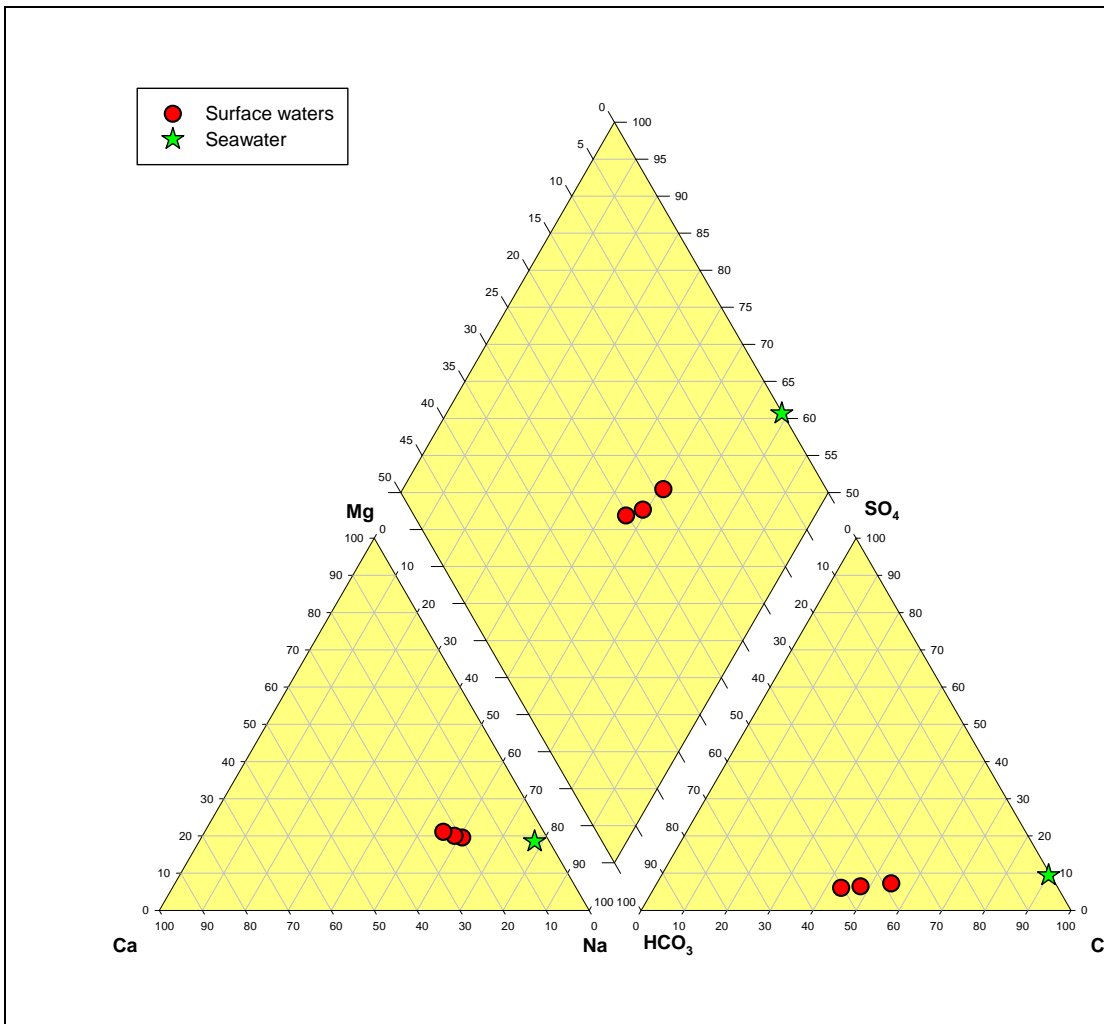


Figure 11-13. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 12488).

## 11.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12488) were identified as hyposulfidic for all layers of the eight profiles except for the subsoil layers from Profile 1 that occurred above water on the bank and were characterised as other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Soil (loamy or clayey) that occurred throughout the main wetland area, and Other Soil (loamy) occurred on the wetland banks.

The soils throughout the main wetland area were dominantly loamy textured in the surface layers and in isolated areas adjacent to the bank they were sandy textured. The subsoils were generally clayey and in some areas loamy in the narrower creeks.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12488) are:

- Acidification hazard: The data identified moderate or high net acidity values in nearly all profiles sampled below the water and low or negative values for the profile on the creek bank above the water level.  $pH_{Ox}$  data identified surface samples with values indicated a potential acidification hazard due to oxidation. There is a medium to high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The medium to high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a medium level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12488):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic for all profiles below water. Soils were loamy textured at the surface and loamy or clayey textured in the subsoil. Nearly all profiles below water had a moderate or high net acidity values, and $pH_{Ox}$ data for a few samples indicated a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (loamy or clayey) – occurring where there was surface water throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Other Soil (loamy) – occurring on the wetland margin above the water on the creek bank. Isolated (&lt;10%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – medium to high level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – medium level of concern</li> </ul>

**Table 11-2. Site description data for Katarapko Floodplain (Wetland ID. 12488).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	16/04/2010	458279	6202133	-30	firm	grasses	on bank adjacent to open water
2	16/04/2010	458265	6202163	30	water, firm	water, Typha	in reeds
3	16/04/2010	458283	6202140	90	water, soft	water	low elevation, in open water
4	16/04/2010	458811	6201483	5	water, root mat	water, grasses	edge of bank
5	16/04/2010	458814	6201489	40	water, firm	water, Typha	mid elevation in reeds
6	16/04/2010	458824	6201483	50	water, soft	water	open water, adjacent to reeds
7	16/04/2010	458452	6200913	35	water, firm	water	mid elevation, edge of open water adjacent to bank
8	16/04/2010	458454	6200909	80	water, soft	water	mid to low elevation, 5m from bank in water

**Table 11-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12488).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	black (10YR2/1)	sandy clay loam	moist		granular	firm	
1_2	5 - 10	small pit	greyish brown (10YR5/2)	clay loam	moist		angular blocky	firm	
1_3	10 - 20	small pit	greyish brown (10YR5/2)	clay	moist		angular blocky	firm	
1_4	20 - 40	small pit	greyish brown (2.5Y5/2)	clay	moist	50% strong brown In the matrix	angular blocky	very firm	too clayey to auger below
2_W	30 - 0	water							
2_1	0 - 3	small pit	very dark grey (5Y3/1)	sand	wet		single grain	loose	contains plant roots
2_2	3 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	weak	contains plant roots, sulfurous odour
2_3	10 - 20	small pit	dark grey (5Y4/1)	sandy clay loam	wet		massive	firm	
2_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist		massive	very firm	

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
3_W1	90 - 0	surface water							water sampled
3_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	weak sulfurous odour
3_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	sulfurous odour
3_3	10 - 20	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
3_4	20 - 40	small pit	dark grey (2.5Y4/0)	clay	wet		massive	very weak	
4_W	5 - 0	water							
4_1	0 - 5	small pit	dark grey (5Y4/1)	sand	wet		single grain	loose	very thick root mat, weak sulfurous odour
4_2	5 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	loose	very thick root mat, weak sulfurous odour
4_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	sandy clay loam	wet		massive	weak	
4_4	20 - 40	small pit	very dark grey (2.5Y3/0)	sandy clay loam	moist		massive	firm	
4_5	40 - 90	small pit	grey (5Y5/1)	sandy clay loam	moist		massive	firm	isolated natronite
5_W	40 - 0	water							
5_1	0 - 5	small pit	dark greyish brown (10YR4/2)	peaty sand	wet		massive	very weak	sulfurous odour
5_2	5 - 10	small pit	olive grey (5Y4/2)	sand	wet		massive	firm	sulfurous odour
5_3	10 - 20	small pit	olive grey (5Y4/2)	sandy loam	wet		massive	firm	
5_4	20 - 40	small pit	olive grey (5Y4/2)	sandy loam	moist		massive	very firm	
6_W1	50 - 0	surface water							water sampled
6_1	0 - 5	small pit	olive grey (5Y4/2)	mucky clay	wet		gel	very weak	sulfurous odour
6_2	5 - 10	small pit	olive grey (5Y4/2)	mucky clay	wet		gel	very weak	sulfurous odour
6_3	10 - 20	small pit	very dark grey (5Y3/1)	mucky clay	wet		massive	very weak	
6_4	20 - 40	small pit	very dark grey (5Y3/1)	clay loam	moist		massive	very firm	
7_W	35 - 0	water							
7_1	0 - 3	small pit	very dark grey (5Y3/1)	mucky clay	wet		gel	very weak	
7_2	3 - 10	small pit	dark grey (2.5Y4/0)	clay loam	wet		massive	very firm	
7_3	10 - 20	small pit	dark grey (2.5Y4/0)	clay loam	wet		massive	very firm	
7_4	20 - 40	small pit	dark grey (2.5Y4/0)	clay	moist		massive	very firm	
8_W1	80 - 0	surface water							water sampled
8_1	0 - 5	small pit	dark grey (5Y4/1)	mucky sandy clay loam	wet		gel	very weak	
8_2	5 - 10	small pit	very dark grey (5Y3/1)	sandy loam	wet		massive	very weak	
8_3	10 - 20	small pit	very dark grey (5Y3/1)	sandy loam	wet		massive	very weak	
8_4	20 - 40	small pit	dark grey (5Y4/1)	sandy loam	moist		massive	very firm	

**Table 11-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12488).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	223	6.86	2.62	6.49	5.40	16	6.02	6.81	0.01	..	0.00	13	hyposulfidic (S <sub>CR</sub> <0.10%)
1.2	5-10	Fine	269	7.24	6.09	7.01	6.42	12	6.02	5.83	0.01	..	0.00	12	hyposulfidic (S <sub>CR</sub> <0.10%)
1.3	10-20	Fine	616	7.87	8.18	7.48	7.41	21	6.46	0.97	<0.01	..	0.00	1	other soil material
1.4	20-40	Fine	1,950	8.41	8.62	7.94	8.24	180	6.95	0.00	<0.01	..	0.91	-121	other soil material
2.1	0-3	Medium	66	6.45	1.96	6.70	5.06	44	5.87	6.32	0.06	..	..	45	hyposulfidic (S <sub>CR</sub> <0.10%)
2.2	3-10	Medium	43	6.54	1.79	6.64	4.72	87	5.35	9.72	0.07	..	..	51	hyposulfidic (S <sub>CR</sub> <0.10%)
2.3	10-20	Fine	42	6.80	2.70	6.95	5.06	82	5.31	10.21	0.10	..	..	72	hyposulfidic (S <sub>CR</sub> <0.10%)
2.4	20-40	Fine	200	8.07	2.98	7.42	5.65	65	5.87	6.81	0.08	..	..	57	hyposulfidic (S <sub>CR</sub> <0.10%)
3.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
3.1	0-5	Fine	59	6.61	1.96	7.00	5.01	45	5.85	11.18	0.13	..	..	91	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.2	5-10	Fine	47	6.72	1.81	6.94	5.18	59	5.47	9.24	0.10	..	..	72	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.3	10-20	Fine	72	7.10	1.51	7.13	4.62	110	5.72	8.27	0.17	..	..	115	hyposulfidic (S <sub>CR</sub> ≥0.10%)
3.4	20-40	Fine	154	8.58	2.87	7.39	6.74	60	6.35	3.40	0.09	..	0.00	61	hyposulfidic (S <sub>CR</sub> <0.10%)
4.1	0-5	Medium	108	6.06	2.57	6.24	5.81	51	4.95	40.36	0.06	..	..	79	hyposulfidic (S <sub>CR</sub> <0.10%)
4.2	5-10	Medium	88	6.16	2.23	6.32	5.62	28	5.03	19.45	0.04	..	..	44	hyposulfidic (S <sub>CR</sub> <0.10%)
4.3	10-20	Fine	85	6.21	3.04	6.74	5.11	20	4.90	17.51	0.02	..	..	30	hyposulfidic (S <sub>CR</sub> <0.10%)
4.4	20-40	Fine	117	6.65	3.55	7.12	5.52	17	5.24	12.64	0.02	..	..	26	hyposulfidic (S <sub>CR</sub> <0.10%)
4.5	40-90	Fine	127	7.73	6.78	7.40	7.48	11	6.42	1.46	0.01	..	0.00	8	hyposulfidic (S <sub>CR</sub> <0.10%)
5.1	0-5	Medium	82	6.55	2.56	6.63	4.71	93	5.81	22.37	0.19	..	..	141	hyposulfidic (S <sub>CR</sub> ≥0.10%)
5.2	5-10	Fine	70	6.29	1.89	6.60	4.55	37	5.65	7.29	0.07	..	..	51	hyposulfidic (S <sub>CR</sub> <0.10%)
5.3	10-20	Fine	58	6.46	2.24	6.71	4.91	40	5.62	6.81	0.04	..	..	32	hyposulfidic (S <sub>CR</sub> <0.10%)
5.4	20-40	Fine	84	7.20	4.12	6.85	5.75	19	5.80	8.75	0.02	..	..	21	hyposulfidic (S <sub>CR</sub> <0.10%)
6.W1	50-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
6.1	0-5	Fine	71	6.24	1.92	6.73	4.94	50	5.66	14.10	0.12	..	..	89	hyposulfidic (S <sub>CR</sub> ≥0.10%)
6.2	5-10	Fine	53	6.47	2.02	6.78	4.59	57	5.53	14.10	0.08	..	..	64	hyposulfidic (S <sub>CR</sub> <0.10%)
6.3	10-20	Fine	68	6.54	2.09	6.82	4.53	72	5.37	17.02	0.16	..	..	117	hyposulfidic (S <sub>CR</sub> ≥0.10%)
6.4	20-40	Fine	110	7.55	4.95	7.11	5.59	33	6.08	6.81	0.03	..	0.00	26	hyposulfidic (S <sub>CR</sub> <0.10%)
7.1	0-3	Fine	33	6.06	2.14	6.96	4.45	35	5.81	6.81	0.03	..	..	26	hyposulfidic (S <sub>CR</sub> <0.10%)
7.2	3-10	Fine	39	6.11	2.27	6.86	4.81	50	4.91	21.40	0.02	..	..	34	hyposulfidic (S <sub>CR</sub> <0.10%)
7.3	10-20	Fine	41	6.50	3.98	7.02	5.21	58	5.18	23.34	0.06	..	..	61	hyposulfidic (S <sub>CR</sub> <0.10%)
7.4	20-40	Fine	38	6.54	3.38	6.95	5.14	64	5.02	20.42	0.03	..	..	39	hyposulfidic (S <sub>CR</sub> <0.10%)



Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity ( $\text{mole H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%S_{\text{CR}}$ )	Retained Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
8.W1	80-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
8.1	0-5	Fine	44	6.06	2.17	6.88	4.75	57	5.29	16.05	0.03	..	..	35	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
8.2	5-10	Fine	40	6.08	1.72	6.72	4.53	84	5.12	15.07	0.11	..	..	84	hyposulfidic ( $S_{\text{CR}} \geq 0.10\%$ )
8.3	10-20	Medium	32	6.41	1.65	6.71	4.64	91	5.22	13.62	0.11	..	..	82	hyposulfidic ( $S_{\text{CR}} \geq 0.10\%$ )
8.4	20-40	Medium	34	7.18	2.10	6.83	4.46	56	5.75	4.86	0.08	..	..	55	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )

**Table 11-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12488).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=3)	6.85-7.07	257-368	8.0-10.8	-154- -100	160-210	80-91

**Table 11-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12488).**

Parameter	units	ANZECC Guidelines	Site 3 (SW)	Site 6 (SW)	Site 8 (SW)
Na	mg l <sup>-1</sup>		37.2	32.2	27.5
K	mg l <sup>-1</sup>		5.0	4.8	4.7
Ca	mg l <sup>-1</sup>		11.4	11.1	11.1
Mg	mg l <sup>-1</sup>		6.85	6.32	6.08
Si	mg l <sup>-1</sup>		3.85	3.58	3.86
Br	mg l <sup>-1</sup>		0.2	0.1	0.1
Cl	mg l <sup>-1</sup>		67	52	46
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.074	<0.022	<0.022
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.02</b>	<b>0.022</b>	<b>0.023</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.025</b>	<b>0.017</b>	<b>0.017</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		12	9.5	8.6
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>140</b>	<b>130</b>	<b>240</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.5	1.2	1.2
Cd	µg l <sup>-1</sup>	0.2	0.04	0.05	0.04
Co	µg l <sup>-1</sup>	2.8	0.12	0.12	0.15
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	0.2	0.2	0.3
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>1.8</b>	<b>2</b>	<b>2</b>
Fe	µg l <sup>-1</sup>	300	124	112	245
Mn	µg l <sup>-1</sup>	1700	18.51	21.88	9.24
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	1.3	1.2	1.3
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.18	0.16	0.28
Se	µg l <sup>-1</sup>	11	0.06	0.06	0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>105</b>	<b>135</b>	<b>109</b>
DOC	mg l <sup>-1</sup>		6.5	7.3	7.6

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

- <sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.
- <sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).
- <sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.
- <sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).
- <sup>H</sup> Hardness affected (refer to Guidelines).
- <sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 12. KATARAPKO FLOODPLAIN (WETLAND ID. 12514)

### 12.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12514) is situated on the western side of the River Murray, about 10 kilometres directly north of the town of Loxton, located in the Katarapko Creek and Katarapko Island area. The wetland is linear in shape. It is about 800 metres in length and about 50 metres at its widest, with a total surface area of 4 hectares. The wetland is bounded to the east by a raised floodplain that separates it from other wetlands and the river and to the west by a hill slope. The other associated wetland in the Katarapko Creek and Katarapko Island Complex that was surveyed was Wetland ID. 12526.

The wetland is not connected to the river. At the time when the soil survey was conducted on May 2010 the wetland had no surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). The wetland surface was covered by vegetation (not identified), with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 12-1.

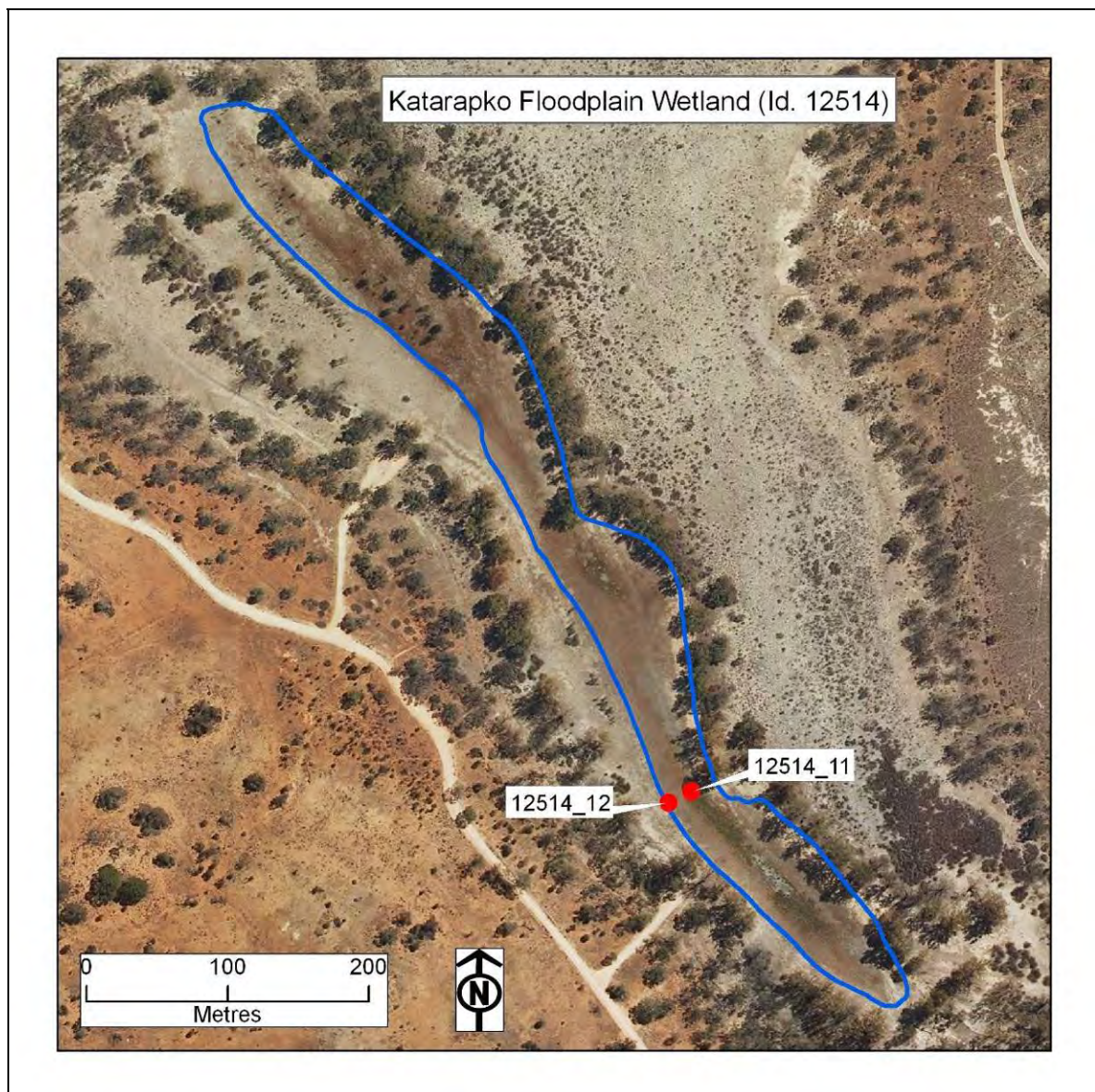


Figure 12-1. Katarapko Floodplain (Wetland ID. 12514) and sample site locations.

## 12.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 12-1. Sites were placed near the middle and margin (Sites 11 and 12) of the wetland. The site and soil profile descriptions are presented in Table 12-2 and Table 12-3.

Middle transect

Site 11 (Figure 12-2) occurred on near the middle of the wetland, and the soil consisted of a dark grey, very firm, clay. Site 12 (Figure 12-3) occurred near the margin of the wetland, and the soil consisted of a dark greyish brown, rigid, clay.

**Table 12-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12514).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12514_11	457665	6196214	Other Soil (clayey)	low elevation, middle of wetland
12514_12	457649	6196206	Other Soil (clayey)	high elevation on margin



**Figure 12-2. Photographs of Site 11, showing the site location in the wetland area covered by plants, and the soil profile.**



**Figure 12-3. Photographs of Site 12, showing the site location in the wetland and the wetland margin with trees growing, and the soil profile.**

## **12.3. Laboratory data assessment**

### **12.3.1. Soil pH testing (pH<sub>W</sub>, pH<sub>OX</sub>, pH<sub>INC</sub>)**

The pH data are provided in Table 12-4 and pH profiles are presented in Figure 12-4. The pH<sub>W</sub> data ranged from 6.15 to 7.26 and sulfuric materials with a pH<sub>W</sub> <4 were not identified. The pH<sub>OX</sub> data ranged from 4.03 to 7.78 and identified that no samples were below the critical value of pH<sub>OX</sub> <2.5. The pH<sub>INC</sub> data ranged from 6.18 to 7.20 and identified that no samples on incubation declined below the critical values of pH <4.

### **12.3.2. Acid base accounting**

The acid base accounting data is provided in Table 12-4 and summarised in Figure 12-5.

#### **Chromium reducible sulfur**

Chromium reducible sulfur values ranged from 0.0 to 0.03 %S<sub>CR</sub> and sulfidic material was detected in one sample.

#### **Titrateable actual acidity**

Titrateable actual acidity values ranged from 4.36 to 12.10 mole H<sup>+</sup>/tonne and were detected in all samples.

#### **Retained acidity**

Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

#### **Acid neutralising capacity**

Acid neutralising capacity values were not measured in any sample.

#### **Net acidity**

Net acidity values ranged from 4 to 31 mole H<sup>+</sup>/tonne. Generally profile samples had low net acidity values and a moderate value occurred in the subsoil of Profile 11.

### **12.3.3. Water soluble sulfate**

Water soluble sulfate data values shown in Table 12-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### **12.3.4. Acid volatile sulfur**

Monosulfidic materials were not observed and samples were not collected for analysis.

### **12.3.5. Hydrochemistry**

Water was not observed on the surface or in the soil pit and no samples for analysis was collected.

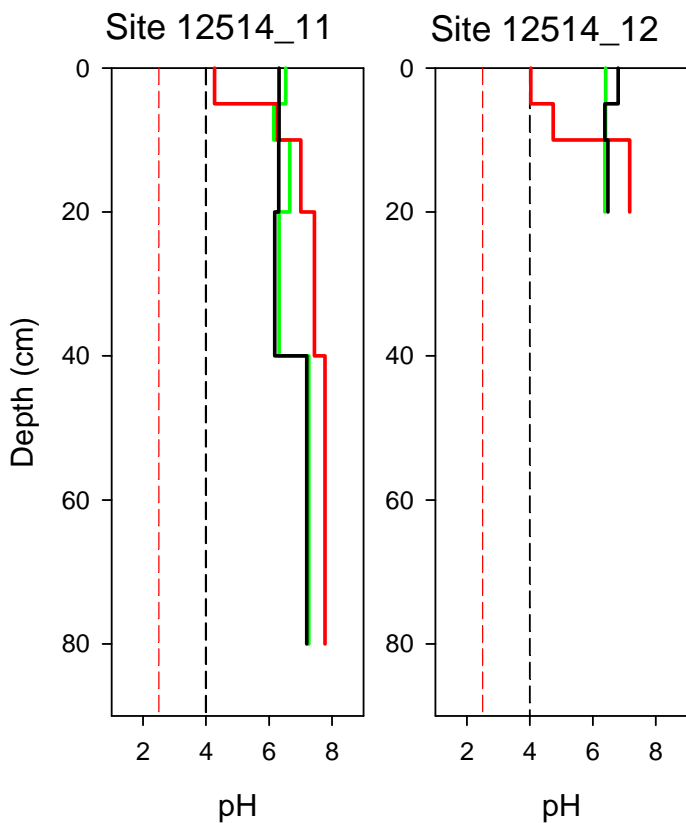


Figure 12-4. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12514), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

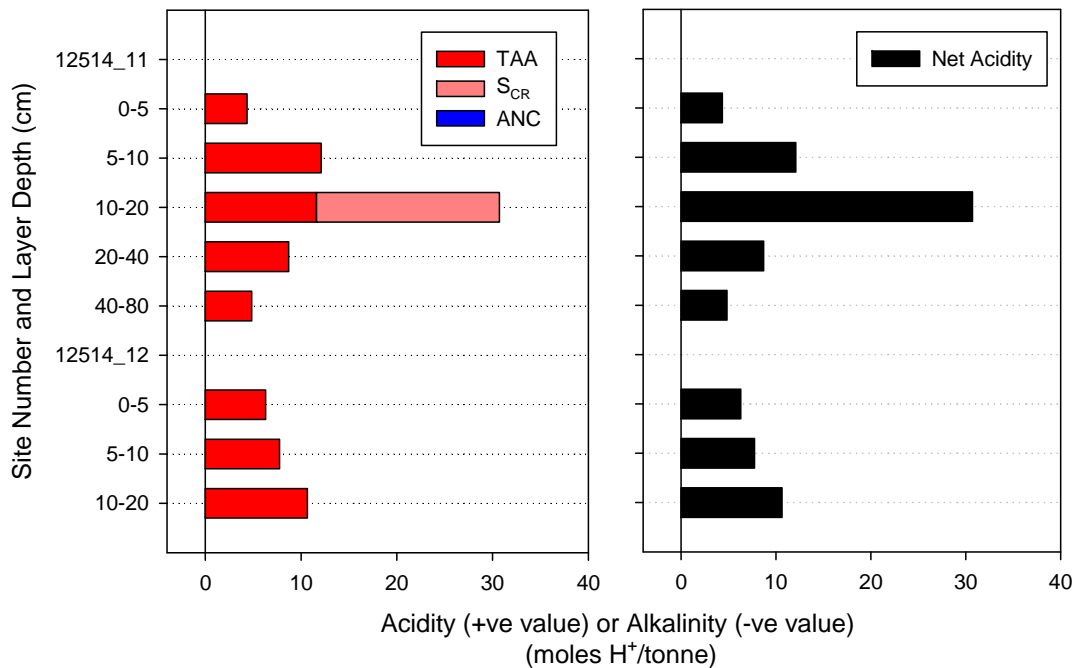


Figure 12-5. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12514). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as  $S_{CR}$  - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

## 12.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12514) were identified as hyposulfidic in one sample for Profile 11, and the remaining samples were classified as other soil material. The acid sulfate soil subtype class identified was Other Soil (clayey) that occurred throughout the wetland.

The soils throughout the wetland were dominantly clayey textured in the surface layers. The subsoils were clayey textured.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12514) are:

- Acidification hazard: The data identified low net acidity values in most samples and pH data did not indicate a potential acidification hazard due to oxidation. There is a low level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The low acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12514):

<b>Soil materials:</b>	The soil layers were characterised as generally as other soil materials. Soils were clayey textured in the surface and subsoil layers. Throughout the wetland there were generally low net acidity values, but pH data did not indicate a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Other Soil (clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – low level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – low level of concern</li> </ul>

**Table 12-2. Site description data for Katarapko Floodplain (Wetland ID. 12514).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
11	3/05/2010	457665	6196214	not reached	cracking, very hard	weed cover	low elevation, middle of wetland
12	3/05/2010	457649	6196206	not reached	cracking, rigid	weed cover	high elevation on margin

**Table 12-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12514).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
11_1	0 - 5	small pit	dark grey (10YR4/1)	clay	dry	10% brownish yellow infused into the matrix adjacent to pores	angular blocky	rigid	contains white salts on ped faces
11_2	5 - 10	small pit	dark grey (10YR4/1)	clay	moist	10% brownish yellow infused into the matrix adjacent to pores	angular blocky	very firm	
11_3	10 - 20	small pit	dark grey (10YR4/1)	clay	moist	10% brownish yellow infused into the matrix adjacent to pores	angular blocky	very firm	
11_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist	5% brownish yellow infused into the matrix adjacent to pores	massive	very firm	
11_5	40 - 80	push tube	dark grey (10YR4/1)	clay	moist		massive	rigid	
12_1	0 - 5	small pit	greyish brown (10YR5/2)	sandy clay loam	dry		angular blocky	rigid	
12_2	5 - 10	small pit	greyish brown (10YR5/2)	sandy clay loam	dry	5% yellowish brown infused into the matrix adjacent to pores	angular blocky	rigid	
12_3	10 - 20	small pit	greyish brown (10YR5/2)	clay	dry	5% yellowish brown infused into the matrix adjacent to pores	angular blocky	rigid	too hard to auger below



**Table 12-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12514).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity (mole $\text{H}^+$ /tonne)	Chromium Reducible Sulfur ( $\%\text{S}_{\text{CR}}$ )	Retained Acidity (mole $\text{H}^+$ /tonne)	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity (mole $\text{H}^+$ /tonne)	Acid Sulfate Soil Material Classification
11.1	0-5	Fine	1,495	6.53	4.27	6.19	6.32	43	6.31	4.36	<0.01	..	0.00	4	other soil material
11.2	5-10	Fine	226	6.15	6.26	6.30	6.32	12	5.59	12.10	<0.01	..	..	12	other soil material
11.3	10-20	Fine	160	6.66	7.01	6.44	6.31	13	5.46	11.61	0.03	..	..	31	hyposulfidic ( $\text{S}_{\text{CR}} < 0.10\%$ )
11.4	20-40	Fine	127	6.32	7.44	6.27	6.18	10	5.71	8.71	<0.01	..	..	9	other soil material
11.5	40-80	Fine	191	7.26	7.78	7.14	7.20	14	6.16	4.84	<0.01	..	0.00	5	other soil material
12.1	0-5	Fine	326	6.41	4.03	6.54	6.80	13	6.00	6.29	<0.01	..	0.00	6	other soil material
12.2	5-10	Fine	390	6.40	4.74	5.98	6.38	14	5.69	7.74	<0.01	..	..	8	other soil material
12.3	10-20	Fine	116	6.38	7.17	6.41	6.48	5	5.62	10.65	<0.01	..	..	11	other soil material

### 13. KATARAPKO FLOODPLAIN (WETLAND ID. 12526)

#### 13.1. Location and setting description

Katarapko Floodplain (Wetland ID. 12526) is situated on the western side of the River Murray, opposite the town of Loxton with the southern inlet about 5 kilometres down river from the town of Loxton, located in the Katarapko Creek and Katarapko Island area. The wetland is a creek linear in shape. It is about 12 kilometres in length and about 50 metres at its widest, with a total surface area of 106 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetland in the Katarapko Creek and Katarapko Island Complex that was surveyed is Wetland ID. 12514.

The wetland is permanently connected to the river at the northern and southern ends and provides an alternative flow path for the river water. At the time when the soil survey was conducted in May 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins and in some areas grasses on the creek bank, with open woodland and shrubland on the surrounding higher floodplain. Twelve sites were sampled as shown in Figure 13-1.

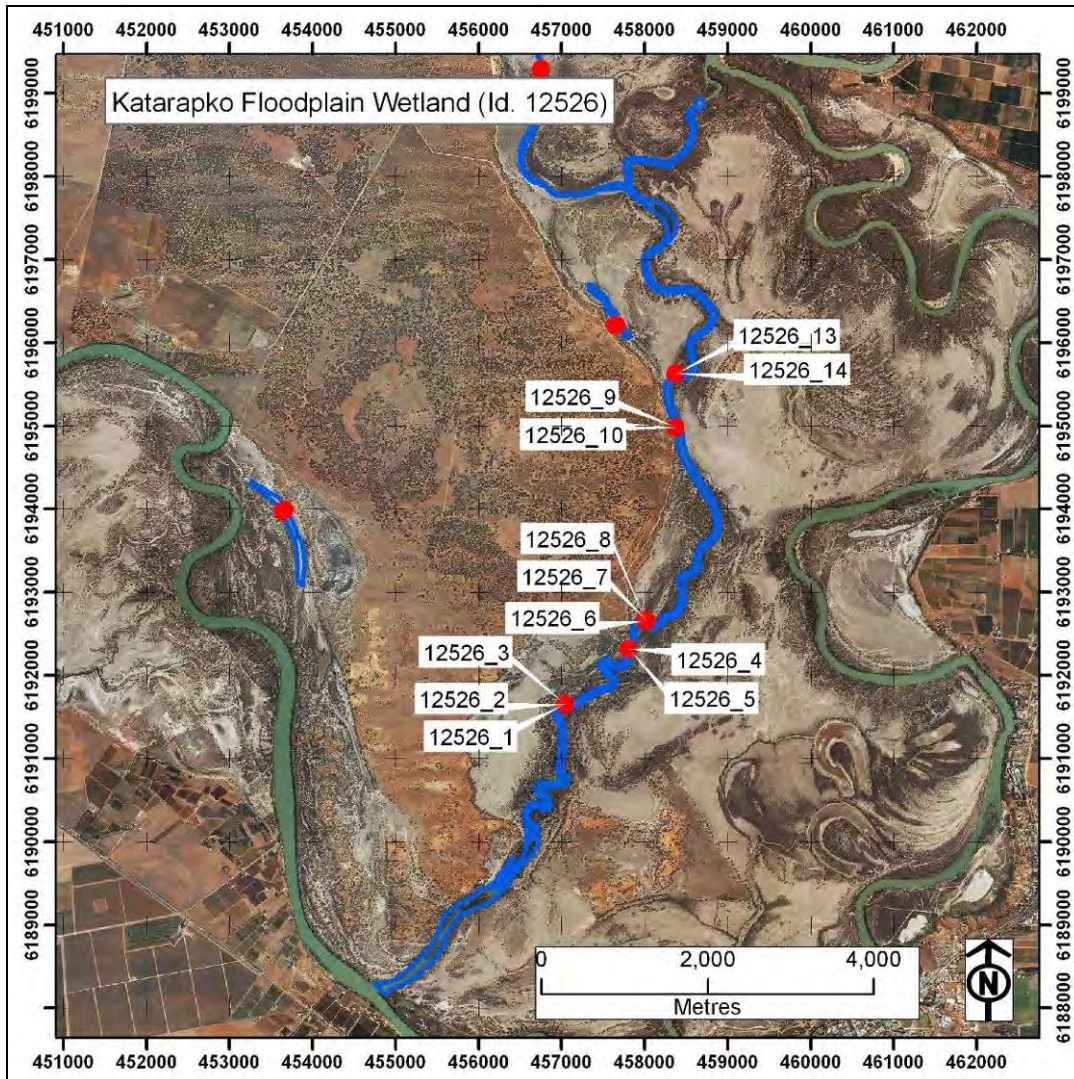


Figure 13-1. Katarapko Floodplain (Wetland ID. 12526) and sample site locations.

## 13.2. Soil profile description and distribution

Twelve sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 13-1. Sites were distributed along the wetland creek at five places, southern end (Sites 1, 2, and 3), southern to middle (Sites 4 and 5), middle (Sites 6, 7 and 8), northern to middle (Sites 9 and 10), and northern end (Sites 13 and 14) of the wetland. The site and soil profile descriptions are presented in Table 13-2 and Table 13-3, and a conceptual cross-section in Figure 13-2.

### Southern transect

Site 1 (Figure 13-3) occurred on the bank adjacent to water, and the soil consisted of a brown, firm, clay loam, over a dark greyish brown, very firm, clay. Site 2 (Figure 13-4) occurred amongst Phragmites in water (30 cm deep), and the soil consisted of a dark grey, firm, sandy clay loam, over a dark grey, very firm, clay. Site 3 (Figure 13-5) occurred in open water (90 cm deep), and the soil consisted of a dark grey, weak, sandy loam, over a grey, very firm, clay loam.

### Southern to middle transect

Site 4 (Figure 13-6) occurred adjacent to the bank amongst Typha in water (50 cm deep), and the soil consisted of a brownish yellow, firm, sandy clay loam and root mat, over a grey, very firm clay. Site 5 (Figure 13-7) occurred in open water (90 cm deep), and the soil consisted of a dark grey, very firm, sandy clay loam, over a grey, very firm clay loam.

### Middle transect

Site 6 (Figure 13-8) occurred adjacent to the bank in thick reeds and water (30 cm deep), and the soil consisted of a dark grey, very firm, loamy sand and root mat, over a dark grey, very firm, clay. Site 7 (Figure 13-9) occurred at the edge of reeds to open water (50 cm deep), and the soil consisted of a very dark grey, weak, sand, over a grey, firm sandy loam to clay loam at depth. Site 8 (Figure 13-10) occurred in open water (90 cm deep), and the soil consisted of a grey, very weak, sandy loam, over a grey, very weak, sandy clay loam.

### Northern to middle transect

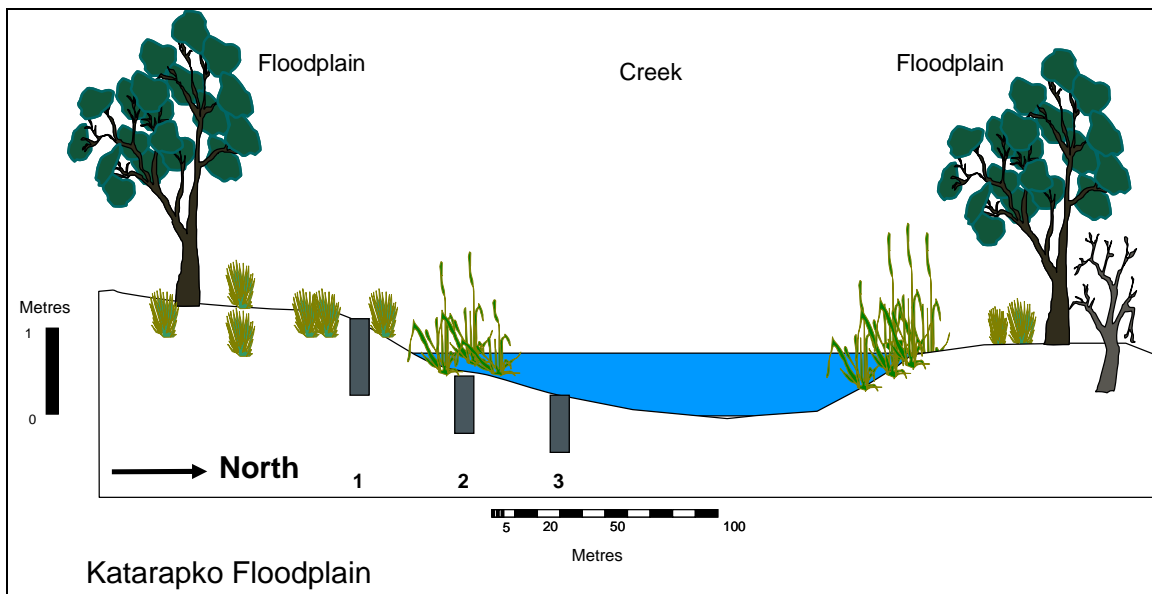
Site 9 (Figure 13-11) occurred adjacent to the bank in water (50 cm deep), and the soil consisted of a grey, very firm, clay. Site 10 (Figure 13-12) occurred in open water (90 cm deep), and the soil consisted of a dark grey, very firm, clay.

### Northern transect

Site 13 (Figure 13-13) occurred adjacent to the bank amongst Phragmites in water (40 cm deep), and the soil consisted of a grey, weak, sand with a sulfurous odour. Site 14 (Figure 13-14) occurred in open water (70 cm deep), and the soil consisted of a grey, weak, sand.

**Table 13-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 12526).**

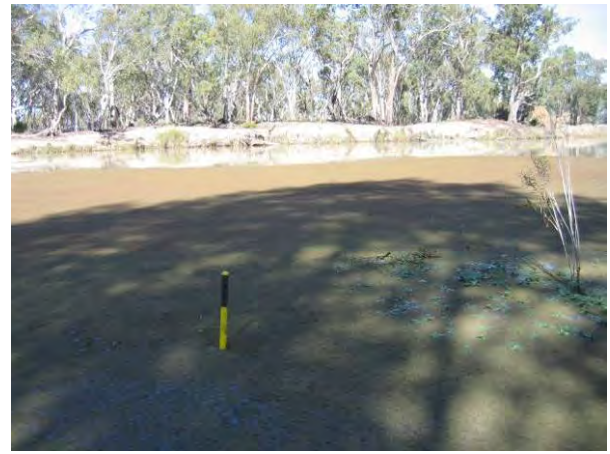
Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12526_1	457044	6191655	Other Soil (clayey)	on edge of bank
12526_2	457046	6191651	Subaqueous Soil (loamy)	in reed on water margin adjacent to bank 2m away
12526_3	457041	6191648	Subaqueous Soil (loamy)	open water, 5m from bank
12526_4	457810	6192319	Subaqueous Soil (loamy)	edge of water next to step down from bank in reeds
12526_5	457812	6192314	Subaqueous Soil (loamy)	open water, 3m from bank and reeds
12526_6	458028	6192657	Subaqueous Soil (clayey)	in thick reeds, near edge of bank
12526_7	458024	6192660	Subaqueous Soil (loamy)	in reeds adjacent to open water
12526_8	458006	6192668	Subaqueous Soil (loamy)	open water, 10m from bank
12526_9	458372	6194982	Subaqueous Soil (clayey)	edge of water next to step down from bank
12526_10	458375	6194981	Subaqueous Soil (clayey)	open water, 5m from bank
12526_13	458375	6195625	Hypersulfidic Subaqueous Soil (sandy)	edge of water near bank
12526_14	458377	6195628	Hypersulfidic Subaqueous Soil (sandy)	open water, 5m from bank



**Figure 13-2. Conceptual cross-section diagram.**



**Figure 13-3. Photographs of Site 1, showing the site location on the creek bank wetland margin above the water, and the soil profile.**



**Figure 13-4. Photograph of Site 2, showing the site location adjacent to the bank amongst reeds in water.**

**Figure 13-5. Photograph of Site 3, showing the site location in open water.**



**Figure 13-6. Photograph of Site 4, showing the site location adjacent to the bank in water.**

**Figure 13-7. Photograph of Site 5, showing the site location in open water.**



**Figure 13-8. Photograph of Site 6, showing the site location adjacent to the bank in thick reeds in water.**



**Figure 13-9. Photograph of Site 7, showing the site location at the edge of the reeds (shovel handle in foreground).**



**Figure 13-10. Photograph of Site 8, showing the site location in open water.**



**Figure 13-11. Photograph of Site 9, showing the site location adjacent to the bank.**



**Figure 13-12. Photograph of Site 10, showing the site location in open water.**



**Figure 13-13. Photograph of Site 13, showing the site location adjacent to the bank amongst thick reeds in the water.**



Figure 13-14. Photographs of Site 14, showing the site location in open water.

### 13.3. Laboratory data assessment

#### 13.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 13-4 and pH profiles are presented in Figure 13-15. The  $pH_W$  data ranged from 4.43 to 8.00 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 1.54 to 8.10 and identified that surface layers in Profiles 2, 3 and 8 and all layers in Profiles 6, 7, 13 and 14 were below the critical value of  $pH_{OX} < 2.5$ , the threshold value normally used to indicate a high likelihood of sulfuric material forming. The  $pH_{INC}$  data ranged from 3.71 to 8.09 and identified that Profiles 13 and 14 samples on incubation declined below the critical values of  $pH < 4$ , indicating that these soils potentially would form sulfuric material on oxidation.

#### 13.3.2. Acid base accounting

The acid base accounting data is provided in Table 13-4 and summarised in Figure 13-16.

##### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.11 % $S_{CR}$  and sulfidic materials were detected in all profiles.

##### Titrateable actual acidity

Titrateable actual acidity values ranged from 0.00 to 45.97 mole  $H^+$ /tonne and were detected in all profiles except for Profiles 4 and 5.

##### Retained acidity

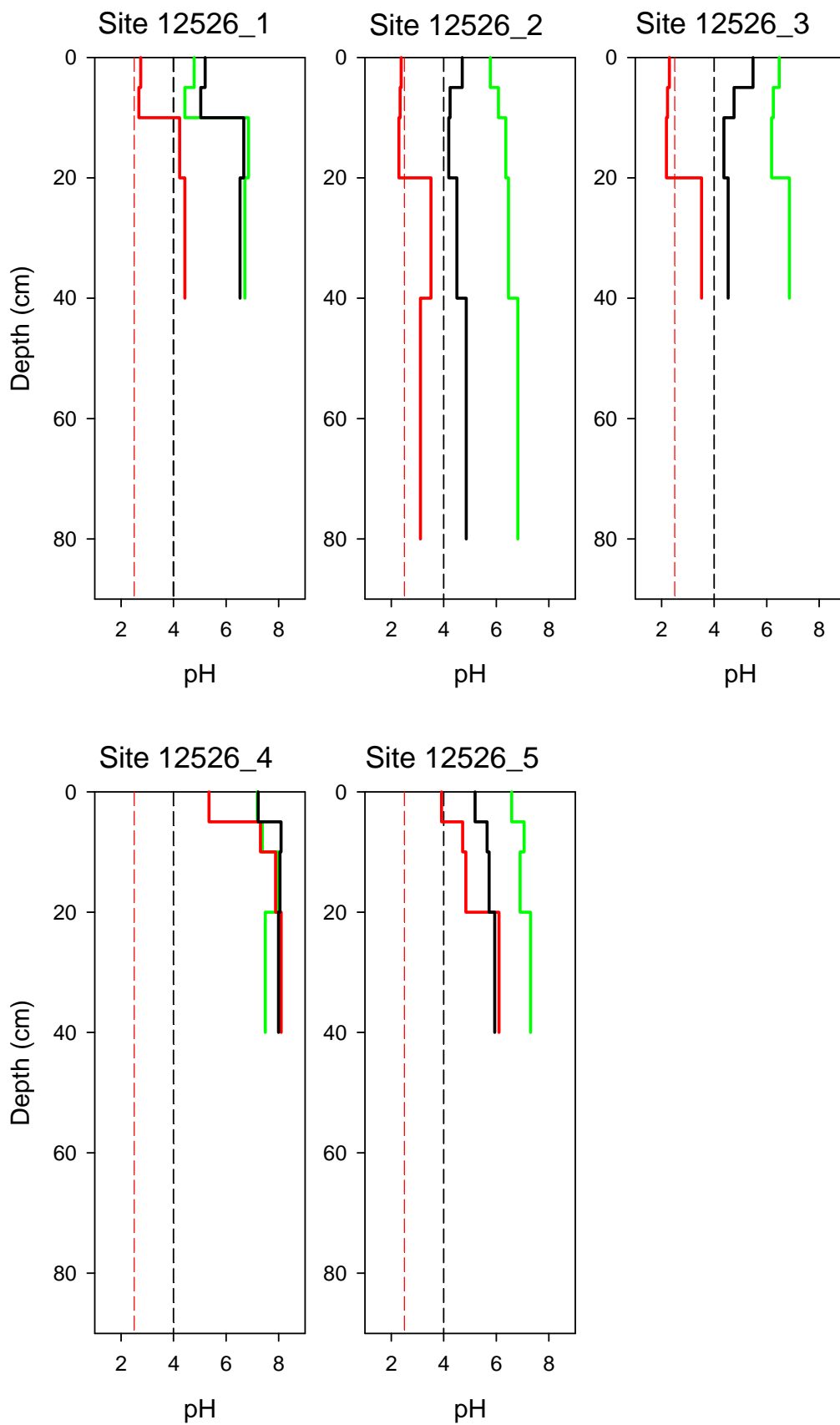
Retained acidity was measured in layers of Profiles 1 and 6, with values of 8.37 to 5.30 mole  $H^+$ /tonne.

##### Acid neutralising capacity

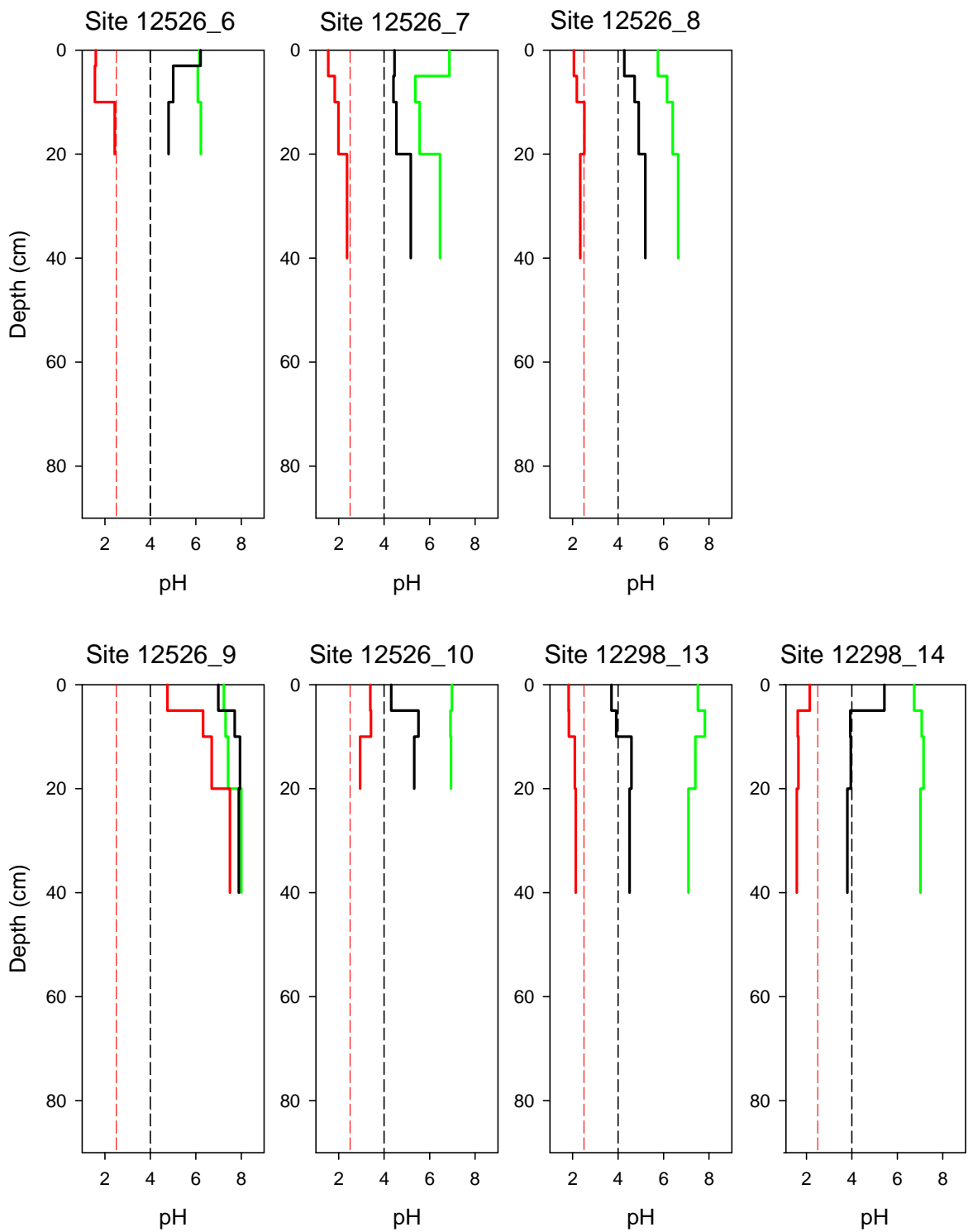
Acid neutralising capacity values were generally 0, and for Profiles 4, 5 and 9 samples ranged from 0.00 to 3.78 % $CaCO_3$ .

##### Net acidity

Net acidity values ranged from -496 to 101 mole  $H^+$ /tonne. Generally profile samples had moderate net acidity values with some profiles having a layer with low or high values, samples in Profiles 4, 5 and 9 had negative values.







**Figure 13-15. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 12526), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).**

### 13.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 13-4 identified no surface layers (except for Profile 1) that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 13.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

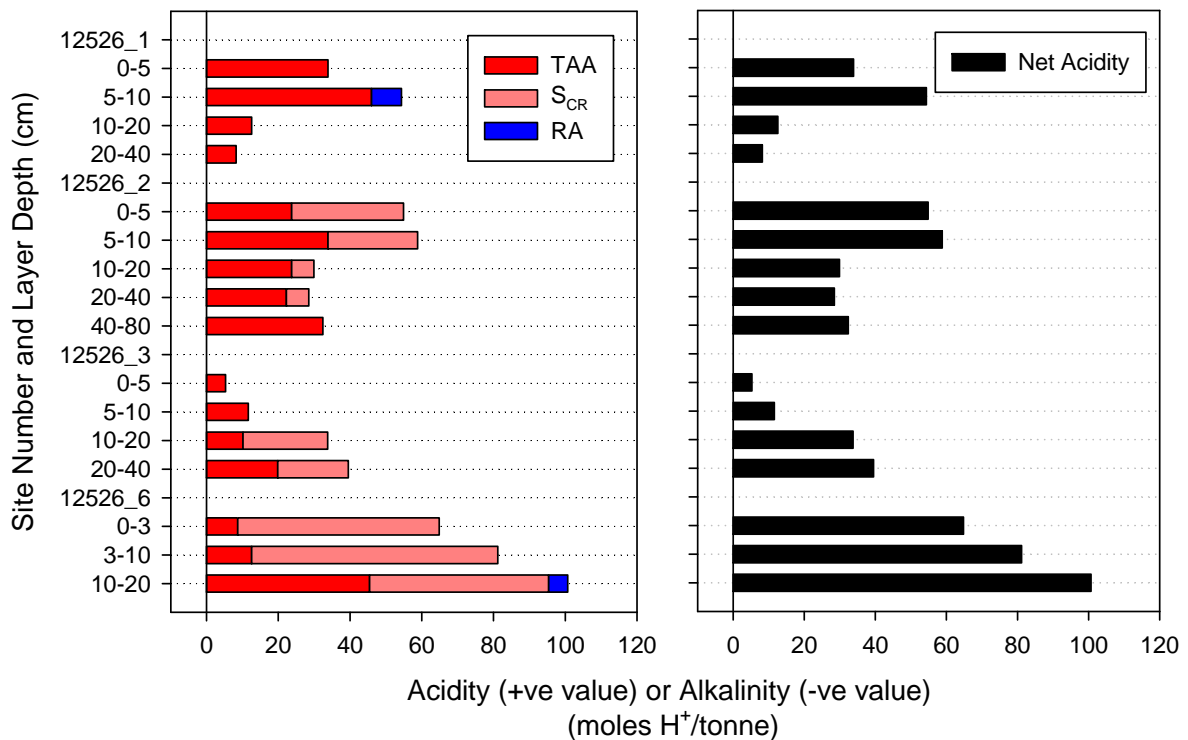
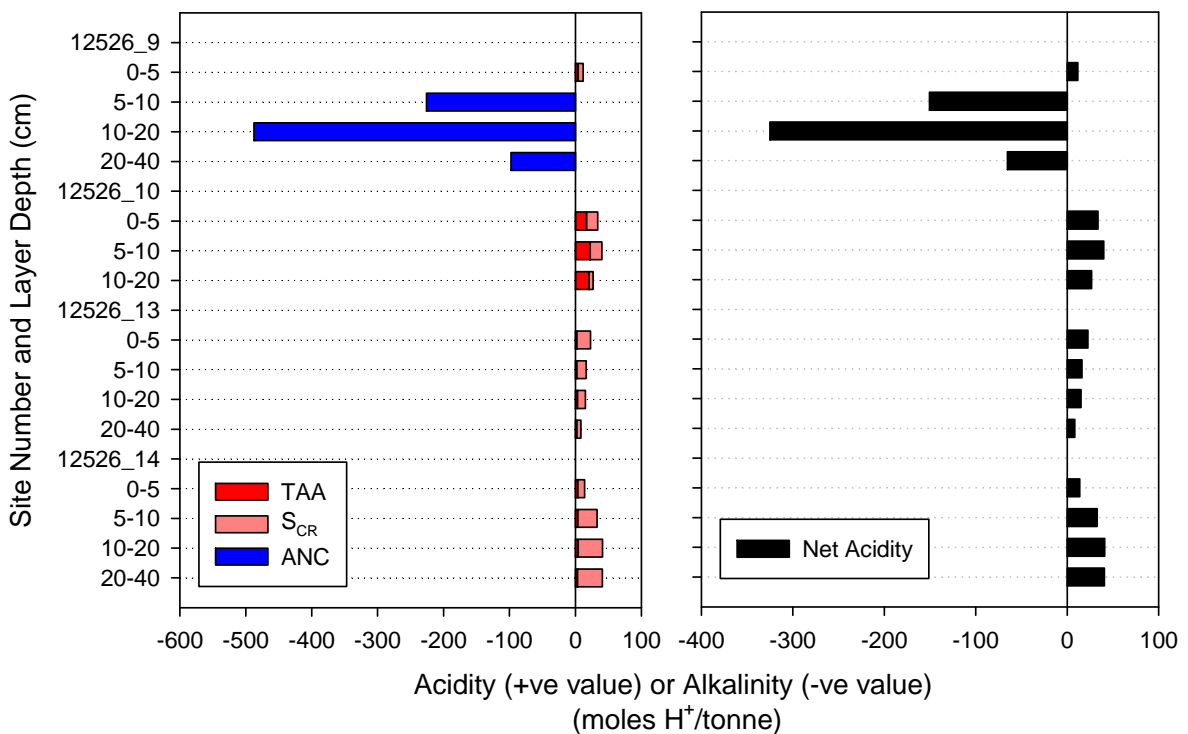
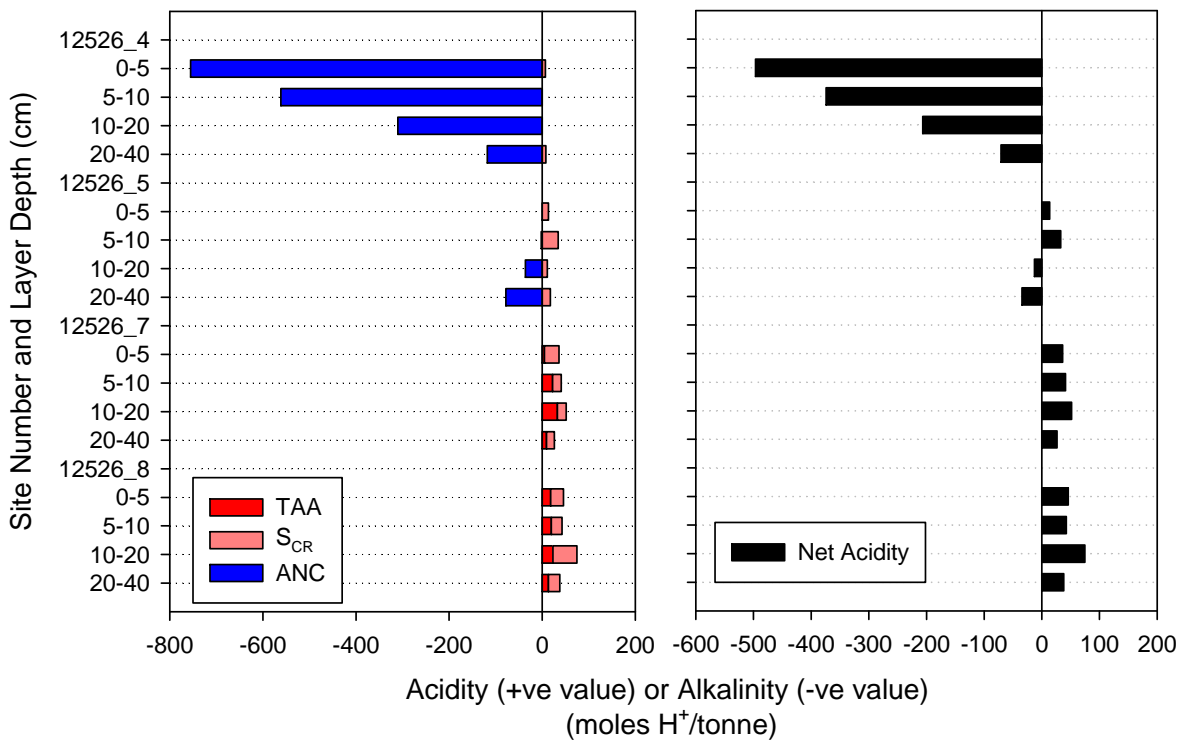


Figure 13-16a. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12526). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), retained acidity (RA - blue bar), and right side shows net acidity.



**Figure 13-16b. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 12526). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 13.3.5. Hydrochemistry

Five surface water samples were collected from this narrow wetland. Field parameters are shown in Table 13-5. The surface water samples had circumneutral pH and low salinity, which varied little along the length of the wetland. Dissolved oxygen and turbidity were high, and alkalinity similar to the range expected for river water.

The surface waters were of Na-HCO<sub>3</sub> to Na-Cl type (Table 13-6, Figure 13-17). Sulfate concentrations in the surface water samples were low and varied from 6.8 to 6.9 mg l<sup>-1</sup>. The SO<sub>4</sub>/Cl ratio in the surface waters (0.203 to 0.209) was slightly higher than seawater (0.142). For the nutrients, NH<sub>4</sub> and PO<sub>4</sub> were slightly elevated above ANZECC Guideline values. Of the metals, Al, Fe, Cu and Zn concentrations were elevated above ANZECC Guideline values, although this may be partly due the high turbidity with colloidal material present.

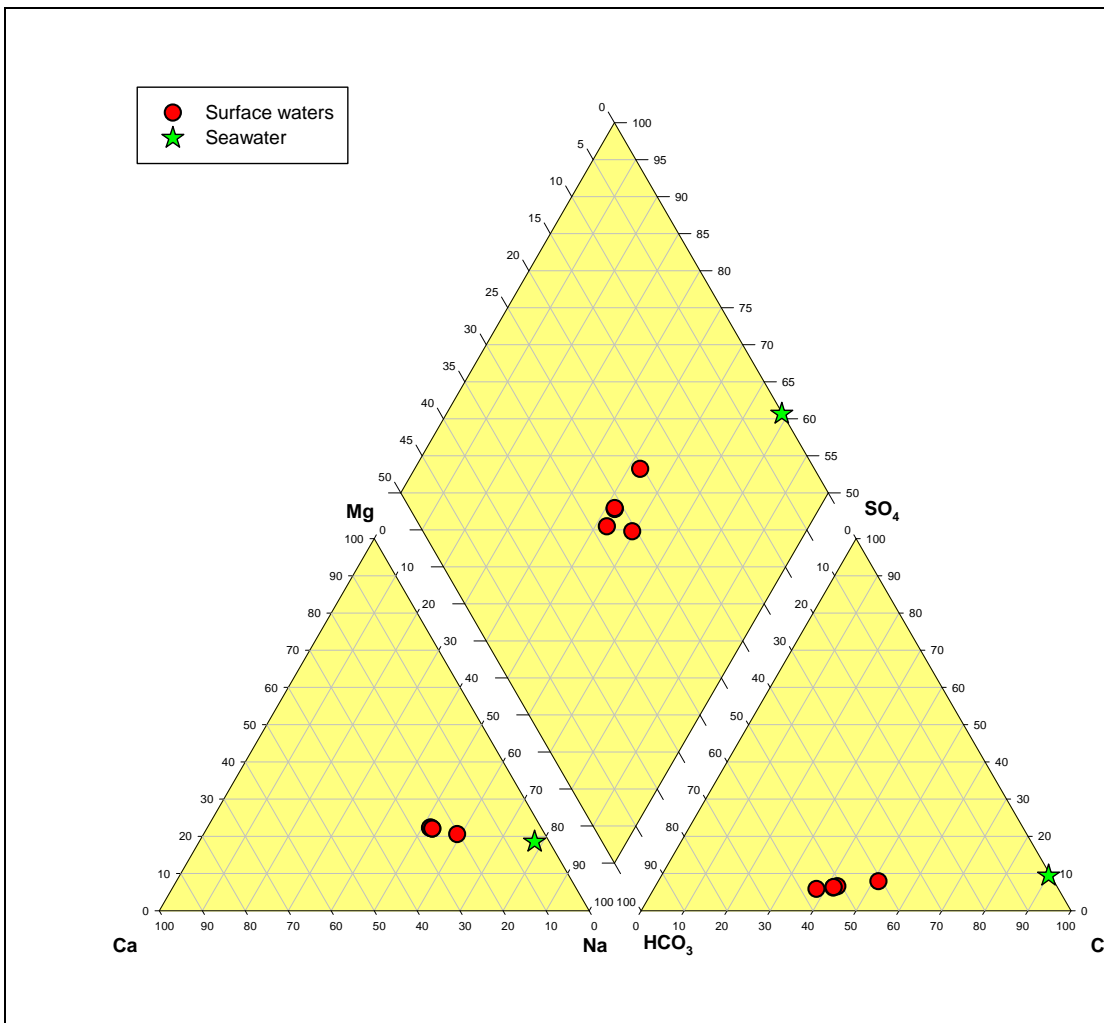


Figure 13-17. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 12526).

## 13.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12526) were identified as hypersulfidic in Profiles 13 and 14 that were sandy textured and occurred at the northern end of the wetland. The remaining soil profile samples were classified as hyposulfidic and a few samples within a profile classified as other soil material (Profiles 1 and 9) or other acidic (Profiles 3). The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (sandy) that occurred in profiles at the northern end of the wetland, Subaqueous Soil (loamy or clayey) that occurred below water throughout the main wetland area and Other Soil (clayey) occurred on the wetland bank.

The soils throughout the main wetland area were dominantly loamy textured in the surface layers and in some areas (northern end of wetland) they were sandy textured. The subsoils were generally clayey and in some areas loamy.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were generally not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 12526) are:

- Acidification hazard: The data identified low to moderate net acidity values throughout the wetland and pH data identified samples with values that indicated a potential acidification hazard due to oxidation particularly at the northern end of the wetland. There is a high level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is generally no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The high acidification hazard indicates that soil acidification potential may increase the solubility of metals. There is a high level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 12526):

<b>Soil materials:</b>	The soil layers at the northern end where the soil was sandy textured were hypersulfidic and other layers were generally hyposulfidic for all profiles below water. Soils were loamy textured at the surface and sandy in some areas, and loamy or clayey textured in the subsoil. Throughout the wetland there were low or moderate net acidity values and pH data indicated a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (loamy or clayey) – occurring where there was surface water throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Hypersulfidic Subaqueous Soil (sandy) – occurring at the sandy textured northern end of the wetland. Minor (&lt;25%) in extent.</li> <li>• Other Soil (clayey) – occurring on the wetland margin above the water on the creek bank. Isolated (&lt;10%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – high level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – high level of concern</li> </ul>

**Table 13-2. Site description data for Katarapko Floodplain (Wetland ID. 12526).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	3/05/2010	457044	6191655	not reached	firm, plant material	dead reed stubble	on edge of bank
2	3/05/2010	457046	6191651	30	water	water, Phragmites	in reed on water margin adjacent to bank 2m away
3	3/05/2010	457041	6191648	90	water	water	open water, 5m from bank
4	3/05/2010	457810	6192319	50	water	water, Typha	edge of water next to step down from bank in reeds
5	3/05/2010	457812	6192314	90	water	water	open water, 3m from bank and reeds
6	3/05/2010	458028	6192657	30	water, plant material	water, Phragmites	in thick reeds, near edge of bank
7	3/05/2010	458024	6192660	50	water	water	in reeds adjacent to open water
8	3/05/2010	458006	6192668	90	water, soft	water	open water, 10m from bank
9	3/05/2010	458372	6194982	50	water	water	edge of water next to step down from bank
10	3/05/2010	458375	6194981	90	water	water	open water, 5m from bank
13	3/05/2010	458375	6195625	40	water	water, Phragmites	edge of water near bank
14	3/05/2010	458377	6195628	70	water	water	open water, 5m from bank

**Table 13-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 12526).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	brown (10YR5/3)	clay loam	dry		subangular blocky	firm	
1_2DUP	5 - 10	small pit	brown (10YR5/3)	clay	dry	5% yellowish red infused into the matrix along faces of peds	subangular blocky	firm	
1_2	5 - 10	small pit	brown (10YR5/3)	clay	dry	5% yellowish red infused into the matrix along faces of peds	subangular blocky	firm	
1_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	dry	5% yellowish red infused into the matrix adjacent to pores	subangular blocky	firm	
1_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	clay	moist	5% yellowish red infused into the matrix adjacent to pores	massive	very firm	
2_W	30 - 0	water							
2_1	0 - 5	small pit	dark grey (5Y4/1)	sandy clay loam	wet		subangular blocky	firm	
2_2	5 - 10	small pit	dark grey (5Y4/1)	clay loam	wet		subangular blocky	firm	
2_3	10 - 20	small pit	dark grey (5Y4/1)	clay loam	wet		massive	firm	
2_4	20 - 40	small pit	dark grey (5Y4/1)	clay loam	moist		massive	very firm	
2_5	40 - 80	push tube	dark grey (2.5Y4/0)	clay	wet		massive	very firm	
3_W1	90 - 0	surface water							water sampled
3_1	0 - 5	small pit	dark grey (5Y4/1)	sandy loam	wet		massive	weak	
3_2	5 - 10	small pit	grey (5Y5/1)	sandy loam	wet		massive	firm	
3_3	10 - 20	small pit	grey (5Y5/1)	sandy clay loam	wet		massive	firm	
3_4	20 - 40	small pit	grey (5Y5/1)	clay loam	moist		massive	very firm	
4_1	0 - 5	small pit	brownish yellow (10YR6/6)	plant material	wet		massive	firm	
4_2	5 - 10	small pit	grey (5Y6/1)	sandy clay loam	wet		massive	firm	
4_3	10 - 20	small pit	grey (5Y6/1)	sandy clay loam	wet		massive	firm	
4_4	20 - 40	small pit	grey (5Y5/1)	clay	moist		massive	very firm	contains nontronite, too clayey to auger below

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
5_W1	90 - 0	surface water							water sampled
5_1	0 - 5	small pit	dark grey (5Y4/1)	sandy clay loam	wet		massive	very firm	
5_2	5 - 10	small pit	dark grey (5Y4/1)	sandy clay loam	wet		massive	very firm	
5_3	10 - 20	small pit	grey (5Y5/1)	clay loam	wet		massive	very firm	
5_4	20 - 40	push tube	grey (5Y5/1)	clay loam	moist		massive	very firm	contains nontronite, too clayey to auger below
6_W	30 - 0	water							
6_1	0 - 3	small pit	dark grey (10YR4/1)	plant material	wet		massive	firm	
6_2	3 - 10	small pit	dark grey (10YR4/1)	loamy sand	wet		massive	firm	
6_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	too many rocks for auger sample recovery
7_1	0 - 5	small pit	very dark grey (5Y3/1)	sand	wet		massive	weak	weak sulfurous odour
7_2	5 - 10	small pit	greyish brown (2.5Y5/2)	sand	wet		massive	weak	
7_3	10 - 20	small pit	grey (2.5Y5/0)	sandy loam	moist		massive	firm	
7_4	20 - 40	push tube	grey (2.5Y5/0)	clay loam	moist		massive	firm	
8_W1	90 - 0	surface water							water sampled
8_1	0 - 5	small pit	grey (5Y5/1)	sandy loam	wet		massive	very weak	
8_2	5 - 10	small pit	greyish brown (2.5Y5/2)	sandy loam	wet		massive	very weak	many plant roots
8_3	10 - 20	small pit	greyish brown (2.5Y5/2)	sandy loam	wet		massive	very weak	
8_4	20 - 40	push tube	grey (2.5Y5/0)	sandy clay loam	wet		massive	very weak	
9_W	50 - 0	water							
9_1	0 - 5	small pit	grey (5Y5/1)	clay	wet		massive	very firm	
9_2	5 - 10	small pit	grey (2.5Y5/0)	clay	wet		massive	very firm	
9_3	10 - 20	small pit	grey (2.5Y5/0)	clay	moist		massive	very firm	contains nontronite
9_4	20 - 40	push tube	grey (2.5Y5/0)	clay	moist		massive	very firm	contains nontronite
10_W1	90 - 0	surface water							water sampled
10_1	0 - 5	small pit	dark grey (2.5Y4/0)	clay	wet		massive	very firm	
10_2	5 - 10	small pit	dark grey (2.5Y4/0)	clay	moist		massive	very firm	contains nontronite
10_3	10 - 20	small pit	dark grey (2.5Y4/0)	clay	moist		massive	rigid	contains nontronite, too hard to auger below



Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
13_W	40 - 0	water							
13_1	0 - 5	small pit	grey (5Y5/1)	sand	wet		massive	weak	weak sulfurous odour
13_2	5 - 10	small pit	grey (5Y5/1)	sand	wet		massive	weak	
13_3	10 - 20	small pit	grey (5Y5/1)	sand	wet		massive	weak	
13_4	20 - 40	small pit	dark grey (5Y4/1)	sand	wet		massive	firm	
14_W1	70 - 0	surface water							water sampled
14_1	0 - 5	small pit	dark grey (5Y4/1)	sand	wet		massive	weak	
14_2	5 - 10	small pit	grey (5Y5/1)	sand	wet		massive	weak	
14_3	10 - 20	small pit	grey (5Y5/1)	sand	wet		massive	weak	
14_4	20 - 40	small pit	grey (5Y5/1)	sandy loam	wet		massive	weak	

**Table 13-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 12526).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> / tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> / tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> / tonne)	Acid Sulfate Soil Material Classification	
1.2DUP	1.1	0-5	Medium	331	4.78	2.75	4.93	5.20	130	4.54	33.87	<0.01	..	..	34	other acidic
	1.2	5-10	Medium	479	4.49	2.51	4.64	5.06	77	4.23	46.94	<0.01	6.55	..	53	other acidic
	1.3	5-10	Medium	386	4.43	2.68	4.45	5.03	39	4.25	45.97	<0.01	8.37	..	54	other acidic
	1.4	10-20	Fine	376	6.85	4.23	6.26	6.67	21	5.61	12.58	<0.01	..	..	13	other soil material
2.2	2.1	20-40	Fine	134	6.71	4.43	6.45	6.53	6	5.89	8.23	<0.01	..	..	8	other soil material
	2.1	0-5	Fine	101	5.77	2.38	5.60	4.70	27	4.65	23.71	0.05	..	..	55	hyposulfidic (S <sub>CR</sub> <0.10%)
	2.2	5-10	Fine	87	6.08	2.34	5.03	4.24	27	4.43	33.87	0.04	0.00	..	59	hyposulfidic (S <sub>CR</sub> <0.10%)
	2.3	10-20	Fine	62	6.36	2.29	5.64	4.19	21	4.51	23.71	0.01	..	..	30	hyposulfidic (S <sub>CR</sub> <0.10%)
	2.4	20-40	Fine	217	6.46	3.51	5.83	4.50	16	4.64	22.26	0.01	..	..	28	hyposulfidic (S <sub>CR</sub> <0.10%)
2.5	40-80	Fine	121	6.82	3.11	5.81	4.86	12	4.52	32.42	<0.01	..	..	32	other acidic incubation	
3.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
3.3	3.1	0-5	Medium	62	6.48	2.30	6.42	5.48	28	5.65	5.32	<0.01	..	..	5	other acidic incubation
	3.2	5-10	Fine	43	6.25	2.23	6.28	4.76	29	5.58	11.61	<0.01	..	..	12	other acidic incubation
	3.3	10-20	Fine	33	6.19	2.19	6.25	4.37	32	5.18	10.16	0.04	..	..	34	hyposulfidic (S <sub>CR</sub> <0.10%)
	3.4	20-40	Fine	68	6.86	3.52	5.81	4.53	28	4.90	19.84	0.03	..	..	40	hyposulfidic (S <sub>CR</sub> <0.10%)
4.4	4.1	0-5	Fine	231	7.19	5.35	6.62	7.22	43	7.24	0.00	0.01	..	3.78	-496	hyposulfidic (S <sub>CR</sub> <0.10%)
	4.2	5-10	Fine	165	7.38	7.31	7.16	8.09	9	7.99	0.00	<0.01	..	2.81	-374	other soil material
	4.3	10-20	Fine	147	7.98	7.88	7.55	8.05	5	8.03	0.00	<0.01	..	1.55	-206	other soil material
	4.4	20-40	Fine	88	7.49	8.10	7.69	7.99	11	7.62	0.00	0.01	..	0.59	-71	hyposulfidic (S <sub>CR</sub> <0.10%)
5.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
5.3	5.1	0-5	Fine	44	6.58	3.92	6.54	5.19	14	7.55	0.00	0.02	..	0.00	14	hyposulfidic (S <sub>CR</sub> <0.10%)
	5.2	5-10	Fine	70	7.06	4.72	6.32	5.65	24	7.17	0.00	0.05	..	0.01	33	hyposulfidic (S <sub>CR</sub> <0.10%)
	5.3	10-20	Fine	95	6.91	4.84	6.69	5.72	29	6.97	0.00	0.02	..	0.18	-13	hyposulfidic (S <sub>CR</sub> <0.10%)
	5.4	20-40	Fine	64	7.30	6.10	6.59	5.94	26	7.01	0.00	0.03	..	0.39	-34	hyposulfidic (S <sub>CR</sub> <0.10%)
6.3	6.1	0-3	Fine	148	6.16	1.60	6.62	6.21	64	5.85	8.71	0.09	..	..	65	hyposulfidic (S <sub>CR</sub> <0.10%)
	6.2	3-10	Medium	44	6.09	1.56	6.29	5.00	69	5.14	12.58	0.11	..	..	81	hyposulfidic (S <sub>CR</sub> ≥0.10%)
	6.3	10-20	Fine	60	6.22	2.43	5.40	4.80	46	4.45	45.49	0.08	5.30	..	101	hyposulfidic (S <sub>CR</sub> <0.10%)
	7.1	0-5	Medium	65	6.87	1.54	6.27	4.46	99	5.80	4.84	0.05	..	..	36	hyposulfidic (S <sub>CR</sub> <0.10%)
7.3	7.2	5-10	Fine	67	5.37	1.83	5.64	4.41	45	4.79	22.26	0.03	..	..	41	hyposulfidic (S <sub>CR</sub> <0.10%)
	7.3	10-20	Fine	65	5.56	1.99	5.93	4.54	43	4.73	32.91	0.03	..	..	52	hyposulfidic (S <sub>CR</sub> <0.10%)
	7.4	20-40	Fine	94	6.46	2.37	6.54	5.17	39	5.31	9.19	0.03	..	..	26	hyposulfidic (S <sub>CR</sub> <0.10%)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC ( $\mu\text{S}/\text{cm}$ )	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate ( $\text{mg SO}_4/\text{kg}$ )	pH KCl	Titrateable Actual Acidity ( $\text{mole H}^+/\text{tonne}$ )	Chromium Reducible Sulfur ( $\%S_{\text{CR}}$ )	Retained Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Neutralising Capacity ( $\%\text{CaCO}_3$ )	Net Acidity ( $\text{mole H}^+/\text{tonne}$ )	Acid Sulfate Soil Material Classification
8.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
8.1	0-5	Fine	42	5.75	2.06	6.24	4.28	48	4.85	18.39	0.04	..	..	46	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
8.2	5-10	Fine	56	6.15	2.19	6.01	4.73	45	4.89	19.84	0.04	..	..	43	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
8.3	10-20	Fine	127	6.40	2.52	6.33	4.91	39	5.02	23.23	0.08	..	..	75	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
8.4	20-40	Fine	86	6.64	2.34	6.71	5.20	40	5.23	13.55	0.04	..	..	38	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
9.1	0-5	Fine	92	7.23	4.75	7.41	6.99	40	6.29	4.36	0.01	..	0.00	12	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
9.2	5-10	Fine	105	7.31	6.32	7.71	7.71	39	6.54	0.00	<0.01	..	1.13	-151	other soil material
9.3	10-20	Fine	164	7.42	6.70	7.71	7.94	17	7.53	0.00	<0.01	..	2.44	-325	other soil material
9.4	20-40	Fine	164	8.00	7.50	8.04	7.89	15	7.33	0.00	<0.01	..	0.49	-65	other soil material
10.W1	90-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
10.1	0-5	Fine	61	6.98	3.39	6.43	4.31	81	5.04	16.94	0.03	..	..	34	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
10.2	5-10	Fine	43	6.92	3.42	6.51	5.51	95	5.08	22.26	0.03	..	..	40	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
10.3	10-20	Fine	42	6.94	2.94	6.42	5.32	54	4.79	20.81	<0.01	..	..	27	other acidic incubation
13.1	0-5	Coarse	44	7.51	1.83	7.36	3.71	33	5.87	2.42	0.03	..	..	23	hypersulfidic
13.2	5-10	Coarse	47	7.82	1.84	7.38	3.92	35	5.96	2.42	0.02	..	..	16	hypersulfidic
13.3	10-20	Coarse	48	7.40	2.10	7.27	4.59	24	5.89	3.39	0.02	..	..	15	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
13.4	20-40	Coarse	39	7.10	2.14	7.23	4.51	21	5.97	2.42	<0.01	..	..	2	other acidic incubation
14.W1	70-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
14.1	0-5	Medium	44	6.74	2.15	6.59	5.43	21	5.71	3.87	0.02	..	..	14	hyposulfidic ( $S_{\text{CR}} < 0.10\%$ )
14.2	5-10	Medium	43	7.07	1.62	6.90	3.93	43	5.71	3.87	0.05	..	..	33	hypersulfidic
14.3	10-20	Medium	38	7.15	1.65	6.80	3.95	46	5.59	4.36	0.06	..	..	41	hypersulfidic
14.4	20-40	Medium	37	7.02	1.58	6.85	3.80	50	5.89	3.39	0.06	..	..	41	hypersulfidic

**Table 13-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12526).**

	pH	SEC $\mu\text{S cm}^{-1}$	DO $\text{mg l}^{-1}$	Eh mV	Turbidity NTU	Alkalinity as $\text{HCO}_3$
Surface waters (n=5)	7.39-7.85	225-234	9.18-12.38	-32- -6	155-158	45-84

**Table 13-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 12526).**

Parameter	units	ANZECC Guidelines	Site 3 (SW)	Site 5 (SW)	Site 8 (SW)	Site 10 (SW)	Site 14 (SW)
Na	mg l <sup>-1</sup>		31.5	20.3	20.4	20.9	20.6
K	mg l <sup>-1</sup>		4.0	4.1	3.9	3.9	4.0
Ca	mg l <sup>-1</sup>		10.2	9.79	9.87	9.81	9.7
Mg	mg l <sup>-1</sup>		6.24	5.17	5.15	5.15	5.1
Si	mg l <sup>-1</sup>		4.11	4.05	4.01	4.02	3.99
Br	mg l <sup>-1</sup>		0.1	0.1	0.1	0.1	0.1
Cl	mg l <sup>-1</sup>		33	34	33	33	33
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.152	0.112	0.150	0.127	0.096
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.04</b>	<b>0.033</b>	<b>0.017</b>	<b>0.030</b>	<b>0.070</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.046</b>	<b>0.031</b>	<b>0.040</b>	<b>0.037</b>	<b>0.038</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		6.9	6.9	6.8	6.9	6.9
Ag	µg l <sup>-1</sup>	0.05	<0.01	<0.01	<0.01	0.01	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<b>692</b>	<b>662</b>	<b>638</b>	<b>678</b>	<b>629</b>
As <sup>B</sup>	µg l <sup>-1</sup>	13	1.5	1.5	1.5	1.5	1.5
Cd	µg l <sup>-1</sup>	0.2	0.04	<0.01	0.02	0.03	0.03
Co	µg l <sup>-1</sup>	2.8	0.37	0.3	0.3	0.3	0.29
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	<b>1.2</b>	0.8	0.8	0.8	0.7
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>3.2</b>	<b>2.2</b>	<b>2.6</b>	<b>2.6</b>	<b>2.4</b>
Fe	µg l <sup>-1</sup>	300	<b>664</b>	<b>634</b>	<b>613</b>	<b>648</b>	<b>598</b>
Mn	µg l <sup>-1</sup>	1700	17.62	9.77	8.8	8.15	7.47
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	3.1	2.0	2.1	1.8	1.6
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.82	0.66	0.66	0.66	0.64
Se	µg l <sup>-1</sup>	11	0.06	<0.06	<0.06	0.06	<0.06
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>99</b>	<b>28.5</b>	<b>82</b>	<b>86</b>	<b>64</b>
DOC	mg l <sup>-1</sup>		6.7	6.6	6.5	7.1	7.2

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

## 14. KATARAPKO FLOODPLAIN (WETLAND ID. 15002)

### 14.1. Location and setting description

Katarapko Floodplain (Wetland ID. 15002) is situated on the eastern side of the River Murray, approximately 11 kilometres down river from the town of Loxton, located in the Gerard Swamp area. The wetland is linear in shape. It is about 1.5 kilometres in length and about 70 metres at it's widest, with a total surface area of 9 hectares. The wetland is bounded to the west by a raised floodplain that separates it from the river and a hill slope to the east.

The wetland is not connected to the river and appears to be a basin at the base of the hill slope. At the time when the soil survey was conducted in May 2010 the wetland had isolated areas of surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Salt bush was growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Four sites were sampled as shown in Figure 14-1.

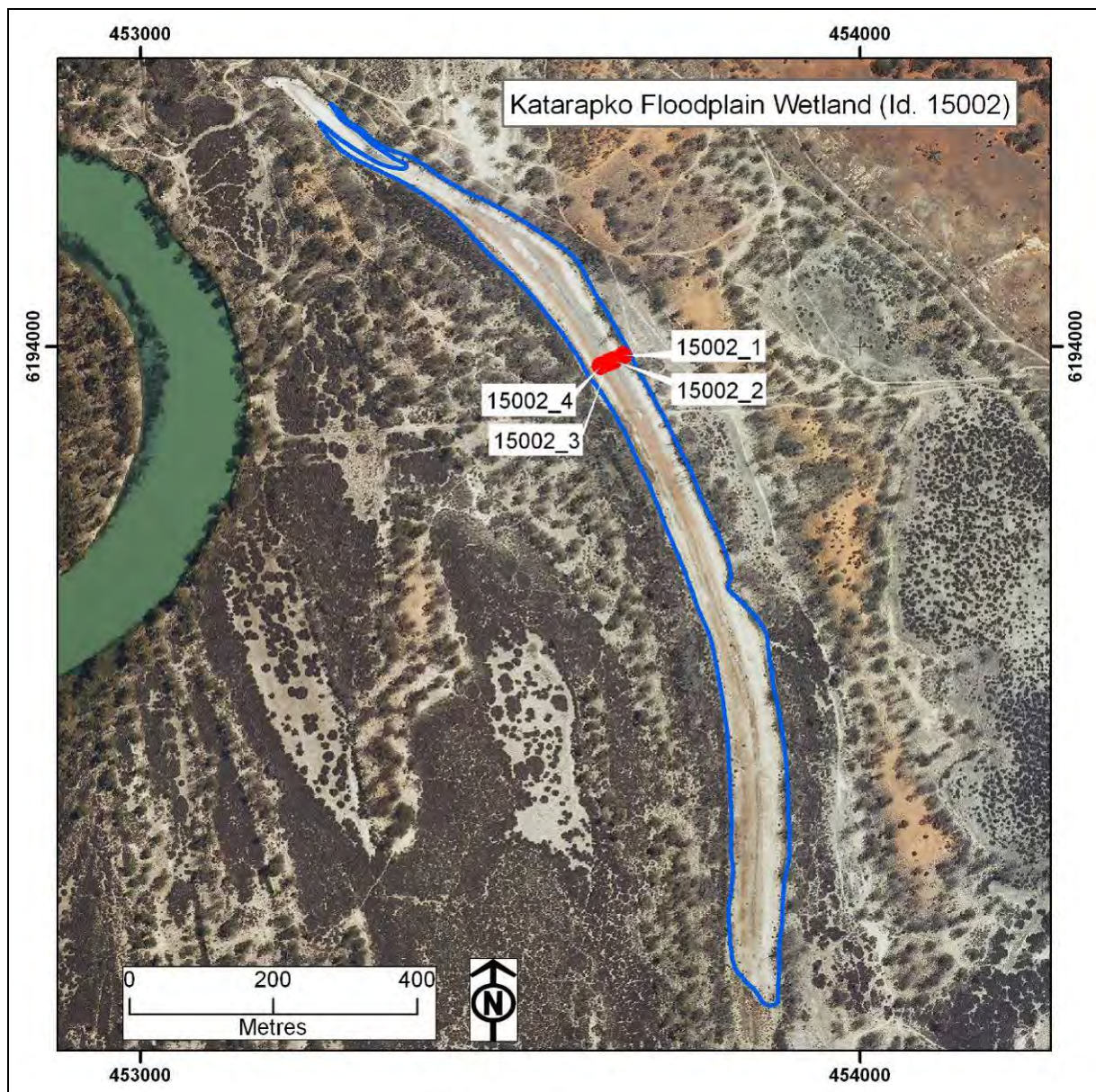


Figure 14-1. Katarapko Floodplain (Wetland ID. 15002) and sample site locations.

## 14.2. Soil profile description and distribution

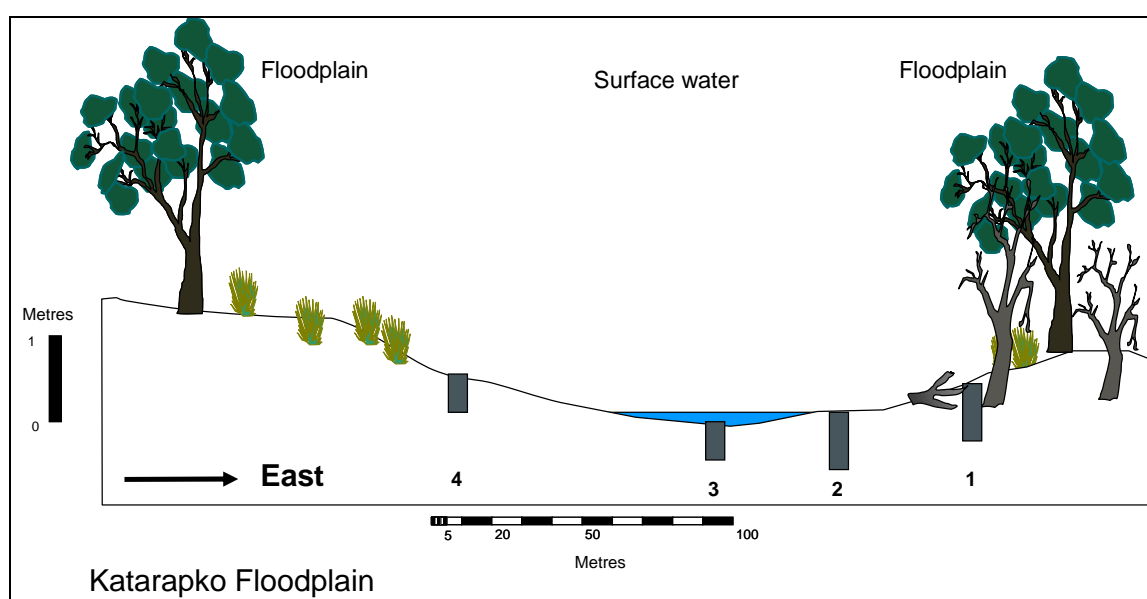
Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 14-1. Sites were distributed along a transect through the middle (Sites 1, 2, 3 and 4) of the wetland. The site and soil profile descriptions are presented in Table 14-2 and Table 14-3, and a conceptual cross-section diagram in Figure 14-2.

### Middle transect

Site 1 (Figure 14-3) occurred at the wetland margin where the salt bush vegetation stopped growing and the surface became bare, and the soil consisted of a brown, weak, sand loam, over an olive grey, very firm, sandy clay loam. Site 2 (Figure 14-4) occurred adjacent to the water, the water table in the pit was about 30 cm deep, and the soil consisted of a grey, firm, sandy loam, over a grey, very firm, clay loam. Site 3 (Figure 14-5) occurred in the middle of the wetland where there was surface water (5 cm deep), and the soil consisted of a salt crust, over a black, firm, sandy clay loam containing monosulfidic material, over a dark grey, very firm, clay. Site 4 (Figure 14-6) occurred on the margin above the shoreline, the water table in the pit was about 30 cm deep, and the soil consisted of a very dark grey, very weak, clay, over a dark grey, very firm, clay.

**Table 14-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 15002).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
15002_1	453671	6193987	Other Soil (loamy)	high elevation, on margin
15002_2	453657	6193980	Other Soil (loamy)	mid elevation, 2m from waters edge
15002_3	453650	6193977	Subaqueous Soil (clayey)	low elevation, middle of wetland
15002_4	453640	6193973	Other Soil (clayey)	mid elevation, 5m from water and 20m from margin



**Figure 14-2. Conceptual cross-section diagram.**



**Figure 14-3. Photograph of Site 1, showing the site location on the margin between salt bush and bare surface, and the soil profile viewing across the wetland.**



**Figure 14-4. Photograph of Site 2, showing the site location just above the water shoreline.**

**Figure 14-5. Photograph of Site 3, showing the site location at the centre of the wetland in the water.**



**Figure 14-6. Photographs of Site 4, showing the site location on the opposite margin just above the water shoreline.**

## 14.3. Laboratory data assessment

### 14.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 14-4 and pH profiles are presented in Figure 14-7. The  $pH_W$  data ranged from 4.70 to 8.39 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 2.81 to 7.81 and identified that no sample was below the critical value of  $pH_{OX} < 2.5$ . The  $pH_{INC}$  data ranged from 4.71 to 6.83 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .

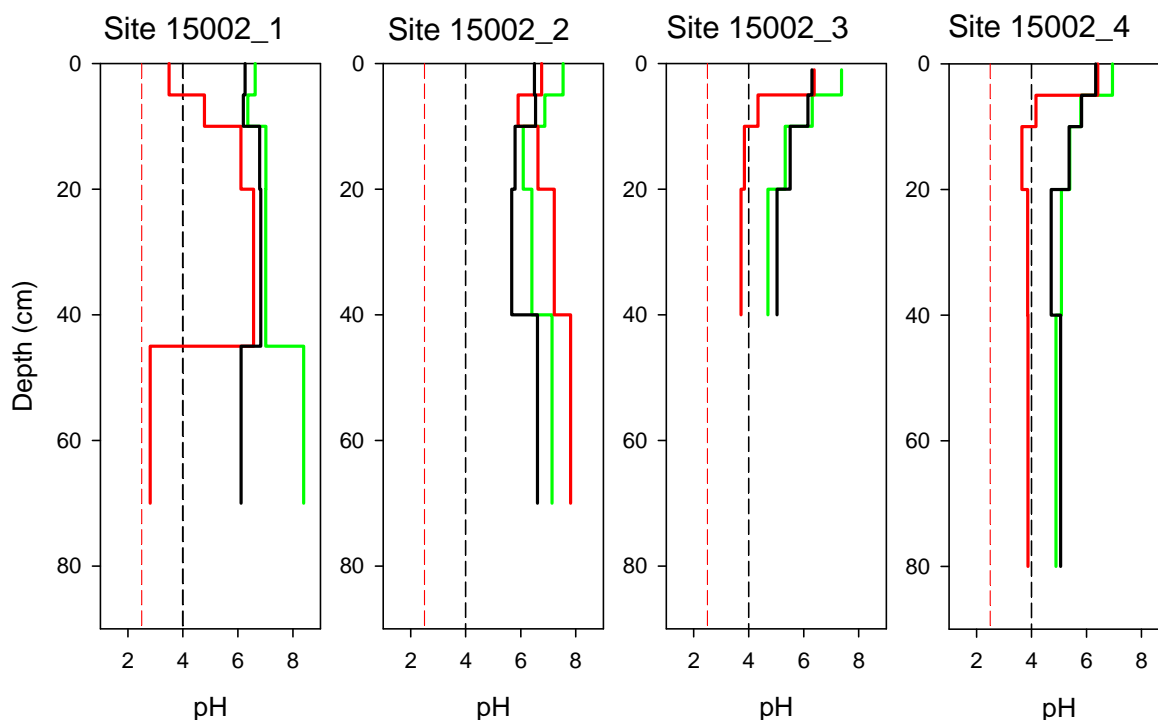


Figure 14-7. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 15002), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

### 14.3.2. Acid base accounting

The acid base accounting data is provided in Table 14-4 and summarised in Figure 14-8.

#### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.09 % $S_{CR}$  and sulfidic materials were detected in at least one layer for all profiles.

#### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 29.03 mole  $H^+$ /tonne and were detected in subsoil samples of Profiles 2, 3 and 4.

#### Retained acidity

Retained acidity was not measured in any of the layers as all samples had a  $pH_{KCl}$  of greater than 4.5.

#### Acid neutralising capacity

Acid neutralising capacity values ranged from 0.00 to 3.77 % $CaCO_3$  and were measured in at least one layer of all profiles.



## Net acidity

Net acidity values ranged from -502 to 29 mole H<sup>+</sup>/tonne. All profiles had negative net acidity values for the surface layers and subsoil layers for Profiles 3 and 4 had low or moderate values and Profiles 1 and 2 were negative values.

### 14.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 14-4 identified that for all profiles the surface layers were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 14.3.4. Acid volatile sulfur

Monosulfidic materials were possibly observed in the upper layer for Profile 3 that occurred in the centre of the wetland below water, samples were not collected for analysis.

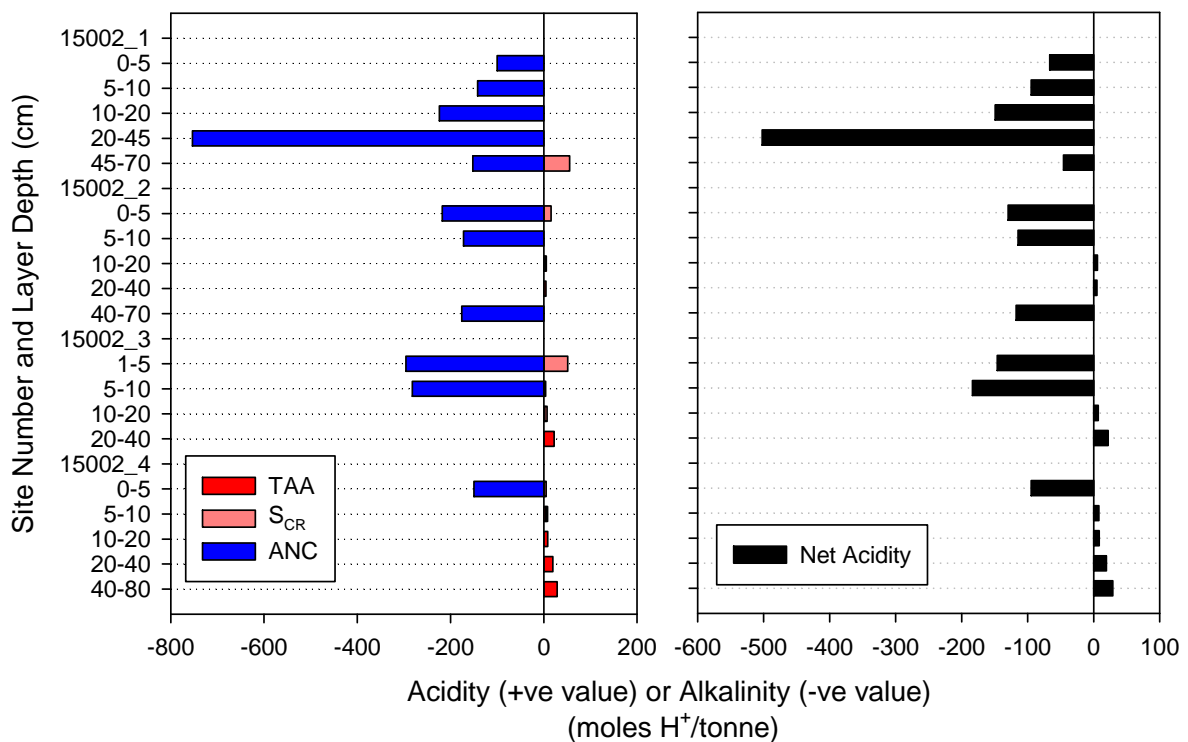


Figure 14-8. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 15002). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

### 14.3.5. Hydrochemistry

One surface water sample and one pit water sample were collected from this wetland. Field parameters are shown in Table 14-5. The surface water had a slightly acidic pH and was hypersaline. Dissolved oxygen was low and alkalinity zero. The pit water was also hypersaline and relatively acidic with zero alkalinity.

The surface water and pit water samples were both of Na-Cl type, with slightly higher Ca and lower  $\text{SO}_4$  relative to seawater composition (Table 14-6, Figure 14-9). Sulfate concentrations in the surface water and pit water were both high; 1500 and 1600  $\text{mg l}^{-1}$  respectively. The  $\text{SO}_4/\text{Cl}$  ratios were 0.013 and 0.009 in the surface water and pit water respectively, much lower than seawater (0.142). For the nutrients,  $\text{NH}_4$  was very high in both samples, with  $\text{PO}_4$  below the detection limit. The detection limit for Fe was very high due to the required dilution prior to analysis, but Mn was extremely high. For the pit waters, a number of trace metals were very high, including Co, Cu, Ni, Pb, Se and Zn. Cadmium and Ag were also elevated above the ANZECC Guideline value. In the surface waters, As, Co, Ni, Se and Zn were also present at high concentrations. Organic C concentrations were also high in the surface water sample.

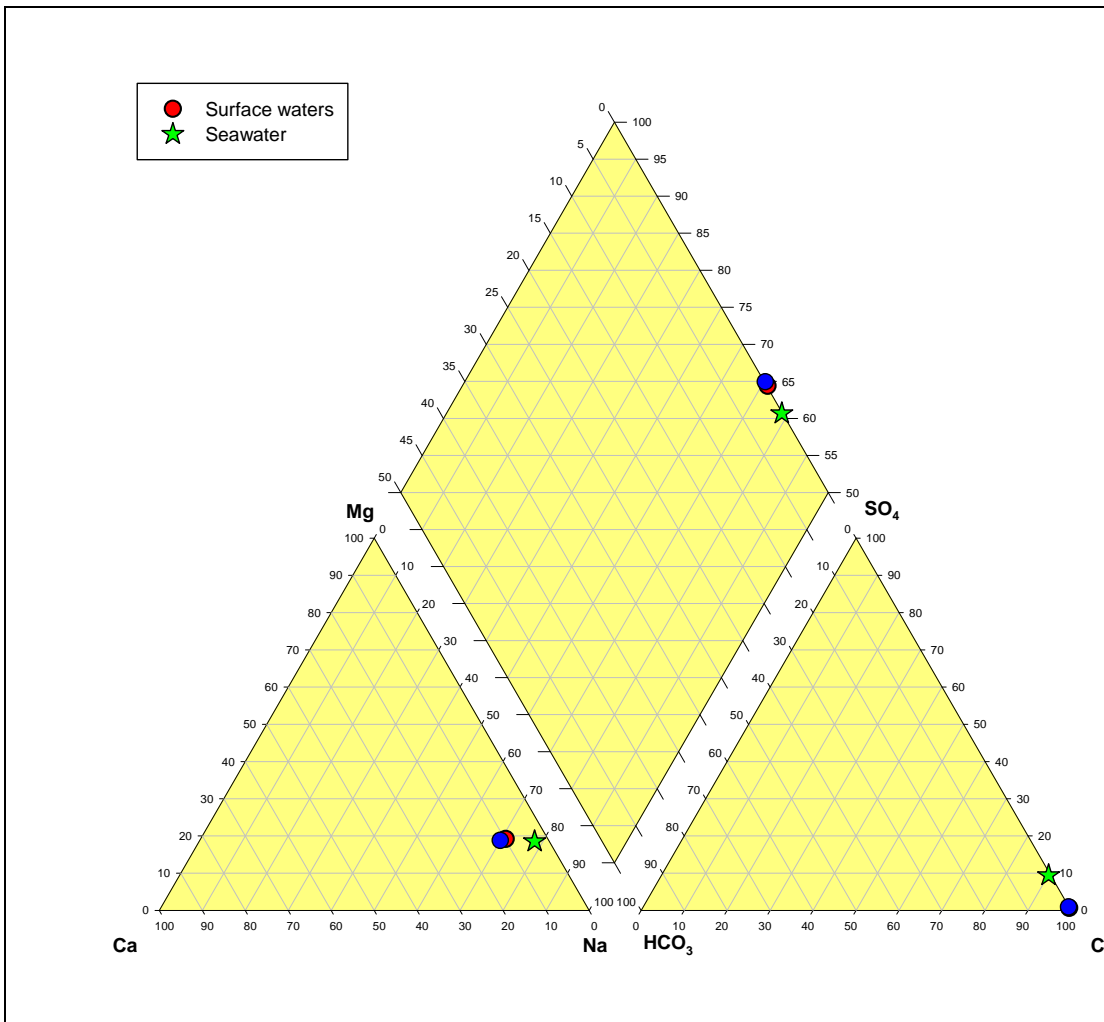


Figure 14-9. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 15002).

## 14.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 15002) were identified as hyposulfidic for samples in surface layers except for Profile 1, subsoil samples tended to be classified as other acidic or other soil material. The acid sulfate soil subtype classes identified were Subaqueous Soil (loamy) that occurred in the low elevated part of the wetland and Other Soil (loamy or clayey) that occurred on the margins above water.

The soils throughout the wetland were dominantly loamy or clayey textured in the surface layers. The subsoils were clayey.

Monosulfidic material was observed and water soluble sulfate data identified that surface layers were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 15002) are:

- Acidification hazard: The data identified negative net acidity values in all profile samples with low or moderate values in some subsoil layers and pH data did not indicate a potential acidification hazard due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was observed. There is a medium to high level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 15002):

<b>Soil materials:</b>	The surface soil layers were generally hyposulfidic and the subsoils characterised as other soil materials or other acidic. Soils were loamy or clayey textured at the surface and clayey textured in the subsoil. All profiles had surface layers with a negative net acidity values and low or moderate values occurred in some of the deep subsoil layers, and pH data did not indicate a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Other Soil (loamy or clayey) – occurred throughout the wetland margins. Dominant (&gt;50%) in extent.</li> <li>• Subaqueous Soil (loamy) – occurring in the low elevated areas of the wetland. Sub dominant (&lt;50%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – low to medium level of concern</li> <li>• De-oxygenation hazard – medium to high level of concern</li> <li>• Metal mobilisation hazard – low level of concern</li> </ul>

**Table 14-2. Site description data for Katarapko Floodplain (Wetland ID. 15002).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
1	3/05/2010	453671	6193987	not reached	sandy, firm	samphire	high elevation, on margin
2	3/05/2010	453657	6193980	-30	sandy, firm	bare	mid elevation, 2m from waters edge
3	3/05/2010	453650	6193977	5	water, salt crust below	water	low elevation, middle of wetland
4	3/05/2010	453640	6193973	-30	soft, clayey	bare	mid elevation, 5m from water and 20m from margin

**Table 14-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 15002).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
1_1	0 - 5	small pit	brown (10YR5/3)	sand	dry		single grain	weak	
1_2	5 - 10	small pit	olive grey (5Y5/2)	sandy loam	moist	20% strong brown infused into the matrix adjacent to pores	angular blocky	firm	
1_3	10 - 20	small pit	olive grey (5Y5/2)	sandy loam	moist	20% strong brown infused into the matrix adjacent to pores	angular blocky	firm	
1_4	20 - 45	small pit	olive grey (5Y5/2)	sandy clay loam	moist	10% strong brown infused into the matrix adjacent to pores	massive	very firm	
1_5	45 - 70	small pit	grey (5Y5/1)	sandy clay loam	moist		massive	very firm	
2_W1	-	pit water							water sampled
2_1	0 - 5	small pit	grey (5Y5/1)	sandy loam	wet		massive	firm	contains thin black layer below surface
2_2	5 - 10	small pit	dark grey (5Y4/1)	sandy loam	wet	40% red In the matrix	subangular blocky	firm	
2_3	10 - 20	small pit	grey (5Y5/1)	sandy clay loam	wet	50% red In the matrix	subangular blocky	firm	
2_4	20 - 40	small pit	grey (5Y5/1)	clay loam	moist		massive	very firm	
2_5	40 - 70	push tube	grey (5Y5/1)	clay loam	wet		massive	very firm	nontronite occurs at interface

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (% , colour, location)	Structure Type (category)	Consistence (category)	Comments
3_W1	5 - 0	surface water							water sampled
3_0	0 - 1	surface salt scrap	light grey (10YR7/1)	salt	dry		massive	rigid	white salt crust
3_1	1 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	firm	
3_2	5 - 10	small pit	dark grey (5Y4/1)	clay loam	wet		subangular blocky	firm	
3_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist	10% strong brown in the matrix	subangular blocky	firm	
3_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist	3% strong brown infused into the matrix adjacent to pores	massive	very firm	
4_1	0 - 5	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	very weak	
4_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet	10% yellowish red infused into the matrix adjacent to pores	subangular blocky	weak	
4_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet	15% yellowish red infused into the matrix adjacent to pores	subangular blocky	firm	
4_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist	10% yellowish red infused into the matrix adjacent to pores	massive	firm	
4_5	40 - 80	push tube	dark grey (5Y4/1)	clay	moist	3% yellowish red infused into the matrix adjacent to pores	massive	very firm	

**Table 14-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 15002).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	18,860	6.63	3.50	6.38	6.26	1,700	6.63	0.00	<0.01	..	0.50	-67	other soil material
1.2	5-10	Medium	12,530	6.36	4.78	6.46	6.20	780	6.69	0.00	<0.01	..	0.71	-95	other soil material
1.3	10-20	Fine	8,180	7.02	6.11	6.82	6.79	250	6.70	0.00	<0.01	..	1.12	-149	other soil material
1.4	20-45	Fine	7,850	7.01	6.57	6.80	6.83	310	6.65	0.00	<0.01	..	3.77	-502	other soil material
1.5	45-70	Fine	3,880	8.39	2.81	7.86	6.12	310	6.68	0.00	0.09	..	0.76	-46	hyposulfidic (S <sub>CR</sub> <0.10%)
2.1	0-5	Fine	3,260	7.54	6.76	6.95	6.50	2,600	7.16	0.00	0.03	..	1.09	-129	hyposulfidic (S <sub>CR</sub> <0.10%)
2.2	5-10	Fine	25,300	6.88	5.90	6.37	6.54	160	7.12	0.00	<0.01	..	0.86	-115	other soil material
2.3	10-20	Fine	15,020	6.09	6.63	5.82	5.79	140	6.39	2.47	<0.01	..	0.00	6	other soil material
2.4	20-40	Fine	9,050	6.41	7.22	6.10	5.67	120	6.25	4.94	<0.01	..	0.00	5	other soil material
2.5	40-70	Fine	4,330	7.14	7.81	6.96	6.61	220	6.60	0.00	<0.01	..	0.88	-117	other soil material
2.W1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	pit water
3.W1	5 - 0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
3.0	0-1	..	..	..	..	6.15	6.58	..	..	..	..	..	..	..	salt crust
3.1	1-5	Medium	54,000	7.38	6.38	5.99	6.30	3,200	7.07	0.00	0.08	..	1.48	-146	hyposulfidic (S <sub>CR</sub> <0.10%)
3.2	5-10	Medium	8,550	6.31	4.34	5.97	6.15	2,600	6.93	0.00	<0.01	..	1.41	-183	other soil material
3.3	10-20	Fine	32,800	5.33	3.84	6.54	5.51	230	6.39	2.47	<0.01	..	0.00	7	other soil material
3.4	20-40	Fine	31,300	4.70	3.72	5.32	5.03	330	5.00	22.26	<0.01	..	..	22	other acidic
4.1	0-5	Medium	42,100	6.94	6.41	6.56	6.33	3,300	6.86	0.00	<0.01	..	0.75	-94	other soil material
4.2	5-10	Fine	29,700	5.79	4.16	5.75	5.82	810	5.94	4.84	<0.01	..	..	8	other soil material
4.3	10-20	Fine	29,000	5.39	3.65	5.14	5.37	300	6.00	8.71	<0.01	..	0.00	9	other acidic
4.4	20-40	Fine	26,500	5.09	3.86	4.82	4.71	300	5.26	19.36	<0.01	..	..	19	other acidic
4.5	40-80	Fine	20,700	4.89	3.87	4.65	5.06	260	4.82	29.03	<0.01	..	..	29	other acidic

**Table 14-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 15002).**

	<b>pH</b>	<b>SEC</b> $\mu\text{S cm}^{-1}$	<b>DO</b> $\text{mg l}^{-1}$	<b>Eh</b> mV	<b>Turbidity</b> NTU	<b>Alkalinity</b> as $\text{HCO}_3$
Surface waters (n=1)	6.63	190135	1.94	-129	125	0
Pit waters (n=1)	5.12	202976	0.63	-95		0

**Table 14-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 15002).**

Parameter	units	ANZECC Guidelines	Site 2 (PW)	Site 3 (SW)
Na	mg l <sup>-1</sup>		48400	72500
K	mg l <sup>-1</sup>		206	498
Ca	mg l <sup>-1</sup>		6830	8770
Mg	mg l <sup>-1</sup>		6900	10400
Si	mg l <sup>-1</sup>		<5	<5
Br	mg l <sup>-1</sup>		350.0	510.0
Cl	mg l <sup>-1</sup>		120000	180000
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	<0.022	<0.022
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>18.70</b>	<b>4.83</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<0.002	<0.002
SO <sub>4</sub>	mg l <sup>-1</sup>		1500	1600
Ag	µg l <sup>-1</sup>	0.05	<b>1.8</b>	<0.2
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<100	<200
As <sup>B</sup>	µg l <sup>-1</sup>	13	<20	<b>40</b>
Cd	µg l <sup>-1</sup>	0.2	<b>1.50</b>	<0.8
Co	µg l <sup>-1</sup>	2.8	<b>613</b>	<b>26.7</b>
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	<4	<6
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	<b>100</b>	<20
Fe	µg l <sup>-1</sup>	300	<10000	<10000
Mn	µg l <sup>-1</sup>	1700	<b>574000</b>	<b>621000</b>
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	<b>345</b>	<b>72.0</b>
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	<b>995</b>	<2
Se	µg l <sup>-1</sup>	11	<b>27</b>	<b>20</b>
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>630</b>	<b>200</b>
DOC	mg l <sup>-1</sup>		53.1	231

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.



## 15. KATARAPKO FLOODPLAIN (WETLAND ID. 15004)

### 15.1. Location and setting description

Katarapko Floodplain (Wetland ID. 15004) is situated on the western side of the River Murray, opposite Lock 4 and approximately 6 kilometres directly southwest of the town of Berri, located in the Ngak Indu area. The wetland is oval in shape. It is about 500 metres in length and about 150 metres at its widest, with a total surface area of 5 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and to the east the river.

The wetland is not connected to the river. At the time when the soil survey was conducted on 17<sup>th</sup> April 2010 the wetland had surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). Typha and Phragmites were growing along parts of the wetland margins and in some areas grasses, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 15-1.

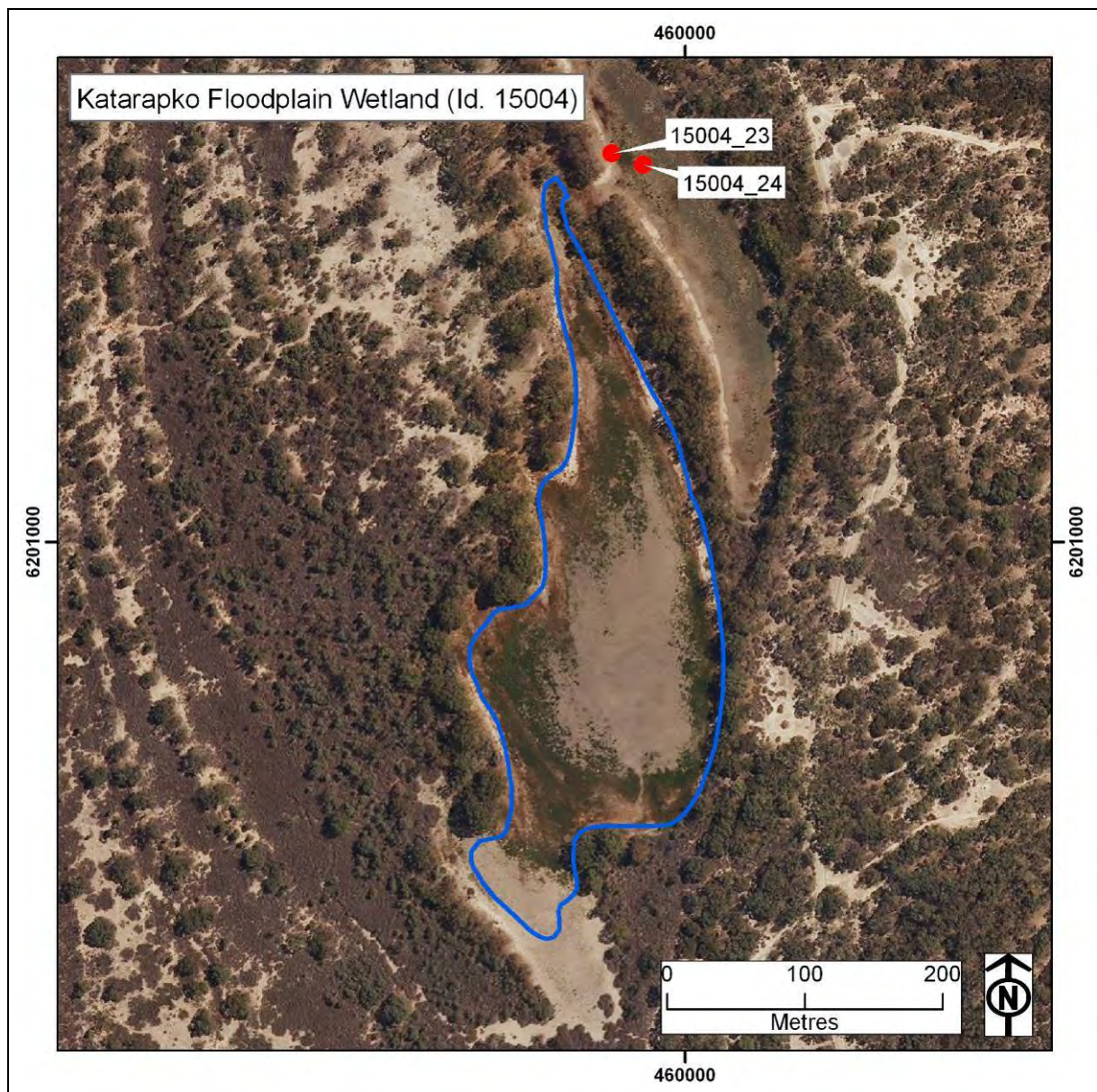


Figure 15-1. Katarapko Floodplain (Wetland ID. 15004) and sample site locations.

## 15.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 15-1. Sites were distributed as a pair (side and open water) at the northern end (Sites 23 and 24) of the wetland. The site and soil profile descriptions are presented in Table 15-2 and Table 15-3.

Northern transect

Site 23 (Figure 15-2) occurred on the margin above the water, and the soil consisted of a brown, firm, loamy sand, over a grey, very weak, sand. Site 24 (Figure 15-3) occurred in open water (20 cm deep), and the soil consisted of a very dark grey, firm, clay.

**Table 15-1. Soil identification, subtype and general location description for Katarapko Floodplain (Wetland ID. 15004).**

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
15004_23	459947	6201282	Other Soil (sandy)	mid elevation, 5m from water
15004_24	459970	6201274	Subaqueous Soil (clayey)	low to mid elevation in open water



**Figure 15-2. Photographs of Site 23, showing the site location on the wetland margin, and the soil profile.**



**Figure 15-3. Photographs of Site 24, showing a view along the wetland and the site location in open water of the wetland.**

### 15.3. Laboratory data assessment

#### 15.3.1. Soil pH testing ( $pH_W$ , $pH_{OX}$ , $pH_{INC}$ )

The pH data are provided in Table 15-4 and pH profiles are presented in Figure 15-4. The  $pH_W$  data ranged from 5.61 to 7.88 and sulfuric materials with a  $pH_W < 4$  were not identified. The  $pH_{OX}$  data ranged from 2.63 to 7.68 and identified that no samples were below the critical value of  $pH_{OX} < 2.5$ . The  $pH_{INC}$  data ranged from 5.51 to 7.69 and identified that no samples on incubation declined below the critical values of  $pH < 4$ .

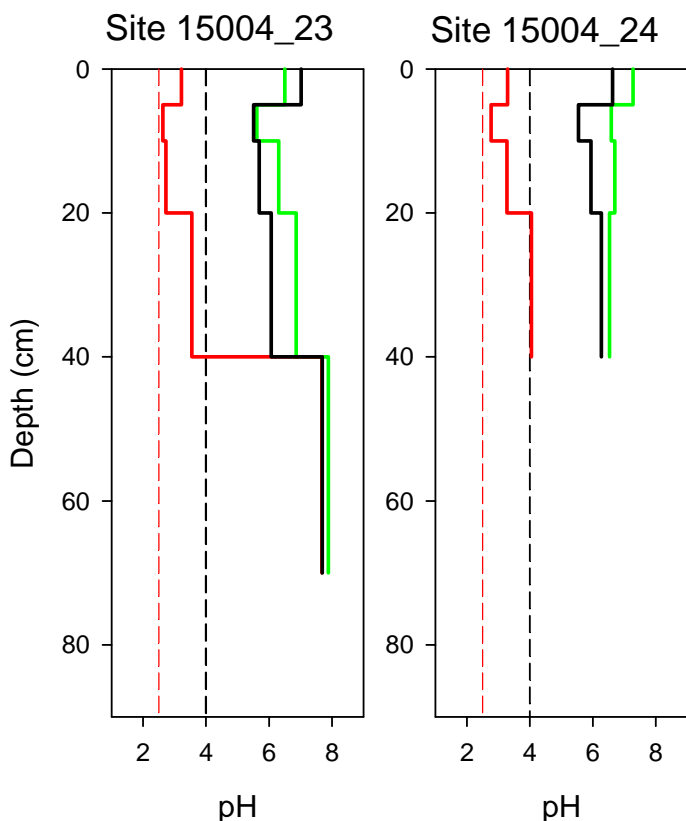


Figure 15-4. Depth profiles of soil pH for Katarapko Floodplain (Wetland ID. 15004), showing soil pH ( $pH_W$  as green line), peroxide treated pH ( $pH_{OX}$  as red line) and incubation pH ( $pH_{INC}$  after 8 weeks as black line). Critical  $pH_W$  and  $pH_{INC}$  value of 4 (black dashed line) and critical  $pH_{OX}$  value of 2.5 (red dashed line).

#### 15.3.2. Acid base accounting

The acid base accounting data is provided in Table 15-4 and summarised in Figure 15-5.

##### Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.03 % $S_{CR}$  and sulfidic materials were detected in all profiles.

##### Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 21.10 mole  $H^+$ /tonne and were detected in both profiles.

### Retained acidity

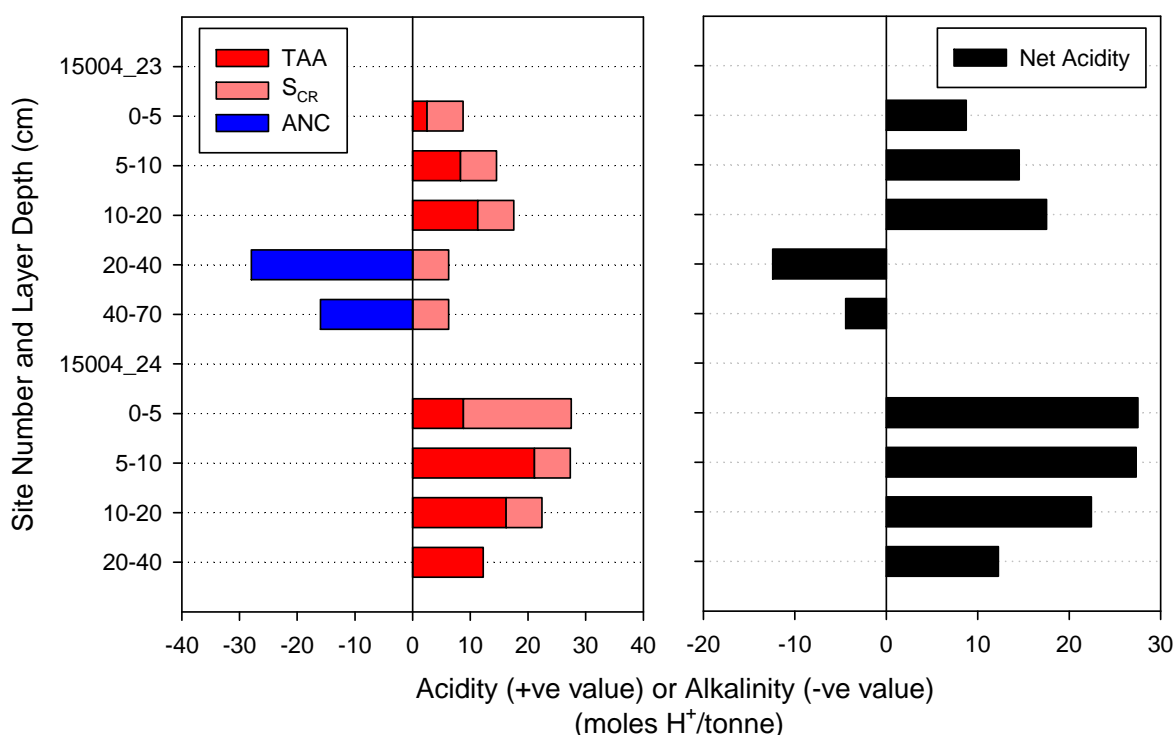
Retained acidity was not measured in any of the layers as all samples had a pH<sub>KCl</sub> of greater than 4.5.

### Acid neutralising capacity

Acid neutralising capacity values were 0, except for the lower subsoil layers of Profile 23 that were 0.08 and 0.14 %CaCO<sub>3</sub>.

### Net acidity

Net acidity values ranged from -12 to 28 mole H<sup>+</sup>/tonne. All profiles had low or moderate net acidity values and Profile 23 had negative values for the lower subsoil layers.



**Figure 15-5. Acid base accounting depth profiles for Katarapko Floodplain (Wetland ID. 15004). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S<sub>CR</sub> - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.**

### 15.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 15-4 identified no surface layers that were above the criterion trigger value of 100 mg/kg SO<sub>4</sub>.

### 15.3.4. Acid volatile sulfur

Monosulfidic materials were not observed and samples were not collected for analysis.

### 15.3.5. Hydrochemistry

One surface water sample was collected from this wetland. Field parameters are shown in Table 15-5. The surface water had circumneutral pH and was moderately fresh. Dissolved oxygen was high and turbidity relatively low. Alkalinity was relatively high.

The surface waters was of Na-Cl type, with elevated  $\text{HCO}_3$  and low  $\text{SO}_4$  relative to seawater composition (Table 15-6, Figure 15-6). Sulfate concentration was very low at  $1.2 \text{ mg l}^{-1}$ . The  $\text{SO}_4/\text{Cl}$  ratio in the surface waters was also very low (0.005) compared to seawater (0.142). For the nutrients,  $\text{NH}_4$  and  $\text{PO}_4$  were very slightly elevated above ANZECC Guideline values. The metals were present at low concentrations, with slightly elevated Zn.

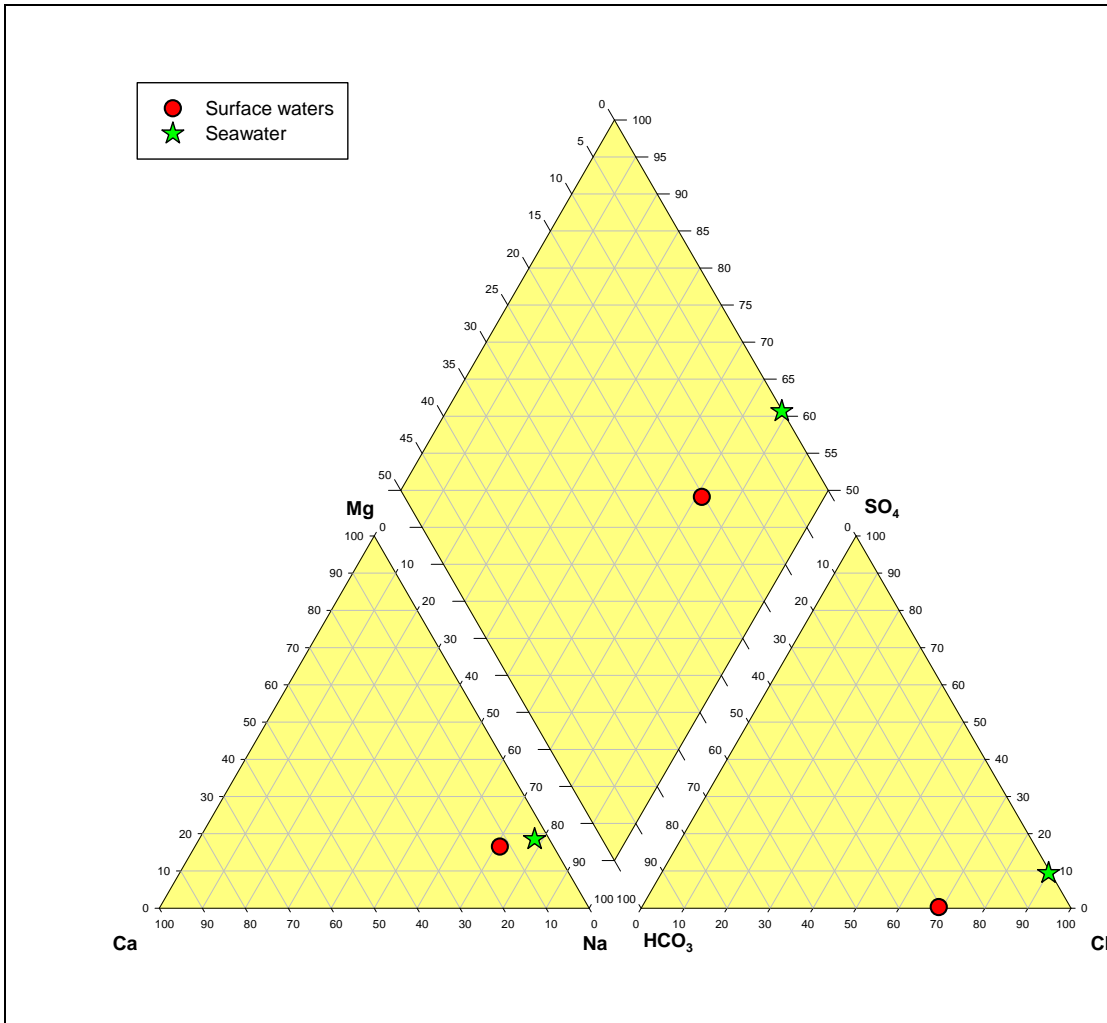


Figure 15-6. Piper diagram of hydrochemical data for Katarapko Floodplain (Wetland ID. 15004).

## 15.4. Discussion

Acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 15004) were identified as hyposulfidic for nearly all samples, a subsoil samples from Profile 23 was characterised as other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey) that occurred throughout the main wetland area and Other Soil (sandy) occurred on the margins above water.

The soils throughout the main wetland area were dominantly clayey textured in the surface layers, and in isolated areas near the margin they were sandy. The subsoils were clayey or loamy.

Monosulfidic material was not observed and water soluble sulfate data identified that surface layers were not in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Katarapko Floodplain (Wetland ID. 15004) are:

- Acidification hazard: The data identified low or moderate net acidity values in all profiles and pH data did not indicate a potential acidification hazard due to oxidation. There is a low to medium level of concern.
- De-oxygenation hazard: The water soluble sulfate data indicated that there is no potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was not observed. There is a low level of concern.
- Metal mobilisation: The low to medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

### Summary of key findings Katarapko Floodplain (Wetland ID. 15004):

<b>Soil materials:</b>	The soil layers throughout the wetland were hyposulfidic. Soils were clayey textured and on the margins sandy textured. All profiles had low or moderate net acidity values for most layers, and pH data for samples did not indicate a potential for acidification due to oxidation.
<b>Acid sulfate soil identification:</b>	<ul style="list-style-type: none"> <li>• Subaqueous Soil (clayey) – occurring throughout the wetland. Dominant (&gt;50%) in extent.</li> <li>• Other Soil (sandy) – occurring on the wetland margins. Isolated (&lt;10%) in extent.</li> </ul>
<b>Hazard assessment</b>	<ul style="list-style-type: none"> <li>• Acidification hazard – low to medium level of concern</li> <li>• De-oxygenation hazard – low level of concern</li> <li>• Metal mobilisation hazard – low level of concern</li> </ul>

**Table 15-2. Site description data for Katarapko Floodplain (Wetland ID. 15004).**

Site Number	Sample Date	Easting m Zone 54H	Northing m Zone 54H	Water depth (+ve) Water table (-ve)	Surface condition	Earth cover (vegetation)	Location Notes
23	17/04/2010	459947	6201282	not reached	sealed	old reed stumps	mid elevation, 5m from water
24	17/04/2010	459970	6201274	20	water	water	low to mid elevation in open water

**Table 15-3. Soil profile description data for Katarapko Floodplain (Wetland ID. 15004).**

Site and Sample (number)	Depth Range (cm)	Observation Method (kind)	Soil Colour (name, Munsell notation)	Texture (Class)	Soil Water Status	Redoximorphic Features (%, colour, location)	Structure Type (category)	Consistence (category)	Comments
23_1	0 - 5	small pit	brown (10YR4/3)	loamy sand	wet		massive	firm	
23_2	5 - 10	small pit	very dark greyish brown (10YR3/2)	loamy sand	wet		massive	firm	
23_3	10 - 20	small pit	very dark greyish brown (10YR3/2)	sand	wet		single grain	weak	
23_4	20 - 40	small pit	grey (10YR5/1)	sand	wet		single grain	very weak	
23_5	40 - 70	small pit	grey (10YR5/1)	sand	moist		single grain	very weak	
24_W1	20 - 0	surface water							water sampled
24_1	0 - 5	small pit	very dark grey (5Y3/1)	clay loam	wet		massive	firm	
24_2	5 - 10	small pit	very dark grey (5Y3/1)	sandy clay loam	wet		massive	firm	
24_3	10 - 20	small pit	very dark grey (5Y3/1)	clay	wet		massive	firm	
24_4	20 - 40	small pit	very dark grey (5Y3/1)	clay	moist		massive	very firm	too clayey to auger below

**Table 15-4. Laboratory data for acid sulfate soil assessment of Katarapko Floodplain (Wetland ID. 15004).**

(red printed values indicates data results of concern)

Site and Layer ID.	Depth Range (cm)	Soil Texture	EC (µS/cm)	pH water	pH peroxide	pH incubation week 0	pH incubation week 8	Sulfate (mg SO <sub>4</sub> /kg)	pH KCl	Titrateable Actual Acidity (mole H <sup>+</sup> /tonne)	Chromium Reducible Sulfur (%S <sub>CR</sub> )	Retained Acidity (mole H <sup>+</sup> /tonne)	Acid Neutralising Capacity (%CaCO <sub>3</sub> )	Net Acidity (mole H <sup>+</sup> /tonne)	Acid Sulfate Soil Material Classification
23.1	0-5	Medium	400	6.50	3.22	6.56	7.02	43	6.28	2.50	0.01	..		9	hyposulfidic (S <sub>CR</sub> <0.10%)
23.2	5-10	Medium	129	5.61	2.63	5.34	5.51	9	5.49	8.30	0.01	..		15	hyposulfidic (S <sub>CR</sub> <0.10%)
23.3	10-20	Fine	106	6.31	2.73	5.83	5.69	11	5.37	11.30	0.01	..		18	hyposulfidic (S <sub>CR</sub> <0.10%)
23.4	20-40	Coarse	110	6.86	3.55	6.86	6.07	9	6.75	0.00	0.01	..	0.14	-12	hyposulfidic (S <sub>CR</sub> <0.10%)
23.5	40-70	Medium	507	7.88	7.68	7.06	7.69	32	7.34	0.00	0.01	..	0.08	-4	hyposulfidic (S <sub>CR</sub> <0.10%)
24.W1	20-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
24.1	0-5	Fine	230	7.27	3.29	7.03	6.62	34	6.10	8.80	0.03	..		28	hyposulfidic (S <sub>CR</sub> <0.10%)
24.2	5-10	Fine	134	6.58	2.77	6.54	5.54	21	5.13	21.10	0.01	..		27	hyposulfidic (S <sub>CR</sub> <0.10%)
24.3	10-20	Fine	150	6.70	3.27	6.55	5.94	19	5.75	16.19	0.01	..		22	hyposulfidic (S <sub>CR</sub> <0.10%)
24.4	20-40	Fine	261	6.53	4.05	6.00	6.27	28	5.87	12.27	<0.01	..		12	other soil material

**Table 15-5. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 15004).**

	pH	SEC µS cm <sup>-1</sup>	DO mg l <sup>-1</sup>	Eh mV	Turbidity NTU	Alkalinity as HCO <sub>3</sub>
Surface waters (n=1)	7.27	975	11.8	-89	38	167



**Table 15-6. Summary of hydrochemical field measurements for Katarapko Floodplain (Wetland ID. 15004).**

Parameter	units	ANZECC Guidelines	Site 2 (PW)
Na	mg l <sup>-1</sup>		149
K	mg l <sup>-1</sup>		9
Ca	mg l <sup>-1</sup>		23.7
Mg	mg l <sup>-1</sup>		19
Si	mg l <sup>-1</sup>		6.38
Br	mg l <sup>-1</sup>		0.8
Cl	mg l <sup>-1</sup>		220
NO <sub>3</sub>	mg l <sup>-1</sup>	0.7	0.053
NH <sub>4</sub> -N <sup>K</sup>	mg l <sup>-1</sup>	0.01	<b>0.08</b>
PO <sub>4</sub> -P <sup>E</sup>	mg l <sup>-1</sup>	0.005	<b>0.025</b>
SO <sub>4</sub>	mg l <sup>-1</sup>		1.2
Ag	µg l <sup>-1</sup>	0.05	<0.01
Al <sup>A</sup>	µg l <sup>-1</sup>	55	<5
As <sup>B</sup>	µg l <sup>-1</sup>	13	2.2
Cd	µg l <sup>-1</sup>	0.2	<0.01
Co	µg l <sup>-1</sup>	2.8	1
Cr <sup>C</sup>	µg l <sup>-1</sup>	1	<0.1
Cu <sup>H</sup>	µg l <sup>-1</sup>	1.4	0.44
Fe	µg l <sup>-1</sup>	300	116
Mn	µg l <sup>-1</sup>	1700	130
Ni <sup>H</sup>	µg l <sup>-1</sup>	11	2.6
Pb <sup>H</sup>	µg l <sup>-1</sup>	3.4	0.043
Se	µg l <sup>-1</sup>	11	<0.1
Zn <sup>H</sup>	µg l <sup>-1</sup>	8	<b>36</b>
DOC	mg l <sup>-1</sup>		44.2

**Notes.**

The ANZECC guideline values for toxicants refer to the trigger values applicable to 'slightly-moderately disturbed' freshwater systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). For the nutrients NH<sub>4</sub> and PO<sub>4</sub>, trigger values are provided for Freshwater Lakes and reservoirs. Surface water values outside the ranges defined in the ANZECC guidelines are indicated with red text. (SW) and (PW) indicate whether the sample was taken from surface water or pit-water (groundwater that entered an excavated pit), respectively.

<sup>A</sup> Trigger value for Aluminium in freshwater where pH > 6.5.

<sup>B</sup> Trigger value assumes As in solution as Arsenic (AsV).

<sup>C</sup> Trigger value for Chromium is applicable to Chromium (CrVI) only.

<sup>E</sup> Guideline is for filterable reactive phosphorous (FRP).

<sup>H</sup> Hardness affected (refer to Guidelines).

<sup>K</sup> Guideline for South-east Australia-Freshwater Lakes and reservoirs.

